

WASHINGTON SUBURBAN SANITARY COMMISSION



WESTERN BRANCH POTABLE WATER SYSTEM UPGRADES

BOA CONTRACT NO. CD6915B20



DECEMBER 2025

I HEREBY CERTIFY THAT THESE DOCUMENTS
WERE PREPARED BY ME, AND THAT I AM A
DULY LICENSED PROFESSIONAL ENGINEER
IN THE STATE OF MARYLAND
LICENSE NO. 20566
EXPIRATION DATE: 09/06/2026



12/19/2025

WASHINGTON SUBURBAN SANITARY COMMISSION
WESTERN BRANCH POTABLE WATER SYSTEM UPGRADES
CONTRACT #CD6915B20

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SECTION 01110
SUMMARY OF WORK

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section includes
 - 1. Summary of work including work by the Commission, sequence of construction, Contractor use of Premises and special conditions for substantial completion

1.2 GENERAL REQUIREMENTS

- A. Construction of the new Well House, Water line and connections to the Treatment Plant Buildings, shall be accomplished without disruption of service to the Treatment Plant Buildings.
- B. Connections to existing pipes and/or structures shall be scheduled and coordinated in advance with the Commission. It may be necessary to make connections during night hours or on weekends. No claim for extra compensation or extension of contract time will be allowed on account of the necessity for connections to be made during "off" hours. Permission of the Commission shall be obtained by the Contractor prior to making any changes or connections to the existing system.
- C. The Commission shall supply the process control equipment and perform the programming. The Contractor shall coordinate with the Engineer during the integration process.
 - 1. For the integration, the Contractor shall provide a systems integrator to collaborate with the Commission during system integration. The integrator's qualifications shall be submitted to the Engineer for approval.
- D. When the Contractor desires certain valves functions to be interfaced, the Contractor shall inform the Commission, in writing, a minimum of sixty (60) days prior to the date the Contractor desires those interfaces to be made.

1.3 COMMISSION WORK SCHEDULE

- A. The Commission observes a 5-day work week, Monday through Friday, 8 hours a day.
- B. Holidays:
 - 1. New Year's Day.
 - 2. Martin Luther King's Birthday.
 - 3. Presidents' Day.
 - 4. Memorial Day.
 - 5. Independence Day.

6. Labor Day.
7. Columbus Day.
8. Veterans Day.
9. Thanksgiving Day and the following Friday.
10. Christmas Day.
11. State and National Election Days.
12. Inauguration Day.

C. Permission to Work.

1. Notify the Commission in writing, at least 8 hours before start of site activity.
2. Except as noted below, do no work requiring services of the Commission's inspection and supervisory forces for more than 8 hours a day nor on Commission holidays or weekends, unless authorized by the Commission in writing.
 - a. Clean up and other items for which no specific payment is involved may be performed on Saturdays and Holidays with Engineer's permission.
 - b. Request written permission of the Commission to work on Saturdays, Sundays, Holidays or longer than 8 hours per day in order to comply with construction schedule, or because of emergency.
 - 1) Costs incurred by the Commission for overtime hours may be back-charged to the Contractor at the WSSC current published rate.
 - 2) Minimum of 3 hours overtime per day will be charged for work on Saturday, Sunday and holidays.
3. Do not work in roadways during peak vehicular traffic hours following jurisdictional restrictions and requirements contained elsewhere in Contract Documents.
4. If the Contractor receives written authorization from the Engineer to work outside the scope of normal working hours as described above, costs incurred by the Commission arising from such lengthening of hours including the furnishing of Inspectors, Resident Engineer, or Project Manager or others deemed necessary by the Engineer shall be the Contractor's responsibility and the cost thereof will be deducted from monies owed the Contractor. The following hourly rates will apply. Contractor will pay other items at actual cost.

a. Civil Inspector	\$199.50
b. Electrical Inspector	\$212.82
c. Mechanical Inspector	\$212.82
d. Project Manager	\$200.00
e. Resident Engineer	\$165.00

1.4 REFERENCE DOCUMENTS

A. Applicable Codes, Specifications and Standards.

1. References to codes, specifications, and standards in Contract Documents are to the latest edition, amendment, and/or revision of reference standard in effect on date of Bid Opening.

- B. Documents on Site.
 - 1. Maintain on site, copies of appropriate documents, including codes, specifications, permits, and reference standards named in Contract Documents.
- C. Electronic Documentation.
 - 1. Use e-builder for submitting, storing and reviewing electronic documentation.

1.5 COMMISSION RESPONSIBILITIES

- A. Land Acquisition, Rights-of-Way, and Permits:
 - 1. The Commission has:
 - a. Secured land and right-of-way necessary for carrying out and completing Contract Work. Easements have been obtained by the Commission as shown in the Drawings.
 - b. Obtained permits for construction listed on Drawings, except for the Erosion and Sediment Control Permit for Utility Construction, which is issued directly to the Contractor as stated elsewhere in the Contract Documents.
 - 1) A copy of each permit will be provided by the Commission and shall be available at the construction site.
 - 2. The Commission will establish an e-builder account to be used and assign Contractor's representatives.

1.6 ABBREVIATIONS AND SYMBOLS

- A. Abbreviations used for technical society, institution, association, or governmental authority references in Specifications:

Abbreviations and Symbols	
AA	Aluminum Association
AAMA	Architectural Aluminum Manufacturer's Association
AAN	American Association of Nurserymen
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ACPA	American Concrete Pipe Association
ADA	Americans with Disabilities Act
AGA	American Gas Association
AGMA	American Gear Manufacturer's Association
AI	Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ALS	American Lumber Standards
ANSI	American National Standards Institute
APA	American Plywood Association
AREMA	American Railway Engineering and Maintenance-of-Way Association

ASA	American Standards Association, Inc.
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
AWPA	American Wood Preservers Association
AWPI	American Wood Preservers Institute
AWS	American Welding Society
AWWA	American Water Works Association
BOCA	Buildings Officials Code Administration International, Inc.
CRSI	Concrete Reinforcing Steel Institute
DEP	Department of Environmental Protection (Montgomery County)
DNR	Department of Natural Resources
DIPRA	Ductile Iron Pipe Research Association
EPA	Environmental Protection Agency (Federal)
FS	Federal Specifications or Federal Standards
ICEA	Insulated Cable Engineers Association
IEEE	Institute for Electrical & Electronic Engineers
IES	Illuminating Engineering Society of North America
ISA	Instrument Society of America
MBMA	Metal Building Manufacturers Association Standards
MCDPWT	Montgomery County Department of Public Works and Transportation
MDE	Maryland Department of the Environment
MDOT	Maryland Department of Transportation
MIL	Military Specifications
MNCP&PC	Maryland National Capital Park and Planning Commission
MOSH	Maryland Occupational Safety and Health
MPS	Maryland Park Service
MSCS	Maryland Soil Conservation Service
MSHA	Maryland Department of Transportation State Highway Administration
NACE	NACE International (Formerly, National Association of Corrosion Engineers)
NAPCA	National Association of Pipe Coating Applicators
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association
NESC	National Electric Safety Code
NETA	National Electric Testing Association, Inc.
NFC	National Fire Code
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology
NPS	National Park Service
NSF	NSF International (Formerly, National Sanitation Foundation)
OSHA	Occupational Safety and Health Administration

PCA	Portland Cement Association
SCS	Soil Conservation Service
SDR	Standard Dimensional Ratio
SSPC	Steel Structure Painting Council
UBC	Uniform Building Code, International Conference of Building Officials
ULI	Underwriter's Laboratories Incorporated
USSG	United State Standard Gauge
USSWG	United States Steel Wire Gauge
WSSC	Washington Suburban Sanitary Commission

1.7 CONTRACTOR RESPONSIBILITIES

A. Use of Premises and Offsite Work.

1. Lands by Contractor.
 - a. Permits and approvals shall specify treatment of said areas during and at completion of construction.
 - b. Furnish copies of permits and approvals to the Commission before using areas.
 - c. Obtain staging area(s) and mobilize equipment and materials to and from staging area(s) at no additional cost to the Commission.
 - d. See Sections 01500 and 01570 for securing additional grading and sediment control permits.
2. Private Property.
 - a. Do not enter upon private property for any purpose without obtaining written permission from property owner.
 - b. File letters of permission from property owners with Engineer before entering private property.
3. Public Utility Easement (PUE): Not entered upon unless a concurrent WSSC water and sewer easement and Work are shown on Drawings.

B. Existing Structures: Not loaded with weights that will endanger structure, nor endanger any part of Work due to stresses or pressures.

C. Public Convenience.

1. Conduct work to ensure least possible obstruction to traffic and inconvenience to the Commission, general public, and residents in vicinity of Work, and to ensure the protection of persons and property.
2. Keep fire hydrants on or adjacent to Work, accessible to fire fighting equipment.
3. Make temporary provisions to ensure use of sidewalks and proper functioning of gutters, stormwater systems, drainage ditches, and culverts, and keep them free of obstructions.
4. See Traffic Control Plan and drawings.

D. Explosives:

1. Explosives are not anticipated and shall not be used for this project..

- E. Dimensions at points of connection: Verified by actual field measurements. Before beginning work;
 - 1. Perform test pits at each point of connection.
 - 2. Refer discrepancies between Contract Documents and existing conditions to Engineer.
- F. Pre-Construction Photography.
 - 1. Submit prior to beginning any Work that may cause site disturbance.
 - a. Digital date-stamped color photography provided in CD disc format or uploaded to E-Builder.
 - 1) Photographs: Taken by competent photographer.
 - a) Take at sufficient intervals to fully document the pre-construction conditions of the work site, not more than 100 feet apart along the street and/or right of way.
 - b) Include identification markers such as houses, businesses, signs, property numbers, mail boxes, or landscaping, in each view to properly confirm location of the view for ease of identification.
 - c) Devote particular attention of pre-existing damage to streets, curbs, sidewalks, driveways, signs, mailboxes, retaining walls, landscaping, etc.
 - 2) Submit Photo log along with CD disc that provides;
 - a) Name and number of the contract.
 - b) Name of Contractor.
 - c) Name of photographer.
 - d) Include for each photograph;
 - File name
 - Date taken
 - Location of the view
- G. Pre-Construction Video.
 - 1. Document by video, and submit in digital format on DVD or upload to e-builder;
 - a. All pre-existing site conditions adjacent to and within the limits of construction.
 - b. Clear and continuous view of the project alignment.
 - 2. Submit prior to beginning Work that may cause site disturbance.
- H. Public Notification.
 - 1. Deliver written notices to each home or business 48 hours prior to commencement of work being conducted, including a local telephone number for inquiries or complaints.
 - 2. Provide owner or occupant with summary of work to be completed, and time and duration of service interruption to building.
 - 3. Contact any home or business that cannot be reconnected within time stated in written notice.
 - 4. Submit via e-builder copies of all delivered notices.

I. Sequence of Construction

1. See Contract Drawings for sequence of construction.
2. When permanent paving patches are within the scope of the project:
 - a. Include placement of new paving (permanent patch) in the overall construction schedule.
 - b. Unless otherwise noted in the Contract Documents, no more than 1 mile of paved area may be disturbed or repaired with temporary patch at any one time.
 - c. For long trenches, daily placement of asphalt patches shall not be included as part of the permanent patch
 - d. Protect new paving from damage due to construction activities.
 - e. Provide signage that states no construction equipment will be allowed on the new paving.
 - f. The Contractor shall repair paving damaged by construction activities within 72 hours and at no expense to the Commission.
 - 1) Document at the end of each workday, the condition of the new paving.

J. Water Line Shutdown Coordination

1. The Contractor shall notify Commission sixty (60) days prior to need for shutdown of existing water mains. The Commission will shutdown the water mains and provide dewatering. The Contractor will be responsible for dewatering any water remaining the low points of the pipe sections.
2. The Contractor shall notify the Commission when work requiring the shutdown is complete in order for the Commission to place the water line back in service.

1.8 CONSTRUCTION STAKEOUT BY CONTRACTOR

- A. The Commission will or has established baselines, benchmarks or other necessary control points for the Contractor's use.
 1. Perform stakeout from Commission-furnished control points (traverse, property lines and corners, and benchmarks) and employ qualified and experienced personnel to provide stakeout.
 2. Furnish certification of competency and qualifications of employees to Engineer before commencing with Work.
- B. Preserve and maintain in proper position survey points, benchmarks, and baselines provided by the Commission.
 1. Retain Professional Surveyor licensed to practice in State of Maryland to reset points disturbed by Contractor's employees, equipment or neglect to give them proper protection, or Engineer may arrange for resetting points with Commission Survey Party and deduct costs from monies due Contractor.
- C. Notify Engineer of any construction stakeout deviations from Drawings.
 1. Discrepancies will be resolved under Engineer's direction before proceeding with Work.
- D. For pipeline construction:
 1. Stakeout test pits and furnish the Commission with actual utility locations and elevations, or as otherwise directed by the Commission.

2. Stakeout centerlines and offset lines with spacing of stations maximum of 50 feet (stakes, nails, crosses).
 3. Stakeout intermediate points (P.C., P.T., structures, fittings, end of lines, and topographic changes) and as deemed necessary by the Commission.
 4. Submit grade sheets showing for each station the marked point elevation, invert elevation required and corresponding cut for both centerline and appropriate offset.
 - a. Each set of notes shall check within plus or minus 0.04 feet.
 - b. Use Contractor's Construction Stake Out Record form. See Detail M/10.0.
 5. Flag stakes for protection to aid in their preservation and maintenance.
 6. Perform other engineering and stakeout necessary for setting of batter boards, forms, string lines, and finished grade control, slope stakes and other controls which may be required for proper construction of Work.
- E. Construction shall not begin until the Commission has received and signed grade sheets and has received 2 copies of notes.
1. Work done without lines and grades or without written approval of the Commission will not be estimated or paid for and may be ordered removed and replaced at no cost to the Commission.

1.9 PROJECT PROGRESS MEETINGS

- A. Project progress meetings will be held periodically to allow Engineer to review Project status.
1. Contractor's superintendent shall attend meeting and accompany Engineer on inspection of Project site.

1.10 INTERPRETATION OF QUANTITIES

- A. Quantities appearing in Bid Schedule are approximate only.
1. Payment to Contractor will be made only for actual quantities of work performed or materials furnished following Contract.
 2. Where actual quantity of pay item varies more than 25 percent above or below estimated quantity stated in Contract, an equitable adjustment will be considered upon request of either party.
 3. Adjustment: Based upon any increase or decrease in unit costs due solely to variation above 125 percent or below 75 percent of estimated quantity.
 - a. This adjustment shall only be applied to the quantity above 125 percent or below 75 percent of estimated quantity.
 - b. If quantity variation causes an increase in time necessary for completion, Engineer will, upon receipt of written request for extension of time, ascertain facts and make adjustment for extending completion date, as in his judgement the findings justify.
- B. The 25 percent above or below estimated quantities does not apply to fixed unit price contingent items.

1.11 LUMP SUM ITEMS

- A. All work required by the Contract Documents except for contingent items will be paid for by Lump Sum item as provided in the Bid Schedule.

1.12 CONTINGENT ITEMS

- A. Refer to Section 01270 for a list of contingent items. All contingent items are measured and paid per Section 01270.
- B. Fixed quantity and unit price contingent items listed in Bid Schedule do not necessarily occur on Drawings.
- C. During course of Work, Engineer may direct incorporation of any or all of these items.
- D. Payment to Contractor in this case will be for quantities directed by Engineer and computed following Contract Documents based on unit prices listed in Bid Schedule.

1.13 INCIDENTAL ITEMS

- A. When no item is provided in Bid Schedule, no measurement and payment will be made, but the cost thereof considered incidental.

1.14 ARCHAEOLOGICAL ARTIFACTS AND HUMAN REMAINS

- A. Articles of historical or scientific value, including coins, fossils, and articles of antiquity, which may be uncovered or otherwise brought to attention of Contractor during course of Contract shall remain property of Owner of property on which articles reside.
 - 1. Report findings immediately to Engineer who will determine method of removal, where necessary.

1.15 ASBESTOS-BEARING ROCK

- A. Use of asbestos-bearing rock as an unbound surfacing material on roads, sidewalks, parking lots, road shoulders, trails, and other areas subject to traffic, vehicular or pedestrian, is prohibited.
- B. Health and Safety of Workers, Commission Employees, and the Environment: Following applicable Federal, State, and local laws and regulations including, but not limited to 29 C.F.R. 1910.1001, 29 C.F.R. 1926.1101, 40 C.F.R. 61 subpart m, 40 C.F.R. 302, 49.
- C. C.F.R. 171, 49 C.F.R. 172, and COMAR 26.11.21 Et Seq.

- D. Secure services to ensure compliance with all applicable Federal, State and local laws and regulations.
 - 1. Environmental Consultants and Contractors, Inc.
 - 2. Apex Environmental, Inc.
 - 3. Or equal.
- E. Practice effective dust control at all times.
 - 1. Use water suppression techniques to control dust as it is generated during construction.
 - 2. Keep excavated rock wet during operations that may generate dust, including, but not limited to blasting, excavations, loading, and hauling of rock.

PART 2 PRODUCTS

(NOT USED)

PART 3 EXECUTION

(NOT USED)

END OF SECTION

SECTION 01150
SITE CONDITIONS

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section includes general requirements relating to site conditions and responsibility for existing utilities, structures, and facilities.

1.2 EXISTING UTILITIES

- A. General.
1. Existing utility structures and appurtenances are shown following best available information.
 2. The Commission will not be responsible for completeness or accuracy thereof nor for any deductions, interpretations, or conclusions drawn there from.
 3. Notify Miss Utility 48 hours in advance of work in vicinity of existing utility structures and appurtenances and verify by test pit or other means actual locations of existing utility structures and appurtenances before construction in their vicinity.
 4. Support and protect utility structures and appurtenances following Drawings and Owner's requirements and take other steps necessary to protect structures from disturbance or damage.
 5. Support and protect utility structures and appurtenances known, but not shown on Drawings, which occupy same space as facility to be constructed at no additional cost to the Commission.
 6. Notify Utility Owner and Engineer immediately when previously unknown or different underground utility structures or appurtenances are encountered and take necessary precautions to support and protect utility.
 7. Relocations or temporary protection arranged by or for convenience of Contractor will be at no additional cost to the Commission.
 8. Removal or relocation of existing utility structures and appurtenances that physically occupy same space as facility, structure, or pipeline to be constructed are at no cost to Contractor.
 - a. Cost will be paid for as set forth in General Conditions, Article 14.
 9. Fulfill requests from public utility corporations, jurisdictional agencies, or other owners to adjust public utility structures and appurtenances within or adjacent to limits of construction.
 - a. Furnish copies of requests and replies thereto to Engineer, and coordinate activities with utility.
 - b. Additional cost or time extension incurred resulting from lack of coordination with utilities will be at no additional cost to the Commission.

10. Any costs incurred as result of damage to incorrectly marked existing utility structure or appurtenances are to be resolved with Owner of damaged utility and not the responsibility of the Commission.
 11. Repair damage to utility structures or appurtenances shown on Drawings or otherwise known.
 - a. Restore damaged utility structures and appurtenances as near as practicable to their original condition to the Engineer's or utilities' approval, at no additional cost to the Commission.
- B. Relocations by Others: Coordinated with construction schedules of others performing relocations of existing utilities to avoid delay in Work.
- C. Access to Utilities: Permit free and clear access to existing utility structures and appurtenances, including Commission sites, by personnel of Utility Owners or Operators, for inspection, maintenance, providing additional service, and construction of new utilities.
1. Maintain and protect utility structures and appurtenances at all times.

1.3 OTHER EXISTING IMPROVEMENTS, STRUCTURES, AND FACILITIES

- A. Locate, protect and maintain, or remove and restore, existing improvements, structures, and facilities within and adjacent to Construction area whether shown on drawings, unless Engineer directs otherwise.
- B. Trees and Shrubberies: Protect from damage.
1. If damaged, replace or repair damage, under Engineer's direction, at no cost to the Commission.
- C. Property Survey Pipes, Stones, and Monuments: Protect and if required, replace using Professional Surveyor licensed to practice in State of Maryland, at no cost to the Commission.
- D. Fences, Curbs, Gutters, Walkways, Driveways, Driveway Aprons and Flagstone: Remove and replace in original position or at Engineer's direction.
1. Replace, in kind, those damaged, at no cost to the Commission.

PART 2 PRODUCTS

(NOT USED)

PART 3 EXECUTION

(NOT USED)

END OF SECTION

SECTION 01270
MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.1 BASIS FOR MEASUREMENT AND PAYMENT

- A. Measurement and Payment will be made for only those items included in the Bid Schedule or Contract Change Order(s) for the Project.
- B. All measurement for payment will be for completed work performed according to Contract Drawings, Specifications, and the Form of Bid. The Commission shall measure all work according to the methods outlined below.
- C. Payment for any item is full compensation for furnishing all labor, materials, equipment, installation, tools, testing, fittings, accessories, and incidental items required to provide a complete and operable item of the work.
- D. Mobilization and demobilization shall be included in the lump sum items cost.
- E. Where units differ between the items listed in Part 2 Products below and the Form of Bid, the Form of Bid governs.
- F. Removal: All items in the Form of Bid requiring removal shall include the removal from the site as well as the proper disposal in accordance with applicable regulations.
- G. Incidental Items: All costs for work implied or detailed in the Contract Documents for which there are no specific bid items are to be included in other appropriate items.
- H. Non-Payment Items: All cost for work implied or detailed in the plans, supplemental/special conditions, approved shop drawings and Contract Documents for which there are no specific bid items are to be considered incidental to the work and shall be included in the Form of Bid to which the work pertains. No separate payment will be made to the contractor.
- I. Contingent Items: Authorization from the Commission is required prior to installation of contingent items below.

1.2 PAYMENT FOR MATERIAL STORED OFF SITE

- A. For purposes of administering this provision, the following definitions are provided.
 - 1. Material stored NEAR the Work Site: A storage location shall be considered near the work site if it is not more than fifty (50) miles (approximately one hour drive) from the work.
 - 2. Material stored DISTANT from the Work Site: Locations beyond the limit of fifty (50) miles shall be considered distant.

- B. All proposed off site locations, regardless of whether they are near or distant, shall be approved by the Commission prior to any payment. The approval process will include an inspection of the proposed storage site, which may or may not coincide with any inspection of materials stored.
- C. Prior to payment for any material stored off site, said material shall be inspected to verify that it is properly stored, i.e., segregated, inventoried, identified as the property of the Commission. This material shall be clearly identified and physically segregated from any other material or stock, in such a manner that it is clear from casual observation that said material is not a part of any other stock or stored material.
- D. For materials stored distant to the Work site, the Contractor shall reimburse the Commission for all reasonable costs incurred by the Commission, to include but not limited to salary, transportation, lodging and per diem, for the Commission's or the Engineer's employees to travel to and from the storage locations for the purpose of verifying the material is properly stored. It is anticipated that such trips would occur whenever additional material is claimed for payment and/or at least every six (6) months until the material is delivered to the work site.
- E. Except for unusual circumstances, the Contractor will not be required to reimburse the Commission's costs for visits to storage locations near the work site.
- F. The Contractor shall hold the Commission harmless from any and all losses, additional costs, direct or indirect damages and/or delays, whatsoever, which may occur as a result of a failure of the Contractor to deliver (or have delivered), in a timely manner, materials (for which payment has been made) to the work site for installation and incorporation into the Work.
- G. The Contractor shall provide to the Commission, a Release of Lien or other suitable certification by the Seller, in addition to paid invoices, verifying that the Contractor has valid title to all materials for which payment is requested. The Seller, however, shall not be required to waive his rights for recovery, if his contract is breached.
- H. The Contractor shall furnish proof of insurance (in addition to any other insurance that may be required by or as a result of the Contract) that covers the stored material from loss by theft, fire, vandalism and extended coverage perils, at the location stored, in an amount equal to one hundred percent (100%) of the replacement value of the material stored.

1.3 ELECTRONIC PAYMENT PROCESS

- A. Contractor's payments may be accomplished electronically. It is strongly recommended that the contractor take advantage of electronic direct deposit of the payment even if the payment application is submitted in hard copies.

PART 2 MATERIALS

2.1 UNIT PRICE ITEMS

- A. Work required by the Contract Documents except for contingent items will be paid for by unit price item as provided in the Bid Schedule.

2.2 CONTINGENT ITEMS

- A. Borrow Excavation Of Suitable Soils, Installed
 - 1. Measurement: This work will be performed as per Section 02315 of the specification and special provisions and will be paid in cubic yards.
 - 2. Payment: Borrow excavation will also include grading, shaping slopes, channels, swales, and other excavations. It will be paid in cubic yard based upon the computed in place quantity using existing and proposed contours.
- B. Undercut And Dispose Of Unsuitable Soils
 - 1. This work will be performed under the conditions as described in Section 02315 of the specifications and special provisions. Due to over saturation the excavated material will be hauled in sealed trucks. Also, the hauling trucks will be cleaned before leaving the site as necessary to prevent the tracking of sediment into the County right of way.
 - 2. Payment: This item will be paid in cubic yard based upon the computed in place quantity using field measurements or existing and proposed contours.
- C. Fill/Select Material Installed
 - 1. Measurement: Compacted aggregate backfill as described in Section 02315 will be measured by the cubic yard of material placed.
 - 2. Payment: Select backfill will be paid at the contract unit price per cubic yard for aggregate backfill and shall include all materials, equipment, and labor required to furnish and compact, complete in place.
- D. Rock Excavation
 - 1. Measurement: The rock excavation and disposal will be determined and performed as per Section 02315 of the specifications without blasting.
 - 2. Payment: This item will be paid in cubic yard based upon the computed in place quantity using field measurements or existing and proposed contours.
- E. Gravel And Sand For Various Purposes
 - 1. Measurement: Gravel and sand for various purposes will be measured by the ton of material placed.
 - 2. Payment: Gravel and sand for various purposes will be paid at the contract unit price per ton for aggregate backfill and shall include all materials, equipment, and labor required to furnish and compact, complete in place.
- F. Field Adjustments of Erosion and Sediment Control Practices
 - 1. Measurement: All field adjustments of silt fence, super silt fence, and/or filter logs will be measured by linear foot, when directed by the Engineer.

2. Payment: The payment for field adjustments of silt fence, super silt fence, and/or filter logs, when directed by the Engineer will be at the fixed contingent contract unit price per linear foot. The price shall include all materials, labor, equipment, tools and incidentals to complete, maintain, and remove all field adjusted erosion and sediment control measures as specified in the Contract Documents, or as directed by the Commission.

G. Test Pit

1. Measurement: The Contractor has the responsibility to determine pipe material, pipe inside and outside diameter, thickness and location of adjacent pipe joints to existing pipes prior to starting Work for pipe connections. Test pit shall be performed prior to connecting proposed pipe to existing pipe and abandoning existing pipe fittings. The test pits shall be considered incidental to the water main work and will not be measured separately.
2. Payment: No separate payment will be made for test pits. All costs associated with the test pits, including all excavation, tamped backfill, and all material, labor, equipment, tools and incidentals necessary to complete the work, shall be incidental to the water main bid item. Any pavement to be replaced will be incidental to the asphalt pavement restoration bid item.

H. Concrete Sidewalk

1. Measurement: Concrete sidewalk per Section 02950 shall include the removal and replacement to include but not limited to excavation, grading to a satisfactory section, compaction of subgrade, entrance, forming, pouring, tinting and finishing of concrete and clean up.
2. Payment: Payment will be made at the unit price per square yard. grading to a satisfactory section, compaction of subgrade, entrance, forming, pouring, tinting and finishing of concrete and clean up. Payment to replace existing sidewalk will be made at the unit price per square yard.

I. Concrete Curb and Gutter

1. Measurement: Concrete curb and gutter per Section 02950 shall include the removal and replacement to include but not limited to excavation, grading to a satisfactory section, compaction of subgrade, entrance, forming, pouring, tinting and finishing of concrete and clean up.
2. Payment: Payment will be made at the unit price per linear feet.

J. Asphalt Concrete Pavement

1. Measurement: Asphalt concrete pavement per Section 02950 shall be measured in square yards (tons for variable depth) of the type specified as evidenced by plant delivery tickets. For all overlays, field measurements and calculations will be made also for use as a comparison between estimated and actual quantity used. Measurement for new roadways will be based on plan quantities and field measurement, not quantity tickets.

2. Payment: Asphalt concrete pavement will be paid at the contract unit price bid per square yards (tons for variable depth) for the type of Asphalt concrete specified. This price shall be full compensation for asphalt concrete pavement, complete in place, including all materials, labor, tools, equipment, tack coat, all other incidentals necessary.

K. Mill And Overlay

1. Measurement: Mill and overlay shall be measured by square yards of material milled 2 inches deep and asphalt overlay installed.
2. Payment: Mill and overlay shall be paid at the contract unit price per square yard of 2 inches deep and asphalt overlay. This price shall include all labor incidentals, materials, maintenance of traffic for removal and disposal of existing pavement as well as overlay of base course in accordance with Prince George's County specifications to complete the work as specified.

L. Contingent 100 Pound Weight Fittings

1. Description:
 - a. This item consists of furnishing and installing various sizes of ductile iron pipe fittings with restrained joints, measured by hundred-pound weight (CWT), to accommodate unforeseen field conditions encountered during water main construction.
 - b. These fittings are used where field modifications are required due to unmarked or unknown utilities that alter the horizontal or vertical alignment of the proposed water main.
 - c. This item is not applicable to fittings or appurtenances required to resolve conflicts with utilities that are already shown in the Contract Documents.
2. Measurement:
 - a. Unit of measure for Extra Fittings will be by the hundred pound (CWT) complete in place, as determined from the nominal tabulated weight of each fitting per ANSI/ AWWA C153 (the weight of the fitting before the application of any lining or coating other than standard coatings).
 - b. Weight of retainer glands, bolts, nuts and gaskets will not be measured. The weight of any fitting shall not be less than the nominal tabulated weight by more than ten percent (10%). No separate vertical or horizontal measurement will be made for Extra Fittings.

3. Payment: The unit price Bid per hundred pound weight shall be made at each and includes all materials; labor; tools; equipment; hauling; hand and mechanical excavation to planned trench subgrade; excavation for bell holes; sheeting and/or shoring; pumping; stone or gravel cradle; backfilling, rehandling of material; removal and disposal of unsuitable material; compacting; concrete thrust collars and buttresses; coatings; chlorinating; testing; maintaining service; and all incidentals necessary to complete these items of Work.

M. Allowance For Unanticipated Additional Work

1. Description:
 - a. The work covered by this Section includes the furnishing of all tools, materials, equipment and the performance of all labor to complete any unanticipated additional work clearly outside the scope of the Contract Documents or as directed by the Engineer.
 - b. The unanticipated additional work is not included elsewhere in the scope of any other unit price or lump sum item on the Proposal Form. This includes hidden or unforeseen site conditions, and approved extra work required by the Engineer after award of the contract, which was not intentionally withheld prior to contract advertisement.
 - c. This contingency allowance is for the exclusive use of the City and is to be distributed at its sole discretion.
 - d. Any work to be performed under this Section shall be approved in writing and shall be authorized at the discretion of the Engineer. The Contractor shall submit the cost proposal for additional work, not covered by the bid items in this proposal/Contract, for approval by the Engineer.
 - e. Any authorized additional work shall not include any extension of time to complete the contract, except as separately approved in writing by the Engineer.
2. Measurement: After receiving the request for unanticipated additional work from the Engineer, which will outline the scope of work to be done, the Contractor shall submit a price proposal to the Engineer. This price proposal shall include estimated quantities, unit prices and lump sum prices for those items not already included in the Proposal Form. If the Contractor and the Engineer cannot successfully negotiate the cost for the unanticipated additional work, then the Engineer may direct the Contractor to perform the work on a Force Account basis in accordance with the Pipeline Construction General Conditions, latest revision.

3. Payment: Payment for “Unanticipated Additional Work,” complete in place, shall be made from Item No. B-13 for which the WSSC has established an estimated budget/ upset limit of \$350,000.

PART 3 EXECUTION

(NOT USED)

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SECTION 01320
CONSTRUCTION SCHEDULE - CRITICAL PATH METHOD (CPM)

PART 1 GENERAL

1.1 SCOPE

- A. Contractor shall prepare and maintain a preliminary schedule herein referred to as the "Preliminary Construction Schedule" and a detailed progress schedule, herein referred to as the "Complete Detailed Construction Schedule" as described below. These schedules shall be the Contractor's working schedules and used to plan, organize, and execute the Work. Contractor shall record and report actual performance and progress on a monthly basis, and show how the Contractor plans to complete all remaining Work as of the end of each progress report period.
- B. The Preliminary Construction Schedule shall be maintained until the Complete Detailed Construction Schedule is accepted by the Engineer. Each schedule submittal, including updates, shall include three (3) hard copies and be posted on e-Builder.
- C. The Complete Detailed Construction Schedule shall be in the form of a network analysis system produced using Oracle's Primavera P6 Professional R16.2, and shall show activities required for complete performance of items of Work. Each submittal, including updates, shall include three (3) hard copies of the schedule. In addition, the XER file shall be posted on e-Builder.

1.2 QUALIFICATIONS

Contractor shall submit for approval prior to submission of the Preliminary Construction Schedule, the resume of the scheduler they intend to use for developing and updating the schedule. If Contractor intends to engage a firm that specializes in the development and maintenance of project schedules, Contractor must submit the firm's qualifications & experience statement for approval prior to submission of the Preliminary Construction Schedule. The Scheduler or firm shall have a minimum of five (5) years' experience scheduling, updating, and monitoring CPM construction schedules.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.1 SCHEDULE SUBMITTAL REQUIREMENTS

A. Preliminary Construction Schedule

Within fifteen (15) days after the Contract start date set forth in the Notice to Proceed (NTP), submit to the Engineer for review:

1. A Preliminary Construction Schedule in time scale format indicating planned Contractor operations during the first 120 days. Cost of activities and/or Project Deliverables expected to be completed or partially completed before submission and acceptance (by the Engineer) of the Complete Detailed Construction Schedule shall be included.
2. A preliminary Work Breakdown Structure (WBS). A hierarchy that represents the Work required to finish the project. The lowest level of the WBS shall have activities and deliverables.

B. Complete Detailed Construction Schedule

1. General

- a. Within sixty (60) days after the Contract start date set forth in the Notice to Proceed, submit the Complete Detailed Construction Schedule (CDCS) for the Engineer's review and mutual acceptance. The CDCS shall consist of a complete detailed Critical Path Method (CPM) schedule showing usage of the entire Contract Time provided in the Contract. The mutually accepted schedule, unless subsequently changed with the concurrence of or at the direction of the Engineer, shall be the Contractor's working schedule and shall be used to plan, organize and execute the Work; record and report the actual performance and progress; and forecast remaining Work for the duration of the Contract. Additionally, the mutually accepted schedule shall be the basis for determining progress payments to the Contractor.
- b. The Schedule shall consist of diagrams, accompanying mathematical analyses including tabular reports and narratives as specified herein.
- c. Contractor shall schedule the Work such that any specified intermediate milestone dates and completion dates are met as specified in the Contract Documents.

2. Construction Sequencing and Constraints

- a. The Contractor's schedule shall clearly identify proposed construction durations for each activity. Activities shall be developed in sufficient detail to identify impacts to existing pipelines and/or facilities. The schedule shall include a detailed list of all expected shutdowns with shutdown duration specifically shown.
 - 1) All work requiring shutdown shall be coordinated with the Commission prior to beginning any work.
 - 2) Materials and equipment to be used during shut down shall be on site and readily available prior to starting work in the shutdown limits.

- b. The Contractor shall coordinate with Prince George's County (DPIE) to determine when lane closures along Aragona Boulevard are permitted.
- 3. Critical Path Method Detailed Network Diagram
 - a. A Schedule Network Diagram using the Precedence Network Diagram (PDM) method shall be provided. This diagram shall be provided in electronic pdf format that will be legible when printed out on 22" x 34" paper.
 - b. In the Schedule Network Diagram, Contractor shall provide sufficient detail and clarity of form and technique so that the Work can be properly controlled and so that the Engineer can readily monitor and follow progress of the Work. The diagram shall comply with the various limits imposed by the Contract Documents including but not limited to contractually specified intermediate milestone dates and completion dates showing use of the entire Contract Time. The degree of detail shall be generally determined by the following outline:
 - 1) The Work Breakdown Structure of the project.
 - 2) The types of work to be performed and the labor trades involved including but not limited to the following examples: fitting, welding, piping installation, electrical, painting, testing, etc.
 - 3) Submittal preparation, submittal review, procurement, fabrication, delivery, installation and test activities for major materials and equipment.
 - c. Activity durations shall not be in excess of 20 working days except in the case of non-construction activities such as procurement of materials or delivery of equipment. Durations shall be the result of definitive manpower and resource planning under contractually defined onsite work conditions and shall be shown in units of whole working days. Contractor shall allow durations as set forth in this Section for WSSC review and approval of Contractor submittals. No imposed dates, other than those dates contained in the Contract Documents will be allowed.
 - d. Contractor shall plot the network diagram to show a continuous flow from left to right. The critical path(s) shall be clearly and prominently identified. Activity descriptions will be clear and will allow for definitive geographical start and completion boundaries in order to facilitate progress reporting.
 - e. Contractor shall provide supplementary written information sufficient to describe the construction methods to be used and the Activity Resource Requirements including resource restraints and other factors considered in the preparation of the network diagram in order to facilitate the Engineer's understanding.
 - f. Only Finish to Start relationships will be allowed unless a narrative description is attached to explain the logical necessity of any other relationship used in the schedule. This must receive the approval of the Engineer. No Start to Finish relationships will be allowed.
 - g. No Lags or Leads will be allowed unless a narrative description is attached to explain the logical necessity of any Lag or Lead used in the schedule. This must receive the approval of the Engineer.

4. Computerized CPM System

- a. The network activities of the detailed schedule diagram shall be processed by the computerized CPM scheduling system to show, as a minimum, the following data:
 - 1) Activity number.
 - 2) Activity description.
 - 3) Schedule duration for each activity in work days.
 - 4) Early start, early finish, late start, late finish, actual start and actual finish (by date).
 - 5) Total float (positive and negative).
 - 6) Original duration, activity percent complete, and remaining duration.
 - 7) Activity cost value.
 - 8) Manpower (by trade) and equipment resources planned for each activity.
 - a) Manpower shall be listed on a single person basis. Crews will not be accepted.
 - b) Equipment shall be listed by individual piece of equipment.
 - 9) Responsibility Code for each activity.
- b. As a minimum, the following computer-produced report sorts of the activity data (as previously noted) shall be supplied with clear identification of same on the first page of each report:
 - 1) Activity Report: Activity number sort by ascending number.
 - 2) Predecessor/Successor Report (Logic Report): A listing of Preceding and Succeeding activities for every activity in ascending order by Activity Number. For completed activities, the Actual Start Date shall be used as the secondary sort.
 - 3) Total Float Report: A list of all activities sorted in ascending order of Total Float. Activities which have the same amount of total float shall be listed in ascending order of Early Start Dates.
 - 4) Critical Path Report: A list of all activities on the longest path through the project. Activities shall be listed in ascending order of Early Start Dates.
 - 5) Resource usage curve and report showing trades or equipment required for each day of the project duration, with each resource identified by activity number.
 - 6) Listing of holidays and other non-work days.
 - 7) Listing of all imposed dates (constraints).

5. Cost Loaded CPM Requirements

- a. Contractor shall indicate a cost value for each work activity with the sum of those individual activity costs being equal to the total cost of the contract amount.
 - 1) Cost loaded activities such as "startup" or "mobilization" will not be allowed unless Contractor submits supporting documentation of actual costs for these activities. All other overhead and other Contractor costs shall be allocated to the work activities in relationship to the work activities apportioned value.

- 2) Unless otherwise specified, markup and overhead costs will be allowed on installation and work activities only, not on submittal, fabrication and delivery activities.
- 3) Unless otherwise specified, payment for Contractor submittals will not be allowed. Payments will be made to Contractor only as set forth in General Conditions Article 22.
- 4) Payment for Insurance and Bond costs will be allowed as set forth in General Conditions Article 22.
 - a) In addition to indicating the activity costs on the required computer printout reports, Contractor shall provide a cash flow curve by early and late dates.
 - b) On a monthly basis, the activity cost values will be progressed in accordance with the activity progress, except in the case of fabrication and delivery of material and equipment items. In such cases the activity duration will progress in proportion to its fab/delivery status, and its cost will remain 0% complete until the item is actually delivered and installed as set forth in the General Conditions.
 - c) The activity cost values and the monthly progress update shall be the basis of payment to the Contractor. The monthly activities percentages shall be approved by the Engineer prior to the Contractor processing the CPM update reports. The schedule update accepted by the Engineer and all reports specified herein must be included with the Contractor's Monthly Progress Application for Payment.
6. Additional requirements:
 - a. The Schedule Baseline file must contain activity codes categorizing all project activities. For example these activity codes could be and are not limited to:
 - 1) Phases/Locations
 - 2) Responsibility (Community, Contractor, Engineer, etc.)
 - 3) Type of work (Administrative, Civil, Electrical, etc.)
 Noting that values under each code are flexible and based on the scheduler's plan
 - b. For Baseline schedule, Activities within each category shall be sorted by logic order and float file
 - c. For the Update schedule(s), activity table must show actual dates and progress percentage.
7. Review of system:
 - a. Contractor shall participate in Engineer's review and evaluation of proposed network diagrams and analysis. Resubmit revisions necessary as a result of this review to Engineer within ten (10) days after conference. Allow 30 days for Engineer's checking and further action.

- b. Progress payments will be withheld pending attainment of mutually acceptable schedule. Engineer's review and acceptance of Contractor's schedule is for conformance to requirements of the Contract Documents. Review and acceptance by Engineer of Contractor's schedule does not relieve Contractor of any of its Contract Document responsibilities for accuracy or feasibility of schedule, or of Contractor's ability to meet interim project milestone dates and Contract completion date, nor does such review and mutual acceptance expressly or impliedly warrant, acknowledge or admit the reasonableness of the logic, durations, manpower, or equipment loading of Contractor's schedule.
8. Monthly Schedule Updates
- In conjunction with each monthly payment estimate, the Contractor shall submit a Monthly Schedule Update. Three (3) sets of hard copies of all Monthly Schedule Update reports shall be submitted. In addition, the XER file shall be posted on e-Builder. Each Monthly Schedule Update shall include:
- a. Activity Report: Activity number sort by ascending number.
 - b. Total Float Report: A list of all activities sorted in ascending order of Total Float. Activities which have the same amount of total float shall be listed in ascending order of Early Start Dates
 - c. Narrative Report: The Narrative Report shall state the percentage of work physically completed and include a description of the physical progress during the report period, plans for the forthcoming report period, current & anticipated problem areas, delaying factors and their impact, and an explanation of corrective actions taken or proposed. The report shall specifically address the status of uncompleted activities which have less than 30 days float and which are either in progress or scheduled to be started within the next reporting period. At the request of the Engineer, Contractor shall participate in pre-update conferences to verify progress & review modifications to the detailed network schedule prior to the formal monthly submittal.
 - d. Visualizer Reports as follows:
 - 1) General Relationship Differences
 - a) Relationship Lag
 - b) Predecessor Activity ID
 - 2) Relationships Added/Deleted
 - a) Predecessor Relationships Added
 - b) Predecessor Relationships Deleted
 - c) Successor Relationships Added
 - d) Successor Relationships Deleted
 - e) General Resource Assignment Data – Actual Cost
 - f) WBS Added/Deleted
 - g) WBS Added
 - h) WBS Deleted
- Visualizer Reports shall be attached to the Narrative.
- As a minimum, the following data output shall be included on each update report:
- a. Activity number.
 - b. Activity description.
 - c. Schedule duration for each activity in work days.

- d. Early start, early finish, late start, late finish, actual start and actual finish (by date).
 - e. Total float (positive and negative).
 - f. Original duration, activity percent complete, and remaining duration.
 - g. Activity cost value.
9. Contractor shall submit, at no additional cost, a revised Detailed Network Diagram and supporting analysis data when one or more of the following conditions occur:
- a. When a change or delay significantly affects (by 20 work days or more) any specified intermediate milestone dates or completion dates or the sequence of activities.
 - b. When the Contractor proposes to change any sequence of activities or where the complete revised network diagram including notes on new or modified relations will replace the complete original diagram, such proposed changes shall be submitted for review and acceptance by the Engineer prior to incorporation into the project schedule.
 - c. When the status of the Work is such that the Detailed Network Diagram and supporting analysis are no longer representative for planning and evaluation of the Work and that a new baseline schedule has to be generated.
 - d. When the Work progress on the project is behind schedule based on the mutually accepted baseline schedule the Engineer may require that the Contractor develop a Recovery Schedule to identify how the Contractor intends to make up the lost time on the project.
 - e. When a submittal is marked as “REVISE AND RESUBMIT” or “REJECTED”. A sample original schedule is shown in Figure 1 for one submission and one review. The Contractor shall revise the CPM schedule to include additional activities for the re-submittal and re-review, as shown in Figure 2. The predecessor for the re-submittal shall be the rejection of the previous submittal, and the successor for the re-review shall be the re-submittal. This process shall be repeated for each re-submittal and re-review. Thirty (30) calendar days shall be allowed for each re-review by the Engineer.
 - f. When Re-Work is required due to the original Work not complying with the requirements of the Contract Documents. The Contractor shall revise the CPM schedule to include additional activities for the Re-Work. The predecessor for the first Re-Work shall be the original Work. This process shall be repeated for any subsequent Re-Work.

10. Weather Delays

- a. The Contract Time as defined in General Conditions, Article 1, already includes an allowable number of lost workdays due to weather as shown in Table 1. This table has been developed using historical weather data for the WSSC service area. If the Contractor submits a weather delay claim longer than the seasonal limits as shown in Table 1, the Contractor shall submit records showing the dates and times on which workdays were lost due to weather delays. Allowable lost workdays that are not used in a season will not carry over into the next season.

- 1) For each workday that was lost due to weather, the Contractor shall submit documentation to the WSSC Project Manager, within the time limits as set forth in General Conditions, Article 15. This documentation must include the arrival and departure times of Contractor and subcontractor personnel and crew on each lost workday. The WSSC Project Manager must approve each lost workday.
- 2) The Contractor shall demonstrate that the weather posed a risk to health or safety, or made outside work impractical or dangerous. Include photographs to document weather and site conditions.
- 3) The Contractor shall demonstrate that the work activities that could not be performed due to the weather delay were on the critical path of the CPM Schedule.
- 4) The Contractor shall report weather data at the work site for each workday that was lost, including air temperatures and times at the start and end of the workday, and amount of precipitation. The Contractor shall provide data from the nearest National Weather Service or NOAA reporting station.

The National Weather Service data is available from:
https://w2.weather.gov/climate/local_data.php?wfo=lwx

NOAA data is available from:
<https://www.ncdc.noaa.gov/cdo-web/datasets>

- b. Contractor shall provide a written Time Impact Analysis (TIA), within the time limits as set forth in General Conditions, Article 15, illustrating the influence of each delay on any specified intermediate milestone dates or completion dates.
- c. Each TIA shall include a revised schedule fragnet and shall demonstrate how the Contractor proposes to incorporate the delay into the detailed progress schedule. Submission of justification shall be based on revised activity logic and durations in addition to such other supporting evidence that the Engineer deems necessary. Contractor shall submit three hard copies of the schedule of each TIA. In addition, the XER file of each TIA shall be posted on e-Builder.
- d. The Engineer will, after receipt of such justification and supporting evidence, review the facts and advise the Contractor in writing as to agreement or disagreement with the Contractor's analysis. Upon agreement by both parties, the influence of delays will be incorporated via a schedule fragment network analysis (fragnet) into the detailed progress schedule at the next monthly update after both cost and time have been negotiated and a change order is executed.

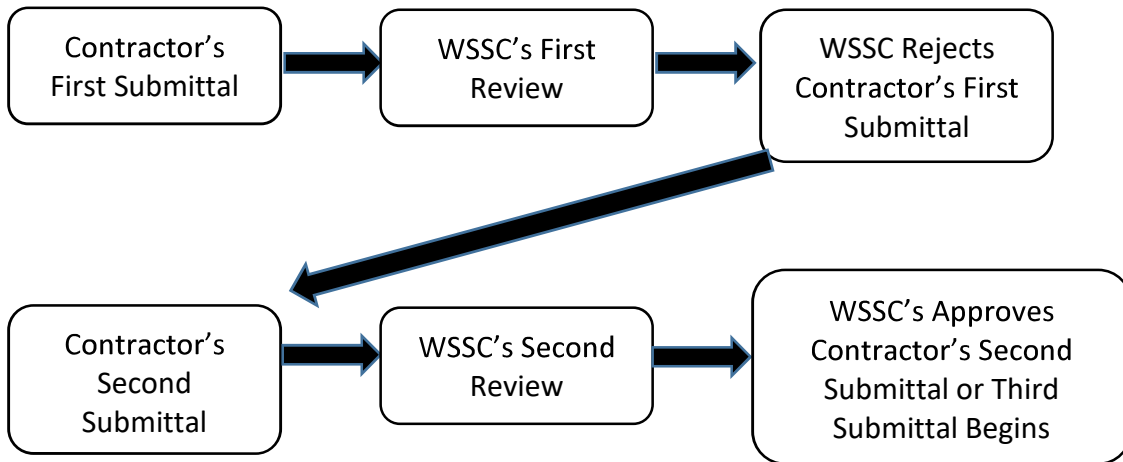
Table 1: Allowable Number of Lost Workdays Due to Weather

Time Period	Season	Allowable number of lost workdays
December 1 to March 31	Winter	6
April 1 to June 30	Spring	3
July 1 to August 31	Summer	1
September 1 to November 30	Fall	1

Figure 1: Example of Submittal and Review



Figure 2: Example of Re-submittal and Re-Review



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SECTION 01330
SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section includes general requirements and procedures related to preparation and transmittal of Submittals to include Schedules, Contractor's Drawings, Samples, Manuals, Methods of Construction, and Record Drawings to Engineer demonstrating performance of Work.
 - 1. Other requirements for submittals are specified under applicable sections of the Specifications.

1.2 SUBMITTAL REQUIREMENTS

- A. General.
 - 1. Submit each under separate cover or transmittal.
 - 2. Furnish neat, legible, and sufficiently explicit detail to enable proper review for Contract compliance.
 - 3. Show complete and detailed fabrication; assembly and installation details; wiring and control diagrams; catalog data; pamphlets; descriptive literature; and performance and test data.
 - 4. Include calculations or other information sufficient to show comprehensive description of structure, machine, or system provided and its intended manner of use.
 - a. With each submission, furnish Engineer specific written notation and justification of each variation in Contractor's Submittals from requirements of Contract Documents.
 - b. Fabrication, purchase or delivery of materials to the site, and installation of materials or Work performed before approval, or not conforming to approved submittals, shall be at Contractor's risk.
 - 5. Engineer's review and approval of submittals shall not relieve Contractor from responsibility for fulfillment of terms of Contract, unless Engineer has received specific written notice of each variation and has given specific written approval.
 - 6. Contractor assumes all risks of error and omission.
- B. Process and Requirements.
 - 1. Not later than ten (10) days after Notice to Proceed, submit written list of materials and equipment to be purchased, giving name, address, and telephone number of Supplier, Manufacturer, or processor.
 - a. Submit updated material and equipment list when changes are made.
 - 2. Coordinate and schedule submittals with construction schedule and Engineer.

3. With the first submittal, but not later than thirty (30) days after Notice to Proceed, submit a complete submittal schedule, listing as near as practicable and by Specification Section number, submittals required, and approximate date submittal will be forwarded.
 - a. Arrange submittals schedule so that related equipment items are submitted concurrently.
 - b. Engineer may require changes to submittal schedule to permit concurrent review of related equipment.
4. To each submittal affix the following signed Certification Statement.
 - a. "Certification Statement: By this submittal, we hereby represent that we have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and pertinent data and we have checked and coordinated each item with other applicable approved drawings and all Contract requirements."
 - b. Electronic submission via e-Builder shall include the above certification statement. Processing the submittal through e-Builder shall be equivalent to signing the certification statement.
5. Identification.
 - a. Submit the following identification data, as applicable:
 - 1) The Commission Contract Number.
 - 2) Contract name and location.
 - 3) Submittal Numbers:
 - a) Number by specification section followed by sequential number. Number format example is 11300-01.
 - b) Resubmittals shall bear original submittal number and be sequentially lettered (Example 11300-01A).
 - 4) Product identification.
 - 5) Drawing title, drawing number, revision number, and date of drawing and revision.
 - 6) Applicable Contract Drawing Numbers and Specification Section and Paragraph Numbers.
 - 7) Subcontractor's, Vendor's and/or Manufacturer's name, address and phone number.
 - 8) Contractor's Certification Statement.
 - b. Identify on exterior, catalog product data or brochures submitted in packages of multiple items. Include page and catalog item numbers for items submitted.
 - 1) Highlight catalog, product data, or brochures containing various products, sizes, and materials to show particular item submitted.
 - 2) Mark items not applicable to Contract "not applicable" or cross out.
6. Number of Copies: See requirements in Submittals specified herein.
7. Approval Process.
 - a. Follow submittal schedule provided to Engineer. Engineer will return submittal within thirty (30) days.
 - b. Submittals will be returned, marked with one of following classifications:
 - 1) APPROVED: Requires no corrections, no marks.

- 2) APPROVED AS NOTED: Requires minor corrections. Items may be fabricated as marked without further resubmission. Resubmit 2 corrected copies to the Engineer for record.
 - 3) REVISE AND RESUBMIT: Requires corrections. No items may be fabricated. Resubmit entire submittal following original submission with corrections noted. Allow thirty (30) days for checking and Engineer's appropriate action.
 - 4) REJECTED: Requires major corrections or is otherwise not following Contract Documents. No items shall be fabricated. Resubmit entire submittal following original submission with corrections noted. Allow thirty (30) days for checking and Engineer's appropriate action.
 - 5) INFORMATION ONLY: Items specified by Contract Documents.
- c. The Contractor shall be allowed up to three (3) submissions (initial plus two resubmittals) of the same submittals for review. The Contractor shall reimburse the Commission for reviews beyond three submissions at the rate of \$500.00/submittal.
- C. Electronic Submittals: PDF Format, as approved by Engineer. All electronic submittals shall be made via the Commission's electronic document management system, currently e-Builder. The Engineer will return submittals and comments via e-Builder.

1.3 SUBMITTALS

- A. Schedules: See Section 01320
- B. Mobilization Plan
1. Before site mobilization submit plans for mobilization, safety, security, traffic, and housekeeping programs in writing to Engineer.
 2. Do not mobilize until receipt of approval.
 3. Designate a representative of the Contractor's staff who responsible for implementation and enforcement of these programs.
 4. Duties of said designee include responsibility for enforcing the environmental protection provisions of these specifications, the requirements of the OSHA and other applicable Federal, State and local standards.
 5. Any changes in programs must be submitted and approved in writing in advance.
 6. Submit 6 paper copies and 2 electronic copies. Engineer will return 2 copies.
- C. Shop Drawings.
1. For original submittal and each subsequent re-submittal required, submit electronic versions via e-Builder. Submit three (3) hard copies of shop drawings with pages larger than 11"x17" or that exceed 50 pages in length unless otherwise approved by the Engineer.

2. Show types, sizes, accessories, and layouts, including plans, elevations, and sectional views; component, assembly, and installation details; and all other information required to illustrate how applicable portions of Contract requirements will be fabricated and/or installed.
3. In case of fixed mechanical and electrical equipment, submit layout drawings drawn to scale, to show required clearances for operation, maintenance, and replacement of parts. Include manufacturer's certified performance curves, catalog cuts, pamphlets, descriptive literature, installation, and application recommendations, as required. Submit together shop drawings for closely related items such as a pump and its motor. Additional shop drawings and information required for electrical and mechanical equipment are listed in appropriate Specification Sections.
4. Shop drawings for continually furnished items such as pipe, fittings, valves, precast structures and metal work will be waived provided Contractor submits letter naming manufacturer who will furnish these items. Manufacturer shall have on file certified drawing(s) containing above information approved by the Commission, and items furnished shall be as described on certified drawing(s). If Standard Details or Specifications change after certified drawings are approved, new submittals are required.

D. Catalog Data.

1. For original submittal and each subsequent re-submittal required, submit electronic versions of catalog data via E-Builder. Submit 3 hard copies of catalog data that contain drawings larger than 11"x17" or that exceed 50 pages in length unless otherwise approved by the Engineer.
2. Manufacturer's Catalog, Product, and Equipment Data: Certify and include material type, performance characteristics, voltage, phase, capacity, and similar data.
 - a. Furnish wiring diagrams when applicable.
 - b. Indicate catalog, model, and serial numbers representing specified equipment.
 - c. Submit complete component information to verify specified required items.

E. Working Drawings.

1. For original submittal and each subsequent re-submittal required, submit electronic versions of all working drawings via E-Builder. Submit three (3) hard copies of working drawings that contain drawings larger than 11"x17" or that exceed 50 pages in length unless otherwise approved by the Engineer.
2. Submit working drawings as required for changes, substitutions, Contractor design items, and Contractor designed methods of construction. Requirements for working drawings are listed in appropriate Specification Sections or in Special Provisions.

3. Include with drawings calculations or other information to completely explain structure, machine, or system described and its intended use. Review or approval of drawings by Engineer shall not relieve Contractor from responsibility for fulfillment of terms of Contract. Contractor assumes risks of error, and Engineer shall have no responsibility.
 4. Submit working drawings and calculations sealed, dated, and signed by Professional Engineer registered in State of Maryland and experienced in the work or discipline involved.
- F. Method of Construction.
1. For original submittal and each subsequent re-submittal required, submit electronic versions of data detailing method of construction via e-builder.
 2. When Engineer specifies or directs, submit proposed method of construction for specific portions of Work.
 - a. Include detailed written description of phases of construction operation to fully explain to Engineer proposed method of construction.
 - b. If required by Specifications, submit working drawings to supplement description.
 3. Engineer review will follow the process herein and shall not relieve Contractor from responsibility for fulfillment of terms of Contract. Contractor assumes risks associated with proposed method.
 4. After method of construction has been reviewed, submit any requests for modifications in detail, including justification for them. Do not implement modifications prior to Engineer's review.
- G. Manufacturer's Installation Recommendations.
1. For original submittal and each subsequent re-submittal required, submit electronic version of manufacturer's installation recommendations via e-Builder.
 2. Furnish written detail for step-by-step preparation and installation of the materials and products, including recommended tolerances and space for maintenance and operation.
- H. Samples.
1. General: As soon as practicable after Notice to Proceed, submit samples required by Specifications or at Engineer's request. Unless otherwise specified, submit 3 samples of each item as original submittal.
 2. Obtain approval before delivery of material to Contract site.
 3. Samples: Representative of actual material proposed for use in the Contract and of sufficient size to demonstrate design, color, texture, and finish when these attributes will be exposed to view.
 - a. If samples deviate from Contract Documents, advise Engineer in writing with submittal and state reason.
 4. Identification.
 - a. Permanently attach to each sample:
 - 1) The Commission Contract Number.

- 2) Contract Name and Location.
 - 3) Product Identification.
 - 4) Applicable Contract Drawing and Specification Section Number.
 - 5) Subcontractor's, Vendor's and/or Manufacturer's Name, Address and Phone Number.
- b. For each sample, submit under separate cover, a transmittal document containing identification information listed herein.
5. Approval Process.
 - a. Allow thirty (30) days for Engineer's checking and appropriate action. Certain samples may be tested for specified requirements by the Commission before approval. Failure of sample to pass tests will be sufficient cause for refusal to consider further samples of same brand and make of that material.
 - b. Rejected samples will be returned upon request, and resubmittals required shall consist of 3 new samples and an additional 30 days for review. Only 1 test of each sample proposed for use will be made at expense of the Commission. When originally submitted sample fails, retesting of additional samples will be made by the Commission at expense of Contractor. Upon approval, 1 sample so noted will be returned, and remainder will be retained by Engineer until completion of Work.
 - c. Samples of various material or equipment delivered to site or during placement may be taken by Engineer for testing. Samples failing to meet Contract requirements will automatically void previous approvals, and resubmittal of samples will be required.
- I. Record Drawings (As-builts).
 1. Prepare and maintain record drawings for work performed. Complete as-built surveys. Do not permanently seal or bolt manhole covers until after as-built surveys.
 2. Maintain one record copy of Contract Documents at site in good order and annotated to show revisions made during construction. Upload to e-builder monthly. Make record drawings available to Engineer at all times during life of Contract.
 - a. Drawings: Made part of record drawings and to include:
 - 1) Contract Drawings: Annotate or redraft, as required, to show revisions, substitutions, variations, omissions, and discrepancies made or discovered during construction concerning location and depth of utilities, piping, duct banks, conduits, manholes, pumps, valves, vaults, and other equipment. Make revisions and show on all drawing views with actual dimensions established to permanent points.

- 2) Working/Layout Drawings: When required as submittals, record actual layouts of conduit runs between various items of electrical equipment for power, control, and instrumentation; wire sizes, numbers, and functions; configuration of conduits; piping layouts; and duct layouts. Add sections and details as required, for clarity. Revise drawings of switchgear, motors, control centers and other equipment to show actual installations.
- b. Before preliminary inspection, furnish reproducible of record drawings. At completion of Contract and before final payment is made, furnish Engineer one (1) set of reproducible of finally approved record drawings reflecting revisions herein described. Furnish Engineer record drawing data on electronic storage media, in format compatible with the Commission's software.

J. Operation and Maintenance Manuals.

1. Furnish Operation and Maintenance Manuals for various types of equipment and systems, as required by Contract Documents.
2. Unless otherwise indicated, furnish separate manual for each piece of equipment and system. If manual contains other items or equipment, indicate where specified items are located in manual. Include in manual complete information necessary to operate, maintain, and repair specific equipment and system furnished under this Contract, and include the following specific requirements.
 - a. Contents.
 - 1) Table of Contents and Index.
 - 2) Brief description of equipment/system and principal components.
 - 3) Starting and stopping procedures, both normal and emergency.
 - 4) Installation, maintenance, and overhaul instructions including detailed assembly drawings with parts list and numbers, and recommended spare parts list with recommended quantity, manufacturer's price, supplier's address, and telephone number.
 - 5) Recommended schedule for servicing, including technical data sheets that indicate weights and types of oil, grease, or other lubricants recommended for use and their application procedures.
 - 6) One copy of each component wiring diagram and system wiring diagram showing wire size and identification.
 - 7) One approved copy of each submittal with changes made during construction properly noted, including test certificates, characteristic curves, factory and field test results.
 - 8) For electrical systems, include dimensioned installation drawings, single line diagrams, control diagrams, wiring and connection diagrams, list of material for contactors, relays and controls, outline drawings showing relays, meters, controls and indication equipment mounted on equipment or inside cubicles, control and protective schematics, and recommended relay settings.
 - 9) One (1) electronic copy of the manual in PDF format submitted on CD with each final hard copy of the manual.

- b. Material:
 - 1) Covers: Oil, moisture, and wear resistant 9 inches by 11-1/2 inches size.
 - 2) Pages: 60-pound paper 8-1/2 inches by 11 inches size with minimum of 2 punched holes 8-1/2 inches apart reinforced with plastic, cloth, or metal.
 - 3) Fasteners: Metal screw post or Acco metal strap type.
 - 4) Diagrams and Illustrations: Attach foldouts, as required.
 - 5) Legible Original Quality: Reproduced by dry copy method.
- 3. Copies:
 - a. Submit preliminary electronic copy of each manual (via e-Builder) for review and approval no later than date of shipment of equipment. The electronic version shall be an indexed PDF. Installation shall not begin until manuals are accepted by Engineer. Include in preliminary copies all items required under "Contents" above. Submit three (3) hard copies of the preliminary manual for review of content and conformance to the material requirements listed herein. No hard copies will be returned to the Contractor.
 - b. Unless otherwise indicated or specified, provide 5 hard copies of final approved manuals to Engineer before Engineer's inspections and tests required in Section 01450. Post one (1) electronic copy of final approved manual on e-Builder.

K. Substitutions: See Section 01630.

L. Construction Videotape and Photographs Submittal

- 1. The Contractor shall provide digital video and photographic records of pre-construction conditions, construction progress and post-construction conditions as follows:
- 2. Before commencing the Work, the Contractor shall provide a video record of the pre-construction conditions of the site, or property that might be affected by the Contractor's operations during the Work. Two (2) copies of the video record of pre-construction conditions shall be submitted prior to the commencement of the Work. All video and photographs shall be taken by a professional photographer, or by an employee of the Contractor who can demonstrate proficiency at professional quality photography.
- 3. Starting when the Work commences and continuing for as long as the Work is in progress, not less than 12 exposures, two copies each, consisting of different subjects or angles of view each time, shall be taken from different locations in the project area at intervals not exceeding one week apart. All photographs shall be furnished to the Engineer within one week after each exposure.
- 4. The Contractor shall upload photographs to the designated folders in e-Builder. The file name shall include the date and brief description of the photo. Provide additional information on the photo or as a caption associated with the photo that includes but is not limited to the date and the job title, photograph identification, and direction the camera was facing.

5. Prior to commencing the Work, preconstruction photos shall be taken at the Project site and shall be identified by job title, date, and direction the camera was facing. Four exposures shall be taken at each 100-foot property line interval with one each upstream, downstream, and perpendicular to the property line in both directions. This shall be done to provide a 360-degree view of preconstruction conditions at each interval.
6. Upon completion of the Work, the Contractor shall provide a digital video record of the post-construction conditions showing the conditions of roadways, ditches, culverts, driveways, buildings, fences, utilities, and other facilities or property which were within 200 yards or were affected by the contractor's operations during the Work. Two copies of the video record post-construction conditions shall be furnished prior to commencing of the Work.

PART 2 PRODUCTS

(NOT USED)

PART 3 EXECUTION

(NOT USED)

END OF SECTION

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SECTION 01450 QUALITY CONTROL

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section includes general requirements relating to responsibility for quality control involving inspections, tests, certificates, and reports.

1.2 INSPECTIONS

- A. Engineer will provide 24 hours notice and may inspect materials and equipment at all stages of development or fabrication and is allowed access to Contractor's and Supplier's shops.
 - 1. Notify Engineer of shift and production schedules and changes by manufacturer.
 - 2. On-site work may be subject to continual inspection.
 - 3. Inspection by Engineer will not release Contractor from responsibility or liability for material or equipment.
- B. When local codes or laws require approval and inspection of Work by other agencies or organizations before installation or operation, give Engineer three (3) working days' notice of readiness.
 - 1. Obtain required certificates of inspection, testing or approval and submit 1 signed original and 3 copies to Engineer.
- C. Engineer will inspect, before installation, Commission and Contractor furnished materials delivered directly to work sites and mark:
 - 1. Materials without inconsistencies or discrepancies with the Commission's logo.
 - 2. Materials not accepted "Rejected".
 - 3. At plant, Engineer witnessed and inspected Contractor furnished materials within plant testing following above procedures.
- D. Engineer will not mark or remove previously marked logo on material with non-correctable damages or deficiencies and deemed not suitable for work.
 - 1. Remove or repair non-accepted and damaged materials at Engineer's direction.

1.3 TESTING

- A. Shop or Factory Test: When material or equipment testing is required of manufacturer before shipment to Contract site, give Engineer minimum of ten (10) days written notice of appropriate time for required test.
 - 1. Ensure test site is safe, accessible, dry, ventilated and well lighted.
 - 2. Do not proceed with installation of equipment until Engineer approves required test results.

- B. Field and Laboratory.
 - 1. Provide independent field and laboratory testing facilities and personnel to perform required testing, including the following periodic inspections, engineering, and associated services.
 - a. Soils.
 - 1) Inspect and test for excavation suitability, placement, and compaction.
 - 2) Inspect subgrades and foundations.
 - b. Masonry.
 - 1) Sample and test mortar, bricks, and grout.
 - 2) Inspect brick and block samples.
 - 3) Sample wall panels.
 - 4) Inspect placement of reinforcement and grouting.
 - c. Concrete: Following Section 03300 to make cylinder samples and perform test on specimen cylinders.
 - 2. Provide 24 hours notice before specified testing.
 - 3. Engage laboratory testing facilities, where specified in Contract Documents, which have performed previous satisfactory work for the Commission, or are certified by the following, and are approved by Engineer before their use.
 - a. NIST National Voluntary Laboratory Accreditation Program (telephone: 301- 975-4016).
 - b. Washington Area Council of Engineering Laboratories, Inc. (telephone: 301- 652-7925).
- C. Equipment: Coordinated and demonstrated following procedures specified in Contract Documents.
- D. Pipeline and Other Testing: Following test procedures and requirements specified in appropriate Specification Sections.

1.4 REPORTS

- A. Certified Test Reports: Where Contract Documents require transcripts or certified test reports, meet the following requirements.
 - 1. Before delivery of materials: Submit and obtain Engineers approval of required transcripts and certified test reports required in referenced specifications or specified in Contract Documents.
 - a. Testing: Performed in approved independent or manufacturer's laboratory, within one (1) year of submittal for approval.
 - b. Transcripts or test reports: Supplied with notarized letter signed by officer or authorized representative of manufacturer or supplier certifying that tested material meets specified requirements and is of specified type, quality, manufacture, and make.
 - 2. Reference to supplier's certification is limited to its fabricated materials.

- B. Certificate of Compliance.
 - 1. At Engineer's option or where specified, Contractor may submit for approval, notarized (notarization date to be within 12 months of submittal date) Certificate of Compliance from manufacturer or supplier, instead of specified tests and other tests required in reference documents.
 - a. Manufacturer or supplier has performed all required tests.
 - b. Materials to be supplied meet all test requirements.
 - c. Tests have been performed within 1 year of Certificate submittal.
 - d. Tested materials are of same type, quality, manufacture, and make as those specified in Contract Documents.
 - e. Identification of materials tested.
 - 2. Certificate signed by officer or authorized representative of manufacturer or supplier.
 - a. Reference to supplier's certification is limited to its fabricated materials.
 - b. Do not deliver materials until receipt of Certificate approval.
- C. Manufacturer's Certificates: Submitted for installation of items of equipment when required in the Contract Documents.
 - 1. It has been installed under either continuous or periodic supervision of manufacturer's authorized representative.
 - 2. It has been adjusted and initially operated in presence of manufacturer's authorized representative
 - 3. It is operating following specified requirements.
- D. Materials List Furnished by Commission:
 - 1. Submit completed Materials List for items to be used.

1.5 MANUFACTURER SERVICES

- A. Manufacturer services, when required, are specified in appropriate Specification Sections.

PART 2 PRODUCTS

(NOT USED)

PART 3 EXECUTION

(NOT USED)

END OF SECTION

SUPPLEMENT I

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION FOR CLA-VAL

OWNER _____ EQPT SERIAL NO: _____
EQPT TAG NO: _____ EQPT/SYSTEM: _____
PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

- ☐ Installed in accordance with manufacturer's recommendations.
- ☐ Inspected, checked, and adjusted.
- ☐ Serviced with proper initial lubricants.
- ☐ Electrical and mechanical connections meet quality and safety standards.
- ☐ All applicable safety equipment has been properly installed.
- ☐ Functional tests.
- ☐ System has been performance tested and meets or exceeds specified performance requirements (when complete system of one manufacturer).

Note: Attach any performance test documentation from manufacturer.

Comments: _____

I, the undersigned manufacturer's representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20____

Manufacturer: _____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

SECTION 01500
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section includes general requirements relating to responsibilities for temporary construction facilities, controls, and environmental protection, except temporary erosion and sediment control included in Section 01570.

1.2 CONSTRUCTION FACILITIES

- A. General: Temporary facilities and protective devices include, but are not limited to, temporary barricades, fences, bridges, guards, temporary utilities, steel plates over trenches, maintenance of traffic, project identification signs, and construction of haul roads.
 - 1. Use materials of size, shape, and strength suitable for intended use, in construction of the above.
 - 2. Conduct construction operations to cause least inconvenience possible to general public, the Commission, and its employees.
 - 3. Where required, erect and maintain signs, fences, barricades, pedestrian bridges, supply guards and flagmen for protection of public.
 - 4. Take positive measures to prevent entry of children, animals, and unauthorized adults to work site and storage areas at all times.
 - 5. Obtain Engineer's approval before transporting or locating temporary facilities within construction site.
- B. Furnish and construct temporary fencing required to fence off excavation, storage, and operating areas.
 - 1. Erect suitably constructed temporary fences, neat in appearance, and meeting Engineer's approval.
 - 2. Unless otherwise indicated, erect fences 6 feet high.
- C. Barricade or close all openings in roadways, floors, walls, or other parts of structures or walkways while openings are not in regular use.
 - 1. Use barricades substantial in character, neat in appearance, and of size and arrangement with Engineer's approval.

- D. In areas where removal of existing sidewalk is necessary, construct pedestrian bridges of suitable materials, with handrails or sides tightly boarded, following local or State requirements.
 - 1. Construct bridges with minimum width of 6 feet, or greater width to accommodate normal traffic flow at the particular location.


1.3 TEMPORARY UTILITIES

- A. Water.
 - 1. Unless otherwise specified, the Commission will furnish water required during construction period at no cost to Contractor.
 - 2. Make arrangements for, piping, backflow devices, appurtenances, and hookup required.
 - 3. Assure availability of drinking water for work force.
 - 4. Install temporary pumps, tanks, and compressors to produce required pressures.
- B. Electricity.
 - 1. Make necessary arrangements and pay for all temporary electric service and lighting required during construction period.
 - 2. Pay costs for permanent power authorized by Engineer and used during construction period through date of Contract substantial completion
 - 3. Ensure electric service of sufficient capacity and characteristics to supply proper current for various types of construction tools, motors, welding machines, light, heating plant, pumps, testing, and other work required.
 - 4. Install necessary temporary wiring, panelboards, outlets, switches, lamps, fuses, controls and accessories.
- C. Toilets.
 - 1. Locate toilets where directed.
 - 2. Maintain adequate number of temporary prefabricated chemical type toilets, unless otherwise indicated, with proper enclosures for use of workers during construction.
 - 3. Keep clean and comply with local and State health requirements and sanitary regulations.
 - 4. Keep locked during non-working hours.

1.4 PROJECT SIGNS

A. Water Main Replacements, Relocations, and Cleaning and Lining Contracts.

1. Provide metal signs.
 - a. Size: Approximately 24 inch by 36 inch.
 - b. 4-inch WSSC water drop symbol.
 - c. Place QR code at lower right corner of sign.
 - d. White background with blue lettering approximately 2 inch in height centered on the 36-inch width, 1/4 inch between each line except for 1/2 inch at top and bottom borders:

 **WSSC**
Where Water Matters

PROJECT NUMBER

**WATER MAIN
IMPROVEMENTS BY:**


CONTRACT MANAGER:

OFFICE NUMBER _____

CELL NUMBER _____

24 HOUR EMERGENCY NUMBER:
301-206-4002

BY PERMISSION GRANTED TO WSSC
THROUGH LOCAL GOVERNMENT



23700sign_11_14

2. Install sign as directed by Contract Manager
 - a. Four inches by 4 inches by 8-foot post set approximately 3 feet in ground with 3/4-inch exterior plywood of same size as metal sign, firmly attached to top of post.
 - b. Approximately 12 stainless steel wood screws, minimum #10 - 5/8 inch long with washers, to attach sign and name plates to plywood.
3. Install signs within 7 days of start of construction in grass areas within road right of way.

4. Provide at:
 - a. Roundabout at the intersection of Gunpowder Drive & Aragona Boulevard.
 - b. Grass area beyond curb & gutter along Aragona Boulevard. Provide every 200 feet upto project site.

1.5 TRAFFIC CONTROL PLAN

- A. If not included in Contract Documents, submit traffic control plan following 01330 to the Engineer for review and approval.
 1. Maintain normal thru traffic flow following jurisdictional requirements, Manual on Uniform Traffic Control Devices, and specific permit requirements.
 2. Take safety measures following Maryland Department of Transportation, State Highway Administration General Provisions GP-7.05 and GP-7.06 and applicable jurisdictional requirements.
- B. Follow Appropriate Jurisdictional Permits; Absent Jurisdictional Requirements, Roads: Considered secondary unless otherwise indicated on Drawings, and following criteria shall govern.
 1. General: Assign flaggers certified in the State of Maryland and approved by the Maryland Department of Transportation - State Highway Administration or the American Traffic Safety Services Association, whose only duty is to direct traffic when roadway lanes are blocked by construction equipment or operations. All flagging operations shall comply with requirements provided in the Contract Documents.
 - a. Flaggers:
 - 1) Dressed in attire following current MUTCD (Manual on Uniform Traffic Control Devices-OSHA).
 - 2) Required to have photo I.D. and Flagger certification card on them at all times. Provide to Engineer upon request.
 - b. Equipment.
 - 1) STOP/SLOW paddle.
 - (a) 24" x 24", with minimum 8" high letters.
 - (b) Reflective sheeting following Maryland SHA's Specification 950.03.
 - (c) Non-reflective paddles are not allowed.
 - 2) Two-way radios or pilot vehicles: Used when flaggers are not within sight distance of each other, or when directed by Engineer.
 2. Primary Roads Where Shown on Drawings.
 - a. Do not store excavated material and other materials on roadways.
 - b. Close excavations at end of each workday by backfilling or by means of steel plates marked in advance with warning signs, or other accepted materials.
 - c. Leave work area clean and without obstacles during off-work hours.

3. Secondary Roads.
 - a. Maintain two-way traffic during working hours.
 - b. Clean up area of work site at end of each workday to allow maximum use of roadway during off-work hours.
- C. Temporary Facilities: Required for pedestrian and vehicular access to properties adjacent to or contiguous with Project.
 1. If necessary to temporarily interrupt access, after securing Engineer's approval, notify all affected parties of time, extent, and duration of interruption.

1.6 ENVIRONMENTAL PROTECTION

- A. Furnish necessary items for fulfilling work described herein for environmental protection that results directly or indirectly from Work. For erosion and sediment control see Section 01570.
 1. Take precautions in conduct of operations necessary to avoid contaminating water in adjacent watercourses or water storage areas, including wells, whether natural or man-made.
 2. Conduct earthwork, moving of equipment, water control of excavations, and other operations likely to create silting to eliminate pollution of watercourses or water storage areas.
 - a. Dispose of water contaminated with oil, bitumen, harmful or objectionable chemicals, sewage, or other pollutants offsite: Federal Clean Water Act and Resource Conservation and Recovery Act.
 - b. Discharge of pollutants into any watercourse or water storage area prohibited: State of Maryland National Pollutant Discharge Elimination System.
 - c. When water from adjacent natural sources is needed, use intake methods, which avoid contaminating source of supply or becoming source of erosion or sedimentation.
 3. Noise and Air Pollution Control: As to not violate following applicable ordinances, regulations, rules and laws pertaining to noise and air pollution in effect. Conduct operations following provisions in effect and as set forth in:
 - a. Rules and Regulations Governing the Control of Air Quality in the State of Maryland, COMAR 26.11., Maryland Department of the Environment.
 - b. Chapter 3, Montgomery County Code, 1972, Bill No. 42-73, Air Quality Control.
 - c. Subtitle 19, Prince George's County Code, 1999 Edition, Pollution.
 - d. Rules and Regulations Governing the Control of Noise Pollution in the State of Maryland COMAR 26.02.03, Maryland Department of the Environment.
 - e. Chapter 31B, Montgomery County Code, 1972, Bill No. 64-73, Noise Control.

4. Plant Pest Control: By soil moving or handling equipment that has operated in or will operate in regulated areas following plant quarantine regulations.
 - a. In general, these regulations require thorough cleaning of soil from equipment before it is moved from regulated areas to uninfested areas.
 - b. Obtain complete information from regional office of Plant Pest Control Division of United States Department of Agriculture.
5. Preservation of Natural Resources: In construction operations for Work, clean-up, and condition of adjacent terrain upon completion of Work, fully comply with all applicable regulations and laws concerning preservation of natural resources.
6. Dust Control: Throughout construction period, maintain dust control using water sprinklers or chemical dust control binder with Engineer's approval.

PART 2 PRODUCTS

(NOT USED)

PART 3 EXECUTION

(NOT USED)

END OF SECTION

SECTION 01570
TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section includes requirements, procedures, and methods related to responsibilities for providing temporary erosion and sediment control for land-disturbing activities.
 - 1. Land-disturbing activity: Earth movement and land change that may result in soil erosion from water, wind, or movement of sediments into State waters or onto State lands, including but not limited to tilling, clearing, stripping, grading, excavating, filling, and related activities, and covering of land with impermeable material.

1.2 PERMIT

- A. Contractor shall comply with requirements of the WSSC Erosion and Sediment Control Permit.
 - 1. Follow requirements and procedures indicated in the Contract Drawings/Documents.
 - 2. Apply and maintain measures to control erosion of disturbed areas and minimize sedimentation of adjacent watercourses and lands throughout life of Contract.
- B. Permit Procedures.
 - 1. The WSSC Erosion and Sediment Control Inspector shall be present at the Preconstruction meeting, as required by the WSSC Erosion and Sediment Control permit.
 - 2. Field Inspection and Enforcement: Conducted by WSSC.
 - 3. Engineer will issue Stop Work Order when failure to follow with previous violation notice and/or notices for non-compliance with permit requirements.
 - a. Failure to follow Stop Work Order issued by ESC Inspector can result in suspension of permit.
 - 4. Engineer will issue Field Order to direct Contractor to stop utility construction activities and work directly on sediment control compliance issues.
 - 5. Only permit violation correction work is permitted until Stop Work Order is lifted.
 - 6. Contractor is subject to daily civil fines if found working under suspended permit.
- C. Additional Permits: Secure additional permits for work outside indicated right of way, construction strips, or work limits for County or Municipal sediment control or grading permits, State Waterway Construction, or Wetlands Permits, or other environmental permits.

1. Secure arrangements in writing, including statement that requirements and standards of re-stabilization and restoration for access ways and other disturbed areas shall meet or exceed re-stabilization and restoration standards for the Commission's right-of-way.
2. Send copy of final access agreement and copy of additionally required State or County permits to Engineer, before beginning work in areas outside work limits.

PART 2 PRODUCTS

2.1 SEED AND SOD

- A. Seed, Sod, Mulches, Fertilizer, Topsoil, Soil Conditioner, and Other Materials for Seeding and Sodding: See Section 02920 and Contract Documents.

2.2 MATERIAL FOR EROSION AND SEDIMENT CONTROL DEVICES

- A. Geotextiles: See Section 02070.
- B. Silt Fence: Sediment Control Geotextile, see Section 02070.
- C. Stone:
 1. 2 inch to 3-inch stone: AASHTO M-43, size no. 1.
 2. 3/4 inch to 1-1/2-inch stone: AASHTO M-43, size no. 57.
- D. Silt Fence Posts: Minimum 36 inches long, 2 by 2 hardwood posts, with minimum cross-sectional area of 3 square inches.
- E. Chain Link Fence for Super Silt Fence: Galvanized fabric for super silt fence shall be 2 in. mesh from coated No. 9 gauge wire. The ends shall have a knuckled selvage at the bottom and a barbed selvage at the top. The fabric shall conform to M 181. Type I fabric shall meet Class C coating. The fabric shall be 42 in. high.
- F. Filter Log Casing: Produced from 5 mil thick continuous high-density polyethylene or polypropylene, woven into a tubular mesh netting material with openings in the knitted mesh of 1/8 in. to 3/8 in.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Clear only areas designated on Drawings within indicated limits of rights of way, easements, or work limits.
- B. Protect excavated material and disturbed areas from erosion into waters or onto adjacent land.

1. Stockpile excavated material on high side of trench.
 2. Stockpiled material left on paved surfaces must be covered with impermeable material if left overnight.
- C. Install sediment control devices following Drawings or as directed by ESC Inspector, during initial clearing and grubbing operations. Complete installation before trenching or performing other construction.
- D. Maintain erosion and sediment control measures and devices until final re-stabilization and restoration are complete, unless otherwise directed by ESC Inspector.

3.2 STABILIZATION OF DISTURBED AREAS

- A. Following Initial Disturbance or Re-disturbance, Completion of Permanent or Temporary Stabilization:
1. Within 3 days for surfaces of dikes, swales, ditches, perimeter controls and slopes greater than 3:1.
 2. Within 7 days for other disturbed or graded areas.
 3. Maintained to ensure that areas meet requirements of the Contract Documents.
- B. Stabilization.
1. Temporary: Consisting of fast-growing vegetation in accordance with the latest edition of the Maryland Standards and Specifications for Soil Erosion and Sediment Control. Temporary structures such as stabilized construction entrance and stone outlet structures do not require vegetative stabilization. When stabilization is required outside of a seeding season, apply seed and mulch or straw and maintain until the next seeding season. Temporary stabilization shall provide 95% coverage over the disturbed area.
 2. Permanent: Following restoration schedule on Drawings.
- C. Requirements do not apply to areas currently used for material storage or on which actual construction activities are currently performed.
- D. Restabilize areas disturbed by utility construction in kind or as directed in restoration schedule shown on approved drawings.

3.3 EROSION AND SEDIMENT CONTROL DEVICES

- A. Install devices shown on Drawings, or at Engineer's direction, and following Standard Details.
1. Maintain sediment control devices to contain surface drainage and prevent sediment from leaving confines of work site.

B. Silt Fence (Standard Detail SC/1.0).

1. Definition: Temporary continuous barrier constructed of sediment control geotextile supported by posts used to trap sediment but allow surface runoff to filter through.
2. Construction: See Standard Detail.
3. Maintenance: Remove sediment deposits when it reaches approximately 1/2 of height of silt fence or install a second silt fence as directed by ESC Inspector.
 - a. Replace geotextile when silt fence is in place longer than 12 months unless ESC Inspector directs otherwise.
 - b. Areas where construction activities have changed natural contour and drainage runoff: Review daily silt fence locations to ensure effectiveness.
 - 1) Where deficiencies exist, install additional silt fences under ESC Inspector's direction.
 - 2) Promptly repair or replace damaged or otherwise ineffective silt fence.
 - c. Areas where construction activities have not changed natural contour and drainage runoff: Periodically, inspect and repair damage to silt fence to ensure effectiveness.
4. Removal and Restoration: ESC Inspector will determine when silt fence is to be removed, after removal, fill depressions and restore area following restoration schedule.

C. Silt Fence on Pavement

1. Definition: Temporary barrier of woven geotextile used to intercept, retain and filter surface runoff.
2. Construction:
 - a. Use nominal 2 x 4-inch lumber.
 - b. Use woven sediment control textile.
 - c. Space upright supports no more than 10 feet apart.
 - d. Provide two-foot opening between every set of supports and place stone in opening over textile.
 - e. Keep silt fence taut and securely staple to the upslope side of upright supports. Extend geotextile under 2 x 4.
 - f. Where two sections of geotextile adjoin, overlap, fold and staple to post and attach lathe.
 - g. Provide mastic seal between pavement, geotextile and 2 x 4 to prevent sediment- laden water from escaping beneath silt fence installation.
 - h. Secure boards to pavement with 40D 5-inch minimum length nails.
3. Maintenance: Remove accumulated sediment and debris when bulges develop in silt fence or when sediment reaches 25% of fence height. Replace geotextile if torn. Maintain watertight seal along bottom. Replace stone if displaced.
4. Removal and Restoration: ESC Inspector will determine when silt fence is to be removed. Restore area to original condition.

- D. Super Silt Fence (Standard Detail SC/2.0).
1. Definition: Temporary continuous barrier of sediment control geotextile placed over chain link fencing used to intercept sediment.
 2. Construction: Follow Standard Detail and as specified.
 - a. Fasten geotextile securely to fence post.
 - b. Wire tie geotextile spaced every 24 inches horizontally to chain link fence at top and mid-section.
 3. Maintenance: See silt fence specification.
 4. Removal and Restoration: Follow silt fence specification and replace with silt fence when directed by ESC Inspector.
- E. Portable Sediment Tank (Standard Detail SC/15.0).
1. Definition: Compartmental tank through which sediment laden water is pumped to trap and retain sediment.
 2. Construction: Following Standard Detail.
 - a. Tanks may be connected in series.
 - b. Storage volume: 1 cubic foot of storage for each gallon per minute of pump discharge capacity.
- F. Filter Log
1. Definition: Temporary tubular casing filled with compost filter media to intercept sheet flow, retain sediment and filter runoff.
 2. Construction:
 - a. Prior to installation, clear all obstructions including rocks, clods and debris greater than one inch that may interfere with proper function of filter logs.
 - b. Fill log netting uniformly with compost or other approved biodegradable material to desired length such that logs do not deform. Install filter logs perpendicular to the flow direction and parallel to the slope with the beginning and end of the installation pointing slightly up the slope creating a "J" shape at each end to prevent bypass.
 - c. For untrenched installation blow or hand place mulch or compost on uphill side of the slope along log.
 - d. Stake filter log every 4 feet or closer along entire length of log or trench log into ground a minimum of 4 inches and stake log every 8 feet or closer.
 - e. Use stakes with a minimum nominal cross section of 2" x 2" and of sufficient length to attain a minimum of 12 inches into the ground and 3 inches protruding above log.
 - f. When more than one log is needed, overlap ends 12 inches minimum and stake.
 3. Maintenance: Remove sediment when it has accumulated to a depth of 1/2 the exposed height of log and replace mulch. Replace filter log if torn. Reinstall filter log if undermining or dislodging occurs. Replace clogged filter logs.
 4. Removal and Restoration: When no longer required, remove and restore area following restoration schedule.

3.4 CONSTRUCTION OPERATIONS

- A. Do not begin construction operations until required erosion and sediment control devices are in place and functioning.
- B. Do not violate requirements of the WSSC Erosion and Sediment Control Permit during construction operations.
- C. If permit violation is observed, Engineer will issue notice stating violation and date by which violation must be corrected.
 - 1. If violation is not corrected by date stated, ESC Inspector may issue civil citation or Stop Work Order to bring site into compliance with Utility Erosion and Sediment Control Permit requirements and/or approved sediment control plan.
- D. Stop Work orders will not be lifted until violations are corrected and brought into compliance with Permit, and Contractor has requested inspection of site.
 - 1. Cost or Time extensions requested as result of delays occasioned by Stop Work orders will not be granted.
- E. ESC Inspector must approve changes to approved sediment control plan.

3.5 FIELD CONDITIONS

- A. Immediately notify Engineer if conditions arise in field that renders Drawings, these specifications, or requirements of Erosion and Sediment Control Permit inappropriate or inadequate.
- B. Engineer will furnish additional Drawings or modifications, when required, which will become part and condition of Erosion and Sediment Control Permit.

END OF SECTION

SECTION 01630
SUBSTITUTION PROCEDURES

PART 1 GENERAL

1.1 DESCRIPTION

- A. This Section includes requirements related to the Contractor's responsibilities for substitutions.

1.2 SUBMITTAL OF PROPOSED SUBSTITUTIONS

- A. Whenever a material, article, or method is specified or described by using the name of a proprietary product or the name of a particular manufacturer(s) or, vendor(s), followed by the phrase "or equal", the specific item mentioned shall be understood as establishing the type, function, dimension, appearance, and quality desired and is to be the basis upon which bids are to be prepared.
1. Other manufacturers' materials, articles, and methods not named will be considered as substitutions provided required information is submitted on the Form Substitutions For Specified Items and will not require substantial revisions of the Contract Documents.
 2. This applies to specific construction methods when such are required by the Contract Documents.
- B. Whenever a material, article, or method is specified or described without the phrase "or equal", no substitutions will be allowed.
- C. Bids shall be based on materials, articles and methods named and specified in the Contract Documents. If the bidder proposes to use substitutions for named and specified materials, articles and methods followed by the phrase "or equal" within the Contract Documents during the construction process, the bidder shall submit, with their bid a list of proposed substitutions on the Form For Substitutions For Specified Items. This form is provided in the Solicitation.
- D. Request for substitutions received after bids are open will not be considered except as stated herein.

1.3 SUBMITTAL OF DATA FOR PROPOSED SUBSTITUTIONS

- A. In order for substitutions to be considered, the Contractor shall submit, not later than 30 days after date of Notice to Proceed, complete data as set forth herein to permit complete analysis of all proposed substitutions listed on the contractor's submitted Form For Substitution For Specific Items. No substitution will be considered unless the Contractor provides required data in accordance with the requirements of this Section within the thirty day period. The provision of Section 01330 concerning thirty days (30) review time by the Engineer does not apply to substitution requests. The Engineer will take such time as required to ensure full compliance with all Contract requirements. Three (3) copies of the following data shall be submitted in order for the substitutions to be considered.
- B. Complete data substantiating compliance of proposed substitutions with Contract Documents. Substitution shall not change design intent.
 - 1. For Products:
 - a. Identification including manufacturer's name and address.
 - b. Manufacturer's literature, including but not necessarily limited to:
 - 1) Product description, performance, and test data.
 - 2) Reference standards.
 - c. Samples where appropriate.
 - d. Name and address of similar projects on which product was used and dates of installation with contact name and telephone number.
 - 2. For Construction Methods provide
 - a. Detailed description of proposed method.
 - b. Drawings illustrating methods.
 - c. Name and address of similar projects on which method was used and date of use.
 - 3. Itemized technical and cost comparison of proposed substitution with product or method specified. Different types of products and methods will be considered provided final performance is at least equal to that specified.
 - 4. Data relating to impact on construction schedule occasioned by the proposed substitution.
 - 5. Impact on other contracts.
 - 6. Proposed monetary changes supported by accurate cost data on proposed substitution in comparison with product or method specified, including costs for redesigns required. Costs for redesigns due to substituted items are the responsibility of the Contractor.
 - 7. In making request for substitution, Bidder represents that he:
 - a. Has personally investigated proposed product or method determined that it is equal or superior in all respects to that specified.
 - b. The bidder will provide same guarantee for substitution as for product or method specified.

- c. The bidder will coordinate installation of accepted substitution into the work, making design and construction changes as may be required for the Work to be complete in all respects in accordance with Contract requirements without additional cost to the Commission.

1.4 SUBSTITUTIONS AFTER BID OPENING

- A. Requests for substitutions submitted after Bid Opening will not be considered unless evidence is submitted to the Engineer that the following circumstances exist:
 - 1. The specified material or method is unavailable for reasons stated in General Conditions, Article 15.5.1.
 - 2. Complete data as set forth hereinbefore to permit complete analysis of the proposed substitution are submitted with the request.

1.5 APPROVAL OF SUBSTITUTION

- A. The Engineer's decision regarding evaluation of substitutions shall be final and binding.
- B. Request for time extensions and additional costs based on submission, acceptance, or rejection of substitutions will not be allowed.
- C. All approved substitutions will be incorporated into the Contract by Change Order.

END OF SECTION

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SECTION 01650
EQUIPMENT TESTING AND STARTUP

PART 1 GENERAL

1.1 GENERAL

A. Description

1. This section includes requirements for providing a field-testing program for electrical and mechanical equipment which shall be performed, recorded, completed and approved as indicated.
2. Testing requirements for Division 2 sections shall be as indicated therein.
3. Procedures contained in Section 01450 shall apply as indicated.
4. Items to be tested in accordance with this Section are as follows:
 - a. Water Distribution System, Section 02510
 - b. Sump Pumps For Vaults, Section 15446
 - c. Ventilation Equipment for Vaults, Section 15501
 - d. Electric Unit Heaters for Vaults, Section 15850
 - e. Lighting Fixtures, Section 16500
 - f. Control Panels, Section 17200
 - g. Instrumentation, Section 17300

B. Quality Assurance

1. Testing procedures shall be in accordance with Section 01450 and as follows:
 - a. Preliminary Test
 - 1) The purpose of this phase of tests is to demonstrate that all of the equipment and connections when energized will perform the functions required by the Contract Document, the approved Contractor's Drawings, and the approved Operation and Maintenance Manuals for each item of equipment or system; that all equipment has been installed in accordance with the contract documents and the Contractor's Drawings which have been approved; and all phases of the project have been completed. The quality of workmanship and installation shall be examined for deficiencies which shall be logged in a punch list of items of work to be completed prior to the Final Test. Upload an electronic copy of the punch list to e-Builder within five (5) days.
 - 2) When local codes or laws require approval and inspection of the work by other agencies or organizations before installation or operation, such approval shall be obtained. Submit one signed original and three copies of the approvals to the Engineer.
 - 3) Schedule the Preliminary Tests a minimum of ten days before the Prefinal Tests are scheduled.
 - 4) Tests to be provided by the Contractor shall be performed and recorded prior to the Preliminary Tests in order to avoid delays of the scheduled testing procedures.

- b. Final Test
 - 1) The purpose of this final phase of tests is to verify that all integrated equipment and systems operate as complete units; all elements of the project work are ready to be placed in service and turned over to the Commission and that all outstanding items of punch lists have been satisfied, in order to schedule the Certificate of Final Acceptance.
 - 2. All inspections and tests shall be in accordance with the latest edition of the applicable test procedures of the following standards associations.
 - a. ANSI - American National Standards Institute
 - b. IEEE - Institute of Electrical and Electronic Engineers
 - c. ICEA - Insulated Cable Engineers Association
 - d. NEC - National Electrical Code
 - e. NEMA - National Electrical Manufacturers' Association
 - f. NETA - National Electrical Testing Association
 - g. AWWA - American Water Works Association
- C. Submittals
- 1. Submit data, certificates, and record drawings in accordance with Sections 01330 and 01450.
 - 2. Submit a schedule of dates and times for the performance of the specified phases of testing. The schedule shall include a description of the items of equipment and systems to be tested, and the testing sequence to be employed.
 - 3. Record Forms
 - a. Test data record forms shall be provided for each system and item of equipment tested. The form and format of the forms shall be submitted for approval. Completed test forms shall contain the following minimum identifications, data and quality.
 - 1) Project identification.
 - 2) Test stage identification, Preliminary or Prefinal.
 - 3) Sequence number of the test, i.e., First Test, Second Test. Final Test.
 - 4) Date test was begun, and date when completed.
 - 5) Identification of testing facility, e.g., Contractor, Independent Testing Co., Manufacturer.
 - 6) All data shall be typewritten or neatly hand lettered, not long-hand, and shall clear and bold to permit photocopying without loss of clarity.
 - 7) All test data record forms, or the Title Sheet of a multiple page test report shall bear the signature of the person conducting the tests or the chief person of a test team. Signatures shall be augmented by typewritten or hand-lettered facsimiles.
- D. Test Equipment
- 1. All test instruments, meters and auxiliary equipment shall be provided by the Contractor. All test equipment shall be tested, calibrated, and certified within six (6) months of use on this contract.

- E. Definitions
 - 1. Prerequisites - Items of work or submittals required prior to the requirements of this Section.
- F. Pre-Final and Final Testing Perquisites and Test Waiver
 - 1. Verify all Punch list items and Non-Conformances identified during Preliminary or Pre-Final testing have been addressed and resolved.
 - 2. If no punch list items were developed in the Preliminary or Pre-Final test phases, duplicate testing specified for the next phase of testing (Pre-final and Final, respectively) may be waived at the discretion of the Engineer.
- G. Non-Conformances
 - 1. Non-Conformances shall be identified in the Testing Results. Non-Conformances shall be resolved and corrected at the time of testing. If Non-Conformances cannot be corrected, system component shall be repaired or replaced at no additional cost to the Commission and testing shall be performed again. Testing shall be repeated until the expected results are obtained, and the acceptance criteria have been met.

PART 2 MATERIALS

(NOT USED)

PART 3 EXECUTION

3.1 TESTING

- A. Tests, Hardware
 - 1. Prerequisites
 - a. Check doors and hardware for surface defects and cleanliness.
 - b. Verify that doors open and close without sticking or binding and are plumb and square with frames.
 - 2. Preliminary Test
 - a. Demonstrate locks, door holders and other door hardware. Replace hardware which are defective or damaged and cannot be adjusted to operate freely and smoothly as intended for operation.
 - 3. Final Test
 - a. Perform visual inspection for proper appearance and function of doors.
 - b. Verify that punch list items developed in preliminary tests have been corrected.
- B. Tests, Valves, Water Distribution System, Section 02510
 - 1. Prerequisites
 - a. Verify painting of valves in accordance with Section 02510.
 - 2. Preliminary Test
 - a. Inspect valves for signs of leakage during pressure testing of associated piping systems.

- b. Operate manual valves through 3 full cycles of opening and closing. Operate valves from full open to full close without sticking or binding. If valves stick or bind, repair or replace the valve and repeat the valve and repeat the tests.
- c. Operate gear actuators with valve travel from full open to full close through 3 full cycles without binding or sticking.
- 3. Final Test
 - a. No final test will be performed.

C. Tests, Flow Control Valve, Water Distribution System, Section 02510

- 1. Final Test:
 - a. Check the diaphragm assembly for freedom of movement after all pressure is removed from the valve. Insert fabricated tool into threaded hole in top of valve stem and lift the diaphragm assembly manually. Note any roughness, sticking or grabbing. The diaphragm assembly should move smoothly throughout entire valve stroke. The tool is fabricated from rod that is threaded on one end to fit valve stem and has a “T” Bar handle of some kind on the other end for easy gripping. Place marks on this diaphragm assembly lifting tool when the valve is closed and when manually positioned open. The distance between the two marks should be approximately the stem travel shown in stem travel chart. If the stroke is different than that shown, there is a good reason to believe something is mechanically restricting the stroke of the valve. The cover must be removed, the obstruction located and removed.

Due to the weight of the diaphragm assembly this procedure is not possible on valves 8” and larger. on these valves, the same determination can be made by carefully introducing a low pressure-less than five psi) into the valve body with the cover vented. Looking in cover center hole see the diaphragm assembly lift easily without hesitation, and then settle back easily when the pressure is removed.

- b. To check the valve for drip-tight closure, a line should be connected from the inlet to the cover, and pressure applied at the inlet of the valve. If properly assembled, the valve should hold tight with as low as ten PSI at the inlet.
- c. With the line connected from the inlet to the cover, apply full working pressure to the inlet. Check all around the cover for any leaks. Re-tighten cover nuts if necessary, to stop leaks past the diaphragm.
- d. Remove pressure, then re-install the pilot system and tubing exactly as it was prior to removal. Bleed air from all high points.
- e. Follow steps under “Start-Up and Adjustment” Section in Technical Manual for placing complete valve into service.

D. Tests, Sump Pumps for Vaults, Section 15446

- 1. Prerequisites
 - a. Adequately brace and support all piping during the tests so that no movement, displacement or damage occurs from application of test pressures.
 - b. Required hydrostatic testing of piping.

2. Preliminary Test:
 - a. Verify function of controls and status indications shown on the contract drawings.
 - b. Under actual or approved simulated operating conditions, perform the following on each pump:
 - 1) Test for a continuous 1-hour period without malfunction.
 - 2) Monitor for excessive vibration.
 - 3) Driving motor voltage and amperage measured for each phase.
 - 4) Operating temperatures: monitor bearings and motor for temperatures above the manufacturer's recommended normal and maximum operating temperatures.
 - 5) Verify sufficient flow rate and pressure for discharge at grade.
 - 6) The specified test pressure shall be maintained for at least two hours with no pressure drop. Allowable leakage shall be in accordance with AWWA and pipe manufacturers' recommendations.
 - c. Complete all punch list items on the equipment.
3. Prefinal Test:
 - a. Repeat the tests specified under preliminary tests unless waived by the Engineer.
 - b. Verify equipment functions as specified.

E. Tests, Ventilation Equipment for Vaults, Section 15501

1. Prerequisites
 - a. Verify receipt of Preliminary O&M Manual.
 - b. Verify attachment of ID labels to each piece of equipment.
 - c. Identify and list size, type and manufacturer of all equipment to be tested.
2. Preliminary Test
 - a. Test systems as follows:
 - 1) Test and adjust supply air fan speeds to design requirements within limits of mechanical equipment provided. Change drive assemblies as necessary to balance systems to design airflows. Submit complete data on testing and balancing forms.
 - 2) Test and record motor voltage and running amperes including motor nameplate data and starter heater ratings. Record data for each phase of 3 phase power motors.
 - 3) Determine cfm at fan and adjust fan to design airflow rate.
 - b. Test electric heating equipment as follows:
 - 1) Test and record voltage and amperage readings at each electric heater while fully energized. Record air temperatures entering and leaving and air quantity passing through coils.
 - 2) Make air quantity measurements for electric unit heaters by use of a velometer. Take velocity readings at the center of the coil surface and at the edges in order to obtain an averaged airflow measurement.
3. Final Test

Operate ventilating equipment for 3 days during which time no repairs or adjustments other than routine maintenance shall be required.

F. Tests, Electric Unit Heaters for Vaults, Section 15850

1. Prerequisites
 - a. Verify receipt of Preliminary O&M Manual.
 - b. Verify attachment of ID labels to each piece of equipment.
 - c. Identify and list size, type and manufacturer of all equipment to be tested.
2. Preliminary Test
 - a. Test systems as follows:
 - 1) Test and adjust unit heater.
 - 2) Test and record motor voltage and running amperes including motor nameplate data and starter heater ratings. Record data for each phase of 3 phase power motors.
 - b. Test electric heating equipment as follows:
 - 1) Test and record voltage and amperage readings at each electric heater while fully energized. Record air temperatures entering and leaving and air quantity passing through coils.
 - 2) Make air quantity measurements for electric unit heaters by use of a velometer. Take velocity readings at the center of the coil surface and at the edges in order to obtain an averaged airflow measurement.
3. Final Test

Operate heating equipment for 3 days during which time no repairs or adjustments other than routine maintenance shall be required.

G. Tests, Basic Electrical Materials and Methods, Section 16050

1. Prerequisites
 - a. General
 - 1) Perform tests to establish electrical power distribution before any other test requiring electrical power. Availability of normal power supply is a prerequisite to such tests.
 - 2) Test circuits for shorts.
 - 3) Test ground for continuity and resistance. Grounding neutrals for a distribution system 600 volts and below shall not exceed ten ohms.
 - 4) Test each individual power circuit at the panel with the power equipment connected for proper operation.
 - 5) Correct defects and failures in a manner acceptable to the Engineer.
 - b. Wire and Cable
 - 1) Verify conductor identification is in accordance with the contract and approved contractor's drawings.
 - c. Switches, Disconnect Switches, and Receptacles
 - 1) Perform visual inspection for physical damage and missing hardware and accessories.
 - 2) Verify nameplate data with approved contractor's drawings.
 - d. Switchboards, Panelboards and Circuit Breakers
 - 1) Perform visual inspection for physical damage and missing hardware.

- 2) Verify:
 - a) Nameplate data with contract drawings.
 - b) Circuit breakers with panel schedules on contract drawings for number of poles and ratings.
 - c) Calibrate tightness of each connection with torque wrench in accordance with recommendations.
2. Preliminary Test
 - a. Wire and Cable
 - 1) Test circuits for shorts.
 - 2) Perform insulation resistance tests at 1,000 volts DC for one minute from Pole-to-Pole and from Pole-to-Ground. 100 megohms minimum insulation resistance.
 - b. Switches, Disconnect Switches and Receptacles
 - 1) Perform operation of switches and disconnect switches for smooth and proper operation and verify load is turned on and off.
 - 2) Test each receptacle with a circuit tester for voltage, polarity and grounded conditions. Repair or replace defective receptacles and repeat the test.
 - c. Panelboards and Circuit Breakers
 - 1) Perform operations of breakers to ensure smooth operation and verify load is turned on and off.
3. Final Test
 - a. Wire and Cable
 - 1) No final testing required.
 - b. Switches, Disconnect Switches, and Receptacles
 - 1) No final testing required.
 - c. Panelboards and Circuit Breakers
 - 1) No final testing required.

H. Tests, Lighting Fixtures, Section 16500

1. Prerequisites
 - a. Testing of associated basic electrical materials and methods.
2. Preliminary Test
 - a. Perform visual inspection for physical damage and missing hardware and accessories.
 - b. Perform operation of switches for smooth and proper operation of lights. Verify fixture is energized.
3. Final Test
 - a. No final testing is required.

I. Tests, General Instrumentation Requirements, Section 17200

1. Prerequisite
 - a. Testing of associated basic electrical materials and methods.
 - b. Verify receipt of Preliminary O&M Manual.
2. Preliminary Test
 - a. Exercise systems through operational tests in the presence of the Engineer in order to demonstrate achievement of the specified performance.

- b. Coordinate operational tests dependent upon completion of work specified elsewhere. Schedule tests among all parties involved so tests may proceed without delays or disruption by uncompleted work.
 - c. Calibrate instrument in conformance with the Section 17200 component's manufacturer instructions.
 - d. Exercise instrument through an operational test using process conditions, if possible. Record data for 0, 25, 50, 75 and 100 percent of range of each instrument to verify accurate operation.
- 3. Final Test
 - a. Repeat step d. of Preliminary Test.

J. Tests, Custom Control Panels, Section 17200

- 1. Prerequisites
 - a. Conduct factory test as follows:
 - b. Inspect and test control panel for correct operation. Test circuit for continuity, short circuits, and ground faults.
- 2. Preliminary Test
 - a. Test control panel with field wiring connected. Set adjustable set points and time delays as required. Verify operation of control panel and field devices. Perform required adjustments for correct operation.
- 3. Final Test
 - a. No final testing is required.

END OF SECTION

SECTION 01770
PROJECT CLEANUP

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section includes requirements for cleanup, re-stabilization restoration and disposal to maintain a safe and well-kept job site and properly repair disturbed areas.

1.2 CLEANUP

- A. Proceed with construction cleanup as construction progresses.
 - 1. Remove mud, oil, grease, soil, gravel, trash, scrap, debris, and excess materials that are unsightly or may cause accidents to persons or properties.
 - 2. Remove water from floor areas where electrical power tools are to be used and prevent stains on concrete that will be exposed in finish work.
 - 3. Select and employ cleaning materials and equipment with care to avoid scratching, marring, defacing, staining, or discoloring surfaces cleaned.
- B. Final Cleanup: Perform immediately before written request for final inspection of Contract Work or any portion thereof.
- C. Besides normal "Broom Clean" requirements, clean exposed surfaces as listed.
 - 1. Glass: Wash and polish.
 - 2. Painted Surfaces: Remove marks, stains, fingerprints, and dirt.
 - 3. Exposed Slabs: Wash, scrape, and scrub, using detergent to remove bond breaker, dirt, and discolorations.
 - 4. Asphalt Paving: Remove mud, oil, grease, dirt, and trash and hose down.
 - 5. Aluminum: Clean following manufacturer's recommendations.
 - 6. Other Surfaces: Remove blemishes, leave clean, uniform, and dust-free.
 - 7. Premises and Site: Remove trash, debris, and surplus excavated material.
- D. Leave premises orderly and "Broom Clean."

1.3 RESTORATION AND RESTABILIZATION

- A. Restore and restabilize disturbed areas including, but not limited to staging and stockpiling areas, construction strips, access roads, stream crossings, and areas within acquired right of way.

- B. Proceed with final restoration and re-stabilization following Restoration Schedule on Drawings and requirements in Sections 02315 and 02920, including seeding, sodding, and paving when season allows.
- C. Disassemble and remove all temporary construction facilities and leave site in orderly and restored condition following Contract Documents.
- D. Preserve public and private signs, markers, guardrails, and fences, and maintain in existing locations and condition unless written permission is obtained for removal and restoration or replacement.
 - 1. Remove conflicting facilities when grading operations begin and store in manner to keep them clean and in existing condition.
 - 2. Restore to original or new locations at Engineer's direction.
 - 3. Repair or replace damaged items when directed, at no cost to the Commission.
- E. Perform restoration of turf areas following Section 02920.
- F. Perform tree protection, repair, and replacement following Sections 02230 and 02930.
- G. Restore gravel surfaces and roadway shoulders to their condition before being disturbed.
 - 1. Do not reuse shoulder material if contaminated by foreign material.
 - a. Replace with new material of same quality and gradation.
 - 2. Materials and Methods of Construction: Follow jurisdictional requirements and applicable permits secured for this Contract.
 - 3. Surface areas adjacent to shoulders, if left unstable by construction, with stabilized gravel or other acceptable stabilizing material.
- H. Restore pavement, curbs, other paved areas, and sidewalks following requirements elsewhere in Contract Documents.

1.4 DISPOSAL OF WASTE AND EXCESS MATERIALS

- A. Dispose of construction waste and excess materials in authorized County disposal area or temporarily in area covered by current grading or sediment control permit.
- B. Remove waste and excess material disposed of in unauthorized area, and restore area to its condition before disturbance, at no cost to the Commission.
- C. Dispose of human waste in special sites designated therefor.

1.5 REMOVAL OF REJECTED MATERIAL

- A. Remove material delivered to Contract site, which has been determined by Engineer to be unsuitable or not following Contract Documents and dispose of in approved area.

PART 2 PRODUCTS

(NOT USED)

PART 3 EXECUTION

(NOT USED)

END OF SECTION

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SECTION 02070
GEOSYNTHETICS

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section includes requirements for providing geosynthetics for drainage, separation, reinforcement, filtration, fluid barrier and protection for erosion and sediment control, earth retaining systems, ground improvement, roadways, and slope stabilization.

1.2 DEFINITION: Geosynthetics refer to a planar product manufactured from a polymeric material used with soil, rock or other geotechnical related material as an integral part of a civil engineering project, structure or system.

- A. Geotextiles: Permeable textile material used with soil, rock, or other geotechnical engineering related materials as integral part of human-made project, structure, or system.
- B. Geogrids: Deformed or non-deformed grid-like polymeric material formed by intersecting ribs joined at junctions used for reinforcement with soil, rock, or any other geotechnical engineering related materials as integral part of human-made project, structure or system.
- C. Geonets: Netlike polymeric material formed from intersecting ribs integrally joined at junctions used for drainage with soil, rock, or other geotechnical engineering related materials as integral part of human-made project, structure or system.
- D. Geomembranes: Essentially impermeable membrane used as liquid or vapor barrier with soil, rock, or other geotechnical engineering related materials as integral part of human-made project, structure, or system.
- E. Geocomposites: Manufactured material using geotextiles, geogrids, geonets, and/or geomembranes in laminated or composite form.

1.3 SUBMITTALS

- A. Submit following Section 01330.
 - 1. List of geosynthetics used on project to include manufacturer's name, address, material's properties, identification number, and intended application.
 - 2. Submit manufacturer's installation instructions/recommendations.
 - 3. Submit manufacturer's recommended joining and repair methods for geosynthetics used on project.

- B. Submit following Section 01450.
 1. Certificates of Compliance of test results for specified properties.
 - a. Present test methods used for specific properties of geotextiles.

<u>Property</u>	<u>Current Method</u>
Grab Tensile Strength	ASTM-D-4632
Ultimate tensile Strength (Geotextile).....	ASTM D-4595
Ultimate tensile Strength (Geogrid).....	ASTM D-6637
Grab Elongation.....	ASTM-D-4632
Mullen Burst	ASTM-D-3786
Puncture Resistance	ASTM-D-4833
Trapezoidal Tear.....	ASTM-D-4533
Apparent Opening Size (AOS)	ASTM-D-4751
Permittivity	ASTM-D-4491

- C. For high strength Geotextiles and Geogrids used for reinforcement application
 1. Ultimate tensile strength value
 2. Documentation showing long-term pullout interaction coefficients for various soil types or project specific soils.
 3. Strength reduction factors (partial safety factors) for creep deformation, installation damage, chemical and biological degradation certified by the National Transportation Product Evaluation Program (NTPEP) or an independent third-party laboratory.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Follow ASTM D 4873 for geosynthetic roll identification, storage and handling.
- B. Furnish geosynthetic rolls with suitable wrapping for protection against moisture and extended ultraviolet exposure before placement.
- C. Label or tag each roll with sufficient identification for inventory and quality control purposes.
- D. Store rolls in manner that protects them from elements mentioned above.
 1. If stored outdoors, elevate and protect with waterproof cover.

1.5 REFERENCE

- A. Task Force 25 refers to joint committee formed from AASHTO, American Building Contractors (ABC), and American Road Builders and Transportation Association (ARBTA).

PART 2 PRODUCTS

2.1 MATERIALS

- A. Fibers used in manufacture of geosynthetics, and threads used in joining geosynthetics by sewing:
 - 1. Long-chain synthetic polymers composed of at least 85 percent by weight polyolefins, polyesters, or polyamides.
 - 2. Formed in network so that filaments or yarns retain dimensional stability relative to each other, including selvages.
- B. Minimum values for geosynthetic properties represent numerical values with minimum average roll value from test results on any sampled roll in a lot and meeting or exceeding minimum values in the tables.
 - 1. Use value in weaker principal direction.
- C. Drainage and Filtration.
 - 1. Use geotextile to allow passage of water while retaining in-situ soil without clogging.
 - 2. Use drainage composite for wall drains to conduct fluid in its manufactured plane.
 - 3. Filter Geotextile.
 - a. Use nonwoven geotextile meeting geotextile properties for "moderate" degree of survivability following Task Force 25.

<u>Property (unit)</u>	<u>Value</u>
Grab Tensile Strength (lbs.)	130 min
Grab Tensile Elongation (percent)	25 min
Puncture Resistance (lbs.)	40 min
Burst Resistance (psi)	210 min
Trapezoidal Tear (lbs.)	40 min
Permittivity (sec-1)	1 min
AOS (sieve No.)	sands No.50 - No.70 silts/clays No.70 - No.100

- 4. Drainage Composite, Type A.
 - a. Use for retaining walls or structures less than 25 feet in height with sand, silt, or clay backfill soil.
 - b. Heat bond or glue to plastic or nylon geomat drainage core filter geotextile.
 - c. Minimum hydraulic transmissivity: 2 gpm/ft following ASTM D4716.
 - d. Use crush resistance in range of 2500 to 4500 psf, depending on height of wall or structure.
 - e. Apply lower range to heights up to 15 feet following ASTM D1621.
- 5. Drainage Composite, Type B.
 - a. Use for retaining walls or structures less than 25 feet in height with gravel or aggregate backfill.

- b. Heat bond or glue to core filter geotextile.
- c. The minimum hydraulic transmissivity: 10 gpm/ft.
- d. Use crush resistance in range of 2500 to 4500 psf, depending on height of wall or structure.
- e. Apply lower range to heights up to 15 feet.

D. Separation:

- 1. Use separation between aggregate and soil as shown on the contract documents or as directed by the Engineer.

E. Meeting requirements for SE geotextile per MDSHA Standard Specification for Construction and Materials (2008).

- 1. Use geotextile to minimize soil erosion due to construction activity and/or natural forces and to allow free passage of water while retaining in-situ soil without clogging.
 - a. Combine with select stone, soil material, and/or vegetation to achieve this goal.
- 2. Use for slope and scour protection for bridge piers and abutments, drainage channel/swales and stream crossings.
- 3. Temporary erosion control products that include natural fibers following Section 01570.
- 4. Erosion Control Geotextile.
 - a. Place stone from height of less than 3 feet and not exceeding 250 lbs.

Property (unit)Value

Grab Tensile Strength (lbs.)	200 min
Grab Tensile Elongation (percent)	20 min
Seam Strength (lbs.) ASTM D4884	180 min
Puncture Resistance (lbs.)	80 min
Burst Resistance (psi)	320 min
Trapezoidal Tear (lbs.)	50 min
Permeability (cm/sec) ASTM D4491-99a.....	kfabric >
ksoil Ultraviolet degradation at 150 hours	
ASTM D4355	70 percent strength retained.
AOS (sieve no.)	Greater than No 30 sieve on soil with 50 percent or less particles by weight passing No. 200 sieve. Less than No. 50 sieve on soil with more than 50 percent particles by weight passing No. 200 sieve.

F. Sediment Control.

- 1. Use geosynthetic as barrier to remove suspended particles from passing water.
- 2. Use geotextile as silt fence or sediment trapping device.

- a. Quantities of silt fence shown on plans may be increased or decreased at Engineer's direction based on weather, construction procedures, and actual site conditions that occur during construction of project.

<u>Property (unit)</u>	<u>Value</u>
Grab Tensile Strength (lbs.)	90 min
Grab Tensile Elongation (percent)	50 max
Puncture Resistance (lbs.)	40 min
Burst Resistance (psi)	190 min
Permittivity (sec-1)	0.01 min
AOS (sieve No.).....	No. 30 - No. 50

G. Roadways.

1. Use geosynthetic between pavement aggregates and soil subgrade as separating or reinforcing membrane and for paved and unpaved roadways and temporary access roads as shown on contract documents.
2. Geotextile Separator: Meeting requirements for SE geotextile per MDSHA Standard Specification for Construction and Materials (2008).

<u>Property (unit)</u>	<u>Value</u>
Grab Tensile Strength (lbs.).....	200 min
Grab Tensile Elongation (percent).....	40 max
Puncture Resistance (lbs.).....	80 min
Burst Resistance (psi)	400 min

H. Reinforcement and Slope Stabilization.

1. Use geotextile to construct soil reinforced embankments and retaining walls.
2. High strength Geotextile or Geogrid Reinforcement. Ultimate tensile strength determined by ASTM D4595 for geotextiles and ASTM D 6637 for geogrids.

- I. Barriers or Liners: Geomembrane with geotechnical engineering related material to control fluid migration in man-made project, structure, or system.

PART 3 EXECUTION

3.1 GENERAL

- A. To minimize potential damage of geosynthetics to elements, limit exposure, such as ultraviolet light and moisture, between lay down and cover to 5 days.
- B. Join geosynthetic by either sewing or overlapping and make seams following manufacturer's recommendations.
- C. Repair geosynthetic with geosynthetic patch placed over damaged area and extend 3 feet beyond perimeter of tear or damage or following manufacturer's recommendations.

- D. Install geosynthetic material in accordance with the manufacturer's recommendations.
- E. Place only that amount of geosynthetic material required for immediately pending work to prevent undue damage. Place at least 6 inches of fill over exposed geosynthetic within the same workday.
- F. Do not allow tracked construction equipment to operate directly over geosynthetic material. Place a minimum of 6 in. of uncompacted fill prior to operation of tracked vehicles over the geosynthetic material. Keep turning of tracked vehicles to a minimum to prevent tracks from displacing the fill and the geosynthetic material.
- G. Place riprap and stone on erosion control geotextile.
- H. For other applications.
 - 1. Do not drop riprap and heavy stone that is to be placed on top of geosynthetics from height exceeding 1 foot.
 - 2. Do not drop stones for slope protection and smaller size of stone filling onto geosynthetic from height exceeding 3 feet.

3.2 FILTRATION

- A. Install filtration geotextiles for applications including, but not limited to, wrapping aggregate drain, or as part of drainage composite.
 - 1. Soil in contact with filter geotextile to be smooth and free of large or sharp objects, which may puncture or tear geotextile.
 - 2. Place filter geotextile in direct contact with aggregates from base of wall or deeper when aggregate drain is used behind concrete retaining wall.
 - a. Place aggregates in lifts and roll geotextile up to height of each lift.
 - b. For each lift of aggregates place lift of backfill material on other side of filter geotextile.
 - c. Follow this sequence until height of wall is reached.
 - 3. For gabion retaining walls, place filter geotextile next to gabion wall.
 - 4. Roll geotextile upward along the wall as each specified lift of backfill material is placed.
 - 5. Place filter geotextile against trench to specified height when it is used for pipeline surrounded with uniform coarse aggregates or for underdrain system.
 - a. Prepare trench to be smooth and free of large, sharp objects that may puncture or tear geotextile.
 - b. Compact aggregates inside geotextile as previously specified herein.
 - c. Fold geotextile over the top of aggregates with 12-inch overlap.
 - d. Place general backfill above geotextile to top of trench.

3.3 DRAINAGE

- A. Install specified drainage composites for applications including, but not limited to, pore water dissipaters behind retaining walls.
 - 1. Place drainage composite behind and in direct contact with retaining walls.
 - a. As each lift of backfill material is placed, roll drainage composite upward along the wall unless otherwise specified by manufacturer.
 - b. Follow manufacturer's recommendations for anchorage and seals.

3.4 ROADWAYS

- A. Strip topsoil, clear and grub site, excavate or fill to grade; and remove soft areas detected during proof rolling and replace with compacted fill.
- B. Place geotextile or geogrid on prepared subgrade without wrinkles or folds; and overlap adjacent rolls using manufacturers overlap requirements.
- C. Check for damaged geotextile or geogrid before placing aggregate. Repair following manufacturer's recommendations.
- D. Place aggregate by end dumping onto geotextile or geogrid from the edge or previously placed aggregate.
 - 1. Keep construction equipment off geotextile or geogrid.
 - 2. Place aggregate so that minimum specified lift thickness is maintained between construction equipment and geotextile or geogrid at all times.
- E. Fill ruts with aggregate compacted to specified density.
- F. Repair any damage to geotextile or geogrid that occurs during placement of aggregate following manufacturer's recommendation.
 - 1. Modify placement procedures to prevent further damage from occurring.

3.5 TEMPORARY CONSTRUCTION ROADWAYS

- A. Before installing geotextile or geogrid, remove boulders, debris, stumps, and large logs.
 - 1. Do not remove low vegetation, root mat, and desiccated crust overlaying some soft organic soils.
- B. Extend geotextile or geogrid entire width of the roadway and follow manufacturer's recommended overlaps with 12 inches as minimum.
- C. Keep construction equipment off geotextile or geogrid until minimum 12 inches of aggregate is placed over fabric.
 - 1. For very soft soils, place minimum 18 inches of aggregate before construction equipment is allowed over geotextile or geogrid.

- D. Rut entire road surface with loaded rubber tire dump trucks after placing and leveling initial aggregate lift.
 - 1. Add next level of aggregate after uniform rutting of 2 to 4 inches is achieved.
- E. During roadway operations, repair rutting by additional aggregate and not by leveling of existing aggregate.

3.6 REINFORCEMENT AND SLOPE STABILIZATION

- A. Wrapped facing and structural facing are allowed.
 - 1. Unroll wrapped facing of geosynthetic perpendicular to wall face with at least 3 feet of geosynthetic draping over wall facing or used to form facing itself.
 - 2. Overlap adjoining rolls, perpendicular to wall facing, a minimum of 6 inches.
 - 3. Install structural facing using geosynthetic placed in alternating layers with soil to form a slope, with facing material following Drawings.
 - 4. If indicated on the Drawings, provide erosion mat to assist in vegetative growth on slope surface.
- B. Protection of Geosynthetic wall facing from vandalism and ultraviolet: Spray coated layer of compatible bituminous materials directly on geosynthetic with sand broadcast over surface.
- C. Placement and Compaction: Started with soil from area away from wall face and progress toward wall face.
- D. Place the geosynthetic reinforcement in continuous longitudinal strips in the direction of main reinforcement.
- E. Prior to placement, verify the correct orientation of the geosynthetic reinforcement per manufacturer's recommendations and Engineer's approval.
- F. Joints in the machine (strong) direction (perpendicular to the slope) are not permitted with geotextile or geogrid.
- G. Place geosynthetic reinforcement to lay flat and pull tight prior to backfilling.

3.7 EROSION AND SEDIMENT CONTROL

- A. Execute applications of geosynthetic for erosion and sediment control following Section 01570 and specified herein.
- B. Erosion Control Geotextile.
 - 1. Placement.
 - a. Place erosion control geotextile as shown on Standard Details without folds or wrinkles.

- b. Where erosion control geotextile is shown on Drawings, proceed to
 - 1) Form to lines and grades shown on Drawings.
 - 2) Place erosion control geotextile on prepared subgrade.
 - 3) Place sheets parallel to flow and slope.
 - 4) Overlap upstream sheet over downstream sheet and/or upslope sheet over downslope sheet with minimum overlap of 12 inches and stagger vertical overlaps minimum of 5 feet.
 - 5) Anchor sheets with securing pins inserted through geotextile along but not closer than 2 inches to each edge and at laps to prevent displacement before or during construction.
 - 6) Where erosion control geotextile is required below water line, alternate methods of anchorage will be considered upon submittal to Engineer.
 - 7) Replace geotextile damaged or displaced before, during, or after placement and repair at no cost to the Commission.
- c. Gravel blanket material (ASTM C33 No. 57 aggregate): Placed to depths and where shown on Drawings.
 - 1) Begin blanket material placement at toe and proceed up slope.
 - 2) In underwater applications, place geotextile and required thickness of blanket material the same day.
 - 3) Do not drop riprap and heavy stone onto geotextile from height of more than 1 foot.
 - 4) Do not drop slope protection and smaller size of stone filling onto geotextile from a height exceeding 3 feet.

END OF SECTION

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SECTION 02230
SITE CLEARING

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section includes requirements for clearing and grubbing areas within Contract limits of right of way and other areas shown, including work designated in permits and other agreements.
- B. All work including trimming, root pruning and removals: Performed by a Maryland Licensed Tree Care Expert under the supervision of a Maryland Certified Roadside Tree Care Expert.

1.2 DEFINITIONS

- A. Clearing: Removal from ground surface and disposal within designated areas, trees, brush, shrubs, down timber, decayed wood, other vegetation, rubbish, and debris as well as removal of fences and incidental structures.
- B. Grubbing: Removal and disposal of stumps, buried logs, roots larger than 2 inches, matted roots, and organic materials.

PART 2 PRODUCTS

(NOT USED)

PART 3 EXECUTION

3.1 DISPOSITION OF TREES IN PRIVATE PROPERTY

- A. General.
 - 1. Remove trees and shrubs within limits of disturbance unless otherwise indicated in Contract Documents.
 - 2. Do not cut or damage trees outside the proposed limit of disturbance indicated on the contract drawings unless indicated or written permission has been obtained from affected property owner.
 - a. Furnish 3 copies of permission to Engineer before removal operations commence.
- B. Trees and Shrubs to be Removed.
 - 1. Remove trees and shrubs to avoid damage to trees and shrubs designated to remain.

- a. On trees greater than 6 inches diameter at breast height (DBH) remove limbs, crown, and trunk in 8-to-10-foot sections, when necessary, to avoid damage to trees and shrubs designated to remain.
 2. Remove trees and shrubs felled within right of way to authorized disposal site following Section 01770.
 - a. Fill depressions created by removal with soils material suitable for backfill.
- C. Trees and Shrubs to be Saved.
 1. Protect trees and shrubs within right of way, construction strip, or work areas from defacement, injury, and destruction when delineated on Drawings or field marked to be saved.
 - a. See Standard Details for protection and limitations.
 2. Root Pruning.
 - a. When excavating near trees, prune roots 1 inch and larger. Utilize root pruning equipment specifically designed for this purpose.
 - b. When approved by Engineer, large circular saws used to cut concrete and rock saws may be used.
 - 1) Saw cut through roots to depth of required excavation.
 - 2) When excavating very close to trees, dig soil away with shovel, then cut exposed root with saw.
 3. Proceed with work within limits of tree drip line with extreme care, using either hand tools or equipment that will not damage trees.
 - a. Do not store materials or park equipment under drip line of trees to be saved.
 - b. Saw cut roots 1 inch and larger flush with trench wall on tree side of trench.
 - c. Backfill around tree roots immediately after completion of construction in vicinity of trees.
 4. Protect vegetation from damage by motorized equipment emissions.
 5. During working operations, protect trunk, foliage, and root system of trees to be saved with boards or other guards following Standard Details and to prevent damage, injury, and defacement.
 - a. Do not pile excavated material adjacent to base of trees.
 - b. Do not allow runoff to accumulate around base of trees.
 - c. Do not fasten or attach ropes, cables, or guy wires to trees without Engineer's permission.
 - 1) When permission is granted, protect tree before fastening or attaching, using burlap wrapping and softwood cleats.
 - d. Do not use axes or climbing spurs for trimming or trees to be saved.
 - e. Use climbing ropes during trimming and be responsible for damage resulting from these actions.
 6. Remove shrubs to be saved, taking sufficient earth ball with roots to maintain shrub.
 - a. Temporarily replant if required and replace at completion of construction in condition equaling what existed before removal.
 - b. Replace in kind if transplant fails following Section 02930 for transplanting, planting, watering, and guarantee.
 7. Perform tree and shrub repair where required, using tree expert licensed by State of Maryland, within 24 hours after damage occurred.

3.2 DISPOSITION OF TREES AND SHRUBS IN DEDICATED PUBLIC SPACE

- A. See Maryland Department of Natural Resources Forest Service's Roadside Tree Care standards and requirements for disturbance or removal of trees and shrubs in public space in Prince George's or Montgomery Counties, as set forth in permits for this Contract.

3.3 DISPOSITION OF CUT LOGS ON PRIVATE OR PARK PROPERTY

- A. When Contract Documents or special agreements require that felled trees be trimmed and cut into selected lengths and stored on site, stockpile them along edge of right of way or in areas requested by property owner or agent with Engineer's approval.
- B. Unless otherwise required, do not store logs within 100-year floodplain.

3.4 CLEARING AND GRUBBING

- A. Clear items specified herein to limits indicated and remove cleared and grubbed material from site.
 - 1. Do not start earthwork operations in areas where clearing is not complete.
 - 2. Stumps and root mats may be removed concurrently with excavation.
 - 3. Follow erosion, sediment control, and stormwater management measures specified elsewhere.
- B. Clear and grub areas to be excavated, areas receiving less than 3 feet of fill, and areas upon which structures are to be constructed.
 - 1. Remove stumps and root mats in these areas to minimum 1 foot below subgrade or slope surfaces.
 - 2. Fill depressions made by removal of stumps or roots with soils material suitable for backfill.
- C. Clear areas receiving more than 3 feet of fill and cut trees and shrubs as close as practical to existing ground.
 - 1. Grubbing will not be required.
- D. Do not burn without written permission from County Agency.
 - 1. Burn perishable material under constant care of competent watchmen.
 - 2. Burn at times and in manner to avoid jeopardizing material designated to remain on property, surrounding cover, and adjacent property.
 - 3. Disposal of ashes:
 - a. Off-site, or
 - b. Covered properly, or
 - c. Combined with soils material before restoration.
 - 4. Follow applicable laws and ordinances.

3.5 TOPSOIL

- A. Strip existing topsoil from areas to be excavated or graded before Work, and place in well-drained stockpiles in locations with Engineer's approval.

END OF SECTION

SECTION 02315
EARTHWORK FOR PIPELINE CONSTRUCTION

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section includes requirements for excavation, backfill, grading, and related items for pipeline construction.

1.2 DEFINITIONS

- A. Trench Zones.
1. Pipe Embedment Zone: Area surrounding pipe in trench, consisting of Bedding Zone, Haunching Zone, and Initial Backfill Zone defined herein.
 - a. Bedding Zone: Area from pipe bottom to firm subgrade, extending full width of trench and providing support for pipe
 - b. Haunching Zone: Area from pipe bottom up to as far as springline and extending full width of trench
 - c. Initial Backfill Zone: Area from top of Haunching Zone up to as far as 1 foot above top of pipe and extending to full width of trench.
 2. Final Backfill Zone: Area from top of Pipe Embedment Zone to finished grade, extending full width of trench.
 3. Additional Excavation: Excavation below trench bottom to remove unsuitable material such as rock, cobble, soft or organic soil, when Engineer determines that material is unsuitable to support pipe.
- B. Backfill Material.
1. Trench Backfill: Native or Borrow Material placed in trench excavation and meeting specifications herein.
 2. Borrow Material: Suitable material used for Trench Backfill provided from locations outside limits of trench excavation and meeting specification requirements herein.
 3. Bank run gravel: Aggregate material consisting of gravel and sand size particles taken directly from natural deposits, screened and meeting specification requirements herein.
 4. Crushed stone: Aggregate material produced by mining a suitable rock deposit, breaking the removed rock down to the desired size using mechanical crushers and meeting specification requirements herein.
 5. Structural Fill: Compacted Trench Backfill meeting specification requirements herein, to minimize future settlement and provide support or bearing for structures to be constructed upon or within fill.

- C. Pipe.
 - 1. Flexible Pipe: Ductile Iron Pipe (DIP), Polyvinyl Chloride (PVC) Pipe, and Type K Copper Pipe, Steel Pipe, and High-Density Polyethylene (HDPE) Pipe.
 - a. Pipe deriving its supporting strength primarily from passive pressures induced as pipe flexes outward against material in Pipe Embedment Zone.
- D. Paved Areas: Over which paving exists, or is to be placed under this Contract, or areas designated on Drawings to receive future paving: See Section 02950.
- E. Percent compaction: Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined per ASTM D 698 (AASHTO T 99) or ASTM D 1557 (AASHTO T 180) as specified.
- F. Optimum Moisture content: Gravimetric water content determined in accordance with ASTM Standards at which a specified maximum dry density can be achieved for a specified percent compaction
- G. Lift: Loose and uncompacted layer of material placed before compaction

1.3 QUALITY ASSURANCE

- A. Inspection and Testing.
 - 1. Quality Control (QC) Personnel Qualification: All field and laboratory tests shall be performed under the direct supervision of a Maryland registered professional engineer with a minimum of five (5) years of experience in construction inspection of geotechnical projects. QC soil technicians performing field tests shall maintain at least one of the following certifications:
 - a. Washington Area Council of Engineering Laboratories (WACEL): certification for foundation technician.
 - b. Mid-Atlantic Region Technician Certification Program (MARTCP) by Maryland State Highway Administration (SHA): certification for soils & aggregate compaction technician.
 - 2. Field Density Compaction Tests: Perform tests following ASTM D1556, ASTM D6938, or ASTM D2937 at minimum rate of 1 test for every 100 feet of fill for each lift along main trench and at every lateral trench (WHC, SHC, etc.), structure and valve box in Type I areas. If less than 100 feet of pipe is placed in a day, conduct at least 1 test per lift.
 - a. When field-testing indicates differences in soil types, reference and/or verify test results using one-step field proctors or laboratory proctors following ASTM D698 (AASHTO T99).
 - 1) For work on State, County or other roads with jurisdictional requirements: When field-testing indicates differences in soil types, reference and/or verify test results using one-step field proctors or laboratory proctors following ASTM D698 (AASHTO T99) for the compaction of the pipe embedment zone (haunch and initial backfill zones). Use the jurisdictional requirements for the final backfill zone.

- b. Perform field density compaction test as new mains are installed.
 - c. Re-excavate and recompact failed test areas, at 25-foot intervals, the entire trench depth and entire 100 feet length until retests meet above referenced standards.
 - d. Certified compaction test reports shall be submitted to the Commission within two (2) business days of the work being performed.
 - 3. Placing Trench Backfill and earthwork is subject to continuous inspection by WSSC.
 - a. Allow time for the Commission to perform spot tests after completion of each layer of fill in designated area.
 - b. Provide safe access and equipment to cut out smooth-surfaced spot locations designated by Contract Manager for testing.
 - c. The Commission may perform gradation and other tests on Trench Backfill.
- B. Finished Grade Settlement Limitations.
- 1. Guarantee backfilled trench excavation areas designated on Drawings will not pond or settle in excess of following limitations.

<u>Designations</u>	<u>Settlement Limitations</u>	<u>Locations</u>
Type I	0.05 foot	Paved areas and public rights of way
Type II	with positive drainage	Unimproved areas
Type III	0.10 foot	Nonpaved improved areas
Type IV	0.00 foot	Wetlands or wetlands buffer

- 2. Remove and replace Trench Backfill which settles in excess of above limitations with suitable material at no cost to the Commission.
- 3. Remove and replace piping, structures, paving, landscaping, and other site improvements damaged by settlement or repair following Contract Documents, at no cost to the Commission.

1.4 SUBMITTALS

- A. Submit following Section 01330.
 - 1. Working drawings showing sheeting and shoring, and method of dewatering, for structure excavations deeper than 8 feet and larger than 400 square feet.
 - 2. Samples of Borrow Material, except for Borrow Aggregate.
 - a. Size: Minimum of 30 pounds in sturdy cloth or plastic bags.
 - b. In addition to sample identification required in Section 01330, clearly label each sample showing type and material designation, intended use, name and address of supplier, and location where material is mined or manufactured.
- B. Delivery of Borrow Material.
 - 1. Submit prior notification of source, designation, quantity, and intended use for all Borrow Material.
 - 2. Submit delivery tickets with each load of Borrow Material.
 - a. Name and location of supplier.

- b. Type and amount of material delivered, including ASTM's and the Commission's material designations.
- C. Submit following Section 01450.
 - 1. Certificate of Compliance: When recycled concrete is used, submit letter from governing jurisdiction approving its use.
 - 2. Certified Test Reports: Borrow Aggregate.
 - a. In addition to requirements of Section 01450, include information showing type and material designation, intended use, name and address of supplier, and location where material is mined or manufactured.
- D. For Flowable Fill see Section 03300.
- E. Submit Soil's Compaction Reports as follows:
 - 1. Certified by Professional Engineer registered in State of Maryland.
 - 2. Borrow material – Soil classification results per ASTM D 2487 including gradation per ASTM D 6913 /D 7928 as applicable and Atterberg limit tests per ASTM D 4318.
 - 3. Field Density Compaction Test Results. Include all corrections used on field compaction tests conducted per ASTM 6938.
 - 4. Contract Number.
 - 5. Soils Technician's Name and Employer.
 - 6. Test Number.
 - 7. Date of Test.
 - 8. Location of Test (sewer and/or water station, lot number and street name).
 - 9. Retest results of previous tests (and number), if required.
 - 10. Depth of Test.
 - 11. Dry Density.
 - 12. Moisture Content.
 - 13. Maximum Density/Optimum Moisture Curve Relationship Chart following ASTM D698.
 - 14. Test Results.
 - 15. One Step Proctor Determination (when taken).
 - 16. Additional Comments.
 - 17. Submit test results to the Engineer within 2 weeks of test and 3 business days prior to testing mains and/or performing tie ins.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Detectable Warning Tape
 - 1. Description.
 - a. Size: Six-inch width, minimum 5 mils thickness.
 - b. Printing: Two lines, minimum 3/4-inch-high lettering on each line, repeated continuously along length of tape at intervals no greater than 3 feet.

- 1) Water: CAUTION - WATER LINE BURIED BELOW
CALL WSSC 301-206-4002
 - c. Colors.
 - 1) Tape:
 - a) Blue for water.
 - 2) Lettering: Black.
 2. Approved Manufacturers:
 - a. Empire Level Mfg. Corp., Magnatec
 - b. Pro-Line Safety Products (A Division of Pro-Pak Ind., Inc.); Product Nos. 103141251wssc (blue), 103143191wssc (green), and 103128013wssc (yellow)
 - c. Reef Industries, Terra Tape Sentry Line Detectable
- B. Non-Detectable Warning Tape
1. Description.
 - a. Size: Six-inch width, minimum 4 mils thickness.
 - b. Printing:
 - 1) Option 1: Two lines, minimum 1-inch-high lettering on each line, repeated continuously along length of tape at intervals no greater than 2 feet.
 - a) Restrained joint pipe: CAUTION – RESTRAINED JOINT PIPE
CALL WSSC 301-206-4002
 - b) The international “no-dig symbol” shall follow each cycle of text
 - 2) Option 2: Three lines, minimum 1-inch-high lettering on each line, repeated continuously along length of tape at intervals no greater than 2 feet.
 - a) Restrained joint pipe: CAUTION – RESTRAINED JOINT PIPE
CALL WSSC 301-206-4002
 - b) The international “no-dig symbol” shall follow each cycle of text
 - c. Colors.
 - 1) Tape:
 - a) APWA Red for restrained joint pipe.
 - 2) Lettering: Black.
 2. Approved Manufacturers:
 - a. Blackburn Manufacturing Co. Inc., Non- detectable Underground Utility Warning Tape
 - b. Empire Level Utility Products Division, Shieldtec Underground Warning Tape
 - c. In Stock Now! Inc., Non-Detectable Warning Tape, Product No. Nd6rdci
 - d. Mutual Industries, Non-Detectable Underground Marking Tape, Product No. 17783
 - e. Pro-Line Safety Products (a division of pro-pak ind., inc.), Standard 4 mil Non- detectable, Product No. 104346283wssc.
 - f. Reef Industries, Inc., Terratape Standard Non-detectable
 - g. Safety Sign Company, Warnoline Underground Utility Warning Tape

C. Trench Backfill.

1. General Trench Backfill Requirements.

- a. Outside Wetland Areas: Free of organic or frozen material, waste metal products, construction debris, unsightly debris, toxic material, environmentally contaminated soils, materials removed as rock excavation or other deleterious materials and at moisture content permitting compaction to density specified.
 - 1) Clean coarse-grained soils classified per ASTM 2487 as GW, GP, SW, SP
 - 2) Coarse grained soils with fines, Sandy or Gravelly fine-grained soils classified per ASTM 2487 as GM, GC, GW-GC, SP-SM, SM and SC
 - 3) In organic fine-grained soils with less than 30% retained on No. 200 sieve classified per ASTM 2487 as ML and CL
- b. Within Wetlands Areas: Previously excavated native material which can include organic matter, but free of frozen material, waste metal products, unsightly debris, toxic material, or other deleterious materials used only for final backfill zone
- c. Fine grained soils with organics classified per ASTM D 2487 as MH, CH, OL, OH or Pt shall not be used in the pipe embedment zone.
- d. Material Excavated from Trench and meeting these requirements: Use when approved by Engineer; otherwise excavate, haul, and place Borrow Material.

2. General Borrow Material Requirements.

- a. Outside Wetland Areas: Meet General Trench Backfill Requirements for Outside Wetland Areas, stated herein.
- b. Within Wetland Areas: Soil material meeting requirements of ASTM D 2487 or 2488, material classification types SM, SC, ML, or CL but be free of frozen material, waste metal products, unsightly debris, toxic material, or other deleterious materials used only for final backfill zone
- c. Acceptance of Borrow Material from any location outside limits of trench excavation, shall not be construed as approval of entire Borrow Material site, but only insofar as material continues to meet specified requirements, herein.

3. Borrow Aggregate.

- a. Standard Sizes of Aggregate: ASTM C33, coarse aggregate.
- b. Dry Concrete Sand: ASTM C33, fine aggregate.
- c. Crushed stone, graded aggregate base (GAB), or bank run gravel.
 - 1) Aggregate Test Requirements:
 - a) Maximum Sodium Sulfate Soundness (ASTM C88): 12 percent.
 - b) Maximum Los Angeles Abrasion (ASTM C131): 50 percent.
 - c) Maximum Flat and Elongated (ASTM D4791) for crushed stone only: 15 percent.
 - 2) Gradations: Conform to Table of Borrow Aggregate Gradations.

Borrow Aggregate Gradations

(Based on Table “901-A”, July 2008 MSHA Standard Specifications for Construction and Materials)

Sieve Size	Percent Passing Each Sieve by Weight			
	¹ Bank Run Gravel Number 1	² Bank Run Gravel Number 2	³ Crushed Stone Number 3 (GAB)	⁴ Crusher Run Number 4 (CR-6)
			Design Value	Design Value
2-1/2 inch	100	100		
2 inch			100	100
1-1/2 inch			95-100	90-100
1 inch	85-100	90-100		
3/4 inch			70-92	60-90
1/2 inch	60-100	60-100		
3/8 inch			50-70	
Number 4			35-55	30-60
Number 10	35-75	35-90		
Number 30			12-25	
Number 40	20-50	20-55		
Number 200	3-20	5-25	0-8	0-15

¹MSHA - Base Bank Run Gravel

³MSHA - Base Graded Aggregate

²MSHA - Subbase Bank Run Gravel

⁴MSHA - Crusher Run Aggregate

4. Flowable Fill: Section 03300.
5. Recycled Concrete: Free of waste metal products, unsightly debris, toxic material or other deleterious materials and meeting Gradation and Aggregate Test Requirements for Borrow Aggregate, as stated herein.
6. Bentonite: 100 percent high-swelling granular sodium Bentonite, with maximum moisture content of 12 percent.
 - a. Approved Manufacturers:
 - 1) American Colloid Company.
 - 2) Wyo-ben Inc.
 - 3) Bentonite Performance Minerals LLC.
7. Structural Fill: Meet material requirements of Trench Backfill and compaction requirements stated herein.
8. Backfill Requirements for Different Types of Pipes.
 - a. Additional Excavation Area Below Pipe Embedment Zone for Outside and Within Wetland Areas:
 - 1) Compacted general trench backfill meeting requirements
 - 2) Borrow Aggregate meeting requirements of ASTM C33, coarse aggregate size number 57
 - 3) Use geotextile to separate pipe embedment zone material and aggregate in additional excavation area when migration of fines is a concern.
 - b. Pipe Embedment Zone: Requirements for Outside and Within Wetland Areas Specified below for each pipe material:
 - 1) External coating system or polyethylene encased DIP 24 inch and smaller, following Detail M/8.1a:
 - a) Specified in General Trench Backfill Requirements for Outside Wetland Areas.
 - b) Containing no rock or gravel larger than 1-1/2 inches in greatest dimension.
 - c) Liquid limit: Not to exceed 30.
 - d) Plasticity index: Not to exceed 6.
 - e) Dry density: Not less than 105 pounds for each cubic foot as determined by ASTM D698.
 - c. Final Backfill Zone Materials Outside Wetland Areas:
 - 1) Specified in General Trench Backfill Requirements.
 - 2) Containing no rock or gravel larger than 3 inches from top of Pipe Embedment Zone to 2 feet above.
 - 3) From 2 feet above Pipe Embedment Zone to finished grade, no rocks larger than 8 inches in greatest dimension, unless contained in sufficient matrix of soil to avoid point to point contact, except:
 - a) Type I areas, under existing paving, top 30 inches below pavement base course, unless indicated otherwise in Trench Detail for Paved Areas located under ATTACHMENTS: Borrow Aggregate, gradation number 3 crushed stone. Flowable fill and recycled concrete may be used instead of Borrow Aggregate, as specified below:

- (1) Flowable fill, unless otherwise shown on Drawings, from top of Pipe Embedment Zone to below pavement base course, if approved by roadway governing jurisdictions.
 - b) Type I areas, under future paving and within 5 feet of structure, and Type III areas: Top 12 inches below proposed pavement base course or finished grade containing no rocks or gravel larger than 3 inches.
 - d. Final Backfill Zone Materials within Wetland Areas: Specified in General Trench Backfill Requirements, herein.
 - D. Backfill Requirements for Structures.
 - 1. Granular Bedding for Precast or Cast-in-place Structures:
 - a. Granular Bedding Borrow Aggregate: ASTM C33, coarse aggregate size number 3.
 - b. Borrow Aggregate for Additional Excavation Area below Granular Bedding: ASTM C33, coarse aggregate size number 3.
 - 2. Granular Bedding for On-Grade Slabs: Borrow Aggregate meeting ASTM C33, coarse aggregate size number 3.
 - 3. Backfill for Precast or Cast-in-place Structures: Trench Backfill in Final Backfill Zone, unless otherwise shown on Drawings.
 - a. Flowable fill may be used instead of Trench Backfill material for circular shape precast and cast-in-place concrete manholes.
 - E. Trench Erosion Checks.
 - 1. Wood: Follow Details.
 - F. Sheet piling, Shoring, and Bracing Materials.
 - 1. Timber, steel, or combination thereof, designed as required to retain earth around structure, prevent cave-in and settlements, and to fulfill MOSH safety requirements.
 - a. Timber: Structural grade with minimum working stress of 1,100 psi.
 - b. Steel Sheet Piling: ASTM A328, continuous interlocking type.
 - c. Struts, Bracing, and other Accessories Required for Sheet Piling System: ASTM A36.

PART 3 EXECUTION

3.1 EXCAVATION

- A. General: Excavate to lines and grades indicated on Drawings.
 - 1. On-grade Slabs and Pavements: Sufficient to allow for fills, base, and waterproofing materials.
 - 2. Planting Areas: Sufficient to allow for topsoil.
 - 3. Formed Concrete: Sufficient to allow for convenient construction and removal of forms, and for application of waterproofing and curing materials.

- B. Test Pit Excavation: Perform with caution and to prevent damage to facility.
 - 1. Special Requirements: Section 02510.
- C. Material Storage and Disposal of Unsuitable Material.
 - 1. Separate and protect excavated material which is suitable Trench Backfill from contamination by unsuitable excavated material or by other sources.
 - 2. Stockpile suitable materials in location approved by Engineer to avoid contamination and prevent erosion.
 - 3. See Section 02576 for off-site disposal of excess excavated material and unsuitable material.
 - 4. See Section 02230 for site clearing and storage of existing topsoil.
- D. Unauthorized Excavation: Where excavations are made below indicated elevations under slabs, footings, pipes, structures, or outside maximum trench pay widths, restore to proper elevations with materials specified herein at Engineer's direction, at no cost to the Commission.
- E. Trench Excavation.
 - 1. Excavate trenches to width and depth following Details, Drawings, or specified herein.
 - a. Sides of trenches within Pipe Embedment Zones: Practically plumb.
 - 2. Trench widths within Pipe Embedment Zone for Rigid Pipe shown on Details are maximum widths. Trench excavation in paved roads
 - a. Keep heavy equipment as far away as possible from the edges of trenches to minimize trench wall sloughing.
 - b. Clearly mark cut boundaries perpendicular or parallel to roadway and traffic.
 - c. Full depth bound pavement materials should be cut using saw cut, mechanical hammer or other appropriate methods that minimizes damage to adjacent pavement sections.
 - d. Use of a backhoe bucket to directly break pavement is not allowed.
 - e. Do not rock mechanical hammer while cutting pavement.
 - 3. Remove rock, when encountered, to minimum depth of 6 inches below pipe barrel and pipe bell and structures.
 - a. Excavate trench bottom to conform to shape and dimensions of proposed pipe or structure.
 - b. Excavate bell holes in trench bottom to permit proper assembling of joints.
 - c. Support pipe or structure uniformly and continuously, upon specified material.
 - 4. Where material not meeting requirements of Trench Backfill and deemed unsuitable by Engineer is encountered either contiguous to or within proposed limits of excavation, Engineer may direct additional excavation and removal of unsuitable material.
 - a. Depth and extent of additional excavation at Engineer's determination.
 - b. Do not use saturated excavated material from trenches as a backfill.

5. Perform excavation in immediate vicinity of adjacent and crossing facilities by means that will not damage facility.
 - a. Excavate within 1 foot of existing pipelines or conduits by hand.
 - b. Repair or replace damage caused to existing facilities, pipelines, or conduits at no cost to the Commission.
6. Unless otherwise authorized by Engineer, proceed with trench excavation no more than 40 feet in advance of placing of Trench Backfill.
 - a. Engineer may require backfilling and subsequent re-excavation on trenches left open in advance of pipe installation, at no expense to the Commission.
 - b. Protect or enclose trenches left open overnight, or during periods when Contractor's personnel are not present and mark to prevent danger to public or others.
7. Excavate sides of trenches in improved public areas and adjacent to other utilities or structures practically plumb.
 - a. When crossing under existing pipes or conduits, plumb sides of trench from 1 foot above top of existing pipes or conduits to bottom of trench.
 - b. With Engineer's permission, sides of trenches in other areas may be sloped from 1 foot above top of pipe to finished grade, at no additional cost to the Commission.
8. Trench Sheet piling, Shoring, and Bracing: Place so as not to interfere with construction work and be entirely independent of footings and structures.
 - a. Method, design and adequacy of sheet piling, shoring and bracing: Meet requirements of MOSH.
 - 1) Repair damage related or caused by excavation at no cost to the Commission.
 - 2) Sheet piling, shoring, and bracing: Before placement, use means acceptable to Engineer for its removal as backfill progresses.
 - b. Sheet and shore as required to assure safe working conditions, maintain required excavation dimensions for proper construction, and to prevent accidents, cave-ins, and damage to adjacent structures, facilities, and surfaces.
 - 1) In excavations over 4 feet in depth, where Commission personnel are required to enter, sheet piling and shoring shall meet requirements of MOSH for Type "C" soil conditions.
 - c. Remove sheet piling, shoring, bracing and wood forms concurrently with backfilling operations, except in Pipe Embedment Zone and where sheet piling is used as 1 side of form for concrete.
 - 1) Accomplish removal in manner that precludes settlement of backfill, cave-in of excavation sides, and prevents damage to adjacent surfaces.
 - 2) Promptly fill voids left or caused by removal.
 - 3) Compact contiguous areas concurrent with removal of trench sheet piling.
 - d. Follow Details where sheet piling is used for trench width between interior faces of sheet piling.

- e. Sheeting may be left in place, provided that following are met:
 - 1) Positive verification that no voids exist between sheeting and trench wall.
 - 2) Upper wales and horizontal braces are removed, or excavation is backfilled with sand.
 - 3) Existing voids are filled following Trench Backfill requirements.
 - a) Sheeting left in place: Cut off minimum of 1-1/2 feet below finished grade or at Engineer's direction.
- 9. Trench Boxes or Mules: Use of trench boxes: Permitted in areas where excavation sidewalls are suitable and where sheeting, shoring, and bracing are not required to maintain excavation dimensions.
 - a. Structural box design: To withstand pressures imposed thereon.
 - 1) Trench boxes and steel plates and their use: Meet requirements of MOSH.
 - b. Location:
 - 1) Do not extend trench box below top of Pipe Embedment Zone during or after placement of Pipe Embedment Zone material.
 - 2) Remove steel plates used below trench box in Pipe Embedment Zone simultaneously with placement of Pipe Embedment Zone material and before its compaction.
 - c. Box size:
 - 1) Height: Sufficient to assure safe working conditions.
 - 2) Length: To accommodate size and lengths of pipe being installed.
 - 3) Width: For trench opening not more than maximum permitted in Details.
- F. Dewatering and Drainage.
 - 1. Investigate to determine if water is present, whether or not it is indicated within Contract Documents.
 - a. Presence or absence of water will not entitle Contractor to additional compensation.
 - 2. If water is encountered in excavation, install and maintain dewatering system of sufficient capacity to remove it during excavation, pipe placement, and backfill.
 - a. For structures:
 - 1) Until concrete footings have been poured and cured,
 - 2) Walls or other portions of structure are erected to grade,
 - 3) Or until excavation has been backfilled.
 - b. Do not allow sediment-laden water to flow into watercourses, drainageways, or over land without first filtering it through approved desilting device. See Section 01570.
 - 3. Choose methods of dewatering excavations including, but not limited to, sump pumps, wellpoints, deep wells, drainage blankets, and tight sheeting.
 - a. Continuously inspect dewatering system to ensure it is functioning properly.

- b. Ensure system does not disturb or degrade final subgrade for new pipe or structure and does not cause damage or settlement to adjacent surfaces or structures.
 - c. Modify system as required, and repair or restore damage or disturbance caused by system at no cost to the Commission.
 - d. Install necessary temporary surface drainage and keep it operating to Engineer's satisfaction, until permanent drainage or finish grading has been completed.
 - e. Do not allow damming or ponding of water in gutters or storm drains.
4. Remove dewatering devices upon completion of work at Engineer's direction.

3.2 BACKFILL OPERATIONS

A. Placing Trench Backfill.

- 1. Backfill trench excavations with soils material excavated there from, provided this material meets requirements of Trench Backfill herein and at Engineer's approval.
- 2. Do not place, spread, or compact frozen or thawing material or place specified materials upon frozen or thawing ground or during unfavorable weather conditions.
 - a. When work is interrupted by rain, do not resume backfill operations until field tests indicate moisture content and density of materials are within specified limits.
 - b. Rework and recompact after thawing compacted layers which have been frozen before next layer is placed.
 - c. Interruptions in backfill operations due to weather: At no cost to the Commission.
- 3. Mix each lift before compaction to ensure uniform distribution of water content and distribute rocks of permissible sizes through material.
- 4. Place Trench Backfill and utilize compaction equipment that will not damage structures, pipe, and appurtenances.
 - a. Place and compact Trench Backfill around pipe and structures evenly to preclude unbalanced pressure.
 - b. Compaction with large rollers or heavy equipment will not be permitted within 5 feet of structures.
 - c. Repair damage done during backfill operations or replace at Engineer's direction, at no cost to the Commission.
- 5. Place Trench Backfill in uniform lifts of 8 inches maximum in uncompacted thickness, unless otherwise specified herein.
 - a. Spread each layer uniformly and evenly.
 - b. Perform compaction using compacting rollers, pneumatic or vibratory compactors, or other equipment and methods with Engineer's approval.
- 6. When Borrow Material is utilized, place in uniform lifts of 8 inches maximum in uncompacted thickness, or at Engineer's direction.

- a. Any change in lift thickness is based on test sections and tests under Engineer's direction and observation, and dependent upon type of compaction equipment used.
 - b. All compaction work shall be performed using suitable equipment such as sheep foot roller or pneumatic and/or vibratory plate type compaction equipment. Cohesive fine grained backfills are best compacted with pressure, impact or kneading equipment. cohesionless backfills are best compacted with vibration equipment.
 - c. Use of backhoe buckets is not permitted for gravel compaction.
 - 7. Backfill Structural Fill areas in uniform lifts of 8 inches maximum in uncompacted thickness and compact to not less than 95 percent of maximum dry density, following ASTM D698, at moisture content within 2 percent optimum for material.
 - 8. Meet following conditions when flowable fill is used instead of Trench Backfill material when specified herein for Type I areas under existing paved areas and for circular precast or cast-in-place concrete manholes.
 - a. Prevent floatation during placement of flowable fill.
 - b. Install 12 inches minimum of Trench Backfill material around valves, valve boxes, and fire hydrants.
 - c. Place flowable fill at maximum of 10-foot lifts.
 - 1) Cure flowable fill at least 4 hours before placing additional lift of flowable fill.
 - 2) Cure final lift at least 24 hours before placing additional compacted Trench Backfill material or paving.
 - d. For circular precast or cast-in-place concrete manholes, when specified herein, place flowable fill equally around entire manhole from 1 foot above uppermost pipe entering manhole.
 - 1) Backfill trench with flowable fill from top of Pipe Embedment Zone to below pavement base course.
 - 2) Outside Type I areas backfill minimum 12 inches Trench Backfill material above flowable fill.
- B. Placing Trench Backfill for Pipes.
- 1. Do not backfill around pipe, connections, or fittings until Engineer completes measurements and locations.
 - 2. Detectable Warning Tape
 - a. Use blue detectable warning tape for water mainline.
 - b. When water and sewer are installed in same trench use only blue detectable tape.
 - c. Use yellow detectable warning tape for externally coated ductile iron pipelines and test station lead wires.
 - d. Place tape directly over centerline of pipe the full length of trench, 18 to 30 inches below finished surface and with minimal number of splices.
 - 1) Overlap tape minimum 6 inches at splices and intersections.
 - 3. On steep slopes, place trench erosion checks following Details, at locations shown on Drawings or at Engineer's direction.

4. When pipelines cross under existing utilities, use flowable fill.
5. When connecting to existing pipelines, backfill under and around excavated and undermined existing pipes with Trench Backfill compacted as structural fill:
 - a. Backfill existing Rigid Pipe to pipe springline with Borrow Aggregate ASTM C33, coarse aggregate size number 67, or same Borrow Aggregate as used at connecting or adjacent pipe.
 - b. Backfill existing Flexible Pipe to 1 foot above top of pipe.
 - 1) DIP 24 inch and smaller and Type K Copper Pipe: Trench Backfill.
6. Place and compact specified Trench Backfill in following Zones to width and depth following Details and Drawings, unless otherwise specified.
 - a. Additional excavation area below Pipe Embedment Zone: Place as Trench Backfill and compact as Structural Fill.
 - b. Bedding zone: details M/8.0, M/8.1b, M/8.1C
 - 1) Place bedding material in the bottom of the trench in loosely placed uncompacted lifts no greater than 6 inches.
 - 2) Shape the bedding material to evenly support pipe at the proper line and grade, with full contact at the bottom of the pipe.
 - c. Pipe Embedment Zone (haunch and initial backfill zones): Place and compact Trench Backfill as Structural Fill.
 - 1) DIP, 24 inch and smaller: If additional excavation below trench bottom is required to remove unsuitable material, install minimum 6 inches of compacted Trench Backfill between pipe and additional excavation material.
 - 2) All sizes of DIP with external coating system or polyethylene encasement: Place Trench Backfill around pipe without damaging pipe coating and polyethylene encasement.
 - a) Do not drop Trench Backfill directly on pipe; use deflecting boards or other temporary protection.
 - b) Do not permit workers to walk on or place tools on pipe.
 - 3) Pipe Embedment Zone within Wetland Areas: Extend from trench bottom to 6 inches above pipe, full width of trench.
 - 4) Pipe to have concrete encasement: Place around pipe within Pipe Embedment Zone, to limits shown on Details.
 - d. Final Backfill Zone: Place Trench Backfill and compact following these designation types. Trench Backfill not meeting requirements herein: Re-compact at no cost to Commission.
 - 1) Type I areas under existing paving:
 - a) Compact to not less than following percents of maximum dry densities at moisture content within 2 percent of optimum for material, as determined by listed ASTM method.
 - (1) MSHA highways: 92 percent except for top foot below pavement subgrade, and 97 percent for top 1-foot following ASTM D1557.
 - (2) All other paved areas: 95 percent except for top foot, which will be 100 percent following ASTM D698.

- 2) In Type I areas under future paved areas and within public rights of way: Compact to not less than 95 percent of maximum dry density following ASTM D698 at moisture content within range where density can be obtained based on moisture density curves taken on existing soil.
- 3) In Type II: Compact in layers to form thoroughly dense refill free of voids and to preclude settlement within limits specified herein.
- 4) In Type III areas: Place in 12-inch maximum lifts and compact to not less than 90 percent of maximum dry density, following ASTM D698, at moisture content within range where density can be obtained.
- 5) In Type IV areas: Place in 12-inch lifts.

C. Placing Trench Backfill for Structures.

1. Place and compact specified backfill material to width and depth following Details, Drawings, and specified herein.
 - a. Additional excavation area, below Granular Bedding: Place and compact Trench Backfill as Structural Fill.
 - b. Granular Bedding, under structure: Place and compact specified herein.
 - c. Place and compact Trench Backfill as Structural Fill to top of structure or to finished grade, following Drawings or Details.

D. Finished Grade.

1. Grade areas disturbed during Work to existing grade before disturbance, unless otherwise noted on Drawings, Details, or with Engineer's approval.
2. Slope surface to drain, to provide positive drainage in Type I, II, and III areas.

3.3 RESTORATION

- A. Restore and re-stabilize surface features and facilities damaged or destroyed during construction at least to condition existing before construction, following Section 01770, and other applicable Specification Sections.

END OF SECTION

SECTION 02510
WATER SYSTEM PIPING, VALVES & APPURTENANCES

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section includes requirements to furnish, construct, and test piping for water supply and distribution system, including fire protection.

1.2 REQUIREMENTS FOR MANUFACTURERS AND SUPPLIERS AND CONTRACTORS BEFORE DELIVERY

- A. Conduct quality assurance for furnished pipe, fittings, and valves following standards specified herein.
- B. Commission may inspect materials, including in-plant testing of valves, following Section 01450.
- C. Quality assurance for precast concrete utility structures is specified in Section 03400.
- D. Tapping Contractor: Performed successful pressure taps on cast iron, ductile iron pipe (DIP), or polyvinyl chloride (PVC) water mains.
- E. PVC pipe manufactured more than 12 months prior to installation will not be accepted.

1.3 SUBMITTALS

- A. Submit following Section 01330.
 - 1. Manufacturer's shop drawings showing valves, operators, gear ratios, design flows, and pressure differential, performance charts, and parts list for all valves 6 inch and larger.
 - 2. Waiver for pipe and fittings, valves, and precast concrete structures, fire hydrants. Submit letter naming the manufacturer who has on file with the Commission a certified standard drawing containing required Commission approved information. Provide new submittals if specifications change.
- B. Submit following Section 01450 on Contractor provided materials.
 - 1. Certificates of Compliance or Materials Checklist Furnished by the Contractor, for all applicable materials specified herein.
 - 2. Manufacturer's Certificates: Submitted for installation of items of equipment when required in the Contract Documents.
 - a. It has been installed under either continuous or periodic supervision of manufacturer's authorized representative.
 - b. It has been adjusted and initially operated in presence of manufacturer's authorized representative.

- c. It is operating following specified requirements.
- 3. Manufacturer's Certified Test Reports:
 - a. Valves 6 inches and larger:
 - 1) Tests specified in the referenced standards.
 - 2) Tests performed on valves and valve operators.
- C. Tapping Sleeve and Valve or Tapping Assembly and Valve: Submit before main is tapped.
 - 1. Installation and testing instructions.
 - 2. Recommended maximum test pressure and length of time for testing assembly using water as test medium.
- D. Submit for information only:
 - 1. Submit copies of WSSC approved tapping card, MDE Sediment and Erosion Control Certification and American Traffic Safety Services Association (ATSSA) flagger certification.

1.4 STORAGE AND HANDLING

- A. Engineer will inspect materials on site before installation following Section 01450.
- B. Loading, unloading, handling, inspection, and storage of pipe, fittings, valves, joint accessories, and appurtenances: Follow AWWA C600 and AWWA C605 as well as AWWA C900, and as specified herein.
- C. Storage: Store pipe, fittings, valves, and appurtenances off ground using sound wood blocks placed on stable foundation or using other appropriate means. Allow space between rows, individual pieces and bundles with clearance below and above to allow full view for inspection purposes.
 - 1. Store in well-drained area away from brush and accessible for inspection.
 - 2. Do not stack pipe higher than 54 inches high.
 - 3. Keep spigot ends of pipe clean and clear for dimensioning purposes.
 - 4. Do not place excavated or other material over or against stored material.
 - 5. PVC pipe:
 - a. Store so it does not deform or bend.
 - b. Pipe stored outdoors or otherwise exposed to direct sunlight: Cover with canvas or other opaque material with provision for adequate air circulation.
- D. Handling: Unload and handle materials with crane, backhoe, or equipment of adequate capacity, equipped with appropriate slings or padding to protect materials from damage. Use of chains for handling pipe is not permitted.
- E. Repair or Replacement:
 - 1. Repair damages or defects following approved manufacturer's recommendations.
 - 2. Remove and replace at no cost to the Commission materials deemed not repairable.

PART 2 PRODUCTS

2.1 MATERIALS

A. Pipe and Fittings.

1. General:

- a. Provide pipe and fittings of same size and material by same manufacturer, marked with manufacturer's name or trademark.
- b. Bolts and nuts: Marked, cast, or forged with identification of material and producer. Painted markings are not acceptable.
- c. All water mains shall be AWWA C-900 DR-18 PVC.
- d. All process piping within proposed well house building shall be Schedule 80 PVC.

2. Zinc Coated DIP:

- a. External Coating for Ductile Iron Pipe: Zinc Coating conforming to AWWA C150 and C151 with the following minimum properties or approved equal.
 - 1) Coating system shall conform to ISO 8179
 - 2) Coated with a layer of arc-sprayed zinc.
 - a) 200 g of zinc shall be applied per m² of pipe surface area.
 - 3) Asphaltic top-coat shall be applied. The mean dry film thickness shall be greater than or equal to 3 mils. The local allowable minimum thickness is 2 mils.
 - 4) Interior surface shall be cleaned and lined at the pipe casting facility with a standard thickness cement-mortar lining applied in conformity with AWWA C104. An asphalt seal coat may be applied to the surface of the cement-mortar lining if part of manufacturer's standard practice.
 - 5) Pipe bell shall be painted with white or gray paint to signify the pipe is zinc coated.
 - a) Alternatively, the manufacturer's name can be marked in the approximate middle of the barrel followed by the word "Zinc" with a 2-inch-wide circumferential band of silver / gray-toned coating applied approximately 2-inches on both sides of that marking.
 - 6) Piping and flanges located within a vault shall follow all specifications for Zinc Coated DIP specified above except pipe and flanges are permitted to be painted by the manufacturer with paint that has a minimum of 85% zinc in the dry film. Arc-spray technique for zinc coating application is not required but is permitted for pipe and flanges within vaults and if used shall follow specifications provided above.
 - a) Approved Manufacturers of zinc paint
 - Tnemec Series 90-98
 - Rustoleum Cold Galvanizing paint
- b. Handling, Transportation and Storage: per AWWA C600.

- c. Class: Unless otherwise shown on Drawings, follow Special Thickness Class in AWWA C151, minimum Class 54 for 4 inch through 54 inch.
 - d. Lengths:
 - 1) 18 or 20 feet.
 - 2) Pipe provided for installation on curved alignment: Pipe lengths that will not require joint to be deflected more than 80 percent of manufacturer's recommendation.
 - e. In addition to markings required in AWWA C151, for pipe 36 inch and larger diameter, clearly mark manufacturer's pipe control number on each pipe length on face or near inside of bell.
 - f. Imperfections:
 - 1) Wrinkles or dimples:
 - a) On spigot sealing surface: Unacceptable.
 - b) On bell and contour: Acceptable to depth of 3/16 inch, provided minimum metal thickness under imperfection is maintained.
 - c) On pipe barrel: Acceptable to depth of 1/16 inch, provided minimum wall thickness requirements are met.
 - 2) Laminations: On spigot sealing surface and those greater than 1/16 inch in depth on remaining outside surface of pipe: Unacceptable.
 - 3) Pinholes: Acceptable when minimum wall thickness for designated class is maintained.
 - g. Approved manufacturers:
 - 1) American Cast Iron Pipe Company.
 - 2) United States Pipe and Foundry Co. (U.S. Pipe)
 - 3) McWane Cast Iron Pipe Company
3. Alternative Externally Coated Pipe to be used in conjunction with cathodic protection system: When shown on Drawings, coat outside of pipe, fittings, valves, valve boxes and extension stems with one of the two methods identified below.
- a. Class: Unless otherwise shown on Drawings, follow Special Thickness Class in AWWA C151, minimum Class 54 for 4 inch through 54 inch.
 - b. Lengths:
 - 1) 18 or 20 feet.
 - 2) Pipe provided for installation on curved alignment: Pipe lengths that will not require joint to be deflected more than 80 percent of manufacturer's recommendation.
 - c. In addition to markings required in AWWA C151, for pipe 36 inch and larger diameter, clearly mark manufacturer's pipe control number on each pipe length on face or near inside of bell.
 - d. Approved manufacturers:
 - a) American Cast Iron Pipe Company.
 - b) United States Pipe and Foundry Co. (U.S. Pipe)
 - c) McWane Cast Iron Pipe Company

- e. Handling, Transportation and Storage: Following AWWA C215 and C600 and in such a manner as to protect pipe and coating from damage.
 - 1) Coating plant: Bearing surfaces of forklift must be padded with suitable material. Web slings may also be used.
 - 2) Project site: Handle with minimum of two slings of type that will not damage coating.
 - a) Slings:
 - (1) Minimum 18 inches wide and sufficient strength to handle weight safely.
 - (2) Slings shall not pass through pipe.
 - (3) Hooks on ends of pipe will not be allowed.
 - 3) Cables and chains used during transportation must be padded with approved material. Use padded horizontal separator strip between rows of piping and all contact areas where pipe will rest. Use of wood spacers between rows of pipe is acceptable if proper padding is used to protect the coating.
 - 4) Store on padded minimum 12 inch wide skids or select loamy or sand dirt berms, or suspended from cutback ends where possible. Skid chucks used should be padded.
- 4. Fittings: Ductile iron bell, mechanical, or push on joint, unless shown otherwise on Drawings or Standard Details.
 - a. Size, dimensions, and tolerances: AWWA C110 or AWWA C153 and AWWA C111.
 - b. Dismantling joint: AWWA C110 or AWWA C153 and AWWA C111.
 - c. Mechanical joint solid sleeves: AWWA C110 or AWWA C153 and AWWA C111.
 - d. Unless otherwise shown, furnish fittings 3 inch through 24-inch diameter having minimum pressure rating of 350 psi, and furnish fittings larger than 24-inch diameter having minimum pressure rating of 250 psi.
 - e. Mechanical joints: See Joint Material.
 - f. Coatings:
 - 1) Exterior and interior: Fusion bond epoxy coated: Follow AWWA C110 and AWWA C116
 - a) Shop applied materials: (fusion bonded epoxy)
 - g. Fittings 36 inch and larger diameter: In addition to cast markings required in AWWA C110 and C153, clearly stencil on with waterproof paint on each fitting the year, month, and day cast, lot number, and manufacturer's fitting control number.
 - h. Approved manufacturers:
 - 1) American Cast Iron Pipe Co.
 - 2) Clow Water Systems Company, (Division of McWane Incorporated).
 - 3) Tyler Union, (Division of McWane Incorporated).
 - 4) United States Pipe and Foundry Co.
 - 5) SIGMA Corporation.
 - 6) Star Pipe Products.

- 7) North American Cast Iron Products, Inc. (NACIP, Inc.).
- 8) SIP Industries (excluding products manufactured in the Mexico facility).
- 5. Flanged Pipe and Fittings.
 - a. Flanged pipe: AWWA C115 and requirements for pipe above.
 - 1) Approved Manufacturers for Flanged Pipe:
 - a) American Cast Iron Pipe Company.
 - b) United States Pipe and Foundry Co. (U.S. Pipe)
 - c) McWane Cast Iron Pipe Company
 - b. Flanged fittings: AWWA C110 and requirements for fittings above except for flanged joints.
 - 1) Flanges for fittings: Cast integrally with body and with same thickness over their entire circumference.
 - a) Faces: Perpendicular to axis of pipe.
 - b) Bolt holes: Equally centered and spaced.
 - c) Joint accessories: See Joint Material.
 - 2) Bolts, nuts and studs: ANSI A21.11 for end flange joints, except provide minimum 304 stainless steel nuts and bolts with protective coating to prevent galling.
 - 3) Approved Manufacturers for Flanged Fittings (excluding any fittings manufactured in Mexico):
 - a) American Cast Iron Pipe Company.
 - b) United States Pipe and Foundry Co.
 - c) Tyler Union (Division of McWane Incorporated).
 - d) Star Pipe Products.
 - e) Sigma Corporation.
 - f) North American Cast Iron Products, Inc. (NACIP, Inc.).
 - g) SIP Industries
 - h) Clow Water Systems Company, (Division of McWane Incorporated).
 - 4) Blind flanges for entry ports: Steel following AWWA C207
 - a) Drill for bolt circle to match flange on entry port tee.
 - b) Class D for total pressures (operation plus surge) up to 150 psi.
 - c) Class E for total pressures (operation plus surge) up to 275 psi.
 - d) Class F for total pressures (operation plus surge) up to 300 psi.
 - e) Coatings:
 - (1) Exterior and interior: Fusion bond epoxy coated following AWWA C110 and AWWA C116
- 6. V-Bio Polyethylene Encasement: All buried DIP shall be installed with V-Bio polyethylene encasement conforming to AWWA C105.
 - a. V-Bio polywrap linear low-density polyethylene film (minimum 8 mil).
 - b. V-Bio polywrap flat tube: Meet appropriate minimum width for size of pipe installed following AWWA C105, Method A, secured with polyethylene compatible adhesive tape.

- c. Flat sheet V-Bio polywrap: Used for wrapping odd, shaped appurtenances following AWWA C105, secured with polyethylene compatible adhesive tape.
 - d. Approved Suppliers:
 - 1) American Cast Iron Pipe Company.
 - 2) United States Pipe and Foundry Co. (U.S. Pipe)
 - 3) McWane Cast Iron Pipe Company
7. Dismantling Joints.
- a. Flange Spool (3-12 inch): AWWA Class D Steel Ring Flange, compatible with ANSI Class 125 and 150 bolt circles. Pipe is STD Weight Class per ASTM A53.
 - b. End Ring & Body (3-12 inch): The end ring and body are made from ASTM A536 65-45-12 Ductile Iron.
 - c. Gaskets: NBR Gaskets are made from rubber compounded for water and sewer service in accordance with ASTM D 2000 MBA810Z. Other compounds are available for petroleum, chemical, or high temperature service.
 - d. Bolts & Nuts : ASTM A588 HSLA bolt material. Stainless Steel, Types 304 or 316 is optional.
 - e. Tie-rods: High tensile steel per ASTM A193 grade B7. Stainless steel, type 304 or 316 is optional. COATING: Fusion bonded epoxy.
 - f. Approved Manufacturer and Model:
 - g. Romac Industries, Inc. Model. DJ400 (6" & 8") or approved equal.
8. PVC Pipe and Fittings.
- a. Pipe 60 inch and smaller: AWWA C900 as modified herein unless otherwise indicated elsewhere in Contract Documents.
 - 1) Class and thickness for water mains: DR18 or as noted on the drawings, with DIP equivalent outer diameters.
 - 2) Class and thickness for process piping: Schedule 80 or as noted on the drawings.
 - 3) Potable water use: NSF61.
 - 4) Pipe markings: AWWA C900
 - 5) Joining pipes: Utilize elastomeric gasket push on joints following AWWA C900
 - 6) Approved Manufacturers:
 - a) For PVC Pipe requiring joint deflections:
 - (1) IPEX
 - (2) National Pipe and Plastic, Inc.
 - (3) Plastic Trends; US Subsidiary of Royal Building Products
 - b) For PVC Pipe requiring no joint deflections:
 - (1) JM Eagle™
 - (2) Diamond Plastic Corp.
 - (3) North American Pipe.

- (4) IPEX
 - (5) National Pipe and Plastic, Inc.
 - (6) Plastic Trends; US Subsidiary of Royal Building Products
 - (7) NAPCO Royal Pipe & Fittings (Certa-Lok Pipe 4inch through 12 inch, Restrained Joint Integral Bell C900 DR 14, used for nonrestrained trenchless applications only).
 - b. Fittings:
 - 1) See Fittings for Ductile Iron Pipe.
9. Tapping sleeves for existing gray iron, ductile iron, and PVC pipe 36 inch and smaller.
- a. Cast from gray iron, ductile iron, or material manufactured from ASTM A283 Grade C, ASTM A36, or equal.
 - b. Full sleeve type (with test plug) capable of containing pressure with full volume of sleeve.
 - c. Gaskets butt against existing pipe ensuring a watertight seal.
 - d. Suitable for use with Class AB or CD cast iron pipe or ductile iron for sizes 12 inches and smaller without changing either half of sleeve, unless field measurements are taken for type and outside diameter of existing pipe.
 - e. Rated at minimum 200 psi water working pressure for 12 inch and smaller diameter sleeves and minimum 150 psi working pressure for 14 inch to 24 inch.
 - f. Capable of withstanding rated working pressure without leakage past side and end gaskets and no leakage at junction of the two.
 - g. Mechanical Joint:
 - 1) Bolts, hexagonal nuts, rubber gaskets, and other accessories: AWWA C111, except provide minimum 304 Stainless Steel nuts and bolts with protective coating to prevent galling.
 - h. Valve flange:
 - 1) Suitable for connecting to mating end of tapping valve, which has a raised face to ensure true alignment of valve and tapping machine, following Manufacturers Standardization Society (MSS) SP60.
 - 2) AWWA C207 Class D, Class E, or Class F (match tapping valve flange) for material manufactured from ASTM A283 Grade C, ASTM A36, or equal.
 - i. Coatings and linings:
 - 1) No coating or linings for NSF certified Stainless Steel.
 - 2) Gray or ductile iron casted tapping sleeves AWWA C110.
 - a) Material manufactured from ASTM A283 Grade C, ASTM A36, or equal tapping sleeves.
 - b) Interior Lining: Fusion bonded epoxy that is EPA or NSF approved for contact with potable water, a minimum thickness of 12 mils, following AWWA C213.
 - c) Exterior Coating: Fusion bonded epoxy, a minimum thickness of 12 mils, following AWWA C213.

- j. Approved manufacturers:
 - 1) American Flow Control, Series 2800C and 1004.
 - 2) Clow Valve Company (A Division of McWane Inc.), Figure FS5205.
 - 3) M&H Valve Company (A Division of McWane Inc.), Style 1574 and 1674.
 - 4) Mueller Company, Style H-615-24.
 - 5) Tyler Pipe/Utilities Division.
 - 6) United States Pipe and Foundry Co., Ductile Iron T-9.
 - 7) JCM Industries, Inc., Nash, Texas, Number JCM 412 Fabricated Steel Tapping Sleeves with 150 lb. ANSI outlet flange.
 - k. Tapping Saddle Assembly.
 - 1) Full encirclement consisting of, at minimum, upper saddle plate with anchor neck, lower saddle plate, tapping flange and nozzle with gland or gasket for pressure tight seal suitable for potable water ranging in temperature from 32 degrees F to 100 degrees F. All components properly shaped and adequate strength to ensure proper mounting and pressure tight seal around existing pipe.
 - 2) Saddle plates manufactured from ASTM A283 Grade C, ATSM A36 or equal steel, clean and sound without defects that impact their service. No plugging or welding of such defects will be allowed.
10. Copper Pipe and Fittings.
- a. Pipe: Seamless, type K, and following ASTM B88.
 - 1) The copper tube shall be tested and certified to the NSF/ANSI Standard 61 and NSF/ANSI Standard 372.
 - a) Approved Manufacturers:
 - (1) Cambridge-Lee Industries
 - (2) Cerro Flow Products
 - (3) Howell Metal
 - (4) Mueller Industries
 - (5) Wieland Copper Products
 - b. Service Fittings: Copper following high pressure requirements of AWWA C800.
 - 1) Flared Copper tube connections: AWWA C800 for flared connections with straight threads.
 - a) Approved Manufacturers:
 - (1) A.Y. McDonald Manufacturing Company.
 - (2) Cambridge Brass.
 - (3) Ford Meter Box Company.
 - (4) Mueller Company.
 - 2) Brass Nipples: Following NSF 372 and ASTM B43
 - a) Reamed, chamfered with male NPT ends: Following ANSI/ASME B.1.20.1.
 - b) Approved manufacturers;
 - (1) A.Y. McDonald Manufacturing Company.

- (2) Lee Brass Co.
 - (3) Merit Brass Company.
 - 3) Bronze castings: Manufactured of Copper Development Association (CDA) alloys meeting chemical and physical properties of ASTM B584 and following AWWA C800, NSF 372.
 - 4) Compression copper tube connections: Follow AWWA C800.
 - a) Elastomer seal to prevent leakage.
 - b) Corrosion resistant, e.g. stainless steel, split or gripper ring to restrain joint.
 - c) "Tighten to stop" design
 - d) Approved Manufacturers:
 - (1) A.Y. McDonald Manufacturing Company, Q style.
 - (2) Ford Meter Box Company, Q style.
 - (3) Cambridge Brass, Q style.
 - (4) Mueller Company, 110 style.
 - 5) Connections with National Pipe Threaded connections (NPT): Follow ANSI/ASME B1.20.1, NSF 372, and AWWA C800 or ANSI B 16.15.
 - a) Approved manufacturers;
 - (1) A.Y. McDonald Manufacturing Company.
 - (2) Ford Meter Box Company .
 - (3) Lee Brass Company.
 - (4) Merit Brass.
 - c. Service Insulator Assemblies (Available in flare or compression styles).
 - 1) Ensure thread compatibility;
 - a) Insulator: Use same style as outlet end of corporation stop.
 - b) Compression outlet stops: Use same manufacturer. 2)
 - Approved manufacturers:
 - a) Mueller Insulated Products, Mueller Co.
 - b) Ford Meter Box Company, Inc.
 - c) A.Y. McDonald Manufacturing Company.
 - d) Cambridge Brass.
11. Service Saddles:
- d. General:
 - 1) Use for 2 inch and smaller connections.
 - 2) Manufacture saddles with clamps for underground services:
 - a) Rated for minimum service of 150 psi.
 - b) Provide full support around the circumference of pipe.
 - c) Do not distort, scratch, or damage pipe when tightened.
 - d) Contains thick tapping boss, which has been precision-machined with full-length threads for watertight connection that resists pullout.
 - e) Threads: AWWA C800 with standard corporation stop thread.
 - f) Ductile Iron: ASTM A536 with epoxy coating.
 - g) Stainless Steel: ASTM A193 and ASTM A240, type 304.

- h) Saddle body meeting ASTM A395 or A536 and AWWA C800.
 - (1) Uniform quality, true to pattern, of even grain, sound and smooth, and without cold shuts, swells, scales, blisters, sand holes, cracks or other defects.
 - (2) Surfaces: Smooth with no burnt-on sand.
 - (3) Finish: Minimum 12 mils fusion bonded meeting AWWA C213.
- i) Double straps: Type 304 Stainless Steel.
- j) Nuts, washers and studs: Type 304 Stainless Steel
- k) Use watertight gaskets of Buna-N rubber meeting NSF 61 certified and ASTM D2000 or Nitrile around tap hole.
- e. Saddles for Cast Iron or DIP.
 - 1) Approved manufacturers and models for 3 inch:
 - a) Ford Meter Box Co., Inc., Style No. FC202.
 - b) JCM Industries, Inc., Model No. 406-0413.
 - c) Mueller Company, Catalog No. DR 2S0356.
 - d) Smith-Blair, Inc., Model Nos. 317-000-41309-000, 317-000-41313-000, and 317-000-41315-000, all Double Strap.
 - e) PowerSeal Pipeline Products Corporation, Model 3417DI.
 - 2) Approved manufacturers and models for 4 inch and above:
 - a) Ford Meter Box Co., Inc., Style No. FC202.
 - b) Mueller Company, Catalog No. DR2S.
 - c) A.Y. McDonald Manufacturing Company Catalog No. 4855A.
 - d) Smith-Blair, Inc., Model No. 317.
 - e) JCM Industries, Model No. 406.
 - f) PowerSeal Pipeline Products Corporation, Model 3417DI.
- f. Saddles for PVC AWWA C900 Pipe.
 - 1) Use tapping saddle manufactured specifically for AWWA C900 PVC pipe with stainless steel wide band straps, nuts and washers.
 - 2) Approved Manufacturers and Models:
 - a) Ford Meter Box Co., Inc. FC202.
 - b) Smith Blair, Inc., Model No. 317.
 - c) Mueller Company, Series DR2S.
 - d) A.Y. McDonald Manufacturing Company, Model 4855A.
 - e) PowerSeal Pipeline Products Corporation, Model 3417DI.

B. Joint Material:

- 1. Push on and Mechanical Joints: AWWA C111, C110, C153, and C900.
 - a. Mechanical joints: minimum 304 stainless steel tee head bolts with protective coating to prevent galling.
 - b. Gaskets: AWWA C111

- 1) Nitrile (NBR) Gaskets, if specified on Drawings: ANSI/AWWA C111/A211.11
2. Flanged Joints: AWWA C110, AWWA C115, and specified herein.
 - a. Flange bolts, nuts, and washers: minimum 304 stainless steel with protective coating to prevent galling.
 - b. Nuts: Cold punched, hexagonal, trimmed, and chamfered.
 - c. Heads, nuts and threads: ANSI B1.1.
 - d. Bolts: 1/4-inch projection beyond nut when joint with gasket is assembled.
 - e. Gaskets: Full faced, 1/8-inch-thick rubber.
 - f. When flange joints are required for connecting to Class 250 gate valves with flanges, follow ANSI B16.1, Class 250, flat face flanges, unless otherwise specified.
3. Mechanical Couplings: Heaviest standard type for each size without pipe stops and following Drawings.
 - a. Approved manufacturers:
 - 1) Cascade Waterworks Mfg. Co., Style CDC.
 - 2) Dresser Manufacturing Division, Dresser Style No. 138.
 - 3) PowerSeal Pipeline Products Corporation, Style No. 3501 and 3506.
 - 4) Romac Industries, Inc., Style 400.
 - 5) Smith-Blair, Inc. (formerly Rockwell International), Model No. 441.
4. Joint Restraining Material:
 - a. Harness lug for Mechanical Couplings:
 - 1) Stainless Steel for strapping and harnessed joints: Minimum 3/4-inch diameter and in accordance with ASTM A193B8 (304) or B8M (316).
 - 2) Bolts and nuts: Minimum 304 Stainless Steel with protective coating to prevent galling.
 - 3) Approved Manufacturer:
 - a) Romac Industries, Inc. Style 490
 - b) Or equal.
 - b. Wedge action restrainer glands:
 - 1) All manufacturer's installation instructions shall be strictly adhered to.
 - 2) Approved manufacturers for DIP Mechanical Joint:
 - a) EBAA Iron, Inc., MEGALUG Series 11XX-DEC with MEGA-BOND coating, with blue fluoropolymer coated accessories.
 - b) Ford Meter Box Company, Inc., Uni-Flange Series UFR1400-DA-XX- RBH-1 (I or U) with E-Coat, with blue fluoropolymer coated accessories.
 - c) Romac Industries, Inc., RomaGrip Series XX-RGAP-DP6 with Romabond coating, with blue fluoropolymer coated accessories and xylan coated twist off bolts and wedges.
 - d) SIGMA Corporation, ONE-LOK Series SLDE-XPXXTT with CORRSafe coating, with blue fluoropolymer coated accessories.

- e) Star Pipe Products, Stargrip Series 3000-XX with accessories with Starbond coating, with blue fluoropolymer coated accessories.
 - f) Tyler Union, TUF Grip 1000 Series TLD-XX-FBE (FBE/FBP) with accessories, with fusion bonded epoxy or polyester, with E-Coated gripping wedges, wedge collar bolts, and twist off torque limiting nuts, with blue fluoropolymer coated accessories.
 - g) Smith-Blair, Inc., Cam-Lok Series 111 joint restraint with accessories, with Flexi-Coat coating, with E-Coated wedges, twist off bolts, and actuating bolts, with blue fluoropolymer coated accessories.
 - h) SIP Industries, EZ Grip Series joint restraint with EZ shield (a fusion bonded Polyester) coating on the glands, blue fluoropolymer coated mechanical joint accessories, and xylan (a PTFE E-coat) coated twist off bolts and wedges.
- 3) Approved manufacturers for PVC Pipe:
- a) UniFlange, Series 1500, with blue fluoropolymer coated accessories.
 - b) EBAA Iron, Series 2000PV, with blue fluoropolymer coated accessories.
 - c) Capital Industries, EZ Lok 4 inch through 12 inch diameter, with blue fluoropolymer coated accessories.
 - d) PVC Stargrip Series 4000 (Only if being used in conjunction with the Starbond coating system as well as minimum 304 stainless steel bolts with protective coating to prevent galling), with blue fluoropolymer coated accessories.
 - e) Or equal.
- c. Restrained joint for PVC Pipe push-on joint: Meet Uni-B-13. All accessories shall be fluoropolymer blue coated.
- 1) Approved manufacturers:
- a) JCM 620 Sur-Grip.
 - b) EBAA Iron, Series 1600.
 - c) UniFlange, Series 1390-C.
 - d) Or equal.
- d. Push on restrained joint gasket for 4 inch through 24 inch DIP. 1)
- Approved manufacturers:
- a) United States Pipe and Foundry Co., FIELD LOK 350□ for use with TYTON JOINT pipe.
 - b) American Cast Iron Pipe Co., Fast-Grip for use with Fastite pipe.
 - c) American Cast Iron Pipe Co., Amarillo Fast-Grip gasket for use with Fastite pipe.
 - d) McWane Cast Iron Pipe Co., Sure Stop 350□ for use with TYTON JOINT pipe.

C. Valves:

1. Gate Valves, Resilient Seated, sizes 12 inches and smaller: Designed, built and tested following AWWA C509 or AWWA C515 except as modified herein.
 - a. Working pressure rating: 250 psi
 - b. General configuration:
 - 1) Non-rising stem, resilient seated design for installation in horizontal or near horizontal pipelines.
 - 2) Operated with AWWA, 2-inch square operating nut turned counterclockwise to open.
 - c. Valve stem material: Minimum yield strength (determined as stress producing an elongation under load of 0.5 percent, which is 0.01 inches in gage length of 2.0 inches) of 40,000 psi. Following ASTM B763, UNS alloy C99500 or ASTM B138, UNS alloy C67600 in H04 temper.
 - d. Valve stem extension: Follow Standard Details.
 - 1) Approved manufacturer:
 - a) The General Engineering Company, Model/Series WVR-XXWS4D
 - b) Kravitch Machine Company, Model/Series GVENXXXCR.
 - c) Or equal.
 - e. Corrosion resistant coating:
 - 1) Fusion bonded epoxy, follow AWWA C550.
 - 2) Minimum 8 mils dry film thickness.
 - 3) Applied to all ferrous metal surfaces after rendering surfaces free from grease, dirt and moisture, and performing near-white, blast cleaning following SSPC-SP10/NACE 2.
 - 4) Do not coat fasteners or machined surfaces subject to contact and relative movement against other surfaces during operation of valve or other surfaces where such coating would compromise proper installation or functionality of valve.
 - f. Externally accessible bolts, nuts and washers: minimum 304 Stainless steel with protective coating to prevent galling.
 - g. Direct buried valves:
 - 1) Mechanical joint ends following AWWA C111.
 - 2) Non-adjustable, elastomeric stem seals.
 - a) Adjustable packing glands not permitted for direct buried applications.
 - 3) Direct operation of stem from above via 2-inch square nut.
 - a) No gear box provided.
 - 4) Approved Manufacturers and Models:
 - a) American Flow Control Series 2500 (with factory provided round yellow "NDZ" tag under operating nut).
 - b) Clow Valve Co. Model 2638...74XX, Figure No. F-6100 or Model 2639...74XX, Figure 6100.
 - c) Kennedy Valve Co. Figure No. 8571YSS or 7571YSS (YST for Type 316 SS Bolting with protective coating to prevent galling)

- d) M & H Valve Co. Style XX4067014002 (W/SS BOLTING with protective coating to prevent galling) or XX7571011002 (W/SS BOLTING with protective coating to prevent galling).
 - e) Mueller Company Catalog No. A2361LN-23.
 - f) U.S. Pipe, Valve and Hydrant Division Catalog No. AUSP1LN-23.
- 2. Gate Valves, Double Disc, Class 125: Built and tested following AWWA C500 with gray or ductile iron body, bronze mounted, parallel seat, double disc with non-rising stem, nut operated to open left with 2-inch square operating nut.
 - a. To withstand and operate under non-shock working pressure.
 - 1) Valves 12-inch and smaller diameter, 200 psi.
 - 2) Valves 14-inch diameter, 150 psi.
 - b. Bonnet test plugs: Allen or hexagonal socket type flush with bonnet surface.
 - c. Tapping Valves: Follow above requirements, except as modified for passage and clearance for tapping machine.
 - d. Valve ends:
 - 1) Not direct buried: Flanged Ends, ANSI B16.1 Class 125.
 - 2) Direct buried: Mechanical Joint, AWWA C111 and AWWA C500.
 - 3) Tapping valves: Flange inlet.
 - a) Class 125, ANSI B16.1, suitable for connecting to tapping sleeve (gray iron or DIP)
 - 4) Tapping valve: Outlet.
 - a) Direct buried: Mechanical Joint, AWWA C111 and AWWA C500.
 - b) Not direct buried: Flanged Ends, ANSI B16.1 Class 125, and allowing tapping machine adapter to be attached directly to valve.
 - e. Bolts, nuts, washers, and gaskets: See Joint Material previously specified herein.
 - f. Valve Stem Extension: See Resilient Seated Gate Valves.
 - g. Hydrostatic tests shall be performed in accordance with Section 5.1 of AWWA C500. Each test shall be held at the pressure indicated in the standard for a period of a minimum of 20 minutes.
 - h. Approved manufacturers:
 - 1) Flanged end:
 - a) Clow Valve Company (Division of McWane Incorporated), Model No. F-5070.
 - b) Kennedy Valve (Division of McWane Incorporated), Model No. F- 5070.
 - 2) Mechanical joint:
 - a) Clow Valve Company (Division of McWane Incorporated), Model No. F-5065.
 - b) Kennedy Valve (Division of McWane Incorporated), Model No. F- 5065.

- 3) Tapping valves:
 - a) Clow Valve Company (Division of McWane Incorporated), Model No.
 - b) F-5067
 - c) Kennedy Valve (Division of McWane Incorporated), Model No. F- 5067.
3. Flow Control Valve (FCV)
 - a. Provide valves sized and shown on the Contract Drawings and as specified herein. As far as possible all equipment of the same type shall be from one manufacturer.
 - b. All valves and appurtenances shall have the name of the maker and the working pressure for which they are designed cast in raised letters upon some appropriate part of the body.
 - c. Valve shall be of a flanged globe body type, dual external pilot (solenoid) valve operated, with diaphragm, fully stainless steel mounted, and a single seat bore equal to the size of the valve. Valve shall be suitable for a differential pressure of 100 psi and shall be provided with anti-cavitation trim.
 - d. Valves shall be furnished with a stainless steel or bronze indicator rod to show the position of the diaphragm. The valve shall have pet cocks for the attachment of gauges for testing purposes.
 - e. Control is achieved through a set of solenoids in the pilot system, one for opening and one for closing, to be controlled by a valve controller. There shall be an electronic valve position transmitter and differential pressure transmitter mounted on the valve, which will be wired to the valve controller. It will also have a parallel pressure reducing pilot system, which is normally closed but becomes active in a power outage.
 - f. Valves will have a normally closed relief pilot, for surge relief, designed to open, dumping water on the cover of the main valve if the downstream pressure increases above the set point of the control.
 - g. The solenoid valves shall be easily accessible and so arranged to allow their removal from the main valve while the main valve is under pressure and easily adjustable without removal of springs, weights, or use of special tools. Isolating ball valves shall be provided to allow the removal and replacement of the solenoid valves.
 - h. Valve Controller: The Contractor shall provide valve controller as specified herein:
 - 1) The controller will monitor valve position and differential pressure and monitor the flow. The metering controller will also have a built-in totalizer. The valve controller will power these low voltage components.
 - 2) The VC-22D valve pressure controller will accept a 4-20 ma pressure set point signal from the SCADA system.

- 3) The controller shall contain relay dry contact to indicate loss of control power when de-energized. PLC discrete input shall be wired to this contact for alarm indication. The contact shall be closed when power is on, and open when power is off.
- 4) An alarm relay will trigger the pressure valve controller to stop opening if the flow exceeds the maximum flow setpoint.
- i. Approved Manufacturers:
 - 1) Cla-Val Model 133-85BCPSY 6" valve or approved equal.
4. Ball Valve
 - a. Operation: Manual
 - b. Valve shall be full-ported.
 - c. Built with PVC Cell Class 12454 per ASTM D1784.
 - d. Minimum & maximum service temperature
 - e. Valve shall withstand and operate under non-shock working pressure of 150 psi @ 70°F.
 - f. Seals: EPDM O-Ring seals
 - g. End Connection: Flanged
 - h. Recommended flange bolt torque is shown in the following table:

Flange Size (in)	Bolt Diameter (in)	Bolt Torque (ft.lbs)
2-1/2	5/8	20-25
3	5/8	20-25
4	5/8	20-25
6	3/4	30-40

- i. Approved Manufacturer:
 - 1) Hayward Flow Control; TB Series True Union Ball Valves or approved equal.
5. Pressure Relief Valve
 - a. Provide valves sized and where shown on the Contract Drawings and as specified herein. As far as possible all equipment of the same type shall be from one manufacturer.
 - b. All valves and appurtenances shall have the name of the maker and the working pressure for which they are designed cast in raised letters upon some appropriate part of the body.

- c. The valve will be a 100-01 full ported body. The valve will be a flanged, diaphragm actuated main valve. It will be a single chamber valve. No dual chamber valves will be accepted. The main valve will be ductile iron and have stainless trim internals. The stainless-steel stem shall be fully guided throughout its stroke, by a bearing in the valve cover and an integral bearing in the valve seat. The stem will be a one-piece stainless-steel seat. There shall not be any bearing bushings. It will have an NSF approved fusion bonded epoxy coating (KC) on all interior and exterior surfaces. The cover will have a locating lip. The main body can be supplied with a 150ansi flanged ends 250psi working pressures. The CRL relief pilot will have a 20-200 psi spring range. There shall be pilot isolation valves installed (B). There shall be a 0-200 psi gauge mounted on the main valve inlet (P) and outlet. The pilot system will have a "Y" strainer (Y). There shall be an X101 valve position indicator (V) to give a visual indication of valve position. The rubber parts will be BunaN synthetic rubber.
- d. The manufacturer shall be able to provide a computerized cavitation analysis that will show the valve will operate cavitation damage free across its flow range and differential pressure. This analysis will also provide a decibel level of sound. This is required for continuous duty applications.
- e. The manufacturer shall provide a direct factory employee for startup and training.
- f. The manufacturer shall warranty the valve for 3 years from date of shipment.
- g. Approved Manufacturers and Models:
 - 1) Cla-Val Model No. 50G-01BPVY KC 6" valve.
- 6. Flap Valve.
 - a. Allow passage of flow in one direction, while preventing reverse flow.
 - b. Flange end: Class 125, ANSI B16.1, suitable for connecting to ductile iron flange pipe.
 - c. Approved manufacturers:
 - 1) Clow Valve Company (Division of McWane Incorporated), Model No. F-3012.
 - 2) Tideflex Technologies, Inc., Series 35 with stainless steel backup ring
- 7. Plug Valve
 - a. Style: Eccentric plug valve following AWWA C517. Plug valves shall have resilient faced non-lubricated cast iron or semi-steel body plugs with area of port opening not less than 80 percent of the full pipe area.
 - b. Pressure rating: 175 psi for valves with cast iron bodies up to 12"; 150 psi for valves with cast iron bodies and larger than 12".
 - c. Valve seats with welded-in nickel shall be provided on all surfaces contacting the plug face.

- d. The space between the upper trunnion and valve cover and between lower trunnion and valve body shall be fitted with permanently with lubricated stainless-steel bushings. The upper trunnion shall be sealed with packing and a spring-loaded packing box. Upper trunnion arrangement shall be such that repacking can be done without taking the valve out of service, and without removing the cover plate from the valve body.
- e. The valve shall be capable of sealing watertight with the rated working pressure applied to either side of the valve. Valve shall be epoxy coated on the interior and be equipped with a position indicator on the exterior.
- f. End connections: Flanged in accordance with ANSI B16.1, Class 125.
- g. Materials of construction:
 - 1) Body: ASTM A-536 ductile iron.
 - 2) Seat: Nickel or 300 series stainless steel.
 - 3) Plug coating: Buna-N.
 - 4) Plug: ASTM A-536 ductile iron.
 - 5) Thrust bearing: PTFE, Teflon, or Nylatron.
 - 6) Radial bearings: 316 stainless steel or bronze.
 - 7) Shaft seal: Acrylonitrile-butadiene (NBR), V-type.
 - 8) Interior and exterior coating: Liquid or fusion bonded epoxy certified by NSF as complying with NSF-61 and applied in accordance with AWWA C550.
- h. Actuators:
 - 1) Handwheel designed for 80 lb. maximum rim pull with a line pressure of 155 psi. Actuator to have integral 2-inch square operating nut to allow turning with a valve tee.
 - a) Designed for bi-directional valve seating.
 - b) Rated for maximum shutoff pressure differential of 150 psi.
- i. Valve Orientation:
 - 1) The rotation of the plug shall be about a horizontal axis.
 - 2) The plug shall store in the top when the valve is open.
 - 3) The valve shall be oriented such that the seat is opposite the high-pressure side.
 - 4) The operator and handwheel shall be located in an accessible position.
 - 5) Position indicator to be located on valve exterior.
- j. Factory testing:
 - 1) Complete hydrostatic and bi-directional seat test on all valves following AWWA C517. Valves: drip tight during a leak test at the specified shutoff pressure with pressure in either direction. Provide test results of bi-directional test to Engineer. Valves shall pass a body hydro test at 1.5 times the cold working pressure rating. Perform tests prior to shipment.
- k. Manufacturers:
 - 1) DeZurik Water Controls (PEC) 8" Model No. PEF-8-F1-GS-6A-HD12

- 2) DeZurik Water Controls (PEC) 6" Model No. PEF-6-F1-GS-6A-HD8
- 3) DeZurik Water Controls (PEC) 4" Model No. PEF-4-F1-GS-6A-HD8

8. Air Release Valve (ARV)

- a. Float operated to automatically release air from water piping system.
- b. ARV shall adhere to all requirements in AWWA C512.
- c. Body and Cover: Cast iron or ductile iron.
- d. Internal Parts and Float: Stainless steel.
- e. Valve shall be designed for at least 150 psig operating pressure.
- f. Acceptable Manufacturers:
 - 1) 1" automatic ARV from APCO – Valve and Primer Corp., Val-Matic Valve Co., or approved equal.

9. Corporation Stops: ANSI/AWWA C800, except with working and test pressures below.

Size In Inches	Water Temperature	Working Pressure	Test Pressure
3/4, 1, & 1-1/4	Up to 100 degrees F	Note less than 150 psi in closed position	Not less than 225 psi in open position
1-1/2 & 2	Up to 100 degrees F	Not less than 200 psi in closed position	Not less than 300 psi in open position

- a. Bronze: Castings manufactured of CDA alloys meeting chemical and physical properties of ASTM B584 and following AWWA C800, NSF 372.
- b. Type of Threads.
 - 1) Inlet thread: Standard corporation stop thread following ANSI/AWWA C800.
 - 2) Copper tube outlet end: Flare or compression connection type, fitted with coupling nut threaded for use with copper service tube type K following ANSI/AWWA C800.
- c. Compression Connections:
 - 1) Elastomer seal to prevent leakage.
 - 2) Corrosion resistant, e.g. stainless steel, split or gripper ring to restrain joint.
 - 3) "Tighten to stop" design
 - 4) Approved Manufacturers:
 - a) A.Y. McDonald Manufacturing Company, Q style.
 - b) Ford Meter Box Company, Q style.
 - c) Cambridge Brass, Q style.
 - d) Mueller Co., 110 style.
- d. Approved Corporation Stop Manufacturers and Models:
 - 1) A.Y. McDonald Manufacturing Company, 4701 B series (flare style) and 4701BQ series (compression style).

- 2) Ford Meter Box Co., Inc., FB600 series (flare style) and FB1000-XQ series (compression style).
 - 3) Mueller Co., B-25000 series (flare style) and B-25008 series (compression style).
 - 4) Cambridge Brass, 301-XXC series (flare style) and 301-XXH series (compression style).
2. Curb Boxes.
 - a. See Standard Details.
 - b. Approved manufacturers:
 - 1) Geneco: 1101-2-39.
 - 2) Bingham & Taylor Corporation: ROD-39-WSSC-9010.
- D. Fire Hydrants (Standard): Follow AWWA C502 for requirements not included on WSSC approved manufacturer's drawings.
 1. Shall be used unless otherwise noted on drawings.
 2. Approved Manufacturers and Drawings.
 - a. Kennedy Valve (Division of McWane Incorporated), Guardian K 81D, following Kennedy Drawing No. 80783 20781, Rev. 18, dated 3/08.
 - b. Mueller Company, Super Centurion 250, following Mueller Drawing No. FH 237, Rev. F, dated 1/14/11.
 - c. United States Pipe Valve and Hydrant Division (Division of Mueller Company), Sentinel 250, following USPV&HD Drawing No. FH 288, Rev. D, dated 1/14/11.
 - d. Clow Valve (Division of McWane Inc.), Medallion, following Clow Drawing No. D-22742, Rev. B, dated 12/10.
 - e. American Flow Control (Division of American Cast Iron Pipe Company), Model B-62-B-5 following American Flow Control Drawing No. 94-21085, Rev C dated 2/20/15.
- E. Measuring Devices
 1. Pressure Gauges:
 - a. Construction: 3-1/2-inch gauge size, 0 to 690 kPa, 0 to 160 psi range, steel case, glass crystal, brass movement, and 1/4-inch NPT lower connection.
 - b. Furnish with 1/4-inch brass gauge cock.
 - c. Manufacturers and Products:
 - i. Ashcroft; Type 1008.
 - ii. Marsh; J80.
 - iii. Marshalltown.
- F. Detectable Warning Tape: See Section 02315.
- G. Tracer wire for PVC Pipe: TW, THW, THWN, or HMWPE insulated single-strand copper, 10 gauge or thicker wire.

- H. Continuity Test Station.
 - 1. Acrylonitrile- Butadiene-Styrene (A.B.S.) Plastic
 - 2. Diameter 12-inch.
 - 3. Heavy duty frame and lid.
 - 4. Lettering on lid "Water".
 - 5. Approved Manufacturer:
 - a. Bingham & Taylor Corporation, Figure 1200 with ADP4001006P Valve Box Stabilizer.
 - b. Or equal.
- I. Pipe Embedment Material: See Section 02315.
- J. Precast Concrete: See Section 03400.
- K. Castings: Gray iron and following Section 05500.

2.2 SOURCE QUALITY CONTROL

- A. Notify Engineer following Section 01450 for performance of factory tests required herein.
 - 1. Factory hydrostatically test 16 inch and larger diameter Class 125 double disc gate valves following AWWA C500.
 - 2. Factory hydrostatically test 16 inch and larger diameter resilient seated gate valves following AWWA C509.
 - 3. Factory hydrostatically test 16-inch and larger diameter Class 250 double disc gate valve to pass hydrostatic test of 400 psi applied between discs with no visible leakage through the metal, flanged joints, or stem seals.
 - a. Double disc gate valves:
 - 1) Test valve seats to pass factory leakage test with water between gates at working water pressure of 250 psi.
 - 2) Allowable leakage past either seat not to exceed rate of 1.0 oz./hour/inch of nominal valve size.
 - 4. Operation test for gate valves 16 inch and larger diameter: AWWA C500 and C509.

PART 3 EXECUTION

3.1 PUBLIC NOTIFICATION

- A. See Section 01110.

3.2 INSTALLATION OF WATER MAIN

- A. Inspection of Delivered Materials: See Section 01450.

- B. Handling of Pipe and Fittings: Zinc coated ductile iron pipe and fittings following AWWA C600.
1. If damage or coating abrasion occurs and is repairable, repair following approved manufacturer's recommendations.
 - a. Paint used for repair of zinc coating shall meet ISO 8179 requirements of a minimum 85% zinc in the dry film.
 - 1) Approved Manufacturer
 - a) Tnemec Series 90-98
 - b) Rust-Oleum Cold Galvanizing Paint
 - c) Or equal
 2. If pipe is cut in the field in such a way that the zinc label is removed, paint a circumferential band around one end of the pipe using grey or silver paint. Repair paint as specified above can be used for this application.
 3. Cement Mortar Lining:
 - a. Remove and replace rejected pipe, fittings or appurtenance at Contractor's expense.
 - b. Field cut and remove damaged section of pipe to 6 inches beyond damaged lining.
 4. Alternative Externally Coated pipe and fittings.
 - a. Repair as directed by coating manufacturer.
 - b. For cathodically protected systems, test coating for flaws electrically with holiday detector, following NACE SP0274 or SP0188. Repair holidays and recheck. Coating shall be verified free of holidays prior to use.
 5. Remove pipe, fittings, and valves when contaminated with oil, gasoline, kerosene, or other material that damages coating, and replace at no cost to the Commission.
 6. Remove foreign matter from each pipe, fitting, and valve before installing V-Bio polyethylene encasement and placing in trench (not applicable for cathodically protected systems).
 7. Keep interior of pipe clean during installation and thereafter.
 8. Should foreign material or contaminants be observed in previously installed pipe, fittings, and valves, cease work until foreign material is removed or contaminated pipe, fittings, and valves are decontaminated or replaced.
 9. Close open ends of pipes and fittings with watertight seal during periods when work is not proceeding.
- C. Trench Excavation, Backfill, and Test Pits: Follow Section 02315 and as specified herein.
1. Before pipe installation:
 - a. Dig test pits to determine size, type, and exact location of existing pipe to which proposed pipe will connect.
 - 1) If poured lead joint pipe is found, replace with mechanical joint pipe and fittings. Removal of lead joint is incidental to the contract.
 - b. Excavate sufficient trench in advance and test pit all existing underground utilities or structures, whether shown on Drawings or visually identified in the field, to:

- 1) Verify actual locations.
 - 2) Make reasonable changes in line and grade to resolve conflicts, with Engineer's approval.
 - c. Furnish Engineer location and elevation information when previously unknown or different underground utilities or structures are encountered.
 2. Perform additional work made necessary because of failure to take above precautions at no cost to the Commission.
- D. Pipe Placement.
1. Excavate bell holes at each joint to assemble joint so entire length of each pipe barrel, fitting, and valve is supported on firm bedding or soil.
 2. Field Cutting: Smooth and at right angles to pipe axis with cutting/joints to meet pipe locations and elevations shown on Drawings.
 3. Joint Deflections: Follow manufacturer's recommendations.
 - a. Do not deflect PVC pipe at connection to DIP or fittings.
 4. V-Bio polyethylene encasement:
 - a. Zinc Coated DIP and fusion bonded epoxy coated fittings and valves: AWWA C105, for Method A, secured with polyethylene compatible adhesive tape.
 - 1) Seal V-Bio polywrap with minimum two layers of tape on the zinc coated DIP and overlap polyethylene at joint to provide double layer of polyethylene, secure end with minimum two layers of tape.
 - 2) Along pipe barrel, take up slack in V-Bio polywrap tube, making snug but not tight fit. Fold over on top of pipe and secure in place every three feet along the barrel of pipe with minimum 6-inch length of tape.
 - 3) In wet trench area, secure in place every two feet along barrel of pipe with minimum one layer of tape around the pipe.
 - 4) For odd-shaped appurtenances, use flat sheet V-Bio polywrap: AWWA C105, Section 4.4.4, secure ends with minimum two layers of tape.
 - b. PVC pipe: Encase fusion bonded epoxy coated ductile iron fittings and valves in V-Bio polywrap as specified herein. Overlap V-Bio polywrap onto PVC pipe minimum 6 inches.
 - c. Fire hydrant lead pipe: Use zinc coated DIP and fittings and encase in V-Bio polyethylene following Standard Details.
 - d. Before backfilling, inspect V-Bio polywrap for rips, punctures and other damage and repair following AWWA C105.
 5. After placement of pipe, fittings, and valves with External Coating system.
 - a. Before backfilling, inspect coating for possible damage.
 - 1) If damage is detected, repair and holiday test (cathodically protected systems only) as stated herein and in Section 13110.
 6. PVC AWWA C900 Pressure Pipe:
 - a. Make changes in horizontal, vertical, and curved alignment shown on Drawings by using fittings, high-deflection coupling, or joint deflections in the amount permissible by manufacturer's recommendations.

- b. Use short lengths of pipe as necessary to accomplish curvature without exceeding individual allowable joint deflections specified by manufacturer.
 - c. Do not bend pipe.
 - d. Tracer Wires for PVC Pipe:
 - 1) Tape wire to top of pipe using PVC tape every 4 feet along the pipe, and on each side of each fitting.
 - a) Tape: Minimum 2 inches wide and wrapping full circumference of pipe.
 - 2) Where required, splice with direct-bury wire connector, wire nut, or splice kit and install as recommended by manufacturer. Protect and secure splice to pipe specified above.
 - 3) Terminate tracer wire at a Continuity Test Station following Standard Details.
7. Detectable Warning Tape.
- a. Place detectable tape in trench as follows;
 - 1) Use Blue tape for water mainlines and water service connections. See section 02315.
 - 2) Use Yellow tape for coated pipe and test station lead wires. See Section 02315 and 13110.
 - 3) Use Red tape for restrained joint pipe: See below and Section 02315.
- E. Restrained Joints and Buttresses.
- 1. General: Make provisions for counteracting expected thrust due to static and dynamic forces including surge at bends, tees, reducers, valves, fire hydrants, and dead-ends whether or not shown on Drawings.
 - 2. Restrained Joints: Provide following Drawings and Standard Details.
 - a. Mark restrained joints at crown with 2 foot long by 4-inch-wide orange paint stripe perpendicular to and centered on joint.
 - b. If testing pipeline for own convenience before backfilling is complete, provide adequate temporary blocking at no cost to the Commission.
 - c. Install restrained joints on pipe following Standard Details and manufacturer's recommended installation procedures.
 - 1) Place "RESTRAINED JOINT PIPE" tape on outside of V-Bio polywrap encasement at top of pipe with restrained joints before backfill operations have reached top of pipe.
 - a) PVC Water Main: Place "RESTRAINED JOINT PIPE" tape under tracer wire.
 - b) Secure "RESTRAINED JOINT PIPE" tape to V-Bio polywrap encasement every 4 feet along the pipe, and on each side of each fitting, using polyethylene compatible adhesive tape, wrapping full circumference of pipe.
 - 2) Continue backfill operations following specifications and avoid displacement of warning tape.

- d. Apply field coating wherever restraining device installation results in bare metal surfaces, including all thread and re-bar: See FIELD APPLIED COATING OF EXPOSED FERROUS METAL specified herein.
- 3. Buttresses and Anchors: See Drawings and Standard Details. Engineer may inspect and approve excavations before buttresses and anchors are placed.
 - a. Entire face of excavation against which buttresses will bear: Firm bearing, flat and at proper angle to pipeline and reaction force.
 - b. Wood form both sides of buttress and maintain dimensions following Standard Details. Protect mechanical joint bolts from concrete.

3.3 JOINTS

A. Mechanical Joints.

- 1. Before assembling joint, clean both bell and plain end of rust and foreign matter.
- 2. Assemble joint following AWWA C111, C600, C605, C900 and as specified herein.
- 3. For pipe plain ends to be inserted into mechanical joint bells, square cut and bevel end.
 - a. Clean and lubricate joint surfaces.
 - b. Place gland on plain end followed by gasket and insert pipe into bell.
 - c. Press gasket firmly and evenly into bell recess to center plain end in bell.
 - d. Keep joint straight during assembly.
 - e. Make deflection after joint assembly but before tightening bolts.
 - 1) Do not deflect PVC pipe at connection to ductile iron or cast iron pipe or fittings.
 - f. Complete joint by alternate tightening of bolts with torque wrench set between:
 - 1) 45-60 foot/pounds for 3-inch diameter.
 - 2) 75-90 foot/pounds for 4 inch through 24-inch diameter.
 - 3) 100-120 foot/pounds for 30 inch and 36-inch diameter.
 - 4) 120-150 foot/pounds for 42 inch and 48-inch diameter.
 - g. Tighten bolts so gland and face of bell have approximately same distance between them at all times.
- 4. Where satisfactory sealing of joint is not attained at maximum permissible torque, disassemble, reclean, and reassemble joint with new gasket.
- 5. Coat uncoated metal components following FIELD APPLIED COATING OF EXPOSED FERROUS METAL specified herein.

B. Flanged Joints.

- 1. Remove grease from flange surface using solvent-soaked rag and wipe clean of dirt and grit.
- 2. Align flanges accurately, using spirit level, and pipe properly supported before gasket and bolts are inserted.
 - a. Carefully place rubber gasket to ensure full flow and proper sealing of joint.
 - b. Give bolt threads light coat of thread lubricant and then insert and turn nuts by hand.

- c. Pull up bolts with wrench, employing crossover method.
 - d. Bolt lengths and required torque: Follow manufacturer's requirements.
- 3. Coat uncoated metal components following FIELD APPLIED COATING OF EXPOSED FERROUS METAL specified herein below.

C. Dismantling Joints.

- 1. Assemble dismantling joint by placing coupling pieces on pipe ends and then place pipe ends together.
 - a. Do not exceed tolerance between pipe ends of 1/2 inch.
 - b. If tolerance is more than 1/2 inch, provide pipe spacer with 1/2-inch tolerance.
 - c. Do not exceed coupling manufacturer's recommendations for spacer size for leak proof joint assembly.
 - d. Slide middle ring so it is centered at pipe ends juncture.
 - e. Place gaskets and follower rings in place and bolt up.
 - f. Tighten bolts to torque recommended by manufacturer.
- 2. Coat uncoated metal components following FIELD APPLIED COATING OF EXPOSED FERROUS METAL specified herein.

D. Mechanical Couplings.

- 1. Assemble mechanical coupling joint by placing coupling pieces on pipe ends and then place pipe ends together.
 - a. Do not exceed tolerance between pipe ends of 1/2 inch.
 - b. If tolerance is more than 1/2 inch, provide pipe spacer with 1/2 inch tolerance.
 - c. Do not exceed coupling manufacturer's recommendations for spacer size for leak proof joint assembly.
 - d. Slide middle ring so it is centered at pipe ends juncture.
 - e. Place gaskets and follower rings in place and bolt up.
 - f. Tighten bolts to torque recommended by manufacturer.

E. Solid Sleeves.

- 1. Install solid sleeves following Standard Detail and specified herein.
 - a. Insert spacer cut from same type and size of pipe being used inside of sleeve when using one solid sleeve.
- 2. Coat uncoated metal components following FIELD APPLIED COATING OF EXPOSED FERROUS METAL specified herein.

- F. V-Bio Polyethylene Encasement of Joints: When it is impractical to encase joints with VBio polyethylene tubing, wrap joints with flat sheet or split length of V-Bio polyethylene tube specified herein. Seal V-Bio polyethylene with minimum two layers of polyethylene compatible adhesive tape.

3.4 FITTINGS, VALVES, AND ADAPTERS

- A. Install fittings and valves following Drawings.
 - 1. See Field Testing for testing before installation.
 - 2. Set fittings and valves and join pipe as specified previously herein.
 - 3. Where valves occur on end of pipeline, place plug, cap, or blind flange and secure in exposed bell before backfilling trench.
- B. V-Bio Polyethylene Encasement: For all systems that are not cathodically protected, wrap fusion bonded epoxy coated ductile iron fittings, blind flanges, plugs, caps, valves and other odd, shaped appurtenances with V-Bio polyethylene encasement following AWWA C105 and as specified herein.
- C. Install valve box with extension stem where shown or required for nut operated valves following Drawings.
- D. Set valve box at right angle to water main, centered and plumb over valve operating nut with box cover flush with surface of finished grade or as otherwise directed.
 - 1. Before installation, exercise valve for proper working order.
 - 2. Backfill and compact under and around valve boxes to ensure no vertical loads are transmitted to valve operators or bonnets.
 - 3. When valve box is located in unpaved area to be improved, provide marker stake consisting of a piece of 2-inch by 4-inch lumber, minimum of 5 feet long and painted blue its entire length, adjacent to valve box with approximately 3 feet extended above ground.
- E. Install PCCP adapter following manufacturer's recommendations to include maximum joint opening and diaphering of finished joint.
- F. PVC fittings: Use pressure class fusion bonded epoxy coated ductile iron fitting equal to or greater than the pressure class of the pipe to which it is connecting. Where fitting with restrained joints is required, use ductile iron mechanical joint.

3.5 FIRE HYDRANTS

- A. Install fire hydrants where indicated on Drawings following Standard Details. Place streamer outlet perpendicular to street.
- B. Install fire hydrant lead connection level, unless shown otherwise on Drawings.
- C. Replacing Existing Fire Hydrant to Existing Main: Follow Drawings, Standard Details and as specified herein.
 - 1. Blow off hydrant to confirm water flow (attach diffuser unless connecting to sanitary sewer).
 - 2. Leave hydrant open and close lead valve.

3. Confirm fire hydrant flow has stopped.
 4. Test pit on lead valve and tee only to confirm existence and condition of strapping.
 5. Install or replace strapping as necessary from tee to valve.
 6. Install new lead pipe and fire hydrant to existing tee, following Standard Details.
 7. Remove and salvage valve and fire hydrant and deliver to Commission warehouse or as noted on Drawings.
- D. Poured Lead Joint Lead Valve and Fittings:
1. Before removing existing tee and valve, clean existing pipe and check pipe for:
 - a. Lead joint valve and fittings 16 inches and smaller in diameter, with outside diameter or roundness not suitable for watertight connection, abandon as directed by Engineer.
 2. Do not cut existing pipe closer than 18 inches to joint bell unless joint bell will be removed.
 3. Reconnect existing main with new tee and solid sleeve, and install new valve, lead pipe and fire hydrant to existing tee following Standard Details.

3.6 WATER SERVICE CONNECTIONS

- A. Install water service connections from main water line to property lines at elevations indicated on Drawings, Standard Details, or at Engineer's direction.
1. When elevations are not shown, install water service connections with minimum cover of 42 inches.
 2. To make direct service taps, apply 2 to 3 layers of polyethylene compatible adhesive tape completely around polyethylene encased pipe to cover area where tapping machine and chain will be mounted or a minimum of 12 inches. Direct tap through the taped polyethylene encasement.
 3. When connecting to existing polyethylene encased cast or ductile iron water main, wrap water service connection pipe 3 feet from main (including corporation stop and saddle) with V-Bio polyethylene encasement following AWWA C105. Seal polyethylene with minimum 2 layers of tape.
 4. When connecting to existing non-polyethylene encased cast or ductile iron water main, provide service insulator and field applied coating on:
 - a. Exposed water main up to 3 feet both sides of the tap (including service saddle, if used).
 - b. Service connection from water main for distance of 3 feet (including service insulator) following Standard Details and specified herein.
 5. Use copper pipe bending tools.
 6. Mark location of end of water service connection pipe at property line with piece of 2 inch by 4 inch lumber, painted blue its entire length, placed vertically from bottom of trench and extending 2 feet above grade.

7. For connections to a PVC water main, install tracer wire along the top of the water service connection pipe. Follow instructions under Tracer Wires for PVC Pipe, specified herein and the Standard Details.
- B. Perform tapping of water main and insertion of corporation stop by qualified personnel having in their possession qualification card issued by the Commission for performance of this work.
1. When no source of water is available from existing mains, provide potable water.
 - a. Maintain 60 psi pressure during service connection tapping process.
 2. Use wrenches with smooth jaws of proper size to install corporation stops and connect pipes thereto. Do not use wrenches with jaws that will score brass or copper.
 3. Maintain minimum of 18 inches between taps, minimum 18 inches clear from DIP bells and minimum 24 inches clear from PVC pipe bells.
 4. Install service saddle when tapping 3 or 4 inch diameter water main and for taps larger than 1 inch diameter on 6 inch through 12 inch diameter water mains.
 5. After installing saddle, field coat saddle, straps, and associated hardware following FIELD APPLIED COATING OF EXPOSED FERROUS METAL specified herein.
 6. After making tap and completing service connection, blow off at curb stop, pressurize, check for leaks to curb stop, and leave corporation stop in open position.
 7. Backfill excavated area around pipe following Section 02315 and Standard Details.
 8. Do not dry tap ductile iron mains without Engineer's approval.
 - a. If so approved, make tap as specified herein, including lubrication of stop during installation.
 - b. Keep trench open at tap until water main has been placed in service so tap can be inspected for leakage.
 9. PVC Water Pipe: Use of Service-tee fittings or service couplings permitted.
 10. Tapping of PVC Pipe: AWWA C605, pipe manufacturer's recommendations, and specified herein.
- C. Assemble compression joints for type K copper pipe according to manufacturer's recommendations.
1. Prepare copper pipe for connection by cleaning, deburring and rounding.
 2. When rounding, use copper pipe rounding tool as recommended by compression manufacturer.
 3. Insert pipe into connection until it is completely home, tighten nut until it stops turning at end of its internal threads.
 4. Pressure test connection prior to backfilling.

- D. Install service connections with outside meters following Drawings, Standard Details and as specified herein.
 - 1. Mark location of the outside water meter with a piece of 2 inch by 4 inch lumber, painted blue its entire length, placed vertically along side the setting from bottom of excavation and extending 2 feet above grade.
 - 2. Locate lumber within one foot horizontally of setting.
 - 3. Paint 4 inch high letters "WATER METER" in black on both sides of the lumber above grade.
- E. Right of way service connections: Extend to right of way or property line, whichever is closer to main.
- F. For service connections 3 inch and larger diameter, install bends as required.
- G. Replacement of Service Connections.
 - 1. Minimum size copper pipe to property line, or as directed by Engineer.
 - a. 1 inch for any existing connections of 1 inch or smaller in diameter.
 - b. 1 1/2 inch for any existing connections of 1 1/4 and 1 1/2.
 - 2. Utilize existing tap at water main unless otherwise directed by Engineer to:
 - a. Abandon existing tap and retap main line water pipe, or
 - b. Remove existing tap and plug hole.
 - 3. Replace existing curb stop or meter setting.
 - a. Use freeze coupling to cut off flow from existing water service connection. Do not use crimping tools.
- H. Area Service Connection Contracts Only.
 - 1. Engineer will issue an average of 3 work orders per week for water service connections; to be constructed in the order they are received, or as directed by Engineer.
 - 2. Schedule work orders designated as health hazards to be substantially completed within 10 working days and other work orders to be completed within 20 working days of issuance.
 - 3. Provide sufficient equipment and work forces to commence and complete each connection within prescribed timeframe.
 - 4. When directed to mobilize to site designated as Emergency by Engineer start within 24 hours.
 - a. Cost incurred by the Commission due to work orders not completed within timeframe specified herein may be deducted from monies owed Contractor.
 - b. Issuance of new work orders may be suspended until outstanding work orders are completed.
 - c. Complete cleanup, restabilization, and restoration as weather permits on each service connection location before leaving site to commence work at another location.

1) Restore non-paved areas following Section 02920.

3.7 CHLORINATION

- A. Chlorinate and dechlorinate following Section 02511 and specified herein.
- B. Install 1 inch or 2 inch diameter corporation stops and couplings in water mains for chlorination as required.
 - 1. Remove stops not used for services and replace with plug.
- C. While the sample analysis is being performed, Contractor may pressurize main for purpose of making taps for service connections, by installing temporary jumper with approved backflow preventer to isolate main.
 - 1. Remove as soon as taps are completed.
- D. Place mains in service when analysis is complete and approved by Engineer.

3.8 VAULTS AND MANHOLES

- A. Valve Vaults and Manholes: See Drawings, applicable sections of specifications, and Standard Details.

3.10 CONNECTION TO EXISTING MAIN BY TAPPING SLEEVE

- A. Before ordering Tapping Assemblies or Tapping Sleeves for existing pipe larger than 12 inches:
 - 1. Confirm existing pipe type, clean pipe, make circumferential measurement and check for roundness of pipe to verify sleeve will fit.
 - 2. Repair any damage to existing pipe coating with suitable coating material to original line of coating as directed by pipe manufacturer's technical representative at no additional expense before backfilling.
- B. Tapping Sleeve and Valve Procedure for Gray Iron and DIP and PVC pipe.
 - 1. Before Tapping Pipe:
 - a. Clean existing pipe and check pipe outside diameter and roundness to verify that sleeve will fit.
 - b. If existing poured lead joint is encountered, remove and install mechanical joint tee and valve. Restrain valve to tee.
 - c. Install test plug on sleeve for field pressurization of sleeve, valve and tapping machine assembly.
 - d. Air test or hydrostatically test sleeve following manufacturer's instructions to ensure watertightness in presence of Engineer.
 - 2. Install sleeve and valve.
 - 3. Keep closest edge of sleeve minimum of 9 inches from face of existing joint bell for ductile iron and gray iron pipe.

4. In addition to cast markings required in AWWA C110, cast or stencil with waterproof paint, the class designation of connecting pipe (AB or CD).
 5. PVC Pipe:
 - a. Use only cutting/tapping tools and machines made specifically for cutting AWWA C900 pipe.
 - b. Keep closest edge of sleeve minimum of 15 inches from face of existing joint bell.
 - c. Install tapping machine without damage, scarring, or distortion to pipe.
 - d. Support tapping sleeve and valve, so its weight is not carried by pipe.
 - e. Before backfilling, fill void under sleeve with compacted granular material or flowable fill.
 6. After tapping sleeve installation is complete on existing gray iron or DIP, field coat tapping sleeve following FIELD APPLIED COATING OF EXPOSED FERROUS METAL specified herein.
- C. Approved Tapping Contractors.
1. All Counties Tapping & Testing Inc., 4–12-inch DI/CI.
 2. Antron Tapping Service, Inc., 4-12-inch DI/CI.
 3. Aqua New Jersey, Inc., 6-20inch CI.
 4. B. K. Utilities Tapping Service, 4–12-inch DI/CI.
 5. Cherry Hill Construction, Inc., 1-24 inch, DI/ CI /Transite (asbestos cement).
 6. DHC Corporation, 4–12-inch DI/CI.
 7. Hydra Stop, Inc., all sizes DI/CI.
 8. Hydro Tap Service, Inc., 4–16-inch DI/CI, and line stops.
 9. Mega Tap, 1–12-inch DI/CI.
 10. Owens & Dove, 4–16-inch DI/CI.
 11. Penniman & Browne, Inc., 1/2-16-inch PVC/DI/CI/RCP/steel.
 12. Pennsylvania American Water, 6–20-inch CI/ DI/ Transite (asbestos cement).
 13. Pro Tapping, Inc., 3/4-36-inch DI/CI /Transite (asbestos cement).
 14. Quality Cut Tapping Service, 4–16-inch DI/CI.
 15. TDW Services, Inc., all sizes DI/CI.
 16. The Sunbury Municipal Authority, 4–24-inch CI.
 17. W. D. Fox Tapping and Welding, Inc., DI/CI/Transite (asbestos cement).
 18. Western Berks Water Authority, 36” x 16” DI.

3.11 CONNECTIONS TO EXISTING MAINS

- A. Certain information is shown on Drawings relative to existing pipe and other construction.
1. This information was transferred from existing records and is not guaranteed to be accurate. Contractor is to test pit and verify, at no cost to the Commission.
- B. Before pipe installation see Excavation under INSTALLATION OF WATER MAIN previously specified herein.
1. Do not cut existing pipe closer than 18 inches to joint bell unless joint bell will be removed.

2. When trench excavation encounters existing poured lead joint on existing pipe, remove poured lead joint.
 - a. Before removing poured lead joint, clean existing pipe and measure existing pipe outside diameter. Check for roundness to verify that new dismantling joint sleeve and pipe can be installed according to manufacturer's specifications.
- C. Shutdowns.
1. Mains smaller than 10 inches: Operate valves under direct supervision of certified WSSC employee. Mains 10 inches and larger: Commission will operate valves for shutdown.
 - a. The Commission cannot warrant that mains will be dry and free from all leakage.
 - b. After bacteriological analysis is completed and approved by the Engineer, provide written request to shut down main 3 working days prior to intent.
 - c. When new PRV is added to system and/or pressure zone boundary changes are required, provide written request to shut down main 5 working days prior to intent.
 - d. Intent to shut down mains between the hours of 4 p.m. and 7:30 a.m. and on Saturdays, Sundays, and holidays requires 5 working days written request.
 - e. Shutdowns will not occur without Engineer's approval and in the presence of his/her designee.
 2. Pump and dewater to make necessary connections to existing water mains.
 3. Maintain safe working distance from unrestrained closed valve.
 - a. Safe working distance from closed, unrestrained valve chart

Pipe Diameter (Inches)	Length of Straight Pipe in Front of Valve (Feet)
4	65
6	90
8	120
10	150
12	185

Length of straight pipe is the amount of buried straight pipe on dewatered side of closed, unrestrained valve to prevent the valve from moving. No bends, joint deflections, gaps between plain-end inside couplings, or tunnels are to be within the designated length of straight pipe.

4. Make connections with greatest possible speed. Working more than 8 hours, at nighttime, or on weekends, requires prior permission from Engineer. Confirm shutdown time with Engineer prior to scheduling.

5. Will not be scheduled or performed on day before, day of or day after the following days:
 - a. New Year's Day.
 - b. Good Friday.
 - c. Easter.
 - d. Beginning of Passover.
 - e. Memorial Day.
 - f. Independence Day.
 - g. Labor Day.
 - h. Rosh Hashanah.
 - i. Yom Kippur.
 - j. Thanksgiving.
 - k. Hanukkah.
 - l. Christmas.
 6. Provide excavation and backfill required for shutdowns.
 7. Cooperate and coordinate with Commission forces.
 8. Commission will notify consumers prior to shutdown.
- D. Collection Of Pipe And Soil Samples
1. Pipe sample collection
 - a. Cut a 2–3-inch pipe ring from existing pipe at locations shown on drawings.
 - b. Place sample in an appropriately sized zip-top bag and tag the bag with the following information:
 - 1) Contract number of existing pipeline.
 - 2) Maryland state plane coordinates of locations (Easting, Northing).
 - 3) Closest street address.
 - 4) Depth of pipe.
 - 5) Date of sample collection.
 2. Soil sample collection
 - a. Collect soil sample at locations shown on drawings.
 - b. Fill a 2-gallon zip-top bag approximately halfway with soil sample and tag with the following information:
 - 1) Contract number of existing pipeline.
 - 2) Maryland state plane coordinates of locations (Easting, Northing).
 - 3) Closest street address.
 - 4) Depth of pipe.
 - 5) Date of sample collection.
 3. Submit pipe and soil samples to the Engineer for storage.
- E. When connecting to existing polyethylene encased pipe, overlap joint following AWWA C105, Method A.
1. When connecting V-Bio polyethylene encased pipe to non-encased pipe, overlap polyethylene 3 feet onto non-encased pipe following AWWA C105. Seal polyethylene with minimum two layers of compatible adhesive tape.

3.12 FIELD APPLIED COATING OF EXPOSED FERROUS METAL AND PIPE CONNECTIONS OF DISSIMILAR MATERIALS

- A. For cathodically protected systems, coat exposed ferrous metal surfaces of joints, couplings, and uncoated steel with primer and tape coating system after installation.
- B. Do not coat stainless steel nuts and bolts.
- C. Surface Preparation: Clean surfaces of rust, scale, soil, mud, oil, grease, and other contaminants by hand or power tool following SSPC-SP2 or SP3 and other appropriate means as recommended by coating manufacturer.
- D. Remove excess moisture and provide surface dryness as recommended by coating manufacturer.
- E. Application:
 - 1. Apply primer in uniform manner to clean and dry surfaces following coating manufacturer's recommendations.
 - 2. Fill complex and irregular surfaces with appropriate mastic or filler tape to eliminate bridging.
 - 3. Apply inner layer of tape/wrap to primed and filled surfaces following coating manufacturer's recommendations.
 - a. When coating restraining rods or strapping, apply tape wrap longitudinally, i.e., cigarette wrapped.
 - b. Where metal being coated enters concrete, overlap coating onto concrete by minimum of 2 inches after placement of concrete.
 - 4. Complete the Tape Wrapping System by wrapping the outer layer in a cylindrical motion that allows for 1 inch overlap of each revolution until the inner layer is completely covered.
- F. Inspection: After field coating of specified items, conduct visual inspection to verify complete coverage has been accomplished.
 - 1. Repair damaged or incompletely coated surfaces following coating manufacturer's recommendations.

3.13 FIELD TESTING

- A. Before hydrostatic leak test and installation of double disc and resilient-seated gate valves.
 - 1. Operate valves at site from fully closed to fully open and return to fully closed position.
 - 2. Observe for proper movement of discs and gate, and smooth function of valve parts.
 - 3. If required, correct until satisfactory performance is demonstrated.
- B. Before installation, hydrostatically test double disc and resilient-seated gate valves 16 inch and larger diameter for leakage at site in orientation as when installed.
 - 1. Vent air from valve before conducting test.
 - 2. Double disc gate valves:

- a. Apply hydrostatic test pressure equal to valve's rated working pressure between discs for 15 minutes.
 - 1) Rated working pressure: 150 psi unless otherwise noted.
 - 2) Leakage past disc not to exceed 1 ounce per hour per inch of nominal valve size.
 - 3) No leakage through metal, flanged joints, or stem seals.
 - b. Alternatively, provide bulkhead, tapped as necessary, on 1 side of closed valve. Perform hydrostatic leakage test, as described above, between bulkhead and disc.
 - 1) Repeat test on other side of valve.
 3. Resilient seated gate valves:
 - a. Apply hydrostatic test pressure equal to valve's rated working pressure with gate in open position for 15 minutes.
 - 1) Rated working pressure: 150 psi unless otherwise noted.
 - 2) No leakage through metal, pressure-containing joints or stem seals.
 - b. Alternatively, provide bulkhead, tapped as necessary, on 1 side of closed valve. Perform hydrostatic leakage test, as described above.
 - 1) Repeat test on other side of valve.
- C. Hydrostatic tests for water pipes.
 1. Close ends of test sections with caps or plugs properly blocked or restrained to withstand pressures to be imposed.
 2. Do not use existing or new WSSC pipe or appurtenances for temporary restraint or support during test.
 3. Do not use resilient seated gate valves in closed position as the pressure boundary of a test section when test pressure exceeds 250 psi.
 4. Equip and conduct hydrostatic tests with pressures computed by the Commission and described herein.
 - a. When pipe installation is ready for testing and approved backfill operations completed, notify Engineer in writing 5 working days in advance of test.
 - b. Perform chlorination simultaneously with hydrostatic test unless otherwise approved by Engineer.
 - c. Conduct preliminary test to ensure main is ready for final test.
 - d. Provide pressure gage recorder capable of printing continuous record of pressure test readings (by Dickson Pressure Recorders, Model Numbers PW457 or PR81000), and charts, for testing.
 - e. Water meter for testing: Furnished by the Commission.
 - f. Protect and shelter testing equipment.
 - g. Set up testing equipment with a clean water supply. No fire hydrant close to project area. Conduct tests on pipe following AWWA C600.
 - 1) Pressure Test:
 - a) Hydraulic gradient following Drawings.

- b) Pressure (operation plus surge) to be induced at low point of test section for pressure test is equal to elevation of hydraulic gradient minus low point elevation of water main section to be tested, multiplied by 0.433, plus surge pressure as shown below:

<u>Diameter of Pipe</u>	<u>Psi</u>
3-inch to 10-inch	120
12-inch to 14-inch	110
16-inch to 18-inch	100
20-inch	90
24-inch	85
30-inch	80
36-inch	75
42-inch to 60-inch	70

- c) Fill length of water main to be tested with water, expelling air and subject it to pressure computed as described above.
- d) Maintain this pressure for minimum of 2 hours.
- 2) Leakage Test:
- a) Conduct leakage test consecutively with pressure test.
- b) For leakage test induce pressure at high point of test section that is equal to elevation of high hydraulic gradient minus high point elevation of water main section to be tested, multiplied by 0.433, but never less than 100 psi.
- c) Maintain this pressure for minimum of 8 hours.
- d) Calculate maximum allowable leakage for water main using formula:

$$L = \frac{SD\sqrt{P}}{133,200}$$

where:

L = maximum allowable leakage, gallons/hour. S = length of pipe in test section, in feet.

D = nominal diameter of tested pipe, in inches.

P = average test pressure, pounds per square inch, which will be computed by averaging test pressures at low point and pressure at high point above.

5. Pipes 14 Inch and Smaller: Conduct 2 hour combination pressure/leakage test.
- a. For 14 inch and smaller diameter mains the Contractor has the option for 2-hour test to substitute the recording gage with a Calibrated Needle Pressure Gage with zero leakage.
- b. After installation of the water service connections, conduct a 2-hour pressure test at 125 psi, utilizing either option to conduct the test.

- 1) Not to be conducted on replacement and relocation projects without Engineer's direction.
- D. Should test results show displacement, damage, or leakage in excess of allowable amount, repair displacement, damage, and eliminate leakage.
1. Retest until specified conditions are met, to Engineer's requirement, at no cost to the Commission.
 2. Commission will observe test for each segment once without charge to Contractor.
 - a. Cost of further tests will be deducted from monies owed Contractor at prevailing hourly rates published by the Commission.
 3. Additional water use resulting from failed water main test shall be metered in gallons with the Commission reimbursed for water use at the prevailing rates.
- E. PVC Water Pipe Continuity Testing.
1. Test tracer wire for continuity, in presence of Engineer, after backfill is complete and before Substantial Completion.
 2. Notify Engineer in writing 5 working days in advance to schedule testing.
 3. Continuity test to consist of locating the PVC water pipe and water services with an electronic-type pipe locator.
 4. If test for continuity is negative, repair or replace as necessary to achieve continuity.

END OF SECTION

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SECTION 02511
CHLORINATION AND DECHLORINATION

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section includes requirements for chlorination and dechlorination procedures for water mains.

1.2 SUBMITTALS

- A. Submit for Information Only.
 - 1. Qualifications and experience of personnel under whose supervision chlorination or dechlorination is to be performed when using pressurized liquid chlorine described in AWWA B301 or other pressurized chemicals.
 - 2. Method of Construction to include method of chlorination, type and quantity of chemicals, source of water for disinfection, discharge locations of chlorinated water or, if required, method of treating chlorinated water.

PART 2 PRODUCTS

2.1 MATERIALS: Follow Section 02510, AWWA standards, and specified herein.

- A. Dechlorination Tablets: LPD-CHLOR™ Sodium Sulfite, Bio-Max Sodium Sulfite, or VITA-D-CHLOR (ascorbic acid).
- B. Bag: 16-inch (top opening) by 8-inch nylon.
- C. Diffusers:
 - 1. For flow rates up to 120 gpm: Use 4-inch circular strainer to hold bag with sodium sulfite or ascorbic acid tablets, attach to fire hydrant or fire hose using adapter.
 - 2. For flow rates from 31 to 1250 gpm: Use Pollard LPD-250 or LPD-250A Diffusing Dechlorinator.
 - a. Low Flow Inserts: For flow rates from 31 to 200 gpm.
- D. Rubber Bands: Heavy duty to fit around nylon bag.
- E. Fire Hose: Standard 2 1/2 inch.
- F. Adapters: To connect 4-inch circular strainer to fire hydrant or fire hose.
- G. End Wall Cap: Threaded for use with standard fire hose.

- H. Protection Equipment: See LPD-CHLOR™ tablet Material Safety Data Sheets (MSDS).
- I. Chlorine Field Test Kit (Hach Colorimeter).

PART 3 EXECUTION

3.1 CHLORINATION BY CONTRACTOR

- A. Notify Engineer 3 working days before performing chlorination and dechlorination.
 - 1. Provide blow off with sample point at end of each branch and end of main line.
 - 2. All valves including fire hydrant lead valves within chlorinated section to be left open during chlorination.
- B. Supply water for disinfection and filling mains from temporary jumper with approved backflow preventer.
 - 1. When no source of water from existing main is available, provide potable water.
 - 2. Pre-flush water source prior to chlorination until water has chlorine residual less than 2.5mg/l and pH is less than 9.2.
- C. Use continuous feed method or tablet method for chlorination following AWWA C651 for disinfecting water mains, except section 4.4.2.1., and as required herein.
- D. Approved Forms of Chlorine: Liquid chlorine, sodium hypochlorite solution, and calcium hypochlorite granules or tablets following AWWA C651.

3.2 CHLORINATION METHODS

- A. Continuous Feed Method.
 - 1. Proportion mixture of chlorine solution and water so that minimum of 25 mg/l free chlorine concentration is placed into main and appurtenances to be chlorinated. See table below for guidelines regarding quantity of chlorine needed for initial feed.
 - 2. Retain concentrated chlorinated water in main for 24-hour period.
 - 3. At end of 24-hour period, treated water shall contain no less than 10 mg/l free chlorine throughout main.

CONTINUOUS FEED METHOD																
Pipe Diameter (inches)	LENGTH OF PIPE TO BE CHLORINATED															
	100'	200'	300'	400'	500'	600'	700'	800'	900'	1K	2K	3K	4K	5K	6K	7K
1.5	0.025	0.01	0.016	0.02	0.03	0.033	0.038	0.04	0.05	0.06	0.11	0.16	0.22	0.28	0.33	0.38
2	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.20	0.30	0.40	0.50	0.60	0.70
2.5	0.02	0.03	0.05	0.06	0.08	0.09	0.10	0.12	0.13	0.15	0.30	0.45	0.60	0.75	0.90	1.10
3	0.022	0.04	0.06	0.08	0.10	0.13	0.15	0.16	0.20	0.22	0.43	0.60	0.86	1.10	1.30	1.51
4	0.038	0.07	0.12	0.15	0.20	0.23	0.26	0.30	0.35	0.38	0.76	1.15	1.53	1.92	2.30	2.68
6	0.09	0.18	0.26	0.35	0.45	0.53	0.62	0.70	0.80	0.88	1.77	2.70	3.50	4.40	5.30	6.20
8	0.20	0.30	0.50	0.60	0.80	0.90	1.10	1.20	1.40	1.60	3.10	4.70	6.20	7.80	9.30	10.90
10	0.24	0.48	0.70	1.00	1.20	1.50	1.70	2.00	2.20	2.40	4.90	7.30	9.70	12.20	14.60	17.00
12	0.35	0.70	1.10	1.40	1.80	2.10	2.50	2.80	3.20	3.50	7.00	9.00	14.00	17.50	21.00	24.50
16	0.60	1.30	1.90	2.50	3.10	3.70	4.30	5.00	5.60	6.20						
18	0.80	1.60	2.40	3.20	4.00	4.70	5.50	6.30	7.10	7.90						
20	1.00	2.00	2.90	3.90	4.90	5.90	6.80	7.80	8.70	9.70						
24	1.40	2.80	4.20	5.60	7.00	8.40	9.80	11.20	12.60	14.00						

CHART LIST POUNDS OF HTH (70% CHLORINE) TO BE USED TO CHLORINATE GIVEN SIZE PIPE FOR DESIRED PIPE LENGTH.

4. Flush out main at end of 24-hour period using jumper until water has chlorine residual less than 2.5 mg/l total chlorine and pH less than 9.2.
5. Preliminary flushing of pipe required by AWWA C651 before chlorination is optional if interior is broom swept or in clean condition, as determined by Contractor.

B. Tablet Method.

1. Do not use this method unless interior of pipe, fittings, and valves can be kept clean and dry.
2. Average Chlorine Dose: Approximately 25 mg/l free chlorine.
3. Seal ends of pipelines that contain tablets or granules to prohibit entry.
4. Flush out main at end of 24-hour period using jumper until water has chlorine residual less than 2.5 mg/l and pH is less than 9.2

3.3 COMPLETION OF CHLORINATION

- A. Notify Engineer in writing when chlorination is complete and ready to have bacteriological samples taken.
- B. Should residual and bacteriological analyses not be satisfactory to Engineer, rechlorinate main and notify Engineer in writing when rechlorination is complete and ready to have bacteriological sample taken.
- C. Place mains in service when analysis is complete and approved by Engineer.

3.4 DISCHARGING CHLORINATED WATER

A. Methods.

1. Discharge into existing sanitary sewer manhole. Closest sanitary manhole is at the intersection of Constellation Ct & Aragona Boulevard.
 - a. If any unexpected field conditions are encountered during construction which prevents the Contractor from discharging chlorinated water into the manhole mentioned in 3.4.A.1, refer to an alternative means of disposal described below.
2. If a sanitary sewer is not available, an on-site tank may be used to hold discharge water until chlorine naturally dissipates or can be treated with dechlorination chemicals.
 - a. Maintain 12-inches of freeboard above water level in the on-site tank or detention pond to prevent the on-site tank or detention pond from overflowing due to rainfall.
 - b. Tank or detention pond may not be emptied to environment until chlorine residual tested within 15 minutes of sample collection from at least 3 representative locations in the tank or pond is non-detectable (<0.10 mg/l) as required by Part IV, Section D of the General Discharge Permit.
3. When sanitary sewers and are not available, dechlorinate chlorinated water, or store chlorinated water before discharging as specified below.
4. Dechlorination or storage of chlorinated water before discharge.
 - a. Chemically dechlorinate water or store water until chlorine residual is non-detectable.
 - b. The discharge shall meet all Maryland Department of the Environment (MDE) requirements as specified in General Discharge Permit number 06 HT, Part IV Sections A and D.
 - 1) Collect at least 3 grab samples evenly spaced over course of discharge.
 - 2) Analyze samples for chlorine residual.
 - 3) Chlorine residual: Non-detectable in all samples.
 - 4) If water is chemically dechlorinated, dissolved oxygen (DO) shall be measured as well in each of the 3 samples.
 - 5) DO: 5.0 mg/L or greater for discharges to I, I-P, and II waters and 6.0 mg/L or greater for discharges to III, III-P, and IV-P waters.

B. Safety Procedures:

1. Commission health and safety programs.
2. May use subcontractor specializing in dechlorination of superchlorinated water.
 - a. List of such contractors is provided in Appendix F of the Pollution Prevention Plan.

3.5 DISCHARGING POTABLE WATER (0 – 4 milligram per liter [mg/L] Chlorine)

- A. Discharge potable water as specified in 3.4 A.
- B. When sanitary sewers, tanks, or detention ponds are not available at project site, dechlorinate potable water, store, or discharge specified herein.
 1. Safety Procedures: LPD-CHLOR™ MSDS and the Commission health and safety programs.
 2. To treat flow rates up to 120 gpm: Use fabricated diffuser of 4-inch strainer and adapter.
 - a. Place 8 tablets in 8-inch by 16-inch (top opening) nylon bag with 4 tablets pushed to each side of bag.
 - b. Fold bag over tablets, twisting in center.
 - c. Secure with rubber bands and position firmly inside fabricated diffuser.
 - d. Estimated time to replenish tablets: 3 days for flows of 1 to 30 gpm and 15 hours for flows of 31 to 120 gpm.
 3. To treat flow rates from 31 – 1250 gpm: Use Pollard LPD-250 or LPD-250A Diffusing Dechlorinator with low flow insert for flow rates from 31-200 gpm.
 - a. Minimum tablets: 10 for every discharge.
 - b. Carefully stack tablets in column chamber of LPD unit.
 - c. Estimated discharge duration for Pollard diffuser.

Number of Tablets	Estimated Discharge Duration (in hours) that Can Be Treated by the Pollard LPD-250			
	Low flow (1 – 30 gpm)	Medium flow (31 – 150 gpm)	High flow (151 – 300 gpm)	Very High flow (301 – 1250 gpm)
10	Do not use for flows < 30 gpm	8	4	1/2
11		9	4-1/2	1/2
12		10	5	1/2
13		10-1/2	5-1/2	1/2
14		11-1/2	6	1/2
15		12-1/2	6	1/2
16		13	6-1/2	1
17		14	7	1
18		15	7-1/2	1
19		16	8	1
20		16-1/2	8	1

4. Number of tablets used during a given discharge: Dependent on various factors such as flow rate and water temperature.
5. Before being released into the environment, test treated water to assure complete dechlorination has been achieved.
6. Discharging from fire hydrant:
 - a. Attach fabricated diffuser directly to either 2 1/2-inch side or 4-inch side of fire hydrant using appropriate adapters or attach 2 1/2-inch hose to 2 1/2-inch side of hydrant and to fabricated diffuser using appropriate adapter.
 - b. Pollard LPD-250A Diffusing Dechlorinator: Attach directly to 2 1/2-inch side of hydrant or attach 2 1/2-inch hose to hydrant and diffuser.
 - c. Pollard LPD-250 Diffusing Dechlorinator:
 - 1) Attach to 1 end of 2 1/2-inch hose and attach other end of hose to fire hydrant.
 - 2) Do not attach directly to hydrant.
 - d. Direct flow so discharge does not cause erosion or disrupt traffic.
7. Discharging from blowoff or pump:
 - a. Use standard fire hose and appropriate adapters and position diffuser so discharge does not cause erosion, using filter geotextile or tarp when necessary.
 - b. When discharging from end wall-type blowoffs, replace the standard end wall cap with a modified cap equipped with 2 1/2 inch or 4-inch threaded connection.

3.6 CONNECTION BETWEEN EXISTING AND NEW MAINS

- A. Clean and spray or swab new pipe, fittings, and valves with minimum 1 percent solution of chlorine just before installation.

END OF SECTION

SECTION 02576
EXCAVATED MATERIAL DISPOSAL

PART 1 GENERAL

1.1 SUMMARY

- A. This section covers disposal of excavated material, including spoils from shafts, tunnel, and surface connection excavations.
- B. Excavated material shall be used as a clean fill material whenever possible. All unsuitable materials, including special and designated wastes, shall be removed from the site and disposed of, by and at the expense of the Contractor.

1.2 SUBMITTALS

- A. The following documentation shall be submitted in accordance with Section 01330, Submittals.
 - 1. Permits for proposed disposal sites if required by Local, State, and Federal ordinances.
 - 2. Written permission from property owner, along with description of property including current and future land use / zoning designation.
 - 3. Written and signed release from property owner upon completion of disposal work.

PART 2 PRODUCTS

(NOT USED)

PART 3 EXECUTION

3.1 SALVAGEABLE MATERIAL

- A. Excess excavated material shall be loaded, hauled to, and deposited at an approved disposal site.
- B. Excess Excavated material meeting the requirements of 02315 may be utilized for backfill in accordance with the Contract Documents.

3.2 EXCESS MATERIAL.

- A. Vegetation, rubble, broken concrete, debris, asphaltic concrete pavement, excess soil, and other materials not designated for salvage, shall become the property of Contractor and shall be removed from the job site and legally disposed of.

- B. Excess soil may be deposited on private property when written permission is obtained from the property owner.
- C. Contractor shall verify the flood plain status of any proposed disposal site and shall not dispose of excavated materials in an area designated as being within the 100-year Flood Hazard Area.
- D. Waste materials shall be removed from the site on a daily basis, such that the site is maintained in a neat and orderly condition.

END OF SECTION

SECTION 02920
LAWNS AND GRASSES

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section includes requirements for preparation of seed and sod bed, seeding, sodding, fertilizing, liming, and mulching to limits shown, and as required for restoration and re-stabilization of disturbed areas, at Engineer's direction.

1.2 RESTORATION

- A. As defined below, and when noted in Restoration Schedule on Drawings.
 - 1. Type A: Sod for established lawns, park lawns, and frequently mowed public spaces.
 - 2. Type B: Sod for sodded swales.
 - 3. Type C: Surge stone for seeded and stone lined swales.
 - 4. Type D: Seed for improved areas.
 - 5. Type E: Seed for unimproved and outfall areas.
 - 6. Type F: Development sites with existing stabilization of temporary mulch or planted seed.
 - a. Restore in kind and maintain.
- B. All disturbed areas shall receive Type D restoration unless otherwise noted, or upon receiving written approval from the Engineer.

1.3 SUBMITTALS

- A. Submit following Section 01450.
 - 1. Certificates of Compliance Before Delivery of Materials:
 - a. Topsoil.
 - b. Seed.
 - c. Sod.
 - d. Fertilizer.
 - e. Lime.

1.4 REFERENCE DOCUMENTS

- A. Obtain and maintain at work site a copy of Maryland Turf Grass Law and Regulations and Maryland Seed Law and Regulations, available from:

Maryland Department of Agriculture
Turf and Seed Regulatory
50 Harry S. Truman Parkway
Annapolis, Maryland 21401
Phone (410) 841-5960

PART 2 PRODUCTS

2.1 TOPSOIL

A. Properties

1. Fertile natural surface agricultural soil capable of sustaining vigorous plant growth.
2. Containing not less than 1-1/2 percent organic matter as determined by MSHA Standard Method of Test.
3. pH value of not less than 6.5.
4. Free of stones, roots, rubbish, and other objectionable materials such as Bermuda grass, poison ivy, and kindred roots, and material harmful to plant growth.
5. Sufficient pore space to permit adequate root penetration.
6. Meet analysis of sand, silt, and clay when determined following AASHTO M146 with these exceptions:

	Percent Passing by Weight	
	<u>Minimum</u>	<u>Maximum</u>
Sand	20	75
Silt	10	60
Clay	5	30

- B. Topsoil available on site that meets above specified requirements may be utilized with Engineer's approval.

2.2 SPECIAL PURPOSE TOPSOIL

- A. Hand spreadable and meeting requirements listed above for topsoil and following gradation:

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

- B. Topsoil available on site that meets above specified requirements for special purpose topsoil may be utilized with Engineer's approval.

2.3 SEED

- A. Certification: Unless otherwise specified herein, certified by Maryland Department of Agriculture and following requirements of Maryland Seed Law and Regulations.
- B. Seed Mixtures are to meet the guidelines of the Sediment Control Drawings.

2.4 SOD

- A. Grade: Certified or Approved as designated by Maryland Department of Agriculture and following requirements of Maryland Turf Grass Law and Regulations.
 - 1. Machine cut sod at uniform thickness of 3/4 inch \pm 1/4-inch, excluding top growth and thatch.
 - 2. Use individual sod pieces strong enough to support their own weight when lifted by ends.
 - 3. Broken pads, irregularly shaped pieces, and torn or uneven ends will not be acceptable.
 - 4. Lay sod between September 15 and May 15. Do not lay on frozen ground.
- B. Replacement:
 - 1. For replacing previously established turf, use sod similar to what existed before construction.
 - 2. For sod placed where no grass existed before construction or replacing lawn consisting mainly of coarse textured grass without dominant species, use Maryland Certified Sod of Tall Fescue 100 percent Certified Adventure, Apache, Arid, Bonanza, Falcon, Finelawn, Jaquar, Mustang, Olympic, or Rebel.
 - 3. For sod replacing lawn consisting mainly of fine textured grass without dominant species, use Maryland Certified sod of Kentucky Bluegrass 100 percent certified Aspen, Blackburg, Bristol, Cheri, Eclipse, Georgetown, Gnome, Haga, Merit, Midnight, Plush, Trenton, or Victa.

2.5 FERTILIZER

- A. Uniform composition, free flowing and delivered to site fully labeled according to applicable state fertilizer laws and bearing name, trade name, or trademark and warranty of producer.
- B. Submit recommendations and receive Engineer's approval before implementation.

2.6 LIME

- A. Contents: Ground limestone containing at least 50 percent total oxides (calcium oxide plus magnesium oxide).
 - 1. Limestone: Ground to fineness so that at least 50 percent will pass through 100 mesh sieve and 98 percent will pass through 20 mesh sieve.

2.7 MULCH

A. For Protection of Permanent Seeding:

1. Straw: Clean, weed free, unrotted, and anchored with 1 of following methods.
 - a. Mulch anchoring tool for flat slopes, mulch nettings, and cut back or liquid binders listed following manufacturer's recommendation.
 - b. Acrylic DLR (Agro-Tack).
 - c. DCA-70.
 - d. Petroset.
 - e. Terra Tax II.
 - f. Terra Tack AR.
 - g. Or equal.
2. Mulch: Jute or excelsior blanket.
3. Wood Chips: Coverage 1-1/2 inches deep.

B. Mulch Utilized as Temporary Protection and Stabilization: Follow above materials requirements.

PART 3 EXECUTION

3.1 PERMANENT SEEDING

A. Preparation.

1. Harrow, disc, or otherwise loosen subsoil to depth of 4 inches.
2. Spread topsoil or composted sludge evenly over prepared subsoil to following depths.
 - a. Topsoil:
 - 1) Slopes 3:1 or steeper: 2 inches after compaction.
 - 2) Slopes flatter than 3:1: 4 inches after compaction.
3. Where existing topsoil does not meet these requirements, provide required topsoil to meet above minimum thicknesses.
4. Remove objectionable material such as stones 2 inches or larger, clods, brush, roots, and trash from top 4 inches of soil.
5. Perform harrowing, discing, scarifying, and raking on contour of slopes steeper than 3:1.

B. Amendments:

1. Thoroughly mix lime and fertilized into top 3 to 5 inches of soil.
2. Scarify area and rake until surface is leveled to give a maximum of 2 inches in variation, and soil is easily crumbled and uniform fine texture.

C. Seed Application:

1. Apply mixture uniformly with mechanical power-driven seeders, mechanical cyclone hand seeders or hydroseeding equipment.
2. Slurry for hydroseeder may contain seed and fertilizer only.
3. Rake, roll, or drag seedbed in all other areas, if hydroseeder or cyclone seeder is used.

4. Moisten seedbed during periods of drought and/or high temperatures.

D. Mulch Application:

1. Anchor as specified in PART 2 PRODUCTS herein.

3.2 TEMPORARY SEEDING

A. Preparation:

1. Loosen top 2 inches of seedbed.
2. Apply lime and fertilizer at rates specified in on the plans.

B. Seed Application: Follow application for temporary seeding.

C. Mulch Application: Follow application for temporary mulching.

3.3 SODDING

A. Preparation:

1. Harrow, disc, or otherwise loosen subsoil to depth of 6 inches.
2. Harrow, disc, scarify, and rake on contour of slopes steeper than 3:1.
3. Remove objectionable material such as stones, clods, brush, roots, and trash from top 4 inches of soil.

B. Amendments:

1. Thoroughly mix lime and fertilizer into loosened subsoil.
2. Scarify area and rake until surface is leveled to a maximum of 2 inches in variation, and soil is easily crumbled and uniform fine texture.

C. Sodding:

1. Lay sod when outside the seeding dates provided on the plans.
2. Deliver to site within 24 hours, and install within 36 hours, after cutting.
3. During wet weather, dry sod sufficiently to prevent tearing during handling and placing.
 - a. During dry weather, water sod sufficiently before lifting to ensure its vitality and to prevent dropping off of soil during handling.
4. Desiccated sod will be rejected; replace at no cost to the Commission.
5. Place sod in straight lines parallel to one another.
 - a. Stagger lateral joints and butt tight.
 - b. On slopes 5:1 and steeper place sod with long edges parallel to contour starting at top of slope.
 - c. In drainage ditches and sodded channels, place sod with long edge parallel to flow of water.
6. On slopes 2:1 and steeper and in surface drainage V-shaped or flat-bottomed ditches, stake each strip of sod with at least 2 stakes, spaced not more than 2 feet apart, or wire staples.

7. Immediately after completing section of sodding, roll, tamp, and water until underside of sod pad and soil surface beneath it are thoroughly wet and in contact with each other to eliminate air pockets.
8. Completion of placing, rolling, tamping, and watering: Within 8-hour period.
9. Moisten dry sod bed during periods of drought or high temperatures.

3.4 MULCH ONLY

- A. Grade as required.
- B. Place and anchor mulch only at rates specified in PART 2, PRODUCTS, where indicated and directed by Engineer.

3.5 TIME RESTRICTIONS

- A. When permanent seeding or sodding is specified or directed, and is not allowed because of time restrictions specified above, utilize 1 or more of following methods to prevent erosion and sedimentation until permanent seeding or sodding is allowed.
 1. Place and anchor straw mulch or wood chips.
 2. Apply temporary seeding and mulch.
 3. Prepare soil as for permanent seeding and then mulch as specified herein; overseed during next seasonal seeding period.
 4. Provide other erosion control measures acceptable to Engineer.
 5. Remove straw or wood chips used as temporary mulch or work into subsoil minimum depth of 6 inches before initiation of permanent seeding or sodding application.

3.6 MAINTENANCE OF SEEDED AND SODDED AREAS

- A. Maintain seeded and sodded areas until accepted in writing by Engineer.
 1. Water seeded and sodded areas as necessary to establish growth.
- B. Inspect seeded and sodded areas for failures and necessary repairs.
- C. Provide replacements during specified planting seasons.
- D. When Engineer determines stand of turf is inadequate:
 1. Overseed and fertilize using 1/2 of rates originally applied.
 2. Resod.
- E. When Engineer determines stand is over 60 percent damaged:
 1. Reestablish following original lime, fertilizer, and seed.
 2. Prepare sod bed following seeding or sodding recommendations.

END OF SECTION

SECTION 02950
PAVEMENT REQUIREMENTS

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section includes requirements for removing, replacing and providing new paving for roads, driveways, parking areas, curb and gutter, walks, and paved areas within limits indicated, including subgrade and base courses.

1.2 DEFINITIONS

- A. Paved: Covered with gravel, stone, brick, asphalt, concrete, or other material providing a firm, level, or convenient surface for vehicular or pedestrian traffic.

1.3 JURISDICTIONAL REQUIREMENTS

- A. Commission utility contracts involve work in roads, parking and paved areas under following jurisdictions:
 - 1. Maryland State Highway Administration (MSHA).
 - 2. Prince George's County Department of Permitting, Inspections & Enforcement.
 - 3. Prince George's County Public Works and Transportation Department.
 - 4. Incorporated municipalities.
 - 5. Other jurisdictions.
- B. When working in these areas, remove and replace roads, driveways, parking areas, curb and gutter, walks and other paved areas following specific requirements of the authority having jurisdiction.

1.4 PAVEMENT REPLACEMENT

- A. All pavement damaged during construction shall be replaced as indicated on the plans.

1.5 SUBMITTALS

- A. Submit following Section 01330.
 - 1. Certified asphalt mix design.
- B. Submit certified delivery tickets for asphalt furnished.

PART 2 PRODUCTS

2.1 MATERIAL

- A. Commission Furnished Materials.
 - 1. Pavement Repair Identification Markers.
- B. Concrete.
 - 1. Meet requirements in Section 03300, except where jurisdictional requirements apply.
- C. Other Materials.
 - 1. Materials for permanent pavement replacement: Meet latest editions of following jurisdictional requirements:
 - a. State Roads: MSHA Standard Specifications, Standard Details, and Master Permits.
 - b. Prince George's County Roads: Prince George's County Public Works and Transportation Department Specifications and Standard Details.
 - 1) Material must be obtained from county approved hot mix asphalt plants.
 - c. Areas not covered above: Follow Right of Way Construction Permit.
 - 2. Calculate tonnage of hot mix asphalt (HMA) required using the following equation:

$$\text{Quantity (tons)} = 1.05 * [\text{Area (yd}^2\text{)} * \text{Thickness of Lift (inches)}] / 17$$

The simplified equation is developed from the following equation that involves conservative unit weight estimate and material unit conversions.

$$\text{Quantity (tons)} = \text{Area (yd}^2\text{)} * \text{Thickness of Lift (inches)} * (1 \text{ yd} / 36 \text{ inches}) * (27 \text{ ft}^3 / 1 \text{ yd}^3) * \text{Unit Weight HMA (\#/ft}^3\text{)} * (1 \text{ ton} / 2000 \text{ \#}) * 1.05$$

A denominator of 17 in the simplified equation is equivalent to a HMA unit weight of 156.9 lbs/ft³. This value is slightly higher than the historical average for HMA unit weights, but this is designed to be a conservative estimate and it is determined this simplified equation provides an adequate quantity. The equation is multiplied by 1.05 to account for a 5% waste factor.

- D. Temporary Pavement Replacement:
 - 1. Hot Mix Asphalt Surface-Fine (SF): Follow MSHA Standard Specifications.
 - a. When not available, use Engineer approved high performance cold mix asphalt.

2. High Performance Cold Mix Asphalt: Composed of approved suitable aggregate, plant mixed with approved asphaltic liquid blend following blend manufacturer's specifications.

a. Final mix:

- 1) Stripping resistance of retained coating minimum 75% when testing to ASTM-D-1664, latest revision.
- 2) Remain flexible and cohesive to minus fifteen degrees F (-26 degrees C).
- 3) Homogeneous, free of lumps.
- 4) Retain its adhesive qualities in wet applications.
- 5) Approved High Performance Cold Mix Products:
- 6) National Paving and Contracting, Perma-Patch
- 7) Seaboard Asphalt Product, Bond-X Green
- 8) Lafarge North America, QPR
- 9) RoadStone Production LLC, Aquaphalt
- 10) Cold Mix Manufacturing Corp., Green Patch.
- 11) Unique Paving Materials, High Performance Cold Patch.
- 12) JASA High Performance Cold Patch (Cold Mix Liquid)

- b. Acceptable aggregate: Consist of 10% crushed stone or laboratory approved equivalent under ASTM C-136.

Recommended Gradation:

Sieve Size	Percent Passing by Weight
3/8"	90-100%
#4	20-55%
#8	5-30%
#16	0-10%
#50	0-5%
#200	0-2%

c. Acceptable Liquid Asphaltic Blends:

- 1) National Paving and Contracting, Co., Perma-Patch Liquid
- 2) Sylvax Corp., UPM Liquid Asphalt Blend
- 3) Lafarge North America, QPR Blend
- 4) Sylcrete Corp., Sylcrete-EV
- 5) Co-Products Corp., I.A.R.
- 6) Seaboard Asphalt Product, Bond-X

PART 3 EXECUTION

3.1 PUBLIC NOTIFICATION

- A. See Section 01110.

3.2 GENERAL

- A. Construction requiring removal and replacement of roads, driveways, parking areas, curb and gutter, walks and paved areas, and new paving: Meet latest editions of jurisdictional requirements listed above in PART 2 PRODUCTS.

3.3 REMOVAL OF EXISTING PAVEMENT

- A. Cut and remove existing pavement in advance of excavating to neat lines following appropriate jurisdictional standard detail utilizing the Commission standard trench widths.
- B. Saw cut existing concrete pavement and concrete base course full depth and remove load transfer devices where they exist.
- C. Provide temporary walkways and curb and gutter at Engineer's direction.

3.4 USE OF STEEL PLATING

- A. Whenever Steel plating is required or used during construction within paved roadway:
 - 1. Notify Engineer and authority having jurisdiction at least 48 hours in advance of placing steel plates in roadway.
 - 2. Follow jurisdictional requirements and as specified herein.
 - 3. Dimensions: At least 1 inch thick and large enough to allow minimum of 1 foot of bearing on 3 sides of excavation.
 - 4. Placement: Pin plates to prevent movement. Recess plates at Engineer's direction.
 - 5. Taper cold mix asphalt on all edges of steel plate from height of steel plate extending minimum of 1 foot to existing road surface.
 - 6. During months when snowfall may be expected, mark steel plates with 2-inch square stake painted International Orange and extending at least 4 feet above ground, placed adjacent to edge of roadway.
 - 7. If jurisdictional or Commission forces must correct emergency condition due to excavation and/or plate placement, Contractor will be charged for cost of corrective measures required.
 - 8. Unless otherwise approved by Engineer, remove steel plates from service in 7 calendar days or less.

3.5 PREPARATION FOR PAVEMENT REPLACEMENT

- A. Compact Trench Backfill following Section 02315.
- B. Provide temporary or permanent pavement immediately upon completion of backfill.

3.6 TEMPORARY PAVEMENT

- A. Place temporary pavement as specified herein except where otherwise required by jurisdictional requirements.
 - 1. Place and compact hot mix asphalt bituminous concrete mix minimum thickness of 3 inches and at same grade as surrounding surface on Trench Backfills required in Section 02315 for Type I areas under existing paving.
 - 2. When approved by Engineer for use, place and compact high performance cold mix asphalt minimum thickness of 3 inches and at same grade as surrounding surface on Trench Backfills required in Section 02315 for Type I areas under existing paving.
 - a. Stockpiling of high-performance cold mix asphalt will be permitted provided it is stored in manner to prevent infiltration of deleterious material and not longer than 1 month from date of mixing.
 - b. Compact high performance cold mix asphalt using uniform tamping equipment.
 - 3. Provide hot mix asphalt for temporary curb and gutter, walks, and driveways.
 - 4. Mark temporary pavement repairs in all roads with blue paint for water or water and sewer, and green paint for sewer in 4-inch-high letters to read WSSC-S for Systems Construction or WSSC-F for Facilities Construction.
 - 5. Temporary pavement: Remain in place maximum of 60 days, unless jurisdictional requirements are more stringent.
 - a. If approved suppliers of permanent paving are unavailable due to wintertime shutdown, allotted time period will be extended to include shutdown period, upon written request to Engineer.
 - 6. Maintain temporary pavement in condition acceptable to Engineer, or authority having jurisdiction until permanent pavement is placed.
 - 7. If temporary pavement becomes defective and creates an emergency, commence repair to rectify situation within 1 hour after notification by Engineer or Engineer may arrange to have Work performed by others and deduct costs of corrective measures from monies owed Contractor.
 - 8. Resulting patch must be a smooth and level surface flush with existing pavement.

3.7 PERMANENT PAVEMENT

- A. Dimensions: Follow jurisdictional requirements.
 - 1. If pavement has been undermined, damaged, or disturbed by Contractor's operations, increase extent of repaving so that new pavement and base extends at least 18 inches over undisturbed soil.
 - 2. Install pavement repair identification markers in each repair and every 50 feet in longitudinal repairs.
- B. Bituminous Concrete Overlay:
 - 1. Place bituminous concrete overlay to limits and depth specified in Drawings, trench details and Right of Way Construction Permit.

2. Pavement replacement for trenches to be overlaid: Follow standard jurisdictional requirements or as specified below.
- C. Milling and Bituminous Concrete Overlay:
1. Mill and place bituminous concrete overlay to limits and depth specified following jurisdictional requirements.
 2. Pavement replacement for trenches to be overlaid: Follow standard jurisdictional requirements or as specified below.
- D. Bituminous Concrete Pavement Replacement:
1. Prime coat cut surfaces to receive asphalt patch and between each new layer of asphalt.
 - a. Clean surface of loose and foreign materials.
 - b. Apply under pressure: Uniformly, at rate of 0.01 to 0.05 gallons per square yard of area.
 2. Bituminous Concrete: Follow jurisdictional requirements.
 3. Resulting patch must be a smooth and level surface flush with existing pavement.
- E. Concrete Pavement Replacement:
1. Replace load transfer devices where removed.
 2. Place concrete pavement following jurisdictional requirements.
 3. Place expansion joints at 40 feet on center, maximum, or space to match existing joints, whichever is less.
- F. Shoulder Replacement:
1. Replace disturbed shoulder areas with type of material existing before disturbance, following appropriate jurisdictional requirements.
 2. Reuse of gravel or aggregate material may be permitted with Engineer's approval, provided gravel or aggregate is removed and stockpiled separately, and is not infiltrated with foreign material.
- G. Curb and Gutter Replacement:
1. Do not tunnel concrete and asphalt curbs without Engineer's approval.
 2. Replace curb and gutter following jurisdictional requirements.
 3. When curb replacement is required within 4 feet of construction joint, extend replacement to joint.
- H. Walkway Replacement:
1. Remove and replace entire sidewalk square affected.
 2. Space joints to match existing surrounding sidewalk.
- I. Driveway and Other Replacement:
1. Driveways in State or County Rights-of-way: Replace following applicable jurisdictional requirements.
 2. Unless otherwise shown on Drawings, replace driveways at other locations and other paved areas in kind.

3. Remove and replace entire section of affected asphalt driveway from edge to edge. The repair should extend not less than 18" past the edge of the original pavement cut or to the nearest joint if the joint is within five (5) feet of the pavement cut.
4. Remove and replace entire section of affected concrete driveway from joint to joint.

END OF SECTION

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SECTION 03100 FORMWORK

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies labor, materials, equipment, and services necessary for and reasonably incidental to the design, construction, and removal of formwork for cast-in-place concrete.

1.2 QUALITY ASSURANCE

Formwork shall conform to the requirements and provisions of the latest editions of the following publications. In the ACI publications referred to herein, the advisory provisions shall be considered mandatory, as though the word "shall" has been substituted for "should" wherever it appears.

- A. American Concrete Institute (ACI) 117 "Specification for Tolerances for Concrete Construction and Materials"
- B. American Concrete Institute (ACI) 301 "Standard Specifications for Structural Concrete"
- C. American Concrete Institute (ACI) 318 "Building Code Requirements for Structural Concrete"
- D. American Concrete Institute (ACI) 347R "Guide to Formwork for Concrete"

1.3 RESPONSIBILITY FOR FORMWORK

Form design, engineering, erection, construction, bracing, shoring, stripping, removal, reshoring, etc. are the Contractor's complete responsibility.

1.4 SUBMITTALS

- A. Samples or Manufacturers Literature: Furnish for the following materials, for approval prior to construction:
 - 1. Form ties
 - 2. Form oils, release agents, parting compounds
 - 3. Plywood and fiberglass forms for exposed concrete

- B. Shop Drawings of typical areas of forms for concrete work shall be submitted prior to fabrication and assembly. Show and coordinate layout and arrangement of construction joints, form panel joints and spacing of wall form ties for the full height of each wall.

PART2 - PRODUCTS

2.1 FORMS FOR UNEXPOSED CONCRETE

Unexposed concrete surfaces shall be defined as the exterior surfaces of the concrete that will be below the finished grade around the structure and shall be permanently in contact with soil or the surfaces to be covered by face brick.

- A. Plywood - American Plywood Association: EXT-APA (High-density overlay B-B Plyform, Class II). OR
- B. Substantial Steel sheet metal for subgrade and other unexposed work. Clean the forms and remove nails when reusing.

2.2 FORMS FOR EXPOSED CONCRETE

- A. All concrete surfaces other than those defined as "unexposed concrete surfaces" in paragraph 2.01 shall be considered exposed concrete surfaces.
- B. Plywood - American Plywood Association - EXT-APA, age sealed, sanded, grade trade-marked (High Density Overlay B-B Plyform Class I). OR
- C. Steel sheet metal. Steel form surfaces shall not contain irregularities, dents, or sags. Overlay shall not stain the surface of the concrete. Apply form sealer to all form surfaces in contact with finish faces of exposed concrete. Form sealer shall be compatible with paint and other finishes that will be applied to the concrete.

2.3 BRACING, WALERS, STUDS, SHORES, RESHORES

Metal, or suitable graded lumber, of substantial size and configuration for loads to be supported.

2.4 FORM TIES

Plastic cone type, with threaded steel rod or wire, with waterstop, as approved. Submit sample prior to commencing formwork. Rod type or wire type shall have no metal closer than 1-1/2" to finish surface.

2.5 FORM OILS, RELEASE AGENTS, PARTING COMPOUNDS

Approved release, parting or "oil" materials must be compatible with the specified forms, with fair-faced exposure and with future finishes. Coat all forms properly before placing reinforcement and embedded items.

PART 3 - EXECUTION

3.1 FORMWORK FUNCTIONAL DESIGN

Formwork shall be capable of containing concrete in its plastic state without loss of water or cement paste and be removable without damage to concrete surfaces and edges. Arrange formwork for convenient inspection, cleaning, depositing and placement of concrete and draining of water. Design all components (form panels, connections, shoring, bracing, supports, reshores) to resist all live and dead loads, (wind, reshores, construction loads, traffic vibration) that will occur while in use. Design shall include the slow gain of concrete strength with age of previously cast members. Formwork shall be designed such that there is no deflection or weakness affecting established alignment of concrete surfaces. Provide all necessary shores, stringers, soffit forms and the like. Standard of formwork construction shall be ACI- 347 R.

3.2 FORMWORK CONFORMATION

Construct formwork with minimum practicable tolerances to produce concrete work true to lines, dimensions, shapes, locations, grades, and elevations established on Contract Drawings. Provide all recesses, pockets, utility outlets, joints, keys and projections, notches, and openings.

3.3 WORKMANSHIP AND INSTALLATION

All workmanship shall be in best formwork and carpentry practice. Formwork shall be installed with all proper bracing, connections, rough hardware, and proper fastenings for the anchoring materials, for a rigid, secure, and complete job.

A. Special Care Required: At ALL exposed concrete.

- B. Framing and Blocking Lumber: Properly framed, closely fit, accurately set to required lines and levels, plumb, straight, and true, and rigidly secure in place, with proper fastenings to adjacent materials.
- C. Construction Tolerances: Construction tolerances shall be in accordance with ACI 301.
- D. Joints, Openings, Recesses: Construct all indicated and required conditions, keys, jointing details, and openings in strict accordance with indicated details; consult Drawings of all trades. Joints not indicated on Drawings, but desired by Contractor for construction jointing in Project sequences, shall be so located, and built as not to impair strength of structure. Contractor shall seek written approval in advance from the Maryland PE for additional or relocated joints.
- E. Protection for Re-Use: Provide protection and care in handling and stripping and re-use location-to-location to assure continuing acceptability of condition of forms. Form units which are distorted, have an excessive number of patches, have delaminated areas of the plywood surface, etc. shall not be reused. Acceptability of re-used forms shall be as determined by The Maryland PE.
- F. Avoidance of 'Pillow-Effect' or Form-Bulge: Provide adequate forming, bracing, and tying as required. In addition, vertical rate-of-placement shall be controlled by the Contractor to avoid excessive liquid heads on formed faces prior to setting of concrete.
- G. Inserts, Attachments, Accessories to be embedded in Concrete: Proper location, setting, spacing, anchorage and coordination with reinforcing and all related trades, are Contractor's responsibility.

3.4 REMOVAL OF FORMS

- A. Unless otherwise authorized, forms shall not be removed before the expiration of the minimum number of days implicit in the following table:

Walls*	25% of f'_c
Elevated Slabs with less than 10 ft. clear span between supports	50% of f'_c
Elevated Slabs with between 10 ft. to 20 ft. clear span between supports	50% of f'_c

*Where such forms also support formwork for slab or beams, the removal times of the latter shall govern.

The times shown represent cumulative number of days, not necessarily consecutive, during which the temperature of the air surrounding the concrete is above 50 degrees F.

- B. Form removal shall be carried out in such a manner as to assure the complete safety and integrity of the formed surface of the structure. In no case shall any form or shoring be removed or disturbed until the concrete has thoroughly hardened and acquired sufficient strength to safely support its own weight and the live load upon it.
- C. Sufficient shoring and reshoring shall be kept in place to properly support the concrete structure after the forms have been removed and until such time as it is no longer necessary. All forms shall be so designed as to permit this to be done. Reshoring of concrete beams and slabs shall consider necessary spacing, dead, and live loads, and the age and rate of gain of strength of concrete. Reshores shall remain in position at least 28 days. Reshoring shall be planned in advance and shall be subject to review by the Maryland PE.

3.5 REJECTED MATERIAL

Materials, deliveries, completed work or job conditions condemned or rejected by The Maryland PE as failing to meet Contract Specification quality shall be removed and replaced without delay, at Contractor's expense, as directed by The Maryland PE. The Maryland PE's decisions shall be final and will be based solely on these Contract Specifications and engineering standards.

END OF SECTION

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SECTION 03210
REINFORCING STEEL

PART 1 GENERAL

1.1 DESCRIPTION

- A. This section specifies labor, materials, equipment, and services necessary for and reasonably incidental to the furnishing and installation, complete of all reinforcement for concrete structures.

1.2 REFERENCES

Details and placement of concrete reinforcement and accessories shall conform to the latest editions of the following publications. In the ACI publications referred to herein, the advisory provisions shall be considered mandatory, as though the word "shall" has been substituted for "should" wherever it appears.

- A. American Concrete Institute (ACI)
1. ACI 117 - "Specification for Tolerances for Concrete Construction and Materials"
 2. ACI 301 - "Standard Specifications for Structural Concrete"
 3. ACI 350 - "Code Requirements for Environmental Engineering Concrete Structures and Commentary"
 4. ACI SP-66 – "ACI Detailing Manual"
- B. ASTM
1. ASTM A615 - "Standard Specification for Deformed and Plain Billet Steel Bars for Concrete Reinforcement"
- C. Concrete Reinforcing Steel Institute (CRSI)
1. Manual of Standard Practice
 2. Placing Reinforcing Bars

1.3 SUBMITTALS

- A. Make all submittals in accordance with section 01330.
- B. Shop drawings shall not be reprints of the Contract Drawings.
- C. Provide prior to fabrication:
1. Shop Drawings prepared in accordance with CRSI Manual of Standard Practice and ACI SP-66:

- a. Bar lists and schedules with bar bending diagrams.
 - b. Bending lists.
 - c. Placement plans
- 2. Welded, metallic sleeve splice, and mechanical threaded connection.
- D. Informational Submittals:
 - 1. Lab test reports for reinforcing steel showing stress-strain curves and ultimate strengths.
 - 2. Test results of field testing.

1.4 QUALITY ASSURANCE

Refer to section 01450, Quality Control for Contract requirements.

- A. Prior to welding, submit welder qualifications and nondestructive testing procedures in accordance with Section 01330.
- B. Welder Qualifications: Certified in accordance with AWS D1.4/D1.4M.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Unload, store, and handle reinforcing bars in accordance with CRSI publication "Placing Reinforcing Bars."
- B. Reinforcement shall be shipped to the work site with bars of the same size and shape fastened in bundles, with metal identification tags giving size and mark securely wired on. The identification tag shall be labeled with the same designation as shown on the approved submittals.
- C. Reinforcement shall be stored off the ground, protected from moisture, and kept free of dirt, oil, or injurious contaminants.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Deformed Reinforcing Bars:
 - 1. Includes stirrups and ties
 - 2. ASTM A615/A615M, Grade 60, where welding is not required.
 - 3. ASTM A706/A706M, Grade 60, for reinforcing to be welded.
 - 4. ASTM A767/767M, Grade 60, for galvanized bars.
- B. Accessories shall conform to the ACI Detailing Manual SP-66.
- C. Reinforcing bar supports and spacers: ACI 350- (latest edition) detailing manual.

- D. Hooks shall be standard hooks, unless noted otherwise.

2.2 ACCESSORIES

A. Tie Wire:

1. Black, soft-annealed 16-gauge wire.
2. Nylon-, epoxy-, or plastic-coated wire.

B. Bar Supports and Spacers:

1. Use precast concrete bar supports and side form spacers, unless noted otherwise. Do not use other types of supports or spacers.
2. Bar supports shall have sufficient strength and stiffness to carry loads without failure, displacement, or significant deformation. Space bar supports so minimum concrete cover is maintained for reinforcing between supports.
3. Use only precast concrete bar supports where concrete surfaces are exposed to weather, earth, water, chloride intrusion, or corrosive chemicals. Bar supports shall be nonconductive and have geometry and bond characteristics that deter movement of moisture from the surface to the reinforcement.
4. Precast concrete supports shall have same minimum strength and shall be made from same materials as that of the concrete in which they are to be embedded. Precast concrete supports shall be cast and properly cured for at least 7 days before use and shall have a wire or other device cast into each block for the purpose of attaching them securely to reinforcing steel.
5. In walls and slabs exposed to view after form removal, use small precast concrete blocks made of same color as concrete in which they are embedded.
6. Design and fabricate special bar support for top reinforcing bars in slabs where standard bar supports do not possess necessary geometry, strength, or stiffness.
7. Precast Concrete Supports: Total bond precast high-performance concrete bar supports as supplied by Con Sys Inc., Pinawa, MB, Canada.

2.3 FABRICATION

- A. Follow CRSI Manual of Standard Practice.
- B. Fabricate each unit of reinforcement in accordance with the approved shop drawings.
- C. Reinforcement shall be bent cold, as required in ACI 350. The use of heat to bend or straighten reinforcing steel will not be permitted.

PART 3 EXECUTION

3.1 PREPARATION

- A. Notify Engineer when reinforcing is ready for inspection and allow sufficient time for inspection prior to placing concrete.

- B. Prior to placement of concrete, reinforcement shall be free of mud, oil, ice or other material that may adversely affect or reduce the bond. Rust, seams, surface irregularities or mill scale shall not be cause for rejection provided the weight, dimensions, cross sectional area, and tensile properties of a cleaned test specimen are not less than the requirements of the applicable ASTM specifications.
- C. Coat wire projecting from precast concrete bar supports with dielectric material, epoxy, or plastic.

3.2 PLACING AND FASTENING

- A. Secure the reinforcement in such a manner that its displacement does not exceed the limits noted in ACI-350. The ends of all tie wires shall be bent away from forms.
- B. Reinforcement supported from an earth surface shall utilize precast concrete blocks in accordance with ACI-301. Masonry supports are not acceptable.
- C. Bundle or space bars, instead of field bending where construction access through reinforcing is necessary.
- D. Spacing and Positioning: Conform to ACI 318.
- E. Location Tolerances: In accordance with CRSI publication, "Placing Reinforcing Bars."
- F. Bundle or space bars, instead of field bending where construction access through reinforcing is necessary.
- G. Welded Splices: Accomplish by full penetration groove welds and develop a minimum of 125 percent of yield strength of bar.
- H. Stagger splices in adjacent bars where indicated.
- I. Tying Reinforcing Bars:
Tie every other intersection on mats made up of Nos. 3, 4, 5, and 6 bars to secure firmly at required spacing.
Bend tie wire away from concrete surface to provide clearance of 1 inch from surface of concrete to tie wire.
- J. Reinforcement around openings: On each side and above and below pipe or opening, place an equivalent area of steel bars to replace steel bars cut for opening. Extend steel reinforcing a standard lap length beyond opening at each end.
- K. Welding Reinforcement:
 - 1. Only ASTM A706/A706M bars may be welded.
 - 2. Do not perform welding until welder qualifications are approved.

- L. Straightening and Re-bending: Field bending of reinforcing steel bars is not permitted.
- M. Unless permitted by Maryland PE, do not cut reinforcing bars in field.

3.3 CLEAR COVER

All reinforcement shall have a clear cover from the outside of the bar to the concrete surface of 3" when cast against earth, otherwise 2", unless noted otherwise on the Contract Drawings.

3.4 SPLICING

- A. Splices shall be used only where indicated on the Contract Drawings.
- B. Use lap splices, unless otherwise shown or permitted in writing by the Maryland PE.
- C. When splicing bars of different diameters, the minimum lap length is governed by the smaller diameter bar.
- D. Detail all splices and standard hooks for reinforcing bars not dimensioned on the drawings as indicated on the structural drawings.
- E. The lap length shall be as shown on the drawings.
- F. All hooks shall be detailed as ACI standard hooks unless otherwise indicated.
- G. Follow ACI 318.
- H. Use lap splices, unless otherwise shown or permitted in writing by Maryland PE.
- I. Welded Splices: Accomplish by full penetration groove welds and develop a minimum of 125 percent of yield strength of bar.
- J. Stagger splices in adjacent bars where indicated.

3.5 DOWELLING INTO EXISTING CONCRETE

Dowels into existing concrete shall be installed by drilling and using epoxy. Drilling, cleaning and installation of epoxy and dowels shall be per manufacturer's recommendations and as specified in Section 03215 Concrete Doweling.

3.6 TESTS AND INSPECTION

- A. Perform as required by section 01450, Quality Control.
- B. An independent testing agency shall be retained by Contractor and approved by Maryland PE to visually inspect and test reinforcing steel welds in accordance with AWS D1.4/D1.4M.

- C. An independent testing agency shall be retained by Contractor and approved by Maryland PE to inspect each mechanical splice and verify each component is installed in accordance with manufacturer's instructions and ICC Evaluation Services Report or equivalent code agency report.
- D. Special inspection will be provided by Commission as indicated on Drawings.

END OF SECTION

SECTION 03215
DOWELING FOR CONCRETE

PART 1 GENERAL

1.1 DESCRIPTION

- A. This Section includes requirements for providing doweling for cast-in-place concrete in accordance with ACI 350, as modified and supplemented herein, and in accordance with the Contract Documents.
- B. See other Sections of Specifications for concrete related work specified elsewhere:
 - 1. Section 03210 Reinforcing Steel
 - 2. Section 03300 Cast-In-Place Concrete

1.2 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
 - 1. ASTM International (ASTM):
 - a. C881/C881M - "Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete"
 - b. A193 - "Standard Specification for Alloy-Steel and Stainless-Steel Bolting Materials for High-Temperature Service"
 - c. A307 - "Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength"
 - d. C882 - "Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear"
 - e. D648 - "Standard Test Method for Deflection Temperature of Plastics Under Flexural Load"
 - f. D695 - "Standard Test Method for Compressive Properties of Rigid Plastics"
 - 2. American Concrete Institute (ACI)
 - a. ACI 301 - "Standard Specifications for Structural Concrete"
 - b. ACI 350 - "Building Code Requirements for Reinforced Concrete"
 - c. ACI 347 - "Formwork for Concrete"
 - 3. American National Standards Institute (ANSI)
 - 4. International Code Council (ICC): Evaluation Services Report

1.3 DEFINITIONS.

- A. ICBO Reports Published by ICBO for concrete anchor manufacturers
- B. Testing Agency - The Contractor shall provide an independent testing agency to perform testing of adhesive dowels
- C. Special Inspector - Qualified person who shall demonstrate competence, to satisfaction of building official, for inspection of Work specified within this section

1.4 SUBMITTALS

- A. Make submittals to the Engineer for review in accordance with section 01330, to include the following:
 - 1. Product Data: Manufacturer's catalog information.
 - 2. Certified Test Reports
 - 3. Samples: Two random Samples of each batch of products delivered to site, for independent testing.
 - 4. Manufacturer's qualifications include client name, address, contact person, phone number, project location, and description of work.
 - 5. Manufacturer's instructions for preparation, placement, drilling of holes, installation of anchors and adhesive, and handling of cartridges, nozzles, and equipment.
 - 6. Manufacturer's written letter of certification identifying installer's qualifications to install products.
 - 7. ICC Evaluation Services Report:
 - a. Doweling system manufacturer.
 - b. Detailed step-by-step instructions for Special Inspection procedure.
 - 8. Special Inspection report.
 - 9. Manufacturer's Certificate of Proper Installation, in accordance with Section 01640, Manufacturers' Field Services.
 - 10. Copy of manufacturer's operation and repair manuals for each type of equipment delivered to site.

1.5 QUALITY ASSURANCE.

- A. Comply with applicable portions of Section 01450.
- B. Comply with applicable industry standards.
- C. Qualifications:
 - 1. Manufacturer: At least three similar projects with same products within last 3 years.
 - 2. Installer: Trained and certified by manufacturer.
- D. Field Requirements.
 - 1. Obtain and maintain on site a copy of appropriate documents referred to therein.
 - 2. Provide all labor, material, and methods necessary.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING.

- A. Deliver, handle and store in accordance with Contract specifications and manufacturer recommendations and instructions.
- B. Store form materials and accessories above ground on framework or blocking.

1. Cover with a suitable waterproof covering;
2. Provide adequate air circulation and ventilation.

C. Product Information:

1. Disclose of when:
 - a. Shelf life has expired.
 - b. Stored other than per manufacturer's instructions.
2. Container Markings.
3. Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

PART 2 PRODUCTS.

2.1 ADHESIVE.

- A. Disposable, self-contained cartridge system capable of dispensing both components in the proper mixing ratio and that fit into manually or pneumatically operated caulking gun.
- B. Meet requirements of ASTM C881/C881M.
- C. Two-component, insensitive to moisture, designed to be installed in adverse freeze/thaw environments.
- D. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
- E. Mixed Adhesive: Non-sag light paste consistency with ability to remain in a 1-inch diameter overhead drilled hole without run out.
- F. Approved Manufacturers and Products:
 1. HIT HY 200 by Hilti or approved equal
 2. When doweling into existing concrete, coat edge with:
Fx – 752 Binding Agent by Simpson Strong-Tie or approved equal

G. MIXING NOZZLES

1. Disposable; manufactured in several sizes to accommodate size of reinforcing dowels.
2. Non-removable internal static mixer required to ensure proper blending of components.

H. REINFORCING DOWELS

1. As specified in Section 03210, Reinforcing Steel.

PART 3 EXECUTION

3.1 GENERAL

- A. Install in accordance with manufacturer's recommended instructions.
- B. Dispense components through specially designed static mixing nozzle that thoroughly mixes components and places mixed adhesive at base of predrilled hole.

3.2 DOWEL SIZING AND INSTALLATION

- A. Install per adhesive manufacturer's instructions.
- B. Drilling Equipment:
 - 1. Drilling Hammers for Dowel Holes: Electric or pneumatic rotary type with medium or light impact.
 - 2. Hollow drills with flushing air systems are preferred.
 - 3. Where edge distances are less than 2 inches, use lighter impact equipment to prevent micro-cracking and concrete spalling during drilling process.
- C. Hole Diameter: Use drill bit diameter meeting ICC Evaluation Services Report requirements and as recommended by the manufacturer.
- D. Obstructions in Drill Path:
 - 1. When existing reinforcing steel is encountered during drilling and when approved by Maryland PE, enlarge hole by 1/8-inch, core through existing reinforcing steel at the larger diameter, and resume drilling at original hole diameter; or re-drill hole 1 inch from original location, beginning in same line at surface, redirecting drill to miss reinforcing steel.
 - 2. Place dowels in both the misdrilled hole and the new one.
 - 3. When using epoxy anchors, dowels may be pre-bent prior to installation to 15 degrees to align with other bars. Do not heat dowels to bend.
 - 4. If bars have fused epoxy coating and coating is damaged, recoat damaged area with epoxy.
 - 5. Bent Bar Dowels: Where edge distances are critical, and striking reinforcing steel is likely, drill hole at 10-degree angle or less and use pre-bent reinforcing bars.

3.3 FIELD QUALITY CONTROL.

- A. Dowel Testing
 - 1. Test dowels at one per every 20 dowels.
 - 2. Dowels shall be tested to specified yield strength of reinforcing bar.
 - 3. Testing apparatus shall not interfere with development of concrete failure cone at dowel.

4. Testing shall occur only after adhesive has achieved proper cure per manufacturer's requirements.
5. Failure of reinforcing bar or of base concrete will cause dowel to be rejected. For each rejected dowel, additional dowel shall be tested. Rejected dowels shall be reinstalled in sound concrete and retested.
6. If yield strength of reinforcing bar can not be achieved when tested, manufacturer's representative shall recommend revised installation procedures or adhesive products. Modified installations must be tested at same frequency as specified herein.

B. Inspection

1. Engineer shall be onsite during dowel installation. Provide 24-hour advance written notification to Engineer.
2. Engineer shall observe installation for the following
 - a. Drill bit compliance.
 - b. Hole depth and cleanliness.
 - c. Product Description Product name, rod diameter and length.
 - d. Adhesive expiration date.
 - e. Verification of dowel installation in accordance with manufacturer's published instructions.

- C. Manufacturer's Field Services: Provide manufacturer's representative at Site in accordance with sections 01450 and 01640, for installation assistance, inspection, and certification of proper installation.

END OF SECTION

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SECTION 03251
CONCRETE JOINTS AND ACCESSORIES

PART 1 GENERAL

1.1 DESCRIPTION

- A. This Section includes requirements for providing concrete joints and accessories, as modified, and supplemented herein, and in accordance with the Contract Documents.

1.2 RELATED SECTIONS

- A. Section 03100 Concrete Formwork
- B. Section 03210 Reinforcing Steel
- C. Section 03215 Concrete Doweling
- D. Section 03300 Cast-In-Place Concrete

1.3 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
 - 1. ASTM International (ASTM):
 - a. A615/A615M- “Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement”
 - b. D2000 – “Standard Classification System for Rubber Products in Automotive Applications”
 - 2. Corps of Engineers (COE):
 - a. CRD-C-572 – “Corps of Engineers Specifications for Polyvinylchloride Waterstop”

1.4 SUBMITTALS

- A. Make submittals to the Maryland PE for review in accordance with section 01330.
- B. Shop Drawings
 - a. Waterstop: Details of splices, method of securing and supporting waterstop in forms to maintain proper orientation and location during concrete placement.
 - b. Construction Joints: Layout and location for each type.

2. Samples: PVC waterstop splice, joint, and fabricated cross of each size, shape, and fitting of waterstop.
3. Informational Submittals:
 - a. Manufacturer's written instructions for product shipment, storage, handling, installation/application, and repair for:
 - 1) Waterstop
4. Quality Assurance
 - a. Qualifications
 - 1) Waterstop manufacturer shall demonstrate 5 years, minimum, continuous successful experience in production of PVC water stops.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Acceptance at Site: Verify delivered materials are in accordance with Specifications and manufacturer's product data sheets prior to unloading and storing onsite.
- B. Storage: Store materials under tarps to protect from oil, dirt, and sunlight.

1.6 FIELD QUALITY CONTROL

- A. Refer to section 01450 for Contract requirements.
- B. Waterstop splicing defects which are unacceptable include, but are not limited to the following:
 1. Tensile strength less than 80 percent of parent section.
 2. Misalignment of center bulb greater than 1/16 inch.
 3. Bond failure at joint deeper than 1/16 inch or 15 percent of material thickness.
 4. Misalignment that reduces waterstop cross section more than 15 percent.
 5. Visible porosity in the weld.
 6. Bubbles or inadequate bonding.
 7. Visible signs of splice separation when cooled splice is bent by hand at a sharp angle.
 8. Charred or burnt material.

PART 2 PRODUCTS

2.1 WATERSTOP

- A. Waterstops shall be flexible, PVC type, and conform to U.S. Corps of Engineers specification CRD-572.

1. Ribbed Centerbulb Waterstop (New Concrete Joints)

- a. Manufacturers shall be: Sika Greenstreak, Inc., or equal.
- b. Profile Style Number: Catalog No. 03150/GRD, Style 732
- c. Profile: Ribbed with Center Bulb
- d. Dimensions: 6 inches by 3/8 inch thick; non-tapered, not corrugated
- e. The PVC waterstop shall be extruded from elastomeric plastic compound of which basic resin shall be prime virgin polyvinyl chloride (PVC). Compound shall not contain scrapped material, reclaimed material, or pigment.
- f. Factory Fabrications: Use only factory fabrications for intersections, transitions, and changes of direction.

2. Retrofit Waterstop at Existing Concrete (New to Existing Concrete Joints)

- a. Manufacturers shall be: Sika Greenstreak, Inc., or equal.
- b. Profile Style Number: 655
- c. Profile: Ribbed L-shape
- d. Dimensions: 3 inches by 3 inches by 7/16 inch thick; non-tapered, not corrugated
- e. Use Epoxy 7300, or equal.
- f. Use 1/4" diameter stainless steel expansion anchor with 2 1/4" embed.
- g. The PVC waterstop shall be extruded from elastomeric plastic compound of which basic resin shall be prime virgin polyvinyl chloride (PVC). Compound shall not contain scrapped material, reclaimed material, or pigment.
- h. Factory Fabrications: Use only factory fabrications for intersections, transitions, and changes of direction.

2.2 ACCESSORIES

- A. Reinforcing Steel: As specified in Section 03210, Reinforcing Steel.
- B. Dowels: As specified in Section 03215, Concrete Doweling.

C. Joint Sealer:

1. Hot applied Joint Sealer shall meet requirements of ASTM D6690.
2. Cold applied Joint Sealer shall meet requirements of ASTM C920.
3. Polysulfide sealants should not be used.

D. Nails: Galvanized, as required for securing pre-molded joint filler.

E. Masking Tape: As required to temporarily adhere to concrete at each side of joint to receive filler.

F. Ties for PVC Waterstop: "Hog Rings" or grommets for each edge at 12-inch maximum spacing.

PART 3 EXECUTION

3.1 GENERAL

A. Commence concrete placement after joint preparation is complete.

3.2 SURFACE PREPARATION

A. Construction Joints: Prior to placement of abutting concrete, clean contact surface:

1. Remove laitance and spillage from reinforcing steel and dowels.
2. Roughen surface to minimum of 1/4-inch amplitude:
 - a. Sandblast after concrete has fully cured.
 - b. Water blast after concrete has partially cured.
 - c. Green cut fresh concrete with high pressure water and hand tools.
3. Perform cleaning so as not to damage waterstop if one is present.

B. Construction Joint with PVC Waterstop:

1. Follow PVC waterstop manufacturer's written instructions.

3.3 INSTALLATION OF WATERSTOPS

A. General:

1. Continuous waterstop (as specified) shall be installed in all construction joints in walls and slabs of water holding basins and channels and in walls of below grade structures, unless specifically approved otherwise.

2. Join waterstop at intersections to provide continuous seal.
3. Center waterstop on joint.
4. Secure waterstop in correct position. Tie waterstop to reinforcing steel using grommets, "Hog Rings," or tie wire at maximum spacing of 12 inches. Do not displace waterstop during concrete placement.
5. Repair or replace damaged waterstop.
6. Place concrete and vibrate to obtain impervious concrete in vicinity of joints.
7. Joints in Footings and Slabs:
 - a. Ensure that space beneath plastic waterstop is completely filled with concrete.
 - b. During concrete placement, make visual inspection of waterstop area.
 - c. Limit concrete placement to elevation of waterstop in first pass, vibrate concrete under waterstop, lift waterstop to confirm full consolidation without voids, then place remaining concrete to full height of slab.

B. Plastic Waterstop:

1. Install in accordance with manufacturer's written instructions.
2. Splice in accordance with waterstop manufacturer's written instructions using Teflon-coated thermostatically controlled heating iron at approximately 380 degrees-F.
 - a. Allow at least 10 minutes before new splice is pulled or strained in any way.
 - b. Finished splices shall provide cross section that is dense and free of porosity with tensile strength of not less than 80 percent of unspliced materials.
 - c. Use only factory made waterstop fabrications for all intersections, changes of directions and transitions.
 - d. Field splice permitted only for straight butt welds.

END OF SECTION

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SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 DESCRIPTION

- A. This Section includes requirements for providing normal weight cast-in-place concrete to the sizes and shapes and at the locations indicated, in accordance with ACI 350, as modified and supplemented herein, and in accordance with the Contract Documents.
- B. See other Sections of Specifications for concrete used for other than normal weight cast-in-place concrete and for pipes and precast concrete.

1.2 QUALITY ASSURANCE

Refer to section 01450, Quality Control for Contract requirements.

A. Field Requirements.

- 1. Obtain and maintain on site a copy of ACI 301, ACI 347, ACI 350, and appropriate documents referred to therein.
- 2. Furnish materials and labor
- 3. Make cylinders for testing of reinforced concrete. Number of cylinders shall be as follows:
 - a. Two at 7 days, lab cured.
 - b. Two at 7 days, field cured.
 - c. Two at 28 days, lab cured.
 - d. Two at 28 days, field cured.
 - e. Maryland PE may request to make cylinders for testing at 14 days.
- 4. Unless otherwise indicated, concrete testing shall be performed by an independent testing agency hired by the Contractor in accordance with Section 01450.
- 5. Provide adequate facilities for safe storage and proper curing of concrete test cylinders onsite for first 24 hours, and for additional time as may be required before transporting to test lab. Sample, cure, and test concrete in accordance with ASTM C31, ASTM C39, ASTM C143, ASTM C231, and ACI 301-96.
- 6. Provide visual means of identification of reinforcing steel, size, strength, and specification designation following CRSI Manual of Standard Practice.
- 7. Pre-installation Meeting:

- a. Schedule and conduct prior to incorporation of respective products into Project. Notify Maryland PE at least 5 working days in advance of location and time.
- b. Meet with Engineer, Ready-mix producer, Admixture representative, Testing and Inspection personnel.
- c. Agenda shall include:
 - 1) Mix designs, tests of mixes, and Submittals.
 - 2) Admixture types, dosage, performance, and re-dosing at site.
 - 3) Slump and placement time to maintain slump.
 - 4) Placement methods, techniques, equipment, consolidation, and form pressures.
 - 5) Finish, curing, and water retention.
 - 6) Other specified requirements needing coordination.

1.3 SUBMITTALS

Make submittals to the Maryland PE for review in accordance with section 01330.

A. Submit the following documents in accordance with Section 01330.

- 1. Certified concrete mix design for each strength following ACI 350 and ACI 211 for each strength including proposed admixtures.
- 2. Include minimum dry weights of cement; fine and coarse aggregates; quantity, type and name of admixture, if any is proposed to be used; and volume of water per cubic yard of concrete that will be used in the mix of each class of concrete for record purposes.
- 3. Source of fly ash and mix design for flowable fill.
- 4. Drawings showing location, types, details of joints, and sequence of pours.
- 5. Refer to specification Section 03210 "Reinforcing Steel" for submittals relating to reinforcing steel.

B. Submit following Section 01330 before delivery of materials.

- 1. Certified Test Reports:
 - a. Admixtures.
 - b. Aggregate.
 - c. Cement with percentage of alkali (Na_2O).
 - d. Copy of ASTM C1260 test with percentage of expansion due to Alkali Silica Reaction (ASR) when alkali content in cement exceeds 0.6 percent.

- e. Fly ash for flowable fill showing chemical analysis, including quantity of calcium as CaO and analytical Toxicity Characteristic Leaching Procedure (TCLP) data, establishing that fly ash is not hazardous, following 40 CFR 261.
- f. Provide flowable fill mix design proportions, material sources, admixtures, dry cubic yard batch weights, and test data meeting requirements specified herein.
 - 1) Compressive strength per ASTM D 4382
 - 2) Flow consistency per ASTM D 6103
 - 3) Density per ASTM D 6023
 - 4) Hardening time

C. Submit certified delivery tickets for concrete/flowable fill furnished.

- 1. Name and location of batch plant and name of plant inspector.
- 2. Ticket number.
- 3. Load number (batch number).
- 4. Date and truck number.
- 5. Destination including name and location of WSSC contract.
- 6. Concrete type and class (strength) and design mix designation.
- 7. Actual quantities of all materials including admixtures and amount of concrete in cubic yards.
- 8. Time at which mixer drum was charged with cement.
- 9. Amount of free moisture by percentage of permissible mixing water in aggregates, and maximum amount of mixing water that can be added at job site to obtain specified water to cement ratio.
- 10. Blank space for initials of on-site receiving party.
- 11. Time of arrival of concrete or flowable fill truck on site.
- 12. Time of concrete or flowable fill placement.

D. Submit the following Contractor's Drawings in accordance with Section 01330.

- 1. Shop drawings showing reinforcing steel prepared in accordance with ACI 315 including bar lists and bending diagrams, placement drawings, and special details.
- 2. Drawings showing location, types, and details of joints.
- 3. Sequence of pours.
- 4. Working Drawings and Calculations showing concrete strength to be attained at the proposed time of removal of formwork, falsework, and centering.
- 5. Submit the following for flowable fill for abandoning pipes:

- a. Start station
- b. End station
- c. Total volume of flowable fill placed

PART 2 PRODUCTS

2.1 MATERIALS

A. Reinforcement:

- 1. Refer to specification section 03210 "Reinforcing Steel."

B. Fast Setting Repair Mortar:

- 1. Quick setting non-shrink grout and rapid hardening cementitious materials for concrete repairs shall meet requirements of ASTM C928.
- 2. Approved Products:
 - a. Regular Applications.
 - 1) IPA Systems Inc., Octocrete by IPA Systems Inc.
 - 2) Blendcrete by Bonsal, Inc.
 - 3) PermaCrete by Quality Systems, Inc.;
 - 4) Cempatch by CHESCO Creative Products;
 - 5) Five Star Structural Concrete by Five Star Products, Inc.;
 - b. Underwater Applications.
 - 1) Speedcrete Blue Line by Elucid Chemical Co.;
 - 2) Kaufman Products, Inc., HiCap UW.

C. Non-Shrink Grout for dry pack under structured steel and equipment ASTM C1107.

1. Approved Products:

- a. Masterflow 713 grout by BASF Construction;
- b. Five Star Grout by Five Star Products Inc.;
- c. NS Grout by Elucid Chemical Co.;
- d. SureGrout by Kaufman Products Inc.;
- e. Multi-purpose grout by Upcon;
- f. Or approved equal.

D. Concrete Waterproofing Materials

- 1. Refer to specification Section 07100 "Waterproofing and Dampproofing."

E. Appurtenant Materials:

- 1. Vapor Barrier:

- a. Building Paper: FS-UU-B-790A.
 - b. Polyethylene Sheeting: ASTM D2103, 6 mil thick.
2. Curing Materials:
- a. Use only non-staining, clear, or translucent curing compounds meeting requirements of ASTM C309 over all concrete surfaces to remain permanently exposed. For concrete in contact with potable water, compound shall be NSF approved.
 - b. Sheet materials for curing shall meet requirements of ASTM C171.
 - c. Burlap cloth made from Jute or Kenaf for curing, shall meet requirements of AASHTO M182, Class 1.
 - d. Curing Compound for Concrete Surfaces: ASTM C309
3. Temporary Wood Joint Filler:
- a. Straight, sound strips of width and depth shown on Drawings or as approved, to produce true, straight joint edges
 - b. Tapered slightly from face-to-back and coated with paraffin, or equivalent, to seal against moisture and to promote ready removal with forms
4. Joint Sealer:
- a. Refer to specification Section 03251 "Concrete Joints"
5. Waterstops:
- a. Refer to specification Section 03251 "Concrete Joints"
6. Epoxy Compound: ASTM C881.
7. Corrosion Protection for Aluminum to be in contact with concrete:
- a. Coat aluminum accessories and embedded items with an inert compound capable of effecting isolation of the deleterious effect of the concrete on the aluminum in accordance with Section 09900.
 - b. Prepare, prime and topcoat surfaces to be coated following coating manufacturer's recommendations and apply 2 coats of:
 - 1. Ameron Amerlock 400 Hi-Build Epoxy.
 - 2. Tnemec Series N69 Hi-Build Epoxoline II.
 - 3. Or approved equal.
 - c. Coating system: 10 to 16 mils DFT (dry film thickness).
- F. Cement shall meet requirements of ASTM C150, Types I and II. Utilize Type III cement only when approved by Maryland PE.

- G. Formwork shall meet requirements of ACI 347 with materials suitable for use intended and adequate to support loads within tolerances as recommended.
- H. Aggregates shall meet requirements of ASTM C33.
- I. Water:
 - 1. Water used for mixing and curing concrete shall be clean, fresh, and free from injurious substances.
 - 2. If suspected of questionable quality, water shall meet limits of comparison tests with distilled water in accordance with AASHTO T26.
- J. Flowable fill shall be made of cement, fly ash, and water. Approved suppliers are National Ready Mixed Concrete Association, DYNA Corporation and American Stone Mix.
- K. Fly Ash shall meet requirements of ASTM C618, Class F.
- L. Ground Granulated Blast-Furnace (GGBF) Slag: ASTM C-989, Grade 120.

PART 3 EXECUTION

3.1 DESIGN MIX

- A. Design, unless otherwise specified, 28 days compressive strength of concrete shall be as follows:
 - 1. Minimum 4,500 psi concrete for structurally reinforced concrete work, concrete ditches, channels, slope protection, exterior work, and flatwork underfoot, including walks, steps, ramps, drives, slabs, and floors.
 - 2. Minimum 3,000 psi for non-reinforced concrete and masonry cell fill.
 - 3. Minimum 2,000 psi concrete for mud mats, pipe encasement and cradle, filling voids between sewer pipes and casing or tunnel liners, and for under foundations where excavated to excessive depth.
 - 4. Minimum 2,000 psi concrete for grout with maximum size coarse aggregate not exceeding 3/8 inch.
 - 5. Minimum 94 pounds cement per cubic yard and aggregate no larger than 1-1/2 inch for lean mix concrete.
 - 6. 100 to 150 psi for flowable fill for filling voids between sewer pipes and casing or tunnel liners, limited site voids, soil boring voids, manholes and pipes. All pipes to be abandoned that are 8" in diameter and larger shall be filled with flowable fill.

B. Mix Proportioning:

1. Mix for 4,500 psi concrete shall produce watertight concrete resistant to naturally occurring or commonly used chemicals, and shall be performed in accordance with ACI 301 and the following:
 - a. Water to cement ratio: Maximum 0.42.
 - b. Minimum cement content and air entrainment:

<u>ASTM C33 Coarse Aggregate No.</u>	<u>Min. Cement Content</u> <u>(lbs/cy)</u>	<u>Air Entrainment</u>
57 or 67	535	6±1 percent

Maintain the slump range for concrete at the point of delivery within the following limits:

1. Concrete flatwork and incidental construction: 2-3 inches
 2. All other: 2-4 inches
2. Other concrete: ACI 301.
 3. Substitution: GGBF Slag
 - a. Maximum of 50 percent of weight of cement.
 - b. Percentage: Establish by importance of early strength, curing temperature involved, properties of other concrete materials.
 - c. Minimum percentage: Determine by performing ASTM C1260 test if alkali content of cement is higher than 0.6 percent, so expansion of test mortar does not exceed 0.1 percent
 - d. Minimum cement content and water to cement ratio: Determine on basis of combined weight of cement and GGBF slag.
 4. Flowable fill: Cement, fly ash, and water.
 - a. Filler, if required: Sand and/or aggregates of 3/8 inch maximum size.
 - b. Fly ash: Maximum of 25 percent of weight of cement.

C. Admixtures:

1. Water reducing and retarding admixtures may be used with Maryland PE's approval. Ensure compatibility of admixtures, and if retarding admixtures are used, follow form removal procedure specified below.
2. Do not use calcium chloride without prior approval.

3.2 FORMWORK DESIGN AND CONSTRUCTION

- A. Refer to specification Section 03100 "Concrete Formwork"

- B. Design, engineering, construction, and removal of formwork shall be the responsibility of the Contractor.

3.3 PLACING REINFORCEMENT

- A. Refer to specification Section 03210 “Reinforcing Steel”.

3.4 PLACING CONCRETE

- A. Notify Maryland PE at least 24 hours before placing concrete.
- B. Place concrete per ACI 301 and the following:
 - 1. Place vapor barrier under slabs poured on earth, following Drawings.
 - 2. Wet down formwork and reinforcement before placing concrete to prevent leaching of water from concrete, but do not allow free water to stand in forms.
 - 3. Place concrete within 90 minutes after addition of cement, aggregates, water, and admixtures.
 - 4. Discard off-site concrete not placed within these time limits.
 - 5. Do not exceed the concrete free drop of 5 feet without use of adjustable length pipes.
 - 6. Locate joints where shown on Drawings and approved submittals.
 - 7. Seal control joints in exterior slabs.
 - 8. When bonding new concrete to existing, prepare for subsequent placement following ACI 301 with approved bonding compound applied and permitted to cure following manufacturer's recommendations, or as directed by Maryland PE.
 - 9. Place vapor barrier under all slabs poured on earth.
- C. Weather Conditions
 - 1. When air temperature has fallen to, or may be expected to fall below, 40 degrees F. during 7-day period after placement:
 - a. Protect concrete work from physical damage or reduced strength caused by frost, freezing action, or low temperatures following recommendations of ACI 306 and as specified herein.
 - b. Provide adequate means to maintain temperature, in area where concrete is being placed, at between 50- and 70-degrees F. for at least 7 days after placement.

- c. Uniformly heat water and aggregates before mixing as required to obtain concrete mixture temperature of not less than 55 degrees F. and not more than 85 degrees F. at point of placement.
- d. Provide temporary housings or coverings and maintain heat and protection to ensure that ambient temperature does not fall more than 30 degrees F. in 24 hours during 7-day period after placement.
- e. Avoid rapid dry-out of concrete due to overheating and avoid thermal shock due to sudden cooling or heating.
- f. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
- g. Ensure that forms, reinforcing steel, and adjacent concrete surfaces are entirely free of frost, snow, and ice before placing concrete.
- h. Do not use chlorides and other materials containing antifreeze agents, or chemical accelerators, or set-control admixtures in mix designs, unless approved by Maryland PE in advance.

2. When Hot Weather Conditions Exist:

- a. Place concrete following recommendations of ACI 305 and as specified herein.
- b. Cool ingredients before mixing to maintain concrete temperature at time of placement below 80 degrees F. when temperature is rising and below 85 degrees F. when temperature is falling.
- c. Cover reinforcing steel with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedment in concrete.
- d. Do not place concrete when hot weather conditions will cause difficulty from loss of slump, flash set, or cold joints.
- e. Do not use set control admixtures in mix designs unless approved by Maryland PE in advance.

3.5 PLACING FLOWABLE FILL

A. General

- 1. Control segregation of aggregate in the flowable fill to produce a uniform mixture.
- 2. Flowable fill shall not be placed when the air temperature is below forty degrees Fahrenheit.
- 3. Place Flowable fill within 2 hrs. after mixing at the batch plant.

4. Flowable fill shall not be placed over frozen ground or ground containing frozen materials.
5. Protect Flowable fill from freezing for a period of 36 hours after placement.

B. Flowable fill for pipe abandonment

1. Abandon existing water and sewer pipes, tunnels and other voids underneath roadways, paved areas and other required locations by completely filling with flowable fill.
2. Identify connections, clean debris or other obstructions that prevent flowable fill placement.
3. Use tremie placement, grouting techniques, pumping or other appropriate methods to completely fill the abandoned pipes and tunnels.
4. When pumping or grouting techniques are used, monitor pressure of flowable fill and prevent damage to roadway from excessive heaving and avoid damage to existing underground utilities and structures.
5. Place flowable fill to fill volume between abandonment points. Continuously place flowable fill with no intermediate pour points, but not exceeding 500 feet in length.
6. When the engineer determines non-complaint installation of flowable fill, that does not fill voids in abandoned pipe or where voids develop due to excessive shrinkage or bleeding of flowable fill, the contractor may be required to remediate using pressure grouting.

3.6 CURING AND PROTECTION

- A. Method of Curing and Protection: Follow ACI 301 and as required elsewhere in Contract Documents.
- B. Protect structural floors left exposed to atmosphere for more than 3 days by polyethylene covering, dampened burlap, straw, or equivalent materials, as required to control hydration.
- C. During hot and cold weather, cure and protect concrete as required for placing concrete herein.
- D. Cure unreinforced concrete formed with earth, wood, or metal for thrust blocks, joint encasements, pipe encasements, and cradles for at least 2 hours before placing backfill.

3.7 FINISHES

- A. Method of Finishing: Follow ACI 301 and as required elsewhere in Contract Documents.
- B. Where not shown on Drawings, use following finishes:
 - 1. Curbs and Equipment Bases: Rubbed finish.
 - 2. Exterior Slabs: Broom finish, Class B tolerance.
 - 3. Interior Slabs: Trowel finish, Class A tolerance.
 - 4. Other concrete not exposed to view: rough form finish.
 - 5. Other concrete exposed to view: smooth form finish with voids filled and rubbed smooth.

3.8 CONCRETE WATERPROOFING.

- A. Refer to specification section 07100 "Waterproofing".

3.9 ACCEPTANCE OF STRUCTURE

- A. For sanitary engineering installations as defined by ACI 350, concrete will be considered acceptable if it meets the acceptance criteria of ACI 301 and ACI 350.
- B. If the concrete is cored and cores fail to meet specified 28-day strength, the Maryland PE shall have the right to reject the concrete.
- C. For other structures, concrete will be acceptable if it meets acceptance criteria of ACI 301.
- D. The Maryland PE shall be the sole judge to determine if concrete does or does not meet the above requirements.
- E. Concrete not meeting the requirements specified above shall be removed, disposed of, and replaced by the Contractor at no cost to the Commission.
- F. Make repairs using approved repair procedure in Maryland PE's presence.
- G. In addition to the above acceptance requirements, sanitary engineering hydraulic structures which will contain water shall be given a hydrostatic leakage test. The following procedure shall be followed:
 - 1. Leakage testing or cleaning of surfaces shall not begin until concrete has cured and joint sealants have set and cured a minimum of 14 days;

2. Prior to testing, clean exposed surfaces by through hosing and remove surface laitance and loose matter from walls and slabs. Remove wash water and debris from the structures by means other than washing through plant piping;
3. Conduct testing before backfill is placed against walls and after all concrete has attained the specified compressive strength;
4. Provide piping and equipment to test structures for leakage. Coordinate with the Commission;
5. Fill hydraulic structures to be subjected to leakage tests with water to the normal operating liquid level line. Filling shall not exceed 3 feet of water depth per 24-hour period. Filling shall be at a uniform rate over a 24-hour period with continuous monitoring. For structures with adjacent bays, fill all bays simultaneously. Empty adjacent bays alternately. Repair any running leaks which appear during filling before continuing.
6. After the structure has been kept full for 48-hours, it will be assumed for the purposes of the test that the absorption of moisture by the concrete in the structure is complete. Then close all valves and gates to the structure and measure the change in water surface each day for a 5-day period;
7. During the test period, examine exposed portions of the structure, and mark visible leaks or damp spots. Repair visible leaks or damp spots after dewatering. If the drop-in water surface in the 24-hour period exceeds 1/100 of 1% of the normal volume of liquid contained in the structure, the leakage shall be considered excessive;
8. The determination of surface moisture evaporation shall be aided with a 24-inch-deep, white-colored, watertight container of not less than 10-square-foot surface area exposure. Position container to experience environmental conditions similar to the structure being tested. Subtract the water loss due to evaporation from the measured water loss in the basin to determine the water loss due to leakage;
9. If the leakage is excessive, drain the structure as described in paragraph 1 above, repair leaks and damp spots, and refill the structure and again test for leakage. Continue this process until the drop-in water surface in a 24-hour period meets the test requirements;
10. Inspect the manholes of the underdrain system for evidence of leaks in floor slabs. If leaking is indicated, locate and repair;

11. Seed the floor slab of each hydraulic structure with one bag of cement per 250-square-foot surface area. Seeding shall take place after the test filling has reached 18-inches in depth. Detect leaks in construction and expansion joints with the aid of a diver. Stir cementitious deposits on the floor. Observe cement deposits flowing toward leaks and repair where the defect is located;
12. Repairs and additional filling and testing shall be made by the Contractor at no additional cost;
13. Repair leaking concrete cracks by cutting out a square edged and uniformly aligned joint 3/8-inch wide by 1-inch deep. Prepare exposed surfaced of the joint, and apply joint sealant;
14. Alternate methods of crack repair may be submitted by the Contractor for review by the Commission.

3.10 BONDING COMPOUND

- A. Prepare surfaces to receive bonding compound in accordance with the manufacturer's recommendations. All dust, disintegrated materials and foreign particles shall be removed from the existing concrete surfaces. The existing surfaces shall be sound and clean for bonding.
- B. The bonding adhesive shall be mixed and applied in strict accordance with the manufacturer's recommendations. The Contractor shall schedule his operations so that the bonding adhesive may be applied, and the new concrete placed within 24 hours using Sika Armathec 110, or equal. Should this bonding agent be installed over 24 hours before the new concrete is placed, concreting operations shall immediately stop, and the affected area shall be recoated with the bonding material.

END OF SECTION

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SECTION 04100
MORTAR AND MASONRY GROUT

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, equipment, and appliances required for complete execution of Work shown on Drawings and specified herein.
- B. Principal items of work include:
 - 1. Mortar for unit masonry work.
 - 2. Grout for grouting masonry.
 - 3. Mortar for pointing and touchup.
- C. Related Sections:
 - 1. Section 04150, Masonry Accessories
 - 2. Section 04200, Unit Masonry

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the Specifications, the Work shall conform to the applicable requirements of the following documents:
 - 1. ASTM C91, Standard Specification for Masonry Cement
 - 2. ASTM C144, Standard Specification for Aggregate for Masonry Mortar
 - 3. ASTM C150, Standard Specification for Portland Cement
 - 4. ASTM C207, Standard Specification for Hydrated Lime for Masonry Purposes
 - 5. ASTM C270, Standard Specification for Mortar for Unit Masonry
 - 6. ASTM C476, Standard Specification for Grout for Masonry
 - 7. ASTM C979, Pigments for Integrally Colored Concrete
 - 8. ASTM C1019, Standard Methods of Sampling and Testing Grout
 - 9. ACI 530.1/ASCE 6, Specification for Masonry Structures

1.3 SUBMITTALS

Shop drawings shall be submitted for all items specified herein in accordance with Division 01:

- A. Submit the following:
 - 1. Manufacturer's data and mixing instructions for each product.
 - 2. Certificate of compliance with these specifications for each material specified below.
 - 3. Test reports.

4. Samples of colored masonry mortar.

1.4 DELIVERY AND STORAGE

- A. Deliver materials in manufacturer's original containers, bearing labels indicating product and manufacturer's name.
- B. Store cementitious materials in waterproof locations to prevent damage by elements. Reject containers showing evidence of damage.
- C. Store aggregates in separate bins to prevent intrusion of foreign particles. Do not use bottom 6 inches of sand or other aggregate stored in contact with the ground.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Specifications provide products manufactured by XXX

2.2 MATERIALS

- A. Mortar and Grout Materials
 1. Portland Cement: ASTM C-150, Type I above grade and Type II below grade.
 2. Hydrated lime: ASTM C-207, Type "S".
 3. Sand: Clean, coarse, free of loam, salt, organic and foreign matter and conforming to ASTM C-144.
 4. Coarse and fine aggregates for grout: ASTM C-404.
 5. Masonry Cement: ASTM C 91, Type S and meet the following criteria:
 - a. Prepackaged masonry cement shall contain Portland Cement, hydrated lime and plasticizing admixtures or hydraulic hydrated lime. Masonry cements which contain other materials, including ground limestone, ground slag, or other cementitious and non-cementitious materials, are not acceptable.
 6. Water - clean, fresh, potable and free from injurious amounts of oil, acids, alkalies, salts, organic matter or other deleterious substances.
- B. Admixtures
 1. Do not use calcium chloride.
 2. Do not use admixtures, without written approval of Architect.
- C. Mortar pigment
 1. Natural or synthetic iron oxide and chromium oxides meeting the requirements of ASTM C979.

2. Pigment shall not exceed 10% of the weight of portland cement. Carbon black shall not exceed 2% of portland cement.
3. Color shall be selected by the Architect from the manufacturer's full range of colors.

2.3 GROUT AND MORTAR MIXES

- A. Masonry mortar shall be Type "S" according to ASTM C-270. Proportions for masonry mortar shall be one of the following:
 1. Proportions by volume: 1-part Portland cement to 1/4 - 1/2 parts hydrated lime, and aggregate volume of not less than 2-1/4 or more than 3 times the sum of the volumes of cement and lime.
 2. Proportions by volume: 1/2-part Portland cement to 1-part masonry cement, and aggregate volume of not less than 1-1/4 or more than 3 times the sum of the volumes of cement and lime.
- B. Proportions for pointing mortar.
 1. Proportions by volume: 1-part Portland cement to 1/4-part hydrated lime and 2 parts extra fine sand.
- C. Masonry Grout shall conform to the requirements of ASTM C 476 and ACI 530.1/ASCE 6, Section 4. Strength of grout, tested in accordance with ASTM C 1019 shall be equal to f_m as specified in Section 04200, but not less than 2000 psi.
 1. Test grout for every 5000 square feet of masonry, with a minimum of one test per structure.

PART 3 - EXECUTION

3.1 FIELD MORTAR MIXING

- A. Mixing shall be by mechanically operated batch mixer. Entirely discharge before recharging. Mix sand, lime, cement and admixtures dry for two (2) minutes minimum, add water and mix for three (3) minutes minimum. Control batching procedures by measuring materials by volume. Measurement by shovel count shall not be permitted. Mix mortar with less water than the maximum amount, consistent with workability, to provide near maximum tensile bond strength. Mix only quantity that can be used before initial set, or within the first one-half hour.
- B. Mixers, wheelbarrows, mortar boards, etc., shall be kept clean.
- C. Retempering of mortar will not be permitted and mortar allowed to stand more than one (1) hour shall not be used.

3.2 INSTALLATION

- A. Install mortar and grout in accordance with ACI 530.1/ASCE 6.

3.3 REPOINTING MORTAR

- A. Prehydrate the mortar by mixing ingredients together dry, and then add only enough water to make a damp, stiff mix that will retain its form when pressed into a ball. After one to two hours, add water to bring it to the proper consistency.

END OF SECTION

SECTION 04150
MASONRY ACCESSORIES

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and specified herein.
- B. Principal items of work include:
 - 1. Metal joint reinforcement for masonry.
 - 2. Accessories for masonry construction.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 04100 - Mortar and Masonry Grout
- B. Section 04200 - Unit Masonry

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of these specifications, Work shall conform to the applicable requirements of the following documents:
 - 1. ASTM A82 Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
 - 2. ASTM A153 Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware
 - 3. ASTM D1056 Standard Specification for Flexible Cellular Materials - Sponge or Extruded Rubber
 - 4. ACI 530.1/ASCE 6 Specifications for Masonry Structures

1.4 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300, Submittals, submit the following:
 - 1. Provide manufacturers complete product data.
 - 2. Provide manufacturer's certification attesting compliance of material and source of each material specified below.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS FOR MASONRY REINFORCEMENT

- A. Subject to compliance with the Specifications, provide products manufactured by the following:
 - 1. AA Wire Products, Company, Chicago, IL
 - 2. Dur-O-Wal, Inc., Arlington Heights, IL
 - 3. Heckmann Building Products, Inc., Chicago, IL.
 - 4. Holman and Barnard, Inc., Hauppauge, NY.

2.2 MATERIALS

- A. Single Wythe Joint Reinforcement

Steel truss type reinforcement with 3/16 inch side rods and 9 gauge continuous cross rods; manufactured with wire conforming to ASTM A 82, with widths 2-inches less than nominal wall thickness.

- B. Anchors: Cast into concrete or weld to steel.

- 1. Dovetail Slot shall be 1 inch back by 1 inch deep by 5/8 inch throat, 22 gauge, foam filled.
 - 2. Dovetail Anchor - accessory for anchoring triangular flexible tie to dovetail slot, shall be 1/8 inch by 1 inch wide 1/2 inch long dovetail section.
 - 3. Wire/Strap Anchor - 1/4 inch wire or 12 gauge x 3/4 inch x length required, welded or mechanically attached to back up structure.
 - 4. Top of Partition Masonry Anchor – 3/8 inch diameter rod attached to dovetail anchor for anchoring to dovetail slot; hot-dip galvanized finish; clear butyrate tube with compressible filter to be placed over rod anchor.
 - a. Provide No. PTA-310, by Hohmann and Barnard, or approved equal.

- C. Ties

- 1. Triangular Flexible Tie: 3/16 inch wire, sized to suit application.
 - 2. Adjustable Tie: Pintel and eye full tie; properly sized for application, 3/16 inch cold drawn steel.

- D. Finish

- 1. Reinforcements, anchorages and ties shall be hot dipped galvanized, Class B-2, after fabrication in accordance with ASTM A153.

2.3 ACCESSORIES

A. Expansion and Joint Filler Material

1. Closed cell neoprene material conforming to ASTM D 1056, with a minimum compressibility of 50%. Horizontal joint filler shall be 1/4 inch thick. Expansion joints shall be a minimum 3/8" thick.

B. Weep and Vent Holes

1. Open head joints for brick and half-head joints for concrete masonry veneer.

C. Control Joint

1. Wide flange rapid preformed neoprene gasket.

D. Hardware Cloth

1. Waterproof paper backed with 1/2 inch hardware cloth.

E. Through Wall Flashing

1. Self-sealing, fully adhering composite flashing consisting of 32 mil rubberized asphalt bonded to a 8 mil cross laminated polyethylene film to produce an overall 40 mil thickness.
2. Provide Perm-A-Barrier Wall Flashing by W.R. Grace, Flash-Bond by Wire-Bond or Poly-Barrier Wall Flashing by Polytite Manufacturing Corporation.

F. Cavity Drainage Protection

1. CavClear Masonry Mat by CavClear, Hudson, WI. Or approved equal. Description: Fluid conducting, non-absorbent, mold and mildew resistant polymer mesh consisting of 100% recycled polymer with PVC binder. Thickness as noted on Drawings.

PART 3 - EXECUTION

3.1 REINFORCEMENT AND ANCHORAGE

- A. In masonry wall panels, place horizontal joint reinforcement at a vertical spacing of 16 inches on center, unless otherwise noted.
- B. Lap side rods at each end joint a minimum of 6 inches.
- C. Install prefabricated corner and tee assemblies at each wall corner and intersection.

- D. Mitre and butt end joints are prohibited.
- E. Place horizontal joint reinforcement in approximate center of out-to-out wall assembly and assuring a 5/8 inch, minimum, mortar coverage on exterior face and 1/2 inch on interior face.
- F. Adjustable anchor assemblies may be offset no more than that which is stated in manufacturer's published instructions. Pintles may be installed either up or down.
- G. Install horizontal joint reinforcement continuous, terminating only at vertical control joints.
- H. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend 24 inches minimum each side of opening.
- I. Place joint reinforcement continuous and at 8 inches on center vertically above roof.
- J. Place reinforcing bars supported and secured against displacement. Maintain position with 1/2 inch to true dimension.
- K. Coordinate and verify that dowels and anchorages embedded in concrete and attached to structural steel members are properly placed.
- L. Provide wall ties for masonry veneer at maximum 16 inches on center vertically and 16 inches on center horizontally. Place at maximum 8 inches on center each way around perimeter of openings, within 12 inches of openings.
- M. Masonry adjacent to steel and concrete columns to be attached to the column with masonry anchors at 16 inches on center. Anchors to be attached to each face of the column which is adjacent to a masonry wall, unless otherwise noted.

3.2 DOVETAIL SLOTS AND ANCHORS

- A. Provide dovetail slots to concrete contractor for placement into the concrete construction. Dovetail slots shall be placed vertically and spaced 16 inches on center horizontally.
- B. Remove slot filler after forms are removed.
- C. Hook dovetail anchor into slots and set in masonry joints at 16 inches on center.
- D. Install top of partition masonry anchors per manufacturer's instructions.

3.3 BENDING, CUTTING AND SPLICING REINFORCEMENT

- A. Make bends and splices in reinforcement only where indicated, or prior-approval by Engineer. Bend reinforcement only when cold, and prior to any placement in construction, forming around a steel pin of diameter at least 6 times the reinforcement size. Cut bars only by approved sawing, shearing or welding methods. Make ends of reinforcement straight, square, clean and free of defects before splicing. Do not heat or weld bends and splices at points of maximum stress. Clip and bend any tie wires as required to direct the ends away from external surfaces of masonry walls.
- B. Where welding is necessary, provide materials and perform welding in accordance with AWS requirements.
- C. All lap splices to be 48 bar diameters, unless otherwise noted.

3.4 THROUGH WALL FLASHING

- A. Clean areas to receive flashing. Surface shall be free of voids, spalled areas, or sharp protrusions. Concrete surfaces shall be cured a minimum of 7 days.
- B. Apply Primer as recommended by manufacturer.
- C. Apply flashing in strict accordance with manufacturer's instructions and recommendations. Sidelaps shall be a minimum of 2½ inches. End laps shall have a 6" minimum lap. Provide end dams at ends of lintels and other interruptions.
- D. Seal flashing where vertical reinforcing penetrates flashing with a mastic approved for use by manufacturer.

3.5 CAVITY DRAINAGE MAT

- A. Install cavity drainage mat in air-space between insulation and masonry veneer in all masonry veneer construction.
- B. Cavity drainage mat shall be adhered to back-up in accordance with manufacturer's instructions.

END OF SECTION

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SECTION 04200
UNIT MASONRY

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. Furnish labor, materials, equipment and appliances required for complete execution of Work shown on Drawings and specified work.
 - 1. Principal items of work include:
 - a. Exterior masonry wall construction.
 - b. Installation of masonry reinforcement and accessories.
 - c. Masonry unit lintels.
 - d. Installing dampproofing, insulation, flashing and work required to be built into masonry work.
 - e. Building into masonry work all anchors, inserts, hangers and the like provided under other Sections.
 - f. Pointing and cleaning of exposed masonry surfaces.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 04100 - Mortar and Masonry Grout
- B. Section 04150 - Masonry Accessories
- C. Section 07210 - Building Insulation
- D. Section 07600 - Flashing and Sheet Metal

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of the Specifications the Work shall conform to the applicable requirements of the following documents:
 - 1. ACI 530.1/ASCE 6 Specifications for Masonry Structures
 - a. ACI 530.1/ASCE 6, jointly published by the American Concrete Institute and the American Society of Civil Engineers, hereafter referred to as ACI 530.1 shall be considered minimum specifications for all materials, workmanship, methods and techniques for all masonry work.
 - b. Obtain a copy of the above Specifications prior to beginning any work in this Section.
 - 2. ASTM C62 Standard Specification for Building Brick
 - 3. ASTM C90 Standard Specification for Load-Bearing Concrete Masonry Units

4. ASTM C140 Standard Methods for Sampling and Testing Concrete Masonry Units
5. ASTM C216 Standard Specification for Facing Brick
6. ASTM C744 Standard Specification for Prefaced Concrete and Calcium Silicate Masonry Units
7. ANSI A41.1 R70 Code Requirements for Masonry

1.4 TESTING

A. Tests

1. The Owner reserves the right to test materials for compliance with these specifications. Sampling and testing will be done in accordance with the ASTM standard, by an independent testing agency employed by the Owner. Materials that fail to meet requirements are considered defective. Subsequent tests to establish compliance (of the same or new materials) shall be paid for by the Contractor.

1.2 SUBMITTALS

A. In accordance with the procedures and requirements set forth in section 01300 - Submittals, submit the following:

1. Samples of each material to be used showing full range of colors.
2. Manufacturer's specifications and certifications of compliance to the Specifications, including results of tests on masonry units showing such compliance, for each type of masonry. Provide handling, storage, and installation instructions along with protection instructions. Indicate by transmittal that installer has received copies of each instruction.
3. Cold and/or hot weather construction procedures in accordance with ACI 530.1/ASCE 6 sections 2.3.2.2. and 2.3.2.3.
4. Cleaning procedures and cleaner for each masonry type.

1.3 MOCK-UPS

- ##### A. Build mock ups at the site, where directed, full thickness and approximately 4 feet x 4 feet, indicating the proposed color range, texture and workmanship for each type of masonry. Obtain Architects's acceptance of visual qualities of the mock up before start of masonry work. Do not alter, move or destroy mock ups until Work is completed and removal is directed by the Architect.

1.4 DELIVERY, STORAGE AND HANDLING

- ##### A. Deliver materials in the manufacturer's original unbroken, undamaged and unopened packaging with labels bearing the name of the manufacturer and the product. Masonry units and brick shall be factory packaged and strapped, delivered to the site and stored on skids.

- B. Store and handle materials to prevent inclusion of water or foreign matter and to prevent damage of any nature.
- C. Distribute materials on floor slabs to prevent overloading. Designated live loads shown for floor shall not be exceeded.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide special shape, type or size indicated or for application requiring a form, size or finish which cannot be produced from standard masonry units by sawing. Provide solid units where masonry unit is exposed.
- B. Masonry units for fire-rated walls shall comply with Underwriter's Laboratory requirements for fire rating shown on the Drawings.

2.2 MATERIALS

- A. Mortar
 - 1. In accordance with Section 04100 - Mortar and Masonry Grout
- B. Face Brick
 - 1. ASTM C-216, Type FBS, SW. modular as manufactured and distributed by Belden Brick Company, Glen-Gery Corporation, Redland Brick Inc. or equal. Face brick shall be selected and approved by the Owner from samples submitted. Select color from manufacturer's red color range. Sand finished brick shall not be accepted.
 - 2. Net area compressive strength of brick masonry units shall be a minimum of 3200 psi when tested in accordance with ASTM C67. Compressive strength of masonry (f'm) shall be a minimum of 1200 psi in accordance with ACI 530.1 when these units are used with the mortar specified in Section 04100.

PART 3 - EXECUTION

3.1 GENERAL

- A. Examine areas and conditions under which masonry is to be installed and notify the Engineer in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.
- B. Brick having absorption rates in excess of 0.025 oz. per square inch per minute (as determined per ASTM C 67) shall be wetted sufficiently so that the rate of absorption, when brick is laid, does not exceed this amount.
- C. Clean reinforcing, removing loose rust, ice or other coatings from bars, before placement.

- D. Thickness of cavity and composite walls, and other masonry construction shall be the full thickness shown. Build single wythe walls to the actual size of masonry units.
- E. Build chases and recesses as shown and as required for the work of other trades.
- F. Build other work into masonry work as shown, fitting masonry units around other work and grouting to assure anchorage.
- G. Cut masonry units with motor driven saw designed to cut masonry with clean, sharp, unchipped edges. Cut units as required to provide pattern shown or specified, and to fit adjoining work neatly.
- H. Cold and hot weather construction.
 - 1. No masonry shall be erected when ambient temperature has dropped below 45°F unless it is rising and at no time when it has dropped below 40°F. Provisions shall be made for heating and drying of materials, and the complete work shall be protected in accordance with the ACI 530.1/ASCE 6 Section 2.3.2.2. Masonry shall not be laid with ice or frost on its surfaces, and no masonry shall be laid on frozen work. Any work which freezes before the mortar has set shall be removed and replaced at the Contractor's own expense. Do not use any admixtures or antifreeze in the mortar.
 - 2. When the temperature is above 100°F or 90°F with a wind velocity greater than 8 mph, mortar beds shall be spread no more than 4 feet ahead of masonry and masonry units shall be set within one minute of spreading mortar.

3.2 CONSTRUCTION TOLERANCES

- A. Variation from plumb: For vertical lines and surfaces of columns, walls and arises do not exceed 1/4" in 10', or 3/8" in a story height not to exceed 20', nor 1/2" in 40' or more. For external corners, expansion joints, control joints and other conspicuous lines, do not exceed 1/4" in any story or 20' maximum, nor 1/2" in 40' or more. For vertical alignment of head joints do not exceed plus or minus 1/4" in 10', 1/2" maximum.
- B. Variation from level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines do not exceed 1/4" in any bay or 20' maximum, nor 1/2" in 40' or more. For top surface of bearing walls do not exceed 1/8" between adjacent floor elements in 10' or 1/16" within width of a single unit.
- C. Variation of Linear Building Line: For position shown on plan and related portion of columns, walls, and partitions, do not exceed 1/2" in any bay or 20' maximum, nor 3/4" in 40' or more.

- D. Variation in Cross Sectional Dimensions: For columns and thickness of walls, from dimensions shown, do not exceed minus 1/4" nor plus 1/2".
- E. Variation in Mortar Joint Thickness: Do not exceed bed joint thickness indicated by more than plus or minus 1/8", with a maximum thickness limited to 1/2". Do not exceed head joint thickness indicated by more than plus or minus 1/8".

3.3 LAYING MASONRY WALLS

- A. Layout walls in advance for accurate spacing of surface bond patterns, with uniform joint widths and to properly locate openings, movement-type joints, returns and offsets. Avoid the use of less-than-half size units at corners, jambs, and wherever possible at other locations.
- B. Lay-up walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other work.
- C. Pattern Bond: Lay exposed masonry in the bond pattern shown or, if not shown, lay in running bond with vertical joint in each course centered on units in courses above and below.
- D. Stopping and Resuming Work: Rack back 1/2 unit length in each course; do not tooth. Clean exposed surfaces of set masonry, wet units lightly, and remove loose masonry units and mortar prior to laying fresh mortar.
- E. Cover top of walls at the end of each day. Protect wall from water infiltration from the top until wall is capped.
- F. Built-In Work: As work progresses, build-in items specified under this and other sections of these Specifications. Fill in solidly with masonry around built-in items.
 - 1. Fill space between hollow metal frames and masonry solidly with mortar, unless otherwise indicated.
 - 2. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of hardware cloth in the joint below and rod grout into core.
 - 3. Fill cores in hollow masonry units with grout 3 courses (24") under bearing plates, beams, lintels, posts and similar items, unless otherwise noted.
 - 4. Seal masonry tight around wall penetrations such as beams, joists, pipes, ducts, and conduit by cutting masonry units to fit as tightly as possible, then closing final gap all around with mortar, or joint filler and caulking as necessary.

3.4 MORTAR BEDDING AND JOINTING

- A. 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 slush head joints.
- B. Lay hollow concrete masonry units with full mortar coverage on horizontal and vertical face shells; also bed webs with mortar in starting courses on footing or floors, and where adjacent cells are to be reinforced or filled with grout. For starting courses where cells are not grouted, spread full mortar bed including areas under cells.
- C. Maintain joint widths of 3/8", except for minor variations required to maintain bond alignment.
- D. Tooling: Joints shall be tooled to a uniform concave joint. Head joints first and then the bed joints.
- E. Remove masonry units disturbed after laying; clean and reset in fresh mortar. Do not pound corners and jambs to shift adjacent stretcher units which have been set in position. If adjustments are required, remove units, clean and reset in fresh mortar.

3.5 JOINT REINFORCING

- A. Use continuous horizontal joint reinforcement installed in horizontal mortar joints not more than 16" o.c. vertically.
- B. Parapets: Use continuous horizontal joint reinforcement installed in horizontal joints at 8" o.c. vertically.
- C. Reinforced masonry openings greater than 12" wide, with horizontal joint reinforcing placed in 2 horizontal joints immediately above the lintel and immediately below the sill. Extend reinforcements 2'-0" beyond jambs of the opening except at control joints.
- D. Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
- E. Provide continuity at corners and wall intersections by use of prefabricated "L" and "T" sections. Cut and bend reinforcement units as directed by manufacturer for continuity at returns, offsets, pipe enclosures and other special conditions.
- F. Intersecting Load-bearing Walls: Provide rigid steel anchors at not more than 2'-0" o.c vertically. Embed ends in mortar-filled cores.
- G. Non-loadbearing Interior Partitions: Build full height of story to underside of solid floor or structure above, unless shown otherwise. Fill joint with mortar after dead load deflection of structure above approaches final position.

3.6 CAVITY WALLS

- A. Keep cavity clean of mortar droppings and other materials during construction. Strike joints facing cavity, flush.
- B. Tie exterior wythe to back-up wythe of masonry with horizontal joint reinforcement at 16" o.c. vertically.
- C. Coordinate placement of dampproofing and insulation board with work to ensure there are no gaps or air spaces between pieces of insulation board.
- D. Weep joints shall be placed in exterior wythe of cavity wall, spaced a maximum of 32" o.c. horizontally, immediately above ledges, at lintels over openings, and as shown.
- E. Install cavity drainage protection as specified in Section 04150 - Masonry Accessories.

3.7 CAVITY WALL INSULATION

- A. Provide and install insulation as shown and as specified in Section 07210, Building Insulation.

3.8 CONTROL AND EXPANSION JOINTS

- A. General: Provide vertical and horizontal expansion, control and isolation joints in masonry where shown, or where not shown as recommended by brick and concrete masonry unit manufacturer. Build-in related items as the masonry work progresses.

3.9 LINTELS

- A. Install galvanized steel lintels where indicated.
- B. Provide masonry lintels where shown and wherever openings of more than 8" for brick size units and 1'-4" for block size units are shown without structural steel or other supporting lintels. Provide precast or poured-in-place masonry lintels. Cure precast lintels before handling and installation. Temporarily support formed-in-place lintels.

3.10 FLASHING

- A. Provide flashing as shown and as specified in Section 07600, Flashing and Sheet Metal.

3.11 REINFORCED UNIT MASONRY

- A. Vertical reinforcement shall be held in place by means of frames or other suitable means. Place horizontal joint reinforcement as masonry work progresses. Provide minimum clear distance between longitudinal bars equal to nominal diameter of bar. Minimum thickness of mortar or grout between masonry and reinforcement shall be 1/4", except 6 gage or smaller wires may be laid in 3/8" mortar joints. Collar joints which contain both horizontal and vertical reinforcement shall have a minimum width of 1/2" larger than the diameter of the horizontal and vertical reinforcement.
- B. Bar splices shall be contact lap splices. Length of splice shall be a minimum of 24" for #4 bars and 30" for #5 bars.
- C. Low lift grouting shall be used when grout space is less than 2" in width. Place grout at maximum intervals of 24" in lifts of 6 to 8 inches as the work progresses. Cores to be grouted shall be clean of mortar, mortar dropping and debris. Agitate grout to assure complete filling and coverage of reinforcement. Hold grout 1 1/2 inches below top of masonry if work is discontinued for more than a hour.
- D. High lift grouting may be used when the grout space is greater than 2". Grout shall not be placed in lifts greater than 4 feet. Grout core shall be kept clean of mortar, mortar dripping and debris. Provide cleanout holes as required for inspection and cleaning. Replace cleanout plugs after inspection and acceptance. Do not place grout until entire wall has been in place a minimum of 3 days. Hold grout 1 1/2 inches below top of masonry if work is discontinued for more than a hour.
- E. Forms and shoring shall be substantial and tight to prevent leakage of mortar or grout. Brace and shore forms to maintain position and shape. Do not remove forms or shoring until masonry gains enough strength to sufficiently carry its own weight and any other loads, temporary or permanent, placed on it during construction.

3.12 PROTECTION OF WORK

- A. Exposed masonry surfaces shall be protected from staining. Tops of wall shall be covered with nonstaining waterproof coverings when work is not in progress. Installed material shall be secure in high winds.
- B. Protection shall be provided for all openings in the walls to prevent damage to sills, jambs, etc., from all causes. Aluminum or steel frames and other finish materials shall be protected from damage during masonry work.

3.13 REPAIR, POINTING AND CLEANING

- A. Remove and replace masonry units which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install fresh mortar or grout, pointed to eliminate evidence of replacement.
- B. Pointing of Masonry: At the completion of the masonry work, all holes in exposed masonry shall be pointed. Defective joints shall be cut out and tuckpointed solidly with mortar. Pointing and tuckpointing shall be done with a pre-hydrated mortar. The mortar cement shall be controlled so that, after curing of the mortar, no difference in texture or color exists with that of adjacent masonry.
- C. Masonry Cleaning: While laying masonry units, good workmanship and job housekeeping practices shall be used so as to minimize the need for cleaning the masonry work. Protect the base of the wall from mud splashes and mortar droppings. The technique for laying masonry shall be such that mortar does not run down the face of the wall or smear onto the face.
 - 1. After the joints are tooled, cut off mortar failings with the trowel and brush excess mortar burrs and dust from the face of the masonry, use a bricklayer's brush made with medium soft hair.
 - 2. Remove all large mortar particles with a hardwood scraper.
 - 3. If, after using the above outlined techniques, additional cleaning of the walls is found necessary, allow the walls to cure one month prior to initiating further cleaning processes.
- D. Clean masonry to comply with the masonry manufacturer's directions and applicable NCMA "Tek" bulletins or BIA technical notes and the following requirements.
 - 1. Saturate the wall with clean water. The wall shall be thoroughly saturated prior to and at the time the cleaning solution is applied.
 - 2. Clean masonry with an approved cleaning solution for each type of masonry applied with a brush, starting at the top of the wall. Approved cleaners shall be composed primarily of detergents, wetting agents, buffering agents, and a maximum of 10% muriatic acid. Do not use acids on masonry surfaces that will be damaged by use of an acid cleaner. The use of any of the above cleaning agents shall first be approved in writing by the manufacturer of the masonry being cleaned and the Program Manager. The concentration, method of application of the cleaning solution, and method of scraping shall be as outlined on the container by the manufacturer.
 - 3. High pressure water and sandblasting shall not be used for cleaning except with the recommendation of the masonry manufacturer and the written approval of the Engineer.

4. Immediately after cleaning a small area, the wall shall be rinsed thoroughly with quantities of water.
5. Protect adjacent surfaces and materials during masonry cleaning operations.
6. After the walls are cleaned, take the necessary precautions to ensure that other contractors and subcontractors do not damage or soil the walls. Mud protection around the base of walls shall be left in place until the grading work is done.

END OF SECTION

SECTION 05500
METAL FABRICATIONS

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section includes requirements for providing metal fabricated items like castings, gratings, hatchways, ladders, stairs, floor plates, handrail, and railings including all anchors, fasteners, hardware, and accessories necessary to complete the work.

1.2 SUBMITTALS

- A. Submit following Section 01330.

1. Shop Drawings: Show fabrication and installation details for metal fabrications.
 - a. Shop drawings are to be signed and sealed by Maryland PE.
 - b. Show sizes, finishes, locations, required hardware and accessories, and details for all fabricated metal work, threaded fasteners, and welds.
 - c. Indicate welds, both shop and field, by symbols conforming to AWS Standards.
 - d. Shop drawings for continually furnished items will be waived provided Contractor submits a letter naming manufacturer to furnish these items who has on file with Engineer a certified standard drawing containing approved required information.
2. Setting diagrams, erection plans, templates, and directions for installation of backing plates, anchors, and other items.
3. Provide templates for anchors and bolts specified for installation under other Sections.
4. Catalog descriptions of manufacturers' items.
5. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the registered professional engineer, in the State of Maryland, responsible for their preparation.
6. Concrete Anchor Installer Qualifications and Procedures: Submit installer qualifications. Drilled-in anchors shall be installed by an installer with a minimum of five years' experience performing similar installations. Submit a letter of procedure stating method of drilling, the product proposed for use, the complete installation procedure, manufacturer training date, and a list of the personnel to be trained on anchor installation.
7. Samples for Verification: For each type and finish of extruded nosing and tread.
8. Mill Certificates: Signed by manufacturers of stainless-steel sheet certifying that products furnished comply with requirements.

9. Welding certificates.
10. Qualification Data: For professional engineer, registered in the State of Maryland.

B. Submit following Section 01450.

1. Manufacturers' test results of identical railings tested by manufacturer.

1.3 DELIVERY, HANDLING, AND STORAGE

- A. Identify and match mark, if applicable, materials, items, and fabrications for installation or field assembly.
- B. Wherever practicable, deliver items to Contract site as complete units, ready for installation with anchors, hangers, fasteners, and miscellaneous metal items.
- C. Provide storage facilities at Contract site for protection and storage of delivered materials.
 1. Handle and store so as not to damage factory finishes.
 2. Repair damaged finishes, at no cost to the Commission.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Shapes and Bars:
 1. Stainless Steel: ASTM A276, type 316.
 2. Aluminum:
 - a. ASTM B221 with alloy and temper of 6061-T6.
 - b. Aluminum structural members rolled or extruded: ASTM B308 with alloy and temper of 6061-T6.
- B. Plate, Sheet, and Strip:
 1. Stainless Steel: ASTM A264 and ASTM A240, type 316.
 2. Aluminum: ASTM B209 with alloy and temper of 6061-T6.
- C. Mild Steel Forgings: ASTM A668, Class F.
- D. Castings:
 1. Steel: ASTM A27, grade 65-35.
 2. Aluminum: ASTM B108 with alloy and temper of 356.0, T6.

E. Pipe and Tube:

1. Mild Steel.
 - a. For Welding:
 - 1) ASTM A53, type S, Grade B, schedule 40, black.
 - 2) Handrail posts: Schedule 80.
 - b. For Screwed Connections:
 - 1) ASTM A53, type E or S, grade B, schedule 40.
 - 2) Handrail posts: Schedule 80.
2. Stainless: ASTM A312, grade TP 316L.
3. Aluminum: ASTM B221 with alloy and temper of 6061-T6.
 - a. Wall Thickness: Schedule 80, following ANSI H35.2, unless otherwise shown on Drawings.

F. Steel Bolts, Nuts, Washers:

1. General.
 - a. Stainless for use with stainless and aluminum materials.
2. Stainless.
 - a. Bolts: ASTM F593, Type 304, Condition CW1 or CW2 for bolts
 - b. Eyebolts: ASTM A 489
 - c. Nuts: ASTM F594
 - d. Washers: ASTM A 666 Type 304
3. Anchor Bolts: Stainless steel, ASTM F593, Type 304, unless noted otherwise on contract drawings.
4. Expansion/Adhesive Anchors.
 - a. Manufacturer's shear and tensile strength tests: ASTM E488.
 - b. Fastener assemblies working strength: See manufacturer's recommendations.
5. Headed Steel Anchors: Fabricated from cold finished carbon steel meeting requirements of ASTM A108 and fabricated following Drawings.

G. Grating:

1. Aluminum: ASTM B221 with alloy and temper of 6063-T6, mechanically locked, with fluted non-skid surface.

H. Access Hatches for Roof:

1. Hatch Door and Framing:
 - a. Design
 - 1) Cover shall be reinforced to support a minimum live load of 40 psf.
 - 2) Maximum deflection of 1/150th of the span or 20 psf wind uplift.

- 3) Cover shall be 11 gauge aluminum with a 3" beaded flange with formed reinforcing members.
- 4) Cover insulation shall be fiberglass of 1" thickness, fully covered and protected by an 18 gauge aluminum liner.
- 5) Roof hatch shall be equipped with interior and exterior padlock hasps.
- 6) All hardware shall be zinc plated and chromate sealed.
- 7) Factory finish shall be alkyd based red oxide primed steel or mill finish aluminum.

b. General

- 1) Door opening sizes, number, and direction of swing of door leaves, and locations shall be as shown on the Drawings. The Drawings shall indicate the clear opening dimensions.
- 2) All doors shall be aluminum unless otherwise noted.
- 3) Openings larger than 42 inches in either direction shall have double leaf doors, unless shown otherwise on the plans.
- 4) Doors shall be designed for flush mounting and for easy opening from both inside and outside.
- 5) All doors shall be provided with an automatic hold-open arm with release handle.
- 6) Double leaf doors shall be provided with safety bars to go across the open sides of the door, when in the open position. Brackets shall be provided on the underside of the doors to hold the safety bars when not in use.
- 7) All hardware, including but not limited to, all parts of the latch and lifting mechanism assemblies, hold open arms and guides, brackets, hinges, springs, pins, and fasteners shall be stainless steel.
- 8) All doors shall be watertight with a continuous gasket. All single door applications shall include a continuous EPDM odor reduction gasket.
- 9) Door frames shall be extruded and equipped with a 1-1/2-inch minimum drainpipe located by the manufacturer. The drainpipe shall be provided by the Contractor and shall extend to the nearest point of discharge acceptable to the Engineer.
- 10) Approved Manufacturer:
 - a) The BILCO Company; Type "F" Roof Hatch as specified in the drawings or approved equal.

c. Access Doors:

- 1) The inside of the personnel access hatch shall have displayed the sign "WARNING – PERMIT REQUIRED CONFINED SPACE – CHECK ATMOSPHERE BEFORE ENTERING". Sign shall be painted in black lettering against bright yellow background for additional visibility from above when the hatch is opened. Refer to ANSI/NEMA Z535 standards for current safety signs, symbols, and colors.

- 2) Door leaves shall be 1/4-inch, minimum, diamond pattern plate with an approved raised pattern, non-skid surface. Plate shall be stiffened as required to maintain allowable stress and deflection requirements. Stiffeners shall consist of angles or bars welded to the bottom of plate.
- 3) Doors shall be designed for a 300 psf live load minimum, unless noted otherwise.
- 4) Doors shall be designed for flush mounting and for easy opening from both inside and outside.
- 5) All doors shall have an enclosed compression spring assist and open to 90 degrees.
- 6) Exterior doors shall be Type "J-AL" by Bilco Company, Type "W1S" or "W2S" by Halliday Products Inc., Type "TPS" or "TPD", by U.S.F. Fabrication Inc., Type "THG" or "THG-D", by Thompson Fabricating LLC.
- 7) Interior doors shall be Type "K" or "KD", by Bilco Company, Type "S1S" or "S2S" by Halliday Products Inc., Type "APS300" or "APD300", by U.S.F. Fabrication Inc., Type "TH" or "TH-D", by Thompson Fabricating LLC.

d. Fabrication:

- 1) All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.
- 2) All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, fillets, connections, brackets, and other details necessary for a complete installation shall be provided.
- 3) All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.
- 4) Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.
- 5) All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.
- 6) All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05500, Metal Fabrications. All fastenings shall be concealed where practicable.

e. Installation:

- 1) Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.

- 2) All access hatches, and access doors shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions. Embedded support frames shall be set level and square.

I. Fall Prevention System:

1. Aluminum Ladder:

- a. Fabricate aluminum shapes and bars following WSSC Standard Detail M/16.0.
- b. Adjust length of bent plates, except top pair, to make vertical alignment.
- c. Place bottom angles no closer than 6 inches from edge of channel.
- d. Rung shall be solid and no-slip.
- e. Where aluminum contacts concrete, coat aluminum with an epoxy coating system.
- f. Rung shall bear on stringer 3/16" wide.
- g. All welds shall be a minimum of 3/16" wide.
- h. Keep ladder free of obstacles that will interfere with the placement of feet or hands.
- i. Approved manufacturers:
 - 1) Washington Aluminum Company, Inc.
 - 2) Or equal.

2. Grab Bar:

- a. Fabricate aluminum shapes and bars following WSSC Standard Detail M/15.0.
- b. Extruded: Aluminum following ASTM B221 with alloy and temper of 6061-T6.
- c. Casting: Aluminum alloy following ASTM B108 with alloy and temper of 356, T6.
- d. Finish: Standard mill.

J. Accessories:

1. Eye Bolts: ASTM A 489. Shoulder type, 1/2" diameter forged machinery eye bolt with UNC-2 right-hand threads and heavy-duty hexagonal nuts, 1/2 inch by 6 inches with working load limit of 2,400 pounds (straight pull), and Type 316 stainless steel accessories. Use Hilti-HY 200 Adhesive Anchoring System with 6" embedment.

K. Fabrication:

1. General: Fabricate items following Contract Documents and approved Contractor's submittals.
 - a. Straighten work bent by shearing or punching.
 - b. Press exposed edges and ends of metal smooth, with no sharp edges and with corners slightly rounded.

- c. Construct connections and joints exposed to weather to exclude water.
 - d. Quantity and size of anchors: Sufficient for proper fastening of work.
2. Fabricated Products:
- a. Pipe sleeves in concrete construction: Standard weight, black steel pipe, with anchors welded to exterior, size to accommodate passage of conduits, pipes, ducts, and similar items.
 - 1) Flanges for posts: 3/8-inch minimum thickness plate, and for stand-offs from not less than 3/16-inch thickness plate.
 - a) Use stainless steel stud bolts, nuts, and washers for fastening aluminum pipe railing and handrails.
 - b) Use galvanized high tensile strength stud bolts, nuts, and washers for fastening steel pipe railing and handrail.
 - b. Gratings: Removable with locking legs and means of bolting in place unless otherwise shown on Drawings.
 - 1) Bearing bars not less than 3/16-inch-thick of flat stock or equivalent I-bars with center to center spacing of not more than 1-3/16 inches.
 - 2) Structural supports for gratings, of shapes indicated: Fastened to structure with anchors.
 - 3) Cross supports: Allowable maximum deflection in span length, in inches, divided by 360 or 1/4 inch whichever is smaller.
 - 4) Non-skid Surface: Serrated edges on top of grating bars, or other equivalent means.
 - 5) Perimeter banding: Solid.
 - 6) Aluminum grating: Mechanically locked at intersections of all bars.
 - 7) Approved Manufacturers
 - a) Aluminum Rectangular Bar SG Series by Ohio Gratings, Inc., or approved equal.
 - c. Metal Bollards:
 - 1) Fabricate metal bollards from Schedule 40 steel pipe unless otherwise noted.
 - 2) Dimensions of bollards to be per contract drawings.
 - 3) Prime bollards with zinc-rich primer.
 - d. Hatch Door for Vaults: Channel frame with full anchor flange around perimeter.
 - 1) Aluminum covers: Mill finish.
 - 2) Covers with forged brass hinges with stainless steel pins.
 - a) Hinges: Through-bolted to cover and frame with tamperproof stainless-steel bolts and lock nuts.
 - b) Covers: Equipped with stainless steel snap latch to hold in closed position mounted on underside of covers and provided with removable latch release handle.

- (1) Latch release: Protected by flush mounted removable non-ferrous screw plug.
 - (2) Lift handle: Designed to be flush with cover surface when not in use.
 - (3) Covers: Capable of operation with 1 hand with automatic hold open device which will not intrude into opening space enough to hinder ingress and egress and have conveniently positioned release handle for safe closing.
 - c) Cover operation:
 - (1) Compression springs: Enclosed in telescopic stainless-steel tubes and operable with force not to exceed 30 pounds.
 - (2) Telescopic tube: Constructed so upper tube is outer tube.
- 3. Connections: Weld shop connections in weldable materials not designed for service removal.
 - a. Welding: AWS D1.1 requirements
 - 1) Weld behind finished surfaces whenever possible.
 - 2) Grind all exposed welds smooth.
 - 3) Remove weld, brazing, and solder spatter, flux, slag, and oxides from finished surfaces.
 - b. Use sheet metal lock seams only when indicated on Drawings or approved shop and working drawings.
 - c. Complete provisions for bolted field connections in shop unless otherwise shown on Drawings.
 - d. Match exposed work to produce continuity of line and design.
 - 1) Fabricate and fasten metal work so that work will not be distorted, finish impaired, nor fasteners overstressed from expansion and contraction of metal.
 - 2) Conceal fastenings whenever practicable.
 - 3) Use fastenings exposed to public view of same color and appearance as surrounding metal.
- 4. Castings and Forgings: Fabricate.
 - a. Castings and Forgings:
 - 1) Uniform quality, true to pattern, strong, tough, of even grain, sound, smooth, without cold sheets, scabs, blisters, and sand holes, cracks, or other defects.
 - 2) Plugs, filled holes, and welding will not be allowed.
 - b. Castings thicknesses and configurations: Follow Standard Details.
 - 1) Sand blast to remove scale and sand to achieve uniform smooth clean surface.
 - 2) Markings: Raised letters where indicated.

- c. Valve Boxes: Round head, sliding type consisting of snug-fitting top, bottom section and sliding type extension.
 - 1) Lid: Removable only by lifting straight up from shaft shoulder.
- 5. Galvanizing: Follow reference standards specified herein.
 - a. Items fabricated entirely from galvanized shapes, hardware, and sheet, without welding will not require galvanizing after fabrication.

L. Painting and Coatings:

- 1. Corrosion Protection for Contact Surfaces of Different Type Metals:
 - a. Carboline Bitumastic 300M.
 - b. Or equal.
- 2. Corrosion Protection for Aluminum to be Embedded in Concrete: See Section 03300.

M. Source Quality Control:

- 1. Test Metal Railings:
 - a. ASTM E935, Standard Test Methods for performance of permanent metal railing systems and rails for buildings.
 - b. ASTM E894, Standard Testing Method for anchorage of permanent metal railing systems and rails for buildings.

PART 3 EXECUTION

3.1 INSTALLATION

A. Standards:

- 1. AISC Specification for Design, Fabrication, and Erection of Structural Steel for Buildings.
- 2. AISC Code of Standard Practice for Steel Buildings and Bridges, where applicable.

B. Add shims, washers, anchors, and corrective work to ensure that installation is firm, tight, anchored, in true alignment with neat fits, without distortions, unsightly fastenings, raw edges, or protrusions.

C. Touch Up:

- 1. Use compatible paint system for damaged painted areas and field coat at connecting ends.
- 2. Galvanized Items: ASTM A780.

D. Fall Prevention System:

1. Install fall prevention system following Standard Details and specified herein.
2. Adjust manhole frame as necessary to assure fit of ladder extension.

END OF SECTION

SECTION 07100
WATERPROOFING AND DAMPPROOFING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section includes requirements for waterproofing and dampproofing of concrete surfaces that will be in contact with earth below grade.
- B. Principal items of work include: Waterproofing the exterior faces of walls below grade, underslab waterproofing below concrete slab on grade and dampproofing as shown on the Contract Drawings.

1.2 SUBMITTALS

- A. Manufacturer's descriptive product data and certification of compliance with referenced specifications.
- B. Manufacturer's detailed description for handling, recommendation on intended use and installation recommendations.
- C. Samples of waterproofing, dampproofing, and composite drainage panel.
- D. Complete layout and installation drawings and schedules with clearly indicated dimensions.
- E. Detailed drawings showing all anchoring details and construction details at corners, penetrations, flashing, overlaps and terminations.

1.3 STORAGE

- A. Deliver and store materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Waterproofing and dampproofing materials and membranes shall be stored in a dry protected place, up off the ground surface, complying in all respects with the product manufacturers recommendations.
- C. Do not store at temperatures above 90° F for extended periods.
- D. Keep materials away from sparks and flames.
- E. Avoid use of products which contain tars, solvents, pitches, polysulfide polymers, or PVC materials that may encounter waterproofing membrane system.
- F. Protect materials from direct sunlight until ready for use.

1.4 JOB CONDITIONS

- A. Unless otherwise recommended by the manufacturer, do not apply waterproofing or dampproofing when temperature is below 40 degrees F or when there is ice, frost or dampness visible on surfaces to be waterproofed or dampproofed.
- B. Primers and mastics are solvent-based liquids. Prior to the use of any product, consult the manufacturer's product label for handling, use and storage instructions.
- C. Adhere strictly to all manufacturer's cautions, warning and product safety and handling instructions.
- D. Do not apply to frozen concrete.

1.5 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Waterproofing membrane shall be compatible with waterproofing material and installed by methods approved by the membrane manufacturer.

PART 2 - MATERIALS

2.1 WATERPROOFING

A. Acceptable Manufacturers

Subject to compliance with the Specifications provide products manufactured by one of the following:

- 1. W.R. Meadows, Inc.
- 2. Grace Construction Products
- 3. Polyguard Products
- 4. Or Equal.

B. Waterproofing Membrane

- 1. Waterproofing membrane shall be applied to all concrete surfaces exposed to earth and as shown on the Contract Drawings.
- 2. Self-adhering membrane consisting of a minimum 56 mils of rubberized asphalt laminated to a minimum 4 mils of polyethylene for a minimum of 60 mil membrane. Provide a cold-applied membrane which requires no special adhesives or heating equipment.

3. The adhesive side of the membrane shall be protected with a special release paper that can be easily removed for installation. The membrane shall conform to the following requirements:

<u>Test Property</u>	<u>Test Method</u>	<u>Specification Limit</u>
Tensile Strength Membrane	ASTM D 412	
Carrier Film		5,900 psi min.
Polymeric Membrane		460 psi min.
Grab Tensile Strength	ASTM D 5034	70
Pliability, 180-degree bend	ASTM D 146	Unaffected
Elongation (Polymeric)	ASTM D 412	900% min.
Resistance to Puncture	ASTM E 154	48
Permeance, Permeability	ASTM E 96-B	0.036 perms
Water Absorption	ASTM D 570	0.1 max. (% by weight)
Weight, oz/SY, Min.	ASTM D 3776	40
Adhesion to Concrete	ASTM D 903	11 lbs/in.
Lap Adhesion	ASTM D 1876	8.0 lb./in.
Resistance to Hydrostatic Head		230.9 ft of water

4. Primer: As recommended by manufacturer.
5. Mastic: As recommended by manufacturer. Use mastic to seal cut edge terminations.

C. Underslab Waterproofing Membrane

1. Underslab waterproofing membranes shall be heavy duty grade for used below cast-in-place concrete slabs poured on grade where indicated on the drawings. The membrane shall be designed to accept the placing of heavy reinforcement using conventional concrete spaces.
2. Membranes shall be composite sheets comprising a thick HPDE film, an aggressive pressure sensitive adhesive and a weather resistant protective coating. Membrane material shall meet the following requirements:
 - a. Membrane shall be 0.046-inch minimum thickness.
 - b. Lateral Water Migration Resistance shall be suitable for 231 ft of hydrostatic head pressure.
 - c. Low Temperature Flexibility shall be unaffected at temperatures down to -20 degrees F.
 - d. Elongation = 500%.
 - e. Tensile Strength, film shall be 4000 psi.
 - f. Crack Cycling shall be unaffected at -9.4 degrees F, 100 cycles
 - g. Puncture Resistance up to 221 lbs.
 - h. Peel Adhesion to Concrete shall be 5 lbs./in.
 - i. Lap Peel Adhesion shall be 5 lbs.in.
 - j. Permeance to water vapor transmission shall be 0.01 perms.
 - k. Water Absorption shall be 0.5%

2.2 COMPOSITE DRAINAGE PANEL

- A. Composite drainage panel: Three-dimensional, high impact, polystyrene core with a nonwoven filter fabric bonded to the core. Provide a polymeric sheet adhered to the flat side of the polystyrene core. Extend filter fabric beyond the edges to provide total filtering integrity of the drainage system.

- B. Physical Properties:

<u>Test Property</u>	<u>Test Method</u>	<u>Specified Limit</u>
Compressive Strength (Core)	ASTM D 1621	15,000 psf
Apparent Opening Size (Filter Fabric)	ASTM D 4751	100 US Sieve
Water Flow Rate (Fabric)	ASTM D 4491	165 gpm/ft.
Water Flow Rate (System)	ASTM D 4716	15 gpm/ft.

- C. Composite System Requirements:

1. Provide one-inch flange on longitudinal edge.
2. Bond filter fabric to each dimple of polymeric core.
3. Extend filter fabric beyond tow edge of polymeric core to provide total filtering integrity of the drainage system.
4. System shall be approved for use over waterproofing membrane.

2.3 DAMPPROOFING

- A. Dampproofing material shall be solvent type asbestos-free asphalt compound that meets the U.S. EPA Architectural Coatings Rule requirements for VOC.
- B. Dampproofing shall be SEALMASTIC by W.R. Meadows, Inc.; Karnak # 220AF by The Karnak Corporation; Or Equal.

2.4 OTHER MATERIALS

- A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Engineer.

PART 3 - EXECUTION

3.1 PREPARATION

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

- B. Membrane waterproofing shall not be applied until curing has been completed and surfaces are protected against cold. All surfaces shall be dry, smooth, and free from projections and holes.
- C. Underslab waterproofing system shall be applied in accordance with the manufacturer's instructions and recommendations.
- D. Dampproofing shall not be applied until curing has been completed and surfaces are protected against cold. All surfaces shall be dry, clean, smooth, and free from projections and holes.

3.2 APPLICATION

- A. Materials shall be applied at temperature above 40 degrees F., unless specifically listed for application below 40 degrees F. Do not apply materials when there is ice, frost, or dampness visible on the surface to be waterproofed or dampproofed.
- B. Install material in strict accordance with manufacturer's recommendations and using appropriate and approved equipment. Care shall be taken to prevent coating of parts of the structure that will be exposed to view in the completed structure. Allow each coat of dampproofing to cure 24 hours before applying subsequent coats unless otherwise recommended by the manufacturer. Dampproofing shall not be permitted when the temperature is less than 40-degrees F. Where membrane waterproofing and dampproofing are both indicated for applications, the membrane waterproofing shall be applied first.
- C. Protect waterproofing membrane during construction period to prevent damage, soiling, or deterioration other than normal wear and weathering up to the time of final acceptance by the City. No backfilling shall be performed against the installed waterproofing and dampproofing until it is approved by the City. Damage to the membrane shall be repaired by the Contractor at no cost to the City. Repairs shall extend beyond the outermost damaged portion, and the second ply shall extend at least 3-inches beyond the first ply.
- D. Apply dampproofing at the manufacturers recommended application rate. If no application rate is provided, apply at a rate of 6 gallons per 100 SF. Prepare and prime all surfaces per the manufacturer's recommendations.

3.3 PROTECTION

- A. Protect waterproofing on vertical and horizontal applications with immediate application of waterproofing rolled matrix drainage board. Use protection course if no drainage system is specified for use.
- B. Ensure underslab waterproofing membrane is not damaged prior to concrete placement.
- C. Concrete shall be placed within 60 days of underslab membrane application.

- D. Backfill immediately using care to avoid damaging waterproofing and dampproofing system.

END OF SECTION

SECTION 08225
FIBERGLASS DOORS AND FRAMES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Furnish all labor, materials, equipment and appliances required for the complete execution of the Work as shown on Drawings and specified herein.
- B. Principal Items of work include:
 - 1. Fiberglass frames and doors.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 04200 - Unit Masonry
- B. Section 08710 - Finish Hardware
- C. Section 08800 - Glass and Glazing

1.3 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:
 - 1. Samples shall include:
 - a. Corner sections of frames and trim.
 - b. Corner sections of doors.
 - c. Finish and color charts.
 - 2. Shop Drawings shall include, but not be limited to:
 - a. Complete layout and installation drawings and schedules with clearly marked dimensions. Indicate details of construction, profiles, gauges, reinforcing and location of all doors and frames.
 - 3. Manufacturer's literature.

1.4 WARRANTY

- A. The Manufacturer shall unconditionally guarantee the fiberglass reinforced-plastic doors and frames for five (5) years against failure due to corrosion by environmental conditions. Under this guarantee a new door will be offered replacement or the original factory price will be refunded at the discretion of the manufacturer.

1.5 DELIVERY, STORAGE AND HANDLING

- A. All materials shall be boxed or crated and suitably protected prior to shipment from the factory. Protect all hardware which may be attached.
- B. Protect products against damage during delivery, storage, and handling. Stack materials on blocking clear of ground, tilted to permit water drainage and protected from corrosion and construction abuse.
- C. Frames and doors, after being set shall be protected with heavy Kraft paper or other approved means in such manner to prevent damage. Protection shall be maintained until such time as directed by the Engineer.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, provide products from one of the following manufacturers:
 - 1. FIB-R-Door Systems
 - 2. Chem Proof Door Company
 - 3. Or Equal.

2.2 MATERIALS

- A. Provide doors and frames from the same manufacturer.
- B. Fiberglass reinforced plastic doors and frames shall be resin transfer molded (RTM). The doors shall be molded in one piece with gel-coat, fiberglass reinforcement, resin and core material molded together. Window openings, door hardware openings and flush hinge recesses shall be molded in. Secondary cutting and coating will not be allowed. Continuous stainless steel bars shall be molded in during the initial molding. The steel plates shall be pretapped to receive screws for attachment of hardware. Door hardware shall be stainless steel.

- C. Fiberglass reinforcement shall consist of a surfacing mat followed by continuous stand mat wrapped around rigid closed cell polyurethane foam core material. The outer surface shall consist of 30 mils of high quality commercial grade polyester gel-coat. Fiberglass laminate shall be a minimum of 1/8 inch on all sides and edges. The outer surface of the finished door and frame shall have a matte finish and be free of pits, porosity, blisters, wrinkles, dry glass, cracks or crazing.
- D. The fiberglass laminate shall have the following minimum physical properties using the applicable ASTM Standards.

Tensile strength	9,000 psi	ASTM D638
Flexural strength	20,000 psi	ASTM D790
Flexural modulus	1.0x10 ⁶	ASTM D790
Impact, Notched Izod foot pound per inch	15.0	ASTM D256
Barcol hardness	40 min. average	ASTM D2583
Water Absorption, degrees 24 Hours	0.1 percent	ASTM D570
Average coefficient of thermal expansion inch per inch per degree fahrenheit	10.5x10 ⁶	ASTM D696
Flame Spread	25 or less	ASTM E84

2.3 FIBERGLASS REINFORCED PLASTIC DOOR FRAMES

- A. FRP frames shall be solid fiberglass. The stop and frame will be molded in one piece. The frame shall be integrally gel-coated to the Owner's color when molded. Mortises will be molded in. It is not permitted to rout in mortises or remove any material from the head or jambs, to provide mortises.
- B. Reinforcement for mounting hinges, closers, etc., shall be of mild steel plates strategically located and buried in the resin-glass matrix so they will not be exposed to the elements.
- C. The jamb shall be flat on the backside (against the opening) and uniform in thickness as to provide a solid, uniform surface against the wall opening. No wood blocks or spacers are permitted.

- D. Frame shall meet the industry accepted design details of a standard frame profile which is 5-3/4 inches overall jamb depth with a two inch face, 5/8 inch stop and 5/8 inch return for both wrap around or butt mounting.
- E. The gel-coat shall be of .025 thick resin rich surface of an isophthalic or chemical-resistant polyester resin which is resistant to moisture, ultra violet sunlight and many industrial acids, alkalies and solvents and protects the glass reinforcements from degradation.

2.4 DOORS

- A. Fiberglass doors shall be flush type of 1-3/4 inch thickness. Doors shall be constructed with a gel-coat surface of 0.25 resin rich surface of an isophthalic or chemical resistant to moisture, ultra violet sunlight and many industrial acids, alkalies and solvents and protects the glass reinforcement from degradation. The Fiberglass laminate of 1/8 inch thickness shall be the primary structural component of the door. Color shall be selected from manufacturer's standard colors.
- B. The core shall be continuously bonded to the laminate for structural support and rigidity. To enhance this bond, the core shall be perforated so that resin posts are formed during the molding process which additionally ties the outer laminates together.
- C. The fiberglass door shall be formed to size to produce a totally seamless door. All hinge pockets, openings for windows (lites), louvers, locksets and flush bolts are molded in place.
- D. The fiberglass door shall have continuous steel reinforcement for hinge mounting. The lock edge of the door shall be the same steel reinforcement, except it will be interrupted at the lock location for lock installation. The manufacturer shall provide a 1/8 inch thick, 5-inch high x 18 inch long steel reinforcement for closer mounting. Totally encapsulated reinforcements in fiberglass.
 - 1. The door shall be prepared for hardware specified in Section 08710 - Finish Hardware.

2.5 FIRE RETARDANT

- A. The doors and frame shall be "Fire Resistant" and will not support combustion.

2.6 ANCHORS

- A. Jamb anchors shall be 14 gauge galvanized, flat, "T" anchors to suit frame size with legs not less than three inches by 10 inches. Set anchors at every three masonry courses, a minimum of three per jamb.

- B. For cast-in-place concrete, anchor frame jambs with 3/8 inches minimum counter-sunk bolts into expansion shield or inserts, with crush-proof sleeves. Provide a minimum of three per jamb.
- C. Floor anchors at doors shall be 16 gauge galvanized sheet steel at each jamb. Clip type anchors with two holes to receive fasteners.

PART 3 - EXECUTION

3.1 FRAME INSTALLATION

- A. Install plumb, level and true to line, rigidly secured in openings. Set frames in masonry walls prior to beginning masonry work.

3.2 DOOR INSTALLATION

- A. Install plumb, level and true to line. Apply and adjust hardware to achieve quiet and smooth operation.
- B. Doors shall fit snugly and close without forcing or binding. Door clearances shall not exceed 1/8 inch at jambs and heads and meeting stiles at pairs of doors. Clearance between bottom of door and finished floor material or threshold shall not exceed 1/4 inch. Frames shall be manufactured and machined to within 1/32 inch for all dimensions.

3.3 PROTECTION

- A. Protect installation from damage and touch up scratched areas with same paint used for shop coats. Damaged work shall be repaired or replaced.

END OF SECTION

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SECTION 08710
FINISH HARDWARE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Furnish all labor, materials, equipment and appliances required for the complete execution of Work as shown on Drawings and specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 08225 - Fiberglass Doors and Frames

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of these specifications, the Work shall conform to the applicable requirements of the following documents:
 - 1. ANSI/BHMA 156

1.4 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01330 - Submittals, submit the following:
 - 1. Manufacturers' data for each item of hardware. Include installation and maintenance instructions.
 - 2. Furnish templates to fabricators of other work which is to receive hardware.
 - 3. Hardware schedule organized into "hardware sets," indicating complete designation of every item required for each door or opening. Furnish initial draft of schedule at the earliest possible date in order to facilitate the fabrication of other work (such as hollow metal frames) which may be critical in the project construction schedule. Furnish final draft of schedule after samples, manufacturer's data sheets, coordination with shop drawings for other work, delivery schedules, and similar information has been completed and accepted.
 - 4. Prepare a keying schedule in consultation with the Owner.

1.5 QUALITY ASSURANCE

- A. Provide materials, assemblies, equipment and services from a single source for each category except that locksets, latchsets and cylinders must originate from the same manufacturer.
- B. Replace any item of finish hardware which cannot be installed or will not function properly.
- C. Provide hardware complying with NFPA 80 and UL labeled for fire rated openings.
- D. Furnish templates or information to door and frame manufacturer. Coordinate between the manufacturers where two or more articles of hardware are to be mounted on the same door. Verify all dimensions, new and existing.
- E. Coordinate hardware with other work. Furnish hardware items of proper design for use on doors and frames of the thicknesses, profile, swing, security and similar requirements indicated, as necessary for proper installation and function.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Handle, store, distribute, protect and install hardware in accordance with manufacturer's instructions or recommendations. Deliver packaged materials in original containers with seals unbroken and labels intact.
- B. Properly mark or label, so each piece of hardware is readily identifiable with the approved hardware schedule. Tag each change key or otherwise identifying the door of which its cylinder is intended. Where double cylinder functions are used or where it is not obvious which is the key side of a door, appropriate instructions shall be included with the lock and hardware schedule.
- C. Provide secure storage area for hardware.

PART 2 - PRODUCTS

2.1 MATERIALS AND FABRICATION

- A. Hand of Door
 - 1. Drawings show swing or hand of each door leaf (left, right, reverse bevel, etc.). Furnish hardware for proper installation and operation of door.
- B. Manufacturer's Name Plate

1. Do not use manufacturer's products which have name or trade name displayed in a visible location (omit removable nameplates), except in conjunction with required UL labels.

C. Base Metals

1. Produce hardware units of the basic metal and forming method indicated, using manufacturer's non-corrosive metal alloy, composition, temper and hardness but in no case of lesser quality material than specified.

D. Fasteners

1. Manufacture hardware to conform to published templates, generally prepared for machine screw installation. Do not provide hardware which has been prepared for self tapping sheet metal screws, except as specifically indicated.
2. Furnish stainless steel fasteners for installation with each hardware item. Exposed finish (under any condition) to match hardware finish or surfaces of adjacent work. Match the finish of adjacent work as closely as possible, including surfaces to receive painted finish.
3. Provide fasteners which are compatible with unit fastened and the substrate, and which will not cause corrosion or deterioration of finish hardware, base material or fastener.

E. Tools for Maintenance

1. Furnish a complete set of specialized tools as needed for Owner's continued adjustment, maintenance, removal and replacement of builder's hardware.

F. Hardware Finishes

1. Stainless steel, US32D unless otherwise noted.
2. Closers shall have a USP finish unless otherwise noted.

G. Field Checks

1. Make periodic checks during installation of finish hardware to ascertain the correctness of the installation. After completion of the work, certify in writing, that all items of finish hardware have been installed, adjusted and are functioning in accordance with Specification requirements.

2.2 DESCRIPTION OF PRODUCTS

A. Hinges

1. Stainless steel full mortise concealed oil impregnated ball bearing type, five knuckle with non-rising pins for interior doors, and non-removable and non-rising pins for exterior doors. Tips shall be flat.
2. Sizes and weights of hinges:
 - a. Doors up to 36 inches - 4-1/2 inches regular weight.
 - b. Doors 36 inches to 40 inches - 5 inches regular weight.
 - c. Doors 40 inches to 48 inches - 5 inches heavy weight.
3. Provide three hinges per door leaf up to and including 90 inches and one additional hinge for each 30 inches of additional height.
4. Acceptable Manufacturers: Stanley Hardware, Hager Hardware, or Equal.

B. Locksets and Latchsets

1. Stainless steel, heavy-duty mortise type conforming to ANSI A156.13 Series 1000, Grade 1.
2. Wrought steel box strikes.
3. Stainless steel deadbolt with 1 inch throw, approval.
4. 2 3/4 inch back set, 3/4 inch throw, two-piece anti-friction latchbolt.
5. Non-ferrous critical internal parts.
6. Cylinders shall be manufactured to conform to grand master key program.
7. Trim Design: Provide LWM (lever) by Corbin\Russwin or equal.
8. Acceptable Manufacturers: Yale, Corbin\Russwin, Schlage, or Equal.

C. Keys and Keying

1. Provide construction keyed, removable core master key system as directed by the Owner.

2. Furnish ten core removal keys and a quantity of master keys as directed by the Owner, not to exceed ten each per group. Furnish a minimum of 15 change keys per cylinder.
3. Furnish cylinders with six pin cores.
4. Provide a key schedule showing all key numbers and spaces to which each permits entry. The schedule and key cabinet, along with key gathering envelopes containing keys for each lock endorsed with lock number and space designation, shall be turned over to the Owner. Install keys with proper tags in the key cabinet. Establish a construction master key, and apply to locks and cylinders, except for closets, within major spaces. Locks for closets shall be shipped unlocked and the keys delivered to the Owner with the balance of the keys.
5. Acceptable Manufacturers: Yale, Corbin/Russwin, Schlage, or Equal.

D. Panic Hardware

1. Heavy duty push bar exit device, U.L. labeled, with corrosive resistant construction.
2. ANSI A156.3, Grade 1.
3. Exterior trim to closely match locksets.
4. Single/active doors: mortise type.
5. Double doors: concealed vericle rod.
6. ANSI Function 08.
7. Acceptable manufacturer's: Von-Duprin, Adams Rite Manufacturing Company, Corbin/Russwin, Or Equal.

E. Closers

1. Cast iron case with seamless one-piece forged steel spring tub.
2. Heavy duty forged steel arm.
3. Non-sized fully adjustable from size 1-6.
4. Backcheck intensity and location valves.
5. Delayed action closing.

6. Full metal cover.
7. Mechanical hold open device, except at fire rated doors.
8. ANSI 156.4, Grade 1.
9. Conforms to ADA 5 lbf. maximum door opening force requirement for non-fire rated interior doors.
10. Provide mounting brackets, and fasteners required for proper attachment.
11. Acceptable manufacturers: Corbin/Russwin, LCN, Norton, Or Equal.

F. Overhead Door Holder

1. Heavy duty bronze, surface mounted with positive grip holder.
2. Track: extruded bronze.
3. Degree of opening: 85 - 110.
4. Finish: Satin Chrome Plated.
5. Acceptable manufacturers: Corbin/Russwin, Glynn-Johnson, Norton, Or Equal.

G. Door Stops and Bumpers

1. Finish: Satin chrome plated.
2. Floor mounted door stops.
 - a. Acceptable manufacturers and products: H.B. Ives 444, Hager Hardware Model 267F, Glynn-Johnson Model FB36, Or Equal.
3. Wall bumpers
 - a. Acceptable manufacturers and products: H.B. Ives Model 407, Hager Hardware Model 234W, Glynn-Johnson Model 60C, Or Equal.

H. Flush Bolts

1. U.L. listed.
2. Forged brass construction, 1/2" diameter flattened bolt tip, 12" long rod.

3. Fit standard ANSI door preparation.
4. Provide dustproof strikes.
5. Acceptable manufacturers: Glynn-Johnson, Hager Hardware, H.B. Ives, Or Equal.

I. Coordinator

1. U.L. labeled and tested for 100,000 cycles.
2. Stop mounted, provide filler strips to fully cover stop.
3. Adjustable holding power and override feature.
4. Acceptable manufacturers: Glynn-Johnson, Hager Hardware, H.B. Ives, Or Equal.

J. Kickplates

1. Stainless steel, 0.050" thick, beveled 3 sides, 8" high, width 2 inches less than door width.
2. Acceptable manufacturers: H.B. Ives, Hager Hardware, Builders Brass Works, Or Equal.

K. Silencers

1. Rubber silencers: 3 for each single door and 2 for each double doors.
2. Acceptable manufacturers and products: Glynn-Johnson Models 64 or 65, Hager Hardware Models 308D or 307D, H.B. Ives Models 20 or 21, Or Equal.

L. Thresholds

1. Extruded aluminum saddle type with stainless steel fasteners. Six inches wide or as shown on drawings.
2. Acceptable manufacturers: Pemko, National Guard Products, Incorporated, Zero International, Or Equal.

M. Door Bottom Seal

1. Extruded aluminum with neoprene seal.

2. Acceptable manufacturers and products: Pemko Model 57, Zero International Model 328 and National Guard Products, Inc. Model 96, Or Equal.

N. Weatherstripping

1. Extruded aluminum with neoprene seal.
2. U.L. Labeled.
3. Acceptable manufacturers and products: Pemko Model 294, National Guard Products, Inc. Model 190, and Zero International Model 328, Or Equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Templates

1. After the hardware schedule is approved furnish to the various manufacturers, required blueprint templates for fabrication purposes. Templates shall be made available not more than ten (10) days after receipt of the approved hardware schedule.

B. Packaging and Marking

1. Ship hardware with proper non-corrosive fastenings for secure application. Each package of hardware shall be legibly marked indicating the part of the work for which it is intended. Markings shall correspond with the item numbers shown on the approved hardware schedule. Keys shall be tagged within each package set and plainly marked on the face of the envelope with the key control number, door designation and all identification as necessary.

3.2 INSTALLATION

- A. Install hardware in a manner which will eliminate cracks on surfaces.
- B. Mount hardware units at heights recommended in "Recommended Locations for Builders Hardware" by BHMA, except as otherwise indicated or required to comply with governing regulations.
- C. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Do not install surface-mounted items until finishes have been completed on the substrate.
- D. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as is necessary for proper installation and operation.

- E. Drill and countersink units which are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with factory standards.
- F. Cut and fit thresholds and floor covers to profile of door frames, with mitered corners and hair-line joints. Join units with concealed welds or concealed mechanical joints. Cut smooth openings for spindles, bolts and similar items, if any.
- G. Screw thresholds to substrate with No. 10 or larger screws, of the proper type for permanent anchorage and of bronze or stainless steel which will not corrode in contact with the threshold metal.
- H. Set thresholds in a bed of either butyl rubber sealant or polyisobutylene mastic sealant to completely fill concealed voids and exclude moisture. Do not plug drainage holes or block weeps. Remove excess sealant.

3.3 ADJUST AND CLEAN

- A. Adjust and check each operating item of hardware and each door to ensure proper operation or function. Lubricate moving parts as recommended by manufacturer. Replace units which cannot be adjusted to operate freely and smoothly as intended for the application.
- B. Final Adjustment
 - 1. One week prior to acceptance or occupancy make a final check and adjustment of all hardware items. Clean and re-lubricate operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices and compensate for final operation of heating and ventilating equipment.
- C. Instruct Owner personnel in proper adjustment and maintenance of hardware and hardware finishes, during the final adjustment of hardware.

3.4 HARDWARE SETS

- A. The door hardware sets on the Drawings indicates functional and general requirements. Items shall be quality and finish as specified. Hardware set identification refers to set numbers indicated on the Drawings. Consult Drawings for set number required.

B. Hardware shall be as follows:

Hardware Sets

1. HW-1 Exterior Entrance Door (Double Doors)
 - Hinges
 - Entrance Lockset
 - Panic Hardware
 - Overhead Door Closer Holder (each leaf)
 - Flush Bolts w/Dustproof Strikes
 - Coordinator
 - Kickplate
 - Threshold
 - Door Bottom Seal
 - Weatherstripping
 - Astragal w/Weatherstripping

END OF SECTION

SECTION 09900
PAINTING AND COATING

PART 1 GENERAL

1.1 DESCRIPTION

A. Section Includes:

1. Application for new facilities construction, except new buried water piping covered in Section 02510.
2. Performance requirements for materials to be supplied, the requirements for furnishing materials, the preparation of surface the paint will be applied to, the application procedures for painting, and quality assurance.
3. Details of requirements for each Coating System located in the project Painting Schedule, which identifies items to be painted, coating system, and service conditions attached to this section or Drawings.
4. Paint manufacturer's recommended practices on application, use, and cure of given coating.
 - a. Use most stringent specification if there is a discrepancy between this section and the manufacturer's recommendation.

B. Coating System: Surface preparation and application of specified paints for given service.

1.2 QUALITY ASSURANCE

A. Metal: SSPC.

1. VIS 1, Pictorial Surface Preparation Standards For Painting Steel Surfaces.
2. SP 1, Solvent Cleaning.
3. SP 2, Hand Tool Cleaning.
4. SP 3, Power Tool Cleaning.
5. SP 5, White Metal Blast Cleaning.
6. SP 6, Commercial Blast Cleaning.
7. SP 7, Brush-Off Blast Cleaning.
8. SP 10, Near White Blast Cleaning.
9. SP 11, Power Tool Cleaning To Bare Metal.
10. SP 12, Surface Preparation and Cleaning of Steel and Other Hard Materials by High and Ultrahigh Pressure Water Jetting Prior to Recoating.
11. PA Guide 1, Shop, Field, and Maintenance Painting.
12. PA Guide 2, Measurement of Dry Paint Thickness with Magnetic Gages.
13. PA Guide 3, Safety In Paint Application.

- B. Concrete: ASTM Standards.
 - 1. D-4258, Standard Practice for Surface Cleaning Concrete for Coating.
 - 2. D-4259, Standard Practice for Abrading Concrete.
 - 3. D-4260, Standard Practice for Acid Etching Concrete.
 - 4. D-4261, Standard Practice for Surface Cleaning Concrete Unit Masonry Coating.
 - 5. D-4262, pH of Chemically Cleaned or Etched Concrete Surfaces.
 - 6. D-4263, Indicating Moisture by the Plastic Sheet Method.
- C. Finish: Other standards.
 - 1. Federal Specification TT-C-555B.
 - 2. US Navy Bureau of Docks Specification 34YD.
 - 3. Military Specification MIL-C-18480-B.
 - 4. Holiday Testing: NACE RP0188.

1.3 SUBMITTALS

- A. Submit following Section 01330.
 - 1. Manufacturer's data sheets containing:
 - a. Percent solids by volume.
 - b. Minimum and maximum recommended dry film thicknesses for each coat for primer, intermediate, and finish coats.
 - c. Recommended surface preparation.
 - d. Recommended thinners.
 - e. Statement verifying compatibility of coats in system.
 - f. Manufacturers' application instructions including recommended equipment and temperature limits.
 - 2. Letter from manufacturer for each coating supplied stating:
 - a. Coating system designation.
 - b. Coating is recommended for the intended service and surface.
 - c. Each coating meets various standards and specifications included in coating description listed herein.
 - 3. For each paint or coating furnish Paint System Data Sheet PSDS, which is appended to end of this Section.
- B. Submit following Section 01330 and specified herein.
 - 1. Color Samples: Submit 1 sample for each color and finish required.
 - a. Size: Eight inches by 10 inches, on same materials to be finished.
 - b. Engineer will mark and retain approved samples for comparison with actual work as standard for color finish.
 - 2. Mockup Panel Option: Instead of samples required above paint mockup panel of approximately 9 square feet at Engineer's direction, of color selected and on applicable surface.
 - a. Obtain Engineer's approval of mockup panels before proceeding with work.
 - 3. Test Samples: At Engineer's direction, paint samples will be submitted to the Commission for testing.

- a. Submit 1-quart samples with markings to identify material designation, batch number, manufacturer's order number, date of manufacture, and date of sampling.
- b. Allow minimum of seven (7) working days for testing.
- c. Remove rejected paint from project site immediately.
- 4. Work Schedule:
 - a. Include systematic scheme for cleaning and painting.
 - b. Do not begin painting before receipt of Engineer's approval of schedule.
 - c. Allow 7-10 days for Engineer's review approval.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver material to project site in manufacturer's original containers with labels intact and legible, and seals unbroken.
- B. Store containers in dry ventilated storage space.
- C. Receive, open, and mix paint in assigned area kept neat and clean.
 - 1. Remove and dispose of empty containers, wipe cloths, and other debris at end of each day's work.
 - 2. Close partially used paint containers.
 - 3. Take precautions to prevent fire.

1.5 PROJECT CONDITIONS

- A. Paint when ambient and surface conditions are within paint manufacturer's recommendations.
- B. Exterior Painting Operations: Daylight hours.
- C. Apply finish coat after other required work is completed, heating and ventilation system is in operation, and glazing is in place.

PART 2 PRODUCTS

2.1 GENERAL

- A. Painting Systems: Primer, intermediate, and finish coats produced by single manufacturer.
 - 1. Thinners and Other Additives: Recommended by paint manufacturer for each particular system.
- B. Use only pre-tinted paints.
 - 1. On-site tinting of paint may be done only with Engineer's approval.

2.2 MATERIALS

- A. Manufacturer: Provide supplementary labels for each can detailing its specific shelf removal date in English or date code, for paint cans without dates.
- B. Acceptable Manufacturers:
 - 1. Carboline Company.
 - 2. M. A. Bruder & Sons, Inc. (M.A.B. Paints).
 - 3. Tnemec Company, Inc.
 - 4. PPG Industries Inc. (Industrial Coatings).
 - 5. International Protective Coatings.
 - 6. The Sherwin-Williams Company.
 - 7. Devoe Coatings (ICI North America).
 - 8. Madison Chemical Industries Inc.
 - 9. Ameron International Performance Coatings.
 - 10. ABRI Industries, LLC.
 - a. Iron Bond 111 as a primer for coating systems provided by Carboline Company and Sherwin-Williams Company.

2.3 COLOR AND LIFE OF FILM

- A. Use colors defined by Painting Schedule or Paint Type.
- B. Each Coat: Different discernible color or tint.
- C. Colors of Surfaces Finished: Remain free from serious variations and fading for at least 1 year.
 - 1. End of Guarantee Period: No evidence of blisters, peeling, running, scaling, streaks, or stain.
 - 2. Washability: Washing with water and alkali free soap will remove surface dirt without deteriorating paint.

2.4 PAINT SYSTEMS

- A. Descriptions: Paint system should be Paint systems and materials including requirements for types of coating, prime, intermediate and topcoat and coating thickness are given under Coating Systems.
- B. Surface Preparation: Described with paint system, under Surface Preparation, Coating Systems.
- C. Changes: Submit changes to coating system schedule for Engineer's approval with written guarantee from coating manufacturer that system will perform in specified environment.

2.5 COATING SYSTEMS

COATING SYSTEM C4 GENERIC TYPE: EPOXY/EPOXY-NSF APPROVED	
Surface Preparation Concrete	Minimum of 28 day curing for surfaces following SSPC-SP-1 and ensure that excessive moisture gradient does not occur by ASTM D 4263 test over 16-hour period immediately before coating application. Surfaces must be free of grease, form release compounds, dirt, moisture, dust, and other surface contaminants. Tenacious surface contamination may have to be abrasively blasted NACE 04 or SSPC-SP-7 Brush-Off Blast. Ensure that bug holes, wire tie holes, honeycomb and cracks are repaired either using sand mortar mix or epoxy filler acceptable to coating system manufacturer.
Surface Preparation Steel	Follow NACE 02 or SSPC-SP-10 Near White Metal Finish with a 1 to 1.5 mil profile.
1st Coat	High-solids (minimum 75 percent by volume) NSF Part 61 compliant polyamide epoxy applied at 4 to 6 mils DFT.
2nd Coat	High-solids (minimum 75 percent by volume) NSF Part 61 complaint polyamide epoxy applied at 4 to 6 mils DFT.
3rd Coat	None
Thickness	Total system thickness of 8 to 12 mils DFT.
Performance Criteria	Elcometer adhesion shall exceed 1,000 lbs/in ² . Direct impact resistance: Minimum of 36 in-lbs. ASTM G14. Abrasion resistance shall exceed 132 mg following ASTM D4060 CS-17 wheel at 1,000 cycles with 1 kg.
Topcoat Finish	Gloss

COATING SYSTEM C6 GENERIC TYPE: EPOXY/EPOXY	
Surface Preparation Concrete	Minimum of 28 day curing for surfaces following SSPC-SP-1 and ensure that excessive moisture gradient does not occur by ASTM D 4263 test over 16-hour period immediately before coating application. Surfaces must be free of grease, form release compounds, dirt, moisture, dust, and other surface contaminants. Tenacious surface contamination may have to be abrasively blasted following NACE 04 or SSPC-SP-7 Brush-Off Blast. Ensure that bug holes, wire tie holes, honeycomb and cracks are repaired either using sand mortar mix or epoxy filler acceptable to coating system manufacturer. Prime concrete and masonry surfaces with epoxy block filler compatible with intermediate and topcoats.
Surface Preparation Steel	Follow NACE 03 or SSPC-SP-6 Commercial Blast Finish with a 1 to 1.5 mil profile.
1st Coat	Red iron oxide pigmented polyamide epoxy with a minimum of 50 percent Volume Solids applied at 3 to 4 mils DFT.
2nd Coat	High build polyamide epoxy with a minimum of 46 percent Volume Solids applied at 4 to 6 mils DFT.
3rd Coat	None
Thickness	Total system thickness of 7 to 10 mils DFT.
Performance Criteria	Elcometer adhesion for the epoxy primer shall exceed 750 lbs./in ² , the epoxy intercoat shall exceed 750 lbs./in ² . Direct impact resistance for the 2 coatings: minimum of 84 in-lbs. following ASTM G14. Abrasion resistance shall exceed 84 and 132 mg, respectfully following ASTM D4060 CS-17 wheel at 1,000 cycles with 1 kg.
Topcoat Finish	Semi-Gloss.

PART 3 EXECUTION

3.1 PROTECTION

- A. Provide and use safe ladders, scaffolding, rigging, safety harnesses, lighting, and ventilation; make equipment available to Engineer for inspection and inspection activities.
- B. Protect:
 - 1. Surfaces during surface preparation and painting processes with drop cloths and protective covers.
 - 2. Working parts of mechanical and electrical equipment.
 - 3. Newly painted surfaces from contamination and overspray.
- C. Repair damage to property caused by surface preparation or painting.
- D. Check paints, solvents, thinners, strippers, paint gun cleaners for volatility and provide adequate ventilation and protective equipment.
- E. Determine hazards that may be incurred during the work and address hazards following federal, state, and local regulations.
- F. Follow safety, health, and waste removal regulations as established by federal, state, or local governments.

3.2 SURFACE PREPARATION

- A. Inspect metal surfaces with welds for weld flux, weld splatter, laminations, and other imperfections, and remove before surface preparation and painting.
- B. Before painting, remove, mask, or otherwise protect hardware, lighting fixtures, switch plates, aluminum surfaces, mechanical surfaces, nameplates, and other surfaces not intended to be painted.
 - 1. If necessary, disconnect and temporarily move equipment to prepare surfaces to paint.
- C. Do not sandblast PVC, CPVC, or FRP piping and equipment, or factory-coated epoxy, or enamel coated piping and equipment.
 - 1. If surfaces are to be coated for color-coding or to have a topcoat added to shop-applied primer, sweep blasting or other means of surface roughening may be necessary.
- D. Ductile Iron Surface Preparation: NAPF 500-03 Surface Preparation Standard for Ductile Iron Pipe And Fittings In Exposed Locations Receiving Special External Coatings And/or Special Internal Linings.
- E. Other Surface Preparation: See coating system descriptions.

1. If manufacturer's surface preparation, mil thicknesses ambient limitations, or other requirements are more stringent, follow the more restrictive limitations.
2. Complete coating application with at least the WSSC specified minimum coating thickness regardless of the number of extra coats required.

3.3 PAINTING MIXING

- A. Mix paint by mechanical means.
 1. Use paint directly from original containers without additions or thinning except tinting of colors with Engineer's approval, and for meeting manufacturer's thinning requirements for spray application without either exceeding viscosity limits (as measured by Ford or Zahn cup) or maximum thinning percentages as measured volumetrically.
 2. Do not leave paint in spray pots or painter's bucket overnight.
 - a. Discard unused paint before next day.
 3. Do not use any coating beyond its shelf life.
- B. Prepare multiple component coatings using entire contents of each component as packaged by paint manufacturer.
 1. Do not mix partial kits or utilize any mixed multiple component coating which has exceeded its pot life regardless of how it was stored, sealed, or thinned.
 2. Provide small quantity kits for touch up and for small areas.
 3. Do not intermix additional components for reason of color or otherwise, even within same generic type of coating.
- C. Use only specific thinner listed in manufacturer's recommended listing for specific coating system.
 1. Generic Thinners: Not for coatings except for clean-up and paint removal.

3.4 PAINT APPLICATION

- A. Apply paint by brush, rollers, or spray gun as specified or limited by coating manufacturer.
 1. Use good quality brushes and accessories appropriate for system applied.
 2. Use flat brushes 4 1/2 inches or less wide.
 3. Use oval or round brushes 2 1/2 inches or less wide for painting railings and open-grid steel decking.
- B. Follow manufacturer's instructions for painting and drying times.
 1. Spread material evenly and smoothly without runs sags, or other defects.
 2. Fill surface irregularities by moving brush in series of small circles and then apply parallel strokes.
 3. Apply:
 - a. Finish coats vertically on vertical surfaces.
 - b. Apply paint in corners and crevices.

- c. Apply stripe priming by brush over weld seams, gaps, joints and other irregularities on steel surfaces.
- 4. Thin primer for this activity up to 20 percent by volume and apply full primer coat immediately thereafter.
- C. Allow sufficient time between each coat as listed by manufacturer.
 - 1. Slightly abrade surfaces between coats to remove runs, drips, creases to produce a smooth finish following manufacturer's recommendation.
- D. Prime Sides, Cut Ends and Edges.
 - 1. Paint exposed surfaces.
 - 2. Before installation, paint parts of members inaccessible after installation.
- E. Take action to prevent dust and dirt from coming into direct contact with freshly painted surfaces.
- F. Stripe prime to ensure adequate coverage on hard to coat areas such as corners, cracks, rivets, and welds, work paint into rough welds and crevices.
 - 1. Extend striping a minimum of 1 inch from edges with specified paint material to obtain specified color and coverage.
 - 2. Hand or power sand visible areas of chipped, peeled, or abraded paint feathering edges.
 - 3. Prime and finish coat areas following specifications.
 - 4. Apply coatings so they are free of runs, bridges, shiners, laps or other imperfections.
 - 5. Stripe coat weldments applying first coat (prime coat).
- G. Paint by brushes, daubers, or sheepskins cracks, crevices, blind areas, shadow areas, and areas not easily accessed by a spray blast.
- H. Immediately brush out runs and sags; recoat and repaint surfaces under Engineer's direction.
- I. Do not use roller application on irregular surfaces such as rivets, bolts, crevices, welds, corners, or edges except under Engineer's approval.
 - 1. Brush out roller application to form a continuous film.
- J. Metal Objects Delivered to Site: Prime and coat following specification herein.

3.5 FIELD QUALITY CONTROL

- A. Preparation of Blast Cleaned Metal Surfaces: SSPC Visual Standards.
- B. Check conditions are within manufacturers recommendations for temperature and humidity in the presence of Engineer.
- C. Check paint's viscosity is within manufacturer's guidelines in presence of Engineer.

- D. Painters shall have a wet film thickness gage and start coatings work by ensuring that the proper wet thickness is being applied initially and periodically during course of application work.
- E. Measure coating thickness specified for ferrous surfaces with magnetic-type dry film thickness gages.
- F. Measure coating thickness on non-ferrous metal with an eddy current type thickness gage.
- G. Measure dry film coating thickness on non-metallic surfaces such as concrete and wood structures with an ultra-sonic thickness gage.
 - 1. Confirm with a Tooke Gage once a day.
 - 2. Repair Took Gage cuts using both primer and topcoats specified.
- H. All measurements must be taken in the presence of Engineer. SSPC-PA2 coverage and acceptance requirements (typical for E, F, and G above).
- I. Do not apply additional coats until completed coat has been inspected and accepted by Engineer. If item has improper finish color or insufficient film thickness, clean and topcoat with specified paint material to obtain specified color and coverage.
- J. Test coating systems for metal in immersion service with a Holiday detector.
 - 1. Test systems with total thicknesses less than 20 mils with low voltage wet-sponge type detectors.
 - 2. When using a low voltage wet-sponge type detector, ensure that a surfactant is added to the water.
 - 3. For coating system with larger than 20 mils DFT, test with a high voltage detector using specific voltage required for a given thickness.
 - 4. Holiday Detection: NACE RP0188 with NACE Condition "B" being the minimum acceptance criteria.

3.6 FIELD TOUCH-UP OF SHOP APPLIED PRIME COATS

- A. Field touch-up surfaces that are shop primed with inorganic zinc primers with organic zinc rich primer to cover scratches or abraded areas.
 - 1. Use organic zinc coating systems with minimum volume solids of 75 percent and a minimum zinc content of 15 lbs. per gallon.
- B. Field touch-up other shop-primed surfaces with same primer used in original prime coat.

3.7 CLEANING

- A. Touch up and restore where finish is damaged.
- B. Leave glass areas, plaster surfaces, floors and walls, hardware, and other surfaces clean and free from paint, stain, smears, spattering, or smudges.
- C. Do not mar surface finish of item being cleaned.
- D. Leave storage space clean.
- E. Remove abrasive blasting debris.

3.8 COLOR CODING AND LABELING OF PIPING

- A. Piping: Color coded and labeled following schedule.
- B. PVC, CPVC, FRP, Copper, and Factory Coated Piping: Labeled and color banded.

PIPING SYSTEM	PIPE COLOR	BAND COLOR	LABELING FLOW ARROW COLOR
Drain	Orange	Orange	Black
Potable Cold/Finished Water	Light Blue	--	White

****WSSC****

Paint System Data Sheet (PSDS)
(To be completed by Contractor)

Complete this PSDS for each coating system.

Attach Manufacturers Technical Data Sheets, MSDS and letter of compliance. Submit completed documentation to WSSC.

Coating System Number*:	
Specification Generic Description*:	
Service*	
Paint Manufacturers:	
Supplier:	
Representative:	
Representative Telephone:	
Representative Fax:	
Surface Preparation*:	
Paint Schedule Color and Finish*	
Colors or Finish to be supplied	

*Obtain from Paint Schedule and Specification.

Paint Material (Generic)	Product Name/Number (Proprietary)	Specification Min. Coats, Coverage

Coating System _____ will be used at the following locations: (Contractor to list here).

COATING SYSTEM SUMMARY

Coating	Surface	Exposure	Description
C4	Concrete, Masonry & Other Cementitious Surfaces & Steel	Potable and raw water, immersion or splash. Steel submerged in raw or potable water. Concrete, masonry or other cementitious surfaces exposed to submerged and/or splash zone conditions.	Potable Rated Epoxy/ Potable Rated Epoxy
C6	Concrete, Masonry & Other Cementitious Surfaces & Steel	Interior general duty service. Metal subject to mildly corrosive environments such as water condensation, chemical fumes such as hydrogen sulfide, salt spray, and chemical contract. Not to be used in submerged, splashing or misting of water and wastewater.	Epoxy / Epoxy

FCV VAULT COMPONENTS

ITEM	COATING	COLOR	FINISH	COMMENT
Ductile iron piping	System 4	Light Blue epoxy	Holiday free, flow direction color band if black.	Pipe color is function of coating system chosen.
Valve, couplings	Factory applied fusion bond epoxy	Manufacturers std.	As received. Do not cover Manufacturer's description tag.	Do not recoat. Use Plastic caps to cover bolt/nuts.
Vent supports hardware, Metallic Vent pipe inside Vault Vent pipe outside	System 6	Grey epoxy		

END OF SECTION

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SECTION 10524
EMERGENCY EYEWASH STATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Furnish and install emergency eyewash stations as shown on the Drawings and as specified herein. Certain equipment items will be field located by Owner, if not otherwise shown on the Drawings.

1.2 SUBMITTALS

- A. Submit Shop Drawings, Performance Affidavit, Operation and Maintenance Instructions and other information as specified for all items of equipment in this Section in accordance with Section 01330, Submittals. Shop Drawings shall also include complete erection, installation, and adjustment instructions and recommendations.
- B. Provide 1-year warranty against defective materials and workmanship.

1.3 MANUFACTURERS

- A. The materials covered by these Specifications are intended to be standard equipment of proven reliability and as manufactured by reputable manufacturers having experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and operated per manufacturers' recommendations.

1.4 GENERAL REQUIREMENTS

- A. The design, performance, and installation of all emergency shower and/or eyewash equipment shall conform to ANSI/ISEA Z358.1 – Emergency Eyewash and Shower Equipment.

PART 2 - PRODUCTS

2.1 EMERGENCY SHOWER/EYEWASH STATIONS

- A. Provide a pedestal-mounted eyewash safety station as shown on the Contract Drawings.

- B. For interior combination shower/eyewash units, the drench shower shall be operated by pull rod with triangular handle that remains open until manually closed, and the eyewash shall be operated by hand actuated flag type handle or foot treadle that remains open until manually closed.
- C. Pedestal mounted eyewash with stainless steel bowl, Schedule 40 galvanized pipe and fittings, ½" U.S. made chrome-plated stay-open ball valve, powder-coated cast aluminum flag handle and floor flange. Supplied with stainless steel bowl cover to protect bowl from dust, dirt, and other contaminants. Bowl cover opens when valve is activated. Unit shall have (2) polypropylene GS-Plus™ spray heads with integral filters and 1.6 GPM flow control orifices mounted on a chrome-plated brass eyewash assembly. Unit shall include ANSI compliant sign.
- D. Pipe and fitting material shall be galvanized steel (with plastic pipe cover) or PVC.
- E. Safety Station with eyewash shall be Model G1825BC by Guardian Equipment or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Emergency shower/eyewash stations shall be installed where shown on the Drawings or as directed by the Engineer. Where required by OSHA regulations, the background of the mounting location shall be painted the appropriate color.
- B. Install per manufacturer's instructions.

END OF SECTION

SECTION 11055
HYDROPNEUMATIC STORAGE TANK

PART 1 GENERAL

1.1 DESCRIPTION

- A. The Contractor shall furnish, pressure test, install and place in satisfactory operation, hydropneumatic bladder tanks as shown in the Drawings and described herein.

1.2 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

- A. Hydropneumatic Tank

Application:	Raw Well Water Storage
Type	Replaceable Bladder
Process Liquid	Untreated water from well
Quantity	2
Tank Capacity	370 gallon
System Connection	3"
Tank Pressure Set Point	80 psig
Maximum Design Pressure	125 psig
Minimum Operating Temperature Range	-20°F to 150°F

1.3 SUBMITTALS

- A. The Contractor shall submit the following in accordance with Section 01300 - Submittals:
1. Detailed manufacturer's design data, including all materials and coatings.
 2. Dimensional drawings.
 3. Performance data.
 4. Cutsheets and/or brochures.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Hydropneumatic Tank Construction:
1. Shell: Carbon Steel
 2. Heads: Carbon Steel
 3. Exterior: Carbocoat 140-Harvester Red

4. System Connection: NPT Epoxy Lined
5. Replaceable Bladder:
 - a. Heavy Duty Butyl
 - b. FDA Approved
 - c. NSF 61 Listed

2.2 MANUFACTURERS

- A. Hydropneumatic tanks shall be manufactured by Wessels Company and shall match model FXA-1400 or approved equal.

2.3 DESIGN

- A. The hydropneumatic tank shall have no moving parts.
- B. System connection will match manufacturer's recommended location for vertical configuration installation of the tank.
- C. Tank shall have a pressure gauge, bladder integrity monitor and a 0.302"-32 charging valve connection for field adjustment of system pressures.
- D. Tank shall be constructed in accordance with most recent addendum of Section VII Division 1 of the ASME Boiler and Pressure Vessel Code.
- E. Materials of construction, inside and outside, in contact with process liquid shall be NSF/ANSI Standard 61 approved.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Furnish and install steel hydropneumatic tank with replaceable heavy-duty butyl bladder factory pre-charged at 40 psig.
- B. Tanks shall be vertically installed as shown on the drawings in the location indicated on the Contract Drawings. Do not install in horizontal configuration.
- C. Readjust pressure setting of hydropneumatic tank to match system pressure requirements as indicated in 1.2.A.

END OF SECTION

SECTION 11160
WELL PUMPS

PART 1 GENERAL

1.1 DESCRIPTION

- A. The Contractor shall furnish, test, install and place in satisfactory operation, submersible well pumps as shown in the Drawings and described herein.

1.2 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

- A. Well pump requirements as shown on the drawing & specified herein:

Pump Data and Conditions	Low Flow Well Pump	High Flow Well Pump
Type	Submersible	Submersible
Application	Domestic Supply	Fire Demand
Rated Capacity GPM @ Feet of Head	85 gpm @ 170 ft 82 gpm @ 180 ft 50 gpm @ 249 ft	1,100 gpm @ 124 ft @ 75% speed 1,100 gpm @ 252 ft @ 94% speed 425 gpm @ 413 ft @ 100% speed
Motor Drive	Constant Speed	Variable Frequency
Phase	3	3
Horsepower	5 HP	125 HP
Voltage	460 V	460 V
Static Water Level (ft BLS)	55	55
Recommended Pump Intake Setting Depth (ft BLS)	192	245
Anticipated Pumping Rate (GPM)	85	1,100
Anticipated Max Drawdown Level (ft BLS)	65	183

1.3 REFERENCE STANDARDS

The work in this section is subject to the requirements of applicable portions of the following standards:

- A. ANSI – American National Standards Institute
- B. AISI – American Iron and Steel Institute
- C. IEEE - Institute of Electrical and Electronics Engineers
- D. NEMA – National Electrical Manufacturers Association
- E. AWWA – American Water Well Association

F. ISO – International Standards Organization

1.4 SUBMITTALS

A. The Contractor shall submit the following in accordance with Section 01300 - Submittals:

1. Detailed manufacturer's design data, including all materials and coatings.
2. Dimensional drawings.
3. Performance data, pump curves.
4. Cutsheets and/or brochures.

1.5 WARRANTY

A. The warranty period shall be a non-prorated period of 24 months from date of installation, not to exceed 30 months from date of manufacture as indicated on the nameplate.

PART 2 PRODUCTS

2.1 SUBMERSIBLE WELL PUMP DESIGN

- A. The head-capacity curve shall have a steady rise in head from maximum to minimum flow within the published operating region. The shut-off head shall be a minimum of 20% higher than the head at the best efficiency point.
- B. All pump bearings shall be lubricated by the pumped liquid.
- C. The pump shall be suitable for installation discharging the flow at any acute angle between vertical (pumping straight up) and horizontal.
- D. The pump (including cable guard) shall be suitable for use in a well-casing of the same nominal diameter.
- E. The pump shall be suitable for use in clean groundwater up to 104 °F.
- F. There shall be a check valve integrally designed into the pump discharge housing.
- G. The pump shall have integrated protection against upthrust.
- H. The pumping downthrust shall be absorbed by the motor thrust bearing.

- I. The pump impellers shall be secured directly to the smooth pump shaft by means of a split-cone and nut design
- J. Each impeller shall be fitted with a seal ring around its eye or skirt to prevent hydraulic losses
- K. The impellers must reside inside bowl-type stages that are held together with straps (higher-pressure pumps residing in sleeves are exempt from this requirement).
- L. A strainer shall be included as part of the suction inlet assembly.
- M. The discharge shall have internal standard NPT connections.
- N. Pump coupling must be friction-welded to shaft.

O. Pump Construction:

1. Check valve, check valve housing:	304 Stainless Steel
2. Check valve seat	NBR/316 Stainless Steel
3. Impellers, split-cone/nuts, diffuser chambers:	304 Stainless Steel
4. Impeller seal rings:	NBR/PPS
5. Seal ring support:	304 Stainless Steel
6. Intermediate bearings	NBR
7. Suction interconnector, inlet screen	304 Stainless Steel
8. Shaft, priming inducer	431 Stainless Steel
9. Coupling	316/329 Stainless Steel**
10. Straps, cable guard	304 Stainless Steel
11. Upthrust disc:	Carbon/Graphite
12. Upthrust stop washer	304 Stainless Steel
13. Motor adapter plate (if required)	304 Stainless Steel
14. Sleeve*, sleeve flange*	316 Stainless Steel

*If required for higher staged pumps

**Coupling for 4" motor made of 316 stainless steel

- P. Pump shall be coupled to motor by same manufacturer.
- Q. All pump parts must be available for purchase individually or in kits from the manufacturer.

2.2 TESTING

- A. The pump shall be tested for performance by the manufacturer as standard prior to shipping

B. The pump manufacturer shall be capable of providing any of the following tests prior to shipment:

1. Verified Performance Test
2. Witnessed Verified Performance Test

2.3 MANUFACTURERS

A. Well pumps shall be manufactured by Grundfos and shall match the following models or approved equal:

1. 85 GPM Pump : Grundfos 77S50-10, Product Number 98924635
2. 1,100 GPM Pump : Grundfos 1100S1000-3AA, Product Number 18BG96B3

PART 3 EXECUTION

3.1 INSTALLATION

A. Contractor shall furnish well pumps specified herein and install as per manufacturer's installation instructions.

B. Refer to Contract Drawings & Specification Section 13300 to coordinate well construction & well pump installation.

END OF SECTION

SECTION 11170
LIQUID CHEMICAL METERING PUMP SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The Contractor shall furnish and install chemical metering pumps at the locations shown on the Drawings and as specified herein.
- B. The complete installation shall be free from excessive vibration, cavitation, noise, and oil or water leaks.
- C. For chemical applications, the pump supplier shall be responsible for the supply of tubing, piping, fittings, adapters, appurtenances, and accessories starting from the chemical drum, through the metering pump, and ending at the injection quill, inclusive. These shall include, but not be limited to, the pump table, couplings, controls, pressure gauges, calibration columns, isolation valves, Y-strainers, flow indicators, check valves, backpressure/anti-siphon valves, pressure relief valves, and pulsation dampeners as indicated on the Drawings, or as otherwise required. The supplier is responsible for ensuring the chemical compatibility of the materials provided.
- D. The following chemical feed systems shall be provided in this project:
 - 1. One sodium hypochlorite (bleach) feed system.

1.2 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

- A. Chemical Properties:
 - 1. Sodium Hypochlorite:
 - a. Concentration: 12-15 (trade)% as Cl_2
 - b. Specific Gravity: 1.17
 - c. Freezing Point: -5°F
 - d. pH: 11-14

B. Pump Performance and Design Requirements

Chemical	Sodium Hypochlorite	
Application Point	New Wellhouse, Small Well Pump Discharge	New Wellhouse, Large Well Pump Discharge
Pump Type	Solenoid	Solenoid
No. of Pumps	1	1
Normal Operating Range, gph	0.001 – 0.550	0.100-0.550
Min Capacity (gph)	0.001	0.001
Max Capacity (gph)	1.6	1.6
Working Pressure Range (capability)	0-150 psig	0-150 psig

1.3 SUBMITTALS

- A. The following items shall be submitted with the Shop Drawings in accordance with, or in addition to, the submittal requirements specified in Section 01330 - Submittals
1. The Contractor shall obtain and submit to the Engineer certification from the chemical pump Manufacturer and equipment Supplier that the equipment meets the requirements of the Contract Drawings and Specifications. This certification form is included at the end of this Section.
 2. Pump dimensions, general cutaway section, and performance data (discharge pressure, strokes per minute, etc.). Also provide the manufacturer's estimated relationship of pump speed versus flow rate for the particular pump and tube submitted, noting the pressures used for the estimation.
 3. Submit the pump flow rate versus pump speed shop test results for approval before shipment of pumps.
 4. Catalog cut sheets and brochures of all equipment.
 5. Assembly Drawings of the pump table and arrangement of chemical feed equipment on the pump table.
 6. Details on materials of construction of all components including applicable ASTM designations.
 7. Chemical resistance data for all wetted pump parts and accessories including, but not limited to; pump housing, pump liquid end material, pump diaphragms, pump tubes, isolation valves, check valves, check valve balls and o-rings.
 8. Sizing calculations for pulsation dampeners.
 9. Equipment shop coating systems, interior and exterior.
 10. Details of sealing system.
 11. The total uncrated weight of the equipment plus the approximate weight of shipped materials.
 12. Complete wiring diagrams
 13. Complete control descriptions for pump operation

- 14. Complete erection, installation, and adjustment instructions and recommendations.
 - 15. Warranty documentation including statement of duration of warranty period and contact phone numbers and addresses for warranty issues. Such warranty shall be submitted for pumps and all other equipment and accessories.
- B. Submit all installation and start up test results to the Engineer for review.
 - C. Operation and Maintenance Manuals for the chemical metering pump systems shall be submitted in accordance with Section 01330 – Submittals. The manufacturer shall provide estimates of pump tube life based on installation conditions.
 - D. The Contractor shall be responsible for coordinating all interfaces with related mechanical, structural, electrical and instrumentation and control work. The Contractor shall be responsible for all work associated with installation of the equipment.
 - E. Shop drawings shall include all pumps and accessories and shall be submitted as a complete system. Partial submittals will be unacceptable.

1.4 WARRANTY AND GUARANTEE

- A. The pump manufacturer shall warrant the pump for materials and workmanship for a period of three (3) years after the Substantial Completion of the project. Warranty shall be submitted with the Shop Drawings. The pump manufacturer shall replace or repair the defective or unsatisfactory drive train during the warranty period at no cost to the Owner.
- B. All equipment and accessories shall be warrantied for materials and workmanship for a period of one (1) year after Substantial Completion of the project.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. The Manufacturer shall be a company specializing in manufacture, assembly, and field performance of mechanical metering pumps with a minimum of five years' experience.
- B. The chemical metering pumps shall be LMI B Series, Model B71 with AutoPrime™ or approved equal.

2.2 GENERAL

- A. All parts of the equipment furnished shall be designed and constructed for the maximum stresses occurring during fabrication, transportation, installation, testing, and all conditions of operation. All materials shall be new, and both workmanship and materials shall be entirely suitable for the service to which the units are to be subjected and shall conform to all applicable sections of these Specifications.
- B. Equipment and appurtenances shall be designed in conformity with ASTM, ASME, AIEE, NEMA, and other generally accepted applicable standards.
- C. All equipment which contacts the liquid chemicals or raw water shall be NSF 61 approved.

2.3 MATERIALS: CHEMICAL FEED PUMPS

- A. METERING PUMPS shall be a positive displacement pump with a variable speed DC motor, non-spring loaded roller assembly located in the pumphead, integral tube failure detection system and pump tubing assembly with attached connection fittings.
 - 1. Within the pumphead, there shall be no valves, diaphragms, springs, or dynamic seals in the fluid path. Process fluid shall contact the pump tubing assembly and connection fittings only.
 - 2. Capable of self-priming at the maximum rated pressure of up to 100 PSI (8.6 bar).
 - 3. Capable of running dry without damage.
 - 4. Suction lift shall be 8 feet of water.

2.4 ELECTRICAL AND CONTROLS REQUIREMENTS FOR CHEMICAL PUMPS

- A. Housing: Totally enclosed, chemically resistant housing for protection in harsh environments.
- B. Pulse Control: Adjustable stroke frequency and pulse inputs, with options for internal and external pulsing control and flow pacing.
- C. Pressure Capacity: Adjustable to reduce noise, vibration, and wear.
- D. Display: Clear liquid crystal display for easy monitoring of output.
- E. Weight: Not exceeding 15 lbs (6.9 kg) for ease of handling.

- F. Power Consumption: Not exceeding 29 watts per hour under full speed and maximum pressure conditions.
- G. Strokes per Minute: 1 - 100
- H. Valves: Ball type valves with ceramic balls for durability and longevity.
- I. Material: Glass fiber reinforced thermoplastic for chemical resistance.
- J. Encapsulation: Electronics housed in a chemical resistant enclosure for maximum protection.

2.5 METERING PUMP ACCESSORIES

- A. The metering pump supplier shall furnish accessory equipment as specified herein, as specified in Section 15080 – Valves and Piping Specialties, and as shown on the Drawings, including but not limited to the following below.
- B. PRESSURE: All supplied components on both the suction and discharge side of the chemical feed pumps, including tubing and fittings, shall be pressure rated at least to the same “Working Pressure Rating (Capability)” listed in Tables 1.02.B of this Section.
 - 1. Tubing and Fittings.
 - 2. PVC Piping – Not all solvent cements are suitable for the chemical applications. Use a specially formulated solvent cement suitable for sodium hypochlorite for solvent welded joints for ALL chemicals. Use IPS Weld-On 724, or approved equal for ALL chemicals, not just sodium hypochlorite. Use IPS’s recommended primer, P-70, or approved equal.
 - 3. Pump Table – Pump manufacturer shall supply pump skid platform system with a back wall which can hold equipment mounted to it.
 - 4. Injection Quill – Shall be retractable and the injection pipe passes through a valve which is connected to the process pipe saddle. This valve can be closed when the injection pipe is removed for maintenance. Select injection pipe length which dispenses chemical as close to center of process pipe as possible without voiding warranty. End tip shall be cut slanted at 45°. Shall be Saf-T-Flo or approved equal.
- C. All of the above valves shall have internal components that cause tight sealing to prevent unintentional internal leakage.

2.6 TOOLS, SUPPLIES, AND SPARE PARTS

- A. The equipment manufacturer shall furnish all special tools necessary to disassemble, service, repair and adjust the equipment.
- B. Spare parts shall include the following:
 - 1. One (1) spare pump for each chemical and pump type, per pump quantity requirements described in this Section.
 - 2. Two (2) complete sets of gaskets and O-ring seals for each size and material combination offered.
 - 3. One (1) spare valve for each valve type and chemical.
- C. Spare parts shall be delivered at the same time as the equipment to which they pertain. Spare parts shall be stored separately in a locked area, maintained by the Contractor, and shall be turned over to the Owner in a group prior to substantial completion. All of these materials shall be properly packed, labeled (including by chemical), and stored where directed by the Owner and Engineer.

PART 3 - EXECUTION

3.1 STORAGE OF EQUIPMENT AND MATERIALS

- A. Contractor shall store his equipment and materials at the job site in strict accordance with the manufacturer's recommendations and as directed by the Owner or Engineer, and in conformity to applicable statutes, ordinances, regulations, and rulings of the public authority having jurisdiction. Equipment and materials shall not be delivered to the site prior to 90 days in advance of the scheduled installation. Partial payment requests will not be processed for materials delivered prior to 90 days before installation or for materials that are not properly stored.
- B. Material or equipment stored on the job site is stored at the Contractor's risk. Any damage sustained of whatever nature shall be repaired to the Engineer's satisfaction at no expense to the Owner. Stored electrical equipment is to be protected from the elements and shall have space heaters energized.

3.2 INSTALLATION

- A. The Contractor shall furnish and install the metering pumps and all associated equipment and accessories as required and specified herein in accordance with manufacturer's instructions.

- B. The Contractor shall have on hand sufficient personnel, proper construction equipment, and machinery of ample capacity to facilitate the work and to handle all emergencies normally encountered in work of this character. To minimize field erection problems, mechanical units shall be factory-assembled insofar as practical.
- C. Equipment shall be erected in a neat and workmanlike manner on the foundations at the locations and elevations shown on the Drawings.
- D. All equipment sections and loose items shall be match-marked prior to shipping.
- E. The Contractor shall support piping adjacent to pumps such that no weight is carried on pump casings.

3.3 TESTING, CLEANING, AND START-UP

- A. The Contractor shall demonstrate to the Engineer that the completed systems meet the functional requirements intended and that all components of the system are properly calibrated.
- B. After installation of piping and accessories but before connection of chemical piping to the storage tank, pumps, and process piping, the Contractor shall completely flush the system to clean and remove all foreign matter from the piping system.
- C. Complete system hydrostatic tests and operational tests shall be completed with potable water. The Contractor shall check the functioning of all pump accessories, valves, and feed points and shall repair or replace all malfunctioning or unsatisfactory components. The Contractor shall repair all leaking joints and components identified during the test and through the guarantee period.
- D. Before connection of the chemical tubing/piping to the storage tank, pumps, and process piping, perform hydrostatic pressure tests for all assembled tubing, piping, and valving systems, including on the suction side of the pump, at a pressure of 25 psi for 24 hours. Then drain the piping and tubing of all test water before placing into chemical service.
- E. After pressure testing the chemical tubing/piping system, but before placing the chemical feed system into service of injection into the process pipes, test the flow rate of the installed pumps with chemical (not water) within the completely assembled system as follows:
 - 1. Ensure that chemical storage tank is at least half full of chemical.
 - 2. Ensure that the chemical feed piping and valving system is completely assembled and connected to the storage/day tanks per design and ready for normal operation, with the exception that the injection point is

disconnected so that chemical will not enter the ultimate process piping. Disconnect the piping/tubing immediately prior to the injection quill, which usually will be at a portion of flexible tubing which can be disconnected. If there is no flexible tubing near the injection quill, use a capped rigid test port near the quill and shut off the valve to the process pipe. During testing, chemical will flow out at these points (not into process pipe) and the Contractor shall be responsible for capturing, disposing of or reusing the pumped chemical flows during testing. Ensure sufficient ventilation of the area and minimize fumes. Use personal protective equipment as needed.

3. Run the chemical feed pumps to fill the feed piping system. Remove trapped air in the lines.
4. Perform flow rate tests with the chemical to determine the pump flow rate as a function of pump speed (rpm) and percentage (%). Test at least at approximately 25%, 50%, 75%, and 100% of the upper limit of the Normal Operating Range as shown in Tables 1.02.a of this Section. Provide charts of this data and a linear regression equation relating the variables. The flow rate may be measured using the calibration column or by precisely measuring the waste chemical leaving the piping system.

F. Final acceptance tests shall demonstrate the following:

1. The pumps have been properly installed and are in proper alignment.
2. The pumps operate without overheating or overloading of any parts and without objectionable vibration. Vibration shall be within the Hydraulic Institute limits, or manufacturer's limits if more stringent.

END OF SECTION

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SECTION 11220
IN-LINE STATIC MIXING EQUIPMENT

PART 1 GENERAL

1.1 DESCRIPTION

- A. The Contractor shall furnish, pressure test, install and place in satisfactory operation, in-line static mixer as shown in the Drawings and described herein: complete with mixing elements and housing pipe.

1.2 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

- A. Mixer Schedule

Application:	Hypo Solution Inline Mixing for Disinfection
Quantity of mixers	1
Main Process Fluid	Treated water from softener
Main Pipe Diameter	3"
Main Process Flow Rate Range, gpm	50 – 85
Mixer Pressure Rating (also test pressure), psi	150
Chemical Added	Sodium Hypochloride solution
Chemical Flow Rate Range, gph	0.04
Mixing performance Requirement within Flow Rate Ranges described above	At least 95% mixing completion at the end of the mixer outlet, as defined by Coefficient of Variation
Pressure (Head) Loss at Maximum Flow Rate shall not exceed:	4 psi
Length Requirements	None

1.3 SUBMITTALS

- A. The Contractor shall submit the following in accordance with Section 01300 - Submittals:
1. Detailed manufacturer's design data, including all materials and coatings.
 2. Dimensional drawings.
 3. Performance data. Provide chart of flow vs. mixing performance and head loss. List pressure rating.
 4. Cutsheets and/or brochures.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Static mixers shall be manufactured by Koflo, Komax, or Statiflo.

2.2 DESIGN

- A. The mixer shall be the static in-line type with no moving parts. The mixer shall contain fixed static mixing elements inside of a circular pipe spool piece.
- B. Mixing shall be by stationary; rigid elements arranged to split and recombine streams to provide a near-homogeneous stream at the mixer outlet.
- C. The mixer shall be flanged on both sides, compatible with surrounding piping.
- D. Mixer shall be structurally sound and suitable to withstand typical stresses associated with the intended installation arrangement.
- E. Materials of construction, inside and outside, shall be stainless steel, epoxy-coated carbon steel, or epoxy-coated ductile iron. All materials in contact with process liquid shall be NSF 61 approved.

PART 3 EXECUTION

3.1 INSTALLATION

- A. The mixers shall be installed and supported as indicated on the Drawings and as recommended by the manufacturer.

3.2 EXTERIOR COATINGS

- A. The exterior of the static mixer housing shall be epoxy coated (unnecessary for stainless steel) and shall have a different color than the surrounding piping, but the color shall still be a tint of blue, green, or olive. Stencil "Static Mixer" label onto the mixer body.

END OF SECTION

SECTION 11340
WATER SOFTENERS

PART 1 GENERAL

1.1 DESCRIPTION

- A. The Contractor shall furnish, test, install and place in satisfactory operation, water softeners as shown in the Drawings and described herein.

1.2 SUBMITTALS

- A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water softeners.
 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
1. Include diagrams for power, signal, and control wiring.
- C. Informational Submittals:
1. Seismic Qualification Data: Certificates, for water softeners, accessories, and components, from manufacturer.
 - a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 2. Source quality-control reports.
 3. Field quality-control reports.
 4. Sample Warranty: For special warranty.
- D. Closeout Submittals:
1. Operation and Maintenance Data: For water softeners to include in emergency, operation, and maintenance manuals.

1.3 OPERATING CONDITIONS AND PERFORMANCE REQUIREMENTS

A. Softener design specifications as shown on the drawing & specified herein:

Application:	Hardness & Fe Removal
Type	Duplex (2 mineral tanks)
Number of Brine Tanks	1 per tank
Design Flow	90 gpm / tank
Pressure Range	35-125 psig
Temperature Range	35-120°F
Working	Countercurrent Regeneration

1.4 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of water softeners that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Structural failures of mineral and brine tanks.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - d. Attrition loss of resin exceeding 3 percent per year.
 - e. Mineral washed out of system during service run or backwashing period.
 - f. Effluent turbidity greater and color darker than incoming water.
 - g. Fouling of underdrain system, gravel, and resin with turbidity or by dirt, rust, or scale from water softener or soft water, while operating according to manufacturer's written operating instructions.
2. Water Softeners, Warranty Period: From date of Substantial Completion.
 - a. Mineral Tanks: 5 years.
 - b. Brine Tanks: 5 years.

PART 2 PRODUCTS

2.1 DESIGN

A. Mineral Tank

1. Construction: Tanks shall be made of polypropylene and reinforced with a fiberglass wrapping and be NSF/ANSI 44 approved.
2. Pressure Rating: Tanks shall be designed for a maximum working pressure of 125 psi and shall be hydrostatically tested at 300 psi.
3. Conditioning Media: Strong The media is solid, of a proper particle size and contains no plates, shells, agglomerates or other shapes that might interfere with the normal function of the water.

4. Freeboard: 20 inches.
5. Support Legs or Skirt: Tanks shall be floor mounted as shown on the drawings.
6. Upper Distribution System: Slot design.
7. Lower Distribution System: Hub and lateral design and shall provide even distribution of regeneration water and the collection of water.
8. Liner: Material suitable for potable water.

B. Regeneration Control Valve

1. Manufactured from non-corrosive materials, is top mounted on top of mineral tank. Shall be certified to standard NSF/ANSI 61.
2. Shall not weigh more than 15 lbs. and operates using a minimum outlet pressure of 30 psi.
3. Complete manual operation, hydraulically actuated.
4. Sequence of Operation: Multiport pilot-control valve automatically pressure-actuates main operating valve through steps of regeneration: service, brine draw, slow rinse, backwash, purge, and brine refill.
5. Includes means of manual operation of pilot-control valve if power fails.

C. Brine Tank

1. Manufactured from non-corrosive rigid polyethylene.
2. Brine Valve: The brine tank shall have an internal brine well chamber to house the brine valve assembly. The brine float assembly with adjustable salt settings shall provide shut-off to the brine refill.
3. Overflow: The brine tank shall include a safety overflow connection that shall be plumbed to a suitable drain as shown on the drawings.

D. Chemicals

1. Mineral: Strong acid, non-solvent, high capacity, cation resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock.
 - a. Exchange capacity: Minimum exchange capacity of 30,000 grains removed per cubic foot of media when regenerated with a dose of 15 lbs. of salt per cubic foot of media.
2. Salt for Brine Tanks: Use food-grade salt pellets. High-purity sodium chloride, free of dirt and foreign material. Rock, solar salt and granulated forms are unacceptable.

- E. Factory-Installed Connections
 - 1. Inlet/Outlet Connections: E-clip Adapter.
 - 2. Drain Connection: E-clip Adapter.
 - 3. Brine Line Connection: 0.5" Tube

2.2 QUALITY CONTROL

- A. ASME Compliance for FRP Tanks: Fabricate and label mineral tanks to comply with ASME Boiler and Pressure Vessel Code.
- B. UL Compliance: Fabricate and label water softeners to comply with UL 979, "Water Treatment Appliances."
- C. Hydrostatically test mineral tanks before shipment to a minimum of one and one-half times the pressure rating.
- D. Prepare test and inspection reports.

2.3 MANUFACTURERS

- A. Water softeners shall be match the following models or approved equal:
 - 1. Model Hydrus HS 218s OD by Kinetico Water Systems
 - 2. Model CSM 300-2 by Culligan Water Systems

PART 3 EXECUTION

3.1 INSTALLATION

- A. Contractor shall furnish water softeners specified herein and install as per manufacturer's installation instructions.

3.2 STARTUP SERVICE

- A. Complete startup checks according to manufacturer's written instructions.

END OF SECTION

SECTION 13300
GROUNDWATER WELL CONSTRUCTION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The Contractor shall furnish all materials, tools, equipment, labor, and incidentals necessary for the design, construction, testing, and disinfection of new gravel pack groundwater wells, including, but not limited to, drilling, casing, screening, testing, and well head construction. The new well will be outfitted with a multiple pumps and as such the installation of the production casing in perfect vertical alignment is critical to the success of the well.
- B. Quantity: Two (2) well.
- C. Type of Well: Drilled gravel pack deep well tapping the confined (artesian) Magothy Aquifer to be used for potable water supply for a public water system and high flow demands.
- D. This section does not include the installation of any permanent pumps, permanent pump discharge (column) pipes, permanent electrical and control equipment, or permanent yard distribution piping.
- E. The Contractor is responsible for the detailed design of the well screen and gravel pack to allow the well to achieve the performance requirements specified in this Section and in the Drawings, even though minimum gravel pack and screen dimensions are shown on the Drawings.
- F. Plumbness and alignment of the well casings is critical to the future operation of this facility. All boreholes, casings and tubing shall be installed in perfect vertical alignment. Wellhead infrastructure shall be installed in perfect horizontal alignment.
- G. Refer to Appendix B for the logs and testing results of Exploratory Well EX-1.

1.2 RELATED WORK

- A. See Contract Drawings.

1.3 GENERAL DESIGN CRITERIA

- A. AWWA A100: Contractor shall be responsible for and comply with the entire AWWA A100-15 – Water Wells standard, except as explicitly modified herein and as overridden by stricter governmental regulations. All references to AWWA A100 are to the 2015 version of that standard.
- B. Regulations: Contractor shall comply with all applicable federal, state, and local codes and regulations. Particular attention is drawn to Code of Maryland Regulations (COMAR) 26.04.04 “Well Construction”.
- C. Minimum Dimensions: See Drawings.
- D. Design Flow Rate: The design flow rate is 1,100 gallons per minute (gpm) for the high-flow (fire flow) well pump. The design flow rate is 85 gpm for the low-flow (domestic) supply well pumps.
- E. All materials in contact with potable water or groundwater to be used or treated to be used for potable use shall have NSF 61 certification.

1.4 QUALITY ASSURANCE

- A. Experience: Contractor shall have completed the design, construction, testing, and disinfection of at least five (5) groundwater wells within the last 3 years.
 - 1. These wells described above shall have been wells tapping a confined (artesian) aquifer, constructed per AWWA D100, have capacities equal to or greater than the capacity of the well(s) proposed in this Contract, and shall still be in good condition today without significant failures or declines in specific capacity greater than 5% from original specific capacity.
 - 2. In addition to the above requirements, these wells shall be tapped into a coastal plain aquifer within 150 miles radius of the proposed well in this contract.
- B. The Owner’s Inspector shall have access to inspect the work at all times of working.
- C. A qualified supervisor employed by the Contractor shall be on site at all times during construction of the well.
- D. Contractor shall be licensed as a master well driller in the State of Maryland by the State Board of Well Drillers.

1.5 PERMITS

- A. Contractor shall submit Well Construction permit application and acquire the permit from the relevant governmental authority. Contractor shall pay any and all fees associated with the permit.
- B. If the Contractor plans to discharge water to the storm system or stream, he shall be responsible to applying for and obtaining any environmental discharge permits, including Federal/State NPDES permits.

1.6 SUBMITTALS

- A. Except as explicitly stated for the Final Report below, submittals shall be digital, not physical paper.
- B. Submit all information and samples required in AWWA A100 to the Owner.
- C. Submit well screen installation plan. This plan will include the proposed gravel pack, screen selection and manufactures detailed product information, and calculations.
- D. Submit longitudinal projections of the borehole as specified in the sequence of construction (Section 1.07).
 - 1. If the results of the plumbness and alignment testing indicate no measurable calculated drift or horizontal deflection, then the contractor shall proceed with grouting operations.
 - 2. If results of the plumbness and alignment testing indicate a calculated drift or horizontal deflection, then the Contractor shall submit to the Engineer a remediation plan for the repair of any well that fails the plumbness or alignment standards. If the well cannot be repaired, the well shall be plugged in accordance with current state requirements and a new well constructed at the Contractor's expense.
- E. Submit a Video Log of the entire depth of the finished well(s), including screen. Video shall be lighted.
 - 1. Log shall also show a closeup view directed downward at the bottom of the screen.
 - 2. Log shall show one continuous sweep along the entire length of the well in two horizontally opposite directions, resulting in two continuous sweeps showing opposing sides of the inside of the well. Sweep speed shall be no greater than 0.33 fps.

3. Log shall pause for at least 5 seconds at all transitions, such as screen/casing transition, and at each weld location.
- F. Construction: Before drilling begins, Contractor shall submit to the Engineer for approval the intended equipment, methods for construction and drilling. This shall include, but not be limited to:
1. Information on drilling fluid type and method of handling, recycling and the disposal of drilling fluids. Mud circulation pits are not allowed on this project.
 2. Drilling equipment and schedule.
 3. Method of acquiring water.
 4. Preliminary grouting plan.
 5. Method of disposing of or treating wastewater during well development, disinfection, and flow testing.
 6. Disposal of drill cutting and all materials removed from the well bore and all refuse generated during the construction of the well.
- G. Shop Drawings: Before drilling begins, Contractor shall submit to the Engineer for approval the following:
1. Detailed construction plan and schedule.
 2. Material identification, manufacturer's catalog and brochure information (when applicable), and technical data for the following intended materials:
 - a. Casing materials,
 - b. Preliminary screen selections, including slot size and open area, subject to revision after field findings,
 - c. Grout mix,
 - d. Preliminary gravel pack selections, subject to revision after field findings,
 - e. Centralizers for casing and screen,
 - f. Screen and blank casing section,
 - g. Well head flanges and fittings.

- h. Well head protection coverings, if applicable,
 - i. All other materials and equipment shown on Drawings or required by the Specifications.
- H. If a specific casing thickness is not stated in these Specifications and the Contractor is required to design the casing wall thickness, then the Contractor shall submit design calculations for the thickness of the casing.
- I. Contractor shall submit one (1) copy of mill certificates from the well casing manufacturer to the Engineer for approval prior to delivery to the job site. The certificates shall certify that the casing furnished under this contract complies with the requirements set forth in these specifications.
- J. Screen Material Certification: Contractor shall submit screen manufacturer's certification of materials for screen.
- K. Contractor shall submit and deliver production aquifer formation samples (from all such intervals of sampling) to Owner after Contractor has analyzed each such sample. No samples from non-production zones need be delivered.
 - 1. Stratigraphic Log: Contractor shall submit a Stratigraphic Log per AWWA A100 Section 4.2.5.2 accompanying the samples. This log shall include the particle size distribution of each production aquifer sample.
- L. Driller's Log: Contractor shall submit a Driller's Log containing all the information listed in AWWA A100 Section 4.2.5.1. This log shall also include identification of each principal aquifer encountered during drilling.
- M. The Contractor, after considering field drilling findings and analyzing the production aquifer samples, and before delivery and emplacement of screen and gravel pack, shall submit for approval:
 - 1. The material identification, manufacturer's catalog/brochure information, and technical data for:
 - a. The screen, including slot size, open area, and detailed closeup drawings of screen openings.
 - b. The gravel pack, including particle size distribution, specific gravity, and uniformity coefficient.
 - 2. Any revisions to the design of the finished well, including final decision for the limits and dimensions of the casing, grouting, gravel pack, and screen.
 - 3. A 500-gram sample of the approved gravel pack material to the Engineer.

- N. After delivery to project site, but before emplacement of gravel pack, Contractor shall submit to the Engineer the results of independent sieve analysis tests of the gravel pack described in AWWA A100 Section 4.6.3.2.
- O. Methods for Disinfection, Development, and Flow Testing: Before each of the below activities begins, Contractor shall submit for approval the description of methods and materials for:
1. Well development,
 2. Flow Testing,
 3. Disinfection, and
 4. Disposing of all wastewater from the above activities.
- P. Contractor shall complete and submit a Well Completion Report to the applicable governing authority per governmental regulations. Attached in Attachment B is a copy of the State of Maryland Well Completion Report.
- Q. Final Report: Contractor shall submit two (2) physical copies and one (1) digital copy of the Final Report containing information per AWWA A100 Section 4.7.11. This shall include, but not be limited to:
1. All previously approved written and drawn submittals above, including Driller's Log and Shop Drawings.
 2. Test results for drilling-fluid property tests conducted during drilling, as applicable.
 3. Detailed As-built drawings of the well, including, but not limited to, final dimensions and limits of all casings, screens, grout, and gravel pack.
 4. Plumbness and Alignment test results.
 5. Records of well development.
 6. Records and results of flow testing.
 - a. In addition to standard presentations of data and results, the Contractor shall include a digital spreadsheet showing all raw and finished/adjusted flow rate, well level, and time data with data and columns clearly labeled.
 7. Record of Compliance per AWWA C654 (latest edition) confirming the success of bacteriological testing after disinfection.

8. Water Quality Testing: The Contractor is required by this Contract to perform physical and chemical water quality testing. Contractor shall submit results of all water quality testing.
9. Affidavit of Compliance: Contractor shall provide an Affidavit of Compliance certifying that the well complies with all applicable requirements of AWWA A100-15.
10. All information in AWWA A100 Section E.3 of Appendix E.
11. Warranty/Guarantee.

PART 2 - PRODUCTS

2.1 GENERAL

- A. See AWWA A100 and applicable governmental regulations.
- B. All materials specified herein shall be new and free from objectionable defects. No used or old material will be accepted. However, if the Contractor deems it necessary or desirable to use temporary casings to facilitate the construction of the well, temporary casings need not be new and may be used during construction, subject to the approval of the Owner/Engineer.

2.2 WELL CASINGS AND PUMP PORTS

- A. Permanent casing shall comply with the following:
 1. Well casing sizes and materials shall be as indicated on the Contract Drawings.

2.3 WELL SCREEN

- A. Well Screen shall be 304 or 316 stainless steel, such as, Johnson Screen High Flow continuous Vee-Wire®, or approved equivalent.
- B. Screen dimensions: See Drawing PM-02.
- C. Screen entrance velocity shall not exceed 0.1 fps at design flow and assuming that 50% of screen opening area is blocked by particles.
- D. The screen shall be designed to have adequate strength to resist damage during installation.

- E. The screen slot size shall be determined based on gravel pack particle size distribution per AWWA A100.

2.4 GRAVEL PACK

- A. Gravel pack shall be selected based on particle size distribution of production aquifer formation per AWWA A100.
- B. Gravel pack selection will be presented as required in 1.06.
- C. Filter gravel may be used for the artificial gravel pack and shall conform to AWWA Standards for Filtering Material (AWWA A100-06). The gravel pack shall consist of Standard Silica brand, or approved equivalent. Only well-rounded (minimum roundness and sphericity of 0.6 on the Krumbein and Sloss scale) silica gravel is acceptable for use on the construction of the well.
- D. The gravel pack shall be disinfected prior to installation.
- E. Gravel pack shall be installed through a tremie pipe set to within 5-feet of the total depth, and feed to the well as the tremie pipe is withdrawn.

2.5 INSTALLATION OF CENTRALIZERS

- A. In order to center the well screen and inner casing inside the drilled hole, centralizers shall be installed on the well casing in the production well. Centralizers shall be installed at 5-feet above the base of casing, 20-feet above the base of casing and every forty feet thereafter, and at 10 -feet below land surface. At each point, at least three (3) centralizer blades shall be attached, equally spaced about the circumference. The centralizers shall be so located to allow the tremie pipe for cement to be free to move from top to bottom of the well screen. Centralizers shall be plastic or, if metal, shall be insulated from casing and screen.

2.6 GROUT

- A. Sulfate-resistant cement shall be used for all grouting of casings and hole plugging. ASTM Type I or I/II, or API Class B, can be used with additives and lost-circulation materials as necessary and approved by the Engineer. Organic polymers, peanut shells, and cottonseed hulls may not be used as lost circulation materials. Cement emplaced shall be neat.
- B. Prior to commencement of cementing operations, Contractor shall submit written procedure for each stage of each casing string. Mixed cement shall include cement and all additives and lost circulation material approved by the Engineer. Cement reports shall be submitted to the Engineer for each cementing stage within 24 hours.

PART 3 - EXECUTION

3.1 GENERAL

- A. See AWWA A100 and applicable governmental regulations.

3.2 TEST AND MONITORING WELLS

- A. The construction of test wells and monitoring wells are not included in this Contract.

3.3 DRILLING RECORDS AND SAMPLING

- A. Contractor shall record and obtain samples of all materials passed through during drilling, and shall record all construction, per AWWA A100 Sections 4.2.2, 4.2.5, and 4.2.6. The sampling interval shall be no greater than 5-feet within the anticipated production aquifer.
- B. All water bearing strata shall be described in special detail as to whether the material is loose or compact; its color, and, if gravel, whether it is water worn or angular.

3.4 WATER SUPPLY

- A. Contractor shall provide potable water for all construction related work. Exploratory well EX-1 was retained to provide a water source for the construction of the well and shall be disinfected in accordance with AWWA A100-06 Section 4.9 prior to use.
- B. Drilling makeup water will also be supplied by WSSC. A certified backflow preventor is required for connection to the onsite fire hydrant.
- C. Regardless of the water supply the Contractor uses, well EX-1 shall be plugged and abandoned per applicable regulations at the conclusion of the drilling and testing of the new well.

3.5 WATER DISPOSAL

- A. Follow all applicable regulations concerning discharges to storm sewers and waterways. If Contractor plans to discharge any water to a storm drain system or waterway or stream, Contractor shall apply for and obtain any environmental discharge permits required by law and regulation, including a Federal/State NPDES permit.

- B. Any wastewater containing sediment, chlorine, or other contaminants shall be disposed of at a waste facility or treated, including dechlorination, before discharge to a nearby storm drain, all under the responsibility of the Contractor. This includes water from construction activities, well development, and disinfection.
- C. Flow Test Water: When well water is clear and has passed the sand content requirements after well development, it may be directly discharged to a nearby storm drain if:
 - 1. Discharge point is arranged to prevent erosion of sediment,
 - 2. Water has been dechlorinated (if applicable), and
 - 3. Discharge is in accordance with local, State, and Federal National Pollutant Discharge Elimination System (NPDES) discharge requirements.

3.6 SITE PREPARATION AND RESTORATION

- A. The Contractor shall protect adjacent property from damage by water and mud.
- B. During construction, development and testing, the contractor shall maintain the well site so that access to and through the site is maintained and nuisance conditions do not develop. The Contractor shall be responsible for obtaining any necessary permit(s) for the proper disposal of waste material.
- C. Upon well completion, the Contractor shall restore all areas disturbed or altered by construction of the well and by grading, excavating or otherwise providing for drainage and disposal of water, sand, cuttings and drilling mud. Contractor shall stabilize and seed bare soil and disturbed areas.

3.7 FORMATION AND GRAVEL PACK SAMPLES

- A. The Contractor shall be responsible for obtaining and analyzing all formation and gravel pack samples required under these Specifications to ensure their compliance with the Specifications.

3.8 WELL CONSTRUCTION

- A. The conventional rotary method will be employed for the drilling of the production well. If, in the opinion of the Contractor, conditions are found that would warrant the use of some other drilling method, he may propose the use of an alternative. Prior to implementing the proposed method, it shall be approved by the Engineer. A methodology for disposing of drilling fluids, cuttings, formation water, and waste shall be submitted to the Engineer for review. These documents shall be appropriate for forwarding to the appropriate regulatory agencies for approval prior to the start of construction.

B. Drilling Fluid Requirements

1. The density of the drilling fluid should be sufficient to prevent flow once intervals with pressures above pad level are encountered. Mud density should remain sufficient to maintain a positive hydrostatic pressure while avoiding excess solids build-up in the mud. Mud weight should not exceed 9.2 lb/gal unless required to control well flow. Care should be taken to prevent swabbing or pressurizing the well due to high viscosity, high gel-strength muds while tripping the drill string in and out of the hole.
2. Marsh funnel viscosity shall remain at or below 40 seconds when circulating prior to cementing. Marsh funnel viscosity of mud entering the hole during drilling operations shall meet these same requirements. Thickening of mud above 40-second viscosity will require another bit trip to the bottom of the hole and mud circulation before cementing. Maintain viscosity test records in log book.
3. If the borehole is less than gauge, then at the Engineer's Discretion a sweep of the borehole may be required using a hole sweep product or improved mud in order to remove the thick wall cake and replace the wall cake with a thinner, lower fluid-loss wall barrier.

C. A pilot hole of smaller diameter than the final borehole diameter shall be drilled through the aquifer formation to take formation samples. After aquifer formation sample analysis and gravel pack and screen selection, and immediately prior to emplacing screen and gravel pack, the pilot hole in the aquifer formation shall be widened. Drilling fluid shall not be allowed to set and harden against the final borehole diameter, but well development shall commence soon enough to prevent such setting.

D. The cost of furnishing and installing, or installing and pulling out, any surface casing or pit casing that might be needed temporarily for the drilling operations shall be at no extra cost to the Owner.

E. The well shall be constructed, and all permanent casing set round, plumb, and true to line throughout.

F. Well casing and/or well screen shall be installed without bumping or any driving to prevent damage to welded joints or threaded couplings. The Contractor shall keep an accurate record, as assembled, of the order, number, size, and lengths of the individual pieces of casing installed in the well.

G. The Contractor shall employ the services of a company acceptable to the Engineer to obtain geophysical logs for the production well. The logging system shall be equivalent to the Century Geophysical Logging System, or approved equivalent. Caliper log tools shall be standard 3-arm X-Y tool, with a maximum opening equivalent to 24-inches greater than the borehole. The Contractor shall prepare and condition each hole to ensure that each hole is open and can be logged with a minimum of delay. Logs shall be run in the well at the stages listed as follows:

1. Geophysical Logging Schedule
 - a. After completion of pilot hole conduct dual induction, natural gamma and spontaneous potential.
 - b. Following the ream to 270 feet perform an X-Y caliper log.
 - c. Following the ream of the production zone to 355 feet perform an X-Y caliper log.
 - d. After installation of the screen, a video log of the entire screen and well casing. The Contractor shall pump the well until the clarity of the well will support the video survey.
2. The cost of geophysical logging shall be included in the price of the well. No payment will be made for logs that are unusable or inaccurate due to poor performance of the logging equipment. It shall be the responsibility of the Contractor to perform the required logging and to provide the Engineer with three (3) hard copies of each log and video survey, and one (1) copy of each log in electronic format (ASCII and PDF, or other approved format). Field copies will be provided at the time the logs are run.

H. Cementing Procedures.

1. The pressure method shall be utilized in the first stage of casing. Additional stages will be completed by means of a collarless tremie pipe. Approximately six to eight (8) hours after each stage of cementing, the Contractor shall tag the top of the cement with a collarless tremie pipe. When working in a mudded hole, the Contractor shall restore circulation of fluids at as high of a rate as possible to ensure a satisfactory cemented annulus. Prior to cementing in a mudded hole, the Contractor will demonstrate that the hole is gauge or exceeds gauge. Otherwise, the Contractor will be required to clean the hole with the drill bit and a commercially available hole cleaner such as BAROLIFT® or similar product designed to sweep the hole clean and leave behind a thinner, lower fluid loss filter cake while removing excess wall cake build-up. All holes will be gauge or larger prior to running the casing. The Contractor is required to provide 24-hour advance notification to the Engineer of all cementing procedures with a cementing plan. All cementing operations shall be witnessed by the Engineer who will have access to all equipment areas and will be provided with radio communication equipment

if utilized by the Contractor and/or sub-Contractor during cementing procedures.

2. Cementing procedures shall be continuous for each stage after cementing begins. If loss of circulation or no return of cement is encountered, the Engineer shall be notified immediately of what remedial measures are underway to re-establish the circulation and complete the cementing program according to the well design and Specifications.
3. During all stages of cementing in a mud filled hole, the Contractor will use a pre-flush or spacer. Before cementing begins, the Contractor shall submit the pre-flush plan to the Engineer for approval. Contractor will also run a cementing tremie line within 5 feet of the base of casing, or the termination of the last stage of cement for the pre-flush. The tremie line must be removed prior to initiating pressure grouting.
4. When the casings are being set and cemented in place, it is the Contractor's responsibility to ensure that these operations are conducted in such a manner that the casing collapse and burst strengths (with safety factor) are not exceeded and the casings are not caused to fail. Cement shall be pumped or placed so that excessive pressures will not damage the casing.

I. Follow all manufacturer's installation instructions when applicable.

3.9 PLUMBNESS AND ALIGNMENT TEST

- A. All boreholes shall be circular, straight and plumb. No doglegs or departures from a straight line shall be permitted which would interfere with or prevent casings or pumps from being set at their required depths and operated according to manufacturer's requirements or impede achievement of proper cement seals. Contractor shall notify Engineer/Owner two (2) days in advance of plumbness and alignment tests.
- B. The Contractor shall perform a test of hole alignment to confirm compliance with the Specifications. The hole alignment test shall be performed by lowering a section of pipe 40 feet long or a dummy of the specified pump length into the well the depth of 150 feet or as specified by the Engineer. The outer diameter of the test pipe or dummy shall be not more than 0.5-inch smaller than the inside diameter of that part of the casing or hole being tested. The lowered unit shall pass freely through the entire tested section.
- C. If there is evidence that a hole is not plumb, the Engineer may request the Contractor to perform a casing plumbness test in accordance with AWWA A100-06. The Contractor shall provide the Engineer with a written summary of the test results as specified in AWWA 100-06, Appendix D. Costs for all plumbness and alignment tests shall be included in the price of the wells listed in the Cost Proposal Form.

3.10 CAPPING

- A. Whenever there is an interruption in work on a well, the Contractor shall protect the well in such a manner as to effectively prevent either tampering with the well or the entrance of foreign matter into it. The Contractor is responsible for any objectionable material that may fall into the water supply well and its consequences until the completion and acceptance by the Engineer of all work described in these specifications.
- B. Upon completion of the well, the Contractor shall provide permanent wellhead specified elsewhere.

3.11 WELL DEVELOPMENT

- A. Following the construction of the well but before any final pumping tests have been started, the Contractor shall develop and clean out the well. The purpose of the development work is to maximize specific capacity and remove effectively from the well, well walls, and from the formation immediately adjacent to the well, material like mud, clay, fine particles of sand and/or shell and any other type of fine material. The Contractor shall develop the well utilizing a combination of air circulation and high-volume pumping to develop the well until the discharge water is free of sediments and there is no additional specific capacity improvement to the satisfaction of the Engineer. Other methods may be used at the discretion of the Contractor with the prior approval of the Engineer.
- B. Appendix E of AWWA A100 is hereby adopted, and the Contractor shall adhere to its requirements regarding both well development and flow rate performance testing.
- C. As part of and during development, the Contractor shall provide a pump capable of producing 1,200 gpm and perform a 15-minute specific-capacity test on the well before starting development and also at least once per day after starting development to demonstrate development progress. A calibrated flow meter or an orifice plate shall be installed on the discharge pipe to measure the pumping rate. Results shall be reported daily to the Engineer.
 - 1. Level measurement accuracy shall be 0.01 inches.
 - 2. Flow rate and totalized flow during pump development shall be monitored hourly.
- D. Contractor shall furnish a centrifugal sand sampler and a turbidity meter, which shall be installed on the discharge pipe. The Contractor shall periodically sample the pump discharge for turbidity and sand content to determine when adequate development has been achieved to the satisfaction of the Engineer. These results shall be recorded in the Contractor's Daily Log. The contractor shall measure sand content over time and prepare plots of sand content versus time and sand content versus discharge rate.

- E. The well shall be deemed properly developed once following conditions are met and verified by measurement:
 - 1. The well has produced water at the Design Flow Rate for a continuous 6 hours, and the average measured sand content throughout this time interval satisfies sand content requirements. At least four (4) sand content samples, taken at equal time intervals, shall be collected during this verification time interval.
 - a. The sand content requirement is: 0.5 mg/L sand or less.
 - 2. The specific capacity, determined at the Design Flow Rate and for equal time durations during each measurement, for a subsequent test increases by no more than 5% of the preceding test.
 - 3. The well is able to produce water at less than 5 NTU at the Design Flow Rate of 1,000 gpm, and less than 1 NTU at 100 gpm.
- F. Actual well development, regardless of the method used, shall be conducted for a minimum time period of 40 hours, unless directed otherwise by the Owner and Engineer. However, the Contractor shall be responsible for and include as part of the bid all expenses necessary to continue well development up to completion.
- G. After development, the Contractor shall verify that there is no sand or debris accumulated at the bottom interior of the screen.

3.12 FLOW RATE PERFORMANCE TESTS

- A. After well development, Contractor shall perform flow rate performance testing.
- B. Before both the step-drawdown test and the constant-rate flow test, record the static water level for at least 12 hours and ensure that the static level is steady before beginning any flow test.
- C. Level measurement accuracy shall be 0.01 inches.
- D. Contractor shall perform a step-drawdown test per AWWA A100-06 with the following modifications:
 - 1. The test shall have four (4) flow rates at approximately 50% (550 gpm), 75% (825 gpm), 100% (1,100 gpm), and 110% (1,200 gpm) of Design Flow Rate of well.
 - 2. Each step duration shall be at least 60-minutes.
- E. After the step-drawdown test, Contractor shall perform a constant-rate test per AWWA A100 with the following modifications:

1. The flow rate shall be constantly at the Design Flow Rate of the well.
 2. The time duration shall be 12 hours.
- F. For all flow test, the Contractor shall install a calibrated, programable pressure transducer capable of recording water level data at a frequency of one-minute. Alternatively, manual water level will be accepted and the frequency of recording levels shall be at least as follows:
1. Static water levels one (1) hour prior to the start of the test and every 15 minutes prior to the start of the test.
 2. One (1) reading at time zero, coincident with:
 - a. pump start,
 - b. each increase in flow rate during a step-drawdown test, or
 - c. pump stop during recovery test.
 3. One (1) reading each minute for the first 10 minutes.
 4. One (1) reading each 2 minutes for the next 10 minutes.
 5. One (1) reading each 5 minutes for the next 20 minutes.
 6. One (1) reading each 10 minutes for the next 60 minutes.
 7. One (1) reading each 20 minutes for the next 80 minutes.
 8. After the above 180 minutes, recording frequency may be one (1) reading every hour.
 9. If the test duration exceeds 24 hours, readings may be taken every four (4) hours.
- G. For all flow tests, if water level readings and time readings are manual, then a separate person shall be in charge of ensuring that the flow rate is maintained at intended target rate during the first 180 minutes of the test.
- H. Recovery Test: Contractor shall record recovery levels once the constant-rate test pumping stops at a frequency at least as much as the requirements above for recording levels during pumping, except time zero will be coincident with the pump stop. The time duration of recording recovery shall sufficient to witness a steady static level.
- I. Actual flow rates shall be recorded once every 10 minutes during the first 180 minutes, once per hour after the first 180 minutes.

1. If any recorded flow rate measurement deviates from the target flow rate by more than 5%, the test shall be stopped and repeated.

J. Interruption of Test:

1. If a pumping system failure occurs which interrupts the test during the first 180 minutes, the test shall be completely restarted after allowing well level recovery to static levels.
2. If a pump system failure occurs which interrupts the test after the first 180 minutes, but for a time period equal to or less than 15 minutes, the Contractor may continue the test, but shall extend the test duration by the amount of time lost.
3. If a pump system failure occurs which stops flow for more than 15 minutes at any time during the test, the test shall be completely restarted after allowing well level recovery to static levels.

- K. The Contractor shall provide a minimum of one experienced employee to be continuously onsite whenever a pumping test is being performed.

3.13 BIOLOGICAL, CHEMICAL, AND PHYSICAL WATER QUALITY ANALYSES

- A. The Contractor shall retain a qualified analytical testing agency, approved by the State, to collect samples and conduct all field and laboratory analyses. All analyses shall be carried out per applicable governmental regulations.
- B. Samples shall be taken (by Contractor's testing agency) after all flow testing and disinfection. All samples shall be taken after the well has flowed for at least 15 minutes at the Design Flow Rate after the chlorine residual has been measured as zero (0) mg/L.
- C. Testing shall include all biological, physical, and chemical characteristics and primary and secondary contaminants, as required by the Federal and State government regulations. In addition to these, tests shall include hardness and alkalinity.
- D. In addition to other regulatory requirements, take field measurements for pH, temperature, specific conductance, dissolved oxygen, chlorine residual, turbidity, and dissolved carbon dioxide.
- E. All costs associated with testing shall be at the expense of the Contractor.

3.14 WELL DISINFECTION

- A. Disinfect the well in accordance with AWWA A100-06, except as modified herein and when governmental regulations require stricter procedures. Particular attention is drawn to well disinfection requirements in COMAR 26.04.04.24, which requires a disinfection solution with at least 100 mg/L Cl_2 , not AWWA A100-06 50 mg/L.
- B. Per AWWA A100-06, gravel pack shall be disinfected during installation.
- C. Spray outside of all permanent screens, casings, and other materials and equipment to be placed within the well with a chlorine solution of at least 200 mg/L Cl_2 immediately before installation.
- D. After the well has been completely constructed and developed, it shall be thoroughly cleaned of all foreign substances including tools, timbers, rope, debris of any kind, cement, oil, grease, joint dope and scum. The well then shall be disinfected with a chlorine solution.
- E. After the required 12 hours of primary disinfection has passed, the chlorine residual shall be measured to ensure it is greater than 5 mg/L Cl_2 per COMAR 26.04.04.24.
- F. During pump out of the chlorinated wastewater, Contractor shall note when the chlorine residual is measured zero (0) mg/L Cl_2 , at which point pumping to waste at the Design Flow Rate shall continue for 15 minutes before bacteriological testing begins.
- G. Contractor shall be responsible for conducting bacteriological testing.

3.15 WELLHEAD INSTALLATION

- A. Each wellhead shall be completed as indicated in Drawing PM-02.
- B. Each of the three top flanges shall be fitted with a welded eye hook. Submersible well pumps will be fitted with a stainless-steel safety cable and secured to the appropriate eye hook.

3.16 PROTECTION OF PROPERTY AND NUISANCES

- A. The Contractor shall take special precautions to reduce to a minimum the nuisances and damage to property, which could result during execution of the Work. Any damage to public or private property shall be immediately repaired or paid for by the Contractor at no expense to the Owner. Equipment, tools, and materials shall be located in places where they will produce a minimum of nuisance.

3.17 CORRECTIVE WORK

- A. In the event that the well becomes contaminated, or that water having undesirable physical or chemical characteristics does enter the well due to the neglect of the Contractor, he shall, at his own expense, perform such work or supply such casings, seals, disinfecting agents or other materials as may be necessary to eliminate the contamination.

3.18 WELL ABANDONMENT

- A. In the event the Contractor should fail to sink the well to the necessary depth, or should he abandon the well for reasons of his negligence, he shall, if instructed by the Engineer, fill and plug the abandoned well. No payment will be made for work done on an abandoned hole or for salvaging materials or filling and plugging the hole. Abandonment shall be done in accordance with governmental regulations. The Contractor shall notify Engineer of the intent to abandon the well and shall make application and obtain approval to do so at his own expense.
- B. Well EX-1 will be plugged and abandoned at the conclusion of work to install the new production well. The abandonment will be conducted in accordance with COMAR Sec. 26.04.04.34(35)(36). EX-1 will be cut off 2-feet below land surface and excavation will be filled with topsoil.
- C. The existing well will be plugged and abandoned in accordance with COMAR Sec. 26.04.04.34(35)(36). All equipment will be removed from the well. The pumps and motors will be submitted to the owner for recovery. All other materials will be disposed of in accordance with local regulations.

3.19 GUARANTEE

- A. The Contractor shall guarantee that all material, equipment, structures, and work performed are free from defects in workmanship, design, or materials for a period of one (1) year after installation and acceptance by the Owner. If any part of the work shall fail within this period, it shall be replaced, and unit restored to operation at no cost to the Owner. Undue reduction in yield, collapse of casing, or settlement around the well in excess of two inches, failure of a seal, pumping sand from a finished well after being put into service, or clogging will be considered a defect to be covered by this guarantee.

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SECTION 15050
BASIC MECHANICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 DESCRIPTION

- A. This Section includes requirements for basic mechanical materials and methods. It applies to all Sections of Division 15 unless otherwise noted in the individual Sections. Mechanical systems shall be complete including all miscellaneous materials, and ready for operation as indicated in accordance with the Contract Documents.

1.2 QUALITY ASSURANCE

- A. Unless otherwise indicated, provide materials and valves which are the standard products of manufacturers regularly engaged in the production of such materials and valves. Provide the manufacturer's latest standard design that conforms to these Specifications. When two or more units of the same class of valves are required, these units shall be the products of the same manufacturer.
- B. Where materials and valves are specified to meet requirements of the standards or organizations that use a label or listing as a method of indicating compliance, such label or listing shall be attached to the material or valve when delivered to the contract site.
- C. Comply with requirements of the National Fire Protection Association (NFPA), The Plumbing and Gas fitting and regulations of the Washington Suburban Sanitary Commission as directly related to material and workmanship.
- D. Welding shall be performed by certified welders in accordance with AWS for the types of welding required on the Work.
- E. Except where otherwise specified, structural and miscellaneous fabricated steel used in equipment shall conform to American Institute for Steel Construction (AISC) standards and structural members shall be designed for appropriate shock and vibratory loads. Unless otherwise specified, steel which will be all or partially submerged during operation of equipment shall be at least 1/4 inch thick.
- F. All work shall comply with Specification section 01450.

1.3 SUBMITTALS

- A. Submit the following Contractor's Drawings in accordance with Section 01330:
 - 1. Shop drawings including descriptive and published details concerning performance, capacity and noise ratings for each piece of equipment.

2. Catalog data for materials other than equipment that are manufacturer's standard products.
 3. Scaled mechanical layout drawings showing dimensioned plan views and elevations of valves; valve mounting and foundations including anchoring details; piping including support detail; and components including space requirements, coordination with building features and other work.
 4. Manufacturer's instructions and recommendations for installation; handling and storage; and cleaning and maintenance of valves and materials during storage and prior to initial operation.
 5. For field welding, submit evidence that each welder is certified for the type of welding required for the work in accordance with Section 15999 – STEEL PIPE FIELD WELDING.
- B. Submit operation and maintenance manuals for each mechanical system and specific valve listed in and according to Section 01330.
- C. Submit certificates of compliance in accordance with Section 01450 for pipe, fittings and valves for 12-inch and smaller diameter.
- D. Submit manufacturer's certificates for material and equipment as listed and in accordance with Section 01450.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Materials and equipment shall be boxed, crated or otherwise completely enclosed and protected during shipment, handling, and storage. Such boxes, crates or protection shall be clearly labeled with manufacturer's name, brand or model designation, type or grade and color. Complete packing lists and bills for material shall be included with each shipment. Each item of equipment shall be tagged or marked with the same identification number or mark as shown on the packing lists and bills of material.
- B. Protect materials from exposure to the elements and keep dry at all times. Handle and store to prevent damage and in accordance with manufacturer's recommendations.
- C. Material shall not have rust, pitting, decay or other deleterious effects from storage and handling when installed in the work. Material showing such effects or damage shall be repaired or replaced by the Contractor as directed by the Engineer.

1.5 JOB CONDITIONS

- A. The Drawings indicate the extent and general arrangement of piping and valves. Piping and valves shall fit in the space allotted and allow adequate clearance for entry, installation, replacement, servicing and maintenance. Actual and final arrangement, location, grades and elevations of piping and valves shall be verified by the Contractor before ordering material and equipment. If adjustments and modifications are deemed necessary by the Contractor, details of such adjustments and modifications and the reasons therefore shall be submitted to the Engineer for approval as soon as practicable but not later than with the submittal of the scaled layout drawings. No adjustments or modifications shall be made without the Engineer's written approval.
- B. Coordinate the Work so piping, and valves may be moved in place without altering structure components, other equipment or installations. Provide drops, rises or offsets as required for proper installation whether shown on the Drawings or not.

1.6 SEQUENCING AND SCHEDULING

- A. Sequencing and scheduling of mechanical work shall be coordinated with the valve vault construction and other related parts of the Work including verification that all structures, piping, wiring, conduits and equipment components are compatible.

1.7 MAINTENANCE MATERIALS

- A. Maintenance materials in the form of spare parts and extra material, if required, will be specified in the specific Specification Section for equipment or materials.
 - 1. Spare parts listed to be furnished shall be packed in wooden boxes, labeled with the manufacturer's name, address and telephone number; local representative's name, address and telephone number; name of equipment the parts are for and list of parts contained therein.
 - 2. Extra material shall be packed in strong cartons, labeled with manufacturer's name, material name, type, color and location material was installed.
 - 3. Store maintenance material in a location directed by the Engineer.

1.8 MANUFACTURER'S SERVICES

- A. Manufacturers of furnished valves shall provide qualified field representatives to provide manufacturer's services as required during installation, and testing and to instruct Commission Personnel on operation and maintenance of the valves. Field representatives shall be available to observe, instruct, guide and direct the Contractor's handling, installation, and adjustment procedures of the valves. Manufacturer's services shall be provided for one (1) business day limited to 8 hours excluding travel.

PART 2 MATERIAL

2.1 GENERAL

- A. Factory assemble, coat and paint valves as much as is practicable before shipping and handling. A factory applied prime coat is a minimum coating requirement.
- B. Each Flow Control Valve (FCV), Pressure Relief Valve (PRV) and Gate Valve shall have a metal nameplate attached, showing as a minimum manufacturer's name, address and model number.

2.2 VALVE BASES

- A. Unless otherwise indicated, valves shall be provided with concrete bases a minimum of six inches high. Concrete shall meet requirements of Section 03300.

2.3 ANCHOR BOLTS

- A. Provide anchor bolts, nuts and washers meeting requirements of Section 05550 and as indicated on the Drawings. Unless otherwise indicated, size anchor bolts to the largest diameter that will pass through the bolt holes of the equipment base. Length of the bolts shall be long enough to permit a minimum of one inch of grout beneath the base plate and a minimum of three inches anchorage into the structural concrete, unless otherwise indicated.
- B. Provide anchor bolts, nuts and washers together with template or setting drawing sufficiently in advance to permit anchor bolts to be set either prior to or during structural concrete placement.

2.4 FLANGES, JACKING SCREWS AND EYEBOLTS

- A. Flange bolts holes shall be drilled and flanges spot-faced on the back. Stud holes shall not be drilled through.
- B. Jacking screws shall be provided for covers, where required.
- C. Provide eye bolts for lifting valves and equipment, when manual lifting would be difficult or where required.

2.5 LUBRICATION

- A. Equipment shall be lubricated by systems that require attention no more frequent than weekly during continuous operation. Lubrication facilities, oil drains and fill openings shall be accessible from normal operating area or platform. Drain ports shall allow for collection of waste oil in containers from operating area or platform without removing the unit from its installed position.

- B. Pressure grease fittings shall be Zerk Hydraulic or Alemite type. Location of grease fittings shall be accessible for lubricating with provided grease gun. Provide two hydraulic grease guns, each suitable for use with type of grease fittings provided on the equipment.

2.6 SHOP PAINTING

- A. Surface prepare and shop coat equipment, supports, piping, and appurtenances as specified in Section 02510 and as shown on the Drawings except connecting ends and where it would hinder installation. These points shall be shop primed and field painted after installation. Shop primer shall be compatible with field coat.

2.7 SPECIAL TOOLS AND ACCESSORIES

- A. Provide special tools, instruments and accessories when required to adjust, maintain or repair equipment. Equipment requiring special devices for lifting and handling shall be furnished complete with these devices.

PART 3 EXECUTION

3.1 PREPARATION

- A. Inspect area and surfaces to receive mechanical equipment piping, duct work and appurtenances and verify that areas are ready for installation. Before installation, repair defects and damaged area, and adjust surfaces and areas so they are ready for proper installation.
- B. Field measure area to be occupied by mechanical equipment and appurtenances and verify space is adequate and in accordance with approved Contractor's Drawings. If adjustment is required obtain approval of Engineer and adjust as approved.

3.2 INSTALLATION

- A. Valves shall be installed in accordance with Manufacturer's instructions.
- B. Whether shown or not, fittings shall be provided on each side of valves to allow the equipment to be removed and isolated for servicing.

3.3 LUBRICATION

Equipment shall be lubricated in accordance with manufacturer's instructions for the initial operation. Following testing and prior to final acceptance, relubricate if directed.

3.4 SURFACE TOUCH-UP/FIELD PAINTING

- A. Touch-up surfaces where shop coats have been damaged using paint, coatings and film thickness identical to original shop coats.
- B. Clean field installed bolts, nuts, washers and support systems. Paint or coat identical to original shop coat and/or surrounding area.
- C. Field paint as specified in Section 09900 – PAINTING & COATING and as shown on the Contract Drawings.

3.5 PROTECT AND CLEAN

- A. Protect equipment during and after installation from construction dust and debris. Provide temporary protection as required until valves are in operation or receipt of Certificate of Substantial Completion.

3.6 FIELD QUALITY CONTROL

- A. Demonstrate and test the operation of the valves for specified requirements in the presence of the Engineer in accordance with Section 01650 and as specified in the specific Sections for the valves.
- B. Make adjustments and replace defective valves and parts, as required.

3.7 OPERATION INSTRUCTIONS

- A. After the various systems have passed the field quality control requirements and prior to Certificate of Substantial Completion provide Manufacturer's services for operation and maintenance as specified in the specific Sections for the valves.

END OF SECTION

SECTION 15060
INTERIOR PROCESS PIPING, FITTINGS, AND SPECIALTIES

PART 1 - GENERAL

1.1 DESCRIPTION

The Contractor shall furnish and install all materials, equipment and appurtenances necessary for the complete and satisfactory installation of all interior process piping systems within and under structures except as noted, as shown on the drawings and as required for a complete installation as specified herein.

1.2 SUBMITTALS

- A. Submit detailed certified dimensional shop drawings and manufacturer's product data for materials and equipment as specified under [Section 01330](#). Show complete information concerning materials of construction, fabrication, protective coatings, installation and anchoring requirements, fasteners and other details.
- B. Submit Contractor's intended type and location of pipe supports.

1.3 QUALITY ASSURANCE

- A. Certification of Welders (this section does not apply to the elevated steel tank, which is covered elsewhere)
 - 1. All shop and field welding under this contract for stainless steel piping and other piping systems shall be done by experienced welders who are skilled and have experience in the method and materials used. All welders shall be qualified as specified in the ASME Code for Unfired Pressure Vessels, Paragraph U-70.
 - 2. For field welding, the Contractor shall submit to the Engineer for his review and approval a certified statement, from an approved testing agency for each welder he proposes to use for welded piping. Each certified statement shall indicate that the welder has, within six months from proposed employment on this project, been successfully qualified under the requirements of Section IX of the ASME Boiler Construction Code. All certificates and qualifications shall be at the Contractor's expense. The Engineer will return the certified statements to the Contractor for retention on job in the Contractor's field office. Any work installed by an individual who has not been approved by the Engineer shall be removed by the Contractor and shall be replaced with work installed by qualified and approved welders at the Contractor's expense.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All pipe and fittings in contact with potable water or source water to be treated for potable use shall conform to NSF 61 standard for drinking water.
- B. If Pipe and Fittings Schedule is not included within this Specification Section, then ignore all references to such schedule in this Section.
- C. Pipe and fittings shall be as indicated on the drawings and as listed in the schedule included at the end of this section, which schedule is intended to serve as a general guide and is not necessarily a complete listing of every piping system. Systems which may not be listed shall be comprised of the same kind of pipe and fittings as in similar systems which are listed, or as directed by the Engineer. Underground piping shall be as specified in Section 02570.
- D. Bolts and Hardware: Unless otherwise stated, all nuts, bolts, and other associated hardware shall be Type 316 or Type 304 stainless steel or steel coated in fluoropolymer, FluoroKote#1 by Metal Coatings Corp., or approved equal. All stainless steel bolt threads shall be coated with nickel anti-seize compound prior to assembly.

2.2 GENERAL NOTES – PIPING

- A. It is to be noted that in the relatively small piping systems, the drawings do not necessarily show all fittings, offsets, unions, hangers, supports, etc. All such items shall be furnished and installed, however, as required for complete and satisfactory installation of the equipment shown.
- B. Piping for plumbing and HVAC systems is not included in this Section. Miscellaneous piping systems which may not be described specifically by any section of these specifications shall be of the type of pipe and fittings as directed by the Engineer or as shown on the drawings.

2.3 GENERAL NOTES – FITTINGS

- A. All fittings shall be of the same material as the main pipe, unless otherwise specified on the Drawings or herein. In general, all fittings shall be as specified hereinafter in paragraph entitled “Pipe and Fittings Schedule”.
- B. Nipples shall be extra heavy of same material as piping system in which they are installed.
- C. All flanges shall come fairly face to face with the pipe perfectly aligned. The pipes shall not be sprung to make a joint. Gaskets for flanged joints shall be as specified under “Joints”. All joints shall be neatly made and with care.

- D. Screwed type systems shall contain ample unions in piping at equipment to allow easy removal of the equipment.

2.4 DUCTILE IRON PIPE AND FITTINGS

- A. All ductile iron pipe shall be manufactured in accordance with ANSI A21.51 (AWWA C115) for Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water and Other Liquids.
- B. All ductile iron fittings and specials shall conform to ANSI A21.10 (AWWA C-110) for Gray-Iron and Ductile Iron Fittings, 4" through 48", for Water and Other Liquids.
- C. Thickness/Pressure Class: Pipe and fittings shall be pressure rated to at least 250 psi, unless other pressure ratings or pipe thicknesses are specified in Drawings or Pipe Schedule.
- D. Joints for pipe, fittings and specials shall conform to AWWA C111 Specification for Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings. Pipe and fitting joints shall be flanged unless otherwise specifically indicated. Flanges shall be drilled and faced for ANSI Class 125.
- E. Lining (interior) for pipe and fittings: cement mortar lining, double thickness, conforming to AWWA C-104. Lining shall be shop-applied.
- F. Coating (exterior) of pipe and fittings:
 - 1. The flanged DIP within the Base Cone of the new elevated steel tank shall have same coating as underground DIP.
 - 2. The single DI fitting within the Treatment Building may be coated with fusion-bonded epoxy, of a color approved by Engineer.
- G. Buried/Interior Penetrating Pipe: If a continuous pipe penetrates a floor slab, the pipe thickness shall be the greater of that either specified for underground piping or interior piping. The coating shall transition from the underground piping coating system to the interior piping coating system 3" to 12" above floor surface.
 - 1. Exceptions: The DIP within the Base Cone of the new elevated steel tank shall have same coating as underground DIP.
- H. Each piece of pressure ductile iron pipe shall have the weight and class designation conspicuously painted on it as near as possible to flange end of the pipe and these designations shall be clearly legible.
- I. Wherever ductile iron pipe is specified or shown as having a spigot end, plain end will be acceptable.

- J. Where required or shown, the Contractor shall provide ductile iron specials. Specials shall in general consist of spool pieces, less than standard lengths of flanged, spigot end, or bell end pipe, or combination of ends, and nonstandard fittings. The specials shall conform in material, thickness and finish to the pipe in which they are installed. Taped reinforced bosses shall be provided as an integral part of fittings, when shown or specified.
- K. Flanges may be cast integrally with the ductile iron pipe, or screwed on type flanges may be used. Pipe compound of the manufacturer's recommendation shall be used at each threaded joint or flanges.
- L. Where eccentric reducers are indicated to be used, the reducer shall be installed with its straight side at the top of the piping system.

2.5 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS (SINGLE WALL), SOLVENT WELDED, SCHEDULE THICKNESS

- A. Material shall be ASTM D2241, PVC 1120 (12454-B) or PVC 1220 (12454-C) or PVC 2120 (14333-D).
- B. PVC pipe and fittings shall be manufactured from virgin rigid PVC vinyl compounds and shall be Type 1 Grade 1 conforming to ASTM D 1784 and D 1785. Fittings shall conform to the following standard specifications:
 - 1. Socket Type (Schedule 40); ASTM D 2466
 - 2. Socket Type (Schedule 80); ASTM D 2467
 - 3. Threaded Type (Schedule 80); ASTM D 2464
- C. Fittings shall generally be socket cement weld type, but may be flanged or threaded type only as needed to connect to valves, adapters, equipment, and appurtenances.
- D. Flanged fittings shall be of the same material as the specified pipe and material conforming to ANSI B16.5. Gasket materials shall be suitable for the chemical application (if applicable).
- E. Non-chemical Applications: solvent cement for socket type joints shall conform to ASTM D 2564 for PVC pipe and fittings.

- F. Chemical Service joints require special materials. All socket type, solvent cement joints for all chemical service piping and fittings shall utilize primer and cement which is specially formulated for chemical resistance and which is suitable for bleach (sodium hypochlorite) application, even if the particular application is not bleach. Only cements and primers which have documented performance testing with bleach, caustic soda, and strong acids from an independent third party laboratory testing to at least 100 psi for 2,500 hours shall be considered for approval. Use IPS Weld-On CPVC 724 cement and IPS Weld-On P-70 primer for all chemical applications, pressurized and non-pressurized, or approved equal.

2.6 POLYETHYLENE (PE) PROCESS PIPE

- A. Pipe: ASTM D1248, Type III, Category 5, Class C, PE3408 SDR 11.
- B. Fittings: ASTM D3261, PE3408 SDR 11, Butt Heat Fusion Polyethylene Plastic Fittings.

2.7 JOINTS

- A. Joints
 - 1. All joints at equipment shall conform to the equipment requirements. No direct welded connections shall be made to valves or other equipment. Right and left couplings, long screws, or caulking of pipe threads or gasket joints will not be permitted. Mitered joints for elbows and matching straight runs of pipe for tees or elbows will not be permitted.
 - 2. Soldered or brazed joints shall be made with solder and a noncorrosive paste flux. The solder mixture shall be of 95-5 (tin-antimony) content. The use of acid core solder shall not be permitted. The application of excess heat shall be avoided to prevent undue softening or burning of the fittings or tubing when making connections. All soldering operations shall be performed in strict accordance with best accepted practices. Tubing shall be square cut and reamed to remove all burrs. The inside of the fittings and the outside of the tubing at each end shall be well cleaned immediately prior to soldering to remove all traces of oxidation, regardless of how clean the surfaces of the pipe and fittings may appear.
 - 3. Threads shall be standard, clean-cut and tapered. All pipe shall be teamed free from burrs and kept free from scale and dirt. Unless otherwise specified, threaded joints shall be made up with "Permatex" type 2, black, nonhardening pipe joint compound applied to the male thread only. The use of red lead or white lead will not be permitted. The complete threaded joint shall not have more than two threads exposed when made tight. Threads shall comply with ANSI B2.1.

4. Except where special couplings are indicated, steel piping requiring screwed connections shall be connected with screwed, malleable iron, ground joint, brass seat, 150 psi unions; for steel piping requiring flanged connections, flanged malleable iron unions shall be used. The finish of all unions shall match piping in which they are installed. Unions shall be provided at equipment and where required otherwise to facilitate removal of piping or equipment.
5. All gaskets between metal flanged connections and fittings shall be rubber ring gaskets 1/8 inch thick.
6. Welded joints, if required in the project, shall be made by the electric arc or oxyacetylene gas process. Only thoroughly experienced certified pipe welders shall be employed for the work. The welding wire used shall be coated heavily and shall be of material suitable for making the best possible pipe welds. After being welded, the piping, when tested as specified hereinafter, shall show no indication of leakage, weakness, and other defects. Welding and welders shall be in accordance with the paragraph entitled "Certification of Welders" specified hereinbefore.

B. Sleeve Type Couplings

1. Same as in specification section 02570 – Underground Piping.

C. Dismantling Joints and Flanged Coupling Adapters

1. Couplings shall be designed, manufactured and installed in accordance with AWWA C219.
2. The Contractor shall verify the outside diameters of the pipes to be connected, and shall select the correct diameter sleeve-type coupling to ensure a proper fit without utilizing pipe stops.
3. Couplings shall be rated at 200 psi pressure at minimum and have tie rods to resist internal pressure thrust.
4. Dismantling joints shall be Romac Industries, Inc. Style DJ400 or approved equal.
5. Flanged coupling adapters shall be Romac Industries, Inc. Style FCA501 or approved equal.

2.8 WALL PIPE AND WALL SLEEVE CASTINGS THRU WALLS AND FLOORS

- A. Wall pipe or sleeve castings shall be provided in walls and floors for the passage of all pipes.

- B. Wall and floor sleeves for pipes smaller than 4 inches shall be standard weight galvanized steel, conforming to ASTM A120. Sleeves passing through floors shall extend approximately ½ inch above the finish floor. Chromium plated escutcheon plates, of a suitable pattern, shall be furnished and installed to conceal ends of all exposed pipe sleeves above the floors of finished rooms. Sleeves shall be of ample size to permit passage of pipe and insulation (where required) and allow for expansion. Space between pipe and sleeves shall be sealed or caulked with lamp wicking “oakum” and red lead, link seal, or other method as approved by the Engineer. Low melting point asphaltic materials will not be permitted for caulking.
- C. Assembly of synthetic rubber links connected with stainless steel bolts. When the bolts are tightened, Delrin plastic pressure plates compress the rubber links to fill the annular space between the pipe and the wall sleeve to form a watertight seal. Link seals shall be Thunderline or equal.
- D. Generally, except where otherwise noted on the drawings, for pipes four (4) inches and larger passing through walls, wall pipe castings shall be used. The wall pipe castings shall be cast iron. Except where otherwise shown on the drawings the wall pipe casting shall be flanged at one end and shall have a mechanical joint bell at the other and shall be complete with water stop flange. The wall pipe castings shall typically be the width of wall through which the pipe passes, or the length as shown otherwise.
- E. Generally, except where otherwise noted on the drawings, for pipes four (4) inches and larger passing through floors, all sleeves shall be standard weight galvanized steel. Except that no escutcheon plates will be required, these sleeves and their arrangement shall be as specified above for sleeves for pipes smaller than four (4) inches. The space between the pipe and the sleeves shall be sealed or caulked as specified above.
- F. Generally, the diameter of sleeves for non-insulated pipe shall be one pipe size larger than the pipe passing through the sleeve. The diameter of sleeves for insulated pipe shall be of suitable size to allow the insulation to be continuous and of full thickness. Sleeves for flanged pipe shall be of ample diameter to pass the flanges, if cast-on flanges are used; if screwed-on flanges are used, sleeves may be only one size larger than the pipe. Space between pipe and sleeve shall be caulked as specified above.
- G. The Contractor shall not be allowed to box-out the concrete for installation of any wall castings or sleeves, except with the Engineer’s permission for each specific location involved. Castings shall be securely fastened in place so that pouring of concrete will not disturb their position in any manner. The Contractor shall correlate with the other trades (particularly concrete work) to assure that all wall castings and wall and floor sleeves are properly set. When boxed-out sections are allowed, the boxed-out section shall be waterstop lined and treated in general as specified for “Construction Joints” in Section 03300.

- H. The Contractor shall provide Clow Model F-1984 flange fillers, or equal, where needed for closing up between two flanges which do not meet.

PART 3 – EXECUTION

3.1 GENERAL

- A. The Contractor shall verify all dimensions of valves, special castings and fittings, pipe equipment, etc., so that all of the pipe work performed will fit together properly and will conform to the arrangement as shown on the drawings. In selecting laying lengths of fittings, the Contractor shall be guided by the dimensions of equipment to which connections are made and by the indicated dimensions on the drawings. All pipe and specials shall be accurate to the dimensions shown. Hubs, spigots, and flanges shall be at right angles to the axis of the opening, and openings shall be at the exact angle specified.
- B. All piping shall be pressure and leak tested as specified in accordance with the requirements herein. All potable water piping shall be disinfected.
- C. All manufacturer's instructions shall be followed for all products.

3.2 EXPANSION

- A. The installation of all pipes shall be such as to allow for expansion using expansion joints, as shown on the drawings or as may be necessary to prevent undue strain on piping.

3.3 CONNECTION AT DISSIMILAR METALS

- A. Wherever pipes of dissimilar metal join, there shall be provided an insulating union, coupling or flange connector for corrosion control. Connectors shall include an approved type dielectric separator. Connectors shall be the product of Dresser Corporation, or equal. Stainless steel nuts, bolts, and washers shall be used at all places at which such dielectric separators are used.

3.4 INTERIOR PROCESS PIPING INSTALLATION

- A. Pipe Layout in Building
 - 1. Coordinate work to prevent interference between architectural, structural, electrical and mechanical features; the Contract Drawings are generally diagrammatic due to their small scale.
 - 2. Provide such offsets, fittings and other items as may be required to suit conditions.
 - 3. Do not place joints or fittings over switchboards, panels, motors or other electrical equipment.

4. The completed installation shall present a neat, orderly appearance; do not block openings or passageways; run piping parallel to the walls of buildings or structures.
5. Provide clearance between piping, walls, floors, machinery and equipment to prevent the transmission of noise and vibration.
6. Orient hand wheels, levers, valve operators and other valve actuators for convenience of operation; set gate valves with the stem above the horizontal.
7. Cut pipe to measurements established at the site and install without springing or forcing; make changes in direction with fittings.

B. Equipment Connections

1. Make connections to pumps and other equipment in a manner to eliminate strains on piping and equipment.
2. Install unions or flanges adjacent to equipment and wherever their use will facilitate removal of equipment.

C. Flanged Joints

1. Tighten flange bolts so that the gasket is uniformly compressed and sealed; do not distort flanges; do not exceed manufacturer's recommended maximum torque.
2. Leave flange bolts with ends projected 1/8" to 1/4" beyond the face of the nut after tightening.

D. Flange Adapters and Flange Coupling Adapters

1. Flange Adapters: Tighten flange adapter setscrew with torque wrench to manufacturer's recommended tightening torque.
2. Flange Coupling Adapters: Drill hole in plain-end of process pipe at each anchor stud location. Tighten anchor stud fully so that anchor stud protrudes into drilled hole, thereby preventing lateral movement of the pipe.

E. Threaded Joints: ANSI B2.1, NPT

Cut threads full and clean with sharp dies; ream ends of pipe after threading and before assembly to remove burrs; leave not more than three pipe threads exposed at each connection; use joint compound or thread tape on the male thread only.

F. Solder Joints

1. Ream or file pipe to remove burrs; clean and polish contact surfaces of joints.
2. Apply flux to both male and female end; insert end of tube into fittings full depth of socket.
3. Bring joint to soldering temperature, in as short a time as possible, forming continuous solder bead around entire circumference of joint.

G. Solvent Cemented Joints (PVC): Make joints in pipe and fittings in accordance with the procedures and techniques in ASTM D2855.

H. Fusion Welded Joints (PE): Make joints in pipe and fittings in accordance with the procedures and techniques in ASTM D2657 or ASTM D3261 as applicable.

3.5 PIPE SUPPORTS

A. Support piping from structural construction using floor supports, pipe hangers, pipe riser clamps and pipe clamp hangers in conjunction with beam clamps, brackets or other equipment as dictated by structure construction.

B. Trapeze hangers approved by the Engineer may be used where several horizontal pipes run closely parallel; secure pipes on trapeze hangers to prevent sideway motion.

C. Vertical Piping

1. Secure at sufficiently close intervals to keep pipe in alignment and to support weight of pipe and its contents.
2. Support vertical iron and steel pipe on maximum 5'-0" centers with steel pipe riser clamps.
3. Support vertical copper tubing at no more than 10'-0" spacing, using plastic coated steel pipe riser clamps or pipe clamp hangers at end of runs and at intermediate points as installation dictates.
4. Support vertical plastic pipe at 4'-0" centers, using plastic coated pipe riser clamps or pipe clamp hangers at end of runs and at intermediate points as installation dictates.

D. Horizontal Piping

1. Support at sufficiently close intervals to prevent sagging, thrust restraint, and vibration.

2. Install hangers or supports at ends of runs or branches and at each change of direction or alignment.
 3. Install steel clevis-type pipe hangers for horizontal iron and steel pipe on maximum 10'-0" centers.
 4. Install steel clevis-type pipe hangers for copper tubing on 6'-0" centers for 1-1/4" size and smaller, and on 10'-0" centers for copper tubing larger than 1-1/4" size.
 5. Install plastic coated ring-type pipe hangers for horizontal plastic pipe on maximum 4'-0" centers, close to every joint, at ends of each branch, and at each change in direction or elevation; hangers shall not compress, distort, cut or abrade plastic piping and shall permit free movement of the pipe.
- E. Pipe Bracing: The Contractor is responsible for properly bracing piping against lateral movement or sway. The Engineer shall review with the Contractor and approve method of bracing of piping at each location prior to Contractor proceeding with the installation of the bracing. Bracing shall be installed at all locations where sway is anticipated and as directed by the Engineer.

3.6 CUTTING AND PATCHING

- A. Do not cut and patch existing structures without prior permission from the Engineer.
- B. Perform cutting and patching where indicated in the contract drawings. Patch to match adjacent finishes.

3.7 IDENTIFICATION OF PIPING SYSTEMS

- A. All piping systems listed shall be stenciled with the name of the service to indicate the use of that particular pipe, and an arrow showing the normal direction of flow. Stencils shall be plain block letters of the size indicated hereinafter. Stenciled names shall be located near each branch connection, near each valve and at least every 50 feet on straight runs of pipe. All stenciled names shall be so located as to be legible from the floor. Generally, letters on light colored pipes shall be either black or red; on dark colored pipes letters shall be white. Stenciled names shall be applied after the piping has been tested, covered (if required) and painted. Color coding and names are as specified herein. Any system inadvertently not listed shall be stenciled as directed by the Engineer. Paint all valves and operators the same color as the piping.
- B. All materials shall be applied in accordance with the manufacturer's recommendation.

- C. No bright metal parts such as stainless steel, chromeplate, etc., shall be painted. Nor is it intended to paint stainless steel, copper, brass, or aluminum pipes. Pipes of these metals, however, shall be color coded, banded with colors indicated below with 6 inch wide bands not less than 8 feet on centers.

3.8 TESTING OF PIPES

- A. Test and disinfect all interior piping carrying source water or potable water according to the same procedures used for testing underground piping for potable water in Section 02570. Ensure that disinfection reaches all valves and internal surfaces of valves.

END OF SECTION

SECTION 15080
VALVES AND PIPING SPECIALTIES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The work of this section includes, but is not limited to:
 - 1. Provide and install all valves and other piping specialties as specified, as indicated on the contract drawings, and as necessary to provide complete piping systems as intended that are not expressly specified in other sections of these specifications.
- B. This Section applies to potable water service, nonpotable water service, buried installment, exposed (non-buried) installment, interior, and exterior installments.

1.2 QUALITY ASSURANCE

- A. Products shall be new, the latest standard product of reputable manufacturers, and shall have replacement parts available.
- B. Materials contacting potable water or source water to be treated to produce potable water shall conform to NSF 61 standard.
- C. Materials contaminated with gasoline, lubricating oil, liquid or gaseous fuels will be rejected.
- D. The manufacturer of each valve shall have a minimum of 5 years of experience in manufacturing the type of valve supplied.

1.3 SUBMITTALS

- A. Submit in accordance with [Section 01330](#).
- B. Butterfly Shop Pressure Test Results: See Part 3 for special instructions on butterfly pressure testing. Certified copies of the test results shall be submitted to the Engineer for approval prior to shipment of the valve.
- C. Shop Drawings and Product Data
 - 1. Submit manufacturer's catalog data, literature, illustrations and specifications.

2. Submit shop drawings of valves and valve operators including dimensions, net assembled weight of each size valve furnished, construction details, and materials of components.
3. Submit manufacturer's installation instructions.
4. Submit manufacturer's maintenance instructions and complete parts lists.

1.4 JOB CONDITIONS

- A. Investigate conditions affecting this work and coordinate with other contractors to prevent interference between architectural, structural, mechanical and electrical features.
- B. The contract drawings for small diameter pipe are generally diagrammatic and it is not possible to indicate all fittings, valves, and other items required for a complete operating system. Provide all such valves, fittings and specialties to complete the systems as intended.
- C. Provide necessary valve wheels, keys, wrenches, levers and stem extensions. Locate to assure accessibility and operability throughout the operating range without interference. Install valve stem supports, guides and operators. For buried valves, provide valve boxes and stem extensions to grade. Provide valve accessories of the same manufacturer as the valve, unless specified elsewhere.
- D. Provide chain operators for valves 4" size and larger that are located 6'-0" or more above finished floor level.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide valves and piping specialties of the size and type indicated on the contract drawings.
- B. Cast iron valve material shall meet or exceed the requirements of ASTM A126, Class B.
- C. Valve flanges shall conform to ANSI B16.10, (125# and 250# class) as applicable.
- D. Mechanical joint valve ends shall conform to ANSI/AWWA C111/A21.11.
- E. Screwed valve ends shall conform to ANSI B2.1; American Standard Taper pipe threads.

- F. Valves shall be of a design that requires no more than 50 lbs. pull on the hand wheel or standard valve wrench to provide positive shutoff against rated working pressure.
- G. Unless otherwise stated, all buried nuts, bolts, and other associated hardware shall be Type 316 stainless steel or steel coated in fluoropolymer, FluoroKote#1 by Metal Coatings Corp., or approved equal.

2.2 GATE VALVES

- A. Threaded or Soldered Gate Valves
 - 1. Threaded or soldered joint.
 - 2. Bronze body conforming to ASTM B584. Bronze bonnet. Stem: ASTM B21 UNS C46400. Disc Wedge: bronze. Full port design. Rising stem. Cold working pressure rating: 200 psi.
 - 3. Shall conform to MSS SP-80 – Design & Testing – Type 2
 - 4. Shall be Apollo 101T-LF or approved equal.

2.3 BALL CHECK VALVES

- A. Ball check valves (PVC/CPVC) shall be constructed of Class 12454-B PVC or Class 23447-B CPVC as appropriate for the intended chemical service and manufactured by Chemtrol Products Division of NIBCO, Inc., Spears Manufacturing, Hayward or equal. Valve seals and seats shall be constructed of materials suitable for the chemical service. Valves intended for chemical service shall be constructed of materials suitable for the intended service. Valves shall have 150 psi minimum non-shock cold water pressure rating and integral union with screwed ends or as specified otherwise.

2.4 BALL VALVES

- A. Ball valves (PVC/CPVC) shall be of self-lubricating normal impact Class 12454-B PVC or Class 23447-B CPVC construction with renewable Teflon seat, EPDM or Viton "O" rings and removable handles as appropriate for the intended chemical service,. Valves intended for chemical service shall be constructed of materials suitable for the intended service. Valves shall be the true-union type as manufactured by Chemtrol Products Division of NIBCO, Inc., Spears, Hayward or equal, and shall have 150 psi minimum non-stock cold water pressure rating with end connections of the type required to connect to the surrounding piping.

2.5 AIR RELEASE VALVE

- A. Float operated to automatically release air from water piping system.
- B. ARV shall adhere to all requirements in AWWA C512.
- C. Body and Cover: Cast iron or ductile iron.
- D. Internal Parts and Float: Stainless steel.
- E. Valve shall be designed for at least 150 psig operating pressure.
- F. Acceptable Manufacturers: APCO – Valve and Primer Corp., Val-Matic Valve Co., or equal. Shall be model series 15A by Val-Matic or approved Equal.

2.6 CORPORATION STOPS

Brass or red-brass alloy body, ASTM B62. AWWA C800 threaded inlet end for tapping. Outlet end suitable for service pipe intended

2.7 SURGE RELIEF VALVE

- A. External pilot operated. Fusion epoxy coated ductile iron body, stainless steel seat ring. Cast iron globe body, bronze trim, leather packed.
 - 1. Pilot adjustment range: 80-180 psi.
 - 2. Flow range: 20-600 gpm.
- B. Provide a NEMA 4X limit switch on the surge relief valve to indicate when the valve is open.
- C. Acceptable Manufacturers
 - 1. ClaVal Model E-50-01
 - 2. Singer Valve Model 206-RPS (ADDENDUM # 7)
 - 3. Or Equal

2.8 PRESSURE GAUGES (LIQUID SERVICE)

- A. Bronze bourdon tube type, brass socket. Stainless steel case. Acrylic window. Liquid filled.
- B. 4-1/2" dial size. Stainless steel dial, black lines and numbers.

- C. Pressure range as indicated. Graduations and figure intervals proportioned to range.
- D. Polypropylene bushed, stainless steel rotary movement, micro-adjustable pointer. Minimum pressure stop, over-pressure protection. Adjustable zero set point adjustment screw which does not require removal of gauge case.
- E. Accuracy to 1% of full-scale range.
- F. 1/8" NPT bottom connection. Shutoff cock.
- G. When indicated on the contract drawings, provide cadmium-plated diaphragm gauge seal; 316 ELC diaphragm, flushing connection, stopcock.

2.9 ELECTROMAGNETIC FLOW METERS

A. Magnetic Flow Meters:

1. Magnetic flow meters shall be of the low frequency and short form characterized coil design. The characterized field principle of electro-magnetic induction shall produce a positive DC pulsed signal directly and linearly proportional to the flow rate.
2. The metering tube shall be constructed of Type 304 stainless steel. The meter body shall be carbon steel. The flow meter shall have a flanged body to fit between ANSI Class 150 pipe flanges. The flow meter shall have a polyurethane liner and Type 316 stainless steel electrodes. The electrodes shall be flush mounted type. Liners and electrodes shall be suitable for raw water. Provide all required mounting hardware, stainless steel grounding rings and grounding straps for the installation of each magnetic flow meter.
3. The coils, which generate the field, shall be inside the pipe wall and shall be encapsulated in epoxy resin and encased behind the meter lining material. The ratio of flow velocity to reference voltage signals generated shall be compatible with the readout instrument without the necessity of circuit modifications. The meter shall have an average power consumption of 60 watts. Accuracy of the meter shall be $\pm 0.5\%$ of rate.
4. The meter housing shall be splash-proof and weather resistant design. The meter shall be capable of accidental submergence in up to 30 feet of water for up to 48 hours without damage to the electronics.

5. Complete zero stability shall be inherent characteristic of the meter system. This shall eliminate the requirement for valving downstream of the meter for creating a full pipe zero flow condition for calibration purposes. Meter systems requiring field zero adjustment will not be acceptable.
6. The magnetic flow meters shall be factory calibrated on an approved test stand with certified accuracy traceable to NIST, compliant with the ISO 17025 standard, and third-party accreditation by a national verification agency such as A2LA. Calibration curves shall be submitted for each flow meter for 3 points within the specified flow range.
7. The flow meter shall have a remote mounted microprocessor based, NEMA 4X flow transmitter. The flow transmitter shall be powder coated cast aluminum. The flow transmitter shall have an LCD display to indicate the flow rate. The flow transmitter shall convert the meter's DC pulsed signal to a linear 4-20mA dc signal which is proportional to the flow rate.
8. The flow meter shall be capable of being programmed remotely using HART protocol.
9. The flow meter transmitter shall operate on a 120V AC, 60 Hz power source and shall have RFI protection. Provide a signal cable to connect the signal converter to the flow meter. Length of cable shall be as required for the installation (See Electrical Drawings).
10. The Magnetic Flow Meters shall be Endress & Hauser Proline Promag W400, or Rosemount Model 8750WA.

SCHEDULE OF MAGNETIC FLOW METERS

Size	Flow Range	Location	Service
3"	0 – 200 GPM	Well Building	Water Flow
6"	0 – 1,200 GPM	Well Building	Water Flow

PART 3 - EXECUTION

3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver valves and accessories to the job site in the manufacturer's boxes or crates. Mark each valve as to size, type and installation location.
- B. Seal valve ends to prevent entry of foreign matter into valve body.

- C. Store valves and accessories in areas protected from weather, moisture and possible damage.
- D. Do not store materials directly on the ground.
- E. Handle valves and accessories to prevent damage to interior and exterior surfaces.

3.2 INSTALLATION

- A. Install valves and specialties in accordance with the manufacturer's instructions.
- B. Inspect joint surfaces for structural soundness and thoroughly clean before installation.
- C. Pressure test all valves, while installed, along with the general piping system pressure tests.
- D. Test pressure relief valves to ensure that the opening pressure is set properly.

END OF SECTION

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SECTION 15590
POWER VENTILATORS

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. Provide exhaust fans which have been tested and rated in accordance with AMCA standard, and bear AMCA Certified Ratings Seal.
- B. Provide exhaust fans which are listed by UL and have UL label affixed, and which are designed, manufactured, and tested in accordance with UL 705 "Power Ventilators".
- C. Provide motors and electrical accessories complying with NEMA standards.
- D. Exhaust fans shall be standard prefabricated units of the type, size and arrangement indicated on the Drawings. All fans shall be rated and constructed in accordance with the Air Moving and Conditioning Association. Special construction materials, coatings and multi-speed fan motors shall be provided as indicated on the Drawings.
- E. The propellers shall be rigidly constructed, accurately balanced dynamically and statically and free from objectionable vibration or noise.
- F. Fans shall have no overloading characteristics for the horsepower indicated.

1.2 SUBMITTALS

- A. The Contractor shall submit shop drawings on all equipment, accessories and appurtenances and all fabrication work required for all equipment specified in this section in accordance with Section 01330, Submittals. Additional required information shall include: the horsepower, voltage, and rotative speed of motors and the total weight of the equipment plus the approximate weight of the shipped materials. Shop drawings shall also include complete erection, installation, and adjustment instructions and recommendations.
- B. Operation and Maintenance Manuals
 - 1. The Contractor shall submit complete operation and maintenance manuals in accordance with the procedures and requirements set forth in Section 01330, Submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The materials covered by these specifications are intended to be standard equipment of proven reliability and as manufactured by reputable manufacturers having experience in the production of such equipment. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Contract Drawings and operated per manufacturer's recommendations.

2.2 GENERAL INFORMATION AND DESCRIPTION

- A. All parts of the equipment furnished shall be amply designed and constructed for the maximum stresses occurring during fabrication, erection and continuous operation. All materials shall be new and both workmanship and materials shall be of the very best quality, entirely suitable for the service to which the unit is to be subjected and shall conform to all applicable sections of these specifications. All parts of duplicate equipment shall be interchangeable without modification. Manufacturer's design shall accommodate all the requirements of these specifications.
- B. All anchor bolts, washers, clips, clamps and fasteners of any type shall be constructed of 316 stainless steel. All anchor bolts shall be a minimum of 1/2-inch diameter.
- C. Performance:

Manufacturer	Greenheck or equal
Model Number	CUE-140-VG
Flow	1,100 CFM
Fan RPM	716
Horsepower	1/4 HP
Motor RPM	716
Volts/P/Hz	208/1/60

2.3 ADDITIONAL REQUIREMENTS

The following additional requirements shall apply to all fans.

- A. Backdraft or motor-operated dampers shall be provided and installed in the openings as indicated on the Contract Drawings.
- B. All fans shall be provided with either integral or supplementary vibration or sound-absorbing mountings.

- C. Provide removable bird screen, 3/4 inch mesh, 12 gauge aluminum wire.
- D. Provide factory wired non-fusible type disconnect switch at motor in fan housing. Provide conduit chase within unit for electrical connection. The disconnect switch for outdoor fans shall be NEMA 4X stainless steel.

2.4 DAMPERS

- A. All exhaust fans shall include a damper. Dampers shall be coordinated to operate and interface with the fan being furnished. All dampers shall be low leakage type. Dampers shall be gravity or motor operated where indicated. Motor operators shall be rated for use on 120 VAC and shall be as manufactured by Honeywell, Barber-Coleman, or equal.
- B. Dampers shall have aluminum frames and blades with sealing edges and couplings at both ends with tie-rods. Dampers shall be predrilled to match the fan or louver. Damper finish colors shall be selected by the Engineer from the manufacturer's standard color chart.
- C. Dampers shall be sized to fit the specified openings.

PART 3 - EXECUTION

3.1 INSTALLATION OF POWER AND GRAVITY VENTILATORS

- A. Contractor shall install ventilators in accordance with manufacturer's installation instructions and recognized industry practices to insure that ventilators serve their intended function.
- B. Contractor shall coordinate ventilator work with work of walls, and ceilings, as necessary for proper interfacing.
- C. Connect ducts to ventilators in accordance with manufacturer's installation instructions.

3.2 FIELD QUALITY CONTROL

- A. Testing: After installation of ventilators has been completed, test each ventilator to demonstrate proper operation of units at performance requirements specified. When possible, field correct malfunctioning units, then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected.
- B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION

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SECTION 15605
LOUVERS AND DAMPERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Furnish all labor, materials, equipment, and appliances required for the complete execution of additions, modifications, alterations, to existing buildings and new construction work as shown on the Drawings and specified under the several sections of the Specifications.
- B. Principal items of work include:
 - 1. Combination louver damper.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01330 – Submittals

1.3 REFERENCE CODES, SPECIFICATIONS AND STANDARDS

- A. Without limiting the generality of these Specifications, work shall conform to the applicable requirements of the following documents. All referenced Specifications, codes, and standards refer to the most current issue available at the time of the Bid.
 - 1. All work shall comply with the Standard Building Code and the requirements of all other authorities having jurisdiction.
 - 2. All units shall conform to AA-Aluminum Standards and Data, latest edition.
 - 3. Louvers shall bear the AMCA Seal with ratings in accordance with AMCA Standard 500 which applies to air performance ratings and water penetration ratings.
 - 4. All louvers, fasteners and supports shall be designed to meet a wind loading in accordance with the local building codes, but shall not be less than 25 pounds per square foot.

1.4 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in the General Conditions, City Standard Specification 4-1, and Division I, the Contractor shall submit the following:

1. Samples
 2. Shop Drawings
- B. Each submittal shall be identified by the Specification Section Number.
- C. Each submittal shall be complete in all respects, incorporating all information and data listed herein and all additional information required for evaluation of the proposed materials compliance with the Contract Documents.
- D. Partial, incomplete or illegible submissions will be returned to the Contractor without review for resubmission.
- E. Samples shall include:
1. Color and finish samples for each finish type required.
- F. Shop Drawings shall include but not be limited to:
1. Complete detail drawings showing materials, methods of fabrication and clearly indicating all dimensions.
 2. Detailed installation drawings showing all methods of attachment.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Brace and support units to prevent deformation during delivery.
- B. Factory wrap units with approved materials to protect finish during delivery and storage.
- C. Handle units with care to prevent bending or scratching.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Specifications, provide products manufactured by the following:
1. Construction Specialties, Inc.
 2. Ruskin, Philips Industries, Inc.
 3. Airolite Company, Marietta, Ohio

- B. Louvers to be used in Door shall comply with the requirements of the Door manufacturer.

2.2 FABRICATION

- A. Galvanized-steel sheet, of thickness required to comply with structural performance requirements, 18 gauge for frames and 20 gauge for blades. All corners of frames shall be mitered and welded. All material shall be rated for exterior use.
- B. Hardware and fasteners shall be of Type 316 stainless steel and color matched. Screws shall fasten of a vandal proof design.
- C. The louvers shall be stationary style, with a “Y” style.
- F. Louver and damper assemblies which are to be placed in openings exceeding 5 feet in width shall have slidable interlocked heavy gauge extruded aluminum mullions at mid span of integral tongue and groove construction.
- G. Electrically operated damper shall be standard with the approved manufacturer. Electrical characteristics to be coordinated with the Electrical Sections of Division 16 and the Engineer.
- H. Coordinate louver sizes and free area requirements with the HVAC work.
- I. Provide blanked off sections as required.
- J. Bird screens shall be 1/2-inch square steel mesh galvanized or P.V.C. coated, placed in removable .081-inch thick folded aluminum frames standard with the manufacturer.

2.3 FINISH

- A. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat and an overall minimum dry film thickness of 2 mils (0.05 mm). Color and Gloss shall be selected by Engineer from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Anchor louver frames using stainless steel bolts into holes drilled and tapped in channel or angle subframes and suspended lintels, or with strap anchors to masonry in accordance with the manufacturer's approved directions.

- B. Isolate aluminum from contact with masonry or dissimilar metals with heavy coat of bituminous paint or neoprene gaskets.
- C. Mount bird screens on inside face with clips, machine screwed into frames.
- D. All frames shall be installed with aluminum (or compatible) screws, bolts, anchors, etc., in such a manner that the frames are removable.

3.2 CUTTING AND FITTING

- A. Do all cutting and fitting required for the installation in a neat manner.

3.3 CLEANING

- A. Upon completion remove any and all protective coatings, clean off all parts of the work and leave entire installation in orderly condition.

END OF SECTION

SECTION 16010
GENERAL REQUIREMENTS – ELECTRICAL

PART 1 GENERAL

1.1 DESCRIPTION

A. Work Included

1. All items of labor, materials, and equipment, not specified in detail or shown on drawings but necessary for complete installation and proper operation of work described or implied, shall be furnished and installed.
2. Test all electrical conductors, after completion of installation of wiring and apparatus, to ensure continuity, proper splicing, freedom from grounds, except "made grounds" and those required for protection and insulation resistance. Use testing instruments, i.e. megger. Activation of each circuit will be required as final test. Testing shall be done at no additional expense to the Owner.
3. Drawings are indicative of work to be installed but do not indicate all bends, fittings, boxes, etc. that will be required in this Contract. The structural and finished conditions of the project shall be investigated prior to construction.
4. Coordinate work with other trades to avoid interference between piping, ducts, equipment, architectural or structural features. In case of interference, the Engineer decides which work is to be relocated, regardless of which is first installed.
5. Visit the site to determine actual conditions. No extra compensation will be allowed by failure to determine existing conditions.

1.2 QUALITY ASSURANCE

A. Regulations, Standards and Publications

1. ANSI American National Standards Institute, Inc.
2. ASTM American Society for Testing and Materials
3. BOCA Building Officials and Code Administrators
4. IEEE Institute of Electrical and Electronic Engineers
5. IPCEA Insulated Power Cable Engineers Association
6. ISA International Society of Automation
7. NEC National Electrical Code of National Fire Protection Association
8. NEMA National Electrical Manufacturers Association
9. NESC National Electrical Safety Code
10. NFPA 70E Standard for Electrical Safety in the Workplace
11. UL Underwriters' Laboratories

B. Electrical Requirements

1. The installation shall comply with all Federal and State, municipal or other authority's laws, rules and/or regulations.
2. Inspections by the required authorities shall be made. Original final wiring certificates with two copies shall be submitted to the Owner.

3. The electrical inspections shall be made by the County.
4. All electrical equipment and its components and materials shall meet all applicable UL criteria and bear the appropriate label of the Underwriters' Laboratory.
5. All electrical equipment or apparatus of any one system shall be of the same quality as produced by one or more manufacturers, suitable for use in a unified system. The term "manufacturer" shall be understood as applying to a reputable firm who assumes full responsibility for its products.

1.3 SUBMITTALS

A. Shop Drawings

1. All shop drawings shall be submitted to the Engineer for review. All shop drawing submittals shall clearly indicate, using arrows and/or highlighting on all copies, which item(s) are being submitted and that each item being submitted is in compliance with all requirements on the drawings and in these specifications. All pertinent specification and drawing requirements shall be indicated on the shop drawings. If incorrect, they shall be resubmitted in quantity according to Contract conditions until satisfactory. Work shown on shop drawings shall not be executed until such drawings are approved. Electrical items shall not be installed until final approval of the shop drawings has been given by the Engineer.
2. See specific sections for a breakdown of shop drawing items.
3. Submit certification that all equipment is UL listed.
4. Shop drawings shall indicate adequate clearance for operation, maintenance and replacement of operating equipment devices.
5. The Engineer reserves the right to request additional shop drawings.

B. Installation, Operation and Maintenance Manuals

1. Submit required number of installation, operation and maintenance manuals for all equipment being provided for the electrical system. These manuals shall be submitted in 3-ring loose-leaf binders and shall be complete, neat, orderly and indexed.
2. The installation, operation and maintenance manuals shall include a copy of the approved shop drawings for all electrical items installed on the project.

1.4 PRODUCT DELIVERY, HANDLING AND STORAGE

A. Product Handling

1. Deliver all materials in good condition. Store in dry place, off ground, and keep dry at all times.

B. Protection of Installation

1. All unfinished installations, construction materials and equipment shall be protected during construction.

PART 2 PRODUCTS

2.1 SEE SPECIFIC SECTIONS FOR PRODUCTS

PART 3 EXECUTION

3.1 INSTALLATION

A. Protection of Installation

1. All equipment shall be protected during construction. All damaged equipment caused by noncompliance with this requirement shall be repaired at no expense to the Owner.

B. Openings and Chases

1. Determine locations of chases and openings prior to construction so that same may be provided where required. If openings or chases are made after building construction is accomplished, such cutting and repairing of the building shall be made by this Contractor in complete coordination with other trades on the job site to match original conditions in quality, color and type of materials used, and at no additional expense to the Owner.

C. Position of Outlets

1. The Engineer shall determine the position of all relocated outlets and equipment if the required location differs from that indicated on the drawings.

D. Moving Outlets

1. The Owner reserves the right to move any outlet a distance of ten feet before roughing in, at no additional expense.

E. Methods and Materials

1. All work shall be installed in a first-class, neat and workmanlike manner by skilled mechanics. All materials shall be new. Firmly support all materials and equipment.

F. Cutting, Repairing and Finishing

1. All cutting, repairing, finishing and painting required for the installation of work under this Contract shall be performed under this Contract.
2. All disturbed surfaces shall be repaired and finished to match adjacent surfaces by skilled mechanics working in their respective fields.

G. Excavation and Backfilling

1. Excavation and backfilling shall be in accordance with the requirement of Division 2 and as required to complete the work according to details on drawings.

- H. Concrete
 - 1. Concrete work shall be in accordance with the requirements of Division 3 and as required to complete the work according to details on drawings.
- I. Cutting and Patching of Concrete Areas
 - 1. Openings in concrete required for Electrical construction shall be made by taking extreme precautions to prevent excessive damage to existing facilities. Prior to completion, all disturbed areas shall be closed, restored to normal and finished to match surrounding areas.
- J. Access
 - 1. Install all conduit, wire, cable, wiring devices and equipment to preserve access to all equipment installed under this Contract.
- K. Layout of Wiring
 - 1. The layout of wiring as shown on the drawings shall not be considered as absolute. It shall be subject to changes where necessary to overcome obstacles in construction. Where a major deviation from the plans is indicated by practical consideration, shop drawings shall be submitted showing all deviations in detail to clearly indicate the necessity or desirability for the change.
- L. Miscellaneous Supports
 - 1. Furnish and install all necessary angles, beams, channels, hanger rods or other supports for equipment and piping furnished under this Contract requiring support or suspension from building structure.
- M. Continuity of Service
 - 1. Uninterrupted electrical service shall be maintained during the entire time required for complete installation of the work proposed in the Drawings and in the specifications.
 - 2. Temporary equipment, cable, and whatever else is necessary shall be provided as required to maintain electrical service to all facilities. Temporary service facilities, if required at any time, shall not be disconnected or removed until new services are placed in proper operation.
 - 3. If any service or system must be interrupted, the Contractor shall request permission in writing stating the date and time the service will be interrupted, and the areas affected. This request shall be made in sufficient time for proper arrangements to be made. Written permission shall be obtained from the Owner before interrupting electrical service to any facility.

N. Clean Up

1. Upon completion of all work under the electrical specifications, furnish labor, materials, and incidentals to accomplish the following: remove all dirt, foreign materials, stains, fingerprints, etc. from all lighting fixtures, glassware, panelboards, wall plates, system equipment, floors, walls and ceilings adjacent to the above equipment and leave the electrical work in such a condition that no cleaning will be required by the Owner. The complete system shall be subject to inspection and approval by the Owner.

END OF SECTION

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SECTION 16050
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 DESCRIPTION

- A. This Section includes requirements for basic electrical materials and methods. It includes requirements for the following listed materials:
 - 1. Raceway and Fittings
 - 2. Wire and Cable – 600Volt and below
 - 3. Wire connections and Connecting Devices
 - 4. Boxes
 - 5. Wiring Devices
 - 6. Panelboards
 - 7. Grounding Materials
 - 8. Disconnect Switches
- B. This Section applies to all sections of Division 16 and to other sections that include electrical equipment requirements except when in these individual sections' requirements are otherwise specified.
- C. Electrical systems shall be complete including all miscellaneous materials and be ready for operation as indicated in accordance with the Contract Documents.
- D. Classifications of areas shall be as shown on the Drawings.

1.2 QUALITY ASSURANCE

- A. Electrical work shall be performed, and all materials shall be in accordance with the National Electrical Code. Above code shall be minimum requirements for electrical work and if there is a conflict between the requirements specified in the Contract Documents and the code, the more stringent shall apply as determined and approved by the Engineer.
- B. Unless approved otherwise, provide electrical materials and equipment that are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturer's latest standard design that conforms to these Specifications. When two or more units of the same class of material and equipment are required, these units shall be the products of the same manufacturer.

1.3 SUBMITTALS

- A. Submit the following Contractor's Drawings in accordance with Section 01300:
 - 1. Complete list of electrical materials to be furnished showing manufacturer.
 - 2. Complete schedule and listing of system and equipment identification labels with legends.

3. Conduit Layout

1.4 JOB CONDITIONS

- A. The Drawings indicate the extent and general arrangement of the principal electrical elements, outlets, and circuit layouts. It is the intent that all electrical elements and devices provided under this, and other sections be properly connected and interconnected to form a workable system as required by the Contract Documents whether the connections and interconnections are specifically stated in the Specification or shown on the Drawings. Additional circuits shall be installed wherever required to conform to the specific requirements of the furnished equipment and for proper installation of the work without additional cost to the Commission.

1.5 IDENTIFICATION FOR SYSTEM AND EQUIPMENT 600 VOLTS AND BELOW

- A. General
 - 1. Identify and label each raceway, piece of equipment and conductor.
 - 2. Develop a schedule for labels showing the legend of each as shown on the Drawings, schedules and by the nature of the system. In the absence of specific data, the Contractor shall develop legends from the nature of the service or system and submit for approval by the Engineer. The schedule shall be arranged to produce a legible comprehensive identification system.
- B. Raceway Identification
 - 1. Exposed raceways shall be identified at each end within 12 inches of point of termination.
 - 2. Identifying labels shall be factory manufactured with colored paper machine printed with an identifying legend laminated between two sheets of vinylite plastic formed to completely encircle the raceway. Sizes shall match the raceway on which they are to be applied. Labels shall be installed in accordance with manufacturer's instructions.
 - 3. Legends to be used in the labels shall indicate the system voltage and what it serves or type of service. The legend shall appear in a minimum of one-inch-high white letters on a black background for raceways 2½ inch and smaller diameter and two-inch-high letters for raceways larger than 2½ inch diameter.
- C. Equipment Identification
 - 1. Nameplates shall be attached to inside surfaces with adhesive and to the outside surface with round head, self-tapping metal screws.
 - 2. Nameplates shall be two-color laminated plastic not less than 1/16 inch thick, machine engraved to show white letters not less than ¼ inch high on a black background. Legend shall identify the enclosure or piece of equipment.

D. Conductor Identification

1. Power conductors terminating in panelboards, cabinets, motor control centers and special service outlets shall be identified at each end and in intervening junction and pull boxes. Where feeder conductors pass through a common box, tag the feeder to indicate the electrical characteristics, circuit number and panelboard designation. Labels shall be located near the conductor ends for terminals and on exposed portions of conductor within pull and junction boxes.
2. Control wiring shall be identified at each end of each wire by a number conforming to the following:
 - a. Wiring for Pump No. 1 shall be labeled with numbers from 100 to 199. Wiring for Pump No. 2 shall be labeled with numbers from 200 to 299, and so forth. Wiring for auxiliary equipment shall use wire numbers not used for the pumping units. Where it is impractical to maintain the same wire numbers throughout, a terminal block shall be installed at the junction of the different numbered wires. On each side of the terminal block each associated wire number shall be typed or written in with permanent ink.
3. Labels shall be plastic slip-on ferrule type with durable machine printed letters, numerals and other identifying characters.

PART 2 MATERIAL

2.1 RACEWAY AND FITTINGS

A. General

1. Minimum size shall be $\frac{3}{4}$ inch.
2. Fittings shall be of the same material and match the raceway.

B. Raceways

1. Rigid steel, heavy wall, hot-dip galvanized meeting requirements of UL-6 and ANSI C80.1.
2. PVC coated rigid galvanized steel shall meet the requirements for rigid galvanized steel raceway herein and have 40 mils bonded PVC jacket meeting requirements of NEMA RN-1 type A-40.
3. Rigid non-metallic shall be Schedule 40 PVC and Schedule 80 PVC meeting requirements of UL-651 with solvent cement joints.
4. Liquid-tight flexible shall be single strip steel, hot-dip galvanized with PVC jacket meeting requirements of UL-t. Conduit sizes $1\frac{1}{4}$ inch and smaller shall include a continuous copper bonding conductor wound spirally between convolutions on the inside of the conduit meeting requirements of UL-360.
5. Electrical metallic tubing (EMT) shall meet requirements of UL-797 and ANSI C80.3.
6. Intermediate metal conduit (IMC) shall meet requirements of UL-1242 and ANSI C80.6.

7. Rigid aluminum meeting requirements of UL-6 and ANSI C80.5.
- C. Fittings
1. Fittings shall be of the same material and finish as the raceways and shall meet requirements of UL-514 and ANSI C80.4. Threaded connectors shall be used for all rigid metal conduits.
 2. For enclosures, cabinets and boxes in dry areas use nylon insulated bushing and lock-nut.
 3. For enclosures, cabinets and boxes in wet areas use PVC coated watertight hub fitting with gasket.
 4. Connectors for liquid-tight flexible conduit shall have factory installed liner of plastic in areas of contact with conductor insulation. Neoprene sealing rings shall be provided when conduit is installed in knockout.
- D. Miscellaneous Specialty Fittings
1. For exterior walls, roof and where water tightness is required, provide watertight sealing sleeves for raceway penetrations consisting of a steel sleeve with pressure ring and clamps or an assembly of molded rubber links with pressure plates and through bolts which may be tightened at any time. Seal between raceway and concrete shall withstand 25 feet of water head without leaking.
 2. For interior walls, floors and where water tightness is not required provide schedule 40 galvanized steel pipe sleeves and plastic expandable sealant.
 3. Provide raceway expansion fittings where raceway crosses building or concrete expansion joints. Provide bonding jumper with each expansion fitting.
- E. Hazardous Locations
1. Conform with NEC Articles 501 and 502 for areas identified as "Hazardous Areas."
 2. Provide threaded cast boxes and fittings for junction boxes and pull boxes in Class I areas. Boxes and fittings shall be UL listed for installation in Class I, Division 2, Groups A, B, C, and D.
 3. Provide Conduit seal at conduits leaving the "Hazardous Areas".
- F. Raceway Supports
1. Support raceway at intervals and at locations as required by the NEC. Do not use perforated straps or plumbers' tape for conduit supports. Independently support raceways from the structure, except as may be approved by the Engineer.
 2. Supports and hangers shall be steel, hot dip galvanized after fabrication, except stainless steel supports shall be provided for PVC and PVC coated raceways, and aluminum supports provided for use on aluminum raceways.
 3. Fasteners for concrete shall be expansion bolts or inserts, toggle bolts for hollow masonry or frame construction and preset inserts for pre-stressed concrete.

4. For raceways supported on surface, provide straps with holes for one or two fasteners and shaped to fit raceway size.
5. At structural steel members support raceway with hot dip galvanized beam clamps. Drilling or welding may be used only where indicated on the Drawings or as approved by the Engineer.
6. For suspended raceways, provide galvanized hanger rods not less than $\frac{3}{8}$ inch diameter for raceways up to 2-inch diameter and $\frac{1}{2}$ inch diameter rods for raceways larger than 2-inch diameter. Rods shall be threaded a minimum of $1\frac{1}{2}$ inch on each end to permit adjustment.
7. For multiple suspended raceways, the horizontal channel shall not be less than $1\frac{1}{2}$ inches square by 12 Gauge. Weld two or more together when greater strength is required to limit deflection to $1/2000$ of span. Hanger for the horizontal channel shall be sized for the number and size of raceways supported as shown on the drawings or if not shown as approved by the Engineer.
8. Exposed raceways on walls below grade, in damp, wet or corrosive locations shall be installed with standoff brackets provided a minimum of $\frac{1}{4}$ inch air space between the raceway and the mounting surface.
9. Where area or room is identified as "Corrosive, wet or hazardous area", supports, hangers, preformed channels and clamps shall be type 304 stainless steel. Bolts and nuts shall be Type 304 stainless steel.
10. Where raceway may be affected by dissimilar movements of the supporting structures or medium provide flexible or expansion devices.
11. Fasteners for concrete shall be SST expansion bolts or inserts, toggle bolts for hollow masonry or frame construction and preset inserts for pre-stressed concrete.
12. Exposed raceways on walls below grade, in damp, wet, corrosive or hazardous locations shall be installed with standoff brackets providing a minimum of $\frac{1}{4}$ inch air space between the raceway and the mounting surface.

2.2 WIRE AND CABLE - 600 VOLTS AND BELOW

A. General

1. Conductors shall be copper, 98 percent conductivity, soft annealed copper meeting requirements of ASTM B33. No.12 and No.10 AWG shall be solid, and No.8 AWG and larger gauge stranded. All wiring shall be stranded with the exception of b. below.
2. Minimum conductor sizes shall be as follows:
 - a. Power and lighting branch circuits shall be No.12 and No.10 AWG as needed and be copper and solid.
 - b. 120volt ac control circuits shall be No.14 AWG and be copper and stranded.
 - c. Low energy control and signal circuits as indicated on Drawings.

- B. Insulation
1. Unless approved otherwise, wire and cable shall be insulation type THWN or THHN. No.6 AWG and larger gauge shall be XHHW-2.
- C. Identification
1. Wire cable shall have the following information surface printed at regular intervals throughout the entire length. No.6 AWG above shall be XHHW-2.
 2. Manufacture or trade name.
 3. Size of conductor.
 4. Type of insulation
 5. Voltage classification
- D. Color Coding
1. Color coding shall be provided throughout the entire network for service, feeder, branch, control, and low energy signal circuit conductors. Color coding of conductors No.6 AWG and smaller shall have factory impregnated color throughout its entire length. Conductors No.4 AWG and larger gauge may be marked with color coding tape a minimum of 0.004 inch in thickness. Color coding tape shall be applied to cover at least three inches of the conductor length, one-third lapped. The color of conductors for different voltage systems shall be as follows:

SYSTEM	PHASE A	PHASE B	PHASE C	NEUTRAL N	GROUND
240/120Vac Single Phase	Black	Red	N/A	White	Green
208/120Vac Three-Phase	Black	Red	Blue	White	Green
480/277Vac Three-Phase	Yellow	Brown	Orange	Gray	Green
Control and Low-Energy Signal	Red	N/A	N/A	White	Green

- E. Instrumentation signal cables shall be shielded pairs or triads with polyvinyl jackets and overall shield over the multiple pairs or triads. The instrumentation cable shall be rated 300volts at 90°C or better. The size of the instrumentation cable shall be AWG No. 16 with seven strands minimum, unless approved otherwise. Instrumentation cables shall meet all the requirements of ICEA S-61-402 and shall be UL listed.
- F. All Control and Instrumentation wire intended and designed for use with 24 VDC or less shall be considered Low Voltage. To prevent electrical interference and provide isolation from higher voltages, all Low Voltage wire shall be installed in separated and dedicated rigid conduit or cable trays that provide segregation.

- G. 120volt ac control wiring shall be AWG No.14 THHN. Main power (120volt ac) to the panels shall be wired using color coded AWG No.12. Supply power to any panel component shall be accomplished using molded 3-wire plug cords.

2.3 WIRE CONNECTIONS AND CONNECTING DEVICES

- A. Splice and Termination Components
 - 1. Splice connectors for conductors No.10 AWG and smaller gauge solid conductors shall be insulated pressure twist-on nut type.
 - 2. Splice connectors for No.8 AWG and larger gauge conductors shall be split bolt or compression type for making parallel or butt splices. Provide companion preformed plastic insulating covers or tape equivalent to conductor insulation.
 - 3. Provide solderless terminal lugs for stranded and multiple solid conductors at connection to terminals or use UL listed crimp tool compression style lugs.
 - 4. Control conductor connection terminations shall be either spade lug or pressure type.

2.4 BOXES

- A. General
 - 1. Boxes on conduit raceways shall be made of the same material as the conduit except on PVC conduit use PVC coated galvanized steel boxes.
- B. Outlet, Junction and Pull Boxes
 - 1. Outlet, junction and pull boxes for use in dry areas shall be one-piece galvanized sheet steel knock-out type (unless otherwise noted) a minimum size of four inches square or octagonal and 1½ inches deep. Provide appropriate and compatible cover for each box.
 - 2. Boxes for use in damp and wet areas shall meet requirements of NEMA 4X, be PVC coated cast steel or cast iron with threaded external hubs for conduit entrance a minimum size as stated for boxes in dry areas. Boxes shall have gasketed cover plates and be PVC coated with stainless steel hardware.
 - 3. Boxes for use in corrosive areas shall meet requirements of NEMA 4X, Stainless-steel with external hubs and extended ears for conduit entrance, minimum size as stated for boxes in dry areas. Boxes shall have gasketed cover plates and stainless-steel hardware.
 - 4. Boxes for use in hazardous areas shall meet NEC requirements for Class 1, Division 2, Groups C and D.

2.5 WIRING DEVICES

- A. Switches
 - 1. Wall switches shall be rated at a minimum 20 amperes.

- B. Outlet Receptacles
 - 1. General utility duplex convenience receptacles shall be rated at a minimum 20 amperes, specification grade.
 - 2. Provide special purpose receptacles of the type, rating and number of poles as shown on the Drawings.
- C. Device Plates
 - 1. Device plates for outlets shall be one piece suited for the device installed. Plates on unfinished walls shall be zinc-coated sheet steel or cast metal with rounded edges. Plates on finished walls shall be satin finish stainless steel. Screws shall be countersunk heads with color and finish to match plate.

2.6 PANELBOARDS

- A. General
 - 1. Panelboards shall meet requirements of UL-67 and in addition, those used as service disconnects shall meet requirements of UL-869. Panelboards shall be factory assembled, dead front, safety type equipped with circuit breakers and designed so individual bolt-in-type breakers can be removed and replaced without disturbing adjacent units or without loosening or removing insulation supplied to obtain clearances as required by UL. Panelboards shall be sized to accommodate the number of single, double and three pole breakers as shown on the Drawings. Unless approved otherwise, provide for a minimum of six single pole spare spaces in each Panelboard for future installation of breakers.
 - a. Cabinet for the Panelboard shall be equipped with a continuous piano-hinged door trim covering. Inside the door, mount a removable directory behind a transparent protective covering to indicate and identify the different circuit breakers. Panelboard door shall be provided with a lock with two keys provided per lock. Unless approved otherwise, door locks shall be keyed alike. The panelboard cabinet shall be shop primed and finish-painted inside and outside with manufacturer's standard paint system.
 - b. Each panelboard shall be provided with main and neutral buses insulated from the cabinet and a ground bus bonded to the cabinet. Buses shall be copper with ampere rating as shown on the Drawings. Support bus bars on bases independent of the circuit breakers. Buses shall be designed so circuit breakers may be changed with simple tools without machining, drilling or tapping. Make complete provisions for mounting future circuit breakers throughout the entire length of the bus regardless of the number of units and spaces specified. Provide solderless main lugs for main, neutral and ground bus bars.

- c. Circuit breakers shall be molded-case type. Provide quick-make and quick-break toggle mechanism, inverse time trip characteristics, and trip-free operation on overload or short circuit. Automatic tripping shall be indicated by a handle position between the manual OFF and ON position. Provide trip ratings and number of poles as indicated in the drawings. Provide provisions for padlocking external disconnect handles in the OFF position.

2.7 GROUNDING MATERIALS

- A. Ground rods shall be copper clad steel minimum $\frac{3}{4}$ inch diameter and not less than ten feet long.
- B. Ground conductors for connection to the ground rods shall be stranded, bare, soft drawn, copper cable or bar with gauge not lighter than 12 AWG. Green insulated conductors for installation in raceways.
- C. Ground clamps shall be copper alloy multi-bolt type, saddle clamp or compression type assembled with bronze bolts, nuts, and washers.
- D. All welded connections for the grounding system shall be the exothermic process.

2.8 DISCONNECT SWITCHES

- A. Disconnect safety switches shall be fusible or non-fusible with ampere rating, voltage rating, number of poles and enclosure type as shown on the Drawings. All switches shall be heavy duty type. Mechanisms shall have quick-make, quick-break operating handles with provisions for padlocking in the OFF position, interlock to prevent unauthorized opening of the cover when the switch is in the ON position and to prevent closing the switch mechanism with the cover open.

PART 3 EXECUTION

3.1 GENERAL

- A. Install electrical equipment and material of the size, type and general routing as shown on the Drawings or on approved Contractor's Drawings. No splices shall be allowed unless approved by the Engineer.
- B. Install metallic raceway, fittings, boxes, and cabinets free from direct contact with reinforcing steel.
- C. Provide fasteners, anchor bolts, anchorage items and supports as required to insure proper and rigid alignment. Attach equipment with fasteners sized according to size and weight of equipment and thickness of supporting surface.
- D. Where aluminum is placed in contact with dissimilar metal or concrete, separate contact surfaces with gasket, non-absorptive tape, or coating to prevent corrosion.

- E. Make metallic conduit, raceways, and cable trays electrically and mechanically continuous and ground as required. Conduits shall be continuous between outlets, boxes, cabinets, and panels, and shall enter and be secured to each box.
- F. Provide ground conductor in each conduit run.
- G. No more than one 3-phase circuit or feeder circuit in a conduit run, unless shown otherwise on the Drawings
- H. Provide electrical equipment and material per the following schedule, unless noted otherwise on the Drawings:

CONDUIT USE SCHEDULE

AREA	ENCLOSURE	CONDUIT
Dry Location		
Control Room	NEMA 1 or 12	PVC Schedule 80
Generator Room		
Drywell (Pump Room & Intermediate Levels)	NEMA 4X	PVC Schedule 80
Above suspended ceiling, concealed in walls (not concrete encased)	NEMA 1	EMT
Underground Vaults	NEMA 4X	PVC Schedule 80
Outdoors		
Subject to physical damage		Aluminum
Not subject to physical damage		PVC Schedule 80
Direct Buried		PVC Schedule 80
Encased in Concrete		PVC Schedule 80
Wetwell and Areas Class 1, Division 2	NEMA 7, Explosion Proof	PVC Coated R.G.S.

NOTES:

- Minimum size conduit ¾”.
- Minimum ¼” spacing off walls.
- All Stub-ups to 3'-0” A.F.F., rigid galvanized steel (R.G.S.) conduits, except PVC coated rigid galvanized steel as required. Use full length of conduit for stub-up.

3.2 CONDUIT RACEWAYS

A. General

1. Unless approved otherwise, conceal conduits within finished walls, ceiling and floors. Install conduits parallel or perpendicular to building floors, ceilings and walls, and to avoid interference with other work. Cut conduits square and debar cuts to the same degree as conduit manufacturer. Fasten conduit securely to outlets, junction, pull and terminal boxes. Provide caps and seals to prevent entrance of foreign material and moisture during installation and before wire pulling.
2. Keep conduit at least six inches away from high temperature piping, ducts, flues and surfaces. For mounting on concrete and masonry surfaces provide a minimum of ¼ inch standoff support. Support and fasten conduit to building structural members using pipe straps, wall brackets, hangers or ceiling trapeze spaced in accordance with electrical codes. Support conduit at least every eight feet and within three feet of every box, panel, and enclosure.
3. When two or more exposed conduits are in the same general routing, provide parallel installation with symmetrical bends. For three or more provide channel racks. Provide channel rack space for 25 percent additional conduits.
4. Make changes in direction with bends and fittings. Field-made bends and offsets shall be made with a hand bender or conduit-bending machine. Conduit runs shall have no more than the equivalent of three 90 degree bends within 75 feet between boxes or two 90 degree bends within 125 feet. Pull boxes shall be provided where shown, specified, or wherever required to pull conductors and to meet the above requirement. Install expansion fitting when conduit crosses building structural expansion joint. Unless otherwise approved, conduits shall cross perpendicular to building structural expansion joints.

B. Conduit Connections

1. Final connections to motors or vibrating equipment shall be liquid-tight flexible conduit. Unless approved otherwise, flexible conduit shall not be less than one foot nor more than three feet in length.
2. Conduit fittings, connectors and boxes shall be of the same material and be compatible with the conduit material.

C. Underground Conduits

1. For conduits buried in earth, provide minimum 30 inches of cover and minimum of one foot clearance between other utility crossings and parallel runs. Maintain a grade of at least four inches per 100 feet run either from one manhole or pull box to the next or from a high point between them. Drain conduits away from building, if this is not possible, provide watertight seal at building.
2. Provide detectable warning tape approximately 18 inches above and directly over centerline of buried conduit.

D. Conduit Penetrations

1. Concealed penetrations for conduits shall be made not more than $\frac{1}{4}$ inch larger than the diameter of the conduit. Penetrations through walls, ceiling and floors other than concrete for exposed conduits shall be not more than $\frac{1}{4}$ inch larger than the diameter of the conduit and void around conduit filled with non-hardening caulking compound receptive to painting and surface finished same as wall, ceiling or floor.
2. Where a conduit enters through a concrete roof or membrane waterproofed wall, floor or ceiling, provide a watertight sealing sleeve that can be tightened from one side. If the sealing sleeve is not placed with the concrete, core-drill proper size hole to provide a mechanically watertight installation.
3. Where a conduit enters through a concrete non-waterproofed wall, floor or ceiling, provide a galvanized steel sleeve, schedule 40, and fill the space between the conduit and sleeve with plastic expandable compound or an oakum and lead joint. If the sleeve is not placed with the concrete, drill hole not less than $\frac{1}{2}$ inch nor more than one inch larger than sleeve, center sleeve and grout sleeve total depth of penetrated concrete with non-shrink grout, polyurethane, or silicone sealant.

E. Conduit Damage Correction

1. Repair cuts, nicks and abrasions or replace damaged conduit as approved by the Engineer.

F. Conduit Seals

1. Provide a conduit seal for each conduit leaving a hazardous area.

G. Spare Conduits

1. Provide spare conduits for future use as shown on the Drawings. Provide a minimum 200-pound strength nylon pull line in each spare conduit and identify at each end the origin and termination of the conduit. Terminate spare conduits in equipment, boxes or by couplings plugged flush with building surfaces.

3.3 BOXES

A. General

1. Each box shall be of the proper size for the number of conductors enclosed in the box.
2. For boxes mounted on steel, concrete and masonry surfaces provide minimum $\frac{1}{4}$ inch spacer to hold box away from surface or provide non-corrosive coating between surfaces.
3. Provide separate support for boxes and bolt units to building with expansion anchors, toggle bolts or appropriate screws. For lighting fixture outlet boxes, provide supports adequate to support weight of fixture to be mounted on the box.

4. Remove debris including dust, dirt, wire clippings and insulation from interior of boxes. Boxes with open conduit holes are not permitted and shall be replaced at no cost to the Commission. Damaged boxes shall be repaired, as approved by the Engineer, or replaced.
 5. Where boxes are shown on each side of a common wall, do not mount back-to-back but offset horizontally at a minimum of six inches.
 6. In underground locations, conduit entrance into equipment and fixtures shall be made from side or bottom of box. Top penetrations shall not be permitted.
- B. Outlet Boxes
1. Unless approved otherwise, mount boxes flush with finished wall or ceiling.
 2. Unless approved otherwise, mounting heights measured from the finished floor to centerline of the outlet box shall be as follows:
 - a. For switches four feet and in addition for lighting switches mount on strike side of door.
 - b. Duplex convenience outlets 18 inches for dry locations, and 48 inches for wet & damp locations.
 - c. For fixtures and equipment four feet or as shown on the Drawings.
- C. Junction and Pull Boxes
1. Provide pull boxes where required to facilitate conductor installation and to limit conduit runs to less than 150 feet.
 2. Install pull and junction boxes in accessible locations with working space in front of and around the installation. Boxes are not permitted in finished areas without approval of the Engineer.

3.4 CONDUCTORS

- A. Install conductors as shown on the Drawings in raceways with no splices between boxes. Install complete raceway system and clear debris and moisture before conductor installation.
- B. Pull conductors using proper equipment without exceeding manufacturer's recommendation for maximum pulling tension. Protect conductor insulation jacket at all times from kinks, scrapes, punctures and other damage. Replace damaged conductors. Use lubricating compound to reduce pulling force as required. Lubricating compound shall be UL listed compatible with the conductor insulated jacket and with the raceway.
- C. Support conductors in vertical risers with woven grips to prevent loading on conductor connectors.
- D. In conduits entering buildings or from areas where temperature change may cause condensation or moisture, provide seal between conductors and conduit after conductors are put in place.

- E. When using color-coding tape apply with overlapping turns for a minimum length of two inches starting two inches back from the termination point.
- F. Leave a minimum of six inches of free conductor at each connected outlet and a minimum of nine inches at unconnected outlets.

3.5 WIRE CONNECTIONS AND CONNECTING DEVICES

- A. Connect circuit conductors of the same color to the same phase throughout the installation.

3.6 WIRING DEVICES

- A. Switches and receptacles shall be installed in accessible locations and so that the long dimension is vertical.
- B. Provide a bonding jumper between the grounded box and the switch or receptacle ground terminal.

3.7 CABINETS AND ENCLOSURES

- A. Mount cabinets and enclosures so there is a minimum of 1½ inch air space all around.
- B. Arrange conductors in cabinets, panels and enclosures in a neat arrangement, cut to proper length and with surplus conductor removed.
- C. Identify each circuit in the enclosure.
- D. Provide terminals and connectors for the type of material being used.

3.8 PANELBOARD

- A. Secure panelboard rigidly to walls and floors to mounting pads with anchor pads with anchor bolts or Phillips Drill Company concrete anchors. Anchor bolts or concrete anchors shall be Type 316 stainless steel.

3.9 GROUNDING

- A. Unless approved otherwise, ground all exposed non-current carrying metallic parts of electrical equipment, raceway systems, and the neutral of all wiring systems in accordance with the NEC and other applicable codes.

- B. Grounding system shall be bonded to one or more grounding rods driven a minimum of nine feet in the ground. The ground connection to the metal pipe shall be not more than one foot inside the building. Ground conductor for connection to ground rod shall be stranded copper and connected by the exothermic welding process. Earth buried ground conductors shall not be insulated. File or sand surfaces before connecting ground to ensure good metal to metal contact.
- C. Bond the grounding conductors to metallic enclosures at each end and to all intermediate metallic enclosures. Where equipment contains a ground bus, extend and connect grounding conductors to that bus. Run ground conductors inside conduits enclosing the power conductors.
- D. Make connections of grounding conductors to circuits 20 amps or above by a solderless terminal and a 5/16-inch minimum bolt tapped to the motor frame or equipment housing. Ground connections to smaller equipment may be made by fastening the terminal to a connection box. Connect junction boxes to the equipment grounding system with grounding clips mounted directly on the box or with $\frac{3}{8}$ inch machine screws. Remove all paint, dirt or other surface coverings at grounding conductor connection points so that good metal to metal contact is made.

3.10 FIELD QUALITY CONTROL

- A. Perform Testing in accordance with Section 16950.

END OF SECTION

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SECTION 16130
ELECTRICAL BOXES AND FITTINGS

PART 1 GENERAL

1.1 DESCRIPTION

- A. Provide junction boxes, pull boxes, covers, and miscellaneous hardware as indicated, in accordance with the Contract Documents.

1.2 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
 - 1. National Electrical Manufacturers Association (NEMA).
 - 2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
 - 3. Underwriters Laboratory Inc. (UL):
 - a. 508, Industrial Control Equipment.
 - b. 698, Industrial Control Equipment for Use in Hazardous (Classified) Locations.
 - c. 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.

1.3 QUALITY ASSURANCE

- A. Comply with applicable portions of Section 16050, Basic Electrical Materials and Methods.
- B. Provide components that are the standard product of a manufacturer regularly engaged in the production of the required materials and equipment.
 - 1. The manufacturer shall be responsible for the design, construction and proper operation of all components.
- C. Comply with applicable codes and standards.
- D. Design to provide satisfactory performance under the specified operating conditions.

1.4 SUBMITTALS

- A. Submit the following in accordance with Section 01330, Submittal Procedures.
 - 1. Product data.
 - 2. Shop drawings.
 - 3. Special shipping, storage, protection, and handling instructions, if any.
 - 4. Manufacturer's installation instructions.
- B. Submit manufacturer's certificates in accordance with the Section 01450, Quality Control.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Outlet Boxes:
 - 1. Steel City.
 - 2. Appleton Electric Co.
 - 3. Raco.
 - 4. Carlon.
 - 5. Or equal.
- B. Pull and Junction Boxes:
 - 1. Crouse-Hinds Co.
 - 2. OZ Electrical Manufacturing Co.
 - 3. Hope Co.
 - 4. Or equal.
- C. Fittings:
 - 1. Crouse-Hinds Co.
 - 2. Appleton Electric Co.
 - 3. Robroy Industries.
 - 4. OZ Electrical Manufacturing Co.
 - 5. Carlon.
 - 6. Or equal.

2.2 OUTLET BOXES

- A. Provide outlet boxes for use with IMC raceway as follows.
 - 1. Galvanized case metal type.
 - 2. With tapped hubs for conduit entrance.
 - 3. Having galvanized cast metal covers with rubber gasket.
- B. Provide non-metallic outlet boxes for use with concealed PVC raceway. Procure from same manufacturer as raceway.
- C. Provide non-metallic single- and two-gang outlet boxes with integral mounting feet, for use with PVC raceway. Provide non-metallic blank covers with stainless steel mounting screws. Carlon FS or FD, or equal.
- D. For use with PVC coated RMC provide PVC coated galvanized cast metal type outlet boxes with tapped hubs for conduit entrance. Provide covers of PVC coated galvanized cast metal with rubber gasket. Provide minimum 40 mil-thick polyvinyl chloride jacket on exterior surfaces of box bodies and covers.
- E. Provide PVC coated cast outlet boxes in hazardous areas (as defined by NEC), as follows
 - 1. Suitable for Class, Division and Group location as indicated.
 - 2. Conform to UL 886.

3. Bearing UL label as suitable for intended application.

2.3 PULL AND JUNCTION BOXES

- A. Provide junction or pull boxes where indicated, and where required to facilitate wire pulling and connection.
- B. Provide pull and junction boxes less than 100 cubic inches as specified for outlet boxes:
 1. Flush NEMA 4 junction boxes – watertight outside flanged with recessed cover type “YR” as manufactured by OZ/Gedney, or equal.
- C. Provide pull and junction boxes 100 cubic inches and larger for use with PVC raceway, fabricated from PVC, or equal non-metallic product, and:
 1. Equipped with screw cover unless otherwise noted.
 2. Adequately support the boxes to maintain shape.
 3. Provide NEMA 4X boxes with watertight gasketed covers and external mounting feet.
- D. Pull and junction boxes 100 cubic inches and larger installed in hazardous areas, as defined by NEC, shall be suitable for Class, Division and Group as indicated and comply with following:
 1. Provide neoprene gasket.
 2. Provide stainless steel hinges and natural stainless-steel finish.
 3. Confirming to UL 886 and bearing UL label as suitable for intended application.
- E. Boxes shall be supported to maintain shape. Larger boxes shall be formed of structural bracing into rigid assembly to maintain alignment in shipment and installation
- F. Provide drain fittings in NEMA 4X boxes. Crouse-Hinds, Type ECD 11, Killark No. KDB-1, or equal.

2.4 PAINTING

- A. Clean and shop prime all non-galvanized, non-stainless steel metal surfaces in accordance with Section 09900, Painting and Coating, System No. 3.
- B. Use ANSI 61 light gray as the final exterior color for the pull boxes.

PART 3 EXECUTION

3.1 GENERAL

- A. Size boxes in accordance with NEC, or as indicated.

- B. Provide suitable box at outlets especially designed to receive type of fixtures and devices to be mounted thereon, except where otherwise noted for recessed fluorescent fixtures.
- C. Provide fixture outlets with fixture supports of size and type required for fixture to be hung. Fixture studs, generally, shall be 3/8-inch.
- D. Provide boxes of type approved for particular purpose intended.
- E. Recessed wall outlet boxes shall be at least 4-inches square.
- F. In finished areas, provide box covers to fit outlet box installed of required depth so that the edge of ring is flush with finished material.

3.2 INSTALLATION

- A. Securely support each box at two or more points and two or more sides to prevent movement in all directions.
- B. Use boxes to support devices and face plates. Do not use face plates and devices to support boxes.
- C. Where box is concealed in stud wall, securely attach it to full depth stud (or section of stud) on each side of box.
- D. Provide labels in accordance with Section 16195, Electrical Identification.

3.3 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 16950, Testing.
- B. Adjusting and Cleaning: Clean surfaces after installation.
- C. Grounding:
 - 1. Provide grounding in accordance with Section 16450, Grounding.
 - 2. Tighten connections to comply with tightening torques specified by the manufacturers and UL Standard 486A to assure permanent and effective grounding.

END OF SECTION

SECTION 16143 WIRING DEVICES

PART 1 GENERAL

1.1 DESCRIPTION

- A. Provide plugs, plug connectors, device covers, and switches as indicated on drawings and as specified herein. This section includes the following:
 - 1. Receptacles.
 - 2. Ground fault circuit interrupter receptacles.
 - 3. Switches.
 - 4. Mounting hardware.

1.2 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
 - 1. National Electrical Manufacturers Association (NEMA).
 - 2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
 - 3. Underwriters Laboratory Inc. (UL).

1.3 QUALITY ASSURANCE

- A. Comply with applicable portions of Section 16050, Basic Electrical Materials and Methods.
- B. Provide components that are the standard product of a manufacturer regularly engaged in the production of the required materials and equipment.
 - 1. The manufacturer shall be responsible for the design, construction, and proper operation of all components.
- C. Comply with applicable codes and regulations.
- D. Design to provide satisfactory performance under the specified operating conditions.

1.4 SUBMITTALS

- A. Submit the following in accordance with Section 01330, Submittal Procedures:
 - 1. Product data.
 - 2. Drawings.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Toggle Switches:

1. Arrow-Hart, Inc.
 2. General Electric Co.
 3. Harvey Hubbell, Inc.
 4. Or equal.
- B. Corrosion Resistant Switch:
1. Appleton Electric Co.
 2. Crouse-Hinds Products ECM.
 3. Or approved equal.
- C. Receptacles:
1. Arrow-Hart, Inc.
 2. General Electric Co.
 3. Harvey Hubbell, Inc.
 4. Or equal.
- D. Corrosion Resistant Receptacles:
1. Appleton Electric Co.
 2. Or equal.
- E. Dry Type Transformers:
1. Square D
 2. Or equal.

2.2 SWITCHES

- A. Single pole ac toggle switch, quiet type, 120/277Vac, 20 ampere, ivory, specification grade, provide:
1. Arrow-Hart, Inc.; Catalog No. 1991-I.
 2. General Electric Co.; Catalog No. GE5951-2.
 3. Harvey Hubbell, Inc.; Catalog No. 1221-I.
 4. Or equal.

2.3 CORROSION RESISTANT SWITCH

- A. Single gang, dead end, one pole, 3-way, 4-way, 120/277Vac, 20 amperes, in areas classified as NEC Class I, Division 2 hazardous areas, provide:
1. Appleton Electric Co.; EFS Series.
 2. Crouse-Hinds Products ECM; EFS Series.
 3. Or equal.

2.4 RECEPTACLES

- A. Duplex grounding receptacles, corrosion resistant, 2-pole, 3-wire, 125Vac, 20 ampere, NEMA 5-20R configuration, provide:
1. Arrow-Hart, Inc.; Catalog No. 5739CR.
 2. General Electric Co.; Catalog No. GE0526-C.
 3. Harvey Hubbell, Inc.; Catalog No. 53CM62.

4. Or equal.
- B. Single grounding receptacle, corrosion resistant, 2-pole, 3-wire, 125Vac, 20 ampere, NEMA 5-20R configuration, provide:
1. Arrow-Hart, Inc.; Catalog No. 5361-CR.
 2. General Electric Co.; Catalog No. GE0520-C
 3. Harvey Hubbell, Inc.; Catalog No. 53CM61
 4. Or equal.

2.5 CORROSION RESISTANT RECEPTACLES

- A. Install in areas classified as NEC Class 1, Division 2 hazardous locations, receptacles as below:
1. Meltric DNX Decontactors, as indicated on Drawings.
 2. Or equal.

2.6 GROUND FAULT INTERRUPTER (GFI) RECEPTACLES

- A. Provide ground fault interrupter receptacles of following types and rating.
1. “Feed-thru” type ground fault circuit interrupter, with integral heavy duty NEMA 5-20R duplex receptacles arranged to protect connected downstream receptacles on same circuit.
 2. Provide unit designed for installation in a 2-3/4-inch-deep outlet box without adapter, grounding type, Class A, Group 1, in accordance with UL Standard 94.3.
 3. Explosion proof, 20A, 125Vac, 5 MA trip setting ground fault circuit interrupter with explosion proof receptacle in areas classified as NEC Class I, Division 2 hazardous locations.
 4. Snap Switches: Quiet type AC switches. Comply with UL 20 and NEMA WD1.
 5. Wall Plates: Single and combination of types, sizes and with ganging and cutouts as indicated.
 - a. To mate and match with wiring devices to which they are attached.
 - b. Use metal screws for securing plates to devices with screw heads colored to match finish of plates.
 - c. Color to match wiring devices except as otherwise indicated.
 - d. With engraved legend where indicated. Conform to requirements of Section 16195, Electrical Identification.
 - e. Possessing the following additional construction features:
 - f. Material and Finish: 0.04 inch thick, Type 302 satin finished stainless steel in wet and/or corrosive area.
 - g. Material and Finish: Plastic.
 6. Plugs: Watertight, solderless, long plug housing and suitable for activating explosion proof receptacles and areas classified as NEC Class I, Division 2 hazardous locations.
 7. Mounting Hardware: Stainless steel.

2.7 DRY TYPE TRANSFORMERS

1. 1. Transformers shall be size and voltage as indicated on the Drawings, dry type, ventilated, floor mounted, 115°C temperature rise with 220° C insulation system.
2. 2. Transformers shall have aluminum windings, and shall be energy efficient, DOE 2016 compliant.
3. 3. Transformer enclosure shall be painted steel, unless noted otherwise on the Drawings.
4. 4. Transformers shall be Square D.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Comply with following installation requirements for wiring devices:
1. Install wiring devices and accessories as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and in accordance with recognized industry practices to fulfill project requirements.
 2. Coordinate with other work, including painting, electrical boxes and wiring installations, as necessary to interface installation of wiring devices with other work.
 3. Install wiring devices only in electrical boxes, which are clean, free from building materials, dirt and debris.
 4. Install stainless steel wall plates in unfinished spaces.
 5. Install wiring devices after wiring work is completed.
 6. Install wall plates after painting work is completed.
 7. Tighten connectors and terminal, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A. Use properly scaled torque indicating hand tool.
 8. Mount receptacles 18 inches above finished floor in office areas, control rooms, conference rooms and similar above grade areas unless shown otherwise. Mount all other receptacles 4 feet -2 inches above finished floor unless approved otherwise.
 9. Securely fasten equipment to walls or other structural surfaces on which they are mounted. Provide independent, factory applied PVC coated steel or stainless-steel supports and accessories where no wall or other vertical surface exists.
 10. Provide field applied PVC coating for cut ends of PVC coated supports.
 11. Space at least 1/4 inch from wall. Spacers shall be stainless steel, PVC or nylon.
 12. Mount wall switches 4 feet -2 inches above finished floor unless approved otherwise.

13. Install bonding jumpers between the receptacle ground screws and the outlet boxes on all receptacles.

3.2 FIELD QUALITY CONTROL AND TESTING

- A. Perform field inspection and testing in accordance with Section 16950, Testing.
- B. Testing: Prior to energizing circuits.
 1. Test wiring for electrical continuity, and for short-circuits.
 2. Ensure proper polarity of connections is maintained.
 3. Test ground fault interrupter operation with both local and remote fault simulations in accordance with manufacturer recommendations.
- C. Subsequent to Energizing: Test wiring devices and demonstrate compliance with requirements, operating each operable device at least six times.

END OF SECTION

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SECTION 16186
VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.1 DESCRIPTION

- A. Furnish all variable speed, variable frequency drives (VFDs) called for herein. These drives shall be coordinated with the driven equipment to ensure that the entire system is compatible and coordinated properly.

1.2 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
 - 1. Institute of Electrical and Electronics Engineers (IEEE).
 - 2. National Electrical Manufacturers Association (NEMA).
 - 3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
 - 4. Underwriters Laboratories Inc. (UL).

1.3 QUALITY ASSURANCE

- A. Reference Standards: Comply with all federal and State of Maryland laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements.
- B. The complete VFD shall be UL listed and bear the UL label in accordance with UL 508A.
- C. The VFD shall meet the harmonic distortion limits specified in the IEEE 519 standard, as measured at the drive input terminals. The base drive shall include an AC line reactor and/or DC link choke for harmonic filtering. If basic filtering is insufficient to meet IEEE 519 limits, then the VFD supplier shall furnish a passive harmonic filter (<200 HP), or 18-pulse converter with auto transformer (>200 HP), or active front end (>250 HP) as needed. The horsepower ranges suggested here are general guidelines based on cost effectiveness and shall not be used as the sole criterion in determining a solution for harmonic distortion.

1.4 SUBMITTALS

- A. General: Submittals shall be in accordance with Section 01330, Submittal Procedures.
- B. Shop Drawings:
 - 1. Wiring diagrams, front and side views of enclosures, overall dimensions, conduit entrance locations and requirements, nameplate legends, and enclosure details.

2. Datasheets depicting voltage, ratings, and size of switching and overcurrent protective devices, short circuit ratings, and weight.
3. Specific description of harmonic mitigation provisions being made to ensure proper system operation and compliance with IEEE 519.

C. VFD/Equipment Compatibility:

1. Submit in writing that each VFD supplied shall be compatible with equipment to which it is connected. The VFD supplier shall obtain the actual torque requirements (breakaway, accelerating, running, peak and holding torques) continuous current rating and overload current rating from the equipment manufacturers and submit in writing that each VFD is sized correctly and fully compatible for any equipment. Each VFD shall be sized in accordance with the equipment's motors maximum current requirements under peak torque demands.
2. Also submit in writing documentation showing VFD/equipment compatibility across the entire speed range of the motor for each VFD. Ensure the VFD is of sufficient size to maintain a speed setpoint as low as 5 Hz without being limited by the torque output of the motor relative to the load torque at that speed.
3. Each VFD shall be rated for constant torque or variable torque as required for the equipment which speed is being varied and the continuous output current rating shall be at least as required by the equipment manufacturer's approved shop drawings.
4. Submit in writing that the VFD supplier has reviewed each installation for motor lead length restrictions. Review the motor, cable type, length of cable, conduit type, and all other motor lead length constraints. Submit that the proposed VFD for each application has been checked for any problems and is acceptable to be installed as shown on the Drawings.
5. Passive filters on generator power shall be equipped with a dropout contactor for the filter capacitors in order to limit leading power factor during no-load operation.

D. Harmonic Distortion Analysis:

1. Perform harmonic distortion analysis for each VFD to be installed under this project. Provide calculations, results, and report for harmonic distortion analysis performed including specific recommendations for harmonic mitigation measures to comply with requirements of IEEE 519.
2. Perform analysis considering the following two points of common coupling (PCC) locations to ensure adequate power quality conditions within the facility:
 - a. 480V MCC Bus directly supplying the VFD.
 - b. 480V Switchgear bus at substation, if applicable.
3. Perform a system analysis to demonstrate not more than 5% total harmonic distortion (THD) voltage and current distortion level in accordance with the IEEE 519 at all identified distribution buses.

4. Where calculations yield THD-voltage is greater than 5% or THD-current is greater than the IEEE 519 recommended level, provide specific recommendations to reduce distortion by the addition of filters, reactors, or other means.
- E. Submit in writing evidence of a factory authorized service engineer within 100 miles of the plant and that spare parts for each VFD are available at a local distributor within 100 miles of the plant.
- F. Service Manuals: Provide service manuals.
- G. O&M Training: Comply with requirements of Section 01330, Submittal Procedures and as specified herein.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Approved VFD manufacturers:
 1. ABB / General Electric
 2. Allen-Bradley by Rockwell Automation
 3. Benshaw
 4. Siemens
 5. Toshiba
 6. Danfoss
 7. Eaton

2.2 VFD

- A. The VFD shall be completely solid state. The drive shall convert 460 volts 3-phase ac input power into frequency and voltage controller 3-phase output suitable to provide positive speed control to standard induction motors. The adjustable frequency control shall have an input designed to provide a high-power factor that remains constant regardless of load or operating speed and creates no line notching or other disturbances of the power line. Power transistors shall be utilized for high reliability in the output power switching circuit.
- B. Each VFD shall be suitable for operation of standard NEMA Design B motors. The VFD shall not require modification to accommodate any replacement NEMA Design B motor of equal or lower horsepower as long as the output current requirement is not increased. VFD shall include the following features:
 1. PC boards with standard conformal coated for additional protection.
 2. Real time clock with time-of-day functionality.
 3. Data capture, event logs, and reminder warnings system.
 4. USB port for memory stick plug-in for data storage and drive reflashing.
 5. Wireless programming capability using PDA-trAC+ system.
 6. Ethernet IP communication protocol.

- C. The VFD shall be furnished with an integral NEMA-1 rated enclosure equipped at the factory with fans, blowers, heat exchangers, or air conditioner as needed to maintain ambient operating temperature within factory limits.
- D. Drive Disconnect Switch:
 - 1. A main disconnect switch shall be provided for each variable frequency drive to disconnect power to the drive. The disconnect switch shall be sized for the full output current rating of the drive. Each disconnect switch shall have a lockable handle.
- E. Each VFD shall have the following features:
 - 1. Input Power:
 - a. The drive shall operate from 460 V, 3-phase, 60-Hz.
 - b. Variations of up to plus or minus 15 percent of line voltage and plus or minus 2 Hz of line frequency shall be permitted without the drive shutting down on a fault.
 - c. Power line interruptions of up to 0.5-second shall be permitted without the drive shutting down on a fault.
 - d. The drive input circuitry shall not generate line notches or large voltage transients on the incoming line.
 - e. The drive shall present a displacement power factor of 0.95 or better to the ac line at any speed or load.
 - f. The drive control efficiency at rated load and frequency shall be 97.5 percent or better.
 - g. The drive shall have input transient protection. The drive shall withstand line transients up to 6,000 volts peak in accordance with IEEE C62.41.1991. It shall also have control logic noise immunity up to 1,500 volts peak.
 - h. The drive shall be designed to operate on an ac line which may contain line notching and up to 10 percent harmonic distortion. The drive shall not require an input isolation transformer.
 - i. The drive shall not be sensitive to supplied power that has one phase grounded (delta) or referenced to earth ground (wye).
 - j. The drive shall have minimum 42 kA RMS short circuit rating without the use of additional input fusing.
 - k. Control circuit voltage shall be 120V ac provided by an individual control power transformer with both legs fused on the primary side and one leg fused and one leg grounded on the secondary side. See the Drawings for control schematics.
 - l. Inverter section shall be the latest generation IGBT. It shall not require commutation capacitors.
 - m. All drives 5 HP and above shall be furnished with an integral AC line reactor and/or DC link choke in order to smooth current flow and limit current spikes at the input rectifier section.

2. Output Power:

- a. The VFD shall convert 3-phase, 60Hz input power to 3-phase adjustable voltage, adjustable frequency output power using sinusoidal Pulse Width Modulation (PWM) switching techniques and Insulated Gate Bipolar Transistor (IGBT) outputs. Fast switching SCRs shall not be used in the inverter output section.
- b. The drive output frequency shall be adjustable from 0- to 120-Hz.
- c. The VFD shall have selectable or programmable modes of operation including, but not limited to: Linear V/Hz, V/Hz with Quadratic (parabolic) characteristic, V/Hz with programmable characteristic, and Sensorless Vector Control (SVC).
- d. In linear V/Hz mode, drive output shall vary from 0 to 460 VAC at 60 Hz and maintain a constant V/Hz ratio equal to 7.6. Above 60Hz the output voltage shall be limited to 460 VAC. When operating on generator power, the output may vary from 0 to 460 VAC at nominal frequency.
- e. The volts-per-hertz output of the drive shall not be affected or require readjustment when other drive adjustments (such as maximum speed) are changed.
- f. The drive shall have an adjustable programmable microprocessor controlled PWM carrier frequency within a range of 2-8 kHz to reduce noise at the motor and guard against interference with other sensitive electronic equipment.
- g. The drive shall be capable of restoring motor operation after 0.5 second line loss without shutting down on a fault.
- h. The drive shall be capable of operating output open circuited with no fault of damage.
- i. The drive regulator section shall be microprocessor based in order to achieve digital control of output voltage, current, and frequency.
- j. Each VFD shall have a common mode core or output choke to reduce noise at the motor and guard against interference with other sensitive electronic equipment. No drives shall be approved without this feature.
- k. Each drive 60 hp and less shall have software to limit the reflected wave due to long cable lengths to a maximum of 2 times bus voltage. Larger drives shall have designs to minimize reflected wave.
- l. Each VFD shall be suitable for use on heavy duty loads. Heavy duty ratings are rated for the FLA of the equipment continuously, 120 percent of the rated FLA for up to 60 seconds, and 180 percent of the rated FLA for instantaneous duration.

3. Drive Protection Features:

- a. Overcurrent protection.
- b. Short circuit protection.
- c. Fast acting supply fuses.
- d. Supply voltage phase loss.

- e. dc bus undervoltage protection.
 - f. dc bus overvoltage protection.
 - g. Overtemperature protection.
 - h. Power semiconductor protection.
 - i. Dynamic brake overload
4. Drive Diagnostics:
- a. The diagnostic system shall continuously monitor all systems and indicate faults and all shutdown causes. Provide single-pole double-throw (SPDT) dry contact outputs for fault alarms as shown on the Drawings. As a minimum, the following drive diagnostics shall be monitored, indicated on the drive, and alarmed:
 - (1) Overload (overcurrent).
 - (2) Ground fault.
 - (3) Overvoltage.
 - (4) Undervoltage.
 - (5) Overtemperature.
 - (6) Dynamic brake overload.
 - (7) Semiconductor fault (each leg).
 - (8) Power supply fault.
 - (9) Motor over-temperature/shutdown.
 - (10) Motor stalled.
5. Control Features:
- a. The VFD shall have a door-mounted keypad/display that can be used for drive setup and programming, command and control, and fault and status annunciation.
 - b. The drive shall produce an output without external feedback.
 - c. For all analog speed commands, the drive shall maintain set frequency to within 0.6 Hz during power line fluctuations or changes in ambient temperatures.
 - d. For digital speed commands, the drive shall maintain set frequency to within 0.01 Hz during power line fluctuations or changes in ambient temperatures.
 - e. Within the drive rating, the drive shall maintain set frequency and not require readjustment due to changes in load.
 - f. To control the rate of change of output frequency for a step change in input reference, the drive shall have two independently adjustable acceleration and deceleration rates.
 - g. The drive shall have a foldback current limiting circuit. During acceleration, the circuit shall automatically reduce the acceleration rate to a slower rate if the load inertia causes excessive currents.
 - h. The drive shall have a selectable deceleration voltage limiting circuit. The circuit shall extend the set deceleration ramp if the bus voltage approach high limits due to regeneration.

- i. The drive shall have incremental adjustable IR compensation boost. A selectable range for offsetting motor losses at low frequency operation shall be used to optimize motor torque for starting high inertia and high friction loads.
 - j. All drive set-up operations and adjustments shall be digital and stored in a nonvolatile memory (EEPROM). No analog or potentiometer adjustments shall be allowed.
 - k. It shall be possible to program the VFD to automatically restart after a power outage and to specify the number of restart attempts, as well as the time between restart attempts.
 - l. The VFD shall have bi-directional automatic speed search (flycatcher) for starting into rotating loads. The VFD shall be able to catch a motor spinning in either direction and bring the motor to the desired speed in the proper direction without stopping the motor or tripping the drive.
- 6. Speed Control:
 - a. The VFD shall be capable of accepting an analog input (4-20 mA) speed command that can be scaled, inverted, and/or offset. Unless approved otherwise, the analog speed command shall be scaled: $4-20\text{ mA} = 0 - 100\% = 0 - 60\text{ Hz}$. This scaling is required for drives that are to be controlled by the plant Distributed Process Control System (DPCS).
 - b. The system shall have field adjustable minimum speed (0 to 65 percent), maximum speed (45 to 100 percent), acceleration rate, deceleration rate, continuous current limit (range 50 to 150 percent of inverter capacity), V/Hz ratio, and IR compensation adjustments to insure proper motor performance.
 - c. The VFD shall have an analog output (4-20 mA) that can be configured to report back actual motor speed. Unless approved otherwise, the analog speed feedback shall be scaled: $4-20\text{ mA} = 0 - 100\% = 0 - 60\text{ Hz}$.
 - d. Three programmable preset speeds shall be provided.
 - e. Selectable stopping modes of coast, ramp to stop, or DC brake to stop shall be available.
 - f. Three adjustable skip frequencies shall be provided.
- 7. Drive Control Interface:
 - a. Control Transformers:
 - (1) Provide a control power transformer for each drive control circuit. Control transformers shall be 480 volts to 120 volts and shall be provided with primary and secondary fusing.

- b. Selector Switches:
 - (1) Selector switches shall be non-illuminated. Switches shall be 30.5 mm, heavy-duty, oil tight. Switches shall have double-break silver contacts. All switches shall be maintained contact type unless otherwise indicated on the Drawings. Provide auxiliary contact blocks as indicated on the Drawings or in the Description of Operation. Provide a legend plate for each switch with white engraving as indicated on the Drawings.
 - (2) Selector switches shall be Allen-Bradley Bulletin 800T, NEMA Type 4/13, or equal by Square D.
- c. Push Buttons:
 - (1) Push buttons shall be momentary type, 30.5 mm, heavy-duty, oil tight with silver contacts. Provide a legend plate for each push button with white engraving as indicated on the Drawings.
 - (2) Push buttons shall be Allen-Bradley Bulletin 800T, NEMA Type 4/13, or equal by Square D.
- d. Pilot Lights:
 - (1) Pilot lights shall be 30.5mm, heavy-duty, push to test, transformer type with LED lamps. Voltage rating shall be 120 volts. Color cap shall be green for "run" and red for fault". Provide a legend plate for each switch with white engraving as indicated on the Drawings.
 - (2) Pilot lights shall be Allen-Bradley Bulletin 800T, NEMA Type 4/13, or equal by Square D.
- e. Relays:
 - (1) Relays shall be heavy-duty general-purpose type with 10 amp contacts. Relays shall have terminals, which plug-in to a socket, mounted to the inside of the drive enclosure. Contact configuration shall be 3PDT. Relay coils shall operate on 120 volts AC, unless indicated otherwise on the Drawings. Relays shall have an indicator light to indicate the relay coil is energized.
 - (2) Relays shall be Allen-Bradley, or equal.
- f. Elapsed Time Meters:
 - (1) Elapsed time meters shall be time totalizer, non-resettable. They shall have a synchronous motor, which shall drive a set of digit readout wheels to indicate the total time the unit is energized. Readout shall be five-digit including 1/10 digit. Range shall be 0 to 9999.9 hours. Voltage rating shall be 120 volts.
 - (2) Elapsed time meters shall be ENM Company Series T50, or equal.

- g. Control Wiring:
 - (1) All 120 VAC control wiring shall be red. All 24vdc wiring shall be blue. All wiring in the VFD shall be labeled.
- h. Control Terminal Block:
 - (1) Provide a control terminal block in the MCC cubicle to terminate all control wiring from the field. All terminals shall be labeled with machine printed labels.
- i. The VFD shall have (2) independent, galvanically isolated analog inputs that can be configured for 4-20 mA or 0-10 VDC. (Note: WSSC standard is 4-20 mA). The bias and gain of each input shall be individually programmable.
- j. Digital Inputs:
 - (1) Provide a minimum of five multi-function input terminals, capable of being programmed to determining the function when their state is changed.
 - (2) These terminals shall provide various functions including, but not limited to remote/local selection, remote fault condition, remote reset, and start command.
- k. The VFD shall have (2) independent analog outputs that can be configured for 4-20 mA.
- l. Digital Outputs:
 - (1) Provide (3) programmable relay outputs, including at least (1) Form-C relay, for reporting drive operational status. For DPCS installations, unless approved otherwise, the relay output configuration shall include:
 - (2) Control Mode (1 = Remote, 0 = Manual)
 - (3) Run Status (1 = Running, 0 = Stopped)
 - (4) Fault Status (1 = No Fault, 0 = Fault)
 - (5) These contacts shall be rated at 1A at 250V ac.
 - (6) The outputs shall provide various functions including at-speed, drive healthy, drive fail, drive running, over-frequency, under-frequency, and over-torque, under-torque.
- 8. Control Features:
 - a. The condition or fault shall be annunciated on the diagnostic display panel. This display panel shall have a digital potentiometer to manually adjust the speed and be used for programming and other control features. The panel shall be mounted on the VFD enclosure and not behind a window. Provide all cables and other options to mount the panel on the VFD enclosure door.
 - b. The drive shall instantaneously shut down when a fault condition occurs.
 - c. Automatic shutdown in event of loss of input power and during single phasing. Automatic restart after power resumption.

9. Momentary Overload Protection Circuit:
 - a. The drive shall have an adjustable momentary overload protection circuit (MOPC), or equivalent current limiting feature, adjustable from 50 to 150 percent of drive rating.
 - b. The MOPC shall sense a motor load current exceeding the programmed amount of the drive rating. The circuit shall momentarily reduce the output voltage and frequency until the load is reduced to acceptable levels.
 - c. If the load is such that the motor is in a LOCKED ROTOR condition for more than 4 seconds, the drive shall attempt to protect the motor and shut down on a MOPC fault. The fault shall be annunciated on the digital display panel readout.
10. Motor Overload Protection:
 - a. The drive shall provide Class 10 motor overload protection.
 - b. The overload protection shall be adjustable from 50 to 150 percent of the drive full load current rating.
 - c. Motor overload protection shall meet NEC overload protection requirements and shall be tested in accordance with UL Standard 1991.
11. System shall be modular plug-in printed circuit board design with all components easily accessible from the front of the enclosure.
12. Provide all relays, indicating lights, fuses and any other features and options as shown or required on the Drawings. Control schematics are shown on the Drawings. The indicating lights shall be installed on the VFD control station enclosure.

F. Operational Features:

1. System Operation:
 - a. When in HAND mode, VFD Start/Stop and Speed Setpoint shall be controlled by the keypad/display. Start/Stop pushbuttons and speed pots shall not be installed on the VFD enclosure.
 - b. When in Remote mode, VFD Start/Stop and Speed Setpoint shall be controlled by drive digital and analog inputs.
 - c. If a remote Hand/Off/Remote switch is to be installed at the equipment powered by the VFD, then HAND/REMOTE mode control at the drive keypad/display shall be disabled. THIS IS A SAFETY REQUIREMENT AND SHALL BE OBSERVED.
2. Manufacturer's standard features, unless approved otherwise:
 - a. Sustained power loss.
 - b. Momentary power loss.
 - c. Power interruption.
 - d. Power loss ride through of 2 seconds.
 - e. Start on the fly.
 - f. Stall protection.
 - g. Slip compensation.
 - h. Automatic restart after power return (ability to enable/disable function).

- i. Critical frequency lockout (three selectable points minimum, by 1.5 Hz steps in 10 Hz bands, to prevent resonance of system).
 - 3. VFD maintenance system software for complete programming and diagnostics.
 - 4. Operate with no motor connected to output terminals.
 - 5. Carrier frequency:
 - a. Minimum of six settings to allow adjustment in field.
 - b. At or above 5 kHz without derating to satisfy conditions for current, voltage, and horsepower.
 - 6. Factory settings for all parameters, and capability for those settings to be reset.
 - 7. Capability to adjust the following functions, while VFD is running:
 - a. Forward/Reverse direction.
 - b. Acceleration adjustment from 0 to 3,600 seconds.
 - c. Deceleration adjustment from 0 to 3,600 seconds.
 - d. Minimum of six different preset speeds.
 - 8. Analog output gain to calibrate signal for the application used.
- G. Diagnostics:
 - 1. Comprehensive for drive adjustment and troubleshooting.
 - 2. Visual display of specific fault condition.
 - 3. Memory Battery Backup: 100 hours, minimum, during a power loss.
 - 4. Status messages shall not stop drive from running but shall prevent it from starting.
 - 5. Fault Condition Messages and History: First fault protection function to be activated, ability to store six successive fault occurrences in order.
 - 6. Minimum Faults Numerically:
 - a. Over-current (time and instantaneous).
 - b. Over-voltage.
 - c. Under-voltage (dc and ac).
 - d. Over-temperature (drive, motor windings, motor bearing, pump/fan bearing).
 - e. Serial communication fault.
 - f. Short-circuit/ground fault (motor and drive).
 - g. Motor stalled.
 - h. Semiconductor fault.
 - i. Microprocessor fault.
 - j. Single-phase voltage condition.
- H. Operator Interface at VFD Enclosure:
 - 1. VFD shall include a front mounted, sealed keypad, with illuminated LCD display.
 - 2. Keypad shall provide complete programming, operating, monitoring, and diagnostic capability with 10-key keypad with blue backlit LCD display.
 - 3. VFD display shall provide readouts of output frequency in hertz, output voltage in volts, output current in amps, output power in kilowatts, dc bus voltage in volts, interface terminal status, and fault codes.

4. Displays shall be viewed in easy-to-read illuminated LCD with English language as standard.

I. Enclosure Air Conditioner:

1. Provide a NEMA 12 steel air conditioner for the High Flow Pump VFD.
2. The air conditioner shall be thermostatically controlled, and it shall be mounted on the side of the enclosure.
3. The air conditioner shall be sized to maintain a temperature of 80°F inside the enclosure when all VFDs are operating, and the outside ambient temperature is 90°F.
4. The air conditioner shall operate at 208 volt, single phase power.

- J. Unless approved otherwise, the front mounted VFD controls shall be limited to the keypad/display and pilot light for indication of Drive Stopped, Drive Running, and Drive Fault conditions.

2.3 SPECIAL TOOLS, SPARE PARTS, AND MAINTENANCE MATERIALS

A. Spare Parts:

1. Provide one set of fuses for each drive furnished.
2. Provide one set of circuit boards for each horsepower class of drive.
3. Provide one set of power devices (includes power switching modules, bus capacitors, diode bridge, and MOV or snubber assembly) for each horsepower class of drive.
4. Provide additional spare USB adapter module for each type of VFD equipment furnished.

PART 3 EXECUTION

3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery and Handling:

1. Inspect all equipment and materials against approved Shop Drawings at time of delivery.
2. Equipment or materials damaged or not meeting the requirements of the approved Shop Drawings shall be immediately returned for replacement or repair.

B. Storage:

1. Carefully prepare for storage and label all equipment and materials after they have been inspected.
2. Store all equipment and materials in a dry, covered, ventilated location and protect from harm according to the Manufacturer's instructions.

3.2 FACTORY TESTING

- A. The Commission reserves the right to witness all factory tests. The Commission reserves the right to back charge the manufacturer if a second trip is needed to witness equipment due to problems or errors in fabrication and engineering.
- B. Provide 2 weeks written notice to the Commission so arrangements can be made to witness tests.
- C. Provide three copies of the final factory inspection tests to the Commission.
- D. VFDs:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect for physical damage.
 - (1) If visual inspection reveals VFD damage, broken connections, inoperative breakers or switches; conduct internal inspections and tests as necessary to locate the damage.
 - (2) Submit a detailed report to the Commission. Identify the damage, cause of the damage, and corrective measures taken to assure the Commission of the quality of the VFD.
 - b. Compare equipment nameplate information with latest one-line diagram and record/report discrepancies.
 - c. Verify proper device operation such as breakers, starters MCPs, contact relays, and indicators.
 - d. Verify proper operation of elementary control diagrams and operating control equipment in accordance with drawing intent by simulating external signals.
 - 2. Electrical Tests:
 - a. Check automatic operation of breakers, starters, control relays, and MCPs for close and trip operation from protective relays and operators.
 - b. Perform insulation-resistance tests at 1,000V dc for 1 minute on all control circuit wiring and electromechanical components. Minimum acceptable values shall be in accordance with NETA.
 - c. Verify functions of harmonic correction units and associated devices.

3.3 INSTALLATION

- A. Installation shall be in accordance with the approved Shop Drawings and with the manufacturer's instructions and recommendations.
- B. Adjust all equipment to the best industrial standards. Check and adjust all alignment in the field in the presence of the Commission.

- C. In accordance with manufacturer recommendations to maintain 1,000 psi washdown from 6 inches, provide sealed conduits for all VFD connections to prevent water entry into the enclosure.

3.4 COMMISSIONING

- A. All programming, startup, and testing shall be done by the VFD manufacturer's factory trained and certified field service representative. The manufacturer's representative shall be familiar with and completely skilled in the operation, maintenance, and troubleshooting of VFD equipment. Submit the qualifications of the manufacturer's representative for approval. No programming, startup, or testing shall be allowed without prior approval of the representative.
- B. Each VFD shall be started-up and tested before it is scheduled to be online in the particular construction phase as shown on the Drawings. The following shall be done to each VFD when it is scheduled to be started-up with its associated equipment:
 - 1. Give the equipment a running test in the presence of the Commission to demonstrate compliance with this specification. All field adjustments shall be cycled through the complete range of their adjustments to prove compliance with these specifications.
 - 2. Demonstrate the diagnostic system and test instrument use to Commission personnel.
 - 3. Make and record all initial adjustments of the system. These adjustments are to be arrived at in consultation between the manufacturers' representative and the Commission.
 - 4. Prove to the satisfaction of the Commission that all equipment works as required and as specified and that all adjustments are properly set prior to placing any equipment into service.
 - 5. Furnish complete field installation report including the programming parameters for each drive.
- C. Harmonic Analysis Testing:
 - 1. As part of this scope, the VFD supplier shall provide the services of an independent testing agency certified in harmonic analysis testing. The testing agency shall test the system at each of the points of common coupling (PCC) as described below before installation of any new electrical equipment and when all electrical equipment is fully operational. This testing is to assure that all new electrical equipment complies with IEEE 519.
 - 2. The following information shall be submitted in each test report as a minimum for each PCC:
 - a. Isc: Available short circuit current at the PCC.
 - b. Il: Maximum demand load current.
 - c. Isc/Il: The ratio of the available short circuit current to the maximum demand line current.

- d. TDD: Total demand distortion based on the maximum demand load current for each odd harmonic up to the 35th harmonic.
 - e. THD: Total harmonic distortion.
 - f. Provide wave forms of each measurement sample.
- D. Manufacturer's Commissioning Services:
 - 1. The Contractor shall not directly complete work included in this Article unless approved by the Commission. This work shall be completed by the manufacturer's representative.
 - 2. For bidding purposes, the manufacturer shall provide the services of qualified technical personnel to perform duties and tasks as listed below. Additionally, the manufacturer may be responsible to perform tasks at any time period at the plant and shall not assume that work will be completed during normal daytime business hours. Such services are in addition to the services included in other Articles of this section, such as submittals, training, lesson plans, service manuals and maintenance services, etc.
 - 3. The Commission reserves the right to reject any manufacturer's personnel that are unqualified to complete each duty or task.

3.5 FIELD QUALITY CONTROL AND TESTING

- A. Perform field inspection and testing in accordance with Section 16950, Testing.
- B. Adjusting and Cleaning: Adjust operating mechanisms for free mechanical movement.
- C. Grounding: Provide equipment grounding in accordance with Section 16450, Grounding.

3.6 MANUFACTURER'S FIELD SERVICES

- A. Provide manufacturer's field services in accordance with Section 01640, Manufacturers' Field Services. Manufacturer's field services shall respond to the Commission's request for correction of problems during startup and warranty power within 4 hours.
- B. Training:
 - 1. Provide training to instruct representatives of the Commission and Engineer as follows:
 - a. VFD: 4 hours.

END OF SECTION

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SECTION 16195
ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.1 DESCRIPTION

- A. Provide electrical identification products and components for identification of electrical materials, equipment, and installation, including but not limited to the following:
 - 1. Buried electrical line warnings.
 - 2. Conduits, raceways, cables, and conductors.
 - 3. Electrical manhole and handhole covers.
 - 4. Operational instruction signs.
 - 5. Warning and caution signs.
 - 6. Equipment labels and signs.

1.2 REFERENCES

- A. The following is a list of codes and standards that may be referenced in this section:
 - 1. American National Standards Institute (ANSI): A13.1, Scheme for the Identification of Piping Systems, with regard to type and size of lettering for raceway and cable labels.
 - 2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

1.3 QUALITY ASSURANCE

- A. Comply with applicable portions of Section 16050, Basic Electrical Materials and Methods.
- B. Provide components that are the standard product of a manufacturer regularly engaged in the product of the required materials and equipment.
- C. Comply with applicable codes and standards.
- D. Design to provide satisfactory performance under the specified operating conditions.

1.4 SUBMITTALS

- A. Submit the following in accordance with Section 01330, Submittal Procedures.
 - 1. Product data.
 - 2. Schedule of identification nomenclature to be used for identification signs and labels.
 - 3. Samples of each color, lettering style, and other graphic representation required for identification materials, samples of labels and signs.

PART 2 PRODUCTS

2.1 ELECTRICAL IDENTIFICATION PRODUCTS

- A. Provide Adhesive Marking Labels for Raceway and Metal-Clad Cable:
 - 1. Pre-printed.
 - 2. Flexible.
 - 3. Self-adhesive labels with legend indicating voltage and service (emergency, lighting, power, light, power dc, air conditioning, communications, control, and fire, etc.)
- B. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Provide self-adhesive vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.
- C. Pre-tensioned Flexible Wraparound Colored Plastic Sleeves for Raceway and Cable Identification: Provide flexible acrylic band, sized to suit the raceway diameter and arranged to stay in place by pre-tensioned gripping action when coiled around the raceway or cable.
- D. Underground Line Marking Tape:
 - 1. Provide permanent, bright-colored, continuous-printed, plastic tape compounded for direct-burial service not less than 6 inches wide by 4 mils thick.
 - 2. Provide printed legend, indicative of general type of underground line below.
- E. Wire/Cable Designation Tape Markers: Provide vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letters.
- F. Aluminum, Wraparound, Cable Marker Bands:
 - 1. Provide bands cut from 0.014-inch thick, aluminum sheet, fitted with slots or ears for securing permanently around wire or cable jacks or around groups of conductors.
 - 2. Make arrangement for applying legend with stamped letters or numbers.
- G. Plasticized Card Stock Tags:
 - 1. Provide vinyl cloth with preprinted and field-printed legends to suit the application.
 - 2. Use orange background, except as otherwise indicated, with eyelet for fastener.
- H. Brass or Stainless-Steel Tags:
 - 1. Provide metal tags with stamped legend punched for fastener.
 - 2. Dimensions: 2 inches by 2 inches by 19 gauge.

- I. Engraved, Plastic-Laminated Labels, Signs, and Instruction Plates:
 - 1. Provide engraving stock melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 square inches, or 8 inches in length: 1/8-inch thick for larger sizes.
 - 2. Provide engraved legend in white letters on black face and punched for mechanical fasteners.
- J. Baked-Enamel Warning and Caution Signs for Interior Use: Provide preprinted aluminum signs, punched for fasteners, with colors, legend, and size appropriate to the location.
- K. Fasteners for Plastic-Laminated and Metal Signs: Provide self-tapping stainless-steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.
- L. Cable Ties:
 - 1. Provide fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50-pound minimum tensile strength, and suitable for a temperature range from minus 50 to 350 degrees F.
 - 2. Provide ties of specified colors when used for color coding.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Lettering and Graphics:
 - 1. Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated.
 - 2. Install numbers, lettering, and colors as approved in submittals and as required by code and as specified in Section 16050, Basic Electrical Materials and Methods.
- B. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC.
- C. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
- D. Conduit Identification.
 - 1. Identify Raceways of Certain Systems with Color Banding:
 - a. Provide bands for exposed or accessible raceways for identification.
 - b. Provide pre-tensioned bands, snap-around colored plastic sleeves, colored adhesive marking tape, or a combination of the two.
 - c. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.

- d. Install bands at changes in direction, at penetrations of walls and floors, and at 40-foot maximum intervals in straight runs.
- E. Identify Junction, Pull, and Connection Boxes
 - 1. Provide code-required caution sign for boxes, with pressure-sensitive, self-adhesive type label, indicating system voltage in black, preprinted on orange background.
 - a. Install label on outside of box cover.
 - b. Label box covers with identity of contained circuits.
 - c. Use pressure-sensitive plastic labels at exposed locations.
 - d. Provide similar labels or plasticized card stock tags at concealed boxes.
- F. Underground Electrical Line Identification:
 - 1. During trench backfilling, for exterior underground power, signal, and communications lines, install continuous underground plastic line marker, located directly above line at 6 to 8 inches below finished grade.
 - 2. Where multiple lines are installed in a common trench or concrete envelope, do not exceed an overall width of 16 inches; install a single line marker.
- G. Electrical Manholes and Handholes:
 - 1. Provide identification on all new electrical manhole and handhole covers.
 - 2. Identification shall consist of metal tags with stamped legend punched for fastener. Dimensions shall be 2 inches by 2 inches by 19 gauge.
- H. Install line marker for underground wiring, both direct-buried and in raceways.
- I. Use conductors with factory-applied color on the entire length of the conductors except as follows:
 - 1. Use following field-applied color-coding methods in lieu of factory-coded wire for sizes larger than No. 10 AWG.
 - a. Apply colored, pressure-sensitive plastic tape.
 - (1) Provide half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made.
 - (2) Apply the last two laps of tape with no tension to prevent possible unwinding.
 - (3) Use 1-inch-wide tape in colors as specified.
 - (4) Do not obliterate cable identification markings by taping.
 - (5) Adjust tape locations slightly to prevent obliteration.
 - b. Use of colored cable ties in lieu of pressure-sensitive tape.
 - (1) Apply three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart.
 - (2) Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.

2. Power Circuit Identification:
 - a. Securely fasten identifying metal tags or aluminum wraparound marker bands to cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms.
 - b. Use 1/4-inch steel letter and number stamps with legend to correspond with designations on drawings.
 - c. Where metal tags are provided, attach them with approximately 55-pound test monofilament line or one-piece self-locking nylon cable ties.
- J. Tag or label conductors as follows.
 1. Future connections: Indicate cable for future connection or connection under another contract, with identification indicating source and circuit numbers.
 2. Multiple Circuits: Where multiple branch circuits or control wiring or communications/signal conductors are present in the same box or enclosure (except for three-circuit, four-wire home runs):
 - a. Label each conductor or cable.
 - b. Provide legend indicating source, voltage, circuit number, and phase for branch circuit wiring.
 - c. Indicate phase and voltage of branch circuit wiring by means of coded color of conductor insulation.
 - d. For control and communications/signal wiring, use color coding or wire/cable marking tape at terminations and at intermediate locations where conductors appear in wiring boxes, troughs, and control cabinets.
 - e. Use consistent letter/number conductor designations throughout on wire/cable marking tapes.
 3. Match identification markings with designation used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.
- K. Apply warning, caution, and instruction signs and stencils as follows:
 1. Install warning, caution, or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect.
 2. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation.
 3. Install butyrate signs with metal backing for outdoor items.
 4. Emergency Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch-high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.
- L. Install equipment/system circuit/device identification as follows:

1. Apply equipment identification labels of engraved plastic-laminate on each major unit of electrical equipment in building, including central or master unit of each electrical system. This includes communication/signal/alarm systems unless unit is specified with its own self-explanatory identification.
 2. Except as otherwise indicated, provide single line of text, with 1/2-inch-high lettering on 1-1/2-inch-high label (1-inch-high where two lines are required), white lettering in black field.
 3. Text shall match terminology and numbering of the Contract Documents and shop drawings.
 4. Apply labels for each unit of the following categories of electrical equipment.
 - a. Panelboards, electrical cabinets, and enclosures.
 - b. Access doors and panels for concealed electrical items.
 - c. Electrical substations.
 - d. Motor control centers.
 - e. Motor starters.
 - f. Pushbutton stations.
 - g. Contactors.
 - h. Remote and local annunciators.
 - i. Control devices.
 - j. Transformers.
 - k. Battery racks.
 - l. Disconnect switches.
- M. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, breakers, pushbuttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components, where labeling is specified elsewhere.
- N. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.
- O. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

END OF SECTION

SECTION 16323
DRY TYPE TRANSFORMERS

PART 1 GENERAL

1.1 DESCRIPTION

- A. Provide dry type general-purpose air-cooled transformers as shown on the Drawings and specified herein.
 - 1. Provide appurtenances as specified and as shown on the Contract Documents.

1.2 REFERENCES

- A. The following is a list of codes and standards that may be referenced in this section:
 - 1. American National Standards Institute (ANSI): C89.2, Dry-Type Transformers for General Applications.
 - 2. National Electrical Manufacturers Association (NEMA): ST 20- 86, Dry-Type Transformers for General Applications.
 - 3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

1.3 QUALITY ASSURANCE

- A. Comply with applicable portions of Section 16050, Basic Electrical Materials and Methods.
- B. Provide components that are the standard product of a manufacturer regularly engaged in the production of the required materials and equipment.
 - 1. The manufacturer shall be responsible for the design, construction, and proper operation of all components.
- C. Comply with applicable standards.
- D. Design to provide satisfactory performance under the specified operating conditions.

1.4 SUBMITTALS

- A. Comply with Section 01330, Submittal Procedures. Include the following information:
 - 1. Product data.
 - 2. Shop drawings.
 - 3. Special shipping, storage, protection, and handling instructions.
 - 4. Manufacturer's installation instructions.
- B. Submit the following before transformer shipment:

1. Certified routine test reports (for each transformer) in accordance with ANSI/IEEE Standard C57.12.40 and Section 01330, Submittal Procedures.
 2. Certified production test reports (for each network protector) in accordance with ANSI/IEEE Standard C57.12.44 and Section 01330, Submittal Procedures.
 3. Certified sound level test report.
 4. Installation, operation, and maintenance manuals.
- C. Submit manufacturer's certificates in accordance with the Section 01330, Submittal Procedures.
- D. Submit operation and maintenance manuals in accordance with Section 01330, Submittal Procedures.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver, handle, and store the equipment in accordance with Section 01450, Quality Control.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Dry-Type General Purpose Transformers:
1. Square D Company.
 2. Eaton Electrical.
 3. General Electric.

2.2 DRY-TYPE GENERAL PURPOSE TRANSFORMERS

- A. Provide dry-type general purpose transformers that comply with the following:
1. Energy efficient, dry-type, designed for NEMA TP-1.
 2. kVA, primary voltage and connection, secondary voltage and connection, and number of phases, as specified in the Drawings.
 3. Constructed of highest quality low loss core materials to minimize power loss and vibration.
 4. Core and coil assemblies, mounted on rubber isolation pads to minimize and isolate sound transmission.
 5. Use copper windings.
 6. Provide an electrostatic shield between the windings to attenuate and isolate source line noise. Ground the shield to the enclosure.
 7. Maximum Temperature Rise above 40 Degrees C: 115 degrees C.
 8. Having four 2-1/2 percent taps, two above and two below nominal on primary windings.
 9. Sound Level: 3 dB below NEMA Standard.
 10. Insulation Class: 220 degrees C.

11. Size of Neutral: 100 percent.
12. Provide additional coil capacity to compensate for higher nonlinear load loss.
13. Heavy gauge ventilated indoor enclosure.
14. UL listed.

PART 3 EXECUTION

3.1 FACTORY TESTING

- A. Provide three copies of the final factory inspection tests to the Engineer.

3.2 INSTALLATION

- A. Install transformers as specified by Contract.
- B. Mount transformers with vibration isolators so that the vibrations are not transmitted to the structural parts of the building or to other equipments.
- C. Install conduit system to transformer enclosure using flexible couplings at the transformer to help prevent noise transmission.
- D. Adjust tap settings to provide proper voltage at panelboards with mean average loads energized and operating.
- E. Install transformers in conformance to NEC.
- F. Adjustment: Adjust transformer taps to provide optimum conditions at utilization voltage.
- G. Protection: Apply temporary heating accordance with manufacturer's recommendations within enclosure of each transformer throughout periods during which equipment is not in a space that is continuously under normal control of temperature and humidity.

3.3 FIELD QUALITY CONTROL AND TESTING

- A. Perform field inspection and testing in accordance with Section 16950, Testing.
- B. Grounding:
 1. Provide equipment grounding.
 2. Tighten connections to comply with tightening torques specified by the manufacturers and UL Standard 486A to assure permanent and effective grounding.

3.4 MANUFACTURER'S FIELD SERVICES

- A. Provide services in accordance with Section 01640, Manufacturers' Field Services. Manufacturer's field services shall respond to the Commission's request for correction of problems during startup and warranty power within 4 hours.
- B. Training:
 - 1. Provide training to instruct representatives of the Commission and Engineer as follows:
 - a. Dry Type Transformers: 2 hours.

END OF SECTION

SECTION 16375
UNDERGROUND DISTRIBUTION SYSTEM

PART 1 GENERAL

1.1 DESCRIPTION

- A. Furnish and install complete underground distribution system as indicated and specified.

1.2 REFERENCES

- A. The following is a list of codes and standards that may be referenced in this section:
 - 1. American National Standards Institute (ANSI): C2, National Electrical Safety Code.
 - 2. National Electrical Manufacturers Association (NEMA).
 - 3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

1.3 QUALITY ASSURANCE

- A. Comply with applicable portions of Section 16050, Basic Electrical Materials and Methods.
- B. Provide components that are the standard product of a manufacturer regularly engaged in the production of the required materials and equipment.
 - 1. The manufacturer shall be responsible for the design, construction, and proper operation of all components.
- C. Comply with applicable standards.
- D. Design to provide satisfactory performance under the specified operating conditions.

1.4 SUBMITTALS

- A. Submit following in accordance with Section 01330, Submittal Procedures.
 - 1. Shop drawings of duct banks and manholes.
 - 2. One set of contract drawings showing:
 - a. Exact routing and elevation of all underground conduit, duct banks, and manholes.
 - b. Dimensions of all conduits duct banks, manholes, and bends from buildings or other fixed objects.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Encased Buried Conduit:
 - 1. Carlon Company.
 - 2. Or equal.
- B. Manhole Waterproofing Material:
 - 1. Tnemec Company, Inc.
 - 2. Mobil Chemical Company.
 - 3. Koppers Company, Inc.
 - 4. Or equal.
- C. Cable Supports:
 - 1. Continuous concrete inserts, 1-5/8 inches by 1-5/8 inches by 12 gauge stainless:
 - a. B-Line Systems.
 - b. Or equal.
 - 2. Cable brackets, 18 inches long, hot-dipped galvanized steel:
 - a. B-Line Systems.
 - b. Or equal.
 - 3. Insulators, porcelain cable rack saddle:
 - a. B-Line Systems; B4095.
 - b. Or equal.
 - 4. Columns, bases, braces, angles and other accessories and hardware: Compatible with “continuous concrete inserts” above as a minimum.
 - 5. Stainless steel anchor bolts and expansion anchors: Comply with ASTM 320, A151 Type 316.
- D. Frames and Covers:
 - 1. NEENAH; Cat. No. R-1640-D. (RCQ 4 9/30/13)
 - 2. Or equal.

2.2 ENCASED BURIED CONDUIT

- A. Provide Carlon EB-20.
- B. Or equal.

2.3 MANHOLE WATERPROOFING MATERIAL

- A. Provide heavy duty black, No. 46-449, Hi-Build Bituminous Coating, No. 35-J-10, Bitumastic Super Service Black.
- B. Or equal.

2.4 CABLE SUPPORTS

- A. Provide continuous concrete inserts, high-strength fiberglass nonmetallic supports by B-Line or T&B.
- B. Provide cable brackets of 18-inch long, high-strength fiberglass nonmetallic supports by B-Line or T&B.
- C. Provide insulated, porcelain cable rack saddle equivalent to B-Line type B4095 for use with brackets.
- D. Provide columns, bases, braces, angles and other accessories and hardware compatible with “continuous concrete inserts” above, as a minimum.
- E. Provide anchor bolts and expansion anchors of stainless steel, complying with ASTM 320, A151, Type 316.

2.5 FRAMES AND COVERS

- A. Provide heavy-duty gray cast iron, equivalent to NEENAH Cat No. R-1640-D. (RCQ 4 9/30/13)
 - 1. With lettering on the cover to read ‘ELECTRIC’ for electric system manholes.
 - 2. With lettering on the cover to read ‘COMMUNICATIONS’ for communication system manholes.
 - 3. With machine-finished seat to ensure perfect joint between frame and cover.

2.6 CONDUIT SPACERS

- A. Furnish conduit spacers in duct banks as follows:
 - 1. Made of plastic.
 - 2. Maintain spacing of 3 inches between conduits.
 - 3. Maintain spacing of 6 inches between power and communication conduits.

2.7 CONCRETE

- A. Provide minimum compressive strength, 4,000 psi.

2.8 REINFORCING

- A. Reinforcing steel in duct banks to comply with following:
 - 1. Minimum No. 5 bars at 12 inches O.C. longitudinally each face.
 - 2. No. 4 bars at 24 inches O.C. 12-inch overlapping half stirrups.

2.9 CONCRETE ELECTRICAL MANHOLES:

- A. Precast concrete manholes shall be manufactured under controlled conditions, not subject to the elements, using steel forms, internal and external vibrations of concrete, and subject to periodic testing and control of the Construction Materials Testing Institute.
- B. Concrete shall be produced on a performance basis using 7½ bag mix cement. The strength of the concrete shall be at or greater than 3500 psi in 28 days or at time of delivery. The design strength is determined by ASTM-C-94, Section 15, Table 1, with coefficient of variation of 15% and a required over design factor of 1.14.
- C. Basis for concrete strength is the 6 x 12 test cylinder made in conformance with ASTM-C-31 and tested in conformance with ASTM-C-39.
- D. Placing of the concrete shall be done under controlled conditions with temperatures varying not lower than 50°F nor higher than 85°F. Units are to be allowed to cure for 24 hours before removal to drying yards.
- E. Steel reinforcing shall be H-20 bridge loading proven by calculations drawn by a Registered Structural Engineer using new billet steel welded into cages and installed in steel forms before pouring of concrete.
- F. Manhole shall have heavy-duty frames and lids. Lids shall be self-sealing and shall be stamped "ELECTRIC" or "INSTRUMENTATION" as indicated on the Drawings.
- G. Manholes shall be provided with a fiberglass ladder leading to the bottom of the manhole.
- H. Manholes shall be provided with nonmetallic cable racks as required.
- I. All joints shall be sealed with plastic gaskets. All joints shall be sealed watertight.
- J. The manholes shall be waterproofed by applying two coats of Cooper-Black 760 top-service black protective coating to the outside surfaces of the manhole. The coating shall be applied in strict accordance with the manufacturer's recommendations. Final dry mils thickness shall be 12 mils.
- K. Manholes shall be manufactured by A.C. Miller, Penn Cast, or equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install conduit as follows:

1. Use concrete, spacers, reinforcing, etc., as specified, and as indicated for concrete encased conduits.
2. Follow routing on drawing and run conduits in straight lines as far as possible. Where deviation from a straight line becomes necessary, install bends of sufficient radius for proper pulling and installation of cable.
3. To accomplish changes in direction of runs exceeding total of 10 degrees:
 - a. Provide vertical or horizontal, by long sweep bends having minimum radius of curvature of 25 feet, with following exceptions:
 - (1) Use manufactured bends at ends of short runs of 100 feet or less.
 - (2) Use manufactured bends only at or close to end of run.
 - (3) Install manufactured bends with minimum radius of 36 inches where larger radius cannot be used.
 - b. Long sweep bends made up of one or more curved or straight sections and/or combinations thereof.
4. Lay duct lines to minimum slope of 4 inches per 100 feet and slope to manholes and handholes, as indicated. Duct lines are to slope away from buildings where possible.
5. Install spacers at intervals of approximately 4 feet and stagger between tiers of ducts to provide not less than 12 inches of longitudinal separation. Install base spacers to provide at least 3 inches between bottom of trench and underside of bottom conduits. Completely fill space with concrete. Firmly wire conduits and spacers together before concrete is placed.
6. Prior to placing of concrete, remove all dirt, sand, and any other debris from between conduits and from trench bottoms. Hold conduits in place to prevent floating or accidental movement.
7. Stagger joints in conduit at least 6 inches. Do not allow couplings to rest on bottom of trench. Install couplings for plastic conduit in accordance with manufacturer's recommendations.
8. Install concrete encasements so minimum clearance of 12 inches from concrete to parallel pipes, lines, structures, etc., is maintained. At duct crossings, minimum clearance of 6 inches shall be acceptable.
9. Top of concrete to be minimum 30 inches below finished grade or paving. Submit special conditions, which may require lesser clearances to Engineer for approval.
10. Do not use power-driven vibrators for spading of concrete around ducts. Use wooden slicing tool to eliminate voids in concrete envelope.
11. Roll and grade backfill and restore surface to condition at least equal to which it was found immediately before work was begun, or as otherwise indicated.
12. Provide duct bank markers at ends of all duct banks except at manholes or handholes as follows:

- a. Locate approximately every 200 feet along duct run, and at each change in direction of duct run.
 - b. Refer to specification section 16050 and drawings for duct bank installation details.
 - c. 6-inch square or round section by 3 feet long made of Class B concrete.
 - d. Imprint the letter "D" or cast it on top of the marker.
13. Keep conduits clean of concrete, dirt, and other substances during the course of construction.
- a. After the duct lines have been completed, pull a standard flexible mandrel not less than 12 inches long, having a diameter approximately 1/4-inch less than the inside diameter of the conduit, through each conduit.
 - b. After mandrelling, pull a brush with stiff bristles through each conduit to make certain that no particles of earth, sand, or gravel have been left in the line.
 - c. Replace conduit runs that do not allow the passage of the mandrel at no additional cost to the Commission.
 - d. Pneumatic rodding may be used to draw in the lead wire.
 - e. Plug and seal spare conduits after cleaning and installation of nylon pulling rope.

B. Install Manholes and Handholes as follows:

1. Construct manholes and handholes of Class 4000 concrete cast in place in accordance with Section 03300, Cast-in-Place Concrete.
2. Provide cable racks, hooks, insulators, and other features in manholes, as indicated.
3. Place a 6-inch crushed-stone base under each manhole and handhole.
4. Construct cast-in-place manholes and handholes with forms as follows:
 - a. Complete with centering cores and molds, to conform to shape, form, line and grade required, and maintain sufficient rigidity to prevent deformation under load.
 - b. Make all joints leak-proof and arrange horizontally or vertically.
 - c. Place forms on successive units for continuous surfaces and fit to accurate alignment, assuring a smooth completed surface, free from irregularities.
 - d. Provide sump in manhole floor as detailed on drawings.
5. At convenient point close to wall, drive 3/4-inch by 12-foot-long copper-clad steel ground rod into earth as indicated. Extend ground rod approximately 6-inch above finished manhole floor.
6. After completion of manhole, provide a ground loop of No. 4/0 AWG bare copper ground wire within manhole or handhole and Cadweld to ground rod.
7. Connect all conduit grounding bushings, other metallic parts, splices, ground wires run with each feeder and duct bank ground wire to ground loop. Duct bank ground wire shall be a separate No. 4/0 AWG bare copper wire that shall be run within the concrete encasement.

8. Size, space, and place reinforcing bars and ductwork ground wire as indicated and as specified.
9. Set manhole and handhole frames to the required grade, in full bed of concrete mortar to make watertight connection.
10. Install tops of manhole and handhole covers in unpaved areas approximately 1/2-inch above finished grade, and in paved areas install flush with finished surface of paving.
11. Install inserts in the manholes as indicated.
12. Provide two cable pulling irons in wall opposite each duct bank entrance into manhole.
 - a. Install one 12 inches above floor.
 - b. Install one 12 inches below the roof of manhole.
 - c. Where indicated on drawings, install additional pulling irons and features such as openings in manhole walls for future conduit entrances.
 - d. Seal future entrances with required courses of brick.
13. Where duct lines enter manholes, terminate conduits with PVC to non-metallic adapters.

C. Manhole and Handhole Waterproofing:

1. Apply two coats of bituminous waterproofing material to exterior surfaces of manholes and handholes:
 - a. Apply by brush or spray, in accordance with manufacturer's instructions.
 - b. Allow time between coats to permit sufficient drying.

3.2 FIELD QUALITY CONTROL AND TESTING

- A. Perform field inspection and testing in accordance with Section 16950, Testing.
- B. Grounding:
 1. Provide grounding in accordance with Section 16450, Grounding.
 2. Tighten connections to comply with tightening torques specified by the manufacturers and UL Standard 486A to assure permanent and effective grounding.

END OF SECTION

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SECTION 16400
PANELBOARDS

PART 1 GENERAL

1.1 DESCRIPTION

- A. Furnish and install panelboards including circuit breakers and cabinets complete, in conformance with the latest NEMA Standards and Federal Specifications listed below as shown on Drawings and as specified herein.
- B. Related work specified elsewhere may include but is not limited to:
 - 1. Section 16050, Basic Electrical Materials and Methods.
 - 2. Section 16450, Grounding.
 - 3. Section 16950, Testing.

1.2 REFERENCES

- A. The following is a list of codes and standards that may be referenced in this section:
 - 1. National Electrical Manufacturers Association (NEMA):
 - a. AB1, Molded Case Circuit Breakers.
 - b. PB1, Panelboards.
 - 2. Federal Specifications (FS):
 - a. W-C-375a, b, Molded Case Circuit Breakers.
 - b. W-P-115a, b, c, Panelboards.
 - 3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
 - 4. Underwriter's Laboratories, Inc.:
 - a. 50, Enclosures for electrical equipment.
 - b. 67, Panelboards.

1.3 QUALITY ASSURANCE

- A. Reference Standards: Comply with all federal and the State of Maryland laws or ordinances, as well as all applicable codes, standards, regulations and/or agency requirements.

1.4 SUBMITTALS

- A. Shop drawings of the electrical equipment will not be reviewed until the short circuit analysis, protective device coordination study, and arc flash study are approved by Engineer in accordance with the relevant specification section for Electrical System Protective Device Study and Arc Flash Analysis.

- B. General: Provide all submittals in accordance with Section 01330, Submittal Procedures.
- C. Shop Drawings:
 - 1. Drawings and data covering outlines, wiring diagrams and certified test data reports, shall be submitted in accordance with the Section 01330, Submittal Procedures.
 - 2. Submit time-current characteristic curves for each rating of circuit breaker supplied.
 - 3. Provide a separate circuit schedule with loads for each panelboard.
- D. Service Manuals: Submit in accordance with Section 01330, Submittal Procedures.
- E. O&M Training: Submit in accordance with Section 01330, Submittal Procedures.

1.5 DELIVERY AND HANDLING

- A. Shipping: Ship materials complete with identification and quantity of items.
- B. Acceptance at Site: Inspect and inventory items upon delivery to site.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Contingent upon products' compliance with the specifications, acceptable manufacturers are as follows:
 - 1. 1. ABB / General Electric
 - 2. 2. Eaton

2.2 3. SQUARE D / SCHNEIDER ELECTRICMANUFACTURED UNITS

- A. All panelboards shall be completely factory assembled, deadfront type, with automatic branch circuit breakers.
- B. Furnish panelboards complete with branch circuit breakers and a main circuit breaker, or solderless main lugs only, as indicated on the Drawings.
- C. Furnish panelboards with full capacity separate ground bus and furnish panelboards connected to 3-phase, 4-wire service with an insulated neutral bus.
- D. All circuit breaker connections shall be in hole tapped by the manufacturer.

- E. Furnish the panelboard main, neutral and grounding buses, with minimum 98 percent conductivity rectangular tin-plated copper bars provided with bolted type lugs as necessary.
- F. Tin-plated copper buses, connectors and terminals shall conform to the latest standard requirements.
- G. Prevent terminal lugs from turning per NEMA standard PBI and ensure they are suitable for the conductor material and size.
- H. The design of the interior shall permit replacement of circuit breakers without disturbing adjacent units and without machine drilling or tapping.
- I. Install panelboard in motor control center (MCC) if shown on the Drawings. Panelboard shall be provided and installed by the MCC manufacturer when installed in the MCC.

2.3 EQUIPMENT

- A. Ratings:
 - 1. Voltage ratings listed below shall apply to each panelboard, as shown on the drawings.
 - a. 480 volt, 3-phase, 3-wire, 60-Hz.
 - b. 480/277 or 120/208 volt, 3-phase, 4-wire, 60-Hz.
 - c. 120/240 volt, 1-phase, 3-wire, 60-Hz.
 - d. 125 volts, 2-wire, dc.
 - 2. Provide main bus-bracing for each ac panelboard adequate for 22,000 amperes rms symmetrical short circuit for 120/208 volts 60-Hz panelboards and 65,000 amperes rms symmetrical short circuit for 480 volts 60-Hz panelboards.
 - 3. Provide main bus-bracing for each dc panelboard adequate for 10,000 amperes rms symmetrical short circuit at 125V dc, unless approved otherwise.
- B. For all circuit breakers:
 - 1. Furnish bolt-on type branch and main circuit breakers. Furnish frame sizes, trip settings and number of poles as indicated. Clearly and visibly mark circuit breakers with ampere trip rating.
 - 2. Furnish all breakers with quick-make, quick-break, toggle mechanisms and thermal-magnetic, inverse time-limit overload and instantaneous short circuit protection on all poles, unless approved otherwise. Automatic tripping shall be indicated by the breaker handle assuming a clearly distinctive position from the manual ON and OFF position. Furnish breaker handle that is trip free on overloads. Multi-pole breakers shall be common trip.

3. Do not use single pole breakers with handle ties or bails in lieu of multi-pole breakers.
4. Furnish non-padlocking type handle lock device on breakers where indicated on schedules to prevent the manual opening of the selected breakers, unless approved otherwise.
5. Furnish padlocking device on breakers as indicated to prevent the opening of indicated breakers.
6. Ensure that voltage and interrupting rating of all breakers in a panelboard is not less than voltage and short circuit rating of the panelboard main buses, as indicated. Furnish breakers suitable to operate satisfactorily at the frequency indicated.
7. Furnish ground fault interrupter circuit breakers for certain circuits as indicated on the Drawings.
8. Furnish single pole breakers with full module size. Do not install two pole breakers in a single module.
9. Provide solderless lug type breaker terminals.
10. Where schedules indicate space for future breakers, provisions shall be such that no additional connectors will be required to add breakers.

C. Branch Circuit Breakers:

1. 480-volt rating, 225- and 100-ampere frame, minimum interrupting rating 65,000 rms symmetrical amperes at 480 volts, or as shown on the Drawings.
2. 120/240-volt, 60Hz, 100-ampere frame, minimum interrupting rating 22,000 rms symmetrical amperes at 120 volts, or as shown on the Drawings.
3. 125V dc, 100-ampere frame minimum interrupting rating 10,000 rms symmetrical amperes volts, or as shown on the Drawings.
4. 1 pole, 2 pole, and 3 pole with trip settings as shown on the Drawings.

D. Main Circuit Breakers:

1. 480-volt rating, 225-ampere frame, minimum interrupting rating 65,000 rms symmetrical amperes at 480 volts, or as shown on the Drawings, whichever is greater.
2. 240-volt rating, 100-ampere frame, minimum interrupting rating 22,000 rms symmetrical amperes at 240 volts, or as shown on the Drawings, whichever is greater.
3. 125V dc, 100-ampere frame minimum interrupting rating 10,000 rms symmetrical amperes or as shown on Drawings, whichever is greater.
4. 2- or 3-pole with trip settings as shown on the Drawings.

2.4 COMPONENTS

A. Cabinets:

1. Provide NEMA 12 cabinets, unless approved otherwise, without knockouts. Drill cabinets only for the exact conduit entrances and mounting bolts.
2. Finish cabinet fronts, trims, and surface-mounted boxes in ANSI 61 light-gray enamel over a rust-inhibitive primer. Attach the fronts (exterior trims) to the boxes or interior trims, by quarter-turn, indicating trim clamps. Design cabinets for surface or flush mounting as indicated.
3. Unless approved otherwise, construct panelboard cabinets of code-gauge galvanized, sheet steel and equip with gutters of size in accordance with NEC for the risers and outgoing circuits. Ensure that the cabinets do not exceed 78 inches in height.
4. Panelboards shall have dead-front shield to provide access to wiring gutters with front removed, without exposing bus compartment.
5. Furnish fronts with adjustable trim clamps for attachment to front of panelboard enclosure.
6. Complete fronts with doors, catches, and spring-loaded door pulls. Catch and door pull assembly not to extend beyond front of door. Three-point catch, and vault-type handle provided on all doors over 48 inches high, doors over 24 inches wide, and on all double doors. No door locks to be provided.
7. Attach doors to fronts with semi-concealed or concealed hinges.
8. Continuous piano hinges provided on all doors over 36 inches high.
9. Identify each circuit by typewritten directory with transparent tough plastic cover, fastened to inside surface of door.
10. Install panelboard in MCC if shown on the Drawings.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Mount all panelboards such that the height of the top operating handle does not exceed 6 feet 6 inches from the floor. Install all conduit, wiring, and grounding as indicated.
- B. All circuit breakers installed in existing panelboards shall be manufactured by the original panelboard manufacturer and shall be fully compatible with the panelboard.

3.2 FIELD QUALITY CONTROL

- A. Make required continuity and operational tests. Provide directory card filled-out.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Provide services in accordance with Section 01640, Manufacturers' Field Services. Manufacturer's field services shall respond to the Commission's request for correction of problems during startup and warranty power within 4 hours.
- B. Training:
 - 1. Provide training to instruct representatives of the Commission and Engineer as follows:
 - a. Panelboards: 1 hour.

END OF SECTION

SECTION 16450 GROUNDING

PART 1 GENERAL

1.1 SCOPE

- A. Furnish and install a single, complete, electrically continuous grounding system, including all conductors, raceways, and connections, specified, and indicated.
- B. Install and connect the ground system, in order to furnish an adequate ground for the electronic and electrical equipment, in conformance to the National Electrical Code and as shown on the Drawings and described herein.
- C. Electronic equipment and wiring grounding directions shall be closely adhered, to prevent ground loops and stray signal generation.

1.2 QUALITY ASSURANCE

- A. Reference Codes, Standards and Applicable Provisions:
 - 1. National Electrical Code (NEC).
 - 2. National Fire Protection Association (NFPA).
 - 3. American National Standards Institute (ANSI).
 - 4. National Electrical Manufacturers Association (NEMA).
 - 5. Institute of Electrical and Electronic Engineers (IEEE).
 - 6. Insulated Cable Engineers Association (ICEA).
 - 7. American Society for Testing and Materials (ASTM).
 - 8. Underwriters' Laboratories, Inc. (UL).
- B. Tests
 - 1. Measure ground grid resistance with earth test megohmmeter
 - 2. Install additional ground rods and conductors as required until resistance to interconnected ground system is 5 ohms or less.
 - 3. Measure ground resistance in normally dry conditions and not less than 48 hours after rainfall.

1.3 SUBMITTALS

- A. Shop and working drawings shall be provided in accordance with Sections 01300 and 16050.

PART 2 MATERIALS

2.1 ACCEPTABLE MANUFACTURERS

- A. Contingent upon products compliance with the specifications.
- B. Ground rods:

1. Copperweld Corporation, 2 Oliver Plaza, Pittsburgh, PA.,
 2. ITT Blackburn Company,
 3. Approved Equal.
- C. Exothermic Welding.
1. Erico Products Inc., Cleveland, Ohio.
 2. American Brass Mfg. Co.
 3. Therm-O-Weld by Burndy Corporation
 4. Approved Equal.
- D. Connecting Hardware.
1. American Brass Mfg. Co.
 2. Anderson Electric Corp.
 3. Burndy Corporation
 4. O.Z./Gedney, Division of General Signal Corporation
 5. Approved Equal.

2.2 CONDUCTORS

- A. Cables or wire shall be Class A bare or insulated copper, sizes as indicated on the Drawings or as required by the National Electric Code. All conductors shall be protected if physical damage would result from exposure.
- B. Main grounding conductors, grounding electrode conductors and main bonding jumpers shall be no smaller than #4/0 stranded bare copper cable, annealed, with no less than nineteen (19) strands in the cable unless approved otherwise.
- C. Furnish bare conductors where buried in earth or where embedded in concrete.
- D. In buildings run insulated grounding conductors with green insulation only.
- E. Furnish insulated grounding conductors with insulation rated at 600 volts.
- F. Furnish grounding conductors for installation in all non-metallic raceway in addition to, and not to be considered as, the neutral wire of the systems.

2.3 CONNECTIONS

- A. Make all buried and concealed ground connections by exothermic welding.
- B. Make accessible connections to structural members by exothermic welding process or by bolted connectors. Make connections to equipment or ground bus by acceptable bolted connectors suitable for and matching grounding provisions furnished.
- C. All clamps, connectors, lugs, bolts, washers, and nuts shall be silicone bronze and shall be Everdur.

- D. In manholes, for buried ground grid connections, and were indicated on the Drawings, ground cable connections shall be made by Cadweld exothermic welding process.
- E. Apply grounding bushings on both ends of conduit run and intermediate enclosures.

2.4 GROUND RODS

- A. Ground rods shall be copper clad steel ground rods 3/4-inch in diameter of a single 10-foot length.
- B. Rods shall have a rolled scar-resisting surface, with both ends of the rod receiving the same heavy coating of copper as the body of the rod.
- C. The end of the driving rod shall be chamfered, and the point shall be machined smooth, to aid in driving.

PART 3 EXECUTION

3.1 INSTALLATION OF GROUNDING CONDUCTORS

- A. Install grounds conductors so not exposed to physical damage.
 - 1. Install connections firm and tight.
 - 2. Arrange conductors and connectors so no strain on connections.
- B. Bury equipment grounding conductors 24-inch deep. Bring loops or taps up for connections to equipment or other items to be grounded.
- C. All grounding conductors shall be installed in conduit except the grounding electrode conductor or were shown otherwise.
- D. Connect building steel to the station ground system using bonding cable with exothermic welds.
- E. Install loop type, low impedance, grounding system interconnecting all components so at least two ground connections are provided for each major item of electrical equipment. Ensure that severing of any single grounding conductor in this system does not remove grounding protection on any major item.
- F. Perform exothermic welding with properly sized molds in good conditions.

3.2 INSTALLATION OF GROUND RODS

- A. Install ground rods at manholes, substations and buildings whether indicated on drawings or not.
- B. Make connection to overall grounding system as indicated.

- C. Ensure that final resistance of interconnected ground system is 5 ohms, or less. Measure ground resistance in normally dry conditions and not less than 48 hours after rainfall.

3.3 EQUIPMENT GROUNDING

- A. Ground all electrical equipment by means of a grounding conductor installed in raceway feeding that equipment with copper wire sized in accordance with National Electric Code. Grounding conductors installed in conduit shall be furnished with green, 600-volt insulation.
- B. Connect transformer cases and neutrals to grounding system.
 - 1. Connect neutral ground connection at transformer terminal as shown on drawings.
 - 2. Provide two separate, independent, diagonally opposite, connections for power transformers so removal of one connection will not impair continuity of other unless approved otherwise.
- C. Connect two separate ground connections from ground grid to ground bus of switchgear assemblies and all outdoors substation equipment. Ensure that each connection for the item of equipment is from different section of ground grid.
- D. Install a separate grounding conductor from ground system to all 480-volt motors and equipment, in addition to raceway system.
 - 1. Ground motor ground connection to motor frame, independent of mounting bolts or sliding base.
 - 2. Ground motor to nearest point on grounding system, unless approved otherwise.
- E. Scrape bolted surfaces clean and coat with oxide-resistant conductive compound.
- F. All conduit and armored cables leaving the service equipment and/or motor control centers shall be grounded to the service equipment and/or motor control center ground bus.
- G. Ground each lightning mast to ground rod driven near base of mast, in accordance with requirements of UL.
- H. Where lightning arresters are furnished with electrical equipment and ground connections are not inherently provided, ensure that suitable separate grounding conductor connects lightning arresters with system ground.
- I. Ground wire fences when used to enclose electrical equipment. Unless approved otherwise, provide minimal grounding by buried outside peripheral ground loop; connections to each corner fence post and nearby ground rod; flexible connections to each gate; and at least two connections to grounding system from approximately opposite positions of fence.

- J. Also connect the ground rods to the grounding conductor run with the direct burial cable.

3.4 INSTRUMENTATION GROUNDING

- A. Install separate main ground conductors for all DC circuits and instrumentation panels and instruments.
- B. Connect DC and instrumentation grounds to the main station grounding system at a properly selected point as shown on the Drawings or as recommended by the instrumentation supplier.
- C. Shielded cable shall be grounded at one location only in accordance with the recommendation of the instrumentation manufacturer/supplier.

3.5 FIELD QUALITY CONTROL

- A. Field inspection and testing shall be performed in accordance with Section 16950.

END OF SECTION

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SECTION 16480
MOTOR CONTROL CENTERS

PART 1 GENERAL

1.1 DESCRIPTION

- A. Provide 600V rated motor control centers (MCCs) complete for operation on a 480V, 60 Hz system, as indicated on the Drawings and as specified herein.
 - 1. Include motor circuit protectors, circuit breakers, fuses, variable frequency drive, non-reversible motor starters, and other protective equipment as shown on the drawings to form a complete and fully assembled unit. Provide all components therein to be standard products of one manufacturer, except where specifically required or approved otherwise.
 - 2. Provide appurtenances as specified and as shown in the Contract Documents.
- B. Products Installed in MCC but Specified in Other Sections
 - 1. Section 16323 – Dry Type Transformers
 - 2. Section 16400 – Panelboards

1.2 REFERENCES

- A. The following is a list of codes and standards that may be referenced in this section:
 - 1. American National Standards Institute (ANSI):
 - a. C39.1, Electrical Analog Indicating Instruments.
 - b. C57.13, Standard Requirements for Instrument Transformers.
 - c. ANSI/IEEE C62.41-1991, Surge Withstand Capacity.
 - 2. Canadian Standards Association (CSA): 22.2, No. 14 and No. 66 – CSA Requirements for Power Electronics.
 - 3. Federal Commerce Commission (FCC); Part 15, Sub Part J, Class A – RFI/EMI Emission Standards.
 - 4. International Code Council (ICC): ICBO Building Code, Section 16, Seismic Zone 4 – Vibration Standard.
 - 5. National Electrical Manufacturers Association (NEMA):
 - a. ABI, Molded Case Breakers.
 - b. EI2, Instrument Transformers.
 - c. ICS, Industrial Controls and Systems.
 - d. II2, Electrical Indicating Instrument-Relays.
 - e. KSI, Enclosed Switches.
 - 6. Underwriter's Laboratories Inc. (UL):
 - a. 508C, UL Requirements for Power Conversion Equipment.
 - b. 845, Motor Control Centers.

1.3 QUALITY ASSURANCE

- A. Comply with applicable portions of Section 16050, Basic Electrical Materials and Methods.
- B. Provide components that are the standard product of a manufacturer regularly engaged in the production of the required materials and equipment.
 - 1. The manufacturer shall be responsible for the design, construction, and proper operation of all components.
 - 2. The Motor Control Center and all components shall be designed, manufactured, and tested in accordance with the latest applicable standards of NEMA, ANSI and UL 845.
- C. Comply with applicable standards.
- D. Design to provide satisfactory performance under the specified operating conditions.

1.4 SUBMITTALS

- A. Shop drawings of the electrical equipment will not be reviewed until the short circuit analysis, protective device coordination study, and arc flash study are approved by the Owner in accordance with the specification section for Electrical System Protective Device Study and Arc Flash Analysis.
- B. Submit the following in accordance with Section 01330, Submittal Procedures.
 - 1. Front view elevation
 - 2. Floor plan
 - 3. Top view
 - 4. Unit wiring diagrams
 - 5. Nameplate schedule
 - 6. Starter and component schedule
 - 7. Conduit entry/exit locations
 - 8. Assembly ratings including:
 - a. Short-circuit rating.
 - b. Voltage
 - c. Continuous current
 - 9. Major component ratings including:
 - a. Voltage
 - b. Continuous current
 - c. Interrupting ratings
 - 10. Cable terminal sizes
 - 11. Product data sheets
- C. Where applicable the following information shall be submitted to the Owner:
 - 1. Busway connection
 - 2. Connection details between close-coupled assemblies
 - 3. Key interlock scheme drawing and sequence of operations.

4. Special shipping, storage, protection, and handling instructions.
 5. A list of manufacturer's recommended parts required to maintain the equipment for a period of one year, with current price information.
 6. A list of special tools, materials, and supplies furnished with the equipment for use prior to and during startup, and for future maintenance.
 7. Manufacturer's installation instructions.
- D. Submit the following before MCC shipment:
1. Final as-built drawings and information for items listed in Paragraph 1.4, B & C and shall incorporate all changes made during the manufacturing process.
 2. Unit wiring diagrams
 3. Installation information
 4. Seismic certification and equipment anchorage details as specified.
 5. Certified Routine Test reports in accordance with NEMA Standard and Section 01450, Quality Control, for tests including but not limited to following:
 - a. Continuity checks of each conductor against the schematic or elementary diagram, not against the connection diagram.
 - b. Proper sequence of operation of the control circuit.
 - c. Dielectric test performed as follows:
 - (1) Test voltage equal to 1,000 volts plus twice the rated voltage of the equipment applied for a period of 60 seconds, between each terminal and all other terminals with breakers and contactors open.
 - (2) Apply same test voltage between each terminal and grounded metal part, with breakers and contactors closed.
 - d. Above tests are in addition to tests required in accordance with Section 16950, Testing.
 6. Certified Production Test reports in accordance with ANSI/IEEE Standard and Section 01450, Quality Control.
 7. Submit operation and maintenance manuals before providing training to Commission personnel in accordance with Section 01450, Quality Control.
 8. A list of special tools, materials, and supplies furnished with the equipment for use prior to and during startup, and for future maintenance.
- E. Submit manufacturer's certificates in accordance with the Section 01330, Submittal Procedures.

1.5 SPECIAL TOOLS AND SPARE PARTS

- A. Provide spare parts recommended by the manufacturer. At a minimum, provide the following spare parts.
1. Four standard packages of each size of control fuse furnished under this Contract.
 2. Four LED lamps of each color for indicating lights.

3. One spare overload heater for each size furnished under this Contract, up to a maximum of six for any one-size overload heater.
 4. One spare current limiter for each size current limiter supplied per MCC.
 5. Two sets of covers which can be used to close all openings in doors when a unit is removed. Cover to match finish.
 6. One spare unit for each ten or less of each size or type of each of the following components furnished under this Contract.
 - a. Elapsed time meters.
 - b. Control power transformers.
 - c. Switch contact blocks.
 - d. Control relays.
 - e. Control coils for each size starter.
 - f. Starter contact kits including moving contacts, stationary contact springs, screws, etc. for each size starter or contactor.
 - g. Timers, time delay relays and meter relays
- B. Furnish one complete set of special tools required to disassemble, service, repair and adjust the equipment.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. MCCs:
1. ABB / General Electric.
 2. Eaton.
 3. Square D / Schneider Electric

2.2 MCC

- A. Provide MCCs of Advantage model as manufactured by Eaton Electrical, or Model 6 as manufactured by Square D.
1. Provide overall dimensions of the MCC to accommodate within the space assigned.
- B. Having the following operating characteristics:
1. Suitable for 480 volt, 60-Hz, 3-phase, 4-wire, AC supply.
 2. Designed to withstand symmetrical short circuit amps as given on drawings.
- C. NEMA Class II, Type C.
- D. Having the following constructional features:
1. Totally enclosed, self-supporting and free-standing type, NEMA 12 structure.
 2. Dead front, consisting of 20 inches deep (nominal) by 20 inches wide by 90 inches high vertical sections bolted together to form a unit assembly, with the front forming a continuous lineup of a uniform height.

3. Obtain Owner's approval for oversized equipment as long as MCCs can be accommodated in the designated room in compliance with the NEC.
4. Each structure fabricated of steel sheets with heavy-formed steel uprights, top and bottom structural angle frames, and removable top plate.
5. Steel uprights carrying guide rails and steel clips of the quick fastener type for the support of removable starter units.
6. Each structure designed for easy removal or addition of units, as required in future.
7. Each structure designed to provide proper ventilation and to permit mounting of unit starters anywhere within the structure without any change in overload heater ratings.
8. Units of modular design, having minimum height of 12 inches and constructed in multiples of 6 inches plus or minus 1/2 inch, arranged as shown on the drawings.
 - a. Size No. 1 or 2 starters designed to fit into 12-inch or 13-inch units.
 - b. Each single vertical stack suitable to accommodate minimum of six size No. 1 or 2 starter units, each 12 or 13 inches high.
 - c. Units, front mounted only unless approved otherwise.
9. Each structure having removable gasketed top cover plates provided for conduit entry to the top of the horizontal wireway.
10. End sections having gasketed cover plates to close off horizontal bus and wireway openings; removable for adding vertical sections in future.
11. All provisions and spaces to have barriers, buses, doors, etc., so future use requires only the addition of divider pans and guide rail units.
12. All removable covers and pans, not larger than 48 inches high and 24 inches wide and including proper closure strips.
13. All components including bolts for bus connections and bus supports, front accessible.
14. Provide lifting angles securely bolted to the top of the structures for ease of handling in shipment. Defected or distorted structures shall be rejected. Remove the angles and seal the holes after the control centers are placed in permanent locations.
15. Furnish 3-inch galvanized steel base channels with bolt holes, for anchoring the control center to the concrete base. Extend the steel side sheets and the bottom wiring trough doors to the concrete base, covering all exposed metal. Supply a base channel for the front and for the rear of each MCC stack. Ship these channels in advance of the MCC for embedding in the concrete pad or floor slab. Include accurate templates and dimensions with the base channels.
16. Ensure electrical continuity between all metal non-conducting parts.

E. Having wiring troughs as follows:

1. Each structure provided with top and bottom horizontal wiring troughs and vertical wiring troughs, with all troughs accessible through outside doors.
2. All wiring troughs, isolated by barriers from starter and circuit breaker units and from buses.

3. Each top and bottom horizontal wiring trough, having adequate conduit entrance space, free of interference from the bus barriers and the structural members, for the largest conduit required.
 4. Vertical wiring troughs, equipped with cable tie supports to hold cables and wiring in place.
 5. Vertical wiring troughs, having a separate hinged door, with maximum of two doors per section.
 6. Vertical wiring troughs, fully enclosed except for openings into horizontal wireways and openings into structure units.
 7. All openings having rounded edges or grommets to protect wiring entering wireway. Provide removable covers for all unused openings.
 8. Access to the wiring troughs available without opening the unit door.
- F. Provide bus system as follows:
1. Main horizontal three-phase bus:
 - a. Tin-plated over entire length to minimum thickness of 0.1 mil.
 - b. Use hard drawn, high conductivity copper bar.
 - c. Continuous current rating, as shown on the drawings, UL rated. Maximum current density for copper limited to 1,200 amps per square inch.
 - d. Busbars extending the full length of the structure across the top of each structure and supported by bus supports of a noncarbonizing material, resistant to moisture, acid, and alkali, braced for short circuit current stresses caused by currents of a magnitude as shown on the Drawings.
 - e. Provide one-piece busbars without splices, except where necessary for shipping.
 - f. Provide drilling at both ends of the bus for future extension.
 - g. Provide uniform phase sequence of busbars throughout each structure, in accordance with industry standard and identify and label on the front and rear in each structure to indicate phase sequence.
 - h. Arrange bus phase bars edge to edge and stack vertically one above the other.
 2. Vertical Bus:
 - a. Rising to the full height of structure, supported by insulators of the same material as the horizontal bus supports, for distribution of power from the main bus to the starter units.
 - b. Braced for same rating as the main horizontal bus.
 - c. Use extra hard drawn adequately sized rectangular high conductivity copper bars, round edged and tin-plated to minimum thickness of 0.1 mil over its entire length, and providing a lubricated low resistance contact for the stab bus connectors.
 - d. Rated to carry the full load current of all circuit breakers installed in that section, but in no case less than 300 amperes capacity.
 - e. All bus joints, tin-plated.

- f. Provide uniform phase sequence throughout each structure, in accordance with the industry standard and label on the front and rear in each structure to indicate phase sequence.
 - g. Provide ganged shutters or insulating plugs for each starter compartment including all compartments shown as PROVISION or SPARE or SPACE. Provide means for closing shutters or installing the plugs from the front of structure without the necessity of removing nuts, bolts, brackets, etc.
 - 3. Grounding Bus:
 - a. Extending the full length, mounted across the bottom, without splices, except where necessary for shipping.
 - b. Adequately sized hard drawn, high conductivity copper completely tin-plated to a minimum thickness of 0.1 mil.
 - c. Drilled with lugs of appropriate capacity as required.
 - d. Having provisions for future addition at either end.
 - e. Bolted to each vertical structure with paint removed at point of contact.
 - 4. Busbar connections easily front accessible with simple tools. Provide stainless steel everdure or cadmium-plated steel bolts, nuts, washers and locking devices.
 - 5. All horizontal bus joints, easily accessible from the front for inspection and maintenance and isolated from the wireway by sliding polyester doors or removable steel barriers.
 - 6. All busbars except ground bus, isolated and insulated with polyester barriers in front of, rear of and between phase bars. Also furnish horizontal barriers below vertical bus to prevent accidental contact with wire snake.
- G. Furnish Unit Compartments as follows:
 - 1. Removable unit enclosures constructed from not less than 14-gauge sheet steel, with construction providing isolation and baffling of each unit from the other units.
 - 2. Provide unit compartments as part of the enclosure. Include plug-in stabs, fabricated of high spring strength, high conductivity copper alloy, silver-plated and mounted on an insulating base of the same material as used for the main bus supports, for connection to the vertical bus for circuit breakers 400-amp trip and less. Provide bolt-in arrangement for higher rated breakers.
 - 3. Across the line starter, NEMA 4 and smaller, draw out or plug-in type.
 - 4. Having guide rails for accurate alignment both horizontally and vertically within the structure, to eliminate possible damage to the bus.
 - 5. Provide units with a latch lever for padlocking in the tilt-out position (stabs disengaged from the bus) isolating the unit from the power circuit.

6. Having individual gasketed dust tight front door for each unit compartment. Provide formed pan or rolled edge type doors with closed corners designed to open at least 90 degrees. Each door having at least two hinges. Doors more than 35 inches high shall have at least three hinges and doors over 48 inches high shall have at least four hinges. Provide self-aligning type door closing fasteners that cannot be pulled out of the door. Removable covers over 6 inches high shall have at least four fasteners. Provide accurate three-dimensional alignment for all doors.
7. During unit removal, the doors remain in place to permit closing and fastening.
8. Unit doors, interlocked to inhibit opening of the door until the breaker is in "OFF" position. Provide an interlock defeat mechanism for maintenance bypass.
9. Drawout or plug-in units of the same size and same type to be interchangeable where possible. Use identical wiring numbers for all wiring of components in similar units. Connect wires to the same terminals on their respective terminal blocks. Include nameplates on each unit to define the compartments into which the unit is installed. When required to deter phase reversal, mark the units "Front Only" or "Back Only," as applicable.
10. Provide components as follows:
 - a. Use circuit breakers and combination type motor starters in the control centers.
 - b. Mount disconnect operating mechanism on the disconnect, not on the unit door, with "locking" feature available in both, the open and closed positions.
 - c. Include all control units and accessories as indicated on the schematic control circuits on the Drawings.
 - d. Mount all components of a given unit, inside the unit.
11. Provide terminal blocks as follows:
 - a. 30-ampere disconnect type, mounted on drawout or plug-in units for all external control and indicating wiring.
 - b. Rated 600-volt for power wiring with current rating as required by loads. Use disconnect type, for loads through size No. 2.
 - c. Having marked strips on fixed and removal section.
 - d. Provide a minimum of two spare terminals.
 - e. Accessible from the front to provide easy control unit installation and removal and to facilitate field wiring.
 - f. Factory wired, such that disconnection of any wiring is not necessary for unit withdrawal.

H. Circuit Breakers:

1. Type:
 - a. Thermal-magnetic, molded case, with each pole of the breaker providing inverse time delay overload protection and instantaneous short-circuit protection.

- b. Magnetic only, molded case motor circuit protectors, for three phase combination motor controllers.
 2. Minimum interruption ratings at least equal to the available short circuit at the line terminals, and in no case less than 42,000 amperes. All poles open, close and trip simultaneously.
 3. Operated by a toggle type handle and having a quick-make, quick-break over center switching mechanism that is mechanically trip free from the handle.
 4. Tripping due to overload or short circuit clearly indicated by the handle automatically assuming a position mid-way between the manual ON and OFF positions.
 5. Terminals listed with UL, suitable for use with aluminum or copper cable.
 6. Completely enclosed in a molded case, listed with, meet the appropriate classifications of Federal Specifications WC375, and conform to the National Electrical Code.
 7. Frame sizes and trip settings as shown on the Drawings. Minimum frame size, 100 amps.
 8. Circuit breakers with a 400-ampere frame and larger having removable, interchangeable trip units and adjustable magnetic trip elements lockable in the open position.
 9. Provide relays internally mounted within associated breaker cubicle.
 10. Lead all interconnecting wiring to terminal strips on individual devices.
 11. Provide indicating lights, amber-LED and white-microfilament cluster type, R. Stahl Inc. Model 8415. All indication lights shall be LED push-to-test type.
- I. Provide Motor Circuit Protectors and Current Limiters, Additional Features:
1. Sealed trip unit.
 2. Clearly marked ampere rating.
 3. Nonwelding silver alloy contacts.
 4. Individual instantaneous short circuit protection provided by single, adjustable, magnetic only element.
 5. All poles adjusted simultaneously by single adjusting screw.
 6. Motor circuit protector (MCP) and starter with minimum interrupting rating as indicated on the drawings at 480V ac based on NEMA test procedures.
 7. Suitable for use with current limiters; provided where indicated on the Drawings.
 8. Motor circuit protector, limiter and starter with minimum interrupting rating as indicated on the drawings at 480V ac based on NEMA test procedures.
 9. Limiters completely enclosed in a molded case with built-in trip indicator.
 10. Limiters fully coordinated with MCP such that protector clears all low-level faults without limiter reacting and on high faults, opens all three phases if limiter operates.
 11. Select ratings to provide complete protection of, and coordination with, starter overload relays and heaters and comply with following:

- a. Verify motor horsepower.
 - b. Install ratings as required by the NEC for nameplate full load currents of the motors actually installed.
 - c. Furnish proof of coordination to the Owner.
- J. Motor Starters:
- 1. Type, rating and features:
 - a. Magnetic coil operated.
 - b. Horsepower rated.
 - c. Equipped with three overload elements.
 - d. Equipped with a fused epoxy encapsulated control power transformer for 120-volt pilot control.
 - 2. Starter coils suitable for 120 volts, single phase, and 60-Hz operation and having under voltage release.
 - 3. All controllers of combination MCP type.
 - 4. All combinations of motor size, fuse size, circuit breaker size, overload size and contactor size conforming to the National Electrical Code.
 - 5. Of following functional types as shown on the drawings:
 - a. Full voltage.
 - b. Single or two speed.
 - c. Reversing or non-reversing.
 - d. Reduced voltage, wye-delta.
 - 6. Reduced voltage, wye-delta starters to be closed transition type with all contactors fully rated to the starter size. Provide size No. 5 starter with all size No. 5 contactors.
 - 7. Minimum starter size, NEMA Size 1.
 - 8. Include a separate 480/120-control power transformer in the starter enclosure, as follows:
 - a. Dry type, 2 winding, epoxy encapsulated, and single-phase unit.
 - b. Having large enough capacity to furnish power to all equipment connected to it, including devices external to the starter, and having an additional 25 percent spare capacity.
 - c. Provide 2 primary legs fused and one secondary leg fused and the other grounded for each starter.
 - d. Primary leg fuses of Bussman Type FNQ or approved equal.
 - e. Secondary leg fuses of Bussman Type FRN or approved equal.
 - 9. Submit a list of loads on each control power transformer, with the MCC shop drawings.
 - 10. Where additional fusing of control circuits is indicated on the Drawings, coordinate all the fuses in each control circuit.
 - 11. Provide individual layout sketches and post unit wiring diagrams and copies of applicable overload heater tables inside each door or wireway.
 - 12. Furnish auxiliary devices and contacts for motor space heaters, remote status signals and interlocks as shown on the drawings, complete and wired to the terminal blocks in each controller enclosure.

- a. Provide minimum number of auxiliary contacts, as shown on the drawings, plus two spare normally open and two spare normally closed contacts.
- 13. Provide overload relays as follows:
 - a. Manually reset from outside the enclosure by means of an insulated bar or button.
 - b. Of the bimetallic, ambient compensating type.
 - c. Use standard heater elements selected for actual motor nameplate full load amps.
 - d. Do not use on starters used only as contactors.
- K. Pilot Control Devices:
 - 1. Pushbuttons and Selector Switches:
 - a. Type: Round, heavy duty oil tight, NEMA A300 of Allen-Bradley Bulletin 800T, General Electric Type CR104, Square D Type K, Cutler-Hammer Type 10250 T, 30 mm size or equal.
 - b. Operator Legend Plates: Custom lettered, jumbo size as designated on the Drawings.
 - c. All pushbutton switches having full guard and button color to match associated indicating light.
 - d. Contact Blocks: Heavy-duty type.
 - e. Screw terminals for wire connections.
 - 2. Pilot Lights:
 - a. Indicating lights, LED having 100,000 hours half-life, 120V ac, R. Stahl Inc., Type 8415, or approved equal.
 - b. Lens color as shown on the Drawings.
 - 3. Relays:
 - a. All relays sized for the load conditions specified.
 - b. Coil Voltages: 120V ac.
 - c. Light duty relays:
 - (1) General-purpose plug-in type mounted on heavy-duty sockets, of Potter Brumfield, Type KUP14A35 or equal.
 - (2) Built-in neon indicating lamp.
 - (3) Relay sockets having barrier protected screw terminals.
 - d. Heavy duty relays:
 - (1) For motor control circuits and similar duty, use Allen-Bradley Bulletin 700 Type N, Square D Class 8501 Type GO-40, or equal.
 - (2) Having 10-ampere rated 300V ac convertible contacts.
 - e. Time delay relays:
 - (1) Pneumatic type with calibrated dial adjustment, of Agastat Series 7000 Pneumatic, or equal.
 - (2) Having heavy-duty convertible contacts.
 - 4. Provide timers as follows:
 - a. Adjustable, with range as shown on the Drawings.
 - b. On or off delay.
 - c. Power input: 120V ac.

- d. Contact rating: Compatible with current of devices simultaneously operated by contact.
 - e. Plug-in type mounted on heavy-duty octal sockets with barrier protected screw terminals.
- 5. Elapsed Time Meters:
 - a. Power input: 120V ac.
 - b. Size: 3-1/3-inch square.
 - c. Nonreset Type.
 - d. Display: 99,999.9 hours.
- L. Transient Voltage Surge Suppression: Provide transient voltage surge suppression devices as shown on Drawings and in accordance with Section 16289, Transient Voltage Suppression.
- M. Meters and Instrument Transformers:
 - 1. Provide instrument transformers according to IEEE C57.13 and the following:
 - a. Potential Transformers: Secondary-voltage rating of 120V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
 - b. Current Transformers: Ratios as indicated; burden and accuracy class suitable for connected relays, meters, and instruments.
 - c. Control-Power Transformers: Dry type, mounted in separate compartments.
 - 2. Power Circuit Monitoring, Metering, Communication, and Control System:
 - a. Provide standard monitoring and display device of the manufacturer.
- N. Provide wiring to comply with following:
 - 1. Conductor size suitable for loads and insulation.
 - 2. Insulation to be Types SIS, MTW or THWN.
 - 3. Color-coded as follows:
 - a. For ac control:
 - (1) Red.
 - (2) Or as recommended by the manufacturer.
 - b. For Power: Black.
 - 4. All wiring and cable, identified at all terminations by Brady or T&B wire markers or equivalent.
 - a. Use inscribed plastic sleeve type wire markers.
 - b. Indicate circuit numbers, terminal numbers, wire numbers, etc., for each conductor.
 - 5. Terminate with heavy-duty, long ferrule, wire insulating crimp-type terminals having maximum two terminals per terminal screw where pressure type terminals are not provided.
 - 6. Tie internal and external wiring with separate close ties.
 - 7. Regularly fasten and support wiring in vertical wireways.
 - 8. Use minimum No. 14 AWG stranded wires for control wiring.

9. Wire all spare starter auxiliary contacts to terminal strips:
 - a. Provide one set of the two spare normally open and normally closed contacts for each starter.
 - b. Wire these contacts to a common terminal strip for future connection.
 10. Provide incoming and outgoing cable size and location as indicated on the Drawings.
- O. Provide nameplates as follows:
1. Black laminated nameplates with engraved white letters and beveled edge, for each unit compartment door.
 - a. Use nameplate descriptions as determined and approved under the shop drawing submittal.
 2. One large, laminated identification plate:
 - a. To identify the MCC by large letters.
 - b. With following inscribed below in smaller letters and blanks filled in as applicable:
 - (1) 480 volts, 3-phase, 4-wire.
 - (2) Fed from _____ circuit _____.
 3. Manufacturer's nameplate providing information to identify the order, date of manufacture, etc.
 4. Exterior nameplates fastened by stainless-steel screws.
 5. Small nameplate, decal, or similar marking, to identify each fuse block with its proper fuse rating.
 6. Small nameplate for each unit stating "This unit to be used in compartment _____" as previously specified under unit compartments.
- P. Provide MCC layouts as shown on the drawings. Obtain the Commission's approval for any deviations required by the manufacturer.

2.3 PAINTING

- A. Clean and shop prime all non-galvanized, non-stainless steel metal surfaces in accordance with Section 09900, Painting and Coating.
- B. Use ANSI 61 light gray as the final exterior color for the MCC.

PART 3 EXECUTION

3.1 FACTORY TESTING

- A. The Commission reserves the right to witness all factory tests. The Commission reserves the right to back charge the manufacturer if a second trip is needed to witness equipment due to problems or errors in fabrication and engineering.
- B. Provide 2 weeks written notice to the Commission so arrangements can be made to witness tests.

- C. Motor control centers shall have been tested in a high-power laboratory to prove adequate mechanical and electrical capabilities.
- D. All factory tests required by the latest ANSI, NEMA and UL standards shall be performed.
- E. A certified test report of all standard production tests shall be provided to the Owner.
- F. Provide three copies of the final factory inspection tests to the Commission.
- G. MCCs:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect for physical damage.
 - (1) If visual inspection reveals MCC damage, broken bushings, inoperative breakers, or switches; conduct internal inspections and tests as necessary to locate the damage.
 - (2) Submit a detailed report to the Commission. Identify the damage, cause of the damage, and corrective measures taken to assure the Commission of the quality of the MCC.
 - b. Compare equipment nameplate information with latest one-line diagram and record/report discrepancies.
 - c. Verify proper device operation such as breakers, starters MCPs, and indicators.
 - 2. Electrical Tests:
 - a. Check automatic operation of breakers, starters and MCPs for close and trip operation from protective relays and operators.

3.2 INSTALLATION

- A. Install the MCCs and appurtenances in accordance with the instructions of the manufacturer and in accordance with the Contract Documents.
- B. Moving of Units: Use qualified riggers experienced in handling large equipment to move the MCCs.
- C. Connections: Set MCC assemblies in place and connect as shown on the approved shop drawings and in accordance with manufacturer's written instructions.

3.3 FIELD PAINTING

- A. Prepare and paint required surfaces as specified in Section 09900, Painting and Coating.

3.4 FIELD QUALITY CONTROL AND TESTING

- A. Perform field inspection and testing in accordance with Section 16950, Testing.

- B. Provide the services of a qualified factory-trained manufacturer's representative to assist the contractor in installation and startup of the equipment specified under this section. The manufacturer's representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.
- C. The following minimum work shall be performed by the Contractor under the technical direction of the manufacturer's service representative:
 - 1. Rig the MCC assembly into final location and install on level surface.
 - 2. Check all removable cells and starter units for easy removal and insertion.
 - 3. Perform insulation tests on each phase and verify low-resistance ground connection on ground bus.
 - 4. Connect all power wiring and control wiring and verify basic operation of each starter from control power source.
 - 5. Torque all bolted connections made in the field and verify all factory bolted connections.
 - 6. Calibrate any solid-state metering or control relays for their intended purpose and make written notations of adjustments on record drawings. Perform startup of any solid-state starters and adjustable frequency drives
- D. Adjusting and Cleaning: Adjust operating mechanisms for free mechanical movement.
- E. Grounding
 - 1. Provide equipment grounding in accordance with Section 16450, Grounding.
 - 2. Tighten connections to comply with tightening torques specified by the manufacturers and UL Standard 486A to assure permanent and effective grounding.
- F. The Contractor shall perform field adjustments of the short circuit and overload devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short-circuit study, protective device evaluation study, protective device coordination study, manufacturer's instruction leaflets, and the contract documents.
- G. Contractor is responsible for generation of a field report on tests performed, test values experienced, etc., and make the report available to the Commission.
- H. The Contractor shall provide three (3) copies of the manufacturer's field startup report to the Commission.

3.5 MANUFACTURER'S FIELD SERVICES

- A. Provide services in accordance with Section 01640, Manufacturers' Field Services. Manufacturer's field services shall respond to the Commission's request for correction of problems during startup and warranty period within 4 hours.

3.6 MANUFACTURER'S CERTIFICATION

- A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations. Equipment shall be inspected prior to the generation of any reports.
- B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification report to the Commission.
- C. Training
 - 1. Provide training to instruct representatives of the Commission as follows:
 - a. MCCs: 3 hours.

END OF SECTION

SECTION 16500 LIGHTING FIXTURES

PART 1 GENERAL

1.1 DESCRIPTION

- A. Work Included
 - 1. Furnish all labor and materials to complete lighting fixture installation and associated items indicated, specified herein or both. Fixtures of size and type specified herein shall be supplied, installed, and connected for each fixture indicated on the Drawings.

1.2 QUALITY ASSURANCE

- A. Regulations, Standards and Publications
 - 1. FM Factory Mutual Engineering Corp.
 - 2. NEC National Electrical Code of National Fire Protection Association
 - 3. NFPA 70E Standard for Electrical Safety in the Workplace
 - 4. UL Underwriters' Laboratories
- B. Fixtures shall be CSA certified to US and Canadian standards.
- C. Where appropriate fixtures shall be UL listed for hazardous and severe environments.
- D. All fixtures shall meet all Federal, State, and local required criteria.
- E. All light fixtures shall be mounted in accordance with manufacturer's recommendations.
- F. LED drivers shall be Electrical Testing Laboratories, Inc. (E.T.L.) - Certified Ballast Manufacturers Association (C.B.M.) certified.
- G. The installation must comply with the amended National Electrical Code of the National Fire Protection Association.

1.3 QUALIFICATION

- A. When more than one name of manufacturer of fixture is listed in these specifications, the first manufacturer and number determine the style and quality.

1.4 SUBMITTALS

- A. Shop Drawings
 - 1. Submit manufacturer's latest publication of each fixture, including ballast information, construction details, light distribution details and/or coefficients.

PART 2 PRODUCTS

2.1 MATERIALS

A. LED Drivers

1. LED light driver shall be of high efficiency.
2. LED light driver shall allow continued operation of all other LEDs in the event of an LED failure.

B. Light Fixture Schedule

1. SA: Ceiling mounted, 120-volt, high efficiency LED, nominal 8" x 4', totally enclosed gasketed fixture suitable for wet locations. Fixture shall be provided with an electronic driver. Fixture shall produce a minimum of 4,000 initial lumens and have a color temperature of less than or equal to 4,100K. Housing shall be one-piece high impact plastic to provide durability and corrosion resistance. The lens shall be one-piece deep clear polycarbonate, resistant to damage. Fixture shall have plastic latches to apply positive, uniform pressure on the gaskets to seal against dust and moisture. Provide gasketed conduit hubs. Fixture shall be Holophane #EMS L48 4000LM IMAFL WD MVOLT GZ10 40K 80CRI-WLFEND2 or Lithonia #FEM-L48-6000LM-IMACD-MD-MVOLT-40K-80CRI-WLFEND2.
2. WA: Wall mounted, 120 volt, high efficiency LED fixture. The fixture housing shall be constructed of die-cast copper-free aluminum with powder coated finish. Fixture shall have a glass lens and photoelectric control, and shall be furnished with the terminal block option. Fixture shall be Holophane #TWR1 LED ALO SWW2 UVOLT PE DDBTXD.

PART 3 EXECUTION

3.1 INSTALLATION

A. Installation

1. Contractor shall furnish supports for light fixtures. Light fixtures shall be supported with formed channels, angles, rods, clamps, washers, etc. of sufficient size and strength to support weight of fixtures from the building overhead structural members, independently from the ceiling system.
2. The fixture manufacturer's catalog numbers describing the various types of fixtures shall be used as a guide only and do not include all the required accessories or hardware that may be required for a complete installation. The Contractor shall be responsible for furnishing, at no additional cost to the Owner, all the required accessories and hardware for a complete installation.
3. All inoperable lamps shall be replaced with new lamps during the course of construction, up to and including the date of final acceptance by the Owner and Engineer.

END OF SECTION

SECTION 16530
BATTERY EMERGENCY LIGHTING UNITS

PART 1 GENERAL

1.1 DESCRIPTION

- A. Work Included:
 - 1. Furnish, install and connect a complete system of conduits, conductors, unit type battery emergency lighting units and all other materials and equipment necessary for the installation of an emergency lighting system.
 - 2. Provide manufacturer specified for each fixture type. Substitutes will not be accepted without approval prior to the bid.

1.2 QUALITY ASSURANCE

- A. Regulations, Standards and Publications:
 - 1. FM Factory Mutual Engineering Corp.
 - 2. NEC National Electrical Code of National Fire Protection Association
 - 3. UL Underwriters' Laboratories
- B. Qualification:
 - 1. The complete system shall be of a type, which has been in satisfactory service for at least one year under automatic emergency lighting conditions.
 - 2. When more than one name of manufacturer of fixture is listed in these specifications, the first manufacturer and number determine the style and quality.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Submit manufacturer's latest publication of the following:
 - a. Battery Unit
 - b. Fixed Heads
 - c. Combination Battery Unit/Exit Fixtures

PART 2 PRODUCTS

2.1 MATERIALS

- A. Combination Battery Unit/Exit Fixtures:
 - 1. EA: Combination exit fixture/battery emergency light fixtures shall be back mounted, single-faced with red high intensity LED lamps and sealed nickel cadmium battery. The fixture housing shall be white polycarbonate. The exit fixtures shall operate on 120 VAC power. Fixture shall be Holophane #: ECC B R, or equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Battery Unit:

1. Battery units shall be firmly fastened to walls. Mounting height to be determined in field.

B. Wiring:

1. Wiring on low voltage side of unit shall be no smaller than #10.
2. Connect battery emergency lighting units and exit fixtures to lighting circuit for area being protected ahead of all local control switches.

END OF SECTION

SECTION 16700 INSTRUMENTATION

PART 1 GENERAL

1.1 DESCRIPTION

- A. Work Included
 - 1. Furnish and install all instrumentation and provide services as specified herein or as indicated on the Drawings.

1.2 QUALITY ASSURANCE

- A. Regulations and Standards
 - 1. UL Underwriters' Laboratories
 - 2. NEC National Electrical Code
 - 3. NEMA National Electrical Manufacturers Association
 - 4. ANSI American National Standards Institute
 - 5. IEEE Institute of Electrical and Electronic Engineers
 - 6. ISA Instrument Society of America
 - 7.
- B. All instrumentation equipment supplied shall be of the most current and proven design. Specifications and drawings call attention to certain features but do not purport to cover all details entering into the design of the instrumentation equipment.
- C. All necessary fuses and cables required for instrumentation equipment shall be provided with the equipment.

1.3 SUBMITTALS

- A. Shop Drawings
 - 1. Submit shop drawings on all instrumentation in accordance with the requirements of Section 01330. Shop drawings shall be complete in all respects and shall indicate all dimensions, installation methods, size, weight, capacity, ratings, integral controls and types of materials, elevations, and sections. Submittals shall include a complete bill of material, catalog information, descriptive literature of all components and wiring diagrams.

PART 2 PRODUCTS

2.1 MAGNETIC FLOW METERS

- A. Flow meter shall meet the requirements of AWWA C751-2019 and components in contact with the potable water shall meet the requirements of NST/ANSI/CAN 61-2023 and the Safe Drinking Water Act (SDWA).

- B. Magnetic flow meters shall be of the low frequency and short form characterized coil design. The characterized field principle of electro-magnetic induction shall produce a positive DC pulsed signal directly and linearly proportional to the flow rate.
- C. The meter body shall be carbon steel. The flow meter shall have a flanged body to fit between ANSI Class 150 pipe flanges. The flow meter shall have a polyurethane liner and Type 316 stainless steel electrodes. The electrodes shall be flush mounted type. Liners and electrodes shall be suitable for potable water. Provide all required mounting hardware, stainless steel grounding rings and grounding straps for the installation of the magnetic flow meter.
- D. The coils, which generate the field, shall be inside the pipe wall and shall be encapsulated in epoxy resin and encased behind the meter lining material. The ratio of flow velocity to reference voltage signals generated shall be compatible with the readout instrument without the necessity of circuit modifications. The meter shall have an average power consumption of 60 watts. Accuracy of the meter shall be $\pm 0.5\%$ of rate.
- E. The meter housing shall be splash-proof and weather resistant design. The meter shall be capable of accidental submergence in up to 30 feet of water for up to 48 hours without damage to the electronics.
- F. The meter shall be hydraulically calibrated at the manufacturer's calibration facility against a master meter, which is traceable to the National Bureau of Standards. Calibration curves shall be submitted for each flow meter for 3 points within the specified flow range.
- G. Complete zero stability shall be inherent characteristic of the meter system. This shall eliminate the requirement for valving downstream of the meter for creating a full pipe zero flow condition for calibration purposes. Meter systems requiring field zero adjustment will not be acceptable.
- H. The flow meter shall have a remote mounted microprocessor based, NEMA 4X signal converter. The signal converter shall have an LCD display to indicate the flow rate. The signal converter shall convert the meter's DC pulsed signal to a linear 4-20mA dc signal which is proportional to the flow rate. The converter shall operate on a 120V AC, 60 Hz power source and shall have RFI protection. Provide a signal cable to connect the signal converter to the flow meter. Length of cable shall be as required for the installation (See Electrical Drawings).
- I. The Magnetic Flow Meters shall be Endress & Hauser Promag W 400, Toshiba GF642, or equal.

SCHEDULE OF MAGNETIC FLOW METERS

SIZE	FLOW RANGE	LOCATION	SERVICE
1"	2.5 to 80 gpm	Well House	Potable water flow
6"	90 to 2,650 gpm	Well House	Potable water high flow

2.2 PRESSURE TRANSMITTERS:

- A. The components in contact with the potable water shall meet the requirements of NST/ANSI/CAN 61-2023 and the Safe Drinking Water Act (SDWA).
- B. The pressure transmitters shall be a single chamber capacitance type electronic transmitter, which shall produce a linear current output signal proportional to the gage pressure.
- C. The process connection shall be 1/4" NPT female and shall be 316L stainless steel. The transmitter shall have a ceramic process isolating diaphragm.
- D. The transmitter shall have a continuous 100 to 1 span adjustment. Reference accuracy shall be $\pm 0.05\%$ of span.
- E. Zero and span adjustment shall be electronic by means of zero and span buttons.
- F. Process temperature limits shall be -13 to +257°F. The temperature limits for the electronics shall be -4 to +158°F. Humidity limits shall be 0-100% relative humidity.
- G. The transmitter shall be a true 2-wire device with 24-volt DC power being derived from the control panel power supply. The electronic unit shall be of modular plug-in design utilizing integrated circuitry. The transmitter output shall be a linear 4-20mA dc signal with superimposed HART protocol.
- H. The range of the pressure transmitter shall be as indicated on the schedule below.
- I. The transmitter electronics housing shall be constructed of die cast aluminum with a polyurethane coating. The transmitter housing shall meet NEMA 4X requirements. The electrical connection shall be a 1/2" NPT conduit thread.
- J. Each transmitter shall be furnished with a mounting bracket and stainless steel bolts suitable for wall mounting the transmitter.
- K. Provide a calibration data sheet for each pressure transmitter.
- L. The pressure transmitters shall be Endress & Hauser Cerabar S PMC71, or equal.

SCHEDULE

PRESSURE RANGE	LOCATION	SERVICE
0-150 psi	Well House	Potable water pressure

2.3 SUBMERSIBLE LEVEL TRANSDUCERS:

- A. The submersible level transducers shall be an industrial submersible pressure transducer submerged in well water to accurately sense the hydrostatic level. The transducer shall be furnished with an integral signal cable with a molded cable seal.
- B. The transducer shall have a weatherproof housing constructed of 316 stainless steel. The transducer shall have a 1.65" sensing area and an integral diaphragm protector.
- C. The transducer shall operate in a temperature range of -4° to 176° F.
- D. The transducer cable shall be a polyethylene jacketed shielded cable. Length of cable shall be as required for transducer installation. Provide a stainless-steel cable hanger to support the cable.
- E. The pressure transducer shall be a 2-wire device with dc power being provided from the 24vdc power supply in the control panel. The transducer shall output a 4-20mA dc signal proportional to the wet well level.
- F. The accuracy shall be $\pm 0.05\%$ full span from 23° to 122° F with a resolution of $\pm 0.005\%$ full span.
- G. The submersible level transducers shall be In-Situ Level Troll 400, or equal.

SCHEDULE

ELEVATION	PRESSURE RANGE	LOCATION	SERVICE
Approximately 230 ft bls.	0 - 100 psia	Well House	Well level

2.4 CHLORINE RESIDUAL ANALYZERS:

- A. Chlorine residual analyzers shall use colorimetric DPD chemistry to continuously monitor the sampled water for free or total residual chlorine. The analyzer shall use a DPD indicator and a buffer solution.
- B. The analyzer shall be capable of measuring free or total residual chlorine by changing the indicator and buffer solutions.

- C. The analyzer shall take a measurement every 2.5 minutes and the results shall be displayed on a three-digit LCD readout in the range of 0-5 mg/l.
- D. The analyzer shall be designed for 30 days of unattended operation and shall use only 473 mL of each reagent per month.
- E. The analyzer shall operate with an LED light source with a peak wavelength of 520 nm.
- F. The analyzer shall measure a sample blank before each sample measurement to provide automatic zero reference to compensate for sample color and turbidity, and changes in light intensity due to voltage fluctuations or light source aging.
- G. The analyzer shall provide a minimum detection limit of 0.035 mg/L; precision of $\pm 5\%$ or 0.005 mg/L as Chlorine, whichever is greater; and an accuracy of $\pm 5\%$ or 0.035 mg/L as Chlorine, whichever is greater.
- H. The analyzer shall be furnished with a sample inlet fitting and a drain fitting.
- I. The analyzer shall be microprocessor controlled and shall be housed in an ABS plastic enclosure designed for wall mounting. The enclosure shall have two clear polycarbonate windows for viewing the measurement readout and the reagent levels.
- J. The analyzer shall operate on 120 volts, 1 phase power and shall be furnished with a power cord.
- K. The analyzer shall output a 4-20mA dc signal proportional to the chlorine residual.
- L. The analyzer shall have two user-selectable relay output alarms which are selectable for sample concentration alarm, analyzer system warning, or analyzer system shutdown alarm.
- M. The chlorine residual analyzers shall be Hach Model CL17 Free Chlorine Residual Analyzers.

SCHEDULE

RANGE	LOCATION	SERVICE
0 – 4.0 mg/L	Well House	Potable water

2.5 PH METERS:

- A. The pH meter shall consist of a pH sensor, a pH transmitter and interconnecting cable. The pH meter shall continuously monitor the pH of the water.

- B. The pH sensor shall have a ring-shaped PTFE diaphragm and fixed electrolyte. The pH sensor shall have a glass electrode and shall utilize Memosens technology. The pH sensor shall have a built-in temperature sensor.
- C. The pH transmitter shall be microprocessor-based and shall be housed in a NEMA 4X polycarbonate enclosure suitable for wall mounting. The transmitter shall have a two-line display to simultaneously display the pH and the temperature.
- D. The transmitter shall have a pH range of -2 to 16.
- E. The transmitter shall have a resolution of 0.01 pH, and an accuracy of $\pm 0.5\%$ of range.
- F. The transmitter shall operate on 120 volts, 1 phase power.
- G. The transmitter shall output a 4-20mA dc signal proportional to the measured pH.
- H. The pH meter shall be Hach.

SCHEDULE

RANGE	LOCATION	SERVICE
3.0 – 10.0	Well House	Potable water

2.6 NAMEPLATES

- A. Provide a laminated phenolic nameplate for each instrument. The nameplates shall be black with white engraved letters, and they shall be mounted on the front of each instrument or instrument enclosure, or where applicable attached to the instrument with a plastic wire tie. An instrument nameplate schedule shall be submitted to the Engineer for approval prior to performing any engraving.

PART 3 EXECUTION

3.1 INSTALLATION ASSISTANCE AND INSPECTION

- A. Provide the services of manufacturer's service representatives to assist in installation for all instrumentation specified herein.
- B. Each manufacturer's representative shall inspect the installation of each of their instruments and shall issue an installation certificate to the Owner and the Engineer for each instrument certifying that the instrument has been installed in accordance with the manufacturer's recommendations.

3.2 CALIBRATION

- A. Provide the services of manufacturer's service representatives to calibrate all instrumentation provided. All calibration shall be performed in the presence of the Engineer. The calibration of each instrument shall be performed after the instrument installation certificate has been issued.
- B. Each manufacturer's representative shall issue a calibration certificate to the Engineer for each instrument certifying that the instrument has been calibrated and is ready to be placed into service. The calibration certificates shall indicate the calibrated range or setpoint for each instrument.

3.3 TRAINING

- A. Provide four (4) hours of training on the instrumentation provided.
- B. All training shall be performed by a representative from the manufacturer and shall be specific to the instruments provided. Training shall include theory of operation, maintenance requirements, calibration methods and function of instrument in the Process Control System.

END OF SECTION

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SECTION 16710
WELL HOUSE BUILDING PLC
INPUT/OUTPUT LIST

PART 1 GENERAL

1.1 DESCRIPTION

- A. Work Included:
 - 1. The Input/Output (I/O) list for the Well House Building PLC is included in this section.
- B. I/O Type Abbreviations:
 - 1. DI - Digital Input
 - 2. AI - Analog Input

PART 2 PRODUCTS
NOT USED

PART 3 EXECUTION
NOT USED

PART 4 SCHEDULES

4.1 I/O LIST

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Device I/O TAG	P&ID Tagname	HMI/PLC Tagname	Description	Signal	Field 1 (Energized if a DI or DO)	Field 2 (De-Energized if a DI or DO)	P&ID	LOOP	PLC	I/O	Base	Slot	Point	Enclosure
PWP-1	HOR-XXX		Well Pump No. 1 (PWP-1) - HOR Switch	DI	Remote	Off/Hand								Well House CP
PWP-1	MC-XXX		Well Pump No. 1 (PWP-1) - Control Motor	DO	Start	Stop								Well House CP
PWP-1	MN-XXX		Well Pump No. 1 (PWP-1) - Run Status	DI	Running	Off								Well House CP
PWP-1	MF-OL-XXX		Well Pump No. 1 (PWP-1) - Starter Overload	DI	Normal	Fail								Well House CP
HFWP	HOR-XXX		High Flow Well Pump (HFWP) - HOR Switch	DI	Remote	Off/Hand								Well House CP
HFWP	VC-XXX		High Flow Well Pump (HFWP) - Control VFD	DO	Start	Stop								Well House CP
HFWP	VSC-XXX		High Flow Well Pump (HFWP) - Control Speed	AO	0 % (4 mA)	100 % (20 mA)								Well House CP
HFWP	VSI-XXX		High Flow Well Pump (HFWP) - Speed Indication	AI	0 % (4 mA)	100 % (20 mA)								Well House CP

Device I/O TAG	P&ID Tagname	HMI/PLC Tagname	Description	Signal	Field 1 (Energized if a DI or DO)	Field 2 (De-Energized if a DI or DO)	P&ID	LOOP	PLC	I/O	Base	Slot	Point	Enclosure
HFWP	MN-XXX		High Flow Well Pump (HFWP) - Run Status	DI	Running	Off								Well House CP
HFWP	VF-XXX		High Flow Well Pump (HFWP) - VFD Failure	DI	Normal	Fail								Well House CP
AIT-XXX	AIT-XXX		Potable Water (AIT-XXX) - Chlorine Residual	AI	0 mg/l (4 mA)	20 mg/l (20 mA)								Well House CP
AIT-XXX	AIT-XXX		Potable Water (AIT-XXX) - pH	AI	0 pH (4 mA)	14 pH (20 mA)								Well House CP
FIT-XXX	FIT-XXX		Potable Water (FIT-XXX) - Low Flow Rate	AI	0 GPM (4 mA)	XXX GPM (20 mA)								Well House CP
FIT-XXX	FIT-XXX		Potable Water (FIT-XXX) - High Flow Rate	AI	0 GPM (4 mA)	XXX GPM (20 mA)								Well House CP
CFP-XXX	CFP-XXX		Potable Water Chlorine (CFP-XXX) - Dosing Rate	AO	0 % (4 mA)	100 % (20 mA)								Well House CP
CFP-XXX	CFP-XXX		Hypochlorite Feed Pump (CFP-XXX) - Control Motor	DO	Start	Stop								

Device I/O TAG	P&ID Tagname	HMI/PLC Tagname	Description	Signal	Field 1 (Energized if a DI or DO)	Field 2 (De-Energized if a DI or DO)	P&ID	LOOP	PLC	I/O	Base	Slot	Point	Enclosure
PIT-XXX	PIT-XXX		Potable Water (PIT-XXX) - Pressure	AI	0 PSI (4 mA)	XXX PSI (20mA)								Well House CP
LIT-XXX	LIT-XXX		Well (LIT-XXX) - Level	AI	XXX BLS (4 mA)	XXX BLS 20 mA)								Well House CP
MCC-W	JF-XXX		MCC (MCC-W) - Power Status	DI	Normal	Fail								Well House CP
MCC-W	JL-XXX		MCC (MCC-W) - Power Usage	AI	0 KW (4 mA)	XXX KW (20 mA)								Well House CP
MCC-W	JK-XXX		MCC (MCC-W) - Surge Protector	DI	Normal	Fail								Well House CP
WH-PCP	JF-XXX		Pump Control Panel (WH-PCP) - Power Status	DI	Normal	Fail								Well House CP
WH-PCP	JK-XXX		Pump Control Panel (WH-PCP) - Surge Protector	DI	Normal	Fail								Well House CP
WH-PCP	JF-DC-XXX1		Pump Control Panel (WH-PCP) - Power Supply 1	DI	Normal	Fail								Well House CP
WH-PCP	JF-DC-XXX2		Pump Control Panel (WH-PCP) - Power Supply 2	DI	Normal	Fail								Well House CP

Device I/O TAG	P&ID Tagname	HMI/PLC Tagname	Description	Signal	Field 1 (Energized if a DI or DO)	Field 2 (De-Energized if a DI or DO)	P&ID	LOOP	PLC	I/O	Base	Slot	Point	Enclosure
WH-PCP	JF-UPS-XXX		Pump Control Panel (WH-PCP) - UPS Status	DI	Normal	Fail								Well House CP
WH-PCP	JBL-UPS-XXX		Pump Control Panel (WH-PCP) - Batteries	DI	Normal	Replace								Well House CP
WH-PCP	JB-UPS-XXX		Pump Control Panel (WH-PCP) - UPS	DI	On Utility	On UPS								Well House CP

END OF SECTION

SECTION 16900
DPCS CONTROL PANEL AND TESTING

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section Includes: Requirements for installing and testing Commission furnished Distributed Process Control System (DPCS) Input/Output (I/O) Panels, and/or modifications to existing Distributed Process Control I/O System Panels as indicated. DPCS panels that do not include a programmable logic controller (PLC) are referred as Remote Input/Output (RIO) panels.
- B. Provides requirements for materials and installing of Contractor furnished DPCS system equipment and communication cables.

1.2 QUALITY ASSURANCE

- A. Work: Follow approved trade practices, manufacturers' recommendations, and applicable federal, local, and state codes.
 - 1. Instruments and control hardware associated with panels: Properly installed, wired, and tested at the shop and be suitable for operation.
 - 2. Contract Documents are intended to show and define panel design, fabrication, and installation.
- B. Equipment.
 - 1. Install following manufacturers' recommendations using installation manuals for guidance and for details not shown on Drawings.
 - 2. Provide for protection, insurance, and proper storage.
 - 3. Signals received from the field at DPCS monitoring control panel shall be made fully integrated and of the same type throughout circuit.
 - 4. Conduit connections/penetrations to cabinet: Located at side of cabinet as close to the bottom as possible; or bottom of cabinet as close to the fixed sides as possible.
 - a. Connections shall not interfere with installation of the backplane or operation of the door.
 - b. Connections to the top or back of cabinet: Not permitted without prior approval from the Commission.
 - c. Continuously protect and cover equipment from metal shards, dust, debris, and moisture.
 - d. Submit penetration detail or mark indelibly on panel the penetration locations for field acceptance.
- C. Elementary circuit diagrams shown on panel drawings illustrate some electrical schematics for major equipment associated with panels. These schematics are to be considered typical for equipment furnished.
 - 1. Provide technical support and integration services necessary to;

- a. Interface to panels.
 - b. Prepare wiring schematics for equipment.
 - c. Provide interconnections.
 - d. Make panels completely and permanently operational.
2. Furnish changes resulting from deviations from typical schematics, at no increase in scope or cost.
3. Upon request, Engineer will provide shop drawings of equipment supplied by Commission, for use in design of panels and any necessary equipment interface.

1.3 SUBMITTALS

- A. Submit the following in accordance with Section 01330.
 1. Record drawings for panels and enclosures, which have been wired.
 2. As-shipped panel drawings, for as-built purposes.
 3. Coordinate with point-to-point wiring documentation showing at a minimum:
 - a. Wiring between I/O panel interface terminal strip, including terminal and wire numbers for all wiring to the field device.
 - b. Communication cable wiring and interconnections.
 - c. Power connections to PLC/Remote I/O enclosures and other devices.
 - d. Final as-built drawings.
 4. Evidence of qualifications and experience (minimum of five years) for Fiber-Optic Specialty Contractor in areas of installation, termination, and testing of fiber-optic cable systems.
 5. Manufacturer's installation guideline documents for fiber optic cable and all fiber optic accessories.
 - a. Fiber optic cable must be installed within 3 years of its manufactured date.
- B. Submit the following in accordance with Section 01450.
 1. Test results for review and approval prior to commissioning the cable.
 - a. Certified calibrated Optical Time Domain Reflectometer (OTDR) for Fiber-optic test results for each stand of fiber.
 - (1) OTDR calibration certification must be within one year of the actual field test.
 - (2) Use a 500' minimum launch and receiver fiber optic cables.
 - (3) Format (connector pair to connector pair) so that each strand of fiber can be identified when reviewing results.
 - (4) Report loss in dB/km between connectors and dB loss across each connector and show OTDR graphs.
 - (5) Provide OTDR result files per each submission.
 - b. OTDR manufacturer's guidelines for performing OTDR testing and sample test results prior to testing.

2. Developed system test check sheet for Engineers approval.
 - a. Include check box to be initialed by Contractor and Engineer for each I/O point tested as outlined herein.

PART 2 PRODUCTS

2.1 GENERAL

- A. Provide Ancillary equipment, such as termination strips, interface hardware, wiring, cabling, intrinsically safe barriers, and accessories, that are necessary to provide a completely operational interface between the process control system panels to MCC, instrumentation, and all other field control panels.
 1. Do not mount this Ancillary equipment in the Commissioned furnished DPCS panels.
- B. Provide components as shown and/or as specified.
- C. Furnish necessary accessories such as instrument loop power supplies, mounting hardware, terminal blocks, control circuit breakers, and other items which may be required to complete the system.
- D. Analog signals received from field at panels: 4-20 mA DC signals.
 1. Furnish signal conversion necessary for compatibility with panel mounted instruments and interface to digital process control system.
- E. Provide control components such as relays, timers and other equipment necessary to provide the interfacing and/or interlocking required between motor starter and associated protective circuits, or other type of control circuit function applicable to a particular final control element, pre-mounted and wired in applicable panel. All Emergency Stop and other alarm Inputs shall be wired Failed-Safe (normally closed), where the de-energized circuit represents an alarm.
- F. DPCS Wiring Identification.
 1. Identify and label I/O field wiring originating from process control enclosure to field device and/or equipment throughout.
 2. Alphanumeric wire identification: Derived from base/slot/point position where wire is connected.
 3. Base/slot/point positions are identified at terminal within DPCS enclosure and/or on as-shipped panel drawings provided.

2.2 MATERIALS

- A. Electrical Wiring
 1. Solid wire used for AC circuits is not acceptable for use in DPCS enclosures and may not be used in power, instrumentation, or I/O circuits connected to DPCS enclosures
 2. Power wiring: CU stranded THHN, 600 volts.
 - a. 120 VAC circuits:

- (1) Line - BLACK
 - (2) Neutral - WHITE
 - (3) Ground - GREEN
 - (4) Minimum 12 AWG
- b. 24VDC circuits:
 - (1) Line - BLUE
 - (2) DC Common - BLUE WITH WHITE STRIPE
 - (3) Minimum 14 AWG
- 3. Discrete Input Wiring (120 VAC unless otherwise specified): CU stranded THHN, 300 V.
 - a. Signal - RED
 - b. Minimum 14 AWG
- 4. Discrete Output Wiring: CU stranded THHN, 300 V.
 - a. 120 VAC- RED, Minimum 14 AWG
 - b. 24 VDC- BLUE, Minimum 14 AWG
- 5. Analog Wiring: No. 18 AWG, twisted, shielded single pair, instrumentation cable designed for noise rejection for process control, computer, or data log applications and following NEMA WC 55. Belden 88760 or equal.
 - a. Outer Jacket: 45-mil nominal thickness.
 - b. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped for 100 percent coverage.
 - c. Dimension: 0.31-inch nominal OD.
 - d. Conductors:
 - (1) Bare soft annealed copper, Class B, 7-strand concentric, following ASTM B8.
 - (2) 7-strand tinned copper drain wire.
 - (3) Insulation: 15-mil nominal PVC.
 - (4) Jacket: 4-mil nominal nylon.
 - (5) Pair conductors: Color-code Red (+), Black (-).
- 6. CAT5E or CAT6 Cable: No. 24 AWG, Unshielded Twisted Pair (UTP) plenum rated and supports 100 Mbps fast Ethernet or faster.
- 7. Additional guidelines
 - a. Home runs from device's terminal blocks to DPCS panel's terminal blocks with no intermediate connections or splices unless specifically shown on plans.
 - b. Intended and designed for use with 24 VDC or less: Considered Low Voltage.
 - c. To prevent electrical interference and provide isolation from higher voltages, all Low Voltage wire: Installed in separated and dedicated rigid conduit or cable trays that provide segregation.

B. Fiber Optic Cable and Accessories.

- 1. Fiber lengths between fiber optic distribution (FOD) panels that run from building to building: Minimum of 12 conductors.
 - a. Approved manufacturers:

- (1) Draka, DXPCC Heavy Duty Chemical Resistant Cable
 - (2) Belden Tray Optic Heavy-Duty All Dielectric Cable, CPE Jacket
 2. Fiber lengths between interior FOD panels and installed in raceways: ezDistribution indoor/outdoor and tight buffer, minimum of 8 conductors; multimode = 6H; and fiber grade = M2
 - a. Approved manufacturer:
 - (1) Draka
 3. Fiber: 62.5/125 microns.
 4. Fiber optic cable connectors: Provide ST type pre-polished or fusion-spliced fan breakout kits. Mating losses not to exceed 0.75 dB per connection.
 5. Fiber optic patch cables: Duplex type with ST connectors.
 - a. No more than 2 meters of slack at either end or 3 meters total.
 - b. Only use soft Velcro tie wraps for securing patch cables.
 6. Fiber Optic Distribution Boxes (FOD):
 - a. Approved manufacturers
 - (1) Siecor.
 - (2) Corning.
 - (3) Or equal.
 7. Patch panel connectors mounted within FOD: ST type.
 8. Raceways for fiber optic cable: Heavy wall rigid galvanized steel.
 9. All other raceways, fittings, boxes and terminal cabinets: Follow Specification 16050.
- C. Wire Identification Labels: White polyolefin heat shrink type.
- D. Printed Labels: Produced using Brady Pro Plus marker printer or equal.
1. Signal Conditioners:
 - a. Analog current loop isolators, opto coupler, passive isolator and signal converter.
 - b. Approved manufacturers:
 - (1) Moore Industries.
 - (2) Weidmuller

PART 3 EXECUTION

3.1 GENERAL

- A. DPCS Wiring Identification:
1. Identify I/O field wiring originating from DPCS enclosure to field device and or equipment throughout as described hereafter.
 2. Derive alphanumeric wire identification from rack/slot/point position where wire is connected.
 3. Identify rack/slot/point positions at field terminal blocks within DPCS enclosure, field device and/or on as-shipped panel drawings provided.

- B. Analog Cables:
 - 1. Provide heat shrinkable sleeves over outer jacket of cable and conductors at cable termination points.
 - 2. Ground shield of cable at DPCS monitoring control panel only.

3.2 FIELD TESTING

- A. Fiber Optic Testing:
 - 1. OTDR on-reel test: Required after fiber cable is delivered to site and prior to installation of cable at WSSC facility. Results must be within 10% factory test from manufacturer.
 - a. Submit performance test data in report for approval.
 - 2. Perform OTDR test on each fiber conductor after fiber runs are installed. Submit performance test data and OTDR graphs and files in report for approval.
 - a. Performance test data:
 - (1) Connector mating losses not to exceed 0.75 dB per connector.
 - (2) Attenuation losses not to exceed 3.5 dB per kilometer.
 - b. Remove from site any Fiber Optic Cable that does not test satisfactorily.
 - c. Fiber Optic test must be inclusive of testing cumulative (dB) losses through patch panel connection, patch fiber, and dB/km loss for each fiber cable between connector pairs.
 - 3. Satisfactorily test each fiber optic cable member prior to connection at any point along network.
 - a. Terminate all fiber members within fiber-optic patch panels. Use FOD manufacturers' guidelines to install and secure fiber cable within box.
 - b. Identify both active and spare pairs at each termination point along network.
- B. Open Loop Testing
 - 1. General: The open loop test encompasses testing signaling from field devices, such as MCC drives, pumps, valves, instrumentation, and other controls/controllers connected to process control system PLC or RIO panels. It provides the ability to test a device's wiring prior to the RIO panel being made completely functional with the DPCS. Testing can be scheduled only after all devices within a given panel are completely wired, permanently terminated, and energized from permanent sources.
 - a. Conduct test after field conductors have been terminated and identified within process control system PLC or RIO panel and at field terminations.
 - b. Conduct test in presence of Engineer. Accomplish test prior to preliminary testing for equipment as outlined in Section 01450.

- c. Verify that equipment wiring, instrumentation, limit switches, drives, MCC, and other controls/controllers have been properly connected and calibrated.
- d. Develop system test document, including an I/O point list, and have approved by Engineer.
- e. Use approved system test document to record testing results for each loop.
- f. Connect field equipment to permanent power source and energize during test. Signals should not jumpered unless there is a safety or process reason.
- g. Deficiencies: Retest and correct prior to Close Loop testing

C. Conducting Open Loop Test:

- 1. For analog inputs, at field terminals using sourcing meter or using field device, induce a 4 to 20 mA DC signal.
 - a. Test signal at 0 percent, 50 percent, and 100 percent.
 - b. Observe and record the change of state at I/O module within DPCS PLC or RIO panel.
- 2. For digital inputs, operate field device or any equipment connected thereto or jumper applicable terminals at field device.
 - a. Observe and record the change of state at I/O module within DPCS PLC or RIO panel.
- 3. For analog outputs:
 - a. If control network has been successfully tested, PLC will induce signal.
 - (1) Test output at 0 percent, 50 percent, and 100 percent at terminals within the RIO enclosure to field device.
 - b. Otherwise, disconnect one associated loop wire or fuse from terminal within DPCS RIO panel and generate signal.
 - (1) Test output at 0 percent, 50 percent, and 100 percent.
 - c. Observe and record the change of state at I/O at field device.
- 4. For digital outputs:
 - a. If control network has been successfully tested, PLC will induce output signal.
 - b. Otherwise, jumper the signal at terminal within DPCS RIO panel.
 - c. Observe and record change of state at I/O at field device.

D. Prerequisite Requirements to Closed Loop Test:

- 1. Process control network must be successfully tested and made operational prior to closed loop testing.
- 2. Successfully calibrate field instrumentation, limit switches, MCC devices, VFDs, and ancillary field devices.
- 3. Submit calibration certification.
- 4. Verify field equipment is fully functional, powered, and made available to be controlled by PLC.
- 5. Notify Engineer 10 days before commencement of pre-final testing of equipment as outlined in section 01450.

6. For a given device or system, after Open Loop testing is complete, provide Engineer 5 days' notice before commencing Closed Loop Testing.
- E. Conducting Closed Loop Test:
1. Accomplish test with coordination between the Contractor operating equipment and Commission verification at DPCS monitoring control panel, servers, and or operator station(s).
 2. For analog inputs, induce by field device a 4 to 20 mA DC signal. Test signal at 0 percent, 50 percent, and 100 percent and observe at DPCS monitoring control panel, servers, and or operator station(s).
 3. For digital inputs, operate field device/contact to observe change of state at DPCS monitoring control panel, servers, and/or operator station(s).
 4. For analog outputs, induce a signal with a varying output. Test signal at 0 percent, 50 percent, and 100 percent from DPCS monitoring control panel, servers and or operator station(s) to field device and observe at equipment or field device.
 5. Digital outputs are a change of state initiated by the DPCS monitoring control panel, servers and or operator station(s).
 - a. Observe operation of equipment and/or device at both field and DPCS monitoring control panel, servers, and/or operator station(s).
- F. Final Testing:
1. For the purposes of control strategy proofing, 10 days prior to final testing as outlined in section 01450, Contractor will provide access and ability to operate equipment through the DPCS. This proofing may last up to 10 days.

END OF SECTION

SECTION 16910 CONTROL DESCRIPTION

I. SYSTEM DESCRIPTION

The existing potable water well is being replaced with a new Well House. Additionally, some of the water lines and connections to the treatment plant buildings are also being replaced.

The Distributed Process Control System (DPCS) HMI will be configured and programmed by the Owner. PLC and OIT programming will be by the Contractor. PLC programming will adhere to the following:

- All code is to be written in ladder logic. Any other code types (Sequential Function, Function Block, Structured Text, etc.) will not be accepted unless approved by Process Control Group.
- If using AB ControlLogix PLC, all Tags must be scoped at the Global/Controller level.
- Use the Process Control Group supplied abbreviation list for tag naming and I/O identification.
- Any code written that deliberately tries to overly complicate the program flow and readability will not be accepted.
- All PLC controllable field devices (i.e., if the device has at a minimum an HOA switch, open/start command, and feedback status) will have its own device in ladder. Common device logic that passes and receives I/O statuses is Not acceptable.
- It should be assumed that any PLC supplied will be integrated into the plant control system and customer permissives should be accommodated in logic.
- No software Remote / Local mode on OIT. There should be a mechanical HOA switch on front of control panel wired to PLC as input status.

A. WELL PUMPS

One Small constant speed well pumps will supply potable water to the treatment plant via two (2) hydropneumatics tanks and one of (2) water softeners. Hypochlorite will be introduced for disinfection prior to exiting the well house and entering the potable water distribution network. During periods of high flow, the Large variable speed well pump will be operational, the smaller well pump will cease operation, as well as the water softener.s, along with the hypochlorite system..

B. CHEMICAL FEED

The chlorine residual analyzer along with the (2) potable water flow transmitters will be used to regulate the speed of the sodium hypochlorite feed pumps to maintain a predetermined chlorine residual. There is a low flow meter and transmitter as well as a high flow meter and transmitter. Hypochlorite feed pump No. 1 will be paced from the small well pump flow and Hypochlorite feed pump No. 2 will be paced from the large well pump flow meter.

II. EQUIPMENT AND DESIGNATIONS

A. Well Pumps	Two (1 small flow and 1 large flow)
B. Residual Chlorine Analyzer	One
C. pH Analyzer	One
D. Magnetic Flow Meters	Two (1 low flow and 1 high flow)
E. Level Transmitter	One (well level)
F. Sodium Hypochlorite Feed Pump	Two (1 low flow and 1 high flow)

III. RELATED EQUIPMENT OPERATION

A. None

IV. POWER AND CONTROL CONFIGURATION

The Well House Control Panel will house the PLC that contains the control program.

Control and Monitoring will be available as follows:

CONTROL/INDICATION LOCATION	@ Equipment /Process	@ MCC	I/O to or from Well House CP
SMALL WELL PUMP			
Local-Off-Remote (LOR) Select		X	
Remote Status			DI
Start-Stop			DO
Run Status		X	DI
Starter Overload		X	DI
LARGE WELL PUMP			
Local-Off-Remote (LOR) Select		X	DI
Start-Stop		X	DO
Speed Control		X	AO
Speed Indication		X	AI
Run Status		X	DI
VFD Failure		X	DI
INSTRUMENTS AND ANALYZERS			
Well Level Transmitter			AI
Potable Water High & Low Flow Transmitters	X		AIs
Potable Water Pressure Transmitter	X		AI
pH Indicating Analyzer	X		AI

CONTROL/INDICATION LOCATION	@ Equipment /Process	@ MCC	I/O to or from Well House CP
Chlorine Residual Analyzer	X		AI
SODIUM HYPOCHLORITE FEED PUMP			
Local-Off-Remote (LOR) Select	X		
Speed Control			AO
POWER MONITORING			
Power Failure		X	AI
Power Indication		X	AI
Surge Protection Failure		X	DI
Control Panel			
Power Failure			
Surge Protection Failure			AI
Power Supply 1 Failure			DI
Power Supply 2 Failure			DI
UPS Failure			DI
UPS Battery Replacement			DI
On UPS			DI

A. POWER DISTRIBUTION

The small well pump will be powered from MCC-WH and the large well pump will be powered from a VFD also located in the Well House.

Small Well Pump Equipment Summary

The small well pump will be Full Voltage Non-Reversing (FVNR) starter. The motor starter will have provisions for locking out the motor in the de-energized state with the following controls and indications.

1. Control power transformer.
2. I/O blocks.
3. LOCAL-OFF-REMOTE (LOR) three position selector switch.
4. RUN and STOPPED indicating lights.
5. STARTER OVERLOAD indicating light and reset pushbutton.

Large Well Pump Equipment Summary

The large well pump will be on a Variable Speed Drive (VFD). The VFD will have provisions for locking out the motor in the de-energized state with the following controls and indications.

1. Control power transformer.
2. I/O blocks.
3. LOCAL-OFF-REMOTE (LOR) three position selector switch.
4. RUN and STOPPED indicating lights.
5. LCD/LED VFD status, control, and diagnostics display.

6. % speed control.
7. % speed indication.

Low Flow DPCS Input/Output Summary:

The following information at a minimum will be transmitted to the DPCS system from the motor starters:

1. LOR selector switch status.
2. Run status.
3. Starter Overload.

The DPCS system will transmit to the starters the following:

1. Start-Stop command.

High Flow DPCS Input/Output Summary:

The following information at a minimum will be transmitted to the DPCS system from the VFD:

2. LOR selector switch in AUTO.
3. Run status.
4. VFD failure.
5. % speed indication

The DPCS system will transmit to the VFD/bypass starters the following:

1. Operate at % speed.
2. Start-Stop command.

V. DESCRIPTION OF OPERATION

A. WELL PUMPS

Control Modes:

Each well pump can be operated locally at the Motor Control Center (MCC), Variable Frequency Drive (VFD), or through the Distributed Process Control System (DPCS). A LOCAL-OFF-REMOTE selector switch will be provided on the MCC motor starter bucket and on the VFD.

Each of the well pumps will have the following control modes:

Local/Manual Mode:

In Local mode, an operator will select the Local position from the LOCAL-OFF-REMOTE selector switch to run a well pump. The largewell pump will also allow an operator to adjust the speed of the pump from the front of the VFD. In the Off position, a well pump will not run. Local operations should only be used for testing and maintenance purposes.

DPCS Auto Low Flow Mode:

A well pump can only be operated in Auto Mode when the LOCAL-OFF-REMOTE switch is in the REMOTE position.

In software DPCS Auto, the small pump will operate when the potable water pressure drops below an operator-adjustable low pressure (initially set at 50 psi) and will shut off when the pressure increases to an operator-adjustable high pressure (initially set at 80 psi).

DPCS High Flow Mode:

High flow mode will be initiated when the potable water pressure drops to low-low pressure (initially set at 30 psi). The low flow pump will shutdown and the high flow pump will start with the speed adjusted to maintain a constant pressure (initially set at 80 psi). The pump will continue to run until the potable water flow drops to an operator adjustable flow (initially set at 100 gpm). The mode will then automatically switch back to low flow mode operation.

DPCS Manual Mode:

Not Used

Interlocks and Alarms:

Regardless of operating mode, a well pump will be shut down for any of the following abnormalities:

1. Motor overload
2. VFD failure.
3. High-high potable water pressure (initially set at 100 psi).

The DPCS will provide Alarms and Indications regardless of the operating mode:

1. Motor overload.
2. VFD failure.
3. Instrument or analyzer failure as indicated by an analog signal less than 4 mA
4. Potable water pressure high-high or low-low.
5. High flow pump operating.

B. SODIUM HYPOCHLORITE FEED PUMP

Control Modes:

The Sodium hypochlorite feed pumps can be operated locally at the pumps or through the DPCS. Operation of the pump locally will be through a graphical display on the pump.

Local/Manual Mode:

In Local mode, an operator can select Local operation through the graphical display and adjust the speed of the pumps.

DPCS Auto Mode:

In software DPCS Auto, pump No. 1 will be flow paced from the low flow transmitter with feedback trim from the residual chlorine analyzer. In software DPCS Auto, pump No. 2 will be flow paced from the high flow transmitter with feedback trim from the residual chlorine analyzer.

DPCS Manual Mode:

Not Used

Interlocks and Alarms:

Regardless of operating mode, the pump will be shut down for any of the following abnormalities:

1. None

The DPCS will provide Alarms and Indications regardless of the operating mode:

1. Low or high chlorine residual

END OF SECTION

SECTION 16920 CONTROL PANELS

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section Includes: Design standards and manufacturing requirements for Distributed Process Control System (DPCS) panels and enclosures furnished to WSSC by others. It applies to Programmable Logic Controller (PLC) panels and Remote Input/Output (RIO) panels used to control plant equipment and processes. Follow Section 16900 for installation, startup and testing of DPCS panels.

1.2 REFERENCES

- A. Underwriters Laboratory UL508A – Safety Standards for Industrial Control Panels
- B. National Electric Code Section 409 – Industrial Control Panels
- C. NEMA 250-2008 – Enclosures for Electrical Equipment

1.3 QUALITY ASSURANCE

- A. The Owner will provide sample power distribution, I/O module and network diagrams, and sample RLL code for adherence. DPCS and PLC equipment and software: Approved by the Owner.
- B. List of approved and current manufacturers and models will be provided. The current approved DPCS and PLC manufacturers are Allen Bradley ControlLogix. The PLC will be programmed use RLL primarily, using Structured Text when needed and the only viable option. The PLC program will be fully annotated. The current approved Operator Interface Panel is Wonderware AIS (12” or greater). Wonderware InTouch is the approved HMI software.
- C. DPCS panels.
 - 1. Utilize standard catalogued PLC equipment approved by WSSC and suitable for use in industrial water/wastewater processing environment.
 - 2. Include components shown on contract drawings and accessories and hardware not shown but necessary to meet manufacturer recommendations and/or WSSC specifications.
 - 3. Equipment: Installed following manufacturer’s recommendations. Follow manufacturer’s installation manuals for guidance and details not shown on contract drawings.

1.4 SUBMITTALS

- A. Submit for review following Section 01330. Drawings: AutoCAD format and may be electronically transmitted.
 - 1. Power distribution wiring diagram.
 - 2. PLC wiring diagrams including all I/O points.
 - 3. PLC RLL code.
 - 4. Communication and remote I/O interface module wiring diagrams.
 - 5. Operator interface terminal (OIT) wiring diagram if applicable.
 - 6. Back panel and subpanel layouts showing location of panel-mounted equipment.
 - 7. Enclosure elevation drawing showing location of externally mounted equipment.
 - 8. Enclosure assembly diagram if applicable.
 - 9. Complete bill of materials.

PART 2 MATERIALS

2.1 ENCLOSURES

- A. NEMA Rating: Follow standards for NEMA type indicated on drawings or as specified herein.
 - 1. NEMA Type 12 dust-tight:
 - a. Provided for indoor controlled environment locations as shown on drawings. Provide continuous gasket around door opening.
 - b. Phosphate coating for rust proofing and white enamel panel interior finish.
 - 1) Exterior finish: Hoffman custom paint color #RAL7021 (T014) or ANSI-61 gray powdercoat.
 - 2) Enclosures requiring legs: Paint color to match enclosure.
 - 2. NEMA Type 4 watertight and dust-tight: Provided for indoor or outdoor locations as shown on Drawings.
 - 3. NEMA Type 4X corrosion resistant: Provided for indoor and outdoor locations as shown on Drawings.
 - a. Door clamps and hinge pins: Stainless steel.
 - 4. NEMA-rated enclosures for PLC and Remote I/O panels: Hoffman Brand or equal.
- B. General.
 - 1. Designed for connection to 120VAC branch circuits. Equipment that requires higher voltage sources, e.g. VFDs and uV reactor controls: Supplied in separate enclosures.
 - 2. Enclosures that contain interlocked control circuits or circuit supplied from external power source which cannot be de-energized by panel disconnect: Furnish with following warning label;
CAUTION: THIS EQUIPMENT MAY HAVE MORE THAN ONE POWER SOURCE OR IS INTERLOCKED WITH OTHER EQUIPMENT.
 - 3. Mounted outdoors or in unheated areas: Provide internal condensation and freezing protection with thermostat control.

4. Contain incandescent or LED light package equipped with manually operated switch. At least one GFCI-type duplex utility outlet: Provided on control panel.
5. Fully enclosed units with front and/or rear access doors, designed to fit in space available, as specified in contract drawings.
6. Enclosures which contain PLC processor and communication modules: Equipped with door-mounted factory window kits to enable viewing of status LEDs.
7. Vapor-phase protective corrosion inhibitors.
 - a. Inhibitor: Activated upon shipment to site.
 - b. Panels:
 - 1) Do not store with inhibitors inactive.
 - 2) Cover to reduce ventilation and prolong inhibitor life, if necessary.
 - c. Approved Manufacturers:
 - 1) Hoffman A-HC15E.
 - 2) 10E.
 - 3) Or Equal.
8. Front door-mounted nameplate that identifies panel inside, e.g., PLC-D, CHEM RIO-4.
 - a. Nameplates.
 - 1) As shown on contract drawings or listed in specifications.
 - 2) Laminated plastic having black letters on white background and attached using stainless steel screws.
9. Print pocket.
 - a. Mounted inside door.
 - b. Include one copy of relevant as-built drawings prior to shipment.
10. Factory back panels for mounting control panel components and equipment.
 - a. Side panels may be used to increase amount of available panel space.
 - b. 24 inch deep or greater that contain back panel: Supplied with studs for future installation of full length side panels on both sides of enclosure.
11. Sufficient structural reinforcements to limit vibration and prevent distortion or damage to panel and components during shipment, installation and operation.

C. Free-Standing Steel Enclosures

1. Single door: 12-gauge sheet steel.
2. Multiple door: 10-gauge steel.
3. Back panels and side panels: Minimum 12-gauge steel.
4. Full size back panels: Equipped with stiffeners and heavy duty supports as needed to ensure rigidity.
5. Exterior welds: Ground and sanded to smooth finish free of burrs.
6. Surface: Free of ridges, nuts, bolt heads, and similar protrusions.
7. Removable lifting lugs on top of enclosure designed to facilitate rigging and lifting of enclosure during installation.
 - a. Plugs: Provided to fill the lifting ring holes after installation is complete.
8. Full-length door with handle-operated three point latch for front or rear access. Certain installations may require lockable door handles.
9. Floor stands or foot kits, when required, as shown on panel drawings.

10. Provide steel stiffeners as necessary to prevent deflection of back panels and doors due to heavy panel-mounted or door-mounted components.
 - a. Stiffener: Minimum 0.25 inches deep by 1 inch wide tack welded to back of the panel or door.

D. Wall-Mounted Steel Enclosures

1. 14-gauge steel.
2. Back panels and side panels: Minimum 12-gauge steel.
3. Doors: Equipped with rubber gaskets and continuous hinges.
4. PLC enclosures: Equipped with 2-point latching door handles.
 - a. In wet or corrosive environments screw clamps may be required around perimeter of door to ensure tight seal.
 - b. Certain installations may require lockable door handles.

2.2 PANEL WIRING AND TERMINATIONS

- A. Designed, manufactured and tested following latest standards listed herein.
- B. Back panel and side panel wire bundles.
 1. Run inside Panduit-style wire duct to facilitate tracing of circuits.
 2. Exposed wire bundles connecting door-mounted devices and side panels to back panel are allowed.
 3. Fastened down at suitable intervals, not to exceed 12 inches in length.
- C. Segregate AC control power and I/O wiring, and DC control power and I/O wiring within panel as much as possible.
 1. Group wires and cables according to function. Run in separate wire ducts and/or bundles.
 2. Keep analog signals (4-20 mA and 0-10V) as far away from AC control power and I/O wiring as possible.
- D. Use flexible stranded copper wiring.
 1. No solid conductor wire is permitted.
- E. 120VAC and 24VDC wiring in panel: Type MTW, rated for operation at 600V at conductor temperatures not to exceed 90 deg. C.
- F. Analog I/O and Instrumentation cable: No. 18 AWG, twisted, shielded single pair, instrumentation cable with minimum of six twists per foot and including continuous foil shield with drain wire. PVC-coated and rated for operation at 300V at conductor temperatures not to exceed 90 deg. C.
 1. Individual Pair Shield: 1.35 mil, double-faced aluminum/synthetic polymer overlapped for 100% coverage.
 2. Outer Jacket: 45-mil nominal thickness.
 3. Dimension: 0.31 inch nominal OD.
 4. Conductors:

- a. Bare soft annealed copper, Class B, 7-strand concentric, following ASTM B8.
 - b. 20 AWG, 7-strand tinned copper drain wire.
 - c. Insulation: 15-mil nominal PVC.
 - d. Jacket: 4-mil nominal nylon.
 - e. Pair conductors: Color-code Red (+), Black (-).
- G. Minimum wire conductor sizing: Follow UL 508A standards for industrial control panels:
 AC line side power: No smaller than 14 AWG.
 AC line and control circuits: No smaller than 16 AWG.
 DC line, load and control circuits: No smaller than 16 AWG.
 Analog signal wiring: No smaller than 20 AWG.
- H. Panel wiring: Color coded as follows:

BLACK	AC line, load and control circuits operating at line voltage.
WHITE	AC neutral
RED	AC control circuits at line voltage which are controlled by a relay contact or other control element
BLUE	DC, line load and control circuits
BLUE WITH WHITE STRIPE	DC common or 0VDC
YELLOW	Interlocked control circuits or any circuit supplied from external power source which cannot be de-energized by control panel disconnect.
GREEN	Equipment grounding conductors with or without yellow stripe.

- I. Analog and instrumentation conductors: Color coded as follows:
- 1. RED: Positive (+)
 - 2. BLACK: Negative (-)
- J. Wire:
- 1. Run in continuous lengths from screw terminal to screw terminal.
 - 2. Provide wire service loops to simplify removal of panel components.
 - 3. Do not splice wiring.
 - 4. Identified at both ends with white machine printed, sleeve-type labels.

- a. Hand lettered wire labels are not allowed.
- K. Wire numbering: Consistent with nomenclature used in sample drawings.
- 1. All PLC I/O module wiring: Numbered according to I/O point base/slot/point assignments.
- L. 120 VAC Discrete Inputs: The DPCS panel will provide 120VAC to field equipment for signaling purposes only.
- 2. Wires: Red.
 - 3. Field equipment: Equipped with 120VAC rated dry contacts and shall operate the dry contacts. All Emergency Stop and other alarm Inputs shall be wired Failed-Safe (normally closed), where the de-energized circuit represents an alarm.
 - 4. For each dry contact, a pair of wires shall be installed and landed from the DPCS panel to the dry contact.
 - a. One wire shall be hot (+) the other shall be used to return power back to the DPCS when the dry contact is closed.
 - b. Both wires shall be continuous home-runs from field equipment panel to DPCS panel with NO intermediate terminations or splices.
 - c. A sample drawing will be provided and followed.
- M. 120 VAC or 24VDC Relay Outputs: The DPCS panel will be Supplied with 120VAC or 24 VDC control power from the field equipment for control purposes only.
- 1. Wires: Yellow to indicate foreign voltage.
 - 2. DPCS Discrete Output card will provide a dry contact to switch power on and off. Each dry contact will only have one function and serve only one piece of field equipment (for example, a single dry contact cannot be used to turn on a pump and used to illuminate a panel light).
 - 3. For each dry contact, a pair of wires shall be installed and landed from the DPCS panel to the field equipment.
 - a. One wire shall be hot (+) the other shall be used to return power back to the field equipment when the dry contact is closed.
 - b. De-energizing field equipment shall consequently de-energize the 120VAC or 24VDC control power.
 - c. Both wires: Continuous home-runs from field equipment panel to DPCS panel with NO intermediate terminations or splices.
 - d. A sample drawing will be provided and followed.
 - 4. In general, the current for Allen Bradley 1756 output modules shall not exceed 2 Amps and never exceed the manufacturer's limitations. The A-B relay output module (1756-OW16I) used on DPCS panels does not have on board fusing, therefore one of the 2 terminals provided for field connections, typically the line side, shall be equipped with a 2A rated fast blow fuse.
 - 5. In general, the current for CTI output modules shall not exceed 5 Amps and never exceed the manufacturer's limitations. The CTI relay output module (#2534) used on DPCS panels is equipped with on board fusing; therefore standard thru terminals may be used for field connections.

2.3 TERMINAL BLOCKS

- A. Factory assembled on standard 35mm din rail mounted on standoffs to provide easy access to terminal screws.
 - 1. Prefabricated terminal strips are not allowed.
- B. Screw type with pressure plate (compressor type) requiring no lugs on connecting wires.
 - 1. Rated for wire size 12 AWG or smaller.
 - 2. Rated for 600 volt service.
 - 3. Cage clamp style terminals are not allowed.
- C. Furnished with engraved plastic markers displaying wire numbers or alphanumeric designation shown on drawings and/or on the I/O point list.
 - 1. If connected to PLC I/O modules: Numbered according to I/O point base/slot/point assignments.
- D. Reserve one side of each terminal block assembly for incoming field wiring.
 - 1. Common connections and jumpers required for internal wiring on field side of terminal is not allowed.
 - 2. No more than two wires terminated at any single screw terminal.
- E. Through terminals and fuse terminals ganged together to create common voltage buses: Utilize internal screw jumpers.
 - 1. Wire jumpers and comb jumpers are not allowed.
- F. I/O module points, including unused spares: Connected to terminal blocks.
 - 1. Terminal block assemblies for power distribution: Include minimum 25 percent spare fuse terminals, connected to AC or DC bus via internal jumpers.
- G. Fused terminal blocks.
 - 1. Follow typical wiring diagrams for power distribution and I/O modules.
 - 2. Required for overcurrent protection of analog input modules and discrete output modules not equipped with internal fuses or protected by interposing relays.
 - 3. Provided with blown-fuse indicator and fast-acting, 5 x 20mm fuses, unless approved otherwise.
 - 4. Cross section not greater than 8mm.
- H. Terminal block assemblies for analog input and output channels.
 - 1. Include ground terminals that connect directly to panel ground through din rail.
 - 2. Ground terminals: Green and yellow in color.
- I. Feed through terminal blocks: High density with cross section not greater than 2.5mm.
- J. Approved Manufacturer.
 - 1. Weidmuller brand

2. Or equal.

<u>Terminal Type</u>	<u>Wiedmuller Cat. No.</u>
Analog input (+), fused	WSI6
Analog input (-)	WDU2.5
Analog input shield	WPE2.5
Analog output (+)	WDU2.5
Analog output (-)	WDU2.5
Analog output shield	WPE2.5
Discrete input	WDK2.5*
Discrete output	WDU2.5
Digital output, fused	WSI6
All others	WDU2.5 or WSI6

*Note: Discrete input terminal block assemblies require 2-tier terminals. The top tier is used for the individual inputs. The terminals on the bottom tier are ganged together using internal screw jumpers to form a voltage bus for wetting of field contacts.

2.4 PANEL MOUNTED DEVICES

A. Analog signals.

1. Sent to and received from the field: 4-20mA
2. Analog I/O modules: Configured for 4-20mA signals.
3. Include signal converters necessary to make DPCS panel compatible with field equipment on panel.

B. Panel and enclosure.

1. Equipped with ground lugs for connection to external ground.
2. Screw terminal-type ground bus bolted to back panel: Provided for grounding electrical equipment and instrumentation.

C. Instruments, pilot devices or operator panel mounted on outside of enclosure:

1. Suitable for flush mounting.
2. Match the NEMA rating of enclosure.
3. Located between 30" and 62" from floor.

- D. Panel mounted devices:
 - 1. Mounted on din rail whenever possible
 - a. Din rail segments: Extended to include unused panel space.
 - 2. Designed to facilitate removal and maintenance of equipment after installation.
 - 3. Identified by markers placed adjacent to, but not on, given device.
 - 4. Markers:
 - a. Display device tagnames and/or descriptive names.
 - 1) Engraved plastic nameplates or labels printed with indelible ink. Hand lettered markers are not allowed.

2.5 PILOT DEVICES

- A. Selector switches, pushbuttons, and indicating lights: Heavy duty, oil-tight, 30mm, NEMA 13-rated.
- B. Selector switches and pushbuttons.
 - 1. Supplied with operator mechanisms, appropriate number of contact blocks, and any necessary legend plates bearing pertinent information.
 - 2. Contact block terminals: Labeled for identification purposes and contain no less than one single-pole, double-throw contact.
 - 3. Contact blocks: Heavy duty type rated for 10A breaking current at 120V.
- C. Stop and emergency stop pushbuttons: Red in color unless approved otherwise.
 - 1. Other pushbuttons: Black unless approved otherwise.
- D. Pushbuttons.
 - 1. Operation: Momentary.
 - 2. Switch operation for local-remote, auto-manual, and computer-manual selection: Maintained in all positions.
 - 3. Provided with flush head bezels.
- E. Spring return selector switches: Required where indicated on Contract drawings.
- F. The following color code shall be used for the lenses of all indicating lights:

<u>FUNCTION</u>	<u>COLOR</u>	<u>FUNCTION</u>	<u>COLOR</u>
ON	Red	HIGH	White
OFF	Green	AUTOMATIC	White
CLOSED	Green	MANUAL	Blue
OPEN	Red	LOCAL	Blue
LOW	White	REMOTE	White
FAIL	White	POWER ON	White
TRIPPED	White		

- G. Indicating lights: Push-to-test LED-type, rated for 120V operation.

- H. Selector switches, pushbuttons, and indicating lights: Allen-Bradley Series 800, Siemens Class 52, or equal.

2.6 INTERPOSING RELAYS

- A. Used in conjunction with discrete inputs when field equipment being monitored is not compatible with 120VAC.
- B. Discrete outputs: Energize interposing relays interlocked with field control circuits, unless approved otherwise.
 - 1. Relays.
 - a. Coils rated to match field equipment.
 - b. Contacts rated for no less than 5A.
 - c. Only one Form C contact per relay.
 - d. LEDs to indicate when coil is energized.
 - e. Manual override switches for testing.
 - f. Turck/Releco type C12-A21X or equal.
- C. Provide surge suppressors on DC operated relay coils to reduce high transient voltage generated when circuit to operating coil is opened.
- D. May be required when using unfused PLC relay output modules.

2.7 POWER DISTRIBUTION

- A. DPCS panels: Furnished with two 120VAC, 20A-rated circuits.
 - 1. Line filtered circuit for powering the PLC, relay outputs, field contacts for digital inputs, 24VDC power supply, instrumentation, etc.
 - 2. Panels that contain the PLC processor and communication modules: Furnished with 120V receptacle on line filtered circuit for powering transceiver.
 - 3. Auxiliary circuit for powering enclosure lights and utility receptacle.
- B. Provide master disconnect switch and auxiliary branch circuit protectors (miniature circuit breakers).
 - 1. Circuit breakers: Used on AC inputs to power supplies and auxiliary circuits.
 - 2. Provide fused terminal blocks for 24VDC-powered devices and for connecting power to bottom tier of digital input terminal block assemblies.
- C. Input terminals, branch circuit protectors, and fuse terminals: Mounted on din rail and grouped according to function.
 - 1. Fuse terminals for digital input terminal block assemblies: Mounted next to digital input terminals.
- D. Auxiliary Branch Circuit Protectors: Siemens Series SY with trip characteristic C, or equal.

E. DPCS Panel Power Supply

1. Provide DPCS panel with 24VDC power supply rated for either 5A or 10A.
2. Power supplied: Meet or exceed the following specifications;

Input Power:	85 to 132 VACS, 47 to 63 Hz
Minimum Efficiency:	90%
Overload Rating:	150% I (out) rated up to 5 s/min
Protection:	Internally fused, preset current limit
Operating Temp. Range:	0 to 60 deg. C
Mounting:	Din rail mount
Output Voltage:	22.8 to 28V, adjustable
Output Voltage Regulation:	Typical 0.3% V (out)
Ripple and Noise:	<50 mV, pp
Temperature Coefficient:	0.02 percent per degree centigrade
Manufacturer:	Siemens 6EP1333-2AA01 (5A) Siemens 6EP1334-2AA01 (10A) Siemens 6EP1961-3BA20 (Redundancy)

3. DPCS panels that contain PLC processor:
 - a. Equipped with redundant power supplies and redundancy module that can switch to backup unit in case of failure.
 - 1) Redundancy module status contact: Wired into PLC digital input.

F. Power Line Transient Protection.

1. Provide panels containing solid state electronic equipment with line voltage surge suppressor provided with;
 - a. Surge arrester.
 - b. RFI filter.
 - c. Voltage clamp.
 - d. Terminals for incoming and load wires that shall trip power feed circuit breakers.
 - e. Automatic device reset.
 - f. Din rail mountable.
2. Approved Manufacturers;
 - a. Islatrol brand IE-120.

G. Uninterruptable Power Supply: Ferrups style with MBB bypass transfer switch, quick disconnect cables with twistlock connectors, and caster kit.

H. Exhaust Fan Motor Starter

1. The exhaust fan motor starter shall be across-the-line magnetic type rated in accordance with NEMA standards, sizes and horsepower ratings. The motor starter shall have a 120 volt coil. The motor starter shall be located in the Control Room Exhaust Fan Control Panel. The motor starter shall be furnished with an overload relay. Provide a heater element in each phase of the relay sized for the motor nameplate full load amps.

2. The exhaust fan motor starter shall be Allen-Bradley Bulletin 509 or Square D Class 8536.

PART 3 EXECUTION

3.1 FACTORY TESTING.

- A. Equipment: Inspected and tested prior to being shipped to field.
- B. Each piece of hardware: Energized and tested to verify components function following manufacturer specifications.
- C. Factory testing: Include integrated system test to demonstrate proper functioning of CPU, local I/O modules, remote I/O network and remote I/O modules. Conduct test using minimally configured system.
- D. Personal computer and software necessary to create PLC hardware configuration for testing: Provided by factory
 1. WSSC will provide CPU rack for testing remote I/O panels upon request.
- E. Test Each I/O point following procedures outlined below. For purposes of factory testing;
 1. "Field terminals" shall mean the terminal blocks on the DPCS panels meant to receive field wiring
 2. "Console" shall mean the personal computer used to configure PLC and verify I/O test.

Digital Inputs: Jump each digital input field terminal to 120VAC or 24VDC, according to module type. Observe change of state at console.

Digital Outputs: For relay output modules with field connections to both line and load, force each output on at the console and measure the change of state at field terminals with continuity tester. For relay output modules connected to interposing relays on DPCS panel, verify proper output voltage and operation of interposing relays.

Analog Inputs: Introduce 4 to 20 mA DC signal at field terminal and observe changing value at console. Test response at 4 mA, 12 mA and 20 mA.

Analog Outputs: Force each output at console with values corresponding to 4 mA, 12 mA and 20 mA, and measure results at field terminals.

- F. Provide 5 working days notice prior to starting factory testing. WSSC will typically witness testing, but may waive this requirement on case-by-case basis.

- G. Patent defects in equipment: Repaired or replaced, as required, at no cost to the Commission, until substantial completion.
 - 1. If Latent defects are found notify the Commission immediately.
- H. Any factory modifications to DPCS panels shall be approved, tested, and documented prior to final acceptance.

3.2 POST TESTING

- A. Submit following documentation within 14 days of finishing factory panel testing.
 - 1. As-built versions of shop drawings listed herein.
 - 2. Fully annotated PLC logic backed up on CD-ROM.
 - 3. OIT configuration, tags and screens backed up CD-ROM.
 - 4. Complete I/O list following Process Control Group format.
- B. Submit final as-shipped drawings prior to shipment for approval and provide one copy within enclosure(s) to be shipped.
- C. Provide for protection, insurance and proper storage of equipment until received and inspected by the owner.
- D. Deliver spare parts for DPCS panels, as specified in contract drawings and documentation, prior to panel installation.

END OF SECTION

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SECTION 16947
FIBER-OPTIC COMMUNICATION CABLE

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section includes materials, installation, and testing of multimode fiber optic cable. Multimode shall be used everywhere.
- B. Drawings indicate desired location and arrangement of pull boxes, cable runs, and other items.
 - 1. Exact locations: Determined in field, based on physical size and arrangement of equipment, finished elevations and obstructions.
 - 2. Adhere as closely as possible to locations shown on drawings.
- C. Related work specified elsewhere:
 - 1. Basic Electrical Materials and Methods – Section 16050
 - 2. Digital Process Control System Installation – Section 16900

1.2 QUALITY ASSURANCE

- A. Fiber Optic Specialty Contractor Qualifications:
 - 1. Minimum of five years' experience with installation of fiber-optic systems similar to this project.
 - 2. Test equipment must be factory certified within one year of approved testing results.

1.3 SUBMITTALS

- A. Submit following Section 01300.
 - 1. Catalog data on fiber-optic cable, high-density polyethylene (HPDE) duct, pull boxes, connectors, conduit sealant, closures, enclosures, identification tape, and mounting hardware.
 - a. All material must be installed and accepted within three years of date of manufacture.
 - 2. Detailed bill of materials.
 - 3. Testing.
 - a. Catalog data on testing equipment.
 - b. Written test procedure outlining steps and methods used to test cable before and after installation.
 - c. Sample copy of test form to be used in test procedure.
 - d. Sample optical time domain reflector (OTDR) test results and graph.
 - 4. Cable and duct installation procedure.
 - a. Outline construction methods used.
 - b. Identify steps to ensure cable is not damaged during installation.

5. Factory test results for each cable reel, stating signal loss for each fiber in cable.
 6. Field test results for each cable reel, stating signal loss for each fiber in cable before and after installation, as specified herein.
 7. Record drawings indicating locations and station numbers of all pull boxes.
- B. Submit following Section 01450 and as specified herein.
1. Written evidence of minimum five years' experience with installation termination and testing of fiber-optic cable systems similar to this project.
 2. List of completed installations similar to this project. Include name and address of Company, name of project, and date of completion.
 3. Name and qualifications of supervisory personnel directly responsible for installation of fiber-optic system.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver, handle, and store equipment following Section 16900 and manufacturer's recommendations.

PART 2 PRODUCTS

2.1 MULTI-MODE FIBER-OPTIC CABLE

- A. Provide multi-mode fiber-optic cable suitable for use with both 850 and 1,300 nm transmission equipment.
- B. Fiber.
1. 62.5-micron core with 125-micro cladding material.
 2. Maximum individual fiber loss: 3.5 dB/km at 850 nm and 1.5 dB/km at 1,300 nm.
 3. Color-coded.
 4. 12 fiber-pair per fiber-optic cable, unless otherwise specified.
 5. Operating Temperature range: -40°C to 80° C
 6. Crush resistance: 250-lb./inch minimum
 7. Tensile load rating: 600 pounds minimum per fiber optic cable.
- C. Continuous outer jackets of cable: Free from holes, splits, blisters, or inclusions. Same requirement for inner jackets within cable structure and fiber coatings.
- D. Provide loose-tube type cable construction.
- E. Provide fiber optic cable from one distributor.
1. Approved manufacturers
 - a. Draka as follows:
 - (1) Armored burial cable DLSZHD for direct burial applications.

2.2 FIBER-OPTIC ACCESSORIES

- A. For connectors, provide ST type pre-polished or fusion-spliced fan breakout kits. Mating losses not to exceed 0.75 dB per connection.
 - 1. Fiber optic patch cables: Duplex type with ST connectors.
 - a. No more than 2 meters of slack at either end or 3 meters total.
 - b. Only use soft Velcro tie wraps for securing patch cables.
- B. Install connectors after fiber-optic cables are pulled and run to desired location.
- C. Fiber optic patch panels.
 - 1. Approved manufacturers:
 - a. Siecor
 - b. Corning
 - c. Or equal
- D. Provide all other raceways, fittings, boxes, and terminal cabinets following specification 16050.

2.3 FIBER OPTIC DISTRIBUTION BOX (FOD)

- A. Provide minimum of one FOD box to enclose indoor/outdoor fiber optic cable connections for each area as shown on drawings, or wherever FOD box is needed.
- B. If location is not shown on drawings, locate near to RIO enclosure.
- C. Fiber optic cable connections and restraining in FOD enclosures must meet fiber optic cable and FOD manufacturer's recommendations.
- D. Provide ST connectors and connect fiber optic strands to FOD rack.
- E. FOD box: Constructed of Low Zero halogen material, easy to punch, drill, file or saw.
- F. Provide brackets for wall mounting, hardware grounding kit, twelve 6-fiber panels for 72 fibers total capacity and NEMA 4X.
- G. Approved Manufacturer:
 - 1. Corning, Model EDC-12P-NH.

2.4 CABLE PACKING

- A. Permanently mark cable to identify manufacturer, date manufactured, length of cable, product identification code, and UL messages when appropriate.
- B. Marking: Print at regular intervals no more than 1 meter apart.
- C. Package cable and duct on reel with inner hub diameter greater than recommended minimum-ending diameter of cable.

- D. Anchor holes on reels: Admit 63.5-mm (2.5-inch) diameter spindle without binding.
- E. Package: Sturdy enough to endure reasonable handling in process of shipping and storage.
- F. Attach the following information to reel (as a tag), or clearly and permanently stencil, or label on each reel:
 - 1. Customer order number.
 - 2. Customer job number.
 - 3. Customer reel number.
 - 4. Termination.
 - 5. Ship date.
 - 6. Manufacturer's name.
 - 7. Factory reel number.
 - 8. Manufacturer's cable code (type and fiber count).
 - 9. Length of cable.
 - 10. Weight of cable and reel.
 - 11. Defect tag.
- G. Seal ends of cable and duct to prevent the escape of filling compound and entry of moisture during shipping, handling, storage, and installation.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install fiber optic cable:
 - 1. After field reel test report approval.
 - 2. Following engineering data, instructions and recommendations of equipment manufacturers and contract drawings.
 - 3. Performed by workers skilled in fiber optic installations.
 - 4. Do not exceed manufacturer's minimum installation and operating cable-bending radii, pull strength and vertical rise.
 - 5. Do not kink cable and duct as it comes off spool.
 - 6. Do not allow vehicular or pedestrian traffic to run over duct or cable.
 - 7. Use dynamometers or breakaway pulling swings to ensure pulling line tension does not exceed installation tension values specified by the manufacturer.
 - 8. Record and submit maximum pulling tension for each pull, after installation is complete.
 - 9. Provide cable runs and required loops in one continuous length. Do not splice.
 - 10. All penetrations through the bottom of cabinets. If impractical, consult WSSC to discuss penetrations through the side of cabinet.

- B. Test each fiber optic cable member before connection at any point along the network.
 - 1. Identify both active and spare pairs at each termination point along the network.
 - 2. Terminate all fiber members within fiber-optic patch panels.
- C. Conduit Installation
 - 1. Multi-mode fiber: Run though new and existing duct banks and conduit following fiber-optic cable and FOD manufacturers' recommendations and as shown on drawings.
 - a. Check each for foreign material and collapsed sections prior to pulling fiber-optic cable.
 - 2. Run fiber-optic cable though conduit at above ground locations.
 - a. Pull mandrel through conduit to check inside diameter and verify conduit is free from obstructions.
 - b. If mandrel will not pass-through conduit, replace or repair conduit at obstruction point.

3.2 FIELD TEST

- A. Inspect fiber optic cable for physical damage.
- B. Install connectors on each fiber to perform field tests.
- C. Perform fiber optic test with an optical time domain reflectometer (OTDR) for each strand of fiber to verify attenuation, length, continuity, and proper installation.
 - 1. Perform OTDR test by approved independent company.
 - 2. Test using:
 - a. Multimode OTDR at 850 nm and 1300 nm wavelength for multimode fiber.
 - b. Use a 500' minimum launch and receive fiber optic cables.
 - 3. Submit results of measurements for approval.
- D. Test fibers for breaks, abnormalities, and overall attenuation characteristics to ensure that installed cable adheres to required optical parameter.
 - 1. Provide written certification of dB loss at each test location.
- E. Perform attenuation tests:
 - 1. After delivery to site, before cable is removed from the reel.
 - 2. After installation of cable.
 - a. Final test each end of cable after all terminations have been made and installation is complete.
- F. Cable reels that fail continuity or that have higher than specified attenuation shall be subject to rejection and replaced at no additional cost.

3.3 TEST RESULTS

- A. Furnish written Certification.
 - 1. Tests conducted for each fiber, extending to end of each fiber-optic cable run.
 - 2. Provide for each test location:
 - a. Clearly label test type, location, date, wavelength, index of refraction, fiber number, fiber color and fiber identification, as shown on Drawings.
 - b. Format report and trace graphs so that each strand can be identified. Report loss in dB/km between connectors and dB loss across each connector.
 - c. Overall distance and distances to every termination on individual fibers from trace graphs.
 - d. Overall distance and distances to every termination on individual fibers from length markers on cable jacket.
- B. Performance test data:
 - 1. Connection mating losses not to exceed 0.75 dB per connection.
 - 2. Attenuation losses not to exceed 3.5 dB per kilometer.
 - 3. Remove from job site Fiber Optic Cable that does not test satisfactorily.

3.4 FIELD QUALITY CONTROL AND TESTING.

- A. Prerequisites:
 - 1. Inspect for physical damage.
- B. Preliminary Test
 - 1. Install connectors on each fiber to perform field tests.
 - 2. Perform test and submit results.
- C. Prefinal Test
 - 1. Verify all punch list items have been corrected.
 - 2. Verify all equipment functions as complete units, as specified.
- D. Final Test
 - 1. Verify all pre-final punch list items have been corrected.

END OF SECTION

SECTION 16950 TESTING

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section Includes: Requirements for performing, recording, and completing electrical and mechanical equipment field testing program.
- B. Testing Requirements for Division 2 Sections: As specified therein.
- C. Procedures Contained in Section 01450: Applicable as specified.

1.2 QUALITY ASSURANCE

- A. Testing Procedures: Follow Section 01450 and engage independent testing company to perform tests and submit data as specified herein.
 - 1. Preliminary Test:
 - a. Demonstrate that equipment and connections, when energized, perform functions required by Contract Documents, approved Contractor's Submittals, and approved Operation and Maintenance Manuals for each item of equipment or system.
 - b. Have quality of workmanship and installation examined for deficiencies and listed on punch list for repair prior to Prefinal Test.
 - c. Obtain approval and inspection of work by other agencies or organizations before installation or operation, when required by local codes or laws.
 - (1) Submit to Engineer: 1 signed original and 3 copies of approvals.
 - d. Following Construction Schedule and with Engineer's approval, schedule Preliminary Tests minimum of 10 days before Prefinal Tests are scheduled.
 - e. Ensure performance and recording of Contractor's tests and independent testing company tests before Preliminary Tests to avoid delays of scheduled testing procedures.
 - 2. Prefinal Testing: Enables unanimous, satisfactory acceptance for online use by Inspector by demonstrating that:
 - a. Equipment has been installed following Contract Documents and approved Contractor's Drawings.
 - b. Project phases have been completed.
 - c. Integrated equipment and systems operate as complete units.
 - d. Punch list items developed in Preliminary Tests have been corrected.
 - 3. Final Test: Precedes scheduling of Certificate of Final Acceptance and verifies that:
 - a. Outstanding items of punch lists have been corrected.

- b. Project work is ready to be placed in service and turned over to the Commission.
- B. Inspections and Tests: Follow latest edition of applicable test procedures of these standards associations:
 - 1. ANSI.
 - 2. IEEE.
 - 3. ICEA.
 - 4. NEC.
 - 5. NEMA.
 - 6. NETA.
 - 7. AWWA.
- C. Coordinate tests with data, instructions, and recommendations in Short Circuit Calculations and Coordination Studies specified herein and approved before testing.

1.3 SUBMITTALS

- A. Data, Certificates, and Record Drawings: Submit following Sections 01330 and 01450.
- B. Schedule of Dates and Times for Testing: Include description of equipment and systems to be tested and testing sequence.
- C. Short Circuit Calculations and Coordination Study, Low Voltage:
 - 1. Submit complete study in booklet form at shop drawing phase for electrical equipment.
 - 2. Include Low Voltage Distribution System specified in Section 16050 and 16143 and shown on One Line Diagram in Contract Drawings.
 - 3. Contents:
 - a. Overcurrent and ground fault coordination charts, indicating relations of time current curves between selectively coordinated protective devices.
 - b. New 480 Volt feeder breaker in existing Control Building and associated 480 Volt service feeder to MCC-WH.
 - c. 480 Volt Motor Control Center MCC-WH and associated 480 Volt feeders and loads.
 - d. Dry type transformers and associated primary and secondary feeders.
 - e. 208Y/120V Panelboards.
 - 4. Make revisions required by Engineer and resubmit for final approval.
- D. Record Forms
 - 1. Submit test data record forms for each system and item of equipment tested in preapproved form and format.
 - 2. Neatly print or type test form to permit photocopying without loss of clarity to include.
 - a. Project identification.

- b. Test stage identification: Preliminary or Prefinal.
- c. Sequence number of test: First Test, Second Test, and Final Test.
- d. Beginning and ending test dates.
- e. Identification of testing facility: Contractor, independent testing company, or Manufacturer.
- f. Signature of person conducting tests or chief of test team on test data record forms or title sheet of multiple page test report, typewritten or neatly printed name to permit photocopy without loss of clarity.

1.4 TEST EQUIPMENT

- A. Test Instruments, Meters, and Auxiliary Equipment: Tested and calibrated within 6 months of use on this contract and provided by Contractor and independent testing companies and by manufacturers' field service personnel where required.

1.5 DEFINITIONS

- A. Prerequisites: Items of work or submittals required before requirements of this Section.

PART 2
NOT USED

PART 3 EXECUTION
NOT USED

END OF SECTION

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APPENDIX A

GEOTECHNICAL ENGINEERING REPORT

GEOTECHNICAL ENGINEERING REPORT

**WESTERN BRANCH WRRF WATER SYSTEM UPGRADE
TASK ORDER NO. 28
WSSC PROJECT NO. CD6915A20
MARYLAND
KEI PROJECT NO. G21045**

**PREPARED FOR
RUMMEL, KLEPPER & KAHL, LLP
700 EAST PRATT STREET, SUITE 500
BALTIMORE, MD 21202**

**PREPARED BY
KIM ENGINEERING, INC.
3916 VERO ROAD, SUITE K
BALTIMORE, MD 21227**



**KIM
ENGINEERING**

ROCKVILLE | BELTSVILLE | BALTIMORE | STERLING



December 2, 2021

John C. Moore.
Director - Water
RK&K
700 East Pratt Street, Suite 500
Baltimore, MD 21202

Subject: **Geotechnical Engineering Services**
 Western Branch WRRF Water System Upgrade
 Task 28, WSSC Project No. CD6915A20
 Upper Marlboro, Maryland
 KEI Project No.: G21045

Dear Mr. Moore:

Kim Engineering, Inc. (KEI) is pleased to submit our Geotechnical Engineering Report for the above referenced project. This investigation was conducted in accordance with our subcontract agreement made on April 28, 2021.

The purposes of the study were to define the subsurface conditions in the areas of and to the depths of the test borings and to provide geotechnical recommendations for the proposed water treatment building construction. To accomplish this, the following scope of services was performed:

- A. Reviewed and summarized available geologic and subsurface information relative to the project site.
- B. Executed a subsurface exploration program that consists of two (2) standard penetration test (SPT) borings.
- C. Borings were backfilled upon completion of the drilling.
- D. Performed laboratory tests of moisture content, gradation, Atterberg limits, Standard Proctor and corrosivity.
- E. Evaluated the test borings and corresponding laboratory test results.
- F. Performed engineering analysis to provide soil bearing pressures for use in the structural design of the proposed building.



- G. Submit this report that summarizes our work and provides the above information including copies of test borings logs and the laboratory test results.

Services with respect to surveying for line and grade, specific dewatering recommendations, environmental matters, stormwater management, temporary slopes, retaining walls, seepage analysis, slope stability, erosion control, cost or quantity estimates, plans, specifications, and construction observation and testing were not included in the scope of services.

We appreciate the opportunity to be of service to you for this project. If you have any questions regarding this report, please do not hesitate to contact either of the undersigned.

Very truly yours,
KIM ENGINEERING, INC.

A handwritten signature in blue ink, appearing to read "K. Bhusal", written over a light blue horizontal line.

Kamal Bhusal
Project Manager

A handwritten signature in blue ink, appearing to read "Tom Labuda", written over a light blue horizontal line.

Tom Labuda, P.E., P.G.
Principal Engineer



PROFESSIONAL CERTIFICATION: I HEREBY CERTIFY THAT
THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND
THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER
THE LAWS OF THE STATE OF MARYLAND, LICENSE NO.:PE 42702
EXPIRATION DATE: 10-12-2022.



GEOTECHNICAL ENGINEERING REPORT
WESTERN BRANCH WRRF WATER SYSTEM UPGRADE
TASK 28, WSSC PROJECT NO: CD6915A20
6600 CRAIN HIGHWAY, UPPER MARLBORO, MD

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APPENDIX B	Records of Field Testing <ul style="list-style-type: none">• Identification of Soil• Soil Boring Logs
APPENDIX C	Laboratory Test Results <ul style="list-style-type: none">• Natural Moisture Content• Gradation Analysis• Atterberg Limits• Standard Proctor• Corrosivity Test Results

1.0 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

The following is a summary of our conclusions and recommendations:

- a Subsurface conditions in the proposed construction area generally indicates naturally occurring soils consisting of sandy SILT(ML), silty SAND (SM) and poorly graded SAND with silt (SP-SM) in stratum A.
- b The naturally occurring soils of Stratum A are suitable to support foundations designed for a net allowable soil bearing pressure of **2,000** psf for new spread footings founded on approved natural soil or on new compacted fill placed over approved natural soil.
- c Compacted fill in structural areas should typically be classified as silty sandy SILT (ML) or more granular per ASTM D 2487 and compacted to at least 95 percent of maximum dry density per ASTM D 698 standard proctor. The onsite soils such as ML and SM meeting moisture and gradation criteria are considered suitable for reuse as fill and backfill; however, some importing, or substitution may be necessary.
- d Variations in soil conditions may be encountered during construction. Determination of such variations will permit correlation between the subsurface exploration data of this report and actual conditions encountered during construction and verification of conformance with the plans and specifications. We recommend that Kim Engineering, Inc. be retained to perform professional observations of foundation subgrades.

This report is based on information available to us on the proposed construction. If the project characteristics are changed from those indicated herein, our recommendations may require modifications. Please advise us of any changes to the proposed construction.

We recommend that the project specifications include the following statement:

"A geotechnical report has been prepared for this project by Kim Engineering, Inc. and is available to prospective bidders and/or contractors for informational purposes only. The report has been prepared for design purposes only and may not be sufficient to prepare an accurate bid for construction. Contractors wishing copies of this report may secure them from Kim Engineering Inc. at a nominal charge with the understanding that its scope is limited solely to generalized design considerations."

We have prepared this report in accordance with contemporary geotechnical engineering practices and make no warranties, either expressed or implied, as to the professional services provided under the terms of our agreement and included in this report.

2.0 SITE DESCRIPTION AND PROPOSED CONSTRUCTION

The site is located east of 6600 Crain Highway in Upper Marlboro, Maryland within the Western Branch Wastewater Treatment Plant (WWTP) owned and operated by WSSC. Drawing Number 1, Site Location Plan, attached to this report shows the location of the project site. The site consists of existing wastewater treatment plant, administrative buildings, and associated facilities. The site topography is relatively flat. The field subsurface investigation was done within the proposed construction area.

Based on the information provided to us, the proposed construction will consist of a new water treatment building (20 feet by 20 feet slab-on-grade) and installation of small diameter (less than 8-inches diameter) water mains. The structural information for the proposed building was not provided to us prior to the preparation of this report.

3.0 SUBSURFACE EXPLORATION

3.1 Test Boring

In order to evaluate the subsurface conditions of the site for this study, two (2) standard penetration tests borings (B-1 and B-2) were drilled at the site. The approximate locations of the test borings are depicted on the attached Drawing Number 2 - Boring Location Plan.

The standard penetration tests (SPT) borings for the proposed construction were drilled to depths of 25 feet and 20 feet for borings B-1 and B-2, respectively. Auger refusal on a dense gravel layer was encountered at the B-2 boring location at the depth of 20 feet. Subsurface water level readings were taken in each of the test borings during drilling and at the completion of the drilling process. Upon completion, the boreholes were backfilled with auger cuttings (soil).

The test borings were advanced using a truck-mounted drill rig. The exploration program was performed in the field on November 9th, 2021. Hollow-stem augers were advanced to pre-selected depths and representative soil samples were recovered with a standard split-spoon sampler in general accordance with ASTM D-1586. Disturbed representative soil samples were recovered while performing the Standard Penetration Test (SPT). This test (ASTM D-1586) consists of a 140-pound (lb) hammer falling a distance of 30 inches. The number of blows required to drive the standard split spoon sampler (2-inch O.D., 1-3/8-inch I.D.) a distance of 12 inches after an initial set of 6 inches to ensure the sampler is in undisturbed material, is recorded as the Standard Penetration Resistance (N-Value) of the soil.

The N-value, for the majority of subsurface situations, provides a generalized indication of in-situ soil conditions when reviewed by individuals with established geotechnical backgrounds. N-values can be used to provide a qualitative indication of the in-place relative density of granular soils. Similarly, N-values provide an indication of consistency for cohesive soils.

Representative portions of the split-spoon soil samples obtained throughout the exploration program were placed in glass jars and transported to our laboratory for further evaluation and visual classification per the visual-manual identification procedure (ASTM D-2488) and the Unified Soil Classification System. The soil descriptions and classifications discussed in this report and shown on the attached boring logs are based on visual observation and as previously noted, should be considered approximate.

Soil samples recovered on this project will be stored at Kim Engineering, Inc. for a period of thirty (30) days from the date of this report. After thirty (30) days, the samples will be discarded unless prior notification for an alternate disposition is provided to us in writing.

4.0 GEOLOGY

The subject property is located within the Coastal Plain physiographic province. The Coastal Plain province encompasses a series of stratified, generally unconsolidated clays, silts, marls, and sands, deposited under terrestrial, estuarine, near-shore marine and open water marine environments. The age of these deposits ranges from Early Cretaceous (130 million years ago) to Quaternary (10 thousand years ago).

According to the Maryland Geological Map published by The Maryland Geological Survey (1968), the site is underlain by the Quaternary geologic age Lowland Deposits that consist of gravel, sand, silt and clay. Medium- to coarse-grained sand and gravel; cobbles and boulders near base; commonly contains reworked Eocene glauconite; varicolored silts and clays; brown to dark gray lignitic silty clay; contains estuarine to marine fauna in some areas (includes in part Pamlico, Talbot, Wicomico and Sunderland Formations of earlier reports); thickness 0 to 150 feet.

5.0 SUBSURFACE CONDITION

5.1 General Stratification

The subsurface conditions discussed below and those shown on the boring logs represent an estimate of the subsurface conditions based on an interpretation of the boring data using geotechnical engineering judgment. Transitions between different soil strata are usually less distinct than those shown on the boring logs. Although individual test borings are representative of the subsurface conditions at the boring locations on the dates shown, they are not necessarily indicative of subsurface conditions at other locations or at other times.

More comprehensive descriptions of the materials encountered are included in the attached test boring logs. The subsurface investigation indicated that the following generalized strata underlie the site in the areas and to the depths investigated.

Ground Cover: Topsoil was encountered at the surface at the soil borings location. The topsoil thickness was approximately between 4 to 5 inches thick.

Stratum A (Lowland Deposits): Lowland Deposits were encountered below the ground cover at the test boring locations. The natural soil generally consisted of sandy SILT (ML), silty SAND (SM), and poorly graded SAND with silt (SP-SM). The SPT N-values obtained in the coarse-grained soils ranged from 6 blows per foot (bpf) to 32 blows per feet, indicating loose to dense relative densities. The SPT N-value in the fine-grained soils ranged from 6 bpf to 11 bpf, indicating medium stiff to stiff consistencies.

The soil symbols indicated in the stratum descriptions and on the boring logs represent the Unified Soil Classification (ASTM D-2488) group symbols and are based primarily on visual observation of the specimens recovered. Criteria for visual-manual classification of soil samples are given in Appendix B of this report.

5.2 Groundwater

Groundwater observations were performed at the test boring locations. No groundwater was recorded during drilling or at completion of the drilling.

Cave-in depths for the borings also were observed after removal of the drilling augers from the boreholes. Caved in depths for B-1 and B-2 were at approximately 10.7 feet and 13.7 feet below

existing grades, respectively. The cave-in depths are sometimes indicative of groundwater or perched water elevation.

Groundwater level readings are considered to be reliable indication of the water levels at the time indicated. However, fluctuations of groundwater levels as well as perched water may be expected with variations in precipitation, evaporation, surface runoff, and related factors.

6.0 LABORATORY TESTING

Geotechnical laboratory testing was performed on jar samples obtained from selected test borings for soil classification and moisture content. Tests were performed in accordance with ASTM Standards. Corrosivity test including: pH, resistivity, chlorides, sulfides and redox potential were also done for soil samples from the depth of three (3) feet. The test results are presented in Appendix C. The associated ASTM methods are defined below:

ASTM Method	Description
D-2216	Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
D-422	Standard Test Method for Particle-Analysis (Grain Size Distribution)
D-4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
D-698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort

The table below summarizes the laboratory test results:

Table 1: Summary of Laboratory Test Results - USCS

Boring No.	Sample No.	Depths (ft)	USCS	Percent Fines (#200)	Liquid Limit (LL)	Plasticity Index (PI)	Natural Moisture (%)
SB-1	BAG	0.0-5.0	SM	33.9	NV	NP	8.1
	S-5	10.0-11.5	SM	12.8	NV	NP	10.7
SB-2	S-4	7.5-9.0	SP-SM	9.5	NV	NP	8.3

- USCS Soil classification as determined by the Unified Soil Classification System.
- LL: Liquid limit: the moisture percentage at which soil behavior transitions from plastic to liquid.
- PI: Plastic index: Difference between the plastic and liquid limits ($PI = LL - PL$), indicates the range of moisture that the soil acts in a plastic manner. The plastic limit is defined as the minimum moisture percentage at which a soil behaves in a plastic manner.
- NP Non-Plastic.
- NV Non-Viscous

Table 2: Summary of Laboratory Test Results - Standard Proctor

Boring No.	Sample No.	Depths (ft)	USCS	Percent Fines (#200)	Maximum Dry Density (pcf)	Optimum Moisture (%)
SB-1	BAG	0.0-5.0	SM	33.9	126.4	8.4

Table 3: Summary of Laboratory Test Results - Corrosivity Test

Boring No.	Sample Depth (ft)	PH	Resistivity (ohm-cm)	% Solids	Oxidation Reduction Potential (mV)	Sulfides (presence)	Chlorides (mg/kg dry)
SB-1	3.0	5.57	27500	90	226	ND	ND
SB-2	3.0	4.9	11200	92	250	ND	ND

ND: Analyte NOT DETECTED at or above the reporting limit (<1 mg/L)

7.0 GEOTECHNICAL ENGINEERING ANALYSIS

The following evaluations and recommendations are based on our observations at the site, interpretation of the field data obtained during this exploration, and our experience with similar subsurface conditions and projects. Soil penetration data have been used to estimate an allowable bearing pressure using established correlations. Subsurface conditions in unexplored locations may vary from those encountered.

Determination of an appropriate foundation system for a given structure is dependent on the proposed structural loads, soil conditions, and construction constraints such as proximity to other structures, etc. The subsurface exploration aids the geotechnical engineer in determining the soil stratum appropriate for structural support. This determination includes considerations regarding both allowable bearing pressure and compressibility of the soil strata. In addition, since the method of construction greatly affects the soils intended for structural support, consideration must be given to the implementation of suitable methods for the site preparation, fill compaction, and other aspects of construction. Once the architectural and structural designs are finalized, KEI should review copies of the plans and specifications to revise or expand our recommendations.

7.1 Foundation Design Consideration

The construction will involve excavations for water treatment building and installation of small diameter (<8") water mains. Based on the proposed location of the new water treatment building and results of our test borings, the new foundations will be supported on natural soils. The existing natural soils encountered during this exploration are considered suitable for support of shallow foundation systems consisting of spread footings. The foundations should be proportioned for a net allowable soil bearing pressure of 2,000 pounds per square foot (psf) when founded on approved granular soils of Stratum A.

Sizing and other aspects of the design of the foundation should be accomplished by the structural engineer for the project. To reduce the possibility of localized shear failures, strip footings should be a minimum of 18 inches wide, while column footings should be a minimum of 36 inches square. Exterior footing subgrade foundation should be at least 30 inches below the final exterior grade for frost protection. Variable bearing conditions may occur at the project site; therefore, we recommend that the footings be properly reinforced to provide them with greater bending capacity.

Guidelines for the estimated footing subgrade are provided for design purposes only. Prior to the placement of reinforcement and concrete, the bases of the footing excavations should be observed, tested, and approved by a qualified representative of the Geotechnical Engineer to verify that soil conditions at each footing location are suitable for the design bearing pressure. If loose or unsuitable soils are encountered at planned subgrade levels for any footing, the unsuitable soils should be undercut down to suitable bearing materials. The footing can then be directly supported on competent suitable soils at a greater depth or, alternatively, the design footing bearing level can be restored through placement of lean concrete or engineered approved granular fill materials. If the design bearing level is restored using granular engineered fill, then the excavation to remove the unsuitable soils should extend at least 0.5 ft laterally beyond the bottom edges of the footing for each 1 ft of vertical undercut below the footing bearing level. The engineered granular fill materials should be placed and compacted as discussed in a later report section.

Final grading design must promote drainage away from the building to reduce variations in bearing soil moisture content that might result in expansion or contraction and could cause damage to the foundation. It is recommended that the structural plans contain a note to direct that shallow backfill of the foundations receive some degree of mechanical compactive effort to minimize the surficial permeability of these soils. It would also be advisable that all downspouts be routed into a stormwater management system or discharge at least 10 feet away from the foundation line. We highly recommend that the suitability of subgrade soils should be evaluated by a representative of our firm during the construction phase.

7.2 Settlement

Our settlement analysis was performed on the basis of structural assumptions from similar projects. Based on the boring data and the anticipated structural loads, we estimate that total settlements for the foundations should not exceed one inch with differential settlement expected to be less than half the total settlement. The magnitude of differential settlements will be influenced by the distribution of loads and the variability of underlying materials. These settlement values are based on our engineering experience with soils in the general area and the anticipated structural loading from similar projects. Quality control during construction is considered to be extreme importance to ensure that subsequent settlements, following the construction process, are kept to a minimum.

7.3 Ground Bearing Floor Slab

Based on the subsurface conditions, the proposed building floor slab-on-grade can be supported by approved competent existing site soils or new compacted engineered fill. We recommend a modulus of subgrade reaction (k) of 120 pounds per cubic inch (pci) for approved subgrades (k value considers a 1-ft by 1-ft square plate). A minimum 6-inch-thick layer of free draining aggregate is recommended to be placed below the floor slab to serve as a capillary moisture barrier. A polyethylene membrane or similar vapor barrier should be placed over the aggregate to prevent concrete contamination. Proper mix designs, placement methods, and curing methods must be utilized to reduce the potential for concrete shrinkage and curling that are sometimes associated with use of a vapor barrier.

Slab subgrades are often disturbed after final grading due to ongoing construction activities, utility installations, and weather conditions. We recommend that subgrades that become saturated or lose their support capabilities be removed and replaced with new selected compacted engineered fill.

7.4 Seismic Site Coefficient

We are providing a Seismic Site Class Definition per the 2015 International Building Code (IBC).

Our scope of services did not include a seismic conditions survey to determine site-specific (accurate) shear wave velocity information. IBC 2015 provides a methodology for interpretation of Standard Penetration Test resistance values (N-values) to determine a Site Class Definition. However, this method requires averaging N-values over the top 100 feet of the subsurface profile, a depth well in excess of the depths of the test borings.

Based on the subsurface data presently obtained and in general accordance with the 2015 IBC, it appears reasonable to assign the site a Classification "D".

8.0 CONSTRUCTION CONSIDERATIONS

8.1 General

The principal purpose of this section is to comment in general on the items related to foundation construction, earthwork, and related geotechnical engineering aspects of construction that should be expected for this project. It is recommended that the geotechnical engineer be retained to

provide soil engineering services during the actual site preparation and foundation construction phases of the project to perform appropriate evaluations to help ensure that conditions encountered during construction are similar to conditions encountered in the borings. The geotechnical engineer can also assist in interpretation of differing subsurface conditions that may be encountered and recommend remedial work, if needed.

8.2 Site and Subgrade Preparation

Areas proposed for grading or construction should be stripped and grubbed of all existing topsoil, vegetation, roots, organics, and loose and soft on-site soils before placing structural fill. Surficial stripping depths averaging 12 inches may be anticipated.

In addition, existing foundations, abandoned utilities, underground tanks, cisterns, or surface drainage systems such as field tile or perforated pipes possibly encountered in the construction areas should be undercut, removed, or appropriately plugged and backfilled with structural fill in accordance with the recommendations provided in Section 8.3 of this report and at the discretion of a Geotechnical Engineer.

Following preparation of exposed subgrades, accessible portions of the building subgrade should be proofrolled with a loaded 20-ton tandem axle dump truck and witnessed by the Geotechnical Engineer or qualified representative. The purpose of the proofrolling will be to locate any isolated soft, unstable or “pumping” pockets of soil, which should be excavated or otherwise stabilized as directed by the Geotechnical Engineer. Proper site drainage should be maintained at all times to prevent ponding of water at the site during construction. If the soils do become wet, care should be taken to minimize heavy construction equipment from operating on the prone subgrade.

Grades shall be sloped at no steeper than 1 horizontal to 1 vertical (1:1). All cleared and grubbed material shall be disposed of outside and below the limits of the project area.

8.3 Fill Material and Compaction

The project near-surface soils generally consisted of naturally occurring soils consisting of sandy SILT (ML), silty SAND (SM) and poorly graded silty SAND (SP-SM). On-site soils i.e., sandy SILT (ML) or granular and that is free of organic matter or debris, waste materials, frozen materials are considered to be suitable for reuse as compacted engineered fill. Sorting to remove oversized material (larger than 3 inches in diameter) may be required. Proposed fill material that

will be subject to third party compaction testing should be subjected to laboratory analysis consisting of, but not necessarily limited to, Proctor moisture/density determination, Atterberg limits, and gradation.

If imported fill is required at the site, we recommend that the material have low expansive characteristics and classified per Unified Soils Classification (ASTM D 2487) as ML or better. Any imported soil fill required to balance the site should adhere to the following parameters unless specifically accepted in writing by the Geotechnical Engineer at time of placement:

Maximum Dry Density (ASTM D698)	≥ 110 pcf
Liquid Limit	≤ 30
Plasticity Index	≤ 15
Expansion Index	≤ 40

We recommend that the fill material be placed in lifts having a maximum loose lift thickness commensurate with the equipment being utilized to perform the compaction. In no case should those lifts exceed eight (8) inches. Each lift should be uniformly compacted to at least 95% of the laboratory maximum dry density as determined by ASTM D 698, Standard Proctor. Fill materials for the proposed water main should be placed in accordance with the WSSC Standard Specifications Section 02315.

8.4 Groundwater Control and Site Drainage

Based upon the borings, shallow excavations should not encounter groundwater. Standard dewatering practices utilizing sloped lifts, mid-sized trash pump, and “tail ditches” or sump holes should be sufficient to prevent extended saturation of exposed subgrades.

Exposed subgrades must be sloped to facilitate surface runoff away from the construction area and to prevent ponding of surface water. If ponding of surface water does occur, it should be removed by pumping, ditching or as otherwise directed by the inspecting geotechnical engineer. During periods of anticipated inclement weather, exposed surfaces shall be graded and sealed to preclude infiltration of surface water. Subgrades, which become disturbed due to inclement weather or construction traffic and require over-excavation, should be reworked at no additional cost to the project.

8.5 Inspection of Subgrades

We recommend that all subgrades be inspected by a Geotechnical Engineer or an experienced engineering technician. Subgrades should be tested to check whether any unstable areas exist. Any unstable zones that are identified that cannot be re-compacted should be undercut to a depth, within the area marked by the inspecting engineer. The depths and extent of undercuts should be determined by the inspecting Geotechnical Engineer. Deeper undercuts should be avoided, and it is requested that KEI be extended an opportunity to review the conditions warranting any deeper undercuts before undercutting commences. Undercut volume should be backfilled to grade with compacted engineered fill in accordance with the requirements in this report.

9.0 LIMITATIONS

This report has been prepared for the exclusive use by our client for specific application to the proposed construction as presented herein. Our services were performed in accordance with contemporary geotechnical engineering practices. No warranty, either expressed or implied, is made. Our conclusions and recommendations are based on the preliminary design information furnished to us, the data obtained from the subsurface exploration program, and/or current geotechnical engineering practices. The findings and recommendations do not reflect variations in subsurface conditions that could exist between the boring locations or in unexplored areas of the site. Should such variations become apparent during construction, it will be necessary to re-evaluate our conclusions and recommendations based upon on-site observations of the conditions.

Regardless of the thoroughness of a subsurface exploration, there is the possibility that conditions in other areas will differ from those at the boring locations and the conditions may not be as anticipated by the designers. Additionally, the construction process may alter the soil conditions. Therefore, experienced geotechnical engineers should evaluate earthwork and foundation construction to verify that the conditions anticipated in design actually exist in the field at the time of construction. Otherwise, we assume no responsibility for construction compliance with the design concepts, specifications, or recommendations.

In the event that changes are made in the design or location of the proposed facilities, the recommendations presented in the report shall not be considered valid unless the changes are reviewed by our firm and conclusions of this report modified and/or verified in writing. If this report is copied or transmitted to a third party, it must be copied or transmitted in its entirety,

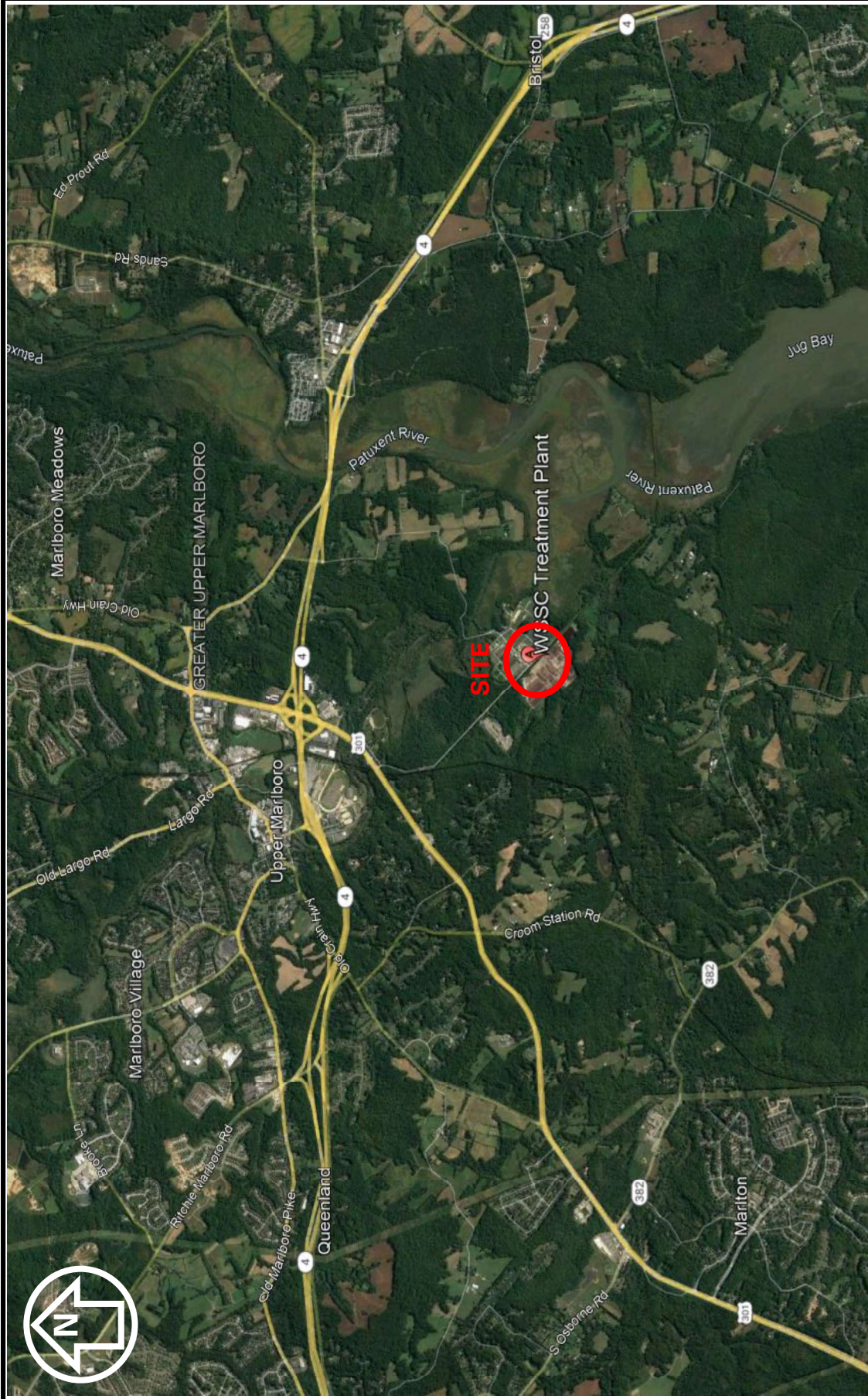
including text, attachments, and enclosures. Interpretations based on only a part of this report may not be valid.

It is important to note that our study was done in an effort to assist planning and design personnel in the preparation of generalized drawings and specifications for the project. As a result of this, potential contractors should be encouraged to conduct their own individually tailored studies to assess soils conditions, rock levels, excavation slope gradients, temporary excavation support methods, and groundwater/perched water levels and conditions. Specifically, our report has been prepared for generalized purposes of planning and design and may not be sufficiently comprehensive for bid preparation purposes.

APPENDIX A

Site Location Plan

Boring Location Plan



Sourced by Google Map



3916 VERO ROAD, SUITE K
BALTIMORE, MD 21227

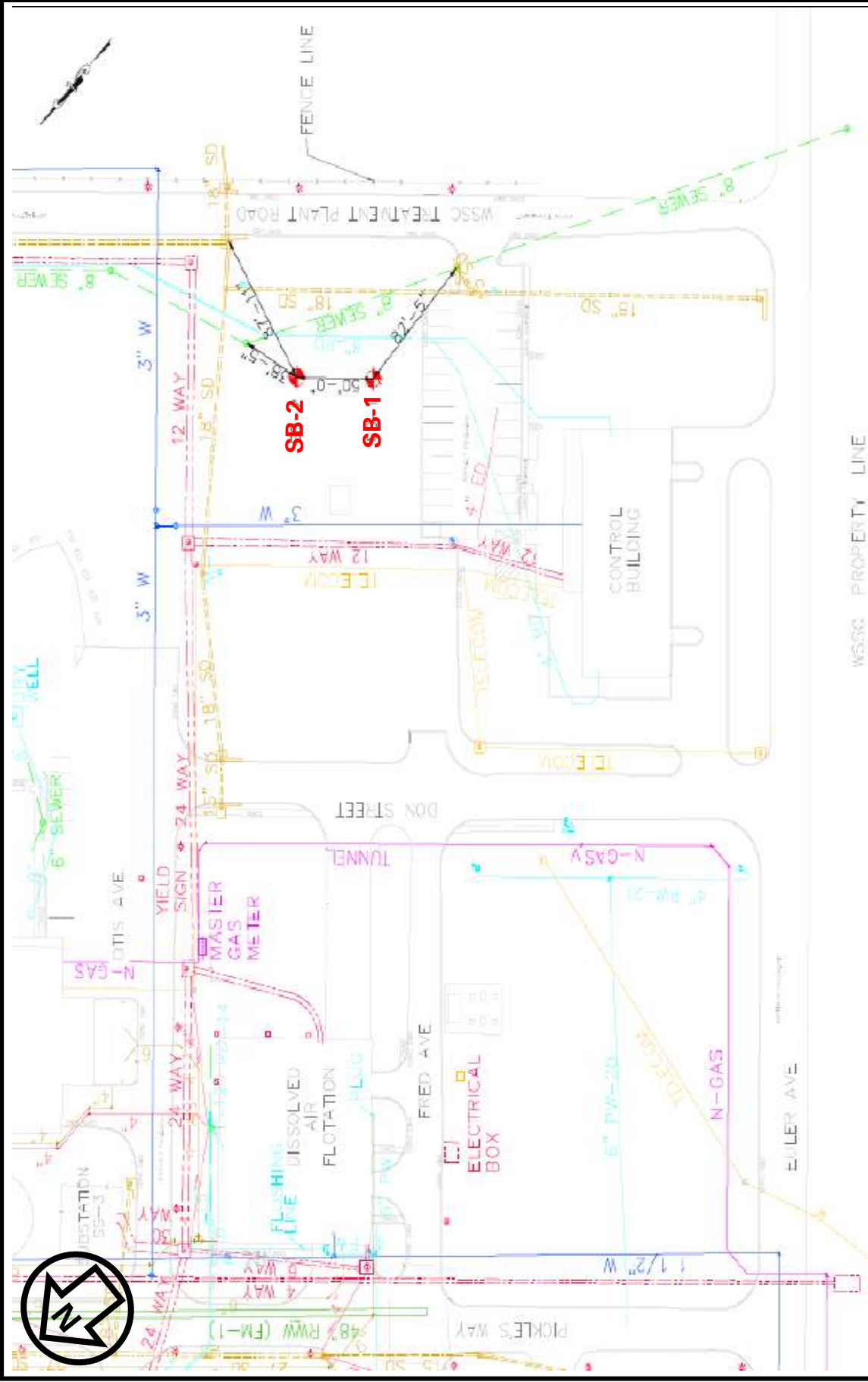
SITE LOCATION PLAN
GEOTECHNICAL ENGINEERING SERVICES
WSSC TO28, CD6915A20
UPPER MARLBORO, PRINCE GEORGE'S COUNTY, MD

PROJECT NO.: G21045

SCALE: NTS

DATE: NOVEMBER 17, 2021

DRAWING NO. 1



3916 VERO ROAD, SUITE K
BALTIMORE, MD 21227

BORING LOCATION PLAN
GEOTECHNICAL ENGINEERING SERVICES
 WSSC TO28 CD6915A20
 UPPER MARLBORO, PRINCE GEORGE'S COUNTY, MD

PROJECT NO.: G21045

SCALE: NTS

DATE: NOVEMBER 17, 2021

DRAWING NO. 2

APPENDIX B

RECORDS OF FIELD TESTING

Identification of Soil

Test Boring Logs



IDENTIFICATION OF SOIL

Soil Classification - ASTM D-2487

Coarse Grained Soils, More than 50% is retained on the No. 200 sieve	Gravels - More than 50% of the coarse fraction is retained on the No. 4 sieve. Coarse = 1" - 3" Medium = 1/2" - 1" Fine = 1/4" to 1/2"	Clean Gravels <5% Passing No. 200 sieve	GW	Well Graded Gravel
			GP	Poorly Graded Gravel
	Sands - More than 50% of the coarse fraction passes the No.4 sieve Coarse = No. 10 to No. 4 Medium = No. 10 to No. 40 Fine = No. 40 to No. 200	Gravels with fines >12% passing No. 200 sieve	GM	Silty Gravel
			GC	Clayey Gravel
		Clean Sands <5% passing No. 200 sieve	SW	Well Graded Sand
			SP	Poorly Graded Sand
		Sands with fines >12% passing No. 200 sieve	SM	Silty Sand
			SC	Clayey Sand
Fine Grained Soils, More than 50% passes the No. 200 sieve	Silts and Clays Liquid Limit of 50 or less Low to medium plasticity	Inorganic	ML	Silt
			CL	Lean Clay
	Silts and Clays Liquid limit of 50 or greater Medium to high plasticity	Organic	OL	Organic silt Organic clay
		Inorganic	MH	Elastic silt
			CH	Fat clay
		Organic	OH	Organic silt Organic clay
Highly Organic	Primarily Organic matter, dark color, organic odor		PT	Peat

Terminology and Definitions

Portions of Soil Components		
Component Form	Description	Label
Noun	Gravel, Sand, Silt, Clay	50% or more
Adjective	Sandy, Silty, Clayey	35% to 49%
Some	some Sand, some Silt	12% to 34%
Trace	trace Sand, trace Clay	1% to 11%
With	with Sand, with Silt	presence only

Particle Size Identification	
Particle Size	Particle Dimension
Boulder	12" diameter or more
Cobble	3" to 12" diameter
Gravel	1/4" to 3" diameter
Sand	0.005" to 1/4" diameter
Silt/ Clay (fines)	Cannot See Particle

Cohesive Soils		
Field Description	N- Value	Consistency
Easily Molded in Hands	0-3	Very Soft
Easily Penetrated Several inches by thumb	4-5	Soft
Penetrated by thumb with Moderate Effort	6-10	Medium
Penetrated by Thumb with Great Effort	11-30	Stiff
Indented by Thumb with only Great Effort	> 30	Hard

Granular Soils	
N- Values	Relative Density
0-4	Very Loose
5-10	Loose
11-30	Medium Dense
31-50	Dense
Greater than 50	Very Dense

Fill: Man made deposit of soils, rock and waste material.

Probable Fill: Soils which contain no visually detected foreign matter but which may be man made deposit.

Rock Fragments: Angular Pieces of rock, distinguished from transported gravel, which have separated from original vein or strata and are present in soil matrix.

Disintegrated Rock: Residual rock material with SPT of more than 60 blows per ft. and less than refusal.

Karst: Descriptive term which denotes the potential for solutioning of limestone rock and the development of sink holes.

Alluvium: Recently deposited soils placed by water action, typically stream or river flood plain soils.

Ironite: Iron oxide deposited within a soil layer forming cemented deposits.

Quartz: A hard silica mineral often found in residual soils.

Mica: A soft plate of silica mineral found in many rocks. And in residual or transported soil derived there from.

Layers: 1/2 to 12 inch seam of minor soil component.

Lenses: 0 to 1/2 inch seam of minor soil component.

Pocket: Discontinuous body of minor soil component.

Test Boring Logs

WASHINGTON SUBURBAN SANITARY COMMISSION
STANDARD BORING LOGSheet 1 of 1Boring 1 of 2Contract No. CD6915A20 Project Description WSSC Western Branch WWTPConsultant RK&K Geotech Consultant/Contractor Kim Engineering, IncBoring No. SB-1 Station , ' Ground Surface Elevation 47.0 ftEasting 1389020.6107 Northing 410086.1224 Logged by JMDate Started 11/9/21 Date Completed 11/9/21Inspector JM Driller JM

WATER TABLE

Depth Below Surface		Time (hours)	Date
Depth (ft)	Elev (ft)		
▼			
▼			

CAVE-IN TABLE

Depth Below Surface		Time (hours)	Date
Depth (ft)	Elev (ft)		
10.7	36.3		11/9/21

Rig Type	Simco
Rig No.	
Drive Hammer	140 LB
Casing Auger Size	6 IN
Size of Core	IN
Size of Bit OD	IN
Hammer Energy Ratio	70 %
Auger Depth	FT

DEPTH IN FEET	ELEV. IN FEET	MATL	MATERIAL DESCRIPTION	SPT SPOON/ROCK CORE			REC (%)	LAB. INDEX TESTS			REMARKS
				SAMPLE NO.	BLOWS/ RQD	SAMPLE DEPTH		NMC (%)	LL (%)	PI (%)	
0.4	46.58		5" Topsoil	1	1-2-4	0.0-1.5	44%	34.98			Elevation was taken from google earth.
2.5	44.50		Brown, dark brown, gray, moist, medium stiff, sandy SILT (ML) with clay.	2	11-12-15	2.5-4.0	56%	10.79			
			Brown, light brown, gray, moist, loose to medium dense, silty SAND (SM) with clay and gravel.	3	5-6-7	5.0-6.5	78%	9.61			
				4	4-6-6	7.5-9.0	56%	10.21			
				5	3-3-3	10.0-11.5	56%	10.71	NV	NP	
				6	5-3-3	13.5-15.0	44%	9.7			
18.5	28.50										
			Light gray, gray, brown, moist, loose, poorly graded SAND with silt (SP-SM) with trace clay and some gravel.	7	4-6-4	18.5-20.0	67%	4.82			
25.0	22.00			8	5-3-7	23.5-25.0	78%	7.97			

WSSC STANDARD BORING LOG (LETTER SIZE) / WSSC TEMPLATE.GDT / WSSC WESTERN BRANCH.GPJ - 12/1/21

Legend: NMC - Natural Moisture Content PI - Plasticity Index REC - Recovery MATL - Material Graphics SPT - Standard Penetration Test
RQD - Rock Quality Designation LL - Liquid Limit Elev - Elevation Geotech - Geotechnical OD - Outside Diameter

Boring and Sampling
Conforms to ASTM/AASHTO:
T-206, T-207

WASHINGTON SUBURBAN SANITARY COMMISSION
STANDARD BORING LOGSheet 1 of 1Boring 2 of 2Contract No. CD6915A20 Project Description WSSC Western Branch WWTPConsultant RK&K Geotech Consultant/Contractor Kim Engineering, IncBoring No. SB-2 Station , ' Ground Surface Elevation 45.0 ftEasting 1389056.4063 Northing 410121.0527 Logged by JMDate Started 11/9/21 Date Completed 11/9/21Inspector JM Driller JM

WATER TABLE

Depth Below Surface		Time (hours)	Date
Depth (ft)	Elev (ft)		
▼			
▽			

CAVE-IN TABLE

Depth Below Surface		Time (hours)	Date
Depth (ft)	Elev (ft)		
13.8	31.3		11/9/21

Rig Type	Simco
Rig No.	
Drive Hammer	140 LB
Casing Auger Size	6 IN
Size of Core	IN
Size of Bit OD	IN
Hammer Energy Ratio	70 %
Auger Depth	FT

DEPTH IN FEET	ELEV. IN FEET	MATL	MATERIAL DESCRIPTION	SPT SPOON/ROCK CORE			REC (%)	LAB. INDEX TESTS			REMARKS
				SAMPLE NO.	BLOWS/ RQD	SAMPLE DEPTH		NMC (%)	LL (%)	PI (%)	
0.3	44.67		4" Topsoil	1	1-4-7	0.0-1.5	56%	22.82			Elevation was taken from google earth.
2.5	42.50		Light brown, brown, gray, moist, stiff, sandy SILT (ML) with clay and gravel..	2	12-16-16	2.5-4.0	67%	4.8			
			Light brown, light gray, moist, loose to medium dense, silty SAND (SM)	3	7-4-3	5.0-6.5	67%	7.94			
7.5	37.50			4	4-4-4	7.5-9.0	33%	8.31	NV	NP	
				5	3-3-7	10.0-11.5	56%	8.19			
				6	4-3-7	13.5-15.0	56%	8.4			
20.0	25.00			7	5-8-7	18.5-20.0	67%	8.44			
			Auger refusal at 20.0 feet due to the hard large gravel.								

WSSC STANDARD BORING LOG (LETTER SIZE) / WSSC TEMPLATE.GDT / WSSC WESTERN BRANCH.GPJ - 12/1/21

Legend: NMC - Natural Moisture Content PI - Plasticity Index REC - Recovery MATL - Material Graphics SPT - Standard Penetration Test
RQD - Rock Quality Designation LL - Liquid Limit Elev - Elevation Geotech - Geotechnical OD - Outside Diameter

Boring and Sampling
Conforms to ASTM/AASHTO:
T-206, T-207

APPENDIX C

LABORATORY TEST

Natural Moisture Content

Particle Size Distribution

Atterberg Limits

Standard Proctor

Corrosivity Test Results

Natural Moisture Content



KIM ENGINEERING, INC.

Moisture Content Determination

Project Name:	WSSC Western Branch WTP	Tested By:	MB
Project No.:	G21045	Tested Date:	11/11/2021

Boring No.	SB-1								
Depth	00.1-5	2.5-4.0	5.0-6.5	7.5-9.0	10.0-11.5	13.5-15.0	18.5-20.0	23.5-25.0	0.0-5.0
Sample No.	S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	BULK
Wt. (wet+tare)	62.83	77.86	65.38	50.21	477.21	67.16	62.15	79.27	864.93
Wt. (dry+tare)	55.53	72.10	60.89	46.53	455.19	62.62	60.01	75.00	818.47
Wt. (tare)	14.39	18.73	14.15	10.50	249.66	15.83	15.61	21.41	242.95
Wt. (water)	14.39	5.76	4.49	3.68	22.02	4.54	2.14	4.27	46.46
Wt. (dry)	41.14	53.37	46.74	36.03	205.53	46.79	44.40	53.59	575.52
Moisture Content	34.98	10.79	9.61	10.21	10.71	9.70	4.82	7.97	8.07

Boring No.	SB-2						
Depth	00.1-5	2.5-4.0	5.0-6.5	7.5-9.0	10.0-11.5	13.5-15.0	18.5-20.0
Sample No.	S-1	S-2	S-3	S-4	S-5	S-6	S-7
Wt. (wet+tare)	87.67	99.09	83.10	348.79	59.22	78.35	78.23
Wt. (dry+tare)	79.66	95.20	78.15	330.88	55.58	73.51	73.07
Wt. (tare)	16.59	14.08	15.79	115.32	11.12	15.91	11.94
Wt. (water)	14.39	3.89	4.95	17.91	3.64	4.84	5.16
Wt. (dry)	63.07	81.12	62.36	215.56	44.46	57.60	61.13
Moisture Content	22.82	4.80	7.94	8.31	8.19	8.40	8.44

Particle Size Distribution

The graph illustrates the grain size distribution of a soil sample. The y-axis represents the percentage of soil finer than a given grain size, ranging from 0 to 100. The x-axis represents the grain size in millimeters on a logarithmic scale, ranging from 100 mm down to 0.001 mm. The curve shows that 100% of the soil is finer than 75 microns (No. 200 sieve). The distribution is well-graded, with a significant portion of the soil falling between 0.075 mm and 0.425 mm.

Grain Size (mm)	Percent Finer (%)
60.0	100
42.5	100
30.0	100
25.0	100
20.0	100
15.0	100
12.5	100
10.0	100
7.5	100
6.0	100
4.75	100
3.75	100
3.0	100
2.5	100
2.0	100
1.5	100
1.18	100
0.85	100
0.75	100
0.60	100
0.425	100
0.300	100
0.250	100
0.200	100
0.150	100
0.125	100
0.106	100
0.075	100
0.060	100
0.0425	100
0.0300	100
0.0250	100
0.0200	100
0.0150	100
0.0118	100
0.0085	100
0.0075	100
0.0060	100
0.00425	100
0.00300	100
0.00250	100
0.00200	100
0.00150	100
0.00118	100
0.00085	100
0.00075	100
0.00060	100
0.000425	100
0.000300	100
0.000250	100
0.000200	100
0.000150	100
0.000118	100
0.000085	100
0.000075	100
0.000060	100
0.0000425	100
0.0000300	100
0.0000250	100
0.0000200	100
0.0000150	100
0.0000118	100
0.0000085	100
0.0000075	100
0.0000060	100
0.00000425	100
0.00000300	100
0.00000250	100
0.00000200	100
0.00000150	100
0.00000118	100
0.00000085	100
0.00000075	100
0.00000060	100
0.000000425	100
0.000000300	100
0.000000250	100
0.000000200	100
0.000000150	100
0.000000118	100
0.000000085	100
0.000000075	100
0.000000060	100
0.0000000425	100
0.0000000300	100
0.0000000250	100
0.0000000200	100
0.0000000150	100
0.0000000118	100
0.0000000085	100
0.0000000075	100
0.0000000060	100
0.00000000425	100
0.00000000300	100
0.00000000250	100
0.00000000200	100
0.00000000150	100
0.00000000118	100
0.00000000085	100
0.00000000075	100
0.00000000060	100
0.000000000425	100
0.000000000300	100
0.000000000250	100
0.000000000200	100
0.000000000150	100
0.000000000118	100
0.000000000085	100
0.000000000075	100
0.000000000060	100
0.0000000000425	100
0.0000000000300	100
0.0000000000250	100
0.0000000000200	100
0.0000000000150	100
0.0000000000118	100
0.0000000000085	100
0.0000000000075	100
0.0000000000060	100
0.00000000000425	100
0.00000000000300	100
0.00000000000250	100
0.000000000002	

% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.4	2.3	10.8	50.6	33.9	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
2"	100.0		
1 1/2"	100.0		
1"	100.0		
3/4"	100.0		
1/2"	100.0		
3/8"	99.2		
#4	97.6		
#10	95.3		
#20	92.3		
#40	84.5		
#60	70.6		
#100	51.1		
#200	33.9		

Material Description

silty sand (SM)

Atterberg Limits (ASTM D 4318)

PL= NP

$$LL = NV$$
$$PI = NP$$

Classification

USCS (D 2487)= SM

AASHTO (M 145)= A-2-4(0)

Coefficients

D₉₀= 0.6312

D₈₅= 0.4366

D₆₀= 0.1899

D₅₀= 0.1452

$$D_{30} =$$
$$D_{15} =$$
$$D_{10} =$$
$$C_y =$$
$$C_c =$$

Remarks

Date Received: 11/09/2021 **Date Tested:** 11/11/2021

Tested By: MB

Checked By: SK

Title: Principal Engineer

Source of Sample: SB-1
Sample Number: BULK

Depth: 0'00"-5'00"

Date Sampled: 11/09/2021

KIM ENGINEERING, INC.

Client: RK&K

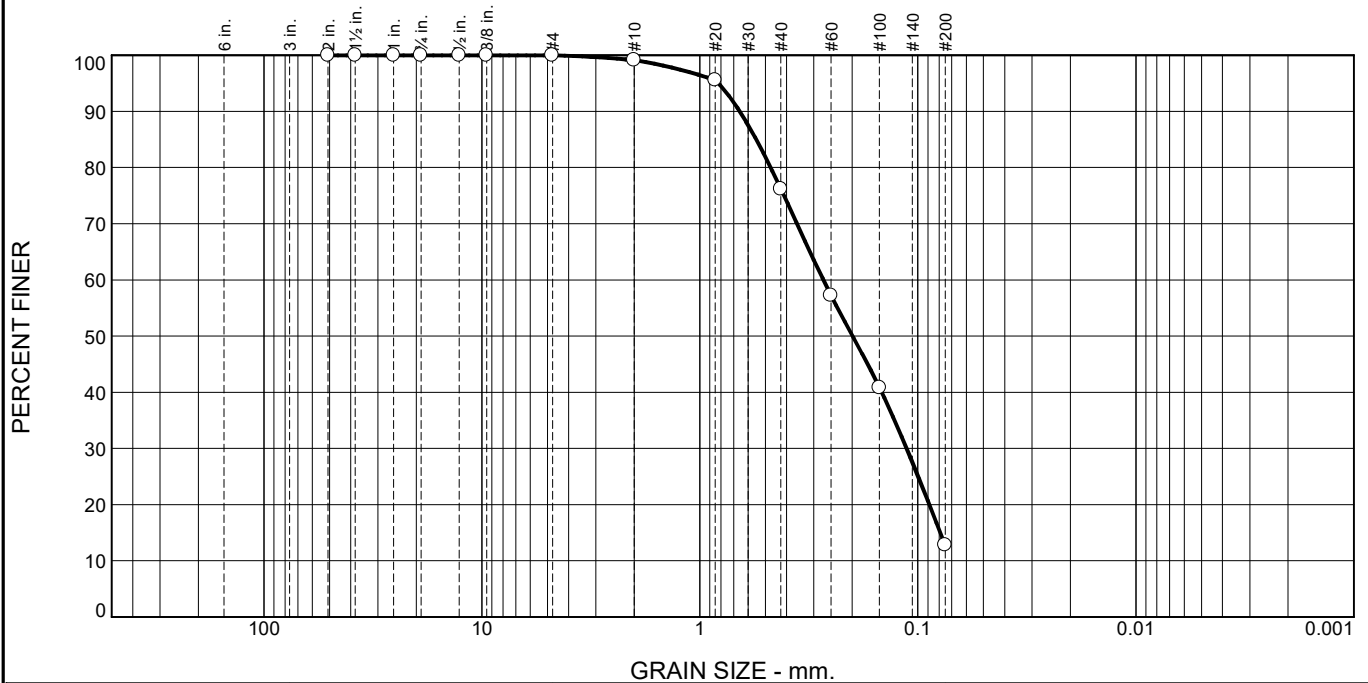
Project: WSSC Western Branch WTP

Gaithersburg, MD

Project No: G21045

Figure

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.9	22.9	63.4	12.8	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
2"	100.0		
1 1/2"	100.0		
1"	100.0		
3/4"	100.0		
1/2"	100.0		
3/8"	100.0		
#4	100.0		
#10	99.1		
#20	95.6		
#40	76.2		
#60	57.2		
#100	40.8		
#200	12.8		

* (no specification provided)

Material Description

silty sand (SM)

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-2-4(0)

Coefficients

D₉₀= 0.6566 D₈₅= 0.5522 D₆₀= 0.2714
D₅₀= 0.1994 D₃₀= 0.1127 D₁₅= 0.0789
D₁₀= C_u= C_c=

Remarks

Date Received: 11/09/2021 Date Tested: 11/11/2021

Tested By: MB

Checked By: SK

Title: Principal Engineer

Source of Sample: SB-1 Depth: 10'00"-11'6"
Sample Number: S-5

Date Sampled: 11/09/2021

KIM ENGINEERING, INC.

Gaithersburg, MD

Client: RK&K
Project: WSSC Western Branch WTP

Project No: G21045

Figure

The graph displays the cumulative percentage of soil finer than a given sieve size. The y-axis represents the 'PERCENT FINER' from 0 to 100. The x-axis represents sieve size in inches (top scale) and sieve numbers (bottom scale). The curve starts at 100% finer for large sieve sizes and drops sharply between sieve No. 40 and sieve No. 200.

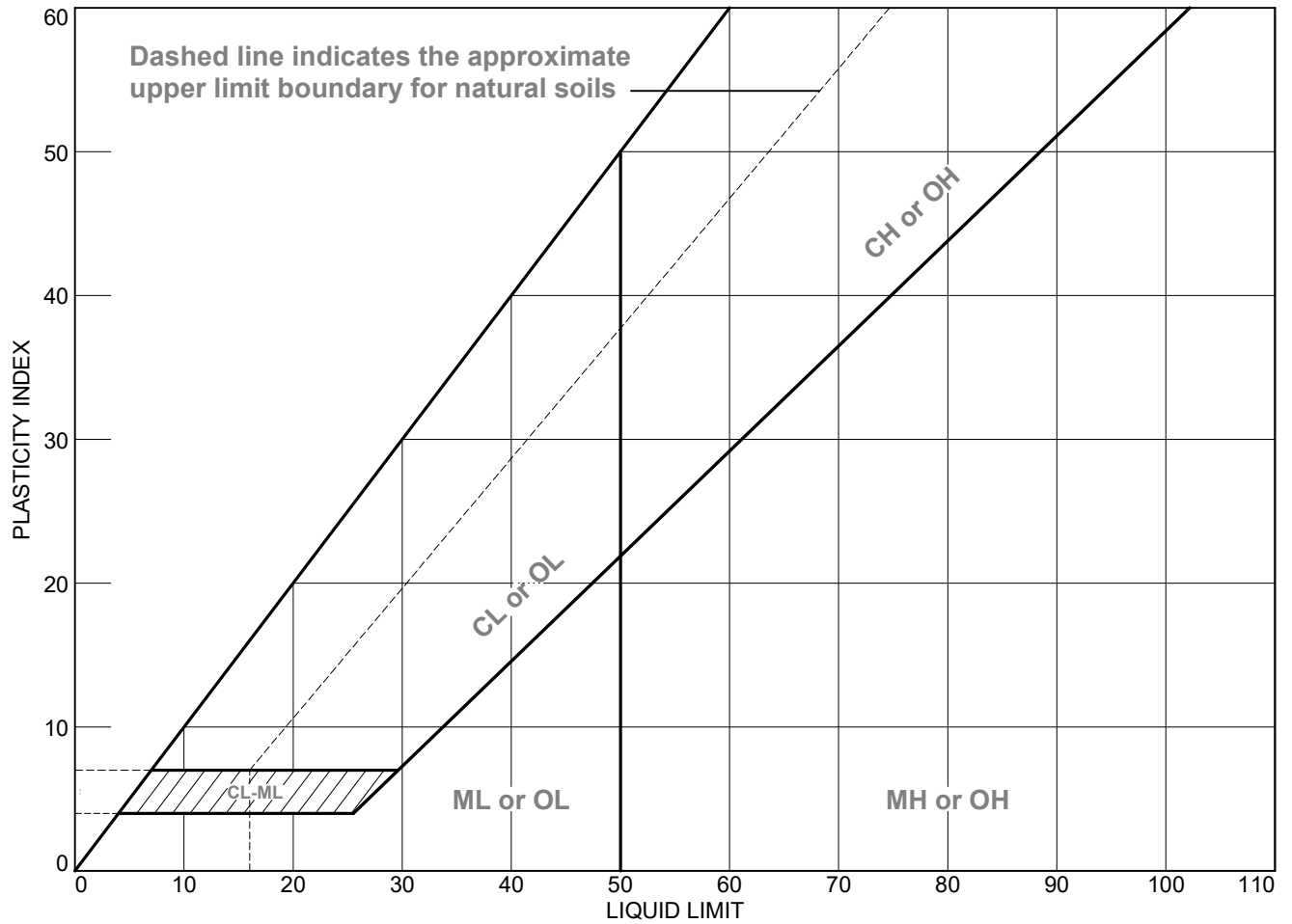
Sieve Size (inches)	Sieve Number	Percent Finer (%)
6 in.	-	100
3 in.	-	100
2 in.	-	100
1 1/2 in.	-	100
1 in.	-	100
3/4 in.	-	100
1/2 in.	-	100
3/8 in.	-	100
No. 4	4	100
No. 10	10	100
No. 20	20	98
No. 40	40	88
No. 60	60	70
No. 100	100	35
No. 200	200	10

<p align="center"><u>Material Description</u></p> <p>poorly graded sand with silt (SP-SM)</p>		
<p align="center"><u>Atterberg Limits (ASTM D 4318)</u></p> <p>PL= NP LL= NV PI= NP</p>		
<p align="center"><u>Classification</u></p> <p>USCS (D 2487)= SP-SM AASHTO (M 145)= A-3</p>		
<p align="center"><u>Coefficients</u></p> <p>D₉₀= 0.5026 D₈₅= 0.3937 D₆₀= 0.2168 D₅₀= 0.1881 D₃₀= 0.1376 D₁₅= 0.0927 D₁₀= 0.0766 C_u= 2.83 C_c= 1.14</p>		
<p align="center">Remarks</p>		
<p>Date Received: <u>11/09/2021</u> Date Tested: <u>11/11/2021</u></p> <p>Tested By: <u>MB</u></p> <p>Checked By: <u>SK</u></p> <p>Title: <u>Principal Engineer</u></p>		

Gaithersburg, MD

Atterberg Limits

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	SB-1	S-5	10'00"-11'6"	10.7	NP	NV	NP	SM
■	SB-1	BULK	0'00"-5'00"	8.1	NP	NV	NP	SM

KIM ENGINEERING, INC.

Gaithersburg, MD

Client: RK&K

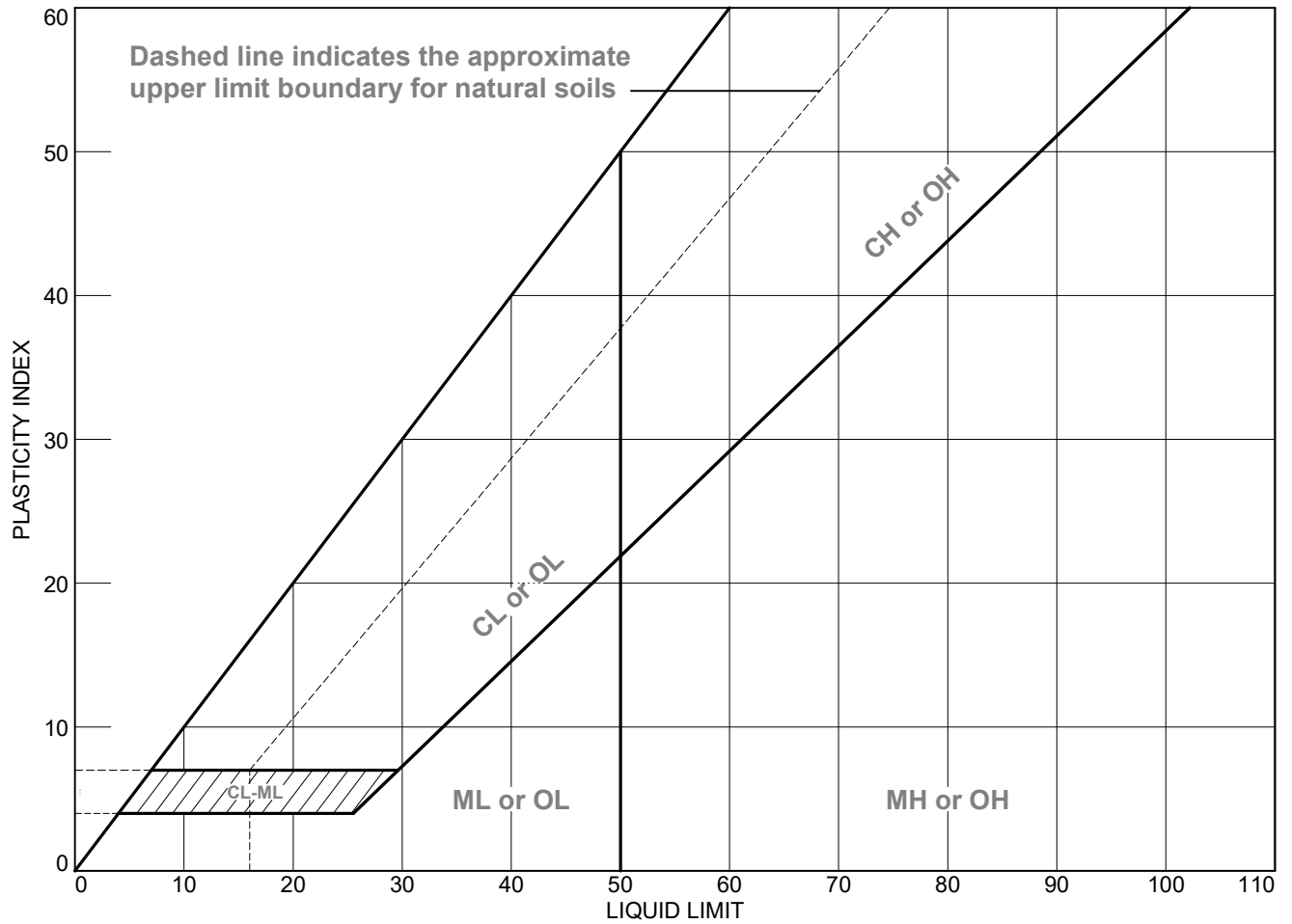
Project: WSSC Western Branch WTP

Project No.: G21045

Figure

Tested By: MB **Checked By:** SK

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	SB-2	S-4	7'6"-9'00"	8.3	NP	NV	NP	SP-SM

KIM ENGINEERING, INC.

Gaithersburg, MD

Client: RK&K

Project: WSSC Western Branch WTP

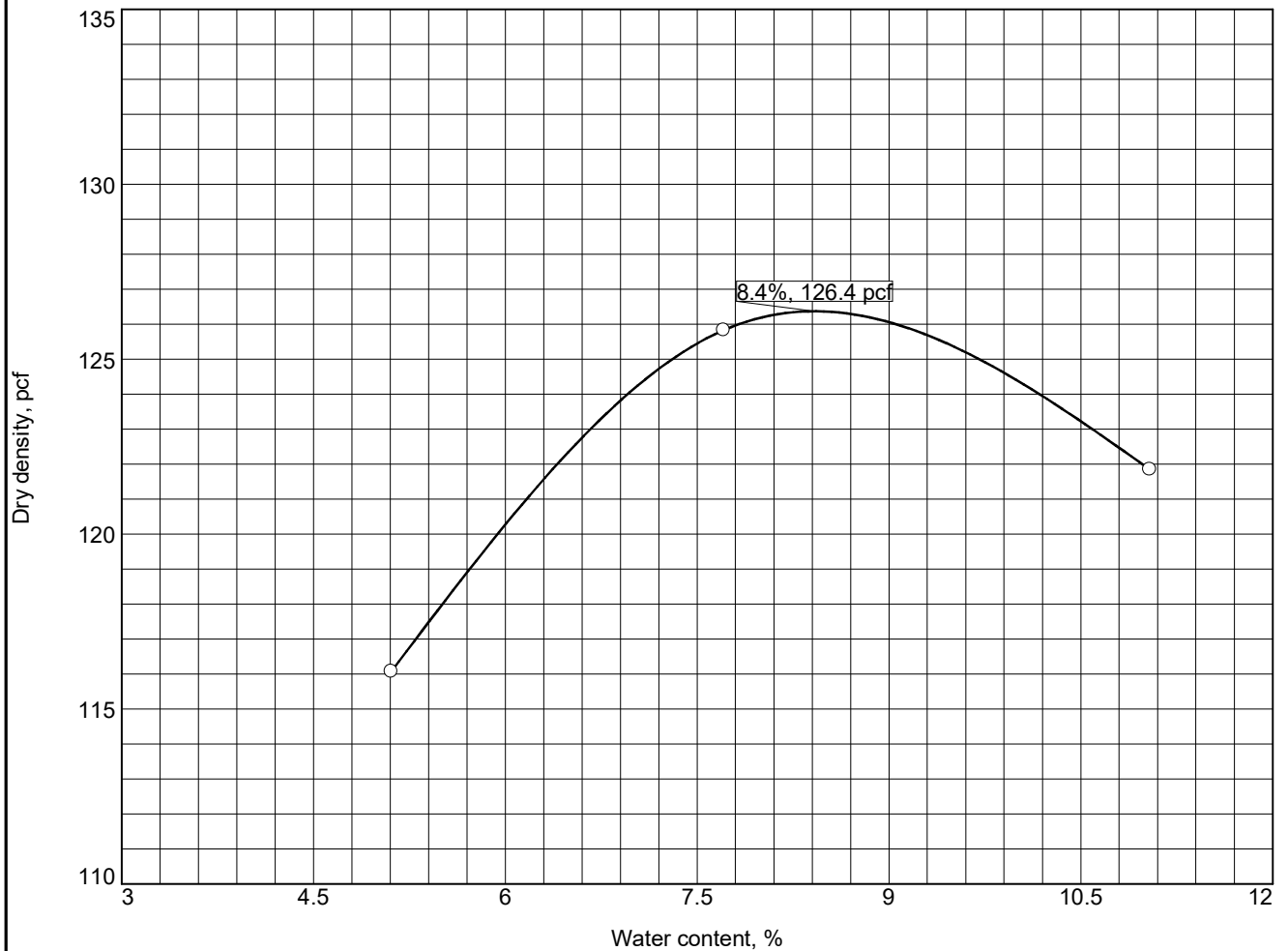
Project No.: G21045

Figure

Tested By: MB

Checked By: SK

Standard Proctor



Test specification: ASTM D 698-07 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
0'00"-5'00"	SM	A-2-4(0)	8.1		NV	NP	2.4	33.9

TEST RESULTS					MATERIAL DESCRIPTION			
Maximum dry density = 126.4 pcf					silty sand (SM)			
Optimum moisture = 8.4 %								
Project No. G21045 Client: RK&K Project: WSSC Western Branch WTP <div>Date: 11/11/2021</div>					Remarks:			
Source of Sample: SB-1 Sample Number: BULK								
KIM ENGINEERING, INC.								
Gaithersburg, MD					Figure			

Figure

Tested By: MB Checked By: SK

Corrosivity Test Results

19 November 2021

Kamal Bhusal
KIM Engineering
1550 Caton Center Drive Ste. K
Halethorpe, MD 21227
RE: WESTERN BRANCH WWTP WSSC

Enclosed are the results of analyses for samples received by the laboratory on 11/11/21 12:26.

Maryland Spectral Services, Inc. is a TNI 2009 Standard accredited laboratory and as such, all analyses performed at Maryland Spectral Services included in this report are 2009 TNI certified except as indicated at the end of this report. Please visit our website at www.mdspectral.com for a complete listing of our TNI 2009 Standard accreditations.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,



Will Brewington
President

Analytical Results

1500 Caton Center Dr Suite G
Baltimore MD 21227
410-247-7600
www.mdspectral.com

Project: WESTERN BRANCH WWTP WSSC

Project Number: G21045

Project Manager: Kamal Bhusal

Reported:

11/19/21 11:51

Client Sample ID	Alternate Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
SB-1 (3')		1111108-01	Soil	11/09/21 00:00	11/11/21 12:26
SB-2 (3')		1111108-02	Soil	11/09/21 00:00	11/11/21 12:26



Will Brewington, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Analytical Results

Project: WESTERN BRANCH WWTP WSSC

Project Number: G21045

Project Manager: Kamal Bhusal

1500 Caton Center Dr Suite G

Baltimore MD 21227

410-247-7600

www.mdspectral.com

Reported:

11/19/21 11:51

SB-1 (3')

1111108-01 (Soil)

Sample Date: 11/09/21

Analyte	Result	Notes	Units	Reporting Limit (MRL)	Detection Limit (LOD)	Dilution	Prepared	Analyzed	Analyst
pH measurement by EPA 9045D Prepared by pH (Paper or Meter)									
pH (Corrosivity)	5.57	O-07	pH Units			1	11/11/21	11/11/21 15:22	ART
PERCENT SOLIDS BY ASTM D2216-05 Prepared by Percent Solids									
Percent Solids	90		%			1	11/16/21	11/17/21 12:57	ART
Anions by EPA 300.0 Prepared by 300.0 Anions Prep									
Chloride	ND		mg/kg dry	5.56	5.56	1	11/12/21	11/18/21 07:22	VVD
SOIL RESISTIVITY BY ASTM G57-06 Prepared by Soil Resistivity									
Resistivity	27500		ohm-cm			1	11/18/21	11/18/21 14:30	LL



Will Brewington, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Analytical Results

Project: WESTERN BRANCH WWTP WSSC

Project Number: G21045

Project Manager: Kamal Bhusal

1500 Caton Center Dr Suite G

Baltimore MD 21227

410-247-7600

www.mdspectral.com

Reported:

11/19/21 11:51

SB-2 (3')

1111108-02 (Soil)

Sample Date: 11/09/21

Analyte	Result	Notes	Units	Reporting Limit (MRL)	Detection Limit (LOD)	Dilution	Prepared	Analyzed	Analyst
pH measurement by EPA 9045D Prepared by pH (Paper or Meter)									
pH (Corrosivity)	4.90	O-07	pH Units			1	11/11/21	11/11/21 15:22	ART
PERCENT SOLIDS BY ASTM D2216-05 Prepared by Percent Solids									
Percent Solids	92		%			1	11/16/21	11/17/21 12:57	ART
Anions by EPA 300.0 Prepared by 300.0 Anions Prep									
Chloride	ND		mg/kg dry	5.43	5.43	1	11/12/21	11/18/21 07:40	VVD
SOIL RESISTIVITY BY ASTM G57-06 Prepared by Soil Resistivity									
Resistivity	11200		ohm-cm			1	11/18/21	11/18/21 14:30	LL



Will Brewington, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

All analyses performed at Maryland Spectral Services included in the report are TNI certified except as indicated at the end of the report.

Analytical Results

1500 Caton Center Dr Suite G
Baltimore MD 21227
410-247-7600
www.mdspectral.com

Project: WESTERN BRANCH WWTP WSSC

Project Number: G21045

Project Manager: Kamal Bhusal

Reported:

11/19/21 11:51

Maryland Spectral Services does not maintain certification for the following analytical parameters:

Maryland Spectral Services

Matrix , Method , Analyte _____

Soil | Soil_Resistivity | Resistivity

Soil | 300.0-Chloride | Chloride



Will Brewington, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

All analyses performed at Maryland Spectral Services included in the report are TNI certified except as indicated at the end of the report.

Analytical Results

1500 Caton Center Dr Suite G
Baltimore MD 21227
410-247-7600
www.mdspectral.com

Project: WESTERN BRANCH WWTP WSSC

Project Number: G21045

Project Manager: Kamal Bhusal

Reported:

11/19/21 11:51

Notes and Definitions

S-98	Spike recovery outside of established control limits.
O-07	This sample was received outside of the EPA recommended holding time.
RE	Sample reanalyses are done at the laboratory's discretion as a mechanism to improve data quality. Any client requested reanalysis will be identified with a sample qualifier.
ND	Analyte NOT DETECTED at or above the reporting limit
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
%-Solids	Percent Solids is a supportive test and as such does not require accreditation



Will Brewington, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Summary of Laboratory Tests						Appendix Sheet 1 of 1 Project Number: 17C14045.00
Boring No.	Sample Depth ft	Sample Type	Description of Soil Specimen	Oxidation Reduction Potential (mV)	Sulfides (presence)	
	Elevation ft					
1111108-01 SB-1	3.0	Jar	Clayey Sand, trace gravel, brown (Visual)	226	ND	
1111108-02 SB-2	3.0	Jar	Clayey Sand, light brown	250	ND	

[illegible]

APPENDIX B

TEST WELL INVESTIGATION REPORT

C1

68111

SEQUENCE NO.

(MDE USE ONLY)

STATE OF MARYLAND

WELL COMPLETION REPORT

FILL IN THIS FORM COMPLETELY

PLEASE TYPE

THIS REPORT MUST BE SUBMITTED WITHIN

45 DAYS AFTER WELL IS COMPLETED.

1 2 3 6

(THIS NUMBER IS TO BE PUNCHED

IN COLS. 3-6 ON ALL CARDS)

ST/CO USE ONLY

DATE RECEIVED

MM DD YY

8 13

DATE WELL COMPLETED

MM DD YY

07 27 22

Depth of Well

22 350 26

(TO NEAREST FOOT)

PERMIT NO.

FROM "PERMIT TO DRILL WELL"

PG - 19 - 0150

28 29 30 31 32 33 34 35 36 37

OWNER

WASHINGTON SUB SANITARY COMM

WELL SITE ADDRESS

6600 SE ROBERT CRAIN HIGHWAY

TOWN

UPPER MARLBORO, MD 20772

SUBDIVISION

SECTION

LOT

WELL LOG

Not required for driven wells

STATE THE KIND OF FORMATIONS PENETRATED, THEIR COLOR, DEPTH, THICKNESS AND IF WATER BEARING

DESCRIPTION (Use additional sheets if needed)

FEET

FROM TO

check if water bearing

SURFACE SOIL

0 5

GRAY SAND

5 10

TAN SAND & LARGE GRAVEL

10 24

TAN SAND

24 30

GRAY & TAN CLAY

30 35

GRAY/TAN/PINK CLAY

35 47

BLACK/GRAY SAND/SHELL/SILTY CLAY

47 80

HARD SHELL LAYERS/GRAY SAND/SILTY CLAY

80 107

SAND/SHELL/SOME SILTY GREEN CLAY

107 204

SILTY GRAY CLAY

204 267

GRAY SAND & SOME WOOD

267 287

MEDIUM GRAY SAND

287 327

MEDIUM GRAY SAND & SOME WOOD

327 351

GRAY SAND & WHITE CLAY

351 360

GROUTING RECORD

yes no

WELL HAS BEEN GROUTED

(Circle Appropriate Box)

TYPE OF GROUTING MATERIAL (Circle one)

CEMENT CM BENTONITE CLAY BC

NO. OF BAGS 45 46 19 NO. OF POUNDS 45 46 506

GALLONS OF WATER 475

DEPTH OF GROUT SEAL (to nearest foot)

from 0 ft. to 240 ft.

48 TOP 52 54 BOTTOM 58

(enter 0 if from surface)

CASING RECORD

casing types insert appropriate code below

ST STEEL CO CONCRETE

PL PLASTIC OT OTHER

MAIN CASING TYPE

Nominal diameter top (main) casing (nearest inch)

Total depth of main casing (nearest foot)

PL 8 35

60 61 63 64 66 70

OTHER CASING (if used)

diameter inch depth (feet) from to

PL 4 0 270

PL 4 340 350

EACH CASING

screen type or open hole

SCREEN RECORD

ST STEEL BR BRASS HO OPEN HOLE

PL PLASTIC OT OTHER

insert appropriate code below

DEPTH (nearest ft.)

1 2

PL 270 340

8 9 11 15 17 21

23 24 26 30 32 36

38 39 41 45 47 51

SLOT SIZE 1 .020 2 3

DIAMETER OF SCREEN 4 (NEAREST INCH)

56 60

from to

240 360

68

MDE USE ONLY

(NOT TO BE FILLED IN BY DRILLER)

T (E.R.O.S.) W Q

70 72 74 75 76

TELESCOPE CASING LOG INDICATOR OTHER DATA

PUMPING TEST

HOURS PUMPED (nearest hour)

4 8 9

PUMPING RATE (gal. per min.)

40 11 15

METHOD USED TO MEASURE PUMPING RATE

ROTO METER

WATER LEVEL (distance from land surface)

BEFORE PUMPING

55.17 17 20 ft.

WHEN PUMPING

59.8 22 25 ft.

TYPE OF PUMP USED (for test)

A air P piston T turbine

C centrifugal R rotary O other (describe below)

J jet S submersible

PUMP INSTALLED

DRILLER INSTALLED PUMP (CIRCLE) (YES or NO)

YES NO

IF DRILLER INSTALLS PUMP, THIS SECTION MUST BE COMPLETED FOR ALL WELLS.

TYPE OF PUMP INSTALLED

PLACE (A,C,J,P,R,S,T,O) IN BOX 29

CAPACITY: GALLONS PER MINUTE (to nearest gallon)

N/A 31 35

PUMP HORSE POWER

N/A 37 41

PUMP COLUMN LENGTH (nearest ft.)

N/A 43 47

CASING HEIGHT (circle appropriate box and enter casing height)

above below

LAND SURFACE

2 (nearest foot)

50 51

LATITUDE 38.792543

LONGITUDE 76.731067

(DEFAULT COORD. WGS 84)

Pursuant to §10-624 of the State Govt. Article of the Maryland Code personal info. requested on this form is used in processing this form pursuant to COMAR 26.04.04. Failure to provide the info. may result in this form not being processed. You have the right to inspect, amend, or correct this form. The Maryland Department of the Environment is subject to the Maryland Public Information Act. This form may be made available on the Internet via MDE's website and is subject to inspection or copying, in whole or in part, by the public and other governmental agencies, if not protected by federal or state law.

NUMBER OF UNSUCCESSFUL WELLS:

WELL HYDROFRACTURED

yes no

Y N

CIRCLE APPROPRIATE LETTER

A A WELL WAS ABANDONED AND SEALED WHEN THIS WELL WAS COMPLETED

E ELECTRIC LOG OBTAINED

P TEST WELL CONVERTED TO PRODUCTION WELL

I HEREBY CERTIFY THAT THIS WELL HAS BEEN CONSTRUCTED IN ACCORDANCE WITH COMAR 26.04.04 "WELL CONSTRUCTION" AND IN CONFORMANCE WITH ALL CONDITIONS STATED IN THE ABOVE CAPTIONED PERMIT, AND THAT THE INFORMATION PRESENTED HEREIN IS ACCURATE AND COMPLETE TO THE BEST OF MY KNOWLEDGE.

DRILLERS LIC. NO.

M W D 4661

DRILLERS SIGNATURE

(MUST MATCH SIGNATURE ON APPLICATION)

LIC. NO.

D

SITE SUPERVISOR (sign. of driller or journeyman responsible for sitework if different from permittee)

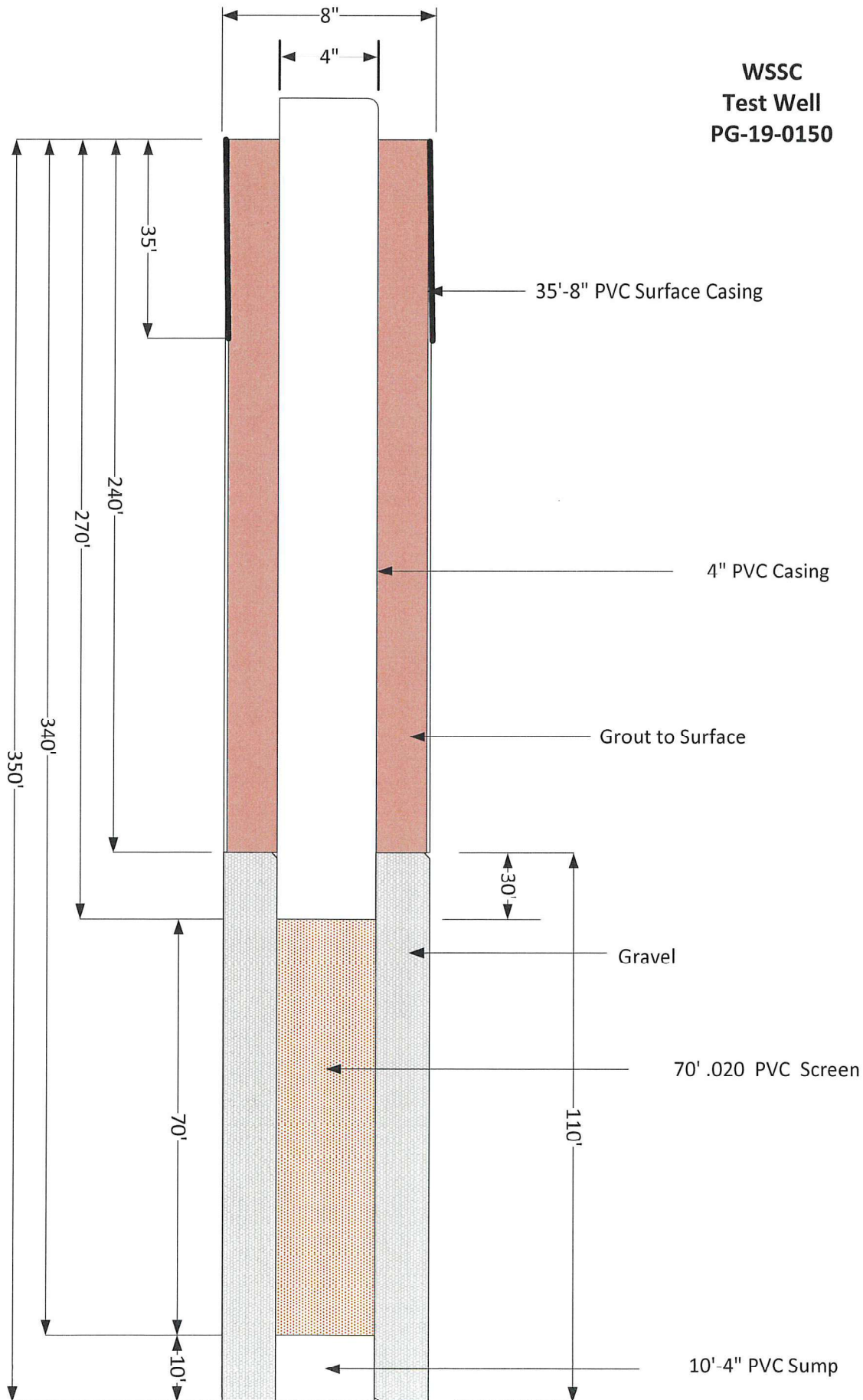
SOMERSET WELL DRILLING CO., INC.


INDUSTRIAL • DOMESTIC • IRRIGATION • GEOTHERMAL

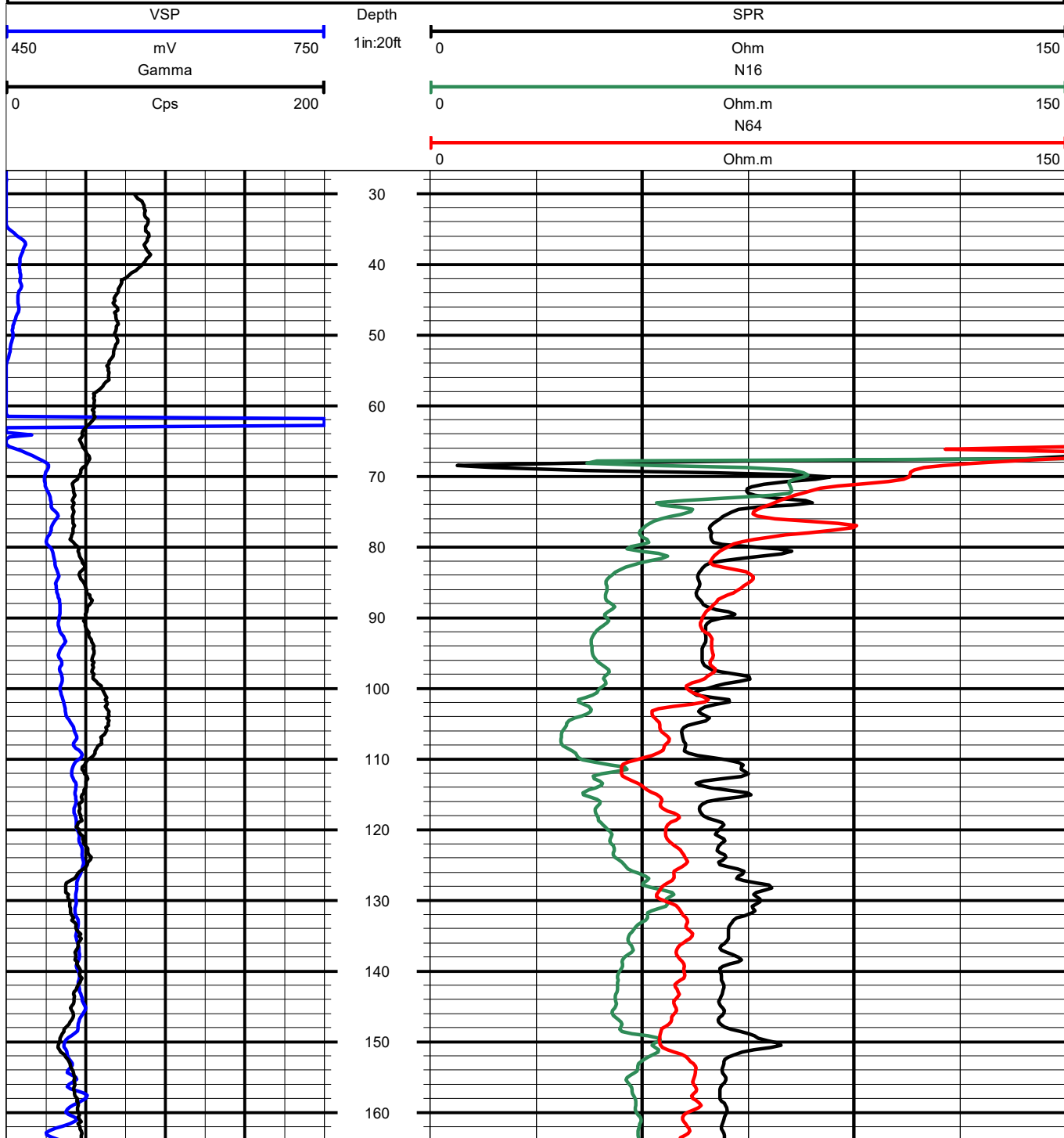


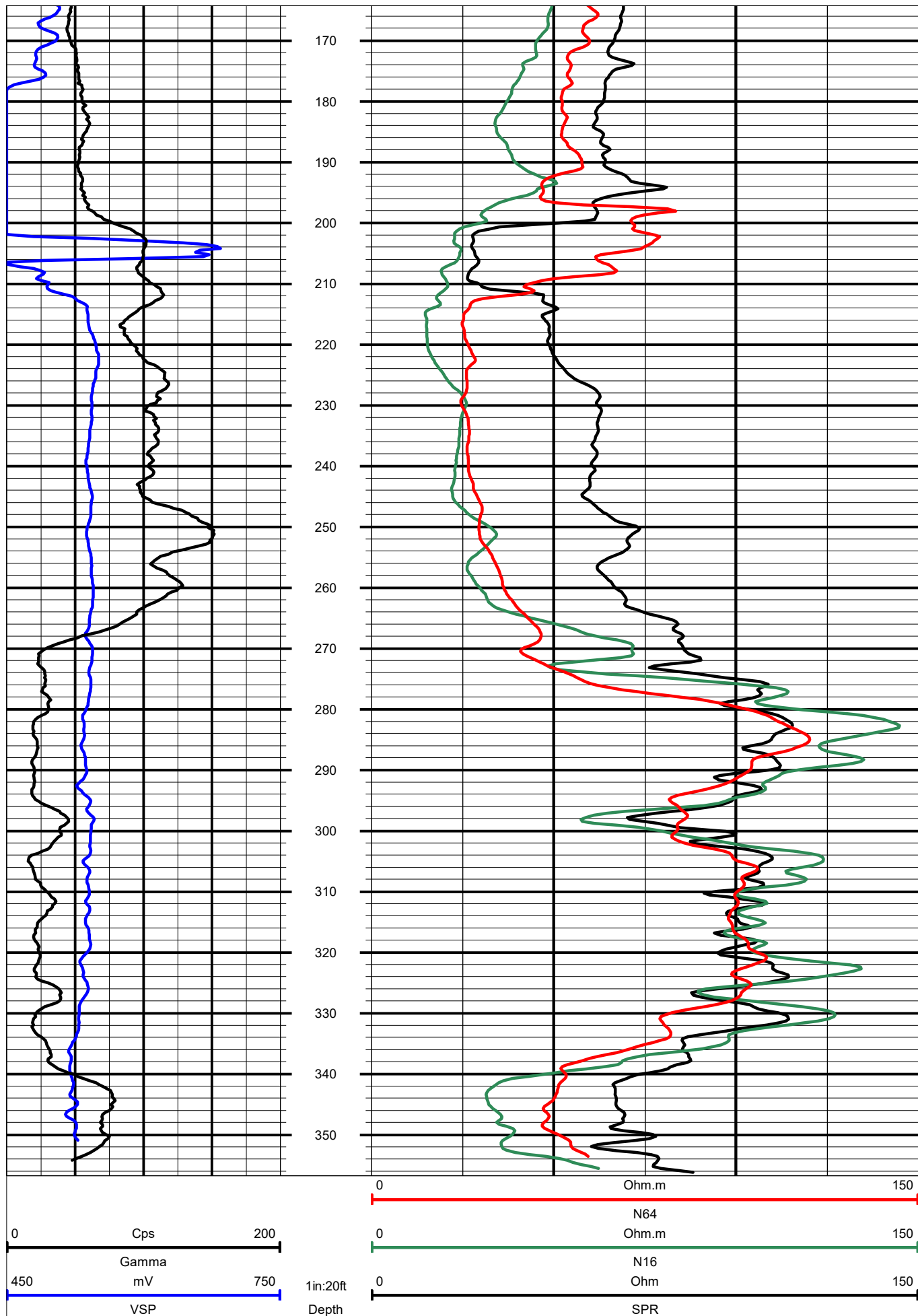
30170 RITZEL ROAD • P.O. BOX 67
WESTOVER, MARYLAND 21871-0067
(410) 651-3721 FAX (410) 651-5255

WSSC Test Well PG-19-0150



 <small>• Water Resources • Geospatial Services • Solutions for Tomorrow. Today.</small>	WELL I.D.		Logging Date: 08/23/2022	Elevation: 44.25 ft
	Boring/Well Name: WSSC-EX-1 USGS: N/A		Logging Speed: 17 ft/min x Up Down Bottom of Casing: 35 ft Total Depth: Driller: 357 ft Logger: 357.03 ft	
Project: WSSC Upper Marlboro Polygamma Logging Client: Shannahan Artesian Well Company Driller: Bobby Harris Location: WSSC Treatment Plant 6600 Crain Hwy Upper Marlboro, MD 20772	Fluid Type: Mud-based water LAT: 38.79263° N LONG: 076.73100° W Datum: WGS84 LAT/LONG Source: <input type="checkbox"/> RTK GPS <input checked="" type="checkbox"/> GPS App <input type="checkbox"/> Imagery <input type="checkbox"/> GPS Handheld	Bit Size: 6 inch Rig Type: Mud Rotary Casing Material: PVC Diameter/Depth: 8 inch to 35 ft bgs	EDI Job No.: 5272 Technician: Ben Gemballa Kayla Warhola Witness(es): Bobby Harris (Shannahan Artesian Well Co.)	
Notes: **FIELD COPY** Log measured from ground surface. Measuring point is ground surface. 8 inch PVC surface casing present to a depth of 35 ft bgs. Lat/lon data obtained using WGS84 datum from Fulcrum GPS services. Elevation data obtained using USGS National Map Elevation Calculator.				





WELL CONSTRUCTION AND LITHOLOGIC LOG



Well ID: **MD-33-5-
WSSC-EX-1**

RK&K Well Naming: State Abbreviation; County FIPS Code; Well Type (1-Irrigation; 2-Potable/RO; 3-UIC Class V/ASR; 4-UIC Class I; 5-Test, and unique identifier. Maryland County FIPS: Refer to: <http://www.epa.gov/enviro/html/codes/md.html>

Project Name:	WSSC Western Branch Potable Water System Design			Project No.:	21170.002
Geologist:	John Mayhut, PG Lithology By R. Higgins	Drilling Contractor:	Somerset Well Drilling Company, Inc.	Driller:	Bobby H.
Well Type:	<input type="checkbox"/> Irrigation; <input type="checkbox"/> Potable/RO; <input type="checkbox"/> Class V Injection/ASR; <input type="checkbox"/> Class I Injection; <input checked="" type="checkbox"/> Test Well				
Well Site Address:	WSSC Treatment Plant @ 6600 Crain Highway, Upper Marlboro, MD				
Testing Competed:	<input type="checkbox"/> Chlorides; <input type="checkbox"/> Specific Conductivity; <input checked="" type="checkbox"/> Water Quality Suite; <input checked="" type="checkbox"/> Q/s; <input checked="" type="checkbox"/> APT – 4 hours; <input type="checkbox"/> Step Drawdown; <input checked="" type="checkbox"/> Geophysical Suite; <input type="checkbox"/> Standard Penetration Test; Other: <u>Grain Size Distribution</u>				

Start Date:	2022-08-23	Finish Date:	2022-08-31	Latitude:	~38.792552	Longitude:	~-76.731117
Drilling Method:	Mud Rotary			Bit Size:	7 7/8-inch-diameter		
Casing Material:	PVC	Diameter:	Inner 4" Outer 4.5"	Cased Depth:	-270	Total Depth:	-355 ft
Production Zone:	<input type="checkbox"/> Open Hole; <input checked="" type="checkbox"/> Screened			If Screened, Slot Size:	*0.006 to 0.500		
Land Surface:	<input type="checkbox"/> NGVD29; <input type="checkbox"/> NAVD88		Static Water Level (bls):	~52 ft	Static Water Level (ELV):	-	
Q (gpm):	42	s (feet):	4.6	Q/s (gpm/ft):	9.1	Chloride (mg/L):	

Depth (below land surface)	Thickness (feet)	Lithology	Description
0-5	5	Sand, pebble	Surface sediments. Moderate brown (5YR 4/4 to 5YR 3/4). Angular grains, poorly sorted. Pebble conglomerate interspersed with clay.
10	5	Sand, medium	Moderate yellowish-brown (10YR 5/4). Semi-angular grains, well sorted, well distributed.
24	14	Sand, clayey	Moderate brown (5YR 4/4). With pebble sand accessories (semi-spherical, poorly sorted). Interspersed with clay.
30 (38*)	6 (14*)	Clay	Grayish brown (5YR 3/2). With pebble sand accessories (semi-spherical, poorly sorted). Interspersed with clay. * 8" surface casing to 35'

WELL CONSTRUCTION AND LITHOLOGIC LOG



Depth (below land surface)	Thickness (feet)	Lithology	Description
37	10	Clay	Grayish brown (5YR 3/2). Clay with sparse angular sand grains. Well sorted. Olive black (5YR 2/1). Clay with fine, spherical sand grains. Well sorted, well distributed.
47	10	Sand, fine	Greyish black (N2). Semi-angular, well sorted, well distributed. Shell fragments observed.
57	10	Sand, fine	Similar to above. Greyish black (N2). Semi-angular, well sorted, well distributed. More clay than 47-57 section. Shell fragments observed.
67	10	Sand, fine	Same as above.
77	10	Sand, medium	Grayish black (N2). More rounded grains than above sections. Large presence of mica & glauconite (phosphatic sand). Small accessories of shells and fossils (bivalves, spicules, etc.) with angular grey (N4) sandstone fragments. Hard layer experienced @ 80 ft.
87	10	Sand, medium	Similar to above. More angular sand grains than 77-87 section. Accessories are finer.
97	10	Sand, medium-fine	Similar to above. Well sorted, well distributed. Sand feels fine to the touch. Contains loosely packed coarse sand with predominant mica & more glauconite than sand above.
107	10	Sand, medium-fine	Similar to above. Rounded, semi-angular grains. Well sorted. Clumps well. Contains loose coarse sand accessories with bivalve and other shell fragments (eg. spicules). Note start of slight color change towards tan (~5YR 2/1).
117	10	Sand, medium-fine	Similar to above. Note continue slight color change towards tan (~5YR 2/1).
127	10	Sand, medium-fine	Similar to above. Most phosphatic sand is rounded. Note slight color change towards tan (~5YR 2/1) evens off.
137	10	Sand, medium-fine	Similar to above. Coarse sand not acquired with this sample. Clumps break apart easily. Clumps well with a little moisture (good apparent porosity?). Note slight color change towards tan (~5YR 2/1) halts.
147	10	Sand, medium-fine	Similar to above. Semi-angular grains. Noticeably less tan than previous sections (between 5GY 4/1 and N3 or N2). Coarse sand accessories including shell fragments.

WELL CONSTRUCTION AND LITHOLOGIC LOG



Depth (below land surface)	Thickness (feet)	Lithology	Description
157	10	Sand, fine-very fine	Greyish black (N2 to N3). Tan mostly gone from sample. Finer grained than previous sections. Well sorted. Coarse sand accessories with shell fragments.
167	10	Sand, fine-very fine	Similar to above. Color trends closer to greyish black (N2). Much clumpier than previous sample. Angular, coarse to medium sand accessories with shell fragments.
177	10	Sand, fine-very fine	Similar to above. Greyish black (N2). More mica than previous section. Accessory shell fragments appear coarser.
187	10	Sand, fine-very fine	Similar to above. Color trends slightly darker than grayish black (N2). Clumps separate easier than above section. Accessory shell fragments coarser than above section.
197	10	Clay	Mostly dark grey (N2), partially light olive grey (5Y 6/1) [could just be dried out though]. Moldable and sticky. Clay starts at ~ 204 according to driller's logs.
207	10	Clay	Same as above.
217	10	Clay	Same as above. A few accessories of coarse sand and pebbles.
227	10	Clay.	Same as above. Very sticky.
237	10	Clay	Same as above. More moldable, less sticky.
247	10	Clay	Same as above.
257	10	Clay	Same as above.
267	10	Sand, coarse	Medium-dark grey (N4 to N3). Predominant angular grains. Roughly spherical. Sparse glauconite observed. [Target layer]
277	10	Sand, medium	Same as above. Medium, edging on fine grained. Angular, roughly spherical grains. Lesser presence of glauconite compared to above section. Note that at depth ~280, organic wood observed in sample for this section.

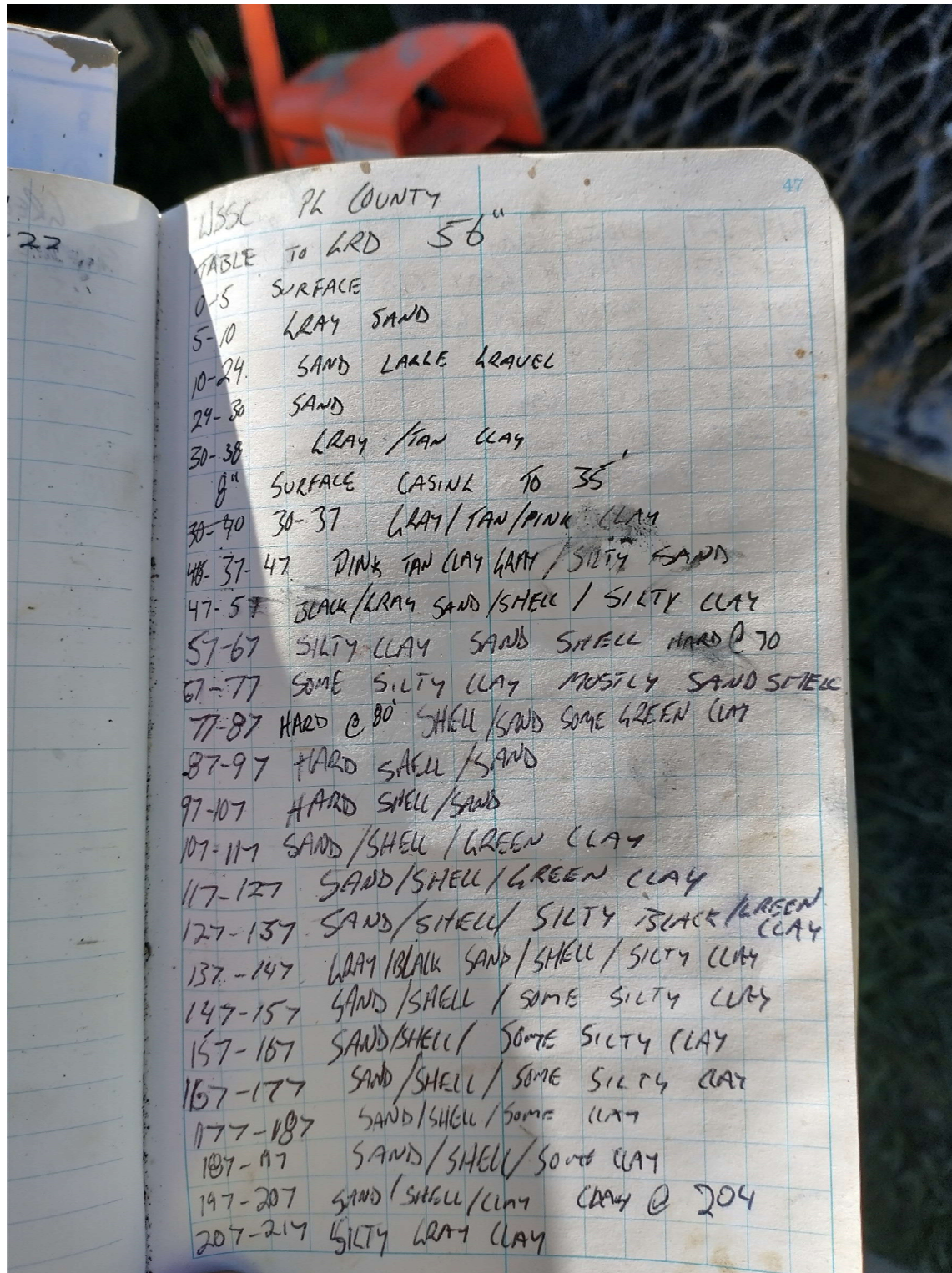
WELL CONSTRUCTION AND LITHOLOGIC LOG



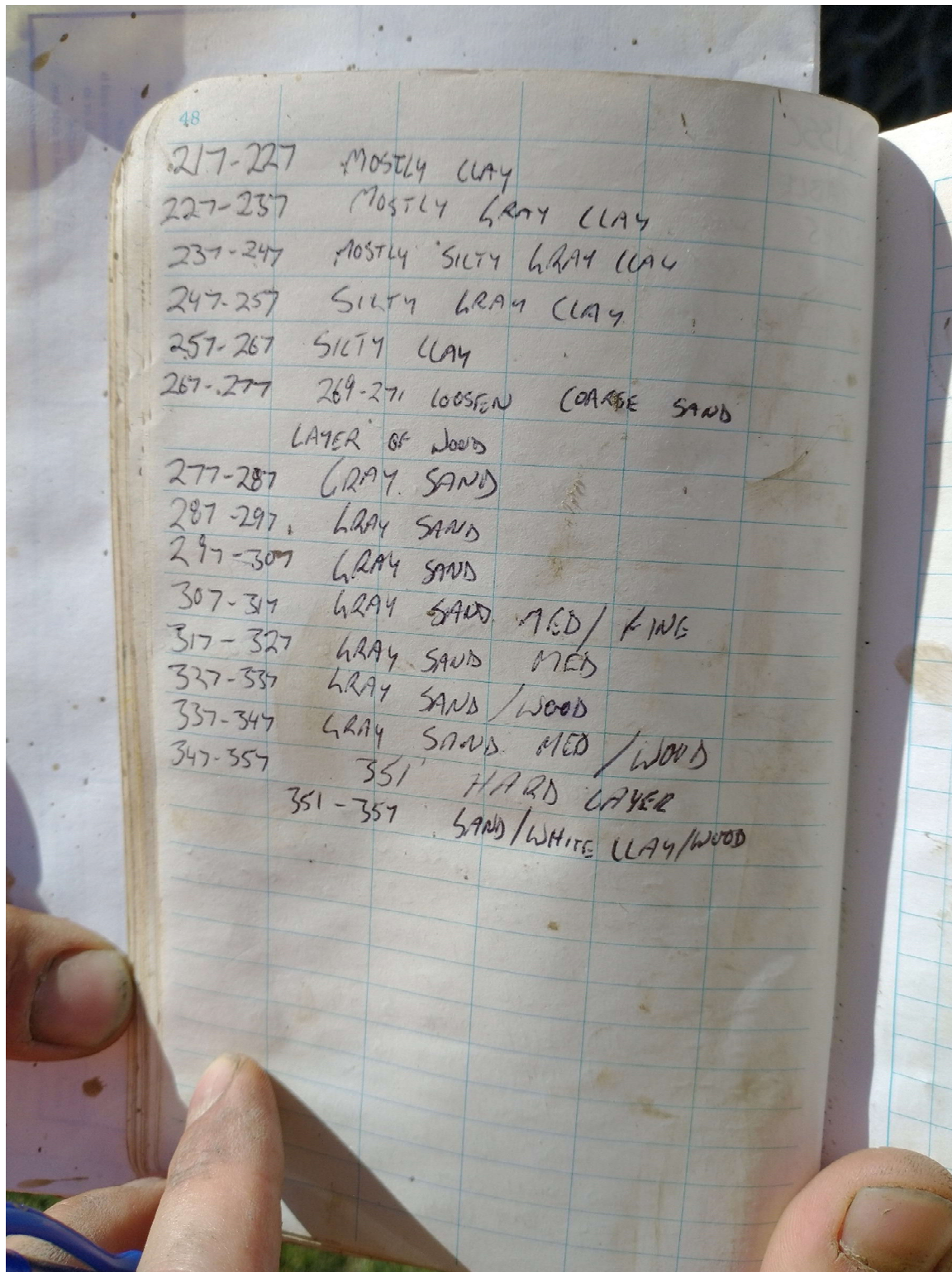
Depth (below land surface)	Thickness (feet)	Lithology	Description
287	10	Sand, medium	Same as above. Medium-dark grey (N4). More medium grained compared to above. Trace sandy clay observed in this section. Note organic wood observed in sample for this section.
297	10	Sand, medium	Same as above. Trace sandy clay observed in this section. Note organic wood observed in sample for this section.
307	10	Sand, medium	Same as above. Trace sandy clay observed in this section. No organic wood observed in this sample [but likely is].
317	10	Sand, medium	Same as above. Medium (edging on fine) grained. Less sandy clay observed in this section. Holds shape well. No organic wood observed in this sample [but likely is].
327	10	Sand, medium-coarse	Same as above. Medium (edging on coarse) grained. Note organic wood observed in this section.
337	10	Sand, medium-coarse	Same as above. Streaks of rounded, fine-grained glauconite. Note organic wood observed in this section.
347	10	Sand, medium	Medium dark grey (N4). Angular, slightly spherical grains. Clumps well. Returning presence of glauconite continues. Note organic wood observed in this section. Hard layer (a mix of sand, white clay, and wood) experienced starting at ~351 ft. White clay observed by drill tech but was not present in sample.
357			Drilling stopped @ ~357 ft.

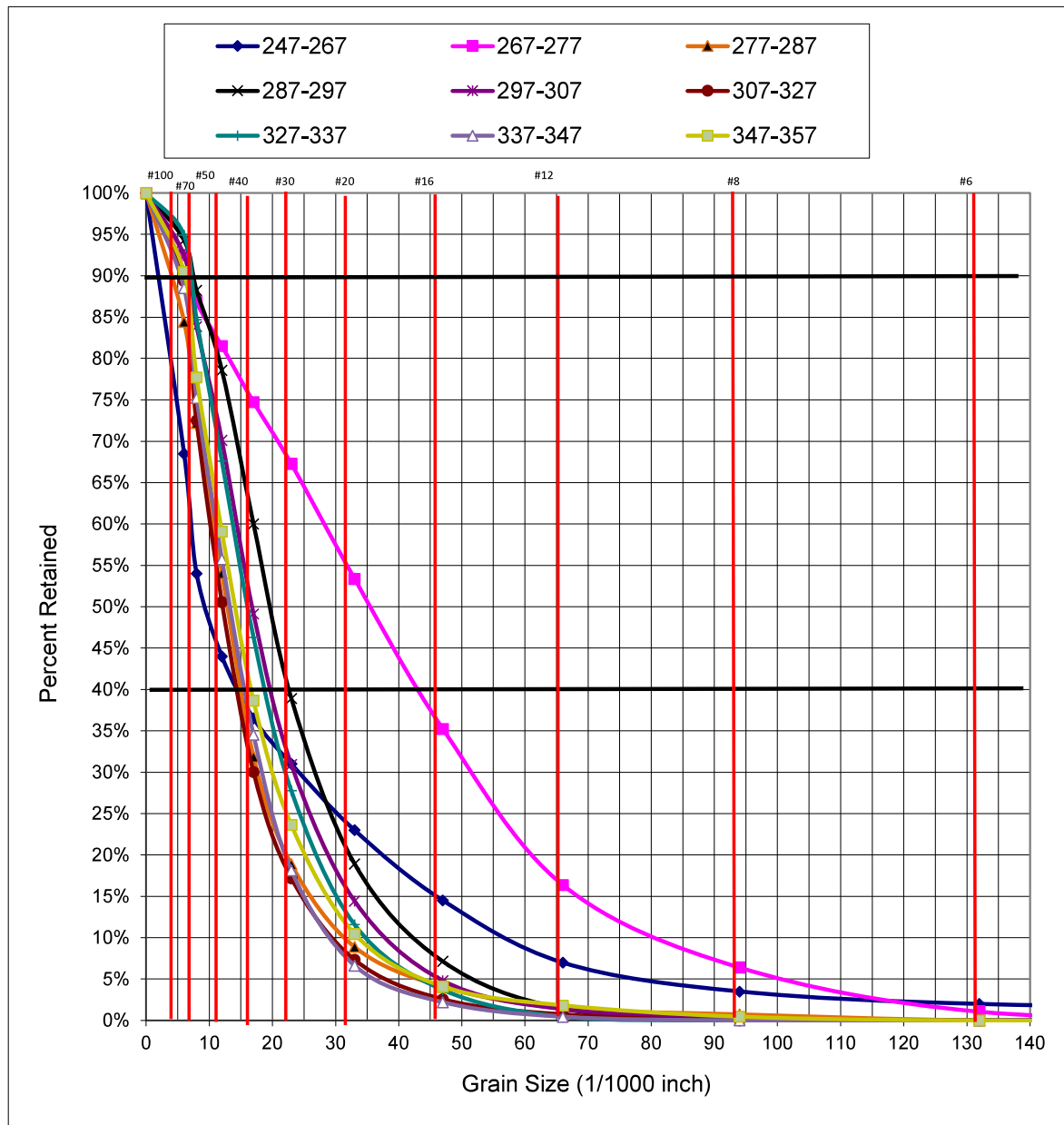
NOTES: See following pages for driller's lithologic log.

WELL CONSTRUCTION AND LITHOLOGIC LOG



WELL CONSTRUCTION AND LITHOLOGIC LOG





Job Name WSSC Test Well
Location Upper Marboro, MD
Driller Somerset Well Drilling

Sample ID 091422-11
Analyzed by: Duvall, Steven
Updated: 9/15/2022

Casing ϕ 4 in
Screen ϕ 4 in

Yield 1000 gpm
SWL (ft) 56 ft

Recommended Slot Size: 20 slot (0.020") from 260' to 350' bgs.
Recommended Gravel Pack: #0 Morie

Based exclusively on the samples provided by the contractor, a sieve analysis graph and suggested screen slot size is provided as requested. Since numerous construction considerations and site circumstances influence successful well completion, Johnson Screens assumes no responsibility for final well performance nor awareness of local regulations pertaining to well installations.