TECHNICAL SPECIFICATIONS
FOR

CLOVER POWER STATION
RETROFIT – SLUDGE SEDIMENTATION BASINS
ISSUED FOR BID

PREPARED FOR:
DOMINION RESOURCES SERVICES, INC.
CLOVER, HALIFAX COUNTY, VIRGINIA

PREPARED BY:
TRC ENGINEERS, INC.

NOVEMBER 2016

In the event of a conflict between the Technical Specifications and the Contract or the CQA Plan and the Contract, as applicable, the terms and conditions of Articles 1 through 30 of the Contract shall control.

All review and approval rights given to “Engineer” or “Owner’s Engineer” in these Technical Specifications and the CQA Plan shall also require the review and approval of the Owner. For the avoidance of doubt, unless otherwise consented to by Owner in writing, Owner’s Engineer shall not have any discretionary, unilateral contractual rights to review and approve any Contractor deliverables.

This manual is accompanied by a set of Drawings, of the same title. These documents are interrelated and are intended to be used together.

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B. Technical Specifications

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D. Construction Quality Assurance Plan for Liner System

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CERTIFICATION SHEETS

CIVIL SPECIFICATIONS CERTIFICATIONS

The following specifications were prepared under my direct supervision:

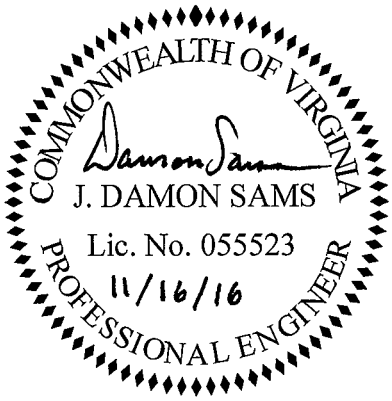
DIVISION NAME	NUMBER	TITLE
Available Information	00220	Geotechnical Data
General Requirements	01110	Environmental Protection Procedures
General Requirements	01310	Progress Schedule and Meetings
General Requirements	01321	Construction Photographs
General Requirements	01330	Submittals
General Requirements	01410	Regulatory Requirements
General Requirements	01420	Reference Standards
General Requirements	01450	Quality Control
General Requirements	01452	Testing Laboratory Services
General Requirements	01570	Temporary Controls
General Requirements	01574	Temporary Water Control
General Requirements	01720	Field Engineering
General Requirements	01760	Monitoring Well Protection
Site Work	02070	High-Density Polyethlyene (HDPE) Geomembrane
Site Work	02076	Geotextiles
Site Work	02222	Removal of Miscellaneous Structures
Site Work	02232	Clearing and Grubbing
Site Work	02260	Cofferdams
Site Work	02315	Excavation
Site Work	02316	Excavation Undercut
Site Work	02317	Trenching, Backfilling, and Compacting
Site Work	02320	Fill
Site Work	02374	Sediment Control Fence
Site Work	02532	Drop Inlet
Site Work	02618	HDPE Piping
Site Work	02720	Aggregate
Site Work	02911	Topsoil
Site Work	02921	Seeding
Site Work	02923	Fertiziling
Concrete	03050	Liner Concrete Pavement

Russel K. Nilsson, P.E.

SPECIFICATIONS CERTIFICATIONS

The following specifications were prepared under my direct supervision:

DIVISION NAME	NUMBER	TITLE
General Requirements	01412	Manufacturers Field Services
General Requirements	01600	Materials and Equipment
General Requirements	01666	Testing of Pipelines
General Requirements	01680	Watertightness Test for Hydraulic Structures
General Requirements	01782	Operation & Maintenance Data
Metals	05550	Access Hatches
Finishes	09915	Protective Coatings
Equipment	11020	General Equipment Requirements
Equipment	11203	Slide Gates
Equipment	11315	Vertical Cantilever Pumps
Mechanical	15050	Basic Mechanical Materials and Methods
Mechanical	15071	Pipe and Pipe Fittings (General)
Mechanical	15075	Mechanical Identification
Mechanical	15102	Valves
Mechanical	15120	Piping Specialties
Mechanical	15140	Pipe Hangars and Supports
Mechanical	15250	Thermal Insulation



Damon Sams, P.E

SPECIFICATIONS CERTIFICATIONS

The following specifications were prepared under my direct supervision:

DIVISION NAME	NUMBER	TITLE
Concrete	03300	Cast-in-Place Concrete
Concrete	03710	Epoxy Tank Liner
Metals	05120	Structural Steel
Metals	05205	Access Platforms, Stairways and Ladders
Metals	05500	Metal Fabrications

Cory Attra, P.E

11.16.16

COMMONWEALTH OF VIRGINIA
BRODERICK C. ATTRA
Lic. No. 55325
PROFESSIONAL ENGINEER

SPECIFICATIONS CERTIFICATIONS

The following specifications were prepared under my direct supervision:

DIVISION NAME	NUMBER	TITLE
Electrical	16015	General Electrical Requirements
Electrical	16050	Basic Electrical Materials and Methods
Electrical	16060	Grounding and Bonding
Electrical	16075	Electrical Identification
Electrical	16120	Conductors and Cables
Electrical	16130	Raceways and Boxes
Electrical	16411	Safety Switches

Conner Sturdivant, P.E., P. Eng.
1344 S. Flores St. San Antonio, TX 78204

TECHNICAL SPECIFICATIONS

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02315	Excavation	02315-1 - 02315-2
02316	Excavation Undercut	02316-1 - 02316-1

02317	Trenching, Backfilling, and Compacting	02317-1 - 02317-2
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02532	Drop Inlet	02532-1 - 02532-2
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02720	Aggregate	02720-1 - 02720-2
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SECTION 00220
GEOTECHNICAL DATA

The OWNER has obtained geotechnical information, which may include laboratory test results, logs of borings, and recommendations from geotechnical consultants. That information is attached to these specifications and/or on the Drawings.

The CONTRACTOR shall be familiar with the subsurface materials and conditions on the Project and shall be knowledgeable of how they will affect the Work. The following is a partial listing of sources of information available to the CONTRACTOR about subsurface materials and conditions: the geotechnical information provided by the OWNER; geologic maps, publications and reports available from the Virginia Department of Mines Minerals and Energy; subcontractors familiar with local ground conditions; and, local consulting geologists and geotechnical engineers. The CONTRACTOR may make their own subsurface investigations.

The soil information provided in the geotechnical report is representative of the specific soil boring locations only. Neither the OWNER or ENGINEER guarantee the soil conditions where soil borings were not acquired. For preparation of the bid costs, it shall be the CONTRACTOR'S responsibility to determine the soil conditions for the project.

END OF SECTION

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SECTION 01110
ENVIRONMENTAL PROTECTION PROCEDURES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The work covered by this Section consists of furnishing all labor, materials and equipment and performing all work required for the prevention of environmental pollution in conformance with applicable laws and regulations, during and as the result of construction operations under this Contract. For the purpose of this Specification, environmental pollution is defined as the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to man; or degrade the utility of the environment for aesthetic and/or recreational purposes.

B. The control of environmental pollution requires consideration of air, water and land, and involves management of noise and solid waste, as well as other pollutants.

C. Schedule and conduct all work in a manner that will minimize the erosion of soils in the area of the work. Provide erosion control measures such as sedimentation or filtration systems, berms, silt fences, seeding, mulching or other special surface treatments as are required to prevent silting and muddying of streams, rivers, impoundments, lakes, etc. All erosion control measures shall be in place in an area prior to any construction activity in that area.

D. These Specifications are intended to ensure that construction is achieved with a minimum of disturbance to the existing ecological balance between a water resource and its surroundings. These are general guidelines. It is the CONTRACTOR'S responsibility to determine the specific construction techniques to meet these guidelines.

E. All phases of sedimentation and erosion control shall comply with and be subject to the approval of the Virginia Department of Environmental Quality (VDEQ) and the U.S. EPA.

1.02 APPLICABLE REGULATIONS

A. Comply with all applicable Federal, State and local laws and regulations concerning environmental pollution control and abatement.

1.03 NOTIFICATIONS

A. The ENGINEER will notify the CONTRACTOR in writing of any observed non-compliance with the foregoing provisions or of any environmentally objectionable acts and corrective action to be taken. State or local agencies responsible for verification of certain aspects of the environmental protection requirements shall notify the CONTRACTOR in writing, through the ENGINEER, of any non-compliance with State or local requirements. The CONTRACTOR shall, after receipt of such notice from the ENGINEER or from the regulatory agency through the ENGINEER, immediately take corrective action. Such notice, when delivered to the CONTRACTOR or its authorized representative at the site of the work, shall be deemed sufficient for the purpose. If the CONTRACTOR fails or refuses to comply promptly, the OWNER may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such stop orders shall be made the subject of a claim for extension of time or for excess costs or damages by the CONTRACTOR unless it is later determined that the CONTRACTOR was in full compliance.

1.04 IMPLEMENTATION

A. Prior to commencement of the work, meet with the OWNER to develop mutual understandings relative to compliance with this provision and administration of the environmental pollution control program.

B. Remove temporary environmental control features, when approved by the ENGINEER, and incorporate permanent control features into the project at the earliest practicable time.

1.05 PROTECTION OF WATERWAYS

A. The CONTRACTOR shall observe the rules and regulations of the Commonwealth of Virginia and agencies of the U.S. Government prohibiting the pollution of any lake, stream, river, or wetland by the dumping of any refuse, rubbish, dredge material, or debris therein.

B. CONTRACTORS are specifically cautioned that disposal of materials into any waters of the State must conform with the requirements of the VDEQ, and an applicable permit from the U.S. Army Corps of Engineers.

C. The CONTRACTOR shall be responsible for providing holding ponds or an approved method which will handle, carry through, or divert around his work all flows, including storm flows and flows created by construction activity, so as to prevent silting of waterways or flooding damage to the property or adjacent properties.

1. Any materials removed from water bodies are to be dewatered in a manner that prevents silting or return of material to water body.

2. Liquid/solid separation to be performed mechanically, by gravity separation in holding ponds or by other means that comply with the requirements. Holding ponds to incorporate means to remove liquid such as filtered riser pipes, decant pipes, underdrains, etc.

1.06 DISPOSAL OF EXCESS EXCAVATION AND OTHER WASTE MATERIALS

A. Material not suitable for backfill and other waste material must be disposed of at sites approved by the OWNER. Excess excavated material suitable for backfill, but not used, shall be spread and compacted in the designated spoils area as approved by the OWNER.

B. Unacceptable disposal sites, include, but are not limited to, sites within a wetland or critical habitat and sites where disposal will have a detrimental effect on surface water or groundwater quality.

C. The CONTRACTOR may make his own arrangements for disposal subject to submission of proof to the ENGINEER that the OWNER of the proposed site(s) has a valid fill permit issued by the appropriate governmental agency and submission of a haul route plan including a map of the proposed route(s).

D. The CONTRACTOR shall provide watertight conveyance of any liquid, semi-liquid, or saturated solids which tend to bleed or leak during transport. No liquid loss from transported materials will be permitted whether being delivered to the construction site or being hauled away for disposal. Fluid materials hauled for disposal must be specifically acceptable at the selected disposal site.

1.07 USE OF CHEMICALS

A. All chemicals used during project construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, reactant or of other classification, must show approval of either the U.S. Environmental Protection Agency or the U.S. Department of Agriculture or any

other applicable regulatory agency. Use of all such chemicals and disposal of residues shall be in conformance with the manufacturer's instructions.

B. Any oil or other hydrocarbon spilled or dumped on the OWNER'S site during construction must be excavated and completely removed from the site prior to final acceptance. Soil contaminated by the CONTRACTOR'S operations shall become the property of the CONTRACTOR, who will bear all costs of testing and disposal.

C. The CONTRACTOR shall provide MSDSs for all hazardous chemicals he may bring onto the project site that OWNER'S employees may be exposed to.

1.08 PAYMENT

A. The work specified in this Section shall be considered incidental and payment will be included as part of the appropriate lump sum or unit prices specified in the Bid Form.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 EROSION CONTROL

A. Provide positive means of erosion control such as shallow ditches or small berms around construction to carry off surface water. Erosion control measures, such as siltation basins, mulching, jute netting and other equivalent techniques, shall be used as appropriate. Flow of surface water into excavated areas shall be prevented. Ditches around construction area shall also be used to carry away water resulting from dewatering of excavated areas. At the completion of the work, ditches shall be backfilled, berms removed, and the ground surface restored to original condition.

3.02 PROTECTION OF STREAMS

A. Care shall be taken to prevent, or reduce to a minimum, any damage to any stream from pollution by debris, sediment or other material, or from the manipulation of equipment and/or materials in or near such streams. Water that has been used for washing or processing, or that contains oils or sediments that will reduce the quality of the water in the stream, shall not be directly returned to the stream. Such waters shall be diverted through a settling basin or filter before being directed into the streams.

B. The CONTRACTOR shall not discharge water from dewatering operations directly into any live or intermittent stream, channel, wetlands, surface water or any storm sewer. Water from dewatering operations shall be treated by filtration, settling basins, or other approved method to reduce the amount of sediment contained in the water.

C. All preventative measures shall be taken to avoid spillage of petroleum products and other pollutants. In the event of any spillage, prompt remedial action shall be taken in accordance with the site policies and procedures.

3.03 PROTECTION OF LAND RESOURCES

A. Land resources within the project boundaries and outside the limits of permanent work shall be restored to a condition, after completion of construction, that will appear to be natural and not detract from the appearance of the project. Confine all construction activities to areas shown on the Drawings.

B. Outside of areas requiring earthwork for the construction of the new facilities, the CONTRACTOR shall not deface, injure, or destroy trees or shrubs, nor remove or cut them without prior approval. No ropes, cables, or guys shall be fastened to or attached to any existing nearby trees for anchorage unless specifically authorized by the ENGINEER. Where such special emergency use is permitted, first wrap the trunk with a sufficient thickness of burlap or rags over which softwood cleats shall be tied before any rope, cable, or wire is placed. The CONTRACTOR shall in any event be responsible for any damage resulting from such use.

C. Where trees may possibly be defaced, bruised, injured, or otherwise damaged by the CONTRACTOR'S equipment, dumping or other operations, protect such trees by placing boards, planks, or poles around them. Monuments and markers shall be protected similarly before beginning operations near them.

D. Any trees or other landscape feature scarred or damaged by the CONTRACTOR'S equipment or operations shall be restored as nearly as possible to its original condition. The ENGINEER will decide what method of restoration shall be used and whether damaged trees shall be treated and healed or removed and disposed of.

1. All scars made on trees by equipment, construction operations, or by the removal of limbs larger than 1 in. in diameter shall be coated as soon as possible with an approved tree wound dressing. All trimming or pruning shall be performed in an approved manner by experienced workmen with saws or pruning shears. Tree trimming with axes will not be permitted.

2. Climbing ropes shall be used where necessary for safety. Trees that are to remain, either within or outside established clearing limits, that are subsequently damaged by the CONTRACTOR and are beyond saving in the opinion of the ENGINEER, shall be immediately removed and replaced.

E. The locations of the CONTRACTOR'S storage, and other construction buildings, required temporarily in the performance of the work, shall be approved by OWNER. The preservation of the landscape shall be an imperative consideration in the selection of all sites and in the construction of buildings.

F. If the CONTRACTOR proposes to construct temporary roads or embankments and excavations for plant and/or work areas, he/she shall submit the following for approval at least ten days prior to scheduled start of such temporary work.

1. A layout of all temporary roads, excavations and embankments to be constructed within the work area.

2. Details of temporary road construction.

3. Drawings and cross sections of proposed embankments and their foundations, including a description of proposed materials.

4. A landscaping drawing showing the proposed restoration of the area. Removal of any trees and shrubs outside the limits of existing clearing area shall be indicated. The drawing shall also indicate location of required guard posts or barriers required to control vehicular traffic passing close to trees and shrubs to be maintained undamaged. The drawing shall provide for the obliteration of construction scars as such and shall provide for a natural appearing final condition of the area. Modification of the CONTRACTOR'S approved drawings shall be made only with the written approval of the ENGINEER. No unauthorized road construction, excavation or embankment construction including disposal areas will be permitted.

G. Remove all signs of temporary construction facilities such as haul roads, work areas, structures, foundations of temporary structures, stockpiles of excess or waste materials, or any other vestiges of construction as directed by the OWNER or ENGINEER. It is anticipated that excavation, filling and plowing of roadways will be required to restore the area to near natural conditions which will permit the growth of vegetation thereon. The disturbed areas shall be prepared and seeded as described in SECTION 02921 - SEEDING, or as approved by the ENGINEER.

H. All debris and excess material shall be disposed of outside wetland or floodplain areas in an environmentally sound manner.

3.04 PROTECTION OF AIR QUALITY

A. Burning. The use of burning at the project site for the disposal of refuse and debris will not be permitted, unless approved by the OWNER.

B. Dust Control. The CONTRACTOR will be required to maintain all excavations, embankment, stockpiles, access roads, plant sites, waste areas, borrow areas, and all other work areas within or without the project boundaries free from dust which could cause the standards for air pollution to be exceeded, and which would cause a hazard or nuisance to others.

C. An approved method of stabilization consisting of sprinkling or other similar methods will be permitted to control dust. The use of petroleum products is prohibited. The use of chlorides may be permitted with approval from the OWNER or ENGINEER.

D. Sprinkling, to be approved, must be repeated at such intervals as to keep all parts of the disturbed area at least damp at all times, and the CONTRACTOR must have sufficient suitable equipment on the job to accomplish this if sprinkling is used. Dust control shall be performed as the work proceeds and whenever a dust nuisance or hazard occurs, as determined by the OWNER or ENGINEER.

3.05 MAINTENANCE OF POLLUTION CONTROL FACILITIES DURING CONSTRUCTION

A. During the life of this Contract, maintain all facilities constructed for pollution control as long as the operations creating the particular pollutant are being carried out or until the material concerned has become stabilized to the extent that pollution is no longer being created.

3.06 NOISE CONTROL

A. The CONTRACTOR shall make every effort to minimize noises caused by its operations. Equipment shall be equipped with silencers or mufflers designed to operate with the least possible noise in compliance with State and Federal regulations.

END OF SECTION

SECTION 01310
PROGRESS SCHEDULES AND MEETINGS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. During construction, the CONTRACTOR will be required to submit weekly progress reports to the OWNER and attend weekly construction meetings at the project location.

1.02 NARRATIVE PROGRESS REPORT

A. The CONTRACTOR shall prepare and submit to the OWNER a written report, on a weekly basis, to include, as a minimum:

1. Summary of Work completed during the past period between Narrative Progress Reports.

2. Work planned during the next period.

3. Explanation of differences between summary of Work completed and Work planned in previously submitted Narrative Progress Report.

4. Current and anticipated delaying factors and their estimated impact on other activities and completion Milestones.

5. Corrective action taken or proposed.

6. The report format shall be submitted by the CONTRACTOR and approved by the OWNER and ENGINEER.

7. The report shall be submitted to the OWNER at the Weekly Progress Meetings or at another agreed time.

1.03 WEEKLY PROGRESS MEETINGS

A. Weekly Progress Meetings shall be attended by the CONTRACTOR.

1. The CONTRACTOR'S on-site superintendent must attend all progress meetings, unless otherwise approved by the OWNER.

2. The day of the week and time of the meeting shall be as determined by the OWNER with input from the CONTRACTOR.

3. The meetings will last a maximum of one hour.

END OF SECTION

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SECTION 01321
CONSTRUCTION PHOTOGRAPHS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Photographic requirements for construction photographs and submittals.

1.02 DEFINITIONS

A. Pre-construction Photographs: Photographs taken, in sufficient numbers and detail, prior to date of commencement of the Work, to show original construction site conditions.

B. Progress Photographs: Photographs, taken throughout the duration of construction at regular intervals and from fixed vantage points, pre-approved by the ENGINEER, that document progress of the Work.

C. Finished Photographs: Photographs, taken by a professional photographer near Date of Substantial Completion and before OWNER'S acceptance of the Work, that are suitable for framing and for use in brochures or on the Internet.

D. Aerial Photographs: Photographs, taken from an aircraft by a professional aerial photographer near Date of Substantial Completion and before OWNER'S acceptance of the Work, that are suitable for framing and for use in brochures or on the Internet.

1.03 SUBMITTALS

A. Format and Media. Digital photography shall be used. Submit color photographs, unless otherwise specified.

1. Prints. Submit each Progress or Pre-construction Photograph print in a three-hole plastic pocket or sleeve, bound in a three-ring notebook. Produce prints on photographic-quality paper approved by Project Manager. Minimum size for Pre-construction Photograph prints shall be 3 in. by 5 in. Progress Photograph prints shall be 4 in. by 6 in.

2. Digital Photography. Use 10.1 megapixel density or greater for photographs. Scanned photographs must equal or exceed 400 dots per inch when scanned from 4 in. by 6 in. prints. Submit digital photographic files on DVDs. Format disks for Windows operating system and in JPEG (Joint Photographic Experts Group) format.

B. Submittal Quantities and Frequencies

1. Pre-construction Photographs

a. A preconstruction video recording of the entire project site, access points, perimeter fencing, features adjacent to access roads, and all access roads, including roads, within 1 mile of the plant site shall be required.

b. A minimum of 60 photos shall be taken prior to any work being done. These photos will be taken at all areas and surround areas where construction will take place.

c. Submit two sets of Pre-construction Photographs prior to first Application for Payment.

2. Progress Photographs

a. Each month, an average of 60 exposures shall be taken as directed by ENGINEER. Plan a minimum of three photo events per month.

b. Proofs of all exposures, in digital format on CD, shall be promptly furnished to the ENGINEER at the end of each month. The ENGINEER shall select an average of twenty exposures per month to be submitted as described under Products.

c. Submit three sets of Progress Photographs with each Application for Payment. Monthly Applications for Payment shall be deemed incomplete if not accompanied by the required Progress Photographs. The CONTRACTOR'S failure or election to not submit a monthly Application for Payment shall not affect the requirement for monthly Progress Photographs.

3. Finished Photographs

a. All photos and videos that were taken at the beginning (pre-construction) shall be taken after all work (including re-vegetation) has been completed.

b. Submit two sets of Finished Photographs after Date of Substantial Completion and prior to final payment. Each set shall contain one 11 in. by 14 in. matte finish color photographic print from each of the two vantage points pre-approved by the ENGINEER. Vantage points for Finished Photographs will be approved separately from vantage points approved for Progress Photographs.

4. Final Aerial Photograph

a. Upon completion of the project, the CONTRACTOR shall have made a color aerial photograph of the Water Recycling Facility as directed by the ENGINEER. The photograph shall be of such view and angle and shall be taken at such time as directed by the ENGINEER. The negatives and three 12 in. by 18 in. color prints shall be provided to the OWNER.

C. Labeling. Place a label on the back of each photographic print, applied so as to not to show through on the front. Labels shall contain the following information:

1. Name of Project, address of Project and CIP Number.

2. Name and address of CONTRACTOR.

3. Date photograph was taken.

4. Location photo was taken from and short description of photo subject.

5. Name and address of professional photographer who took the photograph, if applicable.

D. Hand-deliver or transmit prints in standard photographic mailers marked "Photographs - Do Not Bend."

E. Photographic prints, photographic files and disks become the property of the OWNER. Photographs specified herein shall not be published without written consent by the OWNER.

1.04 QUALITY ASSURANCE

A. CONTRACTOR shall be responsible for the quality of and timely execution and submittal of photographs.

B. For Finished Photographs, CONTRACTOR shall use a professional photographer, with five years minimum professional experience. CONTRACTOR shall submit name, address and credentials of professional photographer for Project Manager's review and approval.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.01 PRE-CONSTRUCTION PHOTOGRAPHS

A. Prior to commencement of construction operations, photograph the site to include initial construction corridor, detour routes, and staging or storage areas.

B. Prepare Pre-construction Photographs as follows:

1. Show the following information on a non-reflective chalkboard placed within the picture frame:

a. Job number.

b. Project Number.

c. Date and time photographs were taken (Automatic date/time is acceptable).

d. Baseline station and direction of view (i.e. N, S, NW, etc.).

2. Pre-construction Photographs shall indicate condition of the following:

a. Roads.

b. Grass covered areas adjacent to the project site.

c. Buildings.

d. Particular features (e.g. yard lights, culverts, fences, electrical vaults, monitoring wells, survey control points, water truck loadout gantry).

3. Show date photographs were taken on negatives.

C. Show the location of vantage points and direction of shots on a key plan of the site.

3.02 PROGRESS PHOTOGRAPHS

A. Progress Photographs document monthly advancement of the Work. Select vantage points for each shot so as to best show status of construction and progress since last photograph submittal. Select camera stations that will require little or no movement or adjustment over the duration of construction.

B. Take monthly Progress Photographs at regular intervals to coincide with cutoff dates associated with each Application for Payment.

3.03 FINISHED PHOTOGRAPHS

A. Finished Photographs shall be "staged" and taken by a professional photographer to depict the most flattering images of a finished facility. Two vantage points, from which Finished Photographs will be taken, shall be agreed to in advance by the ENGINEER. Photographer shall consider lighting, time of day, height of eye, landscaping and placement of vehicles, people and other props in each picture. Filters and post-photography processing may be utilized to achieve a finished product acceptable to the ENGINEER.

3.04 LOCATION

A. Vantage points, times and conditions for camera stations and photography for Progress and Finished Photographs shall be mutually agreed upon by the ENGINEER, CONTRACTOR and Photographer. Progress Photograph vantage points may be changed by mutual agreement as the Work progresses, at no additional cost to the OWNER.

END OF SECTION

SECTION 01330
SUBMITTALS

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Procedures.

B. Construction Progress Schedules.

C. Schedule of Values.

D. Shop Drawings.

E. Product Data.

F. Manufacturer's Instructions.

G. Samples.

H. CONTRACTOR Review.

1.2 PROCEDURES

A. Deliver submittals to ENGINEER.

B. Identify Project, CONTRACTOR, Subcontractor, major Supplier; identify pertinent Drawing sheet and detail number, and Specification Section number, as appropriate. Identify deviations from Contract Documents.

C. Comply with construction schedule for submittals related to Work progress. Coordinate submittal of related items.

D. Allow ENGINEER a minimum of 14 calendar days for review of submittals prior to approval or request for resubmission.

E. After ENGINEER reviews submittal, revise and resubmit as required; identify changes made since previous submittal.

F. Distribute copies of reviewed submittals to concerned persons. Instruct recipients to promptly report any inability to comply with provisions.

1.3 CONSTRUCTION PROGRESS SCHEDULE

A. Show detailed sequence for liner system placement. Sequence clay placement to maximize time between lifts to allow for soils testing and documentation, minimize splices, and to meet regulatory requirements.

1.4 SCHEDULE OF VALUES

A. Submit typed schedule of values. Identify each line item with number and title of major Specifications Sections.

B. Include in each line item a directly proportional amount of CONTRACTOR's overhead and profit.

1.5 SHOP DRAWINGS

A. Submit in the form of one reproducible transparency and one opaque reproduction. After review, reproduce and distribute in accordance with requirements in Article on Procedures, above.

B. Present in a clear and thorough manner. Title each drawing with Project name; identify each element of Drawings by reference to sheet number and detail of Contract Documents.

C. Identify field dimensions; show relationship to adjacent or critical features of Work or products.

1.6 PRODUCT DATA

A. Mark each copy to identify applicable product, models, options, and other data; supplement manufacturer's standard data to provide information unique to the Work.

B. Submit the number of copies which CONTRACTOR requires plus two copies which will be retained by ENGINEER.

1.7 MANUFACTURER'S INSTRUCTIONS

A. When required by an individual Specification Section, submit manufacturer's printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, in quantities specified for product data.

1.8 SAMPLES

A. Provide field samples as required by individual Specifications Sections. Install sample complete and finished. Acceptable samples in place may be retained in the completed Work.

B. Submit samples to illustrate functional characteristics of the product, with integral parts and attachment devices. Coordinate submittal of different categories for interfacing Work.

C. Include identification on each sample, giving full information.

D. Submit number specified in respective Specification Section; one will be retained by ENGINEER. Reviewed samples which may be used in the Work are indicated in the Specification Section.

1.9 CONTRACTOR REVIEW

A. Review submittals prior to transmittal; determine and verify field measurements, field construction criteria, manufacturer's catalog numbers, and conformance of submittal with requirements.

B. Coordinate submittals with requirements of Work and of Contract Documents.

C. Sign or initial each sheet of shop drawings and product data, and each sample label to certify compliance with requirements of Contract Documents. Notify ENGINEER in writing at time of submittal of any deviations from requirements of Contract Documents.

D. Do not fabricate products or begin Work which requires submittals until return of submittal with ENGINEER's acceptance.

PART 2. PRODUCTS

NOT USED.

PART 3. EXECUTION

3.1 Provide submittals requested in the specifications and drawings. Refer to Table 01330-1 for summary of submittals.

Table 01330-1
Summary of Submittals

ITEM/ PRODUCT	REFERENCE LOCATION	SUBMITTAL TYPE	DESCRIPTION
Progress Schedules and Meetings	Section 01310-1.02	Progress Reports	Weekly progress report
Construction Photographs	Section 01321-1.03(B)	Documentation	Preconstruction, Progress, and substantial completion photographs
Submittals	Section 01330-1.3(A)	Liner Placement Sequence	Detailed sequence for liner system placement
	Section 01330-1.4(A)	Schedule of Values	Identify each line item with a number and title of major specification
Reference Standards	Section 01420-1.2(C)	Product Data	When required by a specification section, obtain a copy of standard and maintain on job site until Substantial Completion
Quality Control	Section 01450-1.5(A)	Manufacturer's Information	Submit manufacturer's certificates when required by an individual Specifications Section
	Section 01450-1.6(A)	Samples/Documentation	When required by a specification section, erect complete, full-scale mockup of assembly at Project Site
Testing Laboratory Services	Section 01452-1.5(A)	Samples/Documentation	Provide ENGINEER with test results from the laboratory
Materials and Equipment	Section 01600-1.02(A)	Product Data	Submit names of proposed manufacturer's, material men and dealers who are to furnish materials, fixtures, equipment, appliances, or other appurtenances for review as early as possible
	Section 01600-1.03(A)	Samples/Documentation	Submit for approval typical samples or materials and appliances
Watertightness Test	Section 01680-1.03(A)	Samples/Documentation	Results of watertightness test for each structure in a format similar to that of Figure A attached in the section
Field Engineering	Section 01720-1.2(A)	Samples/Documentation	Submit data demonstrating qualifications of persons providing services, on request
	Section 01720-1.2(B)	Samples/Documentation	Submit documentation verifying accuracy of work, on request
	Section 01720-1.2(C)	Samples/Documentation	Maintain complete, accurate logs of control and survey work as it progresses and submit Record Documents to the ENGINEER

Table 01330-1
Summary of Submittals

ITEM/ PRODUCT	REFERENCE LOCATION	SUBMITTAL TYPE	DESCRIPTION
Operation and Maintenance	Section 01782-1.01(B)	Product Data	Submit O&M Manuals for equipment and processes as described in Table 1 of Section 01782
	Section 01782-2.01	Product Data	Submit Operation and Maintenance Documentation Directory including items from subsections (A) through (E)
	Section 01782-2.02	Product Data	Submit General Manual as outlined in subsections (A) through (D)
	Section 01782-2.04	Product Data	Submit Operation Manual as outlined in subsections (A) through (J)
HDPE Geomembrane	Section 02070-1.5(A)	Product Data	Raw material supplier and CQA information
	Section 02070-1.5(B)	Manufacturer's Information	Geomembrane certifications to meet Specifications of GRI GM13
	Section 02070-1.5(C)	Product Data	Geomembrane product data and manufacturer's information
	Section 02070-1.5(D)	Product Data	Geomembrane Installer's information
	Section 02070-1.5(E)	Shop Drawing	Panel layout diagram
	Section 02070-1.5(F)	Samples/Documentation	Submittals during installation including daily construction reports, subgrade acceptance forms, and QC documentation
	Section 02070-1.5(G)	Samples/Documentation	Submittals after installation including, geomembrane installation certification, as-built, panel layout diagram, and manufacturer/installer warranty
	Section 02070-2.1(B)	Manufacturer's Information	List of approved manufacturer's or substitution options
	Section 02070-2.2(A)	Product Data	Polyethylene Geomembrane Resin specification
	Section 02070-2.2(B)	Product Data	HDPE Geomembrane specifications
	Section 02070-2.2(C)	Product Data	Fabrication information
	Section 02070-2.3(A)	Samples/Documentation	Evaluate and test geomembrane rolls prior to acceptance
	Table 02070-1	Product Data	HPDE Geomembrane-Smooth properties
	Table 02070-2	Product Data	HPDE Geomembrane-Textured properties
	Section 02070-2.3(B)	Samples/Documentation	Conformance test sampling procedures
	Section 02070-2.3(D)	Samples/Documentation	Direct shear testing and stability analysis

Table 01330-1
Summary of Submittals

ITEM/ PRODUCT	REFERENCE LOCATION	SUBMITTAL TYPE	DESCRIPTION
Geotextiles	Section 02076-1.4(A)	Product Data	Submit copy of quality control certification for each roll and results of quality control test no later than 10 days prior to first shipment
	Section 02076-1.4(B)	Manufacturer's Information	Geotextile manufacturer's certifications
	Table 02076-1	Product Data	Properties and requirements for separation geotextile
	Table 02076-2	Product Data	Properties and requirements for cushion geotextile
Cofferdams	Section 02260-1.2(A)	Manufacturer's Information	Proposed drawings and manufacturer information
	Section 02260-1.2(A)	Shop Drawing	Detailed design notes and Shop Drawings stamped and signed and dated by a professional engineer in the state of Virginia
	Section 02260-2.1(B)	Manufacturer's Information	List of approved manufacturer's or substitution options
Fill	Section 02320-1.3(A)	Samples/Documentation	Sequence of Clay Fill Layer placement under provisions of Section 01330
	Section 02320-1.3(B)	Product Data	Material testing documentation and samples of General Fill, Clay, Free Draining Fill, and Non-Frost Susceptible Fill
Sediment Control Fence	Section 02374-2.1	Product Data	List of approved manufacturer's or substitution options
Drop Inlet	Section 02532-1.3(A)	Manufacturer's Information	List of needed materials and accompanying reference standards
HDPE Piping	Section 02618-1.4(A)	Product Data	Submit product data under provisions of Section 1300
	Section 02618-1.4(B)	Product Data	Product data on materials
	Section 02618-1.4(C)	Manufacturer's Information	Manufacturer's substitutions
	Section 02618-2.1	Manufacturer's Information	Manufacturer's substitutions
Aggregate	Section 02720-1.3(A)	Product Data	Provide test results under provisions of Section 1330
	Section 02720-1.3(B)	Product Data	Source of supply and test results under provisions of Section 01452

Table 01330-1
Summary of Submittals

ITEM/ PRODUCT	REFERENCE LOCATION	SUBMITTAL TYPE	DESCRIPTION
Liner Concrete Pavement	Section 03050-1.3(B)(4)	Qualifications	Information and qualifications of independent testing laboratory
	Section 03050-1.3(D)(4)	Product Data	Trial batch data
	Section 03050-1.4(A)(1)	Product Data	Submit items requested in Section 03300
	Section 03050-1.4(A)(2)	Qualifications	Items requested in 1.3(B) and (C)
	Section 03050-1.4(A)(3)	Product Data	Joint sealant product information
	Section 03050-1.4(A)(4)	Samples	Samples of materials as specified and as requested by ENGINEER
	Section 03050-1.4(A)(5)	Schedule/Description	Proposed schedule and written description of means and methods for installation
Environmental Cast-In-Place Concrete	Section 03300-1.3	Product Data	Concrete conforms with product data information for subsection (A) through (G)
Vertical Cantilever Sludge Pumps	Section 11315-1.03	Manufacturer's Product Data	Refer to Section 11315-1.03 A through D
		Shop drawings	
		O&M Manual	
Valves	Section 15102-1.03	Manufacturer's Product Data	For each type of valve submit body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.
Pipe and Pipe Fittings	Section 15071-1.04	Manufacturer's Product Data	Submit product data and shop drawings on each type of pipe, valves, fittings and accessories. Employ welders qualified by current certification of testing to perform welding operations per American Welding Society requirements. Submit documentation for all welders on the job. Submit results of leak tests.
	S3107 Line List	Shop drawings	
		Welder Certification	
		Leak Tests	
Pipe Embedment & Backfill	M4005	Material sources	
		Certifications	
Protective Coatings	Section 09915-1.03	Manufacturer's Product Data	Technical information including label analysis and instructions for handling, storing and applying each coating material

Table 01330-1
Summary of Submittals

ITEM/ PRODUCT	REFERENCE LOCATION	SUBMITTAL TYPE	DESCRIPTION
Access Hatches	Section 05550-1.03	Manufacturer's Product Data	Manufacturer's specifications, standard details, and installation recommendations. Submit shop drawings to accurately describe installation of the products.
	M4001, M4003, M4005	Shop drawings	
		O&M Manual	
Access Platforms, Stairways & Ladders	Section 05205-1.3	Shop Drawings	Submit shop drawings for fabrication and erection of metal platforms, stairs & handrails showing dimensioned layouts and details indicating design loads and deflections.
		Engineer's Certification	
Slide Gates	Section 11203-1.3	Manufacturer's Product Data	Sluice gates, weir gates, & stop gates. Refer to Section 11203-1.3 A 1 through 14.
	M4001, M4002	Shop drawings	
		O&M Manual	
Temporary Pumps	M4004	Manufacturer's Product Data	
Valve Vault	M4005	Manufacturer's Product Data	Precast concrete components
Pressure gauge	M4002	Manufacturer's Product Data	
Epoxy Tank Liner	Section 03710-1.5	Manufacturer's Product Data	Refer to Section 03710-1.5 A through F
		Color Samples	
		Quality Assurance	
Metal Fabrications	Section 05500-1.3	Manufacturer's Product Data	Product data for paint products and grout. Submit detail shop drawings for fabrication and erection of each metal fabrication required. Include anchorage and accessory items.
		Shop drawings	
		Welding certificates	
Electrical Requirements	Section 16015-1.4	Shop drawings	

END OF SECTION

SECTION 01410
REGULATORY REQUIREMENTS

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Description.

B. Permits.

C. Taxes.

1.2 DESCRIPTION

A. Give all notices; observe and comply with all laws, rules, regulations and ordinances applicable to the Work.

B. Notify area utility companies before beginning Work, in accordance with state and local regulations.

C. All construction operations shall be accomplished in accordance with applicable regulations of the U.S. Occupational Safety and Health Administration.

1.3 PERMITS

A. Obtain and pay for all construction permits and licenses and pay all governmental charges and inspection fees necessary for the prosecution of the Work, which are applicable at the time of CONTRACTOR's Bid.

B. Obtain demolition permits when needed.

C. Obtain Clover Power Station permits where needed.

D. OWNER will assist CONTRACTOR, when necessary, in obtaining such permits and licenses.

1.4 TAXES

A. Pay all sales, consumer, use and other similar taxes required to be paid in accordance with the law of the place where the Work is to be performed.

PART 2. PRODUCTS

NOT USED.

PART 3. EXECUTION

NOT USED.

END OF SECTION

SECTION 01412
MANUFACTURER'S FIELD SERVICES

PART 1 - GENERAL

1.01 SUMMARY

A. This section includes general requirements for services to be provided by manufacturer's field representatives including training of OWNER'S personnel and preparation of equipment installation reports.

1.02 DEFINITIONS

A. Person-Day: One person for 8 hours within regular CONTRACTOR working hours.

1.03 QUALIFICATION OF MANUFACTURER'S REPRESENTATIVE

A. The technician shall be an authorized representative of the manufacturer, factory trained, and experienced in the technical applications, installation, operation, and maintenance of respective equipment, subsystem, or system. The proposed representative shall be subject to acceptance by the OWNER. No substitute representatives will be allowed unless prior written approval by the OWNER has been given.

1.04 FULFILLMENT OF SPECIFIED MINIMUM SERVICES

A. Where manufacturers' services are specified, furnish manufacturer's qualified representative for a sufficient period of time to perform all specified functions at no additional cost to the OWNER.

B. Schedule manufacturer's onsite services to avoid conflicting with other onsite testing or other manufacturer's onsite services. Determine that all conditions necessary to allow successful testing have been met before scheduling services.

C. Only those days of service approved by ENGINEER will be credited to fulfill the specified minimum services.

D. Manufacturer's onsite services to include at a minimum:

1. Assistance during installation to include observation, guidance, instruction of the CONTRACTOR'S assembly, erection, installation or application procedures.

2. Inspection, checking, and adjustment as required for equipment to function as warranted by manufacturer and necessary to furnish written approval of installation.

3. Revisiting the site as required to correct problems and until installation and operation are acceptable to the OWNER.

4. Resolution of assembly or installation problems attributable to, or associated with, the respective manufacturer's products and systems.

5. Assistance during functional and performance testing, and startup demonstration and until product acceptance by the OWNER.

6. Training of OWNER'S personnel in the operation and maintenance of respective product as required herein.

7. Completion of equipment installation report with applicable certificates for proper installation and initial, interim, and final test or service.

1.05 TRAINING OWNER'S PERSONNEL

A. Furnish trained, articulate personnel to coordinate and expedite training. Personnel shall be familiar with operation and maintenance manual information furnished by the manufacturer.

B. Furnish manufacturer's' representatives for onsite hands-on training for OWNER'S personnel on operation and maintenance of specified product (system, subsystem, component) and as may be required in applicable Specifications.

C. Prestartup Training

1. Coordinate training sessions with the OWNER'S operating personnel and manufacturers' representatives, and with submission of operation and maintenance manuals.

D. Post-Startup Training

1. If required in Specifications, furnish and coordinate training of OWNER'S operating personnel by respective manufacturer's representatives.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01420
REFERENCE STANDARDS

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Applicability of Reference Standards.

B. Provision of Reference Standards at site.

1.2 QUALITY ASSURANCE

A. Comply with requirements of the standard for products or workmanship specified by association, trade, or federal standards, except when more rigid requirements are specified or are required by applicable codes.

B. Except when a specific date is specified, the date of the standard is that in effect as of the Bid date, or date of the OWNER-CONTRACTOR Agreement when there are no bids.

C. When required by individual Specifications Section, obtain copy of standard. Maintain copy at job site during submittals, planning, and progress of the specific Work, until Substantial Completion.

PART 2. PRODUCTS

NOT USED.

PART 3. EXECUTION

NOT USED.

END OF SECTION

SECTION 01450
QUALITY CONTROL

PART 1. GENERAL

1.1 SECTION INCLUDES

A. General Quality Control.

B. Workmanship.

C. Manufacturer's Instructions.

D. Manufacturer's Certificates.

E. Mockups.

F. Manufacturer's Field Services.

1.2 GENERAL QUALITY CONTROL

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

1.3 WORKMANSHIP

A. Comply with industry standards except when more restrictive tolerances or specified requirements indicate more rigid standards or more precise workmanship.

B. Perform Work by persons qualified to produce workmanship of specified quality.

C. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, and cracking.

1.4 MANUFACTURER'S INSTRUCTIONS

A. Comply with instructions in full detail, including each step in sequence. Should instructions conflict with Contract Documents, request clarification from ENGINEER before proceeding.

1.5 MANUFACTURER'S CERTIFICATES

A. When required by individual Specifications Section, submit manufacturer's certificate, in duplicate, that products meet or exceed specified requirements.

1.6 MOCKUPS

A. When required by individual Specifications Section, erect complete, full-scale mockup of assembly at Project site.

1.7 MANUFACTURER'S FIELD SERVICES

A. When specified in respective Specification Sections, require Supplier or Manufacturer to provide qualified personnel to observe field conditions, conditions of surfaces and

installation, quality of workmanship, start-up of equipment, test, adjust and balance equipment, as applicable, and to make appropriate recommendations.

B. Manufacturer's Representative shall submit written report to ENGINEER listing observations and recommendations.

PART 2. PRODUCTS

NOT USED.

PART 3. EXECUTION

NOT USED.

END OF SECTION

SECTION 01452
TESTING LABORATORY SERVICES

PART 1. GENERAL

1.1 SECTION INCLUDES

A. References.

B. Selection and Payment.

C. Quality Assurance.

D. CONTRACTOR Submittals.

E. Laboratory Responsibilities.

F. Laboratory Reports.

G. Limits on Testing Laboratory Authority.

H. CONTRACTOR Responsibilities.

I. Soils Testing.

1.2 REFERENCES

A. ANSI/ASTM D3740 - Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

B. ANSI/ASTM E329 - Specification for Agencies Engaged in Testing and/or Inspection of Materials Used in Construction.

C. ASTM D422 - Test Method for Particle-Size Analysis of Soils: Sieve Analysis and Hydrometer.

D. ASTM D698 - Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort: Standard Proctor.

E. ASTM D1140 - Test Method for Amount of Material in Soils Finer than the No. 200 Sieve: P200 Content.

F. ASTM D1556 - Test Method for Density and Unit Weight of Soil In Place by the Sand-Cone Method: Sand Cone Density Test.

G. ASTM D1557 - Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort: Modified Proctor.

H. ASTM D2216 - Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock: Natural Moisture Content.

I. ASTM D2434 - Test Method for Permeability of Granular Soils (Constant Head).

J. ASTM D2487 - Classification of Soils for Engineering Purposes (Unified Soil Classification System).

K. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate In Place by Nuclear Methods (Shallow Depth): Nuclear Density Test.

L. ASTM D2937 - Test Method for Density of Soil In Place by the Drive-Cylinder Method.

M. ASTM D3017 - Test Method for Water Content of Soil and Rock In Place by Nuclear Methods (Shallow Depth): Nuclear Moisture Content.

N. ASTM D4318 - Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils: Atterberg Limits.

O. ASTM C136 - Test Method for Sieve Analysis of Fine and Coarse Aggregates.

P. ASTM D4643 - Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method.

Q. ASTM D5084 - Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.

1.3 SELECTION AND PAYMENT

A. CONTRACTOR will employ and pay for services of an independent testing laboratory to perform specified inspection and testing.

B. Employment of testing laboratory shall in no way relieve CONTRACTOR of obligation to perform Work in accordance with requirements of Contract Documents.

1.4 LABORATORY RESPONSIBILITIES

A. Test samples of materials submitted by CONTRACTOR.

B. Provide qualified personnel at site after due notice; cooperate with ENGINEER and CONTRACTOR in performance of services.

C. Perform specified inspection, sampling and testing of products in accordance with specified standards.

D. Determine compliance of materials with requirements of Contract Documents.

E. Promptly notify ENGINEER and CONTRACTOR of observed irregularities or non-conformance of Work or products.

F. Perform additional inspections and tests until compliance is achieved or as required by ENGINEER.

G. Attend preconstruction conferences and progress meetings as required.

1.5 LABORATORY REPORTS

A. After each inspection and test, promptly submit two copies of laboratory report to ENGINEER and to CONTRACTOR. Include: Date issued, Project Title and number, name of inspector, date and time of sampling or inspection, identification of product and

Specifications section, location in the Project, type of inspection or test, date of test, results of test, and conformance with Contract Documents. When requested by ENGINEER, provide interpretation of test results.

1.6 LIMITS ON TESTING LABORATORY AUTHORITY

A. Laboratory may not release, revoke, alter, or enlarge on the requirements of Contract Documents.

B. Laboratory may not approve or accept any portion of the Work.

C. Laboratory has no authority to stop Work.

1.7 CONTRACTOR RESPONSIBILITIES

A. Notify ENGINEER of operations requiring inspection and testing services 24 hours prior to inspection or testing.

B. Provide incidental labor and facilities to provide access to Work to be tested, obtain and handle samples at the site or at the source of products to be tested, facilitate tests and inspections, and for storage and curing of test samples.

C. Notify ENGINEER immediately after receiving non-conforming test results from the laboratory.

D. Provide ENGINEER with test results from the laboratory.

E. If tests indicate Work does not meet specified requirements, remove Work, replace, and retest until compliance is achieved at no cost to OWNER.

1.8 SOILS TESTING

A. Determine the moisture-density relation and maximum dry density by the Standard Proctor Test.

B. Perform one Proctor Test for every type of fill material specified. ENGINEER may require additional Proctor Tests whenever material changes are detected.

C. Refer to Section 2320 for additional soil testing requirements.

PART 2. PRODUCTS

NOT USED.

PART 3. EXECUTION

NOT USED.

END OF SECTION

SECTION 01570
TEMPORARY CONTROLS

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Dust Control.

B. Erosion and Sediment Control.

C. Noise Control.

D. Pollution Control.

1.2 DUST CONTROL

A. Execute Work by methods to minimize raising dust from construction operations.

B. Provide positive means to prevent air-borne dust from dispersing into atmosphere.

C. Do not use oils, bitumens, or chlorides for dust control.

D. Provide dust abatement as directed by the OWNER in the construction permit and comply with pollution control regulations of governing authorities. Provide all materials, labor, and equipment for transportation, gathering, and spreading of water. OWNER shall supply water at no cost to the CONTRACTOR at the water truck load-out station.

1.3 EROSION AND SEDIMENT CONTROL

A. Install erosion and sediment control prior to any site preparation work. Remove erosion controls at the completion of the project.

B. Minimize amount of bare soil exposed at one time.

C. Plan and execute construction to control surface drainage from cuts and fills, and from borrow and waste disposal areas. Prevent erosion and sedimentation.

D. Keep duration of exposure of construction materials before final finishing or cover as short as practical.

E. Conduct operations to avoid washing or deposition of materials into waterways or off-site.

F. Do not track or spill mud, clay, gravel, or other materials onto adjacent streets or off-site. Clean off inadvertent tracking and spills immediately.

G. Periodically inspect earthwork for evidence of erosion and sedimentation; promptly apply corrective measures.

1.4 NOISE CONTROL

A. Limit the operation of heavy equipment and machinery to the hours approved of by the OWNER.

1.5 POLLUTION CONTROL

A. Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances and pollutants produced by construction operations.

B. Comply with all applicable local, state, and federal requirements regarding excess and waste material, including methods of handling and disposal.

C. Dispose of fuels, hazardous materials, and contaminated excavations in a legally approved manner.

D. Comply with the engine requirements described in the power station construction permit.

PART 2. PRODUCTS

NOT USED.

PART 3. EXECUTION

NOT USED.

END OF SECTION

SECTION 01574
TEMPORARY WATER CONTROL

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Control of surface water and ground water during construction.

1.2 WATER CONTROL

A. Rough grade site to prevent standing water and to direct surface water drainage away from Work area.

B. Maintain or relocate existing ditches and spillways.

C. Do not stockpile material such that it restricts surface drainage.

D. If it is necessary to interrupt existing surface water drainage, provide and maintain temporary piping or ditching until permanent drainage is provided.

E. Maintain excavations and trenches free of water. Provide and operate pumping equipment of a capacity to control water flow out of excavations and trenches.

F. Provide piping to handle discharge to prevent erosion or deposit of silt. Remove equipment when no longer needed for temporary water control.

PART 2. PRODUCTS

NOT USED.

PART 3. EXECUTION

NOT USED.

END OF SECTION

SECTION 01600
MATERIALS AND EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION

A. All materials, appliances and types of construction shall be in accordance with the Specifications and shall, further, conform to the requirements of applicable laws, ordinances and codes.

B. All materials and equipment shall be new, unused and designed as specified. They shall be of standard first-grade quality, produced by expert workmen, and be intended for the use for which they are offered. Materials or equipment which are inferior or of a lower grade than indicated, specified or required will not be accepted.

C. The quality of workmanship and materials entering into the Work under each Section shall conform to the requirements of pertinent sections, clauses, paragraphs and sentences, both directly and indirectly applicable thereto, of the Specifications.

D. Equipment and appurtenances shall be designed in conformity with AWWA, NSF, ASME, AIEE, and NEMA standards and shall be of rugged construction and of sufficient strength to withstand all stresses, which may occur during fabrication, test, transportation, installation and all conditions of operation. Protect bearings and moving parts against wear by bushings or other approved means and fully lubricate readily accessible devices. Design details for appearance as well as utility. Protruding members, joints, corners, gear covers and the like shall be finished in appearance. Grind exposed welds smooth. Miter corners of structural shapes.

1.02 MANUFACTURER

A. Submit names of proposed manufacturers, material men and dealers who are to furnish materials, fixtures, equipment, appliances or other appurtenances for review as early as possible to afford proper investigation and checking. No manufacturer will be approved for materials or equipment to be furnished under this Contract unless he shall be of good reputation and have a plant of ample capacity suited to the efficient production of the materials or equipment offered. He shall, upon request, be required to submit evidence that he has manufactured a similar product to the one specified and that it has been previously used for a like purpose for a sufficient length of time to demonstrate that it will fulfill all requirements of the Project.

B. The availability of the manufacturer's service facilities for the maintenance of equipment offered will be considered in the evaluation.

C. All transactions with the manufacturers or subcontractors shall be through the CONTRACTOR.

D. Any two (2) or more pieces of material or equipment of the same kind, type or classification being used for identical types of service, shall be made by the same manufacturer.

1.03 SAMPLES

A. When required, the CONTRACTOR shall submit for approval typical samples of materials and appliances. Identify samples by tags and submit sufficiently in advance of the time when they are to be incorporated into the work so rejections will not cause delay. A letter of transmittal, in triplicate, from the CONTRACTOR requesting approval shall accompany all such samples.

1.04 EQUIVALENT QUALITY

A. As required in other sections for these specifications, certain equipment items and materials must be “pre-approved” prior to bid for use on this project.

B. For those items not requiring pre-bid approval, whenever in the Contract Documents an article, material, apparatus, equipment, or process is called for by trade name of a patentee, manufacturer or dealer, or by reference to catalogue of a manufacturer or dealer, it shall be understood as intending to mean and specify the article, material, apparatus, equipment or process designated, or any approved equal in quality, finish, design, efficiency, and durability and equally serviceable for the purpose for which it is intended. Upon rejection of material or equipment submitted as the equivalent of that specifically named in the Contract, the CONTRACTOR shall proceed immediately to furnish the designated material or equipment.

1.05 DELIVERY, STORING, CARE AND PROTECTION

A. The CONTRACTOR shall deliver materials in ample quantities to ensure the most speedy and uninterrupted progress of the work, so as to complete the work within the allotted time. The CONTRACTOR shall also coordinate deliveries in order to avoid delay in or impediment of the progress of the work of any related contractor. Shipment by weights shall show the weights. Under no circumstances shall equipment be delivered to the site more than one month prior to anticipated installation without written authorization from the ENGINEER.

B. The CONTRACTOR shall be solely responsible for properly storing and providing protection of all materials, equipment and the entire work furnished under this Contract from the time such materials and equipment are delivered at the site of the work until final acceptance of the entire work. He shall at all times take necessary precautions to prevent injury or damage by water or by inclemency of weather to such materials, equipment and work. All injury or damage to materials, equipment or work shall be corrected by the CONTRACTOR.

C. Factory assembled parts and components shall not be disassembled for shipment unless permission is received in writing from the ENGINEER. Finished surfaces of all exposed parts shall be properly protected against adverse conditions that may prevail from time of shipment until ready for operation.

D. All finished surfaces of all exposed flanges shall be protected by wooden blank flanges, stoutly built, and securely bolted.

E. Finished iron and steel surfaces not painted shall be protected against rust and corrosion.

F. After hydrostatic or other tests, all entrapped water shall be drained, and care taken to prevent the entrance of water during shipment, storage and handling.

G. Each box or package shall be legibly marked to show its net weight and contents.

H. At the time of shipment, the shipping list, original bill of lading, shipping memorandum and invoice shall be mailed in triplicate to the ENGINEER. Each shipping list shall give the description and net weight of each item, and gross weight of the shipment. Shipment will not be accepted until the list has been received.

I. Demurrage, or other charges resulting from failure to furnish these items, shall be absorbed by the CONTRACTOR.

J. The CONTRACTOR shall make suitable provision for the handling and delivery of all equipment and material at the site.

K. Stack materials in an approved manner for convenience in counting. Do not place materials directly on the ground.

L. Box, crate or otherwise completely enclose and protect equipment during shipment, handling and storage. Protect equipment from exposure to the elements and keep thoroughly dry at all times.

M. Protect painted surfaces against impact, abrasion, discoloration and other damage. Repaint painted surfaces which are damaged prior to acceptance of equipment in accordance with SECTION 09915 - PROTECTIVE COATINGS.

N. Protect electrical equipment, controls and insulation against moisture or water damage. Connect space heaters provided in the equipment storage areas and operate at all times until equipment is placed in service. Store pumps, motors, electrical equipment and other equipment having antifriction or sleeve bearings in weathertight buildings that are maintained at a minimum temperature of 60°F.

1.06 TOOLS

A. Any special tools (including grease guns or other lubricating devices) which may be necessary for the adjustment, operation, and maintenance of any equipment shall be furnished with the respective equipment.

1.07 INSTALLATION OF EQUIPMENT

A. The CONTRACTOR shall have on hand equipment and machinery of ample capacity to facilitate this work and to handle emergencies normally encountered in work of this character.

B. Erect equipment on the foundations at the locations and elevations shown on the Drawings, unless otherwise directed during installation.

C. Furnish, install and protect necessary anchor and attachment bolts and other appurtenances needed for the installation of the devices included in the equipment specified. Anchor bolts shall be of ample size and strength for the purpose intended. Furnish templates and working drawings for installation.

D. The CONTRACTOR shall, at his own expense, furnish all materials and labor for, and shall properly bed in cement grout as specified, each piece of equipment of its supporting base resting on masonry or concrete foundations. Grout shall completely fill the space between the equipment base and the foundation.

1.08 WARRANTY

A. Unless specified otherwise, all equipment and materials furnished under this contract shall be warranted for a period of one year following testing, start-up, and final acceptance by the ENGINEER and OWNER.

END OF SECTION

SECTION 01666
TESTING OF PIPELINES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, tools, equipment and related items required to perform exfiltration testing and deflection testing of facility piping system and to perform pressure and leakage testing of pressure pipelines.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

A. Hydrostatic pressure and leakage tests shall be made on all pressure pipelines carrying water or industrial slurry.

B. All labor and equipment, including test pump with regulated by-pass meters and gauges required for conducting pipeline tests, shall be furnished by the CONTRACTOR. The CONTRACTOR shall furnish equipment and necessary piping as required to transport water used in testing from source to test location.

C. Time and sequence of testing shall be scheduled by the CONTRACTOR, subject to observation and approval by the OWNER. The CONTRACTOR shall provide adequate labor, tools and equipment to operate valves and to locate and repair any leaks discovered during the initial filling of the pipeline prior to actual testing or during the course of the tests.

3.02 CLEANING

A. At the conclusion of the work, thoroughly clean all pipelines by flushing with water or other means to remove all dirt, stones, pieces of wood, or other material that may have entered the pipes during the construction period. Debris cleaned from the lines shall be removed from the low end of the pipeline. If after this cleaning, obstructions remain, they shall be removed. After the pipelines are cleaned and if the groundwater level is above the pipe or following a heavy rain, the ENGINEER will examine the pipes for leaks. If any defective pipes or joints are discovered, they shall be repaired.

3.03 TEST PROCEDURES FOR GRAVITY PIPELINES

A. Gravity pipelines shall be installed and backfilled and then tested using either Exfiltration Water Testing or Low Pressure Air Testing. In addition, flexible pipes shall be tested using an Allowable Deflection Test.

1. Exfiltration Water Testing

a. The section of pipe to be tested shall be filled with water and allowed to stand for such time as is required for the pipeline to adsorb such water as it will and for the escape of all air from the line. The sections undergoing test shall be carefully examined for leakage. All known leaks shall be repaired, regardless of these test requirements.

b. The line shall then be filled to a reference level in manhole or in a reservoir of sufficient capacity to allow for a reference level to be established. The reservoir must be of sufficient capacity as to not allow the water level to drop below the crown of the pipe during the 24-hour test period. If the water level drops below the crown of the pipe, the test shall be voided and run again or until such time the water level is maintained above the crown throughout the duration of the test.

c. At the end of a 24-hour period, water, if needed, shall be added to the line to bring the water level back to the referenced line. All water added shall be accurately measured by an approved water meter so that an exfiltration rate can be established.

d. Leakage during the above test shall not exceed a rate equal to 25 gallons per inch of internal diameter per mile per twenty-four hours.

e. All observed leaks shall be repaired regardless of the measured leakage rate.

2. Low Pressure Air Testing

a. This test shall conform to the procedure described in ASTM C828, ASTM C924 or other appropriate procedures. For safety reasons, air testing of sections of pipe shall be limited to lines less than 36 in. average inside diameter. Lines 36 in. average inside diameter and larger may be air tested at each joint. The minimum time allowable for the pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch gauge during a joint test, regardless of pipe size, shall be 20 seconds. For sections of pipe less than 36 in. average inside diameter, the maximum time allowable for the pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch gauge shall be computed by the following equation:

$$T = 0.085\ (D)\ (K)\ /\ (Q)$$

where T = time for pressure to drop 1.0 pounds per square inch gauge in seconds

K = 0.00049DL, but not less than 1.0
D = average inside diameter in inches
L = length of line of same pipe size being tested in feet
Q = rate of loss, assume 0.0015 ft^3/min/sq.ft. internal surface

b. All observed leaks shall be repaired regardless of the air test results.

3. Allowable Deflection Test

a. Pipe deflection testing shall be conducted on all gravity pipes constructed of flexible materials (PVC or other plastic materials).

b. Pipe deflection measured not less than ninety (90) days after the backfill has been completed as specified shall not exceed five (5.0) percent. Deflection shall be computed by multiplying the amount of deflection (nominal diameter less minimum diameter when measured) by 100 and dividing by the nominal diameter of the pipe.

c. Deflection shall be measured with a rigid mandrel device cylindrical in shape and constructed with a minimum of nine evenly spaced legs. The outer diameter of the legs shall be 95 percent of the pipe's actual internal diameter. Drawings of the mandrel with complete dimensions shall be submitted to the ENGINEER for each diameter of pipe to be tested. The mandrel shall be hand pulled by the CONTRACTOR through all sewer lines.

d. Any section of sewer not passing the mandrel shall be uncovered at the CONTRACTOR'S expense and the bedding and backfill replaced to prevent excessive deflection. Repaired pipe shall be retested.

3.04 TEST PROCEDURES FOR PRESSURE PIPELINES

A. General

1. After the pipe has been laid and backfilled and the backfill has been otherwise consolidated, all newly laid pipe, or any valved section thereof, shall be subjected to the hydrostatic pressure and leakage tests specified below for that particular type of pipe. The duration of each hydrostatic pressure test shall be at least one hour and each leakage test at least four hours, unless otherwise specified or noted on the Drawings. All meters, fixtures, devices or appliances which are connected to the pipeline system and which might be damaged if subjected to the specified test pressure shall be disconnected and the ends of the branch lines plugged or capped during the testing procedures.

2. Each valved (capped or plugged) section of pipe shall be filled slowly with water and all air shall be expelled. If permanent air vents are not located at all high points, the CONTRACTOR shall install corporation or blow-off cocks at such points so that air can be expelled as filling takes place. After verification that all air has been expelled, the cocks shall be closed and the pipe kept filled until tested. All exposed pipe, fittings, valves, hydrants and joints shall be examined while under test pressure and all visible leaks shall be stopped. Any cracked or defective pipe, fittings, valves or hydrants discovered during testing shall be removed and replaced by the CONTRACTOR. Replacement shall be with sound material and the test shall be repeated until satisfactory to the OWNER.

B. Special Requirements. Where any section of pipeline is provided with concrete thrust blocking, the hydrostatic pressure test shall not be made until at least five (5) days have elapsed after installation of the blocking. However, if high-early-strength cement is used in the concrete, two (2) days shall have elapsed prior to testing.

C. Hydrostatic Pressure Tests

1. After compliance with all applicable procedures described above, pressure of 150 percent of the pipe's normal operating pressure shall be applied, unless another test pressure is specified for the type of pipe being tested. This pressure, based on the lowest point of the line or section under test, shall be corrected to the relative elevation of the test gauge and the pressure maintained for a period of not less than one (1) hour. CONTRACTOR shall coordinate all test pressures with ENGINEER.

2. Pipe Test Pressure Summary Schedule

Pipe ID	Test Pressure, psi
All Flanged Ductile Iron Piping	150
All restrained mechanical joint ductile iron piping	150
All bell and spigot, gravity, ductile iron piping	25
All HDPE solid wall piping	100

D. Leakage Tests

1. Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe, or any valved section thereof, to maintain the specified leakage test pressure after the air in the pipeline has been expelled and the pipe has been filled with water.

2. Leakage shall be determined by recording the quantity of water pumped into the pipeline through a standard water meter of a size appropriate to secure an accuracy of ±2 percent at the average rate of flow pumped. Leakage rate shall be calculated by extrapolation of the total leakage during the testing period to a 24-hour period. Leakage test pressure shall be coordinated with ENGINEER and test pressure shall be maintained for a period of four (4) hours.

3. Allowable leakage for the types of pipe used shall be as follows:

   a. Cast Iron and Ductile Iron. Allowable as permitted by AWWA Standard C-600-82, "Installation of Gray and Ductile Cast-Iron Water Mains and Appurtenances", which is not to exceed that determined by the formula:

$$L = (SD\sqrt{P})/133{,}200$$

   b. Where L is the allowable leakage in gallons per hour, S is the length of pipeline tested in feet, D is the nominal diameter of the pipe in inches, and P is the average test pressure during the leakage tests in pounds per square inch gauge.

4. In the event any section of the line tested fails to meet the above specified requirements for water tightness, the cause of the excessive leakage shall be determined and remedied at the expense of the CONTRACTOR, including retesting if required.

3.05 FINAL ACCEPTANCE

A. No pipe installation will be accepted until all known leaks have been repaired whether or not leakage is within allowable limits. Locating and repairing of leaks shall be performed by the CONTRACTOR at no additional cost to the OWNER.

B. The OWNER will certify that all required pressure and leakage tests have been successfully completed before the pipeline is accepted.

3.06 WATER SOURCE

A. Water shall be made available by the OWNER for testing and other work on this project as specified. Any additional water, if necessary, shall be provided at CONTRACTOR'S expense.

END OF SECTION

SECTION 01680
WATERTIGHTNESS TEST FOR HYDRAULIC STRUCTURES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials and incidentals required and perform watertightness testing of liquid-containing structures as listed herein and all retesting until the structures meet the requirements as specified herein.

1.02 RELATED WORK

A. Concrete is included in DIVISION 3 - CONCRETE.

1.03 SUBMITTALS

A. Submit in accordance with SECTION 01330 - SUBMITTALS, the results of each watertightness test of each structure. The submittal format shall be similar to that shown in Figure A attached to end of this Section.

1.04 REFERENCE STANDARDS

A. American Water Works Association (AWWA)

1. AWWA D110-Wire- and Strand- Wound Circular Pre-stressed Concrete Water Tanks.

B. American Concrete Institute (ACI)

1. ACI 350.1 -Tightness Testing of Environmental Engineering Concrete Structures.

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 PROJECT/SITE REQUIREMENTS

A. Coordinate timing and procedures for obtaining testing water and structure testing with the ENGINEER and OWNER well in advance of the actual testing.

B. Water Source and Disposal

1. Water shall be potable water. Water shall be obtained at a time, rate of flow and location approved by the OWNER.

2. Test water shall be disposed of at the time, rate of flow and location approved by the OWNER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

A. Perform watertightness test prior to placing backfill around structure in order to permit observation and detection of leakage points. Walls may be backfilled prior to testing only when approved in writing by the ENGINEER. The request to backfill prior to testing shall include a description of the method proposed to detect leakage points after the backfill is in place. Approval to place backfill prior to testing shall not relieve the CONTRACTOR of the responsibility for conducting watertightness tests.

3.02 PREPARATION

A. Thoroughly clean the structure to be tested of dirt, mud and construction debris prior to initiating watertightness tests. The floor and sumps shall be flushed with water to provide a clean surface, ready for testing.

B. Inspect the structure to be tested for potential leakage paths such as cracks, voids, etc. and repair such paths in compliance with the provisions specified herein or as approved by the ENGINEER.

C. Confirm adequacy of seals around gates and valves and reset or seal as approved by the ENGINEER. Estimates of gate or valve leakage will not be allowed as adjustments to the measured tank or structure leakage.

D. Inlet and outlet pipes not required to be operational for the tests may be temporarily sealed or bulkheaded prior to testing.

3.03 TESTING PROCEDURES

A. Conditions of Testing

1. Perform tightness testing as recommended in Chapter 2 of ACI 350.1 (hydrostatic test).

2. Do not begin initial filling of concrete structures until all concrete elements of the structure have attained the design twenty-eight (28) days compressive strength of the concrete, nor less than fourteen (14) days after all concrete walls or base slabs have been placed.

3. Initial filling rate, water depth and waiting period shall conform to the recommendations of ACI 350.1.

4. Fill unlined or partially lined concrete structures to the maximum operating water surface level and maintain the water at that level for at least seventy-two (72) hours prior to beginning watertightness tests to minimize water adsorption by the concrete during testing.

B. Testing Procedures

1. Duration of the test shall not be less than that required for a drop in the water surface of 3/8 in. based on the calculated maximum allowable leakage rate but need not exceed five (5) days.

2. Loss of volume measurements shall be taken at 24-hour intervals. The loss of volume is usually determined by measuring the drop in water surface elevation and computing the change in volume of the contained water. Measure water surface elevation at not less than two locations at 180 degrees apart and preferably at four locations 90 degrees apart.

Record water temperature 18 in. below the water surface when taking the first and last sets of measurements.

C. Allowable Leakage

1. The maximum allowable leakage for a 24-hour period, after a 48-hour test period, in which the entire structure interior surface has been wetted, shall not exceed 0.05 percent of the structure volume. If the liquid volume loss exceeds this amount, leakage shall be considered excessive and the structure shall be repaired and retested.

D. Visual Inspection

1. CONTRACTOR shall perform a full hydrostatic head leak test on each basin of the structure and report the results to the OWNER and the ENGINEER of record. Each individual basin must be tested with all adjoining basins empty. Visible moisture will be considered a leak. All leaks detected shall be sealed by epoxy injection performed by a certified technician. All leak testing must be performed prior to backfilling around structure. Re-test after all repairs. Submit Epoxy injection procedure details for approval prior to performing repairs.

E. Reports

1. Submit to the ENGINEER watertightness test results for each structure.

2. Notify the ENGINEER of the scheduling of tests five (5) working days prior to the tests. The ENGINEER will monitor any watertightness testing performed on the structures.

3.04 ACCEPTANCE

A. The following conditions shall be considered as NOT meeting the criteria for acceptance regardless of the actual loss of water volume from the structure.

1. Ground water leakage into the structure.

2. Structures which exhibit water flowing from the tank or from beneath the foundation (except for underdrain systems).

3.05 REPAIRS AND RETESTING

A. Structures failing the watertightness test and not exhibiting visible leakage may be retested after an additional stabilization period of seven (7) days. Tanks failing this retest shall be repaired prior to further testing.

B. Repair structures which fail the watertightness test and structures showing visible leakage in compliance with the provisions specified herein or as approved by the ENGINEER.

C. Repairs and retesting of tanks shall be accomplished at no additional cost to the OWNER.

3.06 SCHEDULE

1. All concrete basins shall be tested for water tightness.

FIGURE A

WATERTIGHTNESS TEST REPORT

PROJECT: _____

SUBMITTED BY _____ TEST DATES_____

STRUCTURE* _____

Allowable loss of water volume _____percent in 24 hrs.

Measured loss of water volume _____percent in 24 hrs.

TEST READINGS

Water temperature at start _____degrees F Water temperature at end _____degrees F

Date	Time	Location 1	Location 2	Location 3	Location 4	Initials
1.						
2.						
3.						
4.						
5.						

Change in level ----------
Average change in level _____
Correction for precipitation/evaporation _____
Corrected change in level = CL = _____
(CL) x (surface area) x (100) = measured percent water loss in 24 hrs.
(initial water volume) x (number of test days)
Notes and field observations**

_____

_____

* Attach a sketch showing a plan of the structure and measurement locations.
** Place date and initial at the beginning of each entry.

END OF SECTION

SECTION 01720
FIELD ENGINEERING

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Submittals.

B. Quality Assurance.

C. Protection

D. Surveying and Field Engineering Services.

E. CONTRACTOR Survey Requirements.

1.2 SUBMITTALS

A. On request, submit data demonstrating qualifications of persons providing services.

B. On request, submit documentation verifying accuracy of survey Work.

C. Maintain complete, accurate log of control and survey Work as it progresses. Submit Record Documents to the ENGINEER.

1.3 QUALITY ASSURANCE

A. Use skilled persons, trained and experienced in the necessary tasks and techniques, for the proper performance of this Work.

B. Verify locations of survey benchmarks prior to starting Work. Promptly notify ENGINEER of any discrepancies discovered.

1.4 PROTECTION

A. Locate and protect control points before starting Work.

B. Preserve permanent reference points during progress of Work.

C. Do not change or relocate reference points or lines without specific approval from ENGINEER.

D. Promptly inform ENGINEER when a reference point is lost or destroyed, or requires relocation.

PART 2. PRODUCTS

NOT USED.

PART 3. EXECUTION

3.1 SURVEYING AND FIELD ENGINEERING SERVICES

A. ENGINEER will identify two benchmarks.

3.2 CONTRACTOR SURVEY REQUIREMENTS

A. Verify the coordinates and elevations of benchmarks prior to commencement of construction. Notify ENGINEER of any discrepancies prior to commencement of construction.

B. Coordinate construction and construction sequencing to allow ENGINEER to evaluate survey data required by ENGINEER identified in subpart 3.1 above.

C. Obtain specified final as-built documentation survey data for ENGINEER.

- As-placed locations of every corner of GCL panels installed and the limits of GCL and geomembrane installation. Provide survey data to the ENGINEER to allow the ENGINEER to update the GCL panel layout diagram developed by the CONTRACTOR.
- As-constructed locations of geomembrane panel corners, location of geomembrane production seams, and location of documented geomembrane repairs to allow the ENGINEER to update the geomembrane panel, seam, and repair layout diagram developed by the CONTRACTOR.
- Elevation of bottom and top of clay.
- Thickness of concrete and breaklines of top of concrete surface.
- Pump Station structure elevations. Include top of concrete elevations for inlet channels, wet well, openings and gates.
- New Piping. Include survey information for top of pipe and pipe invert every 50 linear feet, valve locations, junctions, and at all alignment and grade changes of the pipe.
- Manholes and Junction Boxes. Include invert elevations and top of slab elevations.
- Flow Split Box. Include corners, slab corners, and invert elevations.

D. Correct deficient thicknesses, slopes, and tolerances of materials and fill layers identified by ENGINEER during the review of as-constructed/documentation of survey data.

E. Establish and maintain lines and levels.

F. Set lath on a 100-foot grid pattern for ENGINEER's use in documenting Work.

G. Locate and lay out Work by instrumentation and similar appropriate means.

H. Periodically verify layouts.

END OF SECTION

SECTION 01760
MONITORING WELL PROTECTION

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Protection

B. Adjustment

C. Repair

1.2 PROTECTION

A. Preserve and protect existing monitoring wells from damage.

B. Protect well casing and boring from infiltration of surface water, other water, soil, and any foreign materials.

C. Use hand equipment when excavating, filling, or conducting other operations around monitoring wells.

D. Notify ENGINEER of necessary alterations or damage to monitoring wells.

1.3 ADJUSTMENT

A. When the grade at an existing monitoring well is changed, adjust well to the new grade.

B. Adjust protective casing so that the top is 2.5 to 3 feet above final grade. Cut or extend the PVC well casing and end cap, so that it is one inch below the top of the protective casing. Place a 2-foot–diameter seal of mortar, two parts sand to one part Portland cement, around the well extending 2 feet below final grade.

C. Lowering grade: Carefully excavate around the well; remove protective casing without damage to the PVC well casing. Cut PVC well casing perpendicular to centerline axis.

D. Raising Grade: Extend PVC well casing using a threaded coupling if possible or slip coupling. Attach the slip coupling to the existing PVC with four screws. The screws should not extend into the inside of the well casing.

1.4 REPAIR

A. All repairs made to damaged monitoring wells shall be performed by a well driller/installer that is certified by the state to perform such work.

B. Repair any well damaged by CONTRACTOR's operations by excavating to below the broken casing, extending PVC to previous grade, and replacing protective casing and top seal as specified for adjustment.

C. ENGINEER will observe the repaired well to determine if further repair or replacement is needed. Repair and replacement shall be done at no expense to OWNER.

PART 2. PRODUCTS

NOT USED.

PART 3. EXECUTION

NOT USED.

END OF SECTION

SECTION 01782
OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Drawings and general provisions of the Contract, including General and Special Conditions and other DIVISION 1 - GENERAL REQUIREMENTS sections, apply to this Section.

B. Submit O&M Manuals for equipment and processes as described in Table 1 - Submittal and O&M Summary at end of this Section.

1.02 RELATED WORK

A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Operation and maintenance documentation directory.

2. Emergency manuals.

3. Operation manuals for systems, subsystems, and equipment.

4. Maintenance manuals for the care and maintenance of systems and equipment.

B. Related Sections include the following:

1. DIVISION 2 through DIVISION 16 sections for specific operation and maintenance manual requirements for products in those Sections.

C. O & M Requirements

1. O & M data, submittals and related documentation shall be included for the specific materials as described in Table 1 at the end of this Section.

1.03 SUBMITTALS

A. Initial Submittal: Submit two (2) draft copies of each manual to the ENGINEER and one (1) copy to the OWNER at least fifteen (15) days before requesting inspection for Substantial Completion. Include a complete operation and maintenance directory. ENGINEER will return one (1) copy of draft and mark whether general scope and content of manual are acceptable.

1. Correct or modify each manual to comply with ENGINEER'S comments.

B. Final Submittal: Submit four (4) copies of each manual in final form to the OWNER and one (1) copy to the ENGINEER at least fifteen (15) days before final inspection.

1.04 COORDINATION

A. Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.

1.05 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

PART 2 - PRODUCTS

2.01 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

A. Organization: Include a section in the directory for each of the following:

1. List of documents.

2. List of systems.

3. List of equipment.

4. Table of contents.

B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.

C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.

D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with the same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

2.02 MANUALS, GENERAL

A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page.

2. Table of contents.

3. Manual contents.

B. Title Page: Enclose title page in transparent plastic sleeve. Include the following information:

1. Subject matter included in manual.

2. Name and address of Project.

3. Name and address of OWNER.

4. Date of submittal.

5. Name, address, and telephone number of CONTRACTOR.

6. Name and address of ENGINEER.

7. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2 in. by 11 in. paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.

b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.

3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software CD's for computerized electronic equipment.

4. Supplementary Text: Prepared on 8-1/2 in. by 11 in., 20 lb./sq. ft. white bond paper.

5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.

b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.03 EMERGENCY MANUALS (NOT USED)

2.04 OPERATION MANUALS

A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions.

2. Performance and design criteria.

3. Operating standards.

4. Operating procedures.

5. Operating logs.

6. Wiring diagrams.

7. Control diagrams.

8. Piped system diagrams.

9. Precautions against improper use.

10. License requirements including inspection and renewal dates.

B. Descriptions: Include the following:

1. Product name and model number.

2. Manufacturer's name.

3. Equipment identification with serial number of each component.

4. Equipment function.

5. Operating characteristics.

6. Limiting conditions.

7. Performance curves.

8. Engineering data and tests.

9. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:

1. Startup procedures.

2. Equipment or system break-in procedures.

3. Routine and normal operating instructions.

4. Regulation and control procedures.

5. Instructions on stopping.

6. Normal shutdown instructions.

7. Seasonal and weekend operating instructions.

8. Required sequences for electric or electronic systems.

9. Special operating instructions and procedures.

D. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

E. Product Information: Include the following, as applicable:

1. Product name and model number.

2. Manufacturer's name.

3. Color, pattern, and texture.

4. Material and chemical composition.

5. Reordering information for specially manufactured products.

F. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.

2. Types of cleaning agents to be used and methods of cleaning.

3. List of cleaning agents and methods of cleaning detrimental to product.

4. Schedule for routine cleaning and maintenance.

5. Repair instructions.

G. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

I. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

J. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

PART 3 - EXECUTION

3.01 MANUAL PREPARATION

A. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.

2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by OWNER'S operating personnel.

B. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

C. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.

1. Do not use original Project Record Documents as part of operation and maintenance manuals.

Table 1 - Submittal and O&M Summary

Item Description	Submittal Required	O&M Manual Required	Working Drawing Required	O&M Instruction Required
Structural Concrete	X			
Reinforcing Steel	X			
Misc. & Structural Steel	X			
Pumps	X	X	X	X
Mixers	X	X	X	X
Chemical Feed Equipment	X	X	X	X
Membrane Thickener Equipment	X	X	X	X
Belt Filter Press	X	X	X	X
Screening Equipment	X	X	X	X
Conveyor Equipment	X	X	X	X
Grit Removal Equipment	X	X	X	X
Parshall Flume	X	X	X	
Aeration Equipment	X	X	X	X
Sludge Collection Equipment	X	X	X	X
Tertiary Filter Equipment	X	X	X	X
Ultra-Violet Disinfection Equipment	X	X	X	X
Blowers	X	X	X	X
Air Compressors	X	X	X	X
Pipe Systems	X			
Motors	X	X	X	X
Valves	X	X		X
Gates	X	X		X
Bulk NPW System	X	X	X	X
Motor Controls and Instrumentation	X	X	X	X
Electrical Fixtures	X	X	X	
Chain Link Fencing	X			
Building Fixtures, Etc.	X		X	
Metal Roof Components	X			
Protective Coating System	X			
Ventilation/Heating System	X	X		X
Platforms and Stairways	X			
Miscellaneous Equipment	X	X	X	X
Magnetic Flow Meters	X	X		

END OF SECTION

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SECTION 02070
HIGH-DENSITY POLYETHYLENE (HDPE) GEOMEMBRANE

PART 1. GENERAL

1.1 WORK INCLUDES

A. Providing high-density polyethylene (HDPE) geomembrane in accordance with the Drawings and these Specifications, including, but not limited to, excavation and backfilling of anchor trench, deployment of geomembrane, seaming, repairs, testing, and necessary and incidental items required to complete the Work.

1.2 REFERENCE STANDARDS

A. ASTM D792 - Specific Gravity (Relative Density) and Density of Plastics by Displacement.

B. ASTM D1004 - Test Method for Initial Tear Resistance of Plastic Film and Sheeting.

C. ASTM D1238 - Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.

D. ASTM D1248 - Specification for Polyethylene Plastics Molding and Extrusion Materials.

E. ASTM D1505 - Test Method for Density of Plastics by the Density-Gradient Technique.

F. ASTM D1603 – Test Method for Carbon Black in Olefin Plastics.

G. ASTM D3895 – Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis.

H. ASTM D4218 - Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.

I. ASTM D4437 - Standard Test Methods for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes.

J. ASTM D4833 – Tech Method for Index Puncture Resistance Geotextiles, Geomembrane, and Related Products.

K. ASTM D5199 - Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.

L. ASTM D5397 – Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes using Notched Constant Tensile Load Test.

M. ASTM D5596 –Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.

N. ASTM D5721 – Practice for Air-Oven Aging of Polyolefin Geomembranes.

O. ASTM D5885 – Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry.

P. ASTM D5994 – Test Method for Measuring the Core Thickness of Textured Geomembranes.

Q. ASTM D6370 – Standard Test Method for Rubber-Compositional Analysis by Thermogravimetry (TGA).

R. ASTM D6392 –Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.

S. ASTM D6693 – Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polyethylene Geomembranes.

T. ASTM D7002 – Standard Practice for Electrical Leak Location on Exposed Geomembranes Using the Water Puddle Method.

U. ASTM D7007 – Standard Practices for Electrical Methods for Locating Leaks in Geomembranes Covered With Water or Earthen Materials.

V. ASTM D7238 – Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus.

W. ASTM D7466 – Test Method for Measuring the Asperity Height of Textured Geomembranes.

X. GRI GM6 - Standard Practice for Pressurized Air Channel Test for Dual Seamed Geomembranes.

Y. GRI GM12 – Measurement of Asperity Height of Textured Geomembrane Using a Depth Gauge.

Z. GRI GM13 – Test Properties, Testing Frequency, and Recommended Warrant for High-Density Polyethylene (HDPE) Smooth and Textured Geomembrane.

1.3 DEFINITIONS

A. Installer - CONTRACTOR or organization hired by CONTRACTOR responsible for field handling, transporting, storing, deploying, seaming, and testing of the geomembrane seams (and if applicable, other geosynthetic components).

B. Manufacturer - Company hired by CONTRACTOR to furnish geomembrane.

C. Resin Supplier - Company selected by the manufacturer to furnish polyethylene resin used to manufacture the geomembrane.

D. Geomembrane - A relatively impermeable thin sheet of polyethylene used as a barrier liner or cover to prevent liquid or vapor migration into or from liquid or solid storage facilities.

E. Textured Geomembrane - Geomembrane with roughened, high-friction surfaces created by co-extrusion, extrusion coating, or spray coating.

F. Installation Field Crew - Individuals employed by installer to deploy geomembrane panels and perform field-screening, nondestructive testing, and other critical operations.

G. Fusion Weld - A bond between two polyethylene geomembrane surfaces achieved by fusing both polyethylene surfaces into a homogeneous bond using a power-driven apparatus capable of heating and compressing the overlapped portions of the geomembrane sheets at a specified rate of speed.

H. Extrusion Weld - A bond between two polyethylene materials achieved by extruding a bead of molten polyethylene over leading edge of the seam between upper and lower sheet, or rigid polyethylene piping or plating, using a hand-held apparatus.

I. ENGINEER - Official representative of OWNER. ENGINEER or designated Construction Quality Control Officer (CQA Officer) is responsible for observing and documenting that activities related to quality assurance of the construction conform to the plans and specifications.

1.4 QUALITY ASSURANCE

A. Qualifications:

- Manufacturer: At least 5 years of continuous experience in manufacturing HDPE geomembrane and have produced 10,000,000 square feet (minimum) of HDPE geomembrane, of which at least 8,000,000 square feet has been installed.
- Installer:

  a. At least 5 years of continuous experience in installing polyethylene geomembranes and have installed a minimum of 10,000,000 square feet (minimum) of polyethylene geomembrane for at least 10 completed facilities.

  b. Personnel performing seaming operations: Qualified by experience or by successfully passing seaming tests. At least one seamer to have experience in seaming 5,000,000 square feet (minimum) of polyethylene geomembrane using the same type of seaming apparatus to be used on this project. The most experienced seamer, called the "master seamer," to provide direct supervision, as required, over less experienced seamers.

B. Quality Assurance Program: Manufacturer/Installer agree to participate in and conform with Quality Assurance Program as outlined in this Specification.

1.5 SUBMITTALS

Items A through E shall be submitted no later than 45 days prior to start of geomembrane installation or 15 days prior to delivery of first geomembrane shipment, whichever is sooner.

A. Raw Materials:

- Resin supplier name, production plant(s) location(s), and the resin brand name and product number.
- Copy of quality control certificates issued by HDPE resin suppliers.
- HDPE resin production date(s).
- Results of tests conducted by manufacturer and resin supplier. Results shall conform with requirements in Part 2.2(A).
- Statement by manufacturer certifying that no recycled polymer and no more than 10% rework of the same type of material is added to resin during geomembrane manufacturing.

B. Manufacturer's Certification: Manufacturer shall certify that supplied geomembrane meets Specifications of GRI GM13.

C. Geomembrane Manufacturer/Production Information:

- Corporate background information.
- Manufacturing Quality Control (MQC) Plan.
- List of geomembrane roll numbers proposed for the project and associated batch each roll was produced.
- Quality control certificates for geomembrane rolls and welding rod indicating compliance with requirements of Part 2.

D. Geomembrane Installer's Information:

- Corporate background information.
- Construction Quality Control (CQC) Plan.
- A list of at least 10 completed facilities, totaling 10,000,000 square feet minimum for which the Installer has completed installing polyethylene geomembrane. Include facility name, location, installation date, geomembrane type, and quantity installed.
- List of field crew personnel, along with pertinent project experience information.

E. Installation panel layout diagram identifying placement of geomembrane panels and seams and variances or additional details that deviate from engineering drawings. Following approval, the layout diagram may not be changed without written permission from the ENGINEER.

F. Submittals during installation:

- Daily records/logs prepared by installer documenting the work performed (i.e., productivity), personnel involved, general working conditions, and any problems encountered or anticipated on the project.
- Subgrade acceptance forms prepared by installer for each day geomembrane was deployed.
- Quality control documentation (i.e., trial seam tests, destructive tests, nondestructive tests).

G. Submittals after completion of installation:

- Geomembrane installation certification stating the geomembrane was installed in accordance with the contract documents.
- As-built panel layout diagram.
- Warranty from manufacturer/installer
- Liner integrity survey report.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Shipping: Ship geomembrane liner rolled onto cores that allow for easy handling and deployment.

B. Transportation: Unload and handle geomembrane rolls by appropriate means to prevent damage.

C. On-Site Storage: Provide on-site storage location for geomembrane material with level base that protects the geomembrane from punctures, abrasions, and excessive dirt and moisture.

D. On-Site Handling: Use appropriate handling equipment when moving geomembrane rolls. Instructions for moving shall be given by manufacturer.

1.7 WARRANTIES

A. Manufacturer/Installer shall provide written 2-year warranties from date of substantial completion. Warranties shall address quality of material and workmanship.

PART 2. PRODUCTS

2.1 MANUFACTURERS

A. HDPE Geomembranes

Agru/America, Inc.
500 Garrison Road
Georgetown, SC 29440
1-800-321-1379

Poly-Flex, Inc.
2000 West Marshall Drive
Grand Prairie, TX 75051
1-888-765-9359

GSE, Lining Technology, Inc.
19103 Gundle Road
Houston, TX 77073
1-800-435-2008

B. Substitutions: Submit request to ENGINEER and OWNER with complete supporting technical information under provisions of Section 01600.

2.2 MATERIALS

A. Polyethylene Geomembrane Resin

• Specific Gravity/Density	ASTM D792, Method B or ASTM D1505	0.932 minimum
• Melt Index	ASTM D1238 (190°C & 2.16 kg)	1.0 g/10 minute maximum

- Resin: Virgin material with no more than 10 percent rework (by weight). Rework material to be of the same formulation as parent material. No post-consumer resin allowed.

B. HDPE Geomembrane

- Manufactured from top quality resin.
- No more than 1 percent (by weight) of additives, fillers, or extenders, excluding carbon black.
- Free of holes and shall have no undispersed raw materials, striations, scratches, or blemishes on geomembrane surface.
- Carbon black for ultraviolet protection, added during the manufacture of the geomembrane.
- Uniform textured appearance.

C. Fabrication

- Supply geomembrane in factory-produced rolls. No factory seams may be used to prepare larger geomembrane panels for delivery to the site.
- Label each geomembrane roll with the following information:
  - Name of manufacturer.
  - Product type and identification number (if any).
  - Nominal product thickness.
  - Roll number and dimensions.
  - Roll dimensions.

2.3 ACCEPTANCE TESTING REQUIREMENTS

Evaluate and test geomembrane rolls prior to acceptance. ENGINEER or a designated, independent geosynthetics laboratory may perform additional testing (i.e., conformance testing and direct shear testing) to verify that HDPE geomembrane meets the specifications and project requirements. Testing requirements are detailed in following subsections:

A. Manufacturer's Quality Control Testing

Perform tests on HDPE geomembrane at frequencies given in Tables 02070-1 and/or Table 02070-2 prior to shipping.

Table 02070-1
High Density Polyethylene (HDPE) Geomembrane - Smooth

PROPERTIES	TEST METHOD	TEST VALUE (60 mils)	TESTING FREQUENCY
Thickness (min. average) ▪ Lowest individual of 10 values	D5199	Nom. -10%	Per roll
Density mg/L (minimum)	D1505/D792	0.940 g/cc	200,000 lb
Tensile Properties (min. average)(1) ▪ Yield strength ▪ Break strength ▪ Yield elongation ▪ Break elongation	D6693 Type IV	 126 lb/in. 228 lb/in. 12% 700%	20,000 lb
Tear Resistance (min. average)	D1004	42 lb	45,000 lb
Puncture Resistance (min. average)	D4833	108 lb	45,000 lb
Stress Crack Resistance(2)	D5397 (App.)	500 hr.	per GRI-GM10
Carbon Black Content (range)	D4218(3)	2.0–3.0%	20,000 lb
Carbon Black Dispersion	D5596	Note (4)	45,000 lb
Oxidative Induction Time (OIT) (min. average)(5) ▪ Standard OIT —or— ▪ High Pressure OIT	 D3895 D5885	 100 min. 400 min.	200,000 lb
Oven Aging at 85°C(5)(6) ▪ Standard OIT (min. average) - % retained after 90 days —or— ▪ High Pressure OIT (min. average) - % retained after 90 days	D5721 D3895 D5885	 55% 80%	Per each formulation
UV Resistance(7) ▪ Standard OIT (min. average) —or— ▪ High Pressure OIT (min. average) - % retained after 1,600 hours(9)	D7238 D3895 D5885	 N.R.(8) 50%	Per each formulation

Notes:

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.

— Yield elongation is calculated using a gauge length of 1.3 inches.

— Break elongation is calculated using a gauge length of 2.0 inches.

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D1603 (tube furnace) or D6370 (TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:

— Nine in Categories 1 or 2, and 1 in Category 3.

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.

(7) The condition of the test should be 20-hour UV cycle at 75°C, followed by 4-hour condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value of the original HP-OIT value.

Table 02070-2
High Density Polyethylene (HDPE) Geomembrane - Textured

PROPERTIES	TEST METHOD	TEST VALUE (60 mils)	TESTING FREQUENCY
Thickness (min. average) ▪ Lowest individual for 8 out of 10 values ▪ Lowest individual for any of the 10 values	D5994	Nom. (-5%) -10% -15%	Per roll
Asperity Height (min. average)(1)	D7466	16 mil.	Every second roll(2)
Density (min. average)	D1505/D 792	0.940 g/cc	200,000 lb
Tensile Properties (min. average)(3) ▪ Yield strength ▪ Break strength ▪ Yield elongation ▪ Break elongation	D6693 Type IV	 126 lb/in. 90 lb/in. 12% 100%	20,000 lb
Tear Resistance (min. average)	D1004	42 lb	45,000 lb
Puncture Resistance (min. average)	D4833	90 lb	45,000 lb
Stress Crack Resistance(4)	D5397 (App.)	500 hr.	per GRI-GM10
Carbon Black Content (range)	D4218(5)	2.0–3.0%	20,000 lb
Carbon Black Dispersion	D5596	Note (6)	45,000 lb
Oxidative Induction Time (OIT) (min. average)(7) ▪ Standard OIT —or— ▪ High Pressure OIT	 D3895 D5885	 100 min. 400 min.	200,000 lb
Oven Aging at 85°C(7)(8) ▪ Standard OIT (min. average) - % retained after 90 days —or— ▪ High Pressure OIT (min. average) - % retained after 90 days	D5721 D3895 D5885	 55% 80%	Per each formulation
UV Resistance(9) ▪ Standard OIT (min. average) —or— ▪ High Pressure OIT (min. average) - % retained after 1,600 hours(11)	D7238 D3895 D5885	 N.R.(10) 50%	Per each formulation

Notes:

(1) Of 10 readings, 8 out of 10 must be ≥ 14 mils, and lowest individual reading must be ≥ 12 mils. Also see Note 6.

(2) Alternate the measurement side for double-sided textured sheet.

(3) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.

— Yield elongation is calculated using a gauge length of 1.3 inches.

— Break elongation is calculated using a gauge length of 2.0 inches.

(4) P-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials. The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(5) Other methods such as D1603 (tube furnace) or D6370 (TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.

(6) Carbon black dispersion (only near spherical agglomerates) for 10 different views:

— Nine in Categories 1 or 2, and 1 in Category 3.

(7) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(8) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.

(9) The condition of the test should be 20-hour UV cycle at 75°C, followed by 4-hour condensation at 60°C.

(10) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(11) UV resistance is based on percent retained value of the original HP-OIT value.

Submit test results to ENGINEER prior to shipping geomembrane rolls. Submit single-point constant tensile load test results to ENGINEER within 14 days of shipping. ENGINEER will evaluate test results as discussed in Subsection 2.3(C).

B. Conformance Test Samples

Samples may be collected by a third-party geosynthetic laboratory at the geomembrane plant at a minimum rate of one sample per 100,000 square feet of geomembrane delivered to the site. At least one sample shall also be obtained from geomembrane rolls representing each resin production batch.

Samples: 3 feet long by the full width of the roll and not the first 3 feet of any roll, or as required by the ENGINEER or third-party geosynthetic laboratory to perform required testing. Table 02070 1 and/or Table 02070 2 lists conformance tests and test methods that may be performed on geomembrane roll samples. CONTRACTOR will perform testing through use of a recognized testing laboratory. ENGINEER will evaluate test results as discussed in Subsection 2.3(C).

MANUFACTURER shall not ship geomembrane rolls to the site until test results have been evaluated by ENGINEER and accepted for shipment.

CONTRACTOR will bear the cost for conformance testing. The cost for retesting samples required due to failing test results shall also be paid by CONTRACTOR.

C. Procedures for Determining Geomembrane Roll Test Failures

Table 02070 2 and/or Table 02070-2 lists the acceptance Specifications. For tests results reported in both machine and cross direction, compare results from each direction to listed Specifications to determine acceptance. For test methods requiring multiple specimens, criteria in Table 02070-1 and/or Table 02070-2must be met based on average results of multiple specimen tests. Use the following procedures for interpreting results:

- If the test result values meet stated Specifications, then roll and batch, and entire shipment, if applicable, will be accepted based on conformance testing; and

- If test results do not meet Specifications, then roll and batch must be retested at CONTRACTOR's expense using specimens from the original roll sample or from another sample collected by ENGINEER or third-party geosynthetics laboratory. For retesting, perform two additional tests for a failed test procedure.

  If both retest values meet Specifications, then roll and batch will be accepted based on conformance testing; if one additional test fails, then roll and batch must be rejected without further recourse. ENGINEER or third-party geosynthetics laboratory may obtain samples from other rolls in batch. On the basis of testing these samples, ENGINEER may choose to accept a portion of batch while rejecting the remainder.

  If retesting does not result in passing these results as defined above, or if there is any other nonconformity with the material Specifications, then geomembrane rolls must be withdrawn from the site. Do not resubmit these same rolls for use. Remove rejected geomembrane from the site and replace with acceptable geomembrane.

D. Direct Shear Testing and Stability Analysis

Identify the proposed geomembrane manufacturer a minimum of 4 weeks prior to the start of geomembrane installation to allow a third party laboratory to conduct direct shear testing on the selected geomembrane material.

Collect geomembrane samples for direct shear testing at Manufacturer's plant as directed by ENGINEER. Collect samples of on-site soil/material for direct shear testing that will include the following:

TESTED INTERFACE	NORMAL PRESSURES (lb/ft^2)	STRAIN RATE (in/min)	SATURATION CONDITIONS
Clay Liner and 60-mil HDPE Textured Geomembrane	100, 250, 500	0.04	Saturate and apply load for a minimum of 24 hours and test with a wet interface.
60-mil Textured Geomembrane and Geotextile Cushion	100, 250, 500	0.2	Saturate and apply load for a minimum of 1 hour and run with a wet interface.

CONTRACTOR will perform the required testing through the use of a recognized geosynthetic testing laboratory. CONTRACTOR will bear the cost for direct shear testing.

Direct shear testing results can be used for multiple construction events if same geosynthetic materials are used for each event.

ENGINEER will perform slope stability calculations using the direct shear test results on materials proposed for construction. ENGINEER will determine if the proposed geomembrane will be acceptable or unacceptable based on the evaluation of the stability analysis.

PART 3. EXECUTION

3.1 EARTHWORK PREPARATION

A. Prepare foundation and complete subgrade surface that will support geomembrane. Excavate, backfill, and compact the anchor trenches to dimensions and at locations shown on Drawings.

B. Prior to geomembrane deployment, visually examine subgrade surface to confirm suitability for deployment of geomembrane thereon. Verify that subgrade is firm, smooth, and uniform; and free of excessive moisture, abrupt changes in grade, cracking, protruding stones and clay clods (greater than 1/2 inch), vegetation, and other deleterious debris. Refinish subgrade surface found to be unsuitable for deployment of the geomembrane. Provide ENGINEER with written acceptance of the subgrade surface over which panels are to be deployed for each day of panel deployment.

C. Deploy geomembrane over prepared and acceptable subgrade surface as soon as practicable after the subgrade has been completed and is suitable for deployment of geomembrane.

3.2 INSTALLATION - PANEL DEPLOYMENT

A. Install geomembrane according to approved layout drawing. Notify ENGINEER of revisions or modifications to approved plan prior to installing the geomembrane. Upon placement, identify each panel by roll number, and panel number, and date deployed.

B. Do not place geomembrane during precipitation, in areas of ponded water, or during excessive winds. ENGINEER may order the suspension of work during such conditions.

C. Maintain documentation of above conditions in the daily installation records, and provide such documentation to ENGINEER. Inform ENGINEER if above conditions are not met.

D. Verify the following:

- Equipment does not damage geomembrane.
- Prepared surface underlying geomembrane has not deteriorated since previous acceptance, and is still acceptable at time of geomembrane placement.
- Personnel working on geomembrane do not smoke, wear damaging footwear or clothing, or engage in activities that could damage the geomembrane.
- Methods and equipment used to unroll and seam the geomembrane do not cause scratches, crimps, or gouges in the geomembrane.
- Method used to place the rolls minimizes wrinkles (especially wrinkles between adjacent panels).
- Adequate temporary loading or anchoring (continuously placed, if necessary) does not damage geomembrane.
- No vehicular traffic operates directly over geomembrane, except for balloon-tire all-terrain vehicles (ATVs) when approved by ENGINEER.

Immediately notify ENGINEER if these conditions are, or have been, violated, and take immediate steps to mitigate any damage.

E. Examine each roll for damage after placement and prior to seaming. Inform ENGINEER as to which rolls, or portions of rolls, should be rejected or repaired. Mark and remove from site damaged rolls or portions of rolls that have been rejected, at no risk, or expense to OWNER. Notify ENGINEER when such removal occurs.

3.3 INSTALLATION - FIELD SEAMS

A. Seam Layout:

- Orient seams parallel to the line of maximum slope. Do not orient seams across slopes steeper than 5:1 (horizontal to vertical). Minimize the number of seams in corners, at other odd-shaped geometric intersections, and in collection sumps.
- Do not locate any horizontal seams on slopes steeper than 5:1 (horizontal to vertical).
- Slope panels must extend a minimum of 5 feet beyond the grade break onto the flat base area.
- Use a seam numbering system comparable to, and compatible with, the geomembrane panel numbering system.

B. Seaming Processes/Equipment

- Use the approved processes for field seaming (welding), which are extrusion welds and dual hot wedge fusion welds. Other processes require written authorization from ENGINEER. Dual hot fusion weld all linear seams. Fusion-weld corners, butt seams, and long repairs where possible.

- Comply with the following requirements regarding use, availability, and cleaning of extrusion welding equipment:

  a. Equip welding apparatus with operational thermocouples to continuously monitor temperature in barrel and at nozzle.

  b. Clean and purge extruder prior to beginning seaming until heat-degraded extrudate has been removed from the barrel.

  c. Check vital mechanical components, i.e., Teflon shoes, brushes, and thermostats, daily.

  d. Place electric generator for equipment on a smooth base such that no damage occurs to the geomembrane.

  e. Place a smooth insulating plate or fabric beneath hot equipment after usage to protect geomembrane.

- Comply with the following requirements regarding use, availability, and cleaning of dual hot wedge fusion welding equipment:

  a. Equip welding apparatus to continuously monitor applicable temperatures. Verify and document temperatures daily.

  b. Ground edge of cross seams to a smooth incline (top and bottom) prior to welding. Patch cross seams after welding.

  c. Place electric generator for equipment on a smooth base such that no damage occurs to the geomembrane.

  d. Place a smooth insulating plate or fabric beneath hot equipment after usage to protect geomembrane.

C. Seaming Requirements/Procedures

- Perform geomembrane seaming under the following weather conditions only:

  a. Ambient temperature at least 41°F (5°C), but no higher than 104°F (40°C), unless authorized in writing by ENGINEER. Measure temperatures 1 to 2 feet above the geomembrane surface using a conventional mercury thermometer.

  b. Dry geomembrane.

  c. No ponded water has collected above or below the surface of the geomembrane.

- For seaming at ambient temperatures below 41°F or above 104°F, demonstrate to ENGINEER that the methods and techniques used to perform the seaming produce seams that are entirely equivalent to seams produced at temperatures above 41°F and below 104°F, and that the overall quality of the geomembrane is not adversely affected. ENGINEER may, at his/her sole discretion, deny approval for use of proposed technique regardless of demonstration results.

- For overlapping and temporary bonding, use the following procedures:

  a. Provide sufficient overlap between geomembrane panels to perform extrusion or fusion welding, in accordance with manufacturer's recommendation, and allow peel tests to be performed on the seam. Cap seam if there is insufficient overlap.

  b. Do not use solvents or adhesives on geomembranes unless the product has been approved in writing by ENGINEER based upon samples and data sheets submitted to ENGINEER for testing and evaluation.

  c. Do not use procedures to temporarily bond adjacent geomembrane rolls that will damage the geomembrane; in particular, control the nozzle temperature of the spot welding apparatus to protect the geomembrane from potential damage. Keep spot welding to a minimum. Spot welding is subject to weather restrictions listed above. Perform spot welding only by approved seaming personnel pursuant to Subsection 1.4 of this specification.

- Make trial seams on nondeployed geomembrane seams at the beginning of each seaming period and at least once every 5 hours during continuous operation with each welding machine by each seaming technical performing geomembrane welding with that machine. Make trial seams under the same conditions as actual seams. Trial seams are also required for welding equipment for which the power supply has been interrupted. Seaming personnel must make at least one satisfactory trial seam each day to demonstrate satisfactory abilities. Satisfactory trial seams must pass the inspection and testing described below.

  a. Ensure that trial seam samples are at least 3 feet long by 1 foot wide after seaming, with the seam centered along its length.

  b. Inspect trial seams for proper squeeze-out, footprint pressure, and general appearance. If general appearance is acceptable, then cut ten specimens, 1 inch in width, from each end of the trial seam samples. Give remainder of trial seam to ENGINEER.

  c. Subject five specimens to a shear test and five specimens to a peel test (fusion welds shall be tested for peel on both sides of the air channel). If test specimens exhibit a film-tear bond and meet acceptance specifications listed in Subsection 3.5, Table 02070 3, then the trial seam is satisfactory.

  d. If the trial seam fails the field test or inspection, make a second trial seam (either with or without adjustments in the seaming techniques), and inspect and test it. If no inspection or test on the second trial seam fails, then the trial seam is satisfactory. If the second trial seam fails, then adjust the seaming apparatus or seaming technique as necessary until two consecutive, satisfactory trial seams are obtained.

- Seam Preparation:

  a. Ensure that the seam area is clean and free of moisture, dust, dirt, debris, and foreign material prior to seaming.

  b. Align seams so as to minimize the number of wrinkles and "fishmouths."

  c. If seam overlap grinding is required, complete grinding process according to manufacturer's instructions within one (1) hour of seaming operation. Do not damage geomembrane or cause excessive striation on geomembrane surface when grinding.

- General Seaming Procedures:

  a. Use dual hot wedge fusion welding for linear seams.

  b. Use fusion welding for corner seams, butt seams, and long repairs where possible.

  c. Extend welded seam to the end of geomembrane panels placed in anchor trenches to minimize the potential for tear propagation along the seam.

  d. Whenever possible, start field seaming from top of slope down, to minimize the development of wrinkles. Use hot air only when making tack welds; no double-sided tape, glue, or other method is permitted.

  e. Ensure that the completed liner does not exhibit "bridging" or "trampolining" when protective cover or other materials are placed over geomembrane.

  f. “Walk out” fishmouths or wrinkles at seam overlaps if possible, or cut along ridge of wrinkle in order to achieve a flat overlap, and then weld along overlap and patch each end.

  g. Provide adequate illumination when seaming operations are to be conducted at night.

  h. When restarting an extrusion seam, grind end of existing extrusion bead, and start new seam with less than a 2-inch overlap of existing bead.

3.4 NONDESTRUCTIVE TESTING

A. Nondestructively test each field seam over its full length using one of the methods described in this section. Perform nondestructive testing concurrently with seaming and do not await completion of the project's seaming. Air pressure testing is only applicable to dual hot wedge fusion seams. Conduct vacuum box testing on dual wedge fusion seams with the airspace between the tracks open to the atmosphere at one or both ends of the seam.

B. Vacuum Box Testing

- Vacuum box testing equipment:

  a. Vacuum box with open bottom, clear viewing panel on top, and pliable gasket attached to the bottom.

  b. Vacuum pump assembly equipped with pressure controller and pipe connections capable of achieving a vacuum of 8 psig.

c. Vacuum gauge on vacuum box with an operating range of vacuum pressures from 0 to 10 psig.

d. Soapy solution compatible with the geomembrane and conductive to the formation of bubbles with a means to apply.

- Vacuum box test procedures:

a. Ensure that seams are clean and relatively free from soil or foreign objects.

b. Wet seam approximately twice the length of the vacuum box with a soapy solution.

c. Center vacuum box with gasket in contact with the geomembrane surface over the wetted area of the seam.

d. Apply normal force to the top of the vacuum box, energize vacuum pump, and create a vacuum in vacuum box of 4 to 8 psig. (Ensure that a tight seal is created between the geomembrane and vacuum box.)

e. Examine the geomembrane seam through the viewing panel for bubbles for a period of not less than 10 seconds.

f. Remove the vacuum box after removing or bleeding vacuum from the vacuum box. Proceed to step g if bubbles appeared in step e. If no bubbles appeared in step e, move vacuum box over the next adjoining area with a minimum 3-inch overlap, and repeat the process.

g. If bubbles appeared through the geomembrane, then mark the defective area with an appropriate device for repair according to the provisions of Subsection 3.6(C).

C. Air Pressure Testing

- Air pressure testing equipment:

a. Air compressor with pressure gauge and regulator capable of producing and sustaining a pressure between 25 and 30 psig.

b. Fittings, rubber hose, valves, etc., to operate the equipment and a sharp hollow needle, or other pressure feed device, if approved by ENGINEER.

- Air pressure testing procedures:

a. Seal both ends of the seam to be tested.

b. Insert needle into air channel of dual hot wedge seam.

c. Inflate airspace with compressor to a pressure of approximately 30 psig, close valve, and monitor pressure in the air channel for approximately 7 minutes.

d. Record pressure at the end of 2 minutes and again at the end of 7 minutes.

e. If the pressure difference between the 2-minute and the 7-minute readings exceeds 2 psig, or if the pressure does not stabilize within the 7-minute period, one more 5-minute pressure monitoring interval will be allowed.

f. If the pressure loss over both 5-minute intervals exceeds 3 psig or if the pressure does not stabilize, then the seam fails the test.

g. If the pressure loss over either 5-minute interval does not exceed 3 psig, then the seam may be deemed by the installer to have passed the test.

h. Cut the end of the tested seam interval opposite the pressure gauge to verify that air channel tested was not obstructed by noting a release of air pressure.

- For seam intervals failing the air pressure nondestructive test, perform additional nondestructive testing or visual inspection to identify, if possible, the faulty area of the seam. Repair and retest the faulty area. If the faulty area cannot be identified, then repair and retest the entire seam.

D. Nondestructive Seam Test Failures

Repair seams failing nondestructive testing according to Subsection 3.6(C) and subsequently nondestructively retest according to Subsection 3.4.

3.5 DESTRUCTIVE TESTING

CONTRACTOR will contract to have the seam samples identified in the specifications laboratory-tested at CONTRACTOR's expense. Installer to perform field destructive seam testing.

A. Location and Sampling Frequency

- ENGINEER will select locations where laboratory seam samples shall be cut by installer for destructive testing.

- Collect laboratory destructive samples at a frequency of not less than one per every 500 linear feet of seam length. ENGINEER may direct that additional samples be cut.

B. Sampling Procedure

- For each sample location, ENGINEER will:

  a. Assign a sample number and mark accordingly.

  b. Record sample location on layout drawing.

  c. Record pertinent information, including date, time, number of seaming unit, and name of seamer.

- Ensure that destructive samples are at least 12 inches wide (at least 5 inches on each side of the seam) by 42 inches long. Cut samples into three parts, and distribute as follows:

  a. Cut and retain a 12-inch by 12-inch portion. Perform field testing on this sample as described in Subsection 3.5(C).

b. Cut a 12-inch by 12-inch portion and give it to ENGINEER for record storage.

c. Give the remaining 18-inch by 12-inch portion, to ENGINEER for testing as described in Subsection 3.5(D).

- Repair holes cut into the geomembrane resulting from destructive seam sampling in accordance with Subsection 3.6(C). Nondestructively test repair area in accordance with Subsection 3.4(B).

C. Field Testing

- Field-test a minimum of five1-inch–wide samples for peel, and field-test a minimum of five 1-inch–wide samples for shear. Use a field tensiometer run at a cross-head speed of 2 inches per minute that has been calibrated within 3 months of the start of geomembrane installation.

- Record quantitative and qualitative test results, and evaluate against acceptance specifications listed in Table 02070 3.

- Implement the procedures of Subsection 3.5(E) if any sample fails the field tensiometer test.

D. Laboratory Testing

- Test destructive seam samples in general accordance with the methodology of ASTM D4437. Perform peel testing for dual hot wedge fusion welds on both inside and outside tracks.

- Perform the following tests on each destructive seam sample:

  a. Shear strength, expressed in pounds per inch width (ppi), when tested in general accordance with ASTM D4437.

  b. Peel strength, expressed in pounds per inch width (ppi), recorded during the peel test in general accordance with ASTM D4437.

- Ensure that the shear test gauge length is 2 inches between each edge of the seam and the adjacent grip. Maintain crosshead speed of 2 inches per minute. Monitor load and cross-head displacement during the test.

- Ensure that peel test grips are no closer than 1 inch to the edge of the seam unless material is insufficient to allow insertion at this setting. Maintain cross head speed of 2 inches per minute.

- Report the following values, along with mean and standard deviation where appropriate for each specimen tested in shear:

  a. Maximum tension in pounds per square inch.

  b. Elongation at break (up to a tested maximum of 100 percent).

  c. The locus of failure.

Table 02070-3
60-mil HDPE Geomembrane Acceptance Specifications

PROPERTY	TEST METHOD	UNITS	MINIMUM AVERAGE VALUE	
			NON-TEXTURED	TEXTURED[1]
Shear Strength[2]	ASTM D4437	ppi	120	120
Shear Elongation[2][6]	--	percent	50	50
Peel Strength[3],[4] - Fusion	ASTM D4437	ppi	91	91
Peel Strength[3],[4] - Extrusion	ASTM D4437	ppi	78	78
Peel Separation[5]	--	percent	25	10

Notes:

(1) If the lengthwise edges of the textured geomembrane panels are nontextured, then the nontextured specifications shall apply for the testing of seams made along these edges. For textured to nontextured seams, use the textured specifications.

(2) Five out of the five test specimens shall meet these requirements. In addition, failure type must be film-tear bond (FTB) for all five specimens.

(3) Four out of the five specimens shall meet the three requirements. The fifth specimen shall achieve 80 percent of the listed peel strength.

(4) Failure type shall be film-tear bond (FTB) for five out of five test specimens.

(5) Maximum Acceptance Value for five out of five test specimens. The locus-of-break patterns of the different seaming methods in shear and peel, the following are unacceptable break codes per their description in ASTM D6392 (in this regard, SIP is an acceptable break code):

- Hot Wedge: AD and AD-BrK >25%.
- Extrusion Fillet: AD1, AD2, and AD-WLD (unless strength is achieved).

(6) Elongation measurements shall be omitted for field testing.

- Report the following values, along with mean and standard deviation where appropriate for each specimen tested in peel:

  a. Maximum tension in pounds per square inch.

  b. Seam separation (expressed as percent of original seam area).

  c. Locus of failure.

- Retesting of seams, because of failure to meet any or all of the specifications, may be performed at the sole discretion of ENGINEER.

E. Destructive Seam Test Failure

- Evaluate results from the shear and peel tests against the criteria tabulated in Table 02070 3. Meet Table 02070 3 criteria for the seam to be considered acceptable.

- Determine the repair boundary whenever a seam has failed the destructive testing following one of two options:

  a. Reconstruct the seam path between any two previously tested and passed field and laboratory destructive sample locations; or

  b. Trace the welding path to an intermediate location at least 10 feet from the point of the failed test in each direction, and obtain destructive test samples at these intermediate locations. If the destructive tests on these samples are acceptable, then reconstruct the seam between these intermediate locations. If either sample fails, then repeat the process until an acceptable seam test has been performed on both sides of the original failed sample. If a passing sample is not found on one (or both) sides of the original failed sample, then extend the seam repair to the end(s) of the seam. Continue to track the failing seam path, as necessary, and as appropriate, past the end(s) and onto the prior seams and following the seams made with the same welding equipment. For the retesting of seams, according to this procedure, use the sampling methodology described in Subsection 3.5(B). Continue tracking the seam path until passing field and laboratory destruction sample locations are found at both ends of the seam path, even if seaming occurred by the machine days prior or days after welding the failing destruct seam.

  c. An additional sample taken from the reconstructed zone must pass destructive seam testing, if destructive sample failure(s) causes the reconstruction and the length of the reconstructed seam is greater than 200 feet.

3.6 DEFECTS AND REPAIRS

A. Examine seam and nonseam areas of the geomembrane to identify defects, holes, blisters, undispersed raw materials, and signs of contamination by foreign matter. Clean the surface of the geomembrane at the time of examination. Groom and wash geomembrane surface if the amount of dust or mud inhibits examination. Provide a water truck, an operator, and water and hoses as reasonably necessary to assist in such washing.

B. Liner Integrity Survey

- CONTRACTOR will perform the required liner integrity survey through the use of a recognized company. CONTRACTOR will bear the cost of the liner integrity survey.

- A liner integrity survey will be performed for the geomembrane and approved by the ENGINEER prior to installing pond liner concrete. The liner integrity survey shall be performed using electrical methods (ASTM D7002 or ASTM D7007) or an ENGINEER approved alternate.

- Defects identified by the liner integrity survey will be repaired by the CONTRACTOR.

C. Evaluation

- Mark each location requiring repair due to failure of the nondestructive test, observations, examinations, or destructive tests.

- Do not cover locations that have been repaired or replaced until these locations are examined by ENGINEER and testing results indicate passing values.

D. Repair or replace portions of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test. Several procedures exist for the repair of these areas, as follows:

- Patching—for repair of large holes, tears, undispersed raw materials, contamination by foreign matter, holes resulting from destructive sampling, and locations where the seam overlap is insufficient.

- Spot welding or seaming—for repair of small tears, pinholes, or other minor, localized flaws.

- Capping—for repair of large lengths of failed seams.

- Removal and replacement—used to replace nonconforming or damaged panels or portions thereof.

- Additional procedures if agreed upon by ENGINEER.

E. Extend patches and caps at least 6 inches beyond the edge of the defect. Round the corners of patches and caps. In addition, satisfy the following provisions:

- Abrade surfaces of the geomembrane to be repaired no more than 1 hour prior to the repair if extrusion welding techniques are used.

- Ensure that geomembrane surfaces are clean and dry at the time of repair.

- ENGINEER must approve repair procedures, equipment, materials, and techniques prior to the repair.

F. Log the repair date, time, welder number, and the name of welder operator for each repair. Nondestructively test each repair. Passing tests indicate adequate repair. Large caps may be of sufficient extent to require destructive test sampling at the discretion of ENGINEER.

G. If failing nondestructive tests indicate inadequate repair, reconstruct repair and retest until a passing result is obtained.

H. Cut and seam wrinkles that are higher than they are wide or may adversely affect the long-term integrity of the geomembrane, hinder subsequent construction of the overlying layers, or impede drainage off the geomembrane after it is covered by soil. Perform seaming in accordance with the equipment and procedures described in Subsections 3.3(B) and 3.3(C), respectively, and subject to the test provisions of Subsections 3.4 (nondestructive testing) and 3.5 (destructive testing).

3.7 MATERIAL IN CONTACT WITH GEOMEMBRANES

A. Pipe Penetrations and Appurtenances – Verify that the following requirements are met:

- Non-destructively test seaming performed on pipe penetrations, and other appurtenances according to one of the following methods: (1) vacuum box method as discussed in section 3.4; (2) spark testing according to manufacturer's recommended procedures; (3) factory testing, along with certification, of prefabricated seams (i.e., pipe boots); or (4) capping with a second geomembrane layer where nondestructive testing is not possible due to space limitations.

- The geomembrane has not been visibly damaged while making connection to sumps and appurtenances.

- Installation of the geomembrane in the area of the pipe penetrations and connections of the geomembrane to these structures and appurtenances have been made according to the approved engineering plans and shop drawings.

B. Geotextile - Requirements for installation of the Geotextile are described in Section 02076.

END OF SECTION

SECTION 02076
GEOTEXTILES

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Furnish all labor, materials, tools, supervision, transportation, and installation equipment necessary for the installation of geotextiles, as specified herein, as shown on the Drawings, and in accordance with the Construction Quality Assurance [CQA] Plan.

1.2 REFERENCES

A. AASHTO M288 – Standard Specification for Geotextile Specification for Highway Applications.

B. ASTM D3786 - Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabric - Diaphragm Bursting Strength Tester Method.

C. ASTM D4491 - Standard Test Method for Water Permeability of Geotextiles by Permittivity.

D. ASTM D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.

E. ASTM D4595 - Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.

F. ASTM D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

G. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.

H. ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

I. ASTM D5261 - Standard Test Method for Measuring Mass Per Unit Area of Geotextiles.

1.3 QUALITY ASSURANCE

A. Responsibilities and Qualifications:

- Provide and accept and retain full responsibility for all services of a Geotextile Manufacturer and Installer who meet the following qualifications.
  - Manufacturer: Shall be responsible for the production and delivery of geotextile rolls and shall be a well-established firm with more than 2 years experience in the manufacture of geotextiles. Shall submit a statement listing certified minimum average roll values of the proposed geotextile and the tests used to determine those properties.
  - Installer: Shall be responsible for field handling, storing, deploying, seaming or connecting, anchoring, and other site aspects of the geotextiles. Shall be trained and qualified to install geotextiles.

B. Quality Assurance Program: Agree to participate in, and conform with, all items and requirements of the quality assurance program as outlined in this Specification, and in the Construction Quality Assurance [CQA] Plan.

1.4 SUBMITTALS

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

- A copy of the quality control certificate for each roll of geotextile used. The quality control certificate shall include lot, batch, or roll numbers and identification.

- The results of the quality control tests. The results shall include sampling frequencies and test methods used.

B. Manufacturer's Certification

On the basis of the results of the tests performed by either the Manufacturer’s laboratory or another outside laboratory with which Manufacturer has contracted at its sole cost and expense, Manufacturer shall provide a written certification that the supplied geotextile meets the requirements outlined in this Specification.

1.5 DELIVERY, STORAGE AND HANDLING

A. Unload and handle geotextiles so as to cause no damage.

B. Protect geotextiles from sunlight, moisture, mud, dirt, and dust, excessive heat or cold, puncture, or other damaging conditions.

C. Handle with care so as not to rupture or puncture geotextiles.

PART 2. PRODUCTS

2.1 MATERIALS

A. Geotextile shall consist of either woven or nonwoven polyester or polypropylene. Nonwoven fabric may be needle punched, heat bonded, resin bonded, or combinations thereof. Only nonwoven geotextile can be used as the cushion in the liner system.

B. Unless otherwise noted on the Drawings, furnish materials with Minimum Average Roll Values (MARV) that meet or exceed the criteria specified in Tables 02076-1 and 02076-2. Provide test results for these procedures, as well as certification that the materials' properties meet or exceed the specified values.

C. Minimum Average Role Value (MARV) shall be based on Manufacturer's data and shall be calculated as the mean value of the property of interest plus or minus two standard deviations, as appropriate. Where material proprieties vary among the machine and cross-machine directions, the MARV shall apply to the direction providing the lowest value when a minimum value is specified or the highest value when a maximum value is specified.

Table 02076-1
Separation Geotextile

PROPERTIES AND REQUIREMENTS	QUALIFIER	UNITS	SPECIFIED VALUES[1]	TEST METHOD
Polymer composition	Minimum	Percent	95 percent polypropylene or polyester by weight	
Permittivity	Minimum	1/s	0.05	ASTM D4491
Apparent opening size (AOS)	Maximum	Sieve	40	ASTM D4751
Grab strength[2]	Minimum	lb	AASHTO M288 Class 1	ASTM D4632
Tear strength[2]	Minimum	lb		ASTM D4533
Puncture strength	Minimum	lb		ASTM D6241
UV Resistance	Minimum	%		ASTM D4355

Notes:
(1) All values represent minimum average roll values (i.e., all rolls in a lot shall meet or exceed the values in this table).
(2) Minimum value measured in machine and cross machine direction.

Table 02076-2
Cushion Geotextile

PROPERTIES AND REQUIREMENTS	QUALIFIER	UNITS	SPECIFIED VALUES[1]	TEST METHOD
Type	--	--	Nonwoven	--
Polymer composition	Minimum	Percent	95 percent polypropylene or polyester by weight	
Mass per unit area	Minimum	oz/yd^2	32	ASTM D5261
Grab strength[2]	Minimum	lb	600	ASTM D4632
Tear strength[2]	Minimum	lb	270	ASTM D4533
Puncture strength[3]	Minimum	lb	350	ASTM D4833
UV Resistance	Minimum	%	70	ASTM D4355

Notes:
(1) All values represent minimum average roll values (i.e., all rolls in a lot shall meet or exceed the values in this table).
(2) Minimum value measured in machine and cross machine direction.
(3) Tension testing machine with a 1.75-inch–diameter ring clamp, the steel ball being replaced with a 0.31-inch–diameter solid steel cylinder with a flat tip centered within the ring clamp.

2.2 ACCEPTANCE TESTING REQUIREMENTS

A. General Requirements: Geotextile rolls will be tested and evaluated prior to acceptance. In general, testing of the geotextile will be conducted by Manufacturer. ENGINEER or a designated, independent geosynthetics laboratory may perform additional testing (i.e., conformance testing) as determined necessary by ENGINEER to verify that the geotextile meets the specifications.

B. Manufacturing Quality Control

- Sampling and testing of the geotextile material will be conducted by Manufacturer to demonstrate that the material conforms to the requirements in Part 2.1 of this Section. Submit test results in accordance with the submittal requirement of Part 1.4 of this Section and the CQA Plan.

- Sampling shall, in general, be performed on sacrificial portions of the material, such that repair of the material is not required.

- Samples that do not meet the specified properties shall result in rejection of the applicable rolls.

- At Manufacturer's discretion and expense, additional testing of individual rolls may be performed to more closely identify the noncomplying rolls and/or to qualify individual rolls.

PART 3. EXECUTION

3.1 PREPARATION

A. Grade the area smooth; and remove all stones, roots, sticks, or other foreign material that would interfere with the geotextile being completely in contact with the soil prior to placing the geotextile.

3.2 HANDLING AND PLACEMENT

A. Handle all geotextiles in such a manner as to ensure they are not damaged in any way.

B. Take any necessary precautions to prevent damage to underlying layers during placement of the geotextile. After deployment of the geotextile, the geotextile shall not be left exposed for a period in excess of 20 days unless a longer exposure period is approved by ENGINEER, based on a formal demonstration by Manufacturer that the geotextile is stabilized against U.V. degradation for the proposed period of exposure.

C. Take care not to entrap stones, excessive dust, or moisture in the geotextile during placement.

D. Secure all geotextiles with sandbags, or equivalent. Such sandbags shall be installed during placement and shall remain until overlying protective soil cover or other components of the liner system are in place. Sandbags shall not be left in place without prior approval from ENGINEER.

E. Examine the entire geotextile surface after installation to ensure that no potentially harmful foreign objects are present. Remove any such foreign objects, and replace any damaged geotextile in accordance with Subsection 3.4.

F. Place all soil and geosynthetic materials on top of a geotextile as shown on the Drawings, in such a manner as to ensure that

- the geotextile and underlying materials are not damaged;
- minimum slippage occurs between the geotextile and underlying layers; and
- excess stresses are not produced in the geotextile.

3.3 SEAMS AND OVERLAPS

A. Do not sew geotextiles. Overlap adjacent geotextile panels a minimum of 12 inches.

3.4 REPAIR

A. Repair any holes or tears in the geotextile as follows:

- On slopes steeper than 5 horizontal to 1 vertical, double-seam a patch made from the same geotextile into place (with each seam 0.5 inch apart and no closer than 2 inches from any edge). Should any tear exceed 10 percent of the width of the roll, remove that roll from the slope and replace it with new material.
- On slopes flatter than or equal to 5 horizontal to 1 vertical, spot-seam a patch made from the same geotextile in place with a minimum of a 1-foot overlap in all directions.

B. Take care to remove any soil or other material that may have penetrated the torn geotextiles.

END OF SECTION

SECTION 02222
REMOVAL OF MISCELLANEOUS STRUCTURES

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Removing and disposing of the existing pond liner system, split flow box, pump station, concrete access ramps and pads, light posts, and any other structures requiring removal occurring within the limits of construction.

PART 2. PRODUCTS

NOT USED.

PART 3. EXECUTION

3.1 PREPARATION

A. Protect existing structures including, piping, monitoring wells, and all other structures which are not to be removed or disturbed.

B. Mark location of disconnected utilities. Identify utilities and indicate capping locations on Project Record Drawings.

3.2 EXECUTION

A. Remove indicated structures and appurtenances in an orderly and careful manner. Leave site in clean condition.

B. Except where noted otherwise, immediately remove demolished material from site.

C. Do not burn or bury material on-site.

D. Backfill excavated areas and open holes caused as a result of removal. Use soil specified in Section 02320 - Fill.

E. Rough grade and compact areas affected by removal to maintain site grades and contours.

END OF SECTION

SECTION 02232
CLEARING AND GRUBBING

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Clearing, stripping, grubbing, removing, and disposing of the trees, shrubs, brush, logs, stumps, roots, windfalls, and other plant life, including dead and decayed matter, that exists within the construction areas and which are not specifically designated to remain.

PART 2. PRODUCTS

NOT USED.

PART 3. EXECUTION

3.1 CLEARING AND GRUBBING

A. Remove trees, shrubs, brush, logs, stumps, and natural growth within Construction Limits.

B. Remove stumps, roots, and logs to a minimum depth of 2 feet below ground surface.

3.2 DISPOSAL

A. Remove all debris and spoil within 30 days of accumulation and dispose of off-site. Burning of debris is not permitted.

3.3 PROTECTION OF EXISTING TREES AND VEGETATION

A. Preserve and protect from damage trees within the Construction Limits as designated on the Drawings.

B. Preserve and protect from damage trees and vegetation outside the Construction Limits.

C. Paint any cut or scarred trees and shrubs with asphaltum base tree paint.

END OF SECTION

SECTION 02260
COFFERDAMS

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Design, supply, fabrication, installation, maintenance, and removal of cofferdam in the north pond to allow operation during retrofit of the south pond and reconstruction of the pump station.

1.2 SUBMITTALS

A. The CONTRACTOR shall submit the following to the ENGINEER:

- Proposed drawings and manufacturer information for the proposed system that will be implemented to construct the pump station.
- Detailed design notes and Shop Drawings for the cofferdam that are stamped, signed and dated by a Professional Engineer registered in Virginia. The dam shall be designed to impound solids and fluid to the top berm elevation of the north pond with a factor of safety considered appropriate for the intended use.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle equipment in manner to prevent damage.

PART 2. PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Portadam, Inc., Williamstown, New Jersey, Phone (800) 346-4793.

B. Substitutions: Under provisions of Section 01600.

2.2 MATERIALS

A. Contractor shall be responsible for the furnishing and safe handling of all materials associated with the cofferdam. Materials will be handled according to manufacturer's recommendations.

B. Cofferdam shall be composed of structural components and a barrier material that will maintain dry conditions for Work.

2.3 QUALITY CONTROL

A. The CONTRACTOR shall inspect the cofferdam on a daily basis to verify safe conditions and that the cofferdam has not been damaged due to construction, environmental conditions, or vandalism.

B. Any observed damage, deficiencies, or perceived unsafe conditions shall be corrected immediately by the CONTRACTOR.

PART 3. EXECUTION

3.1 PREPARATION

A. Clean concrete surface of debris that would impact the seal of the cofferdam.

B. Provide the required components to support the cofferdam structure.

3.2 INSTALLATION

A. Install the cofferdam as shown in the submitted Shop Drawings.

3.3 MAINTENANCE

A. Inspect conditions daily and maintain cofferdam to provide continued performance during the pump station construction.

3.4 REMOVAL

A. After flow has been switched to the retrofitted south pond and solids removal has begun in the north pond, the cofferdam will be removed from the site by the CONTRACTOR.

END OF SECTION

SECTION 02315
EXCAVATION

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Dewatering, digging, loading, hauling and disposing of CCR at the onsite landfill.

B. Digging, loading, hauling, and disposing of materials, including finish grading to the extent and elevations shown on the Drawings.

C. Digging, sorting, moving, and/or stockpiling of on-site clay soils.

D. Stripping and stockpiling of Clay Borrow Site and on-site topsoil. Finish grading of stockpile.

E. Excavating and restoring clay borrow site.

PART 2. PRODUCTS

NOT USED.

PART 3. EXECUTION

3.1 PREPARATION

A. Identify required construction survey control lines and datum.

3.2 EXCAVATION

A. Grade perimeter of excavation to prevent surface water drainage into excavation.

B. Notify ENGINEER of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.

C. Remove unsuitable excess excavated material from site.

3.3 FINISHING

A. Blend slopes with existing landscape features, at the intersection of cuts and fills; provide gradual slope between new and existing construction.

B. Finish to elevations shown within 0.10 foot tolerance.

3.4 FIELD QUALITY CONTROL

A. Extend excavation below the existing geosynthetic liner to remove existing impacts as directed by the ENGINEER.

B. Stockpile areas to be approved by ENGINEER or OWNER.

3.5 PROTECTION

A. Notify all area utility companies prior to commencing work in accordance with state and local regulations.

B. Locate, identify, and protect existing utilities from damage.

C. Protect bench marks, survey monuments, monitoring wells, existing structures, fences and gates, sidewalks, paving, and curbs from damage by excavation equipment and vehicular traffic.

D. Protect excavations by shoring, bracing, sheet piling, or other methods required to prevent cave-in or loose soil from falling into excavation.

E. Underpin adjacent structures which may be damaged by excavation Work, including service utilities and piping.

F. Do not remove or disturb any materials outside the Construction Limits.

G. Keep excavations free from water by pumping or constructing diversion berms and/or ditches to divert water.

H. Protect bottom of excavations and soil adjacent to and beneath foundations from frost.

END OF SECTION

SECTION 02316
EXCAVATION UNDERCUT

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Removing and disposing of unsuitable subgrade soils.

B. Backfilling and compacting undercut area.

PART 2. PRODUCTS

2.1 MATERIALS

A. Backfill: GENERAL FILL as defined in Section 02320 – FILL.

PART 3. EXECUTION

3.1 INSPECTION

A. ENGINEER or ENGINEER's representative will monitor and measure the Excavation Undercut.

B. No compensation will be made for Excavation Undercut not monitored by the ENGINEER or ENGINEER's representative.

3.2 PERFORMANCE

A. Excavate and backfill the Undercut in compliance with Section 02317.

B. Compact the fill material to at least 95 percent of the maximum dry density of the material.

3.3 DISPOSAL

A. Dispose of unsuitable or excess excavation off-site.

3.4 FIELD QUALITY CONTROL

A. Perform the same number of tests specified for Fill material under Section 02320.

END OF SECTION

SECTION 02317
TRENCHING, BACKFILLING, AND COMPACTING

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Excavating trenches, backfilling, and compacting for installation of piped utilities.

B. Dewatering, protection and maintenance of trench, support of existing structures, sheeting and shoring, hauling and disposal of excess excavated materials and fill.

1.2 REFERENCES

A. OSHA 29 CFR Part 1926, Occupational Safety and Health Standards - Excavations.

PART 2. PRODUCTS

2.1 BACKFILL MATERIALS

A. Backfill: As shown in the DRAWINGS and complying with Section 02320.

PART 3. EXECUTION

3.1 PREPARATION AND RESTORATION

A. Remove sod, topsoil, and other surface treatment and restore to original condition or better upon completion of the Work.

3.2 PROTECTION

A. Protect excavations by shoring, bracing, sheet piling, or other methods required to prevent cave-in or loose soil from falling into excavation.

B. Place excavated and other material 2 feet minimum back from edge of trench excavation.

C. Minimum trench excavation slope to be 1.5:1.

D. Underpin adjacent structures which may be damaged by excavation Work, including utilities and piping.

E. Notify ENGINEER immediately of unexpected subsurface conditions.

F. Protect bottom of excavations and soil adjacent to and beneath foundations from frost.

3.3 TRENCHING

A. Excavate to the required alignment and grade. Elevations of pipes subject to revisions as necessary to fit field conditions.

B. No adjustment in compensation will be made for grade adjustments not in excess of one foot above or below the plan elevations.

C. Remove water which may accumulate in trench, and construct ditches, flumes, and dams to direct water away from excavation.

D. ENGINEER may limit the amount of open trench where field conditions or plant operations require.

E. ENGINEER may order additional excavation where unsuitable soil conditions are encountered.

F. Promptly dispose of excess excavation off-site or in area designated on Drawings.

3.4 UTILITY TEST HOLES

A. Where potential utility conflicts are anticipated, uncover utility lines well in advance of trench excavation.

B. Determine grade of the utility line. Notify ENGINEER immediately if any conflicts between designed components and existing utility lines are identified.

C. Backfill and restore disturbed area to original condition.

3.5 BEDDING

A. Minimum bedding requirements: Install bedding material from 6 inches below pipe to 12 inches above pipe.

B. Minimum depth of pipe embedment in bedding: One third outside pipe diameter.

C. Mechanically compact bedding.

3.6 BACKFILLING

A. Backfill immediately following completion of pipe installation.

B. Take necessary precautions with backfill and construction operations to protect completed utility system from damage.

C. Backfill with care around structures and cleanouts.

D. Backfill to the original ground elevation unless shown otherwise on Drawings.

3.7 COMPACTING

A. Compact backfills to at least 95 percent of the maximum dry density.

3.8 FIELD QUALITY CONTROL

A. Perform one compaction test for every 100 lineal feet of trench backfilled, under provisions of Section 01452.

B. Backfill to within 0.10 feet of grades shown.

END OF SECTION

SECTION 02320
FILL

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Providing fill materials in accordance with the lines, grades, thicknesses, and typical sections shown on the Drawings.

1.2 REFERENCES

A. AASHTO Designation T96 - Percentage of Wear, Los Angeles abrasion test.

B. AASHTO Designation T104 - Sodium Sulfate soundness test, 5 cycles.

C. ASTM C136 - Test Method for Sieve Analysis of Fine and Coarse Aggregates.

D. ASTM D422 - Test Method for Particle-Size Analysis of Soils.

E. ASTM D698 - Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort: Standard Proctor.

F. ASTM D1140 - Standard Test Method for Amount of Material in Soils Finer than the No. 200 Sieve.

G. ASTM D1556 - Test Method for Density and Unit Weight of Soil In Place by the Sand-Cone Method.

H. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristic of Soil Using Modified Effort: Modified Proctor.

I. ASTM D2216 - Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.

J. ASTM D2434 - Standard Test Method for Permeability of Granular Soils (Constant Head).

K. ASTM D2487 - Classification of Soils for Engineering Purposes (Unified Soil Classification System).

L. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate In Place by Nuclear Methods (Shallow Depth).

M. ASTM D2937 - Standard Test Method for Density of Soil In Place by the Drive-Cylinder Method.

N. ASTM D3017 - Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

O. ASTM D4318 - Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

P. ASTM D4643 - Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method.

Q. ASTM D5084 - Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Material Using a Flexible Wall Permeameter.

1.3 SUBMITTALS

A. Submit sequence of Clay Fill placement with project schedule under provisions of Section 01330.

B. Submit material testing documentation and samples of General Fill, Clay Fill, and Free Draining Fill as described in Part 3 of this specification.

C. Laboratory test data categorizing non-frost susceptible soil below the flow split box.

PART 2. PRODUCTS

2.1 GENERAL FILL

A. Materials free from organic matter and refuse, masonry, metal, sharp objects, boulders, snow, and ice.

B. No solid material larger than 6 inches in its largest dimension.

2.2 CLAY FILL

A. Maximum clump size of 8 inches and capable of being broken down with normal construction equipment to a size of 2 to 3 inches prior to compaction.

B. Fifty percent or more of the soil particles by weight pass the Number 200 sieve.

C. Average Liquid Limit (LL) of 25 or greater with no values less than 20.

D. Average Plasticity Index (PI) of 12 or greater with no values less than 10.

E. Maximum hydraulic conductivity of $1x10^{-7}$ cm/s at a dry density of 95 percent Standard Proctor maximum dry density.

F. CONTRACTOR will secure access to Clay Fill borrow site. Provide Clay Fill in accordance with the Contract Documents.

2.3 STONE FOR TRACKING PAD

A. Virginia Department of Transportation #1 Coarse Aggregate.

B. Durable field or quarry stone that is sound, hard, dense, resistant to action of air and water, and free from seams, cracks, or other structural defects.

C. Meets the requirements of Section 204 Virginia Department of Transportation, 2007 Road and Bridge Specifications.

2.4 FREE DRAINING FILL

A. Classifies as sand or gravel in the Unified Soil Classification System.

B. Maximum particle size of 1 inch.

C. Maximum quantity of material passing the #200 sieve of 5 percent.

PART 3. EXECUTION

3.1 STOCKPILE

A. Stockpile materials on-site at locations indicated on Drawings or directed by OWNER.

B. Stockpile Fill in sufficient quantities to meet project schedule and requirements.

C. Maintain stockpiles during construction. Grade stockpiles to provide positive drainage to prevent erosion or deterioration of materials. Provide erosion control around stockpile.

D. Regrade and restore stockpile areas, after borrow excavation is complete or at completion of the project.

3.2 PREPARATION AND RESTORATION

A. Remove ice and snow before placing Fill. Do not place Fill on frozen subgrade.

B. Cut out soft areas of unsuitable subgrade.

C. Proof-roll subgrade before placing Fill using compaction equipment equipped with smooth-drum roller.

D. ENGINEER will document surface conditions of subbase fill layer prior to placement of Fill.

3.3 PLACEMENT AND COMPACTION OF GENERAL FILL

A. Place and spread General Fill in lift thicknesses as required to obtain the specified levels of compaction. Maximum loose lift thicknesses of 9 inches prior to compaction will not be exceeded.

B. Maintain proper moisture content to achieve specified compaction.

C. Compact to a minimum dry density of 95 percent of the maximum dry density as determined by the Standard Proctor test.

D. Specified compaction will be attained for each layer before any material for the succeeding layer is placed.

3.4 PLACEMENT AND COMPACTION OF CLAY FILL

A. Place and spread Clay Fill in lift thicknesses as required to obtain the specified levels of compaction. Maximum lift thicknesses of 6 inches after compaction will not be exceeded.

B. Maintain moisture content of at least wet of the optimum value as determined by the Standard Proctor test. Maintain a moisture content higher than the minimum specified above if needed to achieve the maximum specified hydraulic conductivity of 1×10^{-7} cm/sec at the specified compaction.

C. Compact material to a dry density of at least 95 percent of the maximum dry density as determined by the Standard Proctor test.

D. Compact Clay Fill using penetrating foot–type compaction equipment having feet protrusion greater in length than the loose lift thickness of clay being placed prior to compaction. Compaction equipment utilized to compact Clay Fill shall have a minimum static weight of 30,000 pounds.

E. Scarify Clay Fill to a minimum depth of 2-inches between lifts when previous lift has dried out or been smooth drum-rolled. Add water as required to maintain specified moisture content

F. Remove and replace Clay Fill that does not meet specified material compaction or hydraulic conductivity testing requirements at no additional cost to OWNER.

G. Place additional lifts of Clay Fill as soon as practical after compaction and completion of clay testing to avoid drying and desiccation of preceding Clay Fill lift.

H. Scarify Clay Fill to a minimum depth of 2-inches between lifts when previous lift has dried out or been smooth drum-rolled to protect from desiccation rain events. Add water as required to maintain specified moisture content and bonding between lifts to provide a homogenous clay mass.

I. Top surface of the layer of Clay Fill will be rolled smooth to facilitate placement of the Geosynthetic Clay Liner. Protruding rocks (larger than ½-inch diameter), debris, and other foreign objects that could damage the Geomembrane will be removed and replaced with Clay Fill.

3.5 PLACEMENT OF STONE FOR TRACKING PAD

A. Excavate to the lines and grades required for placement of Stone.

B. Continuous Geotextile over areas to receive Stone in accordance with Sections 02076.

C. Minimum thickness of stone layer is 16 inches measured vertical from base.

D. Place stone to the limits shown on the plans, and to within a 3-inch tolerance for thickness.

E. Place stone with care to prevent damage to the underlying geotextile and geomembrane. Do not drop clear or washed stone from a height greater than 12 inches.

F. Place stone from the base of the slope upward. Place smaller sized stones to fill voids between the larger sized stones.

3.6 PLACEMENT AND COMPACTION OF FREE DRAINING FILL

A. Place and spread a minimum of 4 inches of material beneath pipes when using as pipe bedding material. Maximum lift thickness of 12 inches after compaction will not be exceeded.

B. Compact to a minimum dry density of 95% of the maximum dry density as determined by the Standard Proctor test.

C. Free draining fill placed over pipes and liner system shall be installed with care to avoid damage to the pipe or liner. Minimize traffic and turning of traffic over pipes and liner.

3.7 TRENCH BACKFILLING

A. Backfill immediately following completion of pipe installation and documentation required by the ENGINEER.

B. Take necessary precautions with backfill and construction operations to protect completed utility system from damage.

C. Backfill with care around structures and cleanouts.

D. Backfill to the original ground elevation unless shown otherwise on Drawings.

3.8 FIELD QUALITY CONTROL OF GENERAL FILL AND FREE DRAINING FILL PLACED FOR SUBGRADE AND BERM CONSTRUCTION

A. CONTRACTOR will collect samples and perform the following tests:

General Fill for Subgrade and Berm Construction

- Continuous in-field moisture (ASTM D3017) and density (ASTM D2922) tests on maximum 100-foot grid on each 12-inch compacted thickness.
- A Standard Proctor (ASTM D1557), sieve analysis and hydrometer (ASTM D422), and Atterberg limits (ASTM D4318) for every 5,000 cubic yards placed, or when visual observations indicate that change has occurred in the material.

B. Grade and finish to within 0.10 foot of the grades shown.

3.9 FIELD QUALITY CONTROL OF CLAY FILL

A. CONTRACTOR will perform the following tests under provisions of Section 01452:

Clay Fill:

- Representative samples will be collected from the Clay Fill stockpiled at a minimum frequency of one sample for every 5,000 cubic yards placed, or when visual observations indicate that change has occurred in the material. Each representative sample collected will be tested for Modified Proctor (ASTM D1557) or Standard Proctor (ASTM D698), USCS classification (ASTM D2487), sieve analysis and hydrometer (ASTM D422), and Atterberg limits (ASTM D4318).
- Continuous in-field moisture (ASTM D3017) and density (ASTM D2922) tests on approximate 100-foot grid on each 12-inch compacted thickness.
- Undisturbed Shelby tube samples will be collected from the in-place compacted Clay Fill liner at a minimum frequency of one sample for each acre-foot thickness of Clay Fill placed. Each undisturbed sample from the liner will analyzed for USCS Classification (ASTM D2487), sieve analysis and hydrometer (ASTM D422), Atterberg limits (ASTM D4318), and moisture/density content (ASTM D4643). Every third undisturbed Shelby tube samples sample collected from the Clay Fill liner will analyzed for hydraulic conductivity (ASTM D5084).

B. Grade and finish to within 0.00 to plus 0.10 foot of thicknesses shown in the Drawings.

END OF SECTION

SECTION 02374
SEDIMENT CONTROL FENCE

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Providing and maintaining sediment control fencing.

PART 2. PRODUCTS

2.1 MATERIALS

A. Envirofence 100x, manufactured by:
Mirafi Civil Engineering Fabrics
P.O. Box 240967
Charlotte, NC 28224

B. Substitutions: Under provisions of Section 01600.

PART 3. EXECUTION

3.1 INSTALLATION

A. Install hardwood posts 2 feet below grade, at maximum 6-foot spacing.

B. Anchor bottom 6 inches of fence netting below grade to create a continuous toe-in structure along fence installation.

C. Install fence in areas designated on the Drawings.

END OF SECTION

SECTION 02532
DROP INLET

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Providing precast inlet including jointing materials, bases, tops, connections, castings, and appurtenances.

1.2 REFERENCES

A. Precast Concrete Manholes and Adjusting Rings: ASTM C478 Specification for Precast Reinforced Concrete Manhole Sections.

B. Precast Concrete Manholes Section: AASHTO M 199 Precast Reinforced Concrete Manhole Sections.

C. Castings: ASTM A48 Specification for Gray Iron Castings.

D. Rubber Gaskets: ASTM C443 Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.

E. Flexible Plastic Gaskets: Type B AASHTO M198 Specification for Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets, Type B Flexible Plastic Gaskets.

F. Virginia Department of Transportation Road and Bridge Specifications, 2007.

G. Virginia Department of Transportation Road and Bridge Standards, Details, 2008.

1.3 SUBMITTALS

A. Submit manufacture's data and details of the following items for approval:

1. Shop drawings of the drop inlet sections, base unit, cover and construction details, including reinforcement, jointing methods, materials and dimension.

2. Frames and grates.

3. Joint materials.

4. Pipe connection seal.

5. Cement mortar materials proposed for channel inverts.

PART 2. PRODUCTS

2.1 MATERIALS

A. Precast Concrete Manholes:

1. Precast Inlet Base Section, Top, and Related Components:

a. Precast inlet structures shall conform to Section 302 of the Virginia Department of Transportation Road and Bridge Specifications and the requirements of AASHTO M 199. Precast structures shall be constructed with 4,000 psi minimum concrete. Reinforcing steel shall be in accordance with ASTM C478, ASTM A497 (wire fabric) and ASTM A615 (reinforcing bars).

b. Precast top unit shall be in accordance Virginia Department of Transportation Road and Bridge Standard T-DI-1 (DI-1– Flat Slab Top with Frame and Grate).

c. Precast base to be monolithic in accordance with Virginia Department of Transportation Road and Bridge Standard B-1. Do not install weep holes in the precast base.

d. Tongue and groove joints to be of fabricator's design meeting approval of the ENGINEER

2. Joints: Joints shall be sealed with mortar, or o-ring gaskets (ASTM C443), or butyl rubber (ASTM C990) and in accordance with Virginia Department of Transportation Standard Specifications.

3. Pipe Connections: Formed or drilled and sealed with link seal. In the event the invert of the outlet is higher than the bottom of the structure, the invert of the structure shall be shaped with cement mortar to prevent standing or ponding water.

4. Manhole Steps: None required

B. Manhole Castings: Virginia Department of Transportation Standard DI-1 cast iron grate and frame precast in inlet top. Cast Iron in accordance with ASTM A48 Specifications for Grey Iron Castings, and with Virginia Department of Transportation Standard Specification Section 224.

C. Mortar: In accordance with Virginia Department of Transportation Standard Specifications.

PART 3. EXECUTION

3.1 INSTALLATION

A. Pipe Connection: Provide smooth, watertight link seal connection as shown on Detail 1 on Plan Sheet S3117.

B. Bed under the precast inlet base with a minimum 12-inch thickness of #67 crushed stone per ASTM C-33. Extend bedding a minimum 6-inches past the outside of the inlet base per Detail 1 on Plan Sheet S3117.

C. Backfill shall be general fill placed in maximum 9 inch horizontal lifts and compacted to 95 percent of the maximum dry density per ASTM D-698. The backfill shall be compacted at ± 2 percent of the optimum moisture content. At a minimum there shall be one in-place moisture-density test per lift.

D. Connect precast inlet structure to adjacent concrete slab by means of No. 4 smooth steel dowels spaced on approximate 12-inch-centers throughout the contact length and extending at least 4 inches the concrete unit and the slab. Holes should not exceed 5/8 inches in diameter.

END OF SECTION

SECTION 02618
HDPE PIPING

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Providing High Density Polyethylene (HDPE) pipe, fittings and appurtenances for gravity flow piping associated with the water truck loadout station, and the drainage pipe in the pump station backfill.

1.2 REFERENCES

A. ASTM D1248 – HDPE weight resin for pipe and fittings.

B. ASTM D3350 – Standard Specification for Polyethylene Plastic Pipe and Fitting Materials

C. ASTM D2513 – Industrial molded fittings for high-density polyethylene (HDPE) pipes.

D. ASTM D3261 – Butt fittings for high-density polyethylene (HDPE) pipes.

E. ASTM D2683 – Socket fittings for high-density polyethylene (HDPE) pipes.

F. ASTM D3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

G. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

H. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications

1.3 DELIVERY, STORAGE, AND HANDLING

A. Protect pipe from the sun, and provide ventilation.

B. Deliver and store valves in shipping containers with labeling in place.

C. Comply with requirements of Section 01600 - Material and Equipment

1.4 SUBMITTALS

A. Submit product data under provisions of Section 01330.

B. Provide data on pipe materials, pipe fittings, and accessories.

C. Substitutions: under provisions of Section 01600.

PART 2. PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Standard Dimension Ratio (SDR) Pipe and Fittings:

1. ISCO Industries, Inc.
   926 Baxter Avenue
   Louisville, KY 40204

2. Performance Pipe.
   5085 West Park Blvd.
   Plano, TX 75093

3. Dura-Line.
   11400 Parkside Drive, Suite 300.
   Knoxville, TN 37934

4. Plasson USA (Spirolite)
   6020 Osborn Street
   Houston, TX 77033

B. Substitutions: Under provisions of Section 01600.

2.2 MATERIALS

A. HDPE Piping: SDR pipe as shown on the Drawings. Only new and undamaged materials shall be used.

B. HDPE piping and fittings shall be made from high-density, extra-high molecular weight material with a broad range of molecular weight distribution. SDR pipe shall have a minimum designation code of PE 3608 and ASTM D3350 cell classification number of 345464C or 355464C.

C. Joints:

1. SDR pipe: Heat fusion process according to MANUFACTURER's specifications.

D. Perforations: As shown on Drawings.

E. Separation geotextile; refer to Section 02076.

F. Geomembrane Pipe Boot: Field fabricate from HDPE geomembrane as shown on the Drawings.

PART 3. EXECUTION

3.1 INSPECTION

A. Inspect pipe, fittings, and other appurtenances before installation to verify quality of material.

B. Bends to be prefabricated.

3.2 PREPARATION

A. Remove dirt and foreign material, inside and outside, from pipe and fitting materials before assembly.

B. Make straight field cuts without damaging pipe.

3.3 BEDDING

A. Place bedding material as shown on the Drawings and under provisions of Section 02317.

3.4 INSTALLATION - PIPE

A. Make heat fusion joints on SDR pipe in accordance with MANUFACTURER's specifications.

B. Install pipe and fittings to the line and grade specified on the Drawings.

C. Provide continuous, smooth invert.

D. Install bedding, backfill, and cover material over pipe as designated in Drawings.

E. Construct bedding sand and cover material over pipe with care, to avoid damage to the pipe. Minimize traffic and turning of traffic over pipe.

F. Wrap pipe a minimum of 2 times with a separation geotextile over the continuous length of the pipe. Provide a method to hold the separation geotextile in place during backfill placement.

G. Adhere geomembrane boot to SDR pipe strictly in accordance with MANUFACTURER's recommendations and the Drawings.

3.5 FIELD QUALITY CONTROL

A. ENGINEER to observe prior to backfilling.

B. When fusing joints and fittings, follow MANUFACTURER's recommendations and procedures for heat joining pipes and fittings.

C. Verify that pipe boot is not punctured or damaged prior to backfilling.

D. ENGINEER will observe pipe boot prior to backfilling.

E. The integrity of each solid wall collection piping system installed shall be documented by flushing with water, by pulling a mandrel, or by another equivalent method following completion of construction of the collection pipe.

END OF SECTION

SECTION 02720
AGGREGATE

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Constructing a dense compacted Dense Aggregate Base below access ramps and structures.

1.2 REFERENCES

A. Virginia Department of Transportation, 2007 Road and Bridge Specifications, Section 208

B. Virginia Department of Transportation, 2007 Road and Bridge Specifications, Section 309

C. ASTM C33 – Standard Specification for Concrete Aggregates

1.3 SUBMITTALS

A. Submit test results under provisions of Section 01330, indicating that the Dense Aggregate Base meets the required specifications.

B. Crushed or recycled concrete may be an acceptable ingredient in the production of Dense Aggregate Base. Submit source of supply and test results from an accredited testing laboratory under provisions of Section 01452. Submit request for substitution under provisions of Section 01600.

PART 2. PRODUCTS

2.1 MATERIALS

A. Dense Aggregate Base:

Virginia Department of Transportation Dense Graded Aggregates No. 21B

Sieve Size	Gradation No. 1
2"	100
1"	85-95
3/4"	--
3/8"	50-69
No. 10	20-36
No. 40	9-19
No. 200	4-7

Dense Aggregate Base shall conform to all requirements outlined in Virginia Department of Transportation, 2007 Bridge and Road Specifications Section 208.

B. Gravel Surfacing:

Virginia Department of Transportation Crusher Run

Sieve Size	Gradation No. 24
2 ½ "	100
2"	90 - 100
No. 4	40 – 20

Gravel Surfacing shall conform to all requirements outlined in Virginia Department of Transportation, 2007 Bridge and Road Specifications Section 205.

C. Pipe Trench Bedding and Backfill:

Provide pipe bedding and backfill conforming with the ASTM C33 gradation shown on the drawings. This material shall conform to the requirements of the Virginia Department of Transportation, 2007 Bridge and Road Specifications.

PART 3. EXECUTION

3.1 INSPECTION

A. ENGINEER to observe and approve subgrade prior to Dense Aggregate Base placement.

B. Apply water to dry subgrade before placement, and rework or recompact as necessary.

3.2 INSTALLATION

A. Dense Aggregate Base: Deposit Base Course material on the subgrade in a manner to minimize segregation and facilitate spreading to a uniform uncompacted layer not less than 9 inches in depth.

B. Add water as necessary to assist compaction. If excess water is apparent, aerate Aggregate Base Course material to reduce the moisture content.

C. On the liner system, compact each layer of Dense Aggregate Base using acceptable equipment with sufficient passes to provide a suitable base for concrete pavement installation.

D. Compact each layer of Aggregate Base Course material outside of liner system to the degree that no further appreciable consolidation or movement of the base is evidenced under action of the compaction equipment.

E. Rework or remove and replace soft or yielding areas as required until proper compaction is obtained. The cost of such reworking or removal and replacement shall be at CONTRACTOR's expense.

F. Do not compact Gravel Surfacing.

END OF SECTION

SECTION 02911
TOPSOIL

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Stripping and placing Topsoil where required based on the Drawings.

PART 2. PRODUCTS

2.1 MATERIALS

A. Friable, fertile, loamy soil containing an amount of organic matter normal to the region, capable of sustaining healthy plant life.

B. Free from refuse, subsoils, materials toxic to plant growth, and foreign objects.

PART 3. EXECUTION

3.1 PREPARATION

A. Remove vegetation, foreign materials, unsatisfactory or contaminated soils, obstructions, and matter harmful to plant growth from ground surface before placement.

B. Prepare subsoil to eliminate uneven areas and low spots. Maintain lines, levels, profiles and contours. Make changes in grade gradual. Blend slopes into level areas.

C. Scarify subsoil to a depth of 3 inches where Topsoil is to be placed. Repeat cultivation in areas where equipment used for hauling and spreading Topsoil has compacted subsoil.

3.2 STRIPPING AND STOCKPILING

A. Strip Topsoil to the available depth, taking care not to incorporate subgrade soils.

3.3 PLACEMENT

A. Place Topsoil to a uniform depth of 6 inches.

B. Finish grade to within 0.10 foot of elevations shown on Drawings.

C. Break down clods and lumps.

END OF SECTION

SECTION 02921
SEEDING

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Preparing the Topsoil.

B. Seeding.

C. Hydroseeding.

D. Mulching.

1.2 REFERENCES

A. Virginia Department of Transportation, 2007 Bridge and Roadway Specifications Section 244.

B. Virginia Department of Transportation, 2007 Bridge and Roadway Specifications Section 603.

C. Virginia Erosion and Sediment Control Handbook, Chapter 3.32.

1.3 DEFINITIONS

A. Weeds: Includes, but is not limited to, Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.

1.4 QUALITY ASSURANCE

A. Provide seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable.

B. Seed which is wet, moldy, or otherwise damaged is not acceptable.

PART 2. PRODUCTS

2.1 SEED MIXTURE

A. Seed mixture shall be in accordance with the Virginia Erosion and Sediment Control Handbook, Chapter 3.32, for Piedmont Area-General Slope.

B. Seed Mixture:

- Kentucky 31 fescue – 128 lbs/acre
- Red Top grass – 2 lbs/acre
- Annual ryegrass (seeding February 16 to April, August 16 to October) – 20 lbs./acre

  Or

  Foxtail Millet (seeding May 1 to August 15) – 20 lbs./acre

  Or

  Winter Rye (seeding November to February 15) – 20 lbs./acre

C. Kinds and varieties of seeds shall be delivered to the project in separate sacks bearing a green seed label denoting that the seed was inspected and approved by the Virginia 249 244.02 Crop Improvement Association. Open bags will not be accepted for use. Seeds shall be mixed under the observation of the ENGINEER on the project or at other approved locations. Seeds shall comply with applicable state and federal seed laws and contract requirements. Seed shall not be used until approved by the ENGINEER.

D. Seed shall be subject to inspection by Virginia State Seed Regulatory Inspectors of the Virginia Department of Agriculture and Consumer Services.

E. Seed tests shall be completed within the 9-month period prior to the beginning of the area scheduled seeding period during which the seed is to be used.

F. Seed shall not be or have been stored in an enclosure where herbicides, kerosene, or other material detrimental to seed germination is stored.

G. Noxious weed seeds, as defined by the rules and regulations adopted for enforcement of the Virginia Seed Law, will not be permitted. The number of restricted noxious weed seeds shall be not more than the number per ounce or per pound of noxious weed seeds specified in the rules and regulations of the Virginia Seed Law.

H. The tag from each sack of seed shall be signed by the CONTRACTOR and delivered to the ENGINEER after each sack is completely used.

2.2 ACCESSORIES

A. Mulching Material: Mulch for seeding shall consist of dry straw or hay, free from noxious weeds. Mulch shall be reasonably bright in color and shall not be musty, moldy, caked, decayed, or dusty.

B. Water: Clean, fresh, and free of substances or matter which could inhibit vigorous growth of grass.

PART 3. EXECUTION

3.1 INSPECTION

A. Verify that prepared soil base is ready to be seeded.

3.2 PREPARATION OF TOPSOIL

A. Grade Topsoil to finish grades to ensure positive drainage.

B. Remove stones or objects over 2 inches in diameter, foreign materials, weeds, and undesirable plants and their roots. Remove contaminated topsoil.

C. Apply fertilizer immediately before seeding in accordance with Section 02923.

3.3 SEEDING

A. Seeding shall be in accordance with the Virginia Erosion and Sediment Control Handbook, Chapter 3.32 for Piedmont Physiographic Regions.

B. Apply seed according to manufacturer's instructions. Rake in lightly.

C. Planting Season: In accordance with manufacturer's instructions.

D. Do not sow immediately following rain, or when ground is too dry, or during windy periods.

E. Regular seeding shall consist of uniformly applying seed, fertilizer, and mulch on prepared areas.

3.4 HYDROSEEDING

A. A hydroseeder may be used if deemed more appropriate for seeding, particularly for slopes. If used, the hydroseeder shall have continuous agitating action that keeps the seed uniformly mixed in the slurry until pumped from the tank.

B. Apply seeded slurry according to manufacturer's instructions. Do not hydroseed area in excess of that which can be mulched on the same day.

C. For hydroseeding, seed shall be put in the mixture slowly to result in a uniform mixture before application. Hydroseeding mixtures shall be constantly agitated from the time of mixing until application on the seed bed and used within 8 hours from the beginning of mixing.

3.5 MULCHING

A. Mulch shall be applied in a separate application within 48 hours after completion of the seeding operation. When straw or hay mulch is used, it shall be applied on seeded areas at the rate of approximately 2 tons per acre. Straw and hay mulch shall be applied to a uniform thickness in such a manner that not more than 10 percent of the soil surface will be exposed at the conclusion of the mulching operations.

B. Straw or hay mulch shall be anchored to the seeded surface by spraying with wood cellulose fiber mulch at the rate of 750 pounds per acre; spraying with an emulsified asphalt at the rate of at least 100 gallons per ton of mulch in a manner that will protect adjacent property and pedestrian traffic areas; disking or punching the mulch partially into the soil; using approved netting; or using other materials or methods approved by the ENGINEER. The CONTRACTOR may use more than one method on the same project.

C. Immediately following mulching, roll mulched area. On large areas, a cultipacker may be used to roll and cover the seed.

3.6 WATERING

A. Apply water with a fine spray immediately after each area has been mulched. Saturate soil to a depth of 4 inches.

B. Keep the surface layer of soil damp by frequent light watering with a fine spray during the germination period when rainfall is insufficient.

END OF SECTION

SECTION 02923
FERTILIZING

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Providing fertilizer.

B. Applying fertilizer.

1.2 REFERENCES

A. Virginia Department of Transportation, 2007 Road and Bridge Specifications Section 244.

B. Virginia Department of Transportation, 2007 Road and Bridge Specifications Section 603.

1.3 REGULATORY REQUIREMENTS

A. Comply with regulatory agency's requirements for fertilizer composition.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

PART 2. PRODUCTS

2.1 FERTILIZER MIXTURE

A. Fertilizer for seeding, sodding, sprigging, and plugging shall have a guaranteed 1-2- 1 ratio and a nitrogen, phosphorous, and potassium (NPK) analysis as detailed in the plans with a minimum 30 percent of the nitrogen from a slow release or slowly soluble source with the remainder of the nitrogen from urea or ammonium nitrate. The following types of slow release or slowly soluble nitrogen fertilizers may be used: urea formaldehyde (UF) (ureaform, methylene urea, and methylene diurea/dimethylene triurea); isobutylidene diurea (IBDU); sulfur-coated urea (SCU); and polycoated urea (PCU). UF products shall have a minimum activity index of 40 percent. The IBDU minimum size guide number shall be 230. All UF and IBDU products shall indicate the slow release/slowly available nitrogen source on the fertilizer analysis label as water-insoluble nitrogen. PCU and SCU shall have a minimum 3-month release duration for the total product. The phosphorous content of the fertilizer shall be triple superphosphate or diamonnium phosphate. The potassium content of the fertilizer shall be potassium 250 244.02 chloride, commonly known as muriate of potash. Slow release or slowly soluble fertilizers may be applied with a hydraulic seeder except for SCU.

PART 3. EXECUTION

3.1 INSPECTION

A. Verify that area is ready to receive the work of this Section.

B. ENGINEER must accept existing site conditions before beginning installation.

3.2 FERTILIZING

A. Application: When dry fertilizer is used, it shall be applied uniformly to the seeding areas at the time of seeding at the rate of 300 pounds of fertilizer per acre (approximately 45 pounds of nitrogen per acre or 1.0 pound of nitrogen per 1,000 square feet) or as directed by the Engineer. Slow release and slowly soluble fertilizer may be applied through a hydraulic seeder except for sulfur-coated urea (SCU). The method of application for fertilizer products will be approved by the Engineer prior to application of the fertilizer. When applied in liquid form or mixed with water, fertilizer shall provide the same value of nutrients per acre as specified for dry fertilizer. Fertilizer applied in liquid form shall be constantly agitated during application

B. Apply after Topsoil is raked smooth and prior to seeding.

C. Do not apply fertilizer at same time or with same machine that will be used to apply seed.

D. Mix thoroughly into upper 2 inches of Topsoil.

E. Lightly water to aid the dispersion of fertilizer.

END OF SECTION

SECTION 03050
LINER CONCRETE PAVEMENT

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Specific requirements for concrete paving above the liner system and access ramps. Concrete shall comply with Section 03300 – Environmental Cast in Place Concrete with exceptions noted below.

1.2 REFERENCES

A. Section 03300 – Environmental Cast-In-Place Concrete.

B. AASHTO TP23, Test Method for Water Content of Freshly Mixed Concrete Using Microwave Oven Drying.

1.3 QUALITY ASSURANCE

A. Requirements of Section 03300.

B. CONTRACTOR to employ an independent testing laboratory experienced in the design and testing of concrete materials and mixes to perform material evaluation tests and design the concrete mixes.

1. Testing agency shall conformance with ASTM E329 and ASTM C1077.

2. Testing laboratory shall have been inspected and passed inspection with the previous two years by Cement and Concrete Reference Laboratory (CCRL) of NIST for testing concrete aggregates, and preparing and testing concrete trial batches with or without admixtures. Testing laboratory shall provide documentation indicating how deficiencies, if any, in the most recent CCRL inspection report were corrected.

3. Testing laboratory is subject to ENGINEER'S acceptance.

4. Submit written description of proposed concrete testing laboratory providing qualifications for personnel, laboratory facilities, equipment and other information requested by ENGINEER.

C. Water Reducing Admixture shall be manufactured under strict quality control in facilities operated under a quality assurance program. Submit a copy of the manufacturer's quality assurance handbook to document the program existence.

1. Manufacturer shall maintain a concrete testing laboratory approved by CCRL at NIST.

2. Manufacturer shall be capable of providing services of qualified field service representatives at the Site.

D. Laboratory Trial Batch:

1. Each concrete mix design shall be verified with a laboratory trial batch, unless indicated otherwise.

2. For classes of concrete that require air-entrainment, test the trial batch at the highest percentage of air allowed for that class.

3. Perform the following tests for each trial batch:

   a. Aggregate gradation for fine and coarse aggregates

   b. Fly ash testing to meet specified properties, unless a certification is submitted by an independent testing laboratory by the supplier.

   c. Slump

   d. Air content

   e. Compressive strength base on three cylinders each tested at seven days and at 28 days.

   f. Shrinkage test in accordance with this Section for Class “A” concrete.

4. Submit the following information for each trial batch:

   a. Project identification.

   b. Date of report.

   c. Complete identification of aggregate source.

   d. Test of aggregates.

   e. Scale weight of each aggregate.

   f. Absorbed water in each aggregate.

   g. Brand, type, and composition of cementitious materials.

   h. Brand, type, and amount of each admixture.

   i. Amounts of water used in trial mixes.

   j. Proportions of each material per cubic yard.

   k. Gross weight and yield per cubic yard of trial mixtures.

   l. Measured slump.

   m. Measured air content.

n. Compressive strength developed at seven days and 28 days, from not less than three trial cylinders cast for each seven day and 28 day test (per mix design).

o. Shrinkage test results where required and as specified in this Section. Report results and averages for original length and at zero, seven, 14, 21, and 28 days of drying.

E. Obtain materials from same source throughout construction.

F. Perform Work in accordance with ACI 301 and ACI 302.1R.

1.4 SUBMITTALS

A. Submit the following items:

1. Items requested in Section 03300.

2. Other Items, including:

a. List of concrete materials and proportions for the proposed concrete mix designs. Include data sheets, test results, certifications, and mill reports to qualify the materials proposed for use in the mix designs. Do not start laboratory trial batch testing until this submittal is approved by ENGINEER.

b. Laboratory Trial Batch Reports as outlined in 1.3 D of this Section.

c. Ready-mixed Concrete: Submit the following:

(1) Physical capacity of the mixing plant.

(2) Trucking facilities available.

(3) Estimated average amount of specified concrete that can be produced and delivered to the Site during a normal, eight-hour day, excluding output to other customers.

3. Joint sealant product information.

4. Samples of materials as specified and as requested by the ENGINEER. Include with each sample names of product, Supplier, and description.

5. Proposed placement schedule and written description of means and methods to install concrete above the liner system in a manner to maintain integrity of the components below the concrete.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Transportation, Delivery, and Handling:

1. Materials used for concrete shall be clean and free from foreign matter during transportation and handling, and kept separate until measured and placed into concrete mixer.

2. Implement suitable measures during hauling, piling, and handling to ensure that segregation of coarse and fine aggregate particles does not occur and grading is not affected.

PART 2. PRODUCTS

2.1 GENERAL

A. Modifications to the products of Section 03300 listed below. Products shall meet requirements listed for Section 03300.

2.2 CONCRETE MIXTURES

A. Cementitious materials: Use ASTM C150 Type II cement.

B. Fine Aggregate: Dune sand, bank run sand, and manufactured sand are unacceptable.

C. Coarse Aggregate: Slag, pit gravel, and bank run gravel are unacceptable.

D. Admixtures: Admixtures shall be compatible with each other. Admixtures shall not contain thiocyanates, shall not contain more than 0.05 percent chloride ion, and shall be non-toxic in the concrete mix after 30 days. Do not use admixtures that have not been incorporated and tested in the accepted mixes unless approved by ENGINEER.

E. Slump: concrete shall have a slump of 4 inches +/- 1 inch

F. Air content: Concrete shall have an air content of 6 percent +/- 1 percent.

G. Minimum Compressive Strength: Concrete shall provide an average compressive strength of 4,000 pounds per square inch (psi) or greater with no values less than 3,500 psi for field cylinders. Laboratory trial batch cylinders shall have a minimum 28 day compressive strength of 5,000 psi.

2.3 VAPOR BARRIERS

A. Not applicable.

2.4 DOWELS

A. Use epoxy coated plain-steel bars, ASTM A615/A 615M, cut bars true to length with ends square and free of burs.

2.5 JOINT FILLERS

A. Expansion Joints: Use pre-formed compressible joint fillers to form expansion joints. Material such as Deck-O-Foam by W.R. Meadows or ENGINEER approved alternate installed as recommended by the manufacturer.

B. Fill contraction and expansion joints with Class B silicone sealant (Section 212.02(b) of the VDOT Standards) with backer rod or filler and bond breaking tape; or alternate approved by ENGINEER. Joint sealants shall be installed in accordance with Section 316.04(m) of the VDOT Standards.

PART 3. EXECUTION

3.1 PREPARATION

A. Liner system has been accepted by ENGINEER and ready to accept concrete.

B. Provide double-layer of cushion geotextile below reinforcement and dowel supports.

C. Moisten base to minimize absorption of water from fresh concrete.

D. Place concrete on 6:1 slopes and steeper, beginning at the toe and working upwards.

3.2 JOINTING

A. Provide contraction and expansion joints at spacings shown on Drawings.

3.3 QUALITY CONTROL

A. Slump: ASTM C143; one test for each concrete load at point of discharge

B. Concrete Temperature: ASTM C1064; one for every two concrete loads at point of discharge, and when a change in the concrete is observed. Test each load when time from batching to placement exceeds 75 minutes.

C. Air Content: ASTM C231; one for every two concrete loads at point of discharge, and when a change in the concrete is observed.

D. Unit Weight: ASTM C138; one for every two concrete loads at point of discharge, and when a change in the concrete is observed.

E. Compressive Strength Tests; performed on at least one composite sample for each 50 cubic yards or fraction thereof placed each day:

1. In accordance with ASTM C39; three (3) specimens tested at seven days and two (2) specimens tested at 28 days.

2. Adjust mix design if test results are unsatisfactory and resubmit for approval.

3. Concrete that does not comply with strength requirements will be considered defective Work.

F. Water/Cementitious Materials Ratio: Perform test when required by ENGINEER in accordance with AASHTO TP23.

END OF SECTION

SECTION 03300
ENVIRONMENTAL CAST-IN-PLACE CONCRETE

PART 1. GENERAL

1.1 SECTION INCLUDES

A. This section specifies cast-in place environmental concrete, including formwork, reinforcement, concrete materials, mix design, placement procedures, waterstops, and finishes for all cast-in-place wastewater structures.

B. This section includes concrete for foundations and footings for wastewater treatment structures, including footings for HDG grating frames.

C. This section does not apply to concrete walkways or concrete pond liners.

D. This section is related to drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections.

1.2 REFERENCES

A. American Concrete Institute
117-90: Standard Specifications for Tolerances for Concrete Construction and Materials
350-06: Code Requirements for Environmental Engineering Concrete Structures
350.5: Specifications for Environmental Concrete Structures
423.6-01: Specification for Unbonded Single-Strand Tendons and Commentary (withdrawn)
506.2-95: Specifications for Shotcrete

B. American Petroleum Institute
RP 13B-1-09: Recommended Practice for Field Testing Water-Based Drilling Fluids

C. American Welding Society
AWS D1.4-98: Structural Welding Code: Reinforcing Steel

D. ASTM International
A82/A82M-97a: Standard Spec. for Steel Wire, Plain, for Concrete Reinforcement
A184/A184M-01: Standard Spec. for Fabricated Deformed Steel Bar Mats
A185/A185M-97: Standard Spec. for Steel Welded Wire Reinforcement, Plain
A416/A416M-02: Standard Spec. for Steel Strand, Uncoated 7 Wire for Prestressed Concrete
A421/A421M-02: Standard Spec. for Uncoated Stress-Relieved Steel Wire
A475-98: Standard Spec. for Zinc-Coated Steel Wire Strand
A496/A496M-97a: Standard Spec. for Steel Wire, Deformed, for Concrete Reinforcement
A497-99: Standard Spec. for Steel Welded Wire Reinforcement, Deformed
A615/A615M-03: Standard Spec. for Deformed and Plain Billet-Steel Bars
A641/A641M-98: Standard Spec. for Zinc-Coated (Galvanized) Carbon Steel Wire
A648-95: Standard Spec. for Steel Wire, Hard Drawn for Prestressing Concrete Pipe
A653/A653M-03: Standard Spec. for Zinc-Coated (Galvanized) Hot-Dip Process
A675/A675M-03: Spec. for Steel Bars, Carbon, Hot-Wrought, Special Quality
A706/A706M-03: Standard Spec. for Low-Alloy Steel Deformed and Plain Bars
A722/A722M-98: Standard Spec. for Uncoated High Strength Steel Bars for Prestressing
A767/A767M-00b: Standard Spec. for Zinc-Coated (Galvanized) Steel Bars
A775/A775M-01: Standard Specification for Epoxy-Coated Reinforcing Steel Bars
A779/A779M-00: Standard Spec. for Steel Strand, 7 Wire, Uncoated, Compacted
A780-01: Standard Practice for Repair of Damaged and Uncoated Areas of Galvanized Coatings
A821/A821M-99: Standard Spec. for Steel Wire, Hard Drawn for Prestressing Concrete Tanks

A882/A882M-02a: Standard Spec. for Filled Epoxy-Coated 7 Wire Prestressing Steel Strand
A884/A884M-02: Standard Spec. for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
A934/A934M-03: Standard Spec. for Epoxy-Coated Prefabricated Steel Reinforcing Bars
A955/A955M-04a: Standard Spec. for Deformed and Plain Stainless Steel Bars
A970/A970M-04a: Standard Spec. for Headed Steel Bars
A996/A996M-03: Standard Spec. for Rail-Steel and Axle-Steel Deformed Bars
A1008/A1008M-06: Standard Spec. for Cold Rolled Steel
C31/C31M-03a Standard Practice for Making and Curing Concrete Test Specimens in the Field
C33-03 Standard Spec. for Concrete Aggregates
C39/C39M-03a: Standard Test for Compressive Strength of Cylindrical Concrete Specimens
C42/C42M-03: Standard Test for Obtaining and Testing Drilled Cores and Sawed Beams
C94/C94M-03: Standard Spec. for Ready Mixed Concrete
C138/C138M-01a: Standard Test for Density (Unit Weight), Yield, and Air Content
C143/C143M-03: Standard Test Method for Slump of Hydraulic-Cement Concrete
C144-03: Standard Spec. for Aggregate for Masonry Mortar
C150-02a: Standard Spec. for Portland Cement
C171-03: Standard Spec. for Sheet Materials for Curing Concrete
C172-99: Standard Practice for Sampling Freshly Mixed Concrete
C173-01: Standard Test Method for Air Content of Freshly Mixed Concrete by Volumetric
C192/C192M-02: Standard Practice for Making and Curing Concrete Test Specimens in Lab
C227-10: Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate
C231-04: Standard Test for Air Content of Freshly Mixed Concrete by the Pressure Method
C260-01: Standard Spec. for Air-Entraining Admixtures for Concrete
C309-03: Standard Spec. for Liquid Membrane-Forming Compounds for Curing Concrete
C387-04: Standard Spec. for Packaged, Dry, Combined Materials for Mortar and Concrete
C404-03: Standard Spec. for Aggregates for Masonry Grout
C494/C494M-99a: Standard Spec. for Chemical Admixtures for Concrete
C595-03: Standard Spec. for Blended Hydraulic Cements
C597-02: Standard Test Method for Pulse Velocity Through Concrete
C618-03: Standard Spec. for Coal Fly Ash and Raw or Calcined Natural Pozzolan
C684-99(2003): Standard Test Method for Making, Accelerated Curing, and Testing Specimens
C685/C685M-01: Standard Spec. for Concrete by Volumetric Batching and Continuous Mixing
C803/C803M-03: Standard Test Method for Penetration Resistance of Hardened Concrete
C805-02: Standard Test Method for Rebound Number of Hardened Concrete
C845-96: Standard Spec. for Elastomeric Joint Sealants
C873-04: Standard Test for Compressive Strength of Concrete Cylinders Cast in Place
C881-02: Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
C900-01: Standard Test Method for Pullout Strength of Hardened Concrete
C920-02: Standard Spec. for Elastomeric Joint Sealants
C928-00: Standard Spec. for Packaged, Dry, Rapid Hardening Cementitious Materials
C939-97: Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete
C940-98a(03): Standard Test for Expansion and Bleeding of Freshly Mixed Grouts
C942-99(04): Standard Test for Compressive Strength of Grouts
C953-06: Standard Test for Time of Setting of Grouts
C989-99: Standard Spec. for Ground Granulated Blast-Furnace Slag
C1017/C1017M-98: Standard Spec. for Chemical Admixtures
C1059-99: Standard Spec. for Latex Agents for Bonding Fresh to Hardened Concrete
C1064/C1064M-03: Standard Test for Temperature of Freshly Mixed Hydraulic-Cement
C1074-04: Standard Practice for Estimating Concrete Strength by the Maturity Method
C1077-03: Standard Practice for Testing Concrete and Aggregates for Use in Construction
C1107-02: Standard Spec. for Packaged Dry, Hydraulic Cement Grout (Nonshrink)
C1138-97: Standard Test Method for Abrasion Resistance of Concrete (Underwater Method)
C1218/C1218M-99: Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
C1240-03a: Standard Spec. for Silica Fume
C1260-07: Standard Test for Potential Alkali Reactivity of Aggregates
C1293-08: Standard Test for Determination of Length Change of Concrete Due to Alkali-Silica

C1315-03: Standard Spec. for Liquid Membrane-Forming Compounds
C1567-11: Standard Test for Determining Potential Alkali-Silica Reactivity
C1602/C1602M-04: Standard Spec. for Mixing Water
D994-98(2003): Standard Spec. for Expansion Joint Filler (Bituminous Type)
D1056-00: Specification for Flexible Cellular Materials – Sponge or Expanded Rubber
D1751-99: Standard Spec. for Expansion Joint Filler (Nonextruding and Resilient Bituminous)
D1752-84: Standard Spec. for Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers
E329-03: Standard Spec. for Testing and/or Inspection of Materials Used in Construction
E1155-96(2001): Standard Test for Determining FF Floor Flatness and FL Levelness

E. U.S. Army Corps of Engineers
CRD-C 513-74: Spec. for Rubber Waterstops
CRD-C 572-99: Spec. for Polyvinylchloride Waterstops

F. National Science Foundation
NSF 61-11: Drinking Water System Components: Health Effects

G. Field references: Keep in Contractor's field office a copy of the following references:
ACI SP-15: Field Reference Manual: Spec. for Structural Concrete (ACI 301-10)
ACI 350.5-12: Spec. for Environmental Concrete Structures (ACI 350.5-12) and Commentary
ASTM C231-04: Standard Test for Air Content by the Pressure Method
ASTM C 1064/1064M-03: Standard Test for Temperature of Freshly Mixed Concrete
ACI 506.2-95: Spec. for Shotcrete Also when conducting any Unbonded post-tensioning work
ACI 423.6-01: Spec. for Unbonded Single-Strand Tendons

1.3 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Product Source: For each type of manufactured material and product indicated.

C. Design Mixes: For each concrete mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments. Indicate amounts of mix water to be withheld for later addition at Project site.

D. Steel Reinforcement Shop Drawings: Details of fabrication, bending, and placement, prepared according to ACI ACI 350-06 and 315. Include material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement, and supports of concrete reinforcement. Include special reinforcement required for openings through concrete structures.

E. Testing agency reports: Testing agency name, location, and qualifications. Testing agency shall report results of concrete and concrete materials tests and inspections performed during the course of the Work to Owner, Engineer, Contractor, and the Concrete Supplier. Strength test reports shall include location in the Work where the batch represented by test was deposited and the batch ticket number. Reports of strength tests shall include detailed information of storage and curing of specimens before testing. Final reports shall be provided within 7 days of test completion.

F. Welding Certificates: Copies of certificates for welding procedures and personnel.

G. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:

a. Cementitious materials and aggregates.

b. Shrinkage test results.

c. Admixtures.

d. Curing materials.

e. Floor and slab treatments.

f. Vapor Barriers.

g. Waterstops.

PART 2. PRODUCTS

2.1 FORM-FACING MATERIALS

A. Prefabricated Forms (Void Forms):

1. Wall/Grade Beam and Structural Slab Void Forms:

a. Function: Create void space directly under grade beams, structural slabs or walls.

b. Composition: Corrugated paper material with a moisture resistant exterior and having an interior fabrication of a uniform, cellular configuration composed of non-wax impregnated components.

c. Depth: As indicated on the drawings.

d. Profile: Provide trapezoidal, Trapvoid form.

e. Strength: Forms must be capable of sustaining a working load based on concrete unit weight of 165 lbs / cf.

f. Accessories: Seam pads to eliminate concrete flow in void forms and end caps to seal off void form end.

g. Acceptable Manufacturer: Trapvoid, seam pads and end caps as manufactured by Sure Void Products, Inc., Englewood, Co., phone (800) 458-5444, or equal.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Steel Bar Mats: ASTM A 184/A 184M, assembled with clips.

C. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

2.3 REINFORCEMENT ACCESSORIES

A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete.

B. Joint Dowel Bars: Plain-steel bars, ASTM A 615/A 615M, Grade 60. Cut bars true to length with ends square and free of burrs.

2.4 CONCRETE MIXTURES

A. GENERAL

1. Description: This section covers the requirements for materials, proportioning, production, and delivery of concrete.

2. Submittals

   a. Mixture proportions: Submit concrete mixture proportions and characteristics.

   b. Mixture proportion data: Submit method and field test records used to establish the required average strength. Submit for acceptance and test data used to establish the average compressive strength of the mixture.

   c. Concrete materials: Submit the following information for concrete materials, along with evidence demonstrating compliance with Contract Documents:
      1) for cementitious materials: types, manufacturing locations, shipping locations, and certificates showing compliance with ASTM C150, C595, C618, C845, or C989;
      2) for aggregates: types, pit or quarry locations, producers' names, gradations, specific gravities, and evidence not more than 90 days old demonstrating compliance with 5.2.1;
      3) for admixtures: types, brand names, producers, manufacturer's technical data sheets, and certification data; and
      4) for water and ice: source of supply.

   d. Except for admixtures, test results confirming conformance with applicable specifications shall not be more than 90 days old. Test results for aggregate soundness, abrasion, and reactivity may be older than 90 days, but not older than 1 year, provided test results for the other properties specified in ASTM C33 indicate that the aggregate quality has not changed. Submit requests to use alternative sources of water to Engineer for review and approval.

3. Field test data basis: When field test records are used as the basis for selecting proportions for a concrete mixture, submit data on materials and mixture proportions with supporting test results confirming conformance with specified requirements.

4. Mixture proportion adjustments: Submit any adjustments to mixture proportions or changes in materials, along with supporting documentation, made during the course of the Work. If Contractor finds it necessary to increase the cementitious materials content, review a request for acceptance of the proposed revised mixture with higher cementitious materials content on a trial basis. Confirm that the adequacy of modified proportions has been verified from a set of new field test data.

5. Concrete for floors: Submit evaluations and test results verifying adequacy of concrete to be placed in floors when the cementitious materials content is less than the minimum specified in Table 5.2.2.1 of ACI 350.5.

6. Abrasion-erosion concrete: Submit evaluations and test results verifying adequacy of concrete to be placed in abrasion-erosion concrete.

7. Volumetric batching: When it is desired to produce concrete by the volumetric batching method, submit request along with description of proposed method.

B. PRODUCTS

1. Materials

a. Cementitious materials: Use ASTM C150 Type I or Type II cement unless one or a combination of the following cementitious materials are specified or permitted:

1) Portland cement conforming to ASTM C150 b) blended hydraulic cement conforming to ASTM C595. For the sections of the structure that are designated as subject to deicing chemicals, submit certification on the composition of the cement verifying that the concrete mixture meets the requirements of Table 5.2.2.9.1 of ACI 350.5;
2) Pozzolanic mineral admixture conforming to ASTM C618. When fly ash is used, the minimum amount shall be 15 percent by weight of the total cementitious materials, unless otherwise specified;
3) ground granulated blast-furnace slag conforming to ASTM C989;
4) silica fume conforming to ASTM C1240; and
5) use cementitious materials that are of the same brand and type and from the same plant of manufacture as the cementitious materials used in the concrete represented by the submitted field test records or used in the trial mixtures.

b. Aggregates: Aggregates shall conform to ASTM C33, unless otherwise specified. When a single size or a combination of two or more sizes of coarse aggregate are used, the final grading shall conform to the grading requirements of ASTM C33, unless otherwise specified or permitted. Aggregates used in concrete shall be obtained from the same sources and have the same size ranges as the aggregates used in the concrete represented by submitted historical data or used in trial mixtures. Unless otherwise specified, coarse aggregates shall have been tested in accordance with ASTM C1260 or ASTM C1567 with expansion no greater than 0.10 percent at 14 days, unless the aggregate has been determined to be nondeleteriously reactive in accordance with ASTM C227 or ASTM C1293.

c. Water and ice: Mixing water for concrete and water used to make ice shall be potable water unless alternative sources of water complying with ASTM C1602/C1602M are permitted.

d. Admixtures: When required or permitted, admixtures shall meet the requirements of the following:
1) air-entraining admixtures: ASTM C260;
2) chemical admixtures: ASTM C494/C494M; and
3) chemical admixtures: ASTM C494/C494M; and chemical admixtures for use in producing flowing concrete: ASTM C1017/C1017M Admixtures used in concrete shall be the same as those used in the concrete represented by submitted field test records or used in trial mixtures.

e. Change of materials: When brand, type, size, or source of cementitious materials, aggregates, water, ice, or admixtures are proposed to be changed, new field data, data from new trial mixtures, or evidence that indicates that the change will not adversely affect the relevant properties of the concrete shall be submitted for acceptance before use in concrete.

f. Performance and design requirements

1) Cementitious materials content: The cementitious materials content shall be not less than that indicated in Table 5.2.2.1 of ACI 350.5 and shall be adequate for concrete to satisfy the specified requirements for durability, strength, water-cementitious material ratio (w/cm), and finishing ability. When a history of finishing quality is not available, evaluate the proposed mixture by placing concrete in a slab at the project site using project materials, equipment, and personnel. The slab shall be at least 8 x 8 ft and have an acceptable thickness. Slump shall not exceed the specified slump. Submit evaluation results for acceptance. For concrete specified as requiring abrasion erosion resistance, cementitious materials content shall be at least 610 lb/cy. Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:
   a) Portland cement to water ration: 60/40 Portland cement to water.
   b) Fly Ash: 25 percent.
   c) Fly Ash: 25 percent
   d) Ground Granulated Blast-Furnace Slag: 50 percent.
   e) Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 60 percent Portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.

g. Use water-reducing admixture or mid-range water-reducing admixture (e.g. plasticizer) in concrete, as required, for placement and workability. Do not use high-range (e.g. superplasticizer) admixtures.

h. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

1) Slump: Unless otherwise specified or permitted, concrete shall have, at the point of delivery, a maximum slump of 3-1/2 in. Determine the slump by ASTM C143/C143M. Slump tolerances shall meet the requirements of ACI 117. When use of a Type I or II plasticizing admixture conforming to ASTM C1017 or when a Type F or G high-range water-reducing admixture conforming to ASTM C494/C494M is permitted to increase the slump of concrete, concrete shall have been proportioned to a slump of 2 to 3 in. before the admixture is added and a maximum slump of 8 in. at the point of delivery after the admixture is added, unless otherwise specified.

2) Size of coarse aggregate: Except when otherwise specified or permitted, nominal maximum size of coarse aggregate shall not exceed the lessor of ¾” nominal size or three-fourths of the minimum clear spacing between reinforcing bars, one-fifth of the narrowest dimension between sides of forms, and one-third of the thickness of slabs or toppings.

3) Air content: Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content of 3 percent, unless otherwise indicated. Do not air entrain concrete to trowel-finished interior slabs on grades, footings, and suspended structural slabs. Unless otherwise specified, air-entrain exposed concrete slabs on grade, foundation walls, stairs, piers, and abutments as indicated in plans. Do not allow entrapped air content to exceed 3 percent. Measure air content in accordance with ASTM C231 or C173.

4) Admixtures: Submit admixtures for workability and shrinkage to Engineer for review and approval. Use of admixtures containing chloride ions shall be

subject to the limitations in 5.2.2.6. Admixtures shall be certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials.

a) Air-Entraining Admixture: ASTM C 260.
b) Water-Reducing Admixture: ASTM C 494, Type A.
c) High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
d) Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.
e) Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

5) Chloride-ion concentration: Unless otherwise specified, maximum water-soluble chloride-ion concentrations in hardened concrete at ages from 28 to 42 days contributed from the ingredients including water, aggregates, cementitious materials, and admixtures shall not exceed the limits of Table 5.2.2.6. When testing is performed to determine water-soluble chloride-ion content, test procedures shall conform to ASTM C1218/C1218M. The type of member described in Table 5.2.2.6 of ACI 350.5 shall apply to the Work as indicated in Contract Documents.

6) Concrete temperature: When the average of the highest and lowest ambient air temperature during the period from midnight to midnight is expected to drop below 40°F for more than three successive days, deliver concrete to meet the following minimum temperatures immediately after placement:

a) 55°F for sections less than 12 in. in the least dimension;
b) 50°F for sections 12 to 36 in. in the least dimension;
c) 45°F for sections 36 to 72 in. in the least dimension; and
d) 40°F for sections greater than 72 in. in the least dimension.

7) The temperature of concrete as placed shall not exceed these values by more than 20°F. These minimum requirements may be terminated when temperatures above 50°F occur during more than half of any 24-hour duration. Unless otherwise specified or permitted, the temperature of concrete as delivered shall not exceed 90°F.

8) When required for concrete exposed to deicing chemicals, the maximum weight of fly ash, natural pozzolans, silica fume, or slag cement that is included in the concrete shall not exceed the percentages of the total weight of cementitious materials given in Table 5.2.2.9.1 of ACI 350.5.

9) Unless otherwise specified, base strength requirements on a 28-day compressive strength determined on 6 x 12 in. cylindrical specimens made and tested in accordance with ASTM C31/C31M and C39/C39M, respectively.

10) Where abrasion-erosion-resistant concrete is indicated in plans, the concrete shall comply with the additional requirements indicated in Table 5.2.2.9.3 of ACI 350.5. In abrasion erosion-resistant concrete, aggregates shall meet requirements of ASTM C33, and concrete shall be tested in accordance with ASTM C1138.

i. Proportioning. Proportion concrete to provide workability and consistency so concrete can be worked readily into forms and around reinforcement without segregation or bleeding, walking of concrete with use of vibration, and to provide an average compressive strength. If the production facility has records of field tests performed within the past 12 months and spanning a period of not less than 60 days for a class of concrete within 1,000 psi of that specified for the work,

calculate a standard deviation and establish the required average strength fcr′ in accordance with ACI 350-06. If field test records are not available, select the required average strength from Table 5.2.3.3.1(b) of ACI 350.5. Unless otherwise specified in plans, Proportion normal-weight concrete mix as follows:

1) Compressive Strength (28 Days): as noted on plans and specifications.
2) Maximum Slump: 3-1/2 inches.
3) Maximum Slump for Concrete Containing Mid-Range Plasticizer: 6 inches.
4) High-Range Plasticizers are not permissible.
5) Maximum Shrinkage: 0.03%.

j. Standard deviation

1) Field test data: Field test records used to calculate standard deviation shall represent materials, quality control procedures, and climatic conditions similar to those expected in the Work. Test records shall comply with one of the following:
   a) data from a single group of at least 15 consecutive compressive-strength tests with the same mixture proportions; and
   b) data from two groups of consecutive compressive strength tests totaling at least 30. Neither of the two groups shall consist of less than 10 tests.

2) Standard deviation: Calculate the standard deviation in accordance with the provisions of 5.2.3.2.2 of ACI 350.5.

k. Required average compressive strength: Unless otherwise specified in drawings, the required average compressive strength of cast in-pace concrete shall conform to the following minimums:

1) footings: 4,000 psi;
2) foundation walls – 5,000 psi;
3) piers – 5,000 psi;
4) pilasters – 5,000 psi;
5) bridge abutments – 5,000 psi;
6) wing walls – 5,000 psi; and
7) retaining walls – 5,000 psi.

l. Use the standard deviation calculated in accordance with 5.2.3.2 to establish the required average compressive strength in accordance with Table 5.2.3.3.1(a) of ACI 350.5.

m. Document that proposed concrete proportions will produce an average compressive strength equal to or greater than the required average compressive strength, and shall consist of field strength records or trial mixture of concrete with equal or greater than specified fc′ for the Work.

n. Trial mixtures: Establish mixture proportions based on trial mixtures in accordance with ACI 350-06.

o. Field verification of adequacy of selected mixture proportions: Using materials and mixture proportions accepted for use in the Work, verify that the concrete can be adequately placed using the intended placing method. Do not walk concrete into formwork using vibration. Verify that the slump and air content obtained at the form are acceptable. Make suitable corrections to the placing methods or to the mixture proportions, if needed. Submit any adjustments to the mixture proportions to Engineer for review and acceptance.

p. Revisions to concrete mixtures: When 15 consecutive compressive strength test results become available from the field, calculate the actual average compressive strength and standard deviation. Calculate a revised value for the required average compressive strength fcr′ in accordance with ACI 350-06. Submit revised mixture proportions to Engineer for review and approval.

2.5 ADMIXTURES

A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride.

B. Air-Entraining Admixture: ASTM C 260.

C. Water-Reducing Admixture: ASTM C 494, Type A.

D. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.

E. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.

F. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

2.6 FIBER REINFORCEMENT

A. Synthetic Fiber: Fibrillated polypropylene fibers engineered and designed for use in concrete, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches long.

B. Products: Subject to compliance with requirements, provide one of the following:

1. Fibrillated Fibers:
   a. Fibrasol F; Axim Concrete Technologies.
   b. Fibermesh; Fibermesh, Div. of Synthetic Industries.
   c. Forta; Forta Corporation.
   d. Grace Fibers; W. R. Grace & Co., Construction Products Div.

2.7 WATERSTOPS

A. Supply and install Earth Shield Thermoplastic chemically resistant water stops as indicated in plans. Proposed alternates shall comply with NSF certified, EPA compliant RCRA, SPCC, CFR 265.193 and CFR 112. Install model in accordance with plans manufacturer recommendations and installation guidelines. Submit proposed alternates to Engineer for review and approval.

2.8 VAPOR BARRIER

A. Vapor Barrier: ASTM E 1745, Class C, of one of the following materials; or polyethylene sheet, ASTM D 4397, not less than 15 mils thick:

1. Nonwoven, polyester-reinforced, polyethylene coated sheet; 15 mils thick.

2.9 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 22 percent solids.

F. Products: Subject to compliance with requirements, provide one of the following:

1. Evaporation Barrier:
   a. Cimfilm; Axim Concrete Technologies.
   b. Finishing Aid Concentrate; Burke Group, LLC (The).
   c. Spray-Film; ChemMasters.
   d. Aquafilm; Conspec Marketing & Manufacturing Co., Inc.
   e. Sure Film; Dayton Superior Corporation.
   f. Eucobar; Euclid Chemical Co.
   g. Vapor Aid; Kaufman Products, Inc.
   h. Lambco Skin; Lambert Corporation.
   i. E-Con; L&M Construction Chemicals, Inc.
   j. Confilm; Master Builders, Inc.
   k. Waterhold; Metalcrete Industries.
   l. Rich Film; Richmond Screw Anchor Co.
   m. SikaFilm; Sika Corporation.
   n. Finishing Aid; Symons Corporation.
   o. Certi-Vex EnvioAssist; Vexcon Chemicals, Inc.

2. Clear, Waterborne, Membrane-Forming Curing Compound:
   a. AH Clear Cure WB; Anti-Hydro International, Inc.
   b. Klear Kote WB II Regular; Burke Chemicals.
   c. Safe-Cure & Seal 20; ChemMasters.
   d. High Seal; Conspec Marketing & Manufacturing Co., Inc.
   e. Safe Cure and Seal; Dayton Superior Corporation.
   f. Aqua Cure VOX; Euclid Chemical Co.
   g. Cure & Seal 309 Emulsion; Kaufman Products Inc.
   h. Glazecote Sealer-20; Lambert Corporation.
   i. Dress & Seal WB; L&M Construction Chemicals, Inc.
   j. Vocomp-20; W. R. Meadows, Inc.
   k. Metcure; Metalcrete Industries.
   l. Cure & Seal 150E; Nox-Crete Products Group, Kinsman Corporation.
   m. Rich Seal 14 percent E; Richmond Screw Anchor Co.
   n. Kure-N-Seal WB; Sonneborn, Div. of ChemRex, Inc.
   o. Florseal W.B.; Sternson Group.
   p. Cure & Seal 14 percent E; Symons Corporation.
   q. Seal Cure WB 150; Tamms Industries Co., Div. of LaPorte Construction Chemicals of North America, Inc.
   r. Hydro Seal; Unitex.
   s. Starseal 309; Vexcon Chemicals, Inc.

2.10 ACCEPTANCE OF STRUCTURE

A. General: Concrete workmanship and materials shall substantially conform to these specifications, plans, and other Contract Documents. Concrete workmanship and materials that do not substantially conform may be repaired or rejected.

1. Engineer shall determine whether concrete workmanship and materials substantially conform to these specifications, plans, and other Contract Documents.

2. Contractor shall propose repair or reconstruction of such workmanship and materials.

3. Engineer shall review and approve Contractor proposed repairs prior to performance of the associated concrete work.

4. Repair rejected concrete Work by removing and replacing or other acceptable repair methods as approved by Engineer. Repairs shall substantially conform to applicable strength, function, durability, dimensional tolerances, and appearance.

5. Formed surfaces resulting in concrete dimensions smaller than permitted by the tolerances of ACI 117 may be considered deficient in strength.

B. Strength of structure

1. Criteria for determining potential strength deficiency: Strength will be considered deficient and concrete Work will be rejected when the Work fails to comply with requirements that control the strength of the structure including, but not limited to, the following conditions:
   a. concrete strength failing to comply with Contract Documents;
   b. reinforcement size, quantity, strength, position, or arrangement at variance with the requirements of Section 3 or Contract Documents;
   c. concrete elements that differ from the required dimensions or location;
   d. curing not in accordance with Contract Documents;
   e. mechanical injury, construction fires, accidents, or premature removal of formwork resulting in deficient strength; and f) insufficient protection of concrete from detrimental environmental conditions.

2. Action required when strength is potentially deficient: When strength of the structure does not substantially conform to these specifications, the following actions may be required by Engineer:
   a. structural analysis, additional testing, or both;
   b. Core tests (If testing is inconclusive or impractical or if structural analysis does not confirm the safety of the structure, load tests may be required and their results evaluated in accordance with ACI 350.5);
   c. Concrete Work rejected by structural analysis or by results of a load test shall be strengthened with additional construction when required by Engineer, or replaced; and
   d. Document all repair Work proposed to bring strength-deficient concrete Work into compliance with Contract Documents, and submit the documentation to Engineer for acceptance.

3. Durability: Concrete work shall be considered deficient and the concrete workmanship and materials shall be rejected when it fails to comply with the requirements that control durability of the structure including, but not limited to, the following conditions:
   a. strength;
   b. air;
   c. slump;
   d. temperature;
   e. curing;
   f. mixture;
   g. admixture;
   h. protection during early stages of hardening and strength development;
   i. fly ash content in excess of 25%;
   j. chloride-ion content; and
   k. mixture.

2.11 PROTECTION OF IN-PLACE CONCRETE

A. Loading and support of concrete: Do not allow construction loads to exceed the superimposed load that the structural member, with necessary supplemental support, is capable of carrying safely and without damage. Gangs of formwork may not be placed on concrete slabs during forming of foundation walls, piers, and other structures. Cure all concrete structures a minimum of (28) day compressive strength prior to placement of service loads.

B. Protection from mechanical injury: During the curing period, protect concrete from damaging mechanical disturbances including load stresses, shock, and vibration. Protect concrete surfaces from damage by construction traffic, equipment, materials, rain or running water, and other adverse weather conditions.

2.12 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.13 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94 and ASTM C 1116, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

2. Do not add plasticizer at plant. Add plasticizer in concrete trucks at the job site following on-site, independent testing of slump, air, and temperature and Quality Assurance approval of delivered concrete product.

2.14 QUALITY ASSURANCE

A. Installer Qualifications: Contractor shall engage an experienced installer who has completed concrete work similar in material, design, and extent to that of the plans and whose work has resulted in construction with a record of successful in-service performance.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

1. Manufacturer must be certified according to the National Ready Mixed Concrete Association's Certification of Ready Mixed Concrete Production Facilities.

C. Testing Agency Qualifications: Contractor shall engage an independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.

E. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."

F. ACI Publications: Comply with the following, unless more stringent provisions are indicated:

1. ACI 350-06, “Code Requirements for Environmental Concrete Structures.”

2. ACI 305.5, "Specification for Environmental Concrete."

3. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

G. Coordinate all foundation penetrations with Engineer, plumbing, mechanical, electrical contractors and local agencies.

PART 3. EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until concrete structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor bolts, accurately located, to elevations required.

2. Install reglets to receive top edge of foundation sheet waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

3. Install dovetail anchor slots in concrete structures as indicated.

3.3 VAPOR BARRIERS

A. Vapor Barrier: Place, protect, and repair vapor-Barrier sheets according to ASTM E 1643 and manufacturer's written instructions.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Do not cut or puncture vapor barriers and water proofing membranes. Repair damages and reseal vapor and waterproofing barriers before placing concrete. Reseal waterproofing barriers in accordance with manufacturer’s requirements.

B. Clean uncoated reinforcement of loose rust and mill scale, earth, ice, and other foreign materials.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Shop- or field-weld reinforcement according to AWS D1.4.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire fabric in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.5 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated.

2. Form from preformed galvanized steel, plastic keyway-section forms, or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas at a minimum of 10-feet on center or as otherwise indicated in plans. Construct contraction joints for a depth equal to at least 1/4th of concrete thickness, as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

3. Joint spacing on slabs and walls shall not exceed 10-feet on center in any direction unless otherwise permitted by Engineer.

4. Do not lap reinforcing steel along the entire length of contraction joints.

5. Do not section or cut reinforcing steel in footings, haunches, foundation walls, pilasters, and piers.

D. Dowel Joints: Install dowel sleeves and dowels or dowel bar and support assemblies at joints where indicated.

1. Use dowel sleeves or lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement, unless approved by Engineer.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mix.

C. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation.

D. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.

2. Maintain reinforcement in position on chairs during concrete placement.

3. Screed slab surfaces with a straightedge and strike off to correct elevations.

4. Slope surfaces uniformly to drains where required.

5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, free of humps or hollows, before excess moisture or bleed-water appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.

2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.

F. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows, when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FINISHING FLOORS AND SLABS

A. General: Generally comply with recommendations in ACI 305.5 for screeding, re-straightening, and finishing of concrete surfaces. Do not wet concrete surfaces for finishing.

1. Place concrete at a rate that allows spreading, straight-edging, and darbying or bull-floating before bleed water appears. Strike smooth the top of walls, buttresses, horizontal offsets, and other similar unformed surfaces and float them to a texture consistent with finish of adjacent formed surface.

2. Use qualified flatwork finishers acceptable to Engineer. Unless otherwise permitted, a minimum of one finisher or finishing supervisor shall be a certified ACI Flatwork Concrete Finisher/Technician or a certified ACI Flatwork Technician or equivalent.

3. Finishes and tolerances.

   a. Scratch finish: Place, consolidate, strike off, and level concrete, eliminating high and low spots. Roughen the surface with stiff brushes or rakes before final set. Produce a finish that meets ACI 117 tolerances.

   b. Float finish: Place, consolidate, strike off, and level concrete, eliminating high and low spots. Do not work concrete further until it is ready for floating. Begin floating with a hand float, a bladed power float equipped with float shoes, or a powered disk float when the bleed water sheen has disappeared and the surface has stiffened sufficiently to permit operation of the specific float apparatus. Unless otherwise specified, produce a finish that will meet tolerance requirements of ACI 117 for a conventional surface. Refloat the slab immediately to a uniform texture.

   c. Normal trowel finish: Rub exposed concrete wall, pedestal, abutment, pilaster, and pier surfaces surface with multiple passes. Hand-trowel the surface smooth and free of trowel marks and honey combs.

   d. Hard trowel finish: Float exposed concrete wall and abutment surfaces with hand or power trowel until a ringing sound is produced as the floor is troweled. Do not add water to surface during finishing.

   e. Broom: Unless otherwise specified in drawings, broom finish all concrete walking surfaces after the concrete is floated. Give the surface a coarse transverse scored texture by drawing a broom or burlap belt across the surface. Tolerances for concrete floors shall be a moderately flat surface in accordance with ACI 117.

   f. Measuring tolerances for slabs
      1) Measure slabs for suspended floors and slabs-on-grade to verify compliance with the tolerance requirements of ACI 117 within 72 hours after slab finishing and before removing supporting formwork or shoring.
      2) Unless otherwise specified, for floor installations 10,000 sf or less in total project area, measure floor finish tolerances in accordance with the 10-foot straightedge method in ACI 117.
      3) Unless otherwise specified, for floor installations exceeding 10,000 sf in total project area, measure floor finish tolerances in accordance with ASTM E1155 and the F-number system in ACI 117.

3.8 MISCELLANEOUS CONCRETE ITEMS

A. Rubbing: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Loop reinforce pedestals as shown in plans. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment. Submit proposed mechanical anchors to Engineer for review and approval.

1. Unless otherwise shown in plans, use Hilti HY-200 2-part epoxy for proposed bonded mechanical anchors.

2. All mechanical anchors shall be GS or SS steel with no cuts or abrasions.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and broom-finish concrete tread surfaces.

3.9 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with recommendations in ACI 305R for hot-weather protection during curing.

B. Evaporation Barrier: Apply evaporation Barrier to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

a. Water.

b. Continuous water-fog spray.

c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.

b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.

c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer recommends for use with floor coverings.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.10 QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement according to requirements specified in this Article. Testing agency shall be NAVLAP or AASHTO certified.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least (1) composite sample for each 50 cy or fraction thereof of each concrete mix placed each day.

   a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mix, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143; (1) test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.

4. Temperature: with each cylinder, slump, and air test.

5. Conduct slump, air, and temperature tests a minimum of every 3rd delivery truck starting with the 2nd delivery truck in sequential order of delivery.

6. Time of discharge: ASTM C94/C94M. When exceeding time constraints, submit a request to Engineer along with a description of the precautions to be taken.

7. Maintain records verifying materials used are of the specified and Engineer approved types and sizes.

8. Ensure proper production and delivery of concrete.

9. Ensure that the concrete produced has the specified characteristics in the freshly mixed state and that they are maintained during transport and delivery.

10. Materials storage and handling:

    a. Cementitious materials: label and store cementitious materials in dry, weather-tight buildings, bins, or silos that will exclude contaminants.

    b. Aggregates: store and handle aggregate in a manner that will avoid segregation and prevent contamination with other materials or other sizes of aggregates. Store aggregates to drain freely. Do not use aggregates that contain frozen lumps.

    c. Water and ice: protect mixing water and ice from contamination during storage and delivery.

    d. Admixtures: protect stored admixtures against contamination, evaporation, or damage. Provide agitating equipment for admixtures used in the form of suspensions or unstable solutions to ensure thorough distribution of the ingredients. Protect liquid admixtures from freezing and from temperature changes that would adversely affect their characteristics.

11. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of four standard cylinder specimens for each composite sample.

    a. Cast and field cure one set of (4) standard cylinder specimens for each composite sample.

12. Compressive-Strength Tests: ASTM C 39; test (3) laboratory-cured specimens at 7 days and two at 28 days.

    a. Test (3) field-cured specimens at 7 days and two at 28 days.

    b. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at age indicated.

C. When strength of field-cured cylinders is less than 85% of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

D. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Engineer.

END OF SECTION

SECTION 03710
EPOXY TANK LINER

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Epoxy coating liner applied to the interior surfaces of walls and floors for concrete pump station and flow split box structures shown in plans.

1.2 RELATED SECTIONS

A. Section 05080 - Factory-Applied Metal Coatings.

B. Section 15075 - Mechanical Identification: Identification of mechanical equipment.

C. Section 16075 - Electrical Identification: Identification of electrical equipment.

1.3 REFERENCES

A. ANSI/NSF 61 - Drinking Water System Components - Health Effects.

B. ASTM D 16 - Terminology Relating to Paint, Varnish, Lacquer, and Related Products.

C. ASTM D 4263 - Indicating Moisture in Concrete by the Plastic Sheet Method.

D. ASTM F 1869 - Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

E. AWWA C 652 - Disinfection of Water-Storage Facilities.

F. AWWA D 102 - Painting Steel Water Storage Tanks.

G. International Concrete Repair Institute (ICRI) Guideline No. 03732 - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.

H. SSPC-SP 1 - Solvent Cleaning.

I. SSPC-SP 2 - Hand Tool Cleaning.

J. SSPC-SP 3 - Power Tool Cleaning.

K. SSPC-SP 5/NACE 1 - White Metal Blast Cleaning.

L. SSPC-SP 6/NACE 3 - Commercial Blast Cleaning.

M. SSPC-SP 10/NACE 2 - Near-White Metal Blast Cleaning.

N. SSPC-SP 13/NACE 6 - Surface Preparation of Concrete.

1.4 DEFINITIONS

A. Definitions of Painting Terms: ASTM D 16, unless otherwise specified.

B. Dry Film Thickness (DFT): Thickness of a coat of paint in fully cured state measured in mils (1/1000 inch).

1.5 SUBMITTALS

A. Comply with Section 01330 - Submittal Procedures.

B. Product Data: Submit manufacturer's product data for each coating, including generic description, complete technical data, surface preparation, and application instructions.

C. Color Samples: Submit manufacturer's color samples showing full range of standard colors.

D. Manufacturer's Quality Assurance: Submit manufacturer's certification that coatings comply with specified requirements and are suitable for intended application.

E. Applicator's Quality Assurance: Submit list of a minimum of 5 completed projects of similar size and complexity to this Work. Include for each project:

Project name and location.
Name of owner.
Name of contractor.
Name of engineer.
Name of coating manufacturer.
Approximate area of coatings applied.
Date of completion.

F. Warranty: Submit manufacturer's standard warranty.

1.6 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

1. Specialize in manufacture of coatings with a minimum of 10 years successful experience.

2. Able to demonstrate successful performance on comparable projects.

3. Single Source Responsibility: Coatings and coating application accessories shall be products of a single manufacturer.

B. Applicator's Qualifications:

1. Experienced in application of specified coatings for a minimum of 5 years on projects of similar size and complexity to this Work.

2. Applicator's Personnel: Employ persons trained for application of specified coatings.

C. Mock-Ups: Prepare 10 foot x 10 foot mock-up for each coating system specified using same materials, tools, equipment, and procedures intended for actual surface preparation and

application. Obtain Engineer's approval of mock-ups. Retain mock-ups to establish intended standards by which coating systems will be judged.

D. Pre-application Meeting: Convene a pre-application meeting [2] weeks before start of application of coating systems. Require attendance of parties directly affecting work of this section, including Contractor, Engineer, applicator, and manufacturer's representative. Review the following:

1. Environmental requirements.

2. Protection of surfaces not scheduled to be coated.

3. Surface preparation.

4. Application.

5. Disinfection.

6. Repair.

7. Field quality control.

8. Cleaning.

9. Protection of coating systems.

10. One-year inspection.

11. Coordination with other work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying:

1. Coating or material name.

2. Manufacturer.

3. Color name and number.

4. Batch or lot number.

5. Date of manufacture.

6. Mixing and thinning instructions.

B. Storage:

1. Store materials in a clean dry area and within temperature range in accordance with manufacturer's instructions.

2. Keep containers sealed until ready for use.

3. Do not use materials beyond manufacturer's shelf life limits.

C. Handling: Protect materials during handling and application to prevent damage or contamination.

1.8 ENVIRONMENTAL REQUIREMENTS

A. Weather:

1. Air and Surface Temperatures: Prepare surfaces and apply and cure coatings within air and surface temperature range in accordance with manufacturer's instructions.

2. Surface Temperature: Minimum of 5 degrees F (3 degrees C) above dew point.

3. Relative Humidity: Prepare surfaces and apply and cure coatings within relative humidity range in accordance with manufacturer's instructions.

4. Precipitation: Do not prepare surfaces or apply coatings in rain, snow, fog, or mist.

5. Wind: Do not spray coatings if wind velocity is above manufacturer's limit.

B. Ventilation: Provide ventilation during coating evaporation stage in confined or enclosed areas in accordance with AWWA D 102.

C. Dust and Contaminants:

1. Schedule coating work to avoid excessive dust and airborne contaminants.
2. Protect work areas from excessive dust and airborne contaminants during coating application and curing.

D. PRODUCTS

1. PPG Protective and Marine Coatings, 11605 Vimy Ridge Rd, Alexander, AR 72002. Toll Free (888) 9PPGPMC. Web Site www.PPGPMC.com/northamerica.
2. System Type: Epoxy (2-part)
3. Surface Preparation: SSPC-SP 13/NACE 6. Abrasive blast.
4. Primer: Amerlock Sealer DFT 1.0 mil.*
5. Finish: Novaguard 840 DFT 18.0-24.0 mils.
6. Total DFT: 19.0 to 25.0 mils.
7. Finish Color: Gray.

PART 2 - EXECUTION

2.1 EXAMINATION

A. Examine areas and conditions under which coating systems are to be applied. Notify Engineer of areas or conditions not acceptable. Do not begin surface preparation or application until unacceptable areas or conditions have been corrected.

2.2 PROTECTION OF SURFACES NOT SCHEDULED TO BE COATED

A. Protect surrounding areas and surfaces not scheduled to be coated from damage during surface preparation and application of coatings.

B. Immediately remove coatings that fall on surrounding areas and surfaces not scheduled to be coated.

2.3 SURFACE PREPARATION OF CONCRETE

A. Interior, Wet Substrate:

1. Prepare concrete surfaces in accordance with manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 03732.

2. Allow concrete to cure for a minimum of 28 days prior to applying primer and epoxy liner.

3. Test concrete for moisture in accordance with ASTM D 4263 and F 1869.

4. Abrasive blast surface to remove laitance and solid contaminants and to provide clean, sound substrate with uniform anchor profile.

5. Fill holes, pits, voids, and cracks with Amercoat 114A Filler and Surfacer.

6. Ensure surfaces are clean, dry, and free of oil, grease, chalk, form release agents, and other contaminants.

7. Broom finished surfaces of all concrete floors.

8. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.

B. Dewater as-required by environmental and ground water conditions in order to permit application of epoxy liner in accordance with manufacturer's instructions, SSPC-SP 13/ NACE 6, and ICRI 03732.

PART 3 - APPLICATION

A. Apply coatings in accordance with manufacturer's instructions.

B. Mix and thin coatings, including multi-component materials, in accordance with manufacturer's instructions.

C. Keep containers closed when not in use to avoid contamination.

D. Do not use mixed coatings beyond pot life limits.

E. Use application equipment, tools, pressure settings, and techniques in accordance with manufacturer's instructions.

F. Uniformly apply coatings at spreading rate required to achieve specified DFT.

G. Apply coatings to be free of film characteristics or defects that would adversely affect performance or appearance of coating systems.

H. Stripe paint with brush critical locations on steel such as welds, corners, and edges using specified primer.

PART 4 - REPAIR

A. Materials and Surfaces Not Scheduled To Be Coated: Repair or replace damaged materials and surfaces not scheduled to be coated.

B. Damaged Coatings: Touch-up or repair damaged coatings. Touch-up of minor damage shall be acceptable where result is not visibly different from adjacent surfaces. Recoat entire surface where touch-up result is visibly different, either in sheen, texture, or color.

C. Coating Defects: Repair in accordance with manufacturer's instructions coatings that exhibit film characteristics or defects that would adversely affect performance or appearance of coating systems.

PART 5 - FIELD QUALITY CONTROL

5.1 Inspector's Services:

A. Verify coatings and other materials are as specified.

B. Verify surface preparation and application are as specified.

C. Verify DFT of each coat and total DFT of each coating system are as specified using wet film and dry film gauges.

D. Coating Defects: Check coatings for film characteristics or defects that would adversely affect performance or appearance of coating systems.

E. Check for holidays on interior steel immersion surfaces using holiday detector.

F. Report:

1. Submit written reports describing inspections made and actions taken to correct nonconforming work.

2. Report nonconforming work not corrected.

3. Submit copies of report to Engineer and Contractor.

5.2 Manufacturer's Field Services: Manufacturer's representative shall provide technical assistance and guidance for surface preparation and application of coating systems.

PART 6 - 3.19 CLEANING

A. Remove temporary coverings and protection of surrounding areas and surfaces.

PART 7 - PROTECTION OF COATING SYSTEMS

A. Protect surfaces of coating systems from damage during construction.

PART 8 - ONE-YEAR INSPECTION

A. Owner will set date for one-year inspection of coating systems.

B. Inspection may be attended by Owner, Contractor, Engineer, and manufacturer's representative.

C. Repair deficiencies in coating systems as determined by Engineer in accordance with manufacturer's instructions.

END OF SECTION

SECTION 05120
STRUCTURAL STEEL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes structural steel.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Engineer structural steel connections required by the Contract Documents to be selected or completed by the fabricator to withstand design loadings indicated.

B. Engineering Responsibility: Engage a fabricator who utilizes a qualified professional engineer to prepare calculations, Shop Drawings, and other structural data for structural steel connections and members.

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data for each type of product specified.

C. Shop Drawings detailing fabrication of structural steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.

2. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.

3. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify high-strength bolted slip-critical, direct-tension, or tensioned shear/bearing connections.

4. Include Shop Drawings signed and sealed by a qualified professional engineer responsible for their preparation.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has completed structural steel work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Fabricator Qualifications: Engage a firm experienced in fabricating structural steel similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to fabricate structural steel without delaying the Work.

C. Comply with applicable provisions of the following specifications and documents:

1. AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."

2. AISC's "Specification for Allowable Stress Design of Single-Angle Members."

3. AISC's "Seismic Provisions for Structural Steel Buildings."

4. ASTM A 6 "Specification for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use."

5. Research Council on Structural Connections' (RCSC) "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Professional Engineer Qualifications: A professional engineer who is legally authorized to practice in the jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for projects with structural steel framing that are similar to that indicated for this Project in material, design, and extent.

E. Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding Code--Steel."

1. Present evidence that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver structural steel to Project site in such quantities and at such times to ensure continuity of installation.

B. Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration.

1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.

2. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.7 SEQUENCING

A. Supply anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, templates, instructions, and directions, as required, for installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Structural Steel, Plates, Angles, Channels and Bars: ASTM A36.

B. Wide Flange Shapes: ASTM A992, Grade 50.

C. Cold-Formed Structural Steel Tubing: ASTM A 500, Grade B.

D. Steel Pipe: ASTM A 53, Type E or S, Grade B.

E. Anchor Rods, Bolts, Nuts, and Washers: As follows:

1. Headed Bolts: ASTM A 325, Type 1, heavy hex steel structural bolts and heavy hex carbon-steel nuts.

2. Washers: ASTM A 36.

F. Nonhigh-Strength Bolts, Nuts, and Washers: ASTM A 307, Grade A; carbon-steel, hex-head bolts; carbon-steel nuts; and flat, unhardened steel washers.

1. Finish: Plain, uncoated.

G. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, and hardened carbon-steel washers.

1. Finish: Plain, uncoated.

H. Welding Electrodes: Comply with AWS requirements. All welding electrodes shall be E70XX.

2.2 PRIMER

A. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer.

B. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds and repair painting galvanized steel, with dry film containing not less than 93 percent zinc dust by weight, and complying with DOD-P-21035A or SSPC-Paint 20.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, of consistency suitable for application, and a 30-minute working time.

2.4 FABRICATION

A. Fabricate and assemble structural steel in shop to greatest extent possible. Fabricate structural steel according to AISC specifications referenced in this Section and in Shop Drawings.

1. Camber structural steel members where indicated.

2. Mark and match-mark materials for field assembly.

3. Fabricate for delivery a sequence that will expedite erection and minimize field handling of structural steel.

4. Complete structural steel assemblies, including welding of units, before starting shop-priming operations.

5. Comply with fabrication tolerance limits of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for structural steel.

2.5 SHOP CONNECTIONS

A. Shop install and tighten nonhigh-strength bolts, except where high-strength bolts are indicated.

B. Shop install and tighten high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Shop install and tighten high-strength bolts according to RCSC's "Load and Resistance Factor Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1. Bolts: ASTM A 325 high-strength bolts, unless otherwise indicated.

2. Connection Type: Snug tightened, unless indicated as slip-critical, direct-tension, or tensioned shear/bearing connections.

D. Weld Connections: Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in correcting welding work.

2.6 SHOP PRIMING

A. Shop prime steel surfaces, except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.

2. Surfaces to be field welded.

3. Surfaces to be high-strength bolted with slip-critical connections.

4. Surfaces to receive sprayed-on fireproofing.

5. Galvanized surfaces.

6. Surface Preparation: Clean surfaces to be painted. Remove loose rust, loose mill scale, and spatter, slag, or flux deposits.

B. Priming: Immediately after surface preparation, apply primer according to manufacturer's instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

2.7 GALVANIZING

A. Hot-Dip Galvanized Finish: Unless otherwise indicated, all structural steel exposed to exterior environmental conditions shall be hot-dipped galvanized according to ASTM A 123.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before erection proceeds, and with the steel erector present, verify elevations of concrete and masonry bearing surfaces and locations of anchorages for compliance with requirements.

B. Do not proceed with erection until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.

B. No connection shall consist of less than two ¾" diameter bolts or welds developing a minimum of 10,000 pounds unless noted otherwise.

C. All fillet welds shall be a minimum of ¼" unless noted otherwise.

D. All welds shall be visually inspected by testing agency.

E. A testing agency shall perform all inspections and testing. The structural steel fabricator and erector shall schedule all work to allow the above testing requirements to be completed.

F. Cuts, holes, openings, etc., required in structural steel members for the work of other trades shall be shown on shop drawings for structural steel and shall be made in the shop. Burning of holes or cuts in structural steel members in the field will not be permitted except by written permission from the Architect.

G. All beam to tube column connections shall be thru plate connections, unless otherwise noted.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC specifications referenced in this Section.

B. Base and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.

1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
2. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate prior to packing with grout.
3. Pack grout solidly between bearing surfaces and plates so no voids remain. Finish exposed surfaces, protect installed materials, and allow to cure.

a. Comply with manufacturer's instructions for proprietary grout materials.

C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

D. Splice members only where indicated.

E. Do not use thermal cutting during erection.

3.4 FIELD CONNECTIONS

A. Install and tighten non-high-strength bolts, except where high-strength bolts are indicated.

B. Install and tighten high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Install and tighten high-strength bolts according to RCSC's "Load and Resistance Factor Design Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1. Bolts: ASTM A 325 high-strength bolts, unless otherwise indicated.

2. Connection Type: Snug tightened, unless indicated as slip-critical, direct-tension, or tensioned shear/bearing connections.

D. Weld Connections: Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in correcting welding work.

1. Comply with AISC specifications referenced in this Section for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.

3.5 FIELD QUALITY CONTROL

A. Owner will engage an independent testing and inspecting agency to perform field inspections and tests and to prepare test reports.

1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from requirements.

B. Correct deficiencies in or remove and replace structural steel that inspections and test reports indicate do not comply with specified requirements.

C. Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.

3.6 CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint. Apply paint to exposed areas using same material as used for shop painting.

1. Apply by brush or spray to provide a minimum dry film thickness of 1.5 mils.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on structural steel are included in Division 9 Section "Painting."

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and apply galvanizing repair paint according to ASTM A 780.

END OF SECTION

SECTION 05205
ACCESS PLATFORMS AND STAIRWAYS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The work included in this section of the specifications consists of the complete furnishing and installation of access platforms on concrete structures and stairways as herein described and as shown on the plans.

B. To ensure compatibility throughout the entire project, the equipment furnished herein shall be identical to that furnished on other equipment items (tanks, access bridges, etc.). It shall be the CONTRACTOR'S responsibility to ensure this requirement is met.

C. Provide kick plates as required to conform to OSHA requirements.

D. This section does not pertain to pre-fabricated steel bridge decks.

1.2 RELATED WORK

A. SECTION 09915 - PROTECTIVE COATINGS

B. SECTION 05120 - STRUCTURAL STEEL

C. SECTION 05500 - MISCELLANEOUS METALS

1.3 SUBMITTALS

A. Submit shop drawings for fabrication and erection of metal stairs, platforms, handrails, and grating showing dimensioned layouts and details and indicating design loads and deflections.

B. Submit certification, sealed and signed by a Professional Engineer registered in Virginia, which the design complies with the requirements of this specification and is in accordance with accepted engineering practices.

C. Number of Copies: Submit six (6) copies of each submittal, unless otherwise indicated. ENGINEER will return two (2) copies.

PART 2 - PRODUCTS

2.1 GRATING

A. Grating shall be provided and installed where indicated on the plans. Unless otherwise shown on the drawings, grating shall be hot dipped galvanized, straight and flat sections of maximum 7’ - 0” in length, sized 4 in. x 1 in. clear opening (NAAMM MBG 531-09). Minimum width of platforms shall be 2’-0” wide for an uninterrupted passage along its entire length.

B. The grating sections shall include intermediate supports of minimum 1/4 in. thick steel plate construction, hot-dipped galvanized after fabrication. The supports shall be sized and located to ensure adequate cross bracing of the grating, as recommended by the grating manufacturer, but in no case shall be greater than 3’- 6” on center, unless otherwise shown on the plans.

C. The top of the grating shall be flush with the top of steel sections for a platform or flush with the top of concrete for concrete mounting.

D. The grating sections shall include stainless steel hold-down clips, as recommended by the manufacturer, on maximum 4 ft. centers. Clips shall ensure easy removal of the grating sections.

E. All Grating shall be banded on all edges and on any proposed pultrusions of pipe or other objects, without exception.

2.2 CONCRETE WALL MOUNT

A. The supplier shall furnish hot-dipped galvanized grating support angles for attachment to the concrete. Where an embedded angle is not required, the grating supports shall be galvanized angles 3 in. x 4 in. x 1/4 in. LLV. Additional supports shall be as shown on the Drawings. Stainless Steel Epoxy anchors, minimum 1/2 in. dia. shall be provided on maximum 24 in. centers, or as shown on the Drawings.

2.3 HANDRAILING

A. The handrail system shall be furnished and installed where indicated on the plans. The handrail shall be of 2-rail HDG steel pipe 1.9 in. outside diameter with the top rail 42 in. high and the intermediate rail 24 in. high. The vertical posts shall be positioned at no greater than 6 in. - 0 ft. on center. The handrail shall be assembled in the field by use of cast HDG steel fittings, as manufactured by J.C. Denier, or equal. The base shall have 2-bolt mounting using minimum 1/2 in. x 4 in. long 304 stainless steel drop-in anchors for concrete mounting and minimum 1/2 in. diameter stainless steel bolts for mounting on steel platforms. The vertical posts shall be pre-cut by the supplier, but the horizontal runs shall be field cut from stock lengths of material by the CONTRACTOR. The railing shall include a 4 in. high kickplate with fastener clips to the vertical posts. The handrail system shall comply with all current OSHA standards. The railing design shall comply with IBC Section 1607.7.

B. For long horizontal runs, as recommended by the handrail manufacturer, the CONTRACTOR shall install expansion joints in the horizontal runs. The joints shall be the standard design of the manufacturer. The joints shall be spaced as recommended by the manufacturer.

2.4 PLATFORMS AND STAIRWAYS

A. Platforms and stairways shall be fabricated in accordance with these plans. Platforms shall be fabricated of a minimum 1/4 in. thick standard structural steel sections, hot-dip galvanized after fabrication. The minimum support size for the platforms shall be 3 in. x 3 in. x 1/4 in. steel angles. Platforms and stairways shall include handrail and grating as herein specified. Stairways shall include stair treads to match grating, <u>with the exception that the top of the grating shall be serrated</u>, and include slip resistant nosing (coated safety yellow per Section 09915).

B. Submittals for platforms and stairways shall include all members, details, and assemblies demonstrating that the proposed materials and workmanship conform to plans and specifications.

2.5 STEEL LADDERS

A. General: Fabricate ladders for the locations shown, with dimensions, spacings, details and anchorages as indicated. Comply with requirements of ANSI A14.3 and OSHA Federal Regulations 1910.27.

1. Finish: Hot Dip Galvanized unless otherwise indicated.

B. Siderails: Continuous steel flat bars, 1/2 in. x 2-1/2-in., with eased edges, spaced 18 in. apart.

C. Bar Rungs: Round steel bars, 3/4 in. diameter, spaced 12 in. O.C.

D. Fit rungs in centerline of side rails, plug weld and grind smooth on outer rail faces.

E. Support each ladder at top and bottom and at intermediate points spaced not more than 10 ft. O.C. by means of welded or bolted steel brackets.

1. Size brackets to support design dead and live loads indicated and to hold centerline of ladder rungs clear of the wall surface by not less than 7 in.

2. Extend side rails 42 in. above top rung, and return rails to wall or structure unless other secure handholds are provided. If the adjacent structure does not extend above the top rung, goose-neck the extended rails back to the structure to provide secure ladder access.

F. Provide non-slip surface on top of each rung, either by coating the rung with aluminum oxide granules set in epoxy resin adhesive, or by using a type of manufactured rung which is filled with aluminum oxide grout.

2.6 Stairways

A. Materials

1. Structural Steel Plates, Shapes, and Bars: ASTM A 36.

2. Steel Pipe: ASTM A 53, Grade A, standard weight (Schedule 40).

3. Steel Plates to be Bent: ASTM A 283, Grade C.

4. Standard Nuts and Bolts: ASTM A 307, Grade A, regular hex head.

5. Zinc (Hot Galvanized) Coating: Comply with ASTM A 123 for products fabricated from rolled, pressed and forged steel shapes, plates, bars, and strips or ASTM A 386 for assembled steel products. Galvanized after fabrication.

6. Stair Treads: 1-1/2 in. x 3/16 in. x 1 in. clear opening, hot dipped galvanized, serrated top with slip resistant nosing (Type W-B weldforged).

B. Fabrication - General

1. Use of materials of the required size and thickness to produce adequate strength and durability in the finished product for the intended use. Work to the dimensions or in accordance with job measurements. Use type of materials shown or specified for the various components of the work.

2. Form exposed work true to line and level, with accurate angles and surfaces, and sharp, straight edges. Ease exposed edges to a radius of approximately 1/32 in. Form bent metal corners to the smallest radius possible without causing grain separation or otherwise impairing the work.

3. Weld corners and seams continuously and in accordance with the AWS code. Grind exposed welds smooth and flush to match and blend with adjoining surfaces.

4. Form exposed connections with hairline joints which are flush and smooth, using concealed fasteners wherever possible.

5. Provide for anchorage coordinated with the supporting structure. Fabricate and space anchoring devices as required to provide adequate support of the work.

6. Cut, reinforce, drill, and tap miscellaneous metal work as may be required to receive other items of work.

7. Shop paint all metal work, except those members or portions of members to be embedded in concrete, surfaces, and edges to be field welded, or galvanized surfaces.

   a. Comply with Steel Structures Painting Council Specifications "One-Coat Shop Paint System No. 7.01 with Red or Brown Primer." Surface preparation comparable to grades BSTL, CSTL, or DSTL or SSPC-Vis I-63T. "Pictorial Surface Preparation Standard for Painting Steel Surfaces."

8. Hot-dip galvanize to coating thickness of 1.25 oz. per square foot all items shown on the drawings.

C. Fabrication and Assembly

1. Use welding or joining pieces together, unless otherwise shown or specified. Fabricate units so that bolts or other fastenings do not appear on finished surfaces. Make joints tight and true. Provide continuous welds ground smooth where exposed.

2. Construct stair units to conform to sizes and arrangements shown. Construct entire assembly to support a live load of 100 lbs. per square foot or 200 lbs. at any point, unless otherwise shown. Provide metal framing, hangers, column, struts, brackets, bearing plates, or other components as required for the support of stairs and platforms.

3. Provide brackets and bearing surfaces as required to anchor stairs to supporting structure.

4. Fabricate stringers of structural steel channels or plates, or a combination thereof. Provide closures for exposed ends of stringers.

5. Construct platforms of structural steel headers and miscellaneous framing members. Bolt headers to stringers or other framing members.

6. Construct riser and subtread metal pans with steel angle supporting brackets sized as required and welded to strings. Secure metal pans to brackets with rivets or welds.

7. Secure sub-platform metal pans to platform frames and weld.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Platforms, ladders, and stairways shall be installed in accordance with the manufacturer's installation requirements.

B. Erect stair work to line, plumb, square, and true with runs registering level with finished floor and platform levels.

C. Perform all cutting, drilling, and installation of stair systems. Fit exposed connections together to form tight hairline joints. Weld connections which are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Grind joints smooth and touch-up shop finish.

D. Do not weld, cut, or abrade the surfaces of units which have been hot-dip galvanized after fabrication are intended for bolted, fitted connections.

E. Stairs shall be firmly anchored to building structure and braced as required to resist sideway, buckling, and deflection.

3.2 PROTECTIVE COATINGS

A. All fabricated steel materials that are not stainless steel shall be hot-dip galvanized after fabrication in accordance with SECTION 09915 - PROTECTIVE COATINGS of these specifications.

B. Cleaning and touch-up of paint and galvanized finish at welds, bolted connections, and abraded areas is specified in SECTION 09915 - PROTECTION COATINGS of these specifications.

3.3 ANCHOR BOLTS AND FASTENERS

Anchor bolts and fasteners shall be stainless steel, unless otherwise noted on the drawings.

END OF SECTION

SECTION 05500
METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Loose bearing and leveling plates.
2. Loose steel lintels.
3. Shelf angles.
4. Steel framing and supports for overhead doors.
5. Steel framing and supports for mechanical and electrical equipment.
6. Metal edgings.
7. Miscellaneous metal trim.
8. Pipe bollards.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Paint products.
2. Grout.

B. Shop Drawings: Detail fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

1. Provide templates for anchors and bolts specified for installation under other Sections.

C. Welding Certificates: Copies of certificates for welding procedures and personnel.

1.4 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm experienced in producing metal fabrications similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."

2. AWS D1.2, "Structural Welding Code--Aluminum."

3. AWS D1.3, "Structural Welding Code--Sheet Steel."

4. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.5 PROJECT CONDITIONS

A. Field Measurements: Where metal fabrications are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions. Allow for trimming and fitting.

1.6 COORDINATION

A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 992, Grade 50.

B. Steel Tubing: Cold-formed steel tubing complying with ASTM A 500.

C. Steel Pipe: ASTM A 53, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.

D. Cast-in-Place Anchors in Concrete: Anchors of type indicated below, fabricated from corrosion-resistant stainless or hot-dipped galvanized materials capable of sustaining, without failure, the load imposed within a safety factor of 4, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

1. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47 malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized per ASTM A 153/A 153M.

E. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

2.3 ALUMINUM

A. Aluminum Extrusions: ASTM B 221, alloy 6063-T6.

2.4 PAINT

A. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements in FS TT-P-664; selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

B. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

2.5 FASTENERS

A. Bolts and Nuts: Regular hexagon-head bolts, ASTM A325, Grade A; with hex nuts; and, where indicated, flat washers.

B. Anchor Bolts: ASTM F1554, Grade 36.

C. Machine Screws: ASME B18.6.3.

D. Lag Bolts: ASME B18.2.1.

E. Wood Screws: Flat head, carbon steel, ASME B18.6.1.

F. Plain Washers: Round, carbon steel, ASME B18.22.1.

G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

1. Material: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.

2.6 CONCRETE FILL

A. Concrete Materials and Properties: Comply with requirements in Division 3 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 4,000 psi, unless otherwise indicated.

2.7 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Shear and punch metals cleanly and accurately. Remove burrs.

C. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

F. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

G. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

H. Allow for thermal movement resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening up of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient.

I. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.

J. Remove sharp or rough areas on exposed traffic surfaces.

K. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

2.8 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Galvanize plates after fabrication.

2.9 LOOSE STEEL LINTELS

A. Fabricate loose structural-steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated.

B. Weld adjoining members together to form a single unit where indicated.

C. Galvanize loose steel lintels located in exterior walls.

2.10 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated. Provide horizontally slotted holes to receive ¾-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.

B. Galvanize shelf angles to be installed in exterior walls.

2.11 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports that are not a part of structural-steel framework as necessary to complete the Work.

B. Fabricate units from structural-steel shapes, plates, and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.

C. Fabricate supports for operable partitions as follows:

1. Beams: Continuous steel shapes of sizes indicated with attached bearing plates, anchors, and braces as indicated. Drill bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.

2. Where wood nailers are attached to girders with bolts or lag screws, drill holes at 24 inches o.c.

D. Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel baseplates and top plates as indicated. Drill baseplates and top plates for anchor and connection bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness, unless otherwise indicated.

1. Unless otherwise indicated, provide 1/2-inch baseplates with four 5/8-inch anchor bolts and 1/4-inch top plates.

E. Galvanize miscellaneous framing and supports where indicated.

2.12 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from structural-steel shapes, plates, and bars of profiles shown with continuously welded joints, and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work. Provide anchors, welded to trim, for embedding in concrete or masonry construction, spaced not more than 6 inches from each end, 6 inches from corners, and 24 inches o.c., unless otherwise indicated.

C. Galvanize miscellaneous steel trim in the following locations:
   1. Exterior.

2.13 STRUCTURAL-STEEL DOOR FRAMES

A. Fabricate steel door frames from structural shapes and bars of size and to dimensions indicated, fully welded together, with 5/8-by-1-1/2-inch steel channel stops, unless otherwise indicated. Plug-weld built-up members and continuously weld exposed joints. Secure removable stops to frame with countersunk machine screws, uniformly spaced at not more than 10 inches o.c. Reinforce frames and drill and tap as necessary to accept finish hardware.

B. Provide steel strap anchors, 1/8 by 2 inches, with a minimum 6-inch embedment and 2-inch hook, unless otherwise indicated, for securing door frames into adjoining concrete or masonry. Weld anchors to frame jambs no more than 12 inches from both bottom and head of frame, and space anchors not more than 30 inches apart.

C. Extend bottom of frames to floor elevation indicated with steel angle clips welded to frames for anchoring frame to floor with expansion shields and bolts.

D. Galvanize frames in the following locations:

   1. Exterior.

2.14 PIPE BOLLARDS

A. Fabricate pipe bollards from Schedule 40 steel pipe.

   1. Cap bollards with 1/4-inch- minimum steel plate.

2.15 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

2.16 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:

1. ASTM A123, for galvanizing steel and iron products.

2. ASTM A153/A 153M, for galvanizing steel and iron hardware.

B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed metal fabrications:

1. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."

C. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

E. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

3.2 SETTING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Install anchor bolts in accordance with plans. Vacuum clean all drillings prior to applying epoxy bonding agent. Unless otherwise specified, use Hiliti HY-200 2-part epoxy to bond anchor bolts to concrete.

1. Wedge anchors are not permissible.

C. Set bearing and leveling plates leveling nuts unless otherwise specified in drawings as imbeds. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.

1. Unless otherwise specified in drawings use 10,000 psi non-shrink grout, nonmetallic, in beneath structural steel member and bearing plate.

2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.3 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings, if any.

B. Anchor supports for operable partitions securely to and rigidly brace from building structure.

C. Support steel girders on concrete or steel pipe columns. Secure girders with anchor bolts embedded in concrete or with bolts through top plates of pipe columns.

1. Where grout space under bearing plates is indicated at girders supported on concrete, install as specified above for setting and grouting bearing and leveling plates.

D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified above for setting and grouting bearing and leveling plates.

1. Do not grout baseplates of columns supporting steel girders until girders are installed and leveled.

3.4 INSTALLING PIPE BOLLARDS

A. Anchor bollards in place with concrete footings. Support and brace bollards in position in footing excavations until concrete has been placed and cured.

B. Fill bollards solidly with concrete, mounding top surface.

3.5 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 9 Section "Painting."

END OF SECTION

SECTION 05550
ACCESS HATCHES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This item shall consist of the furnishing and installation of factory fabricated access hatches and associated appurtenances as shown on the Drawings.

B. The minimum clear opening shown on the Drawings must be met, without exception.

1.02 RELATED WORK

A. SECTION 01330 - SUBMITTALS

B. SECTION 05500 - MISCELLANEOUS METALS

1.03 SUBMITTALS

A. Submit shop drawings, catalog cuts, technical specifications, warranty information, and other descriptive material for review and approval in accordance with Specifications SECTION 01330 - SUBMITTALS. Submittals shall include the following:

1. Product Data: Manufacturer's specifications, standard details, and installation recommendations.

2. Shop Drawings: Submit edited product data or shop drawings, or a combination thereof, as required to accurately describe installation of the products to be provided. Show elevations, field measurements, reinforcement, anchorages, expansion provisions, installation accessories, and detail sections of composite members.

3. O&M Data per SECTION 01782 - OPERATION AND MAINTENANCE DATA.

B. Number of Copies: Submit six (6) copies of each submittal, unless otherwise indicated. ENGINEER will return two (2) copies.

1.04 APPLICABLE STANDARDS AND SPECIFICATIONS

A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by basic designation only.

B. American Society For Testing And Materials (ASTM)

1. ASTM A 36: Standard Specification for Structural Steel.

2. ASTM A193/A193M Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.

3. ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

4. ASTM B211 Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire.

5. ASTM B316/B316M Standard Specification for Aluminum and Aluminum-Alloy R and Cold-Heading Wire and Rods.

1.05 PERFORMANCE REQUIREMENTS

A. Operation of the covers shall be smooth and easy with controlled operation throughout the entire arc of opening and closing.

B. Operation of the covers shall not be affected by temperature.

1.06 OPERATION AND MAINTENANCE MANUALS

A. Operation and maintenance manuals shall be provided by the equipment manufacturer. Each manual shall be an index binder prepared specifically for this project and submitted in accordance with SECTION 01782 - OPERATION AND MAINTENANCE DATA.

B. As a minimum the manual shall contain:

1. A complete bill of materials.

2. General arrangement drawings.

3. Detail drawings showing size, anchorages, supports, installation details, and dimensions needed for installation and correlation with other materials and equipment.

4. Cut sheets and product information.

5. Statement of Structural Suitability.

6. Written copy of Manufacturer's standard warranty.

1.07 WARRANTY

A. The CONTRACTOR shall bear full responsibility for the proper installation of all access covers and hatches within the structures as shown on the plans.

B. The CONTRACTOR shall guarantee that the equipment furnished and installed shall be free from defects in design, materials and workmanship for one year from date of final acceptance by the OWNER.

C. Materials shall be free of defects in material and workmanship for a minimum period of one (1) year from the date of OWNER'S acceptance. Should a part fail to function in normal use within this period, CONTRACTOR shall repair the installation at no charge.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Products of the following manufacturers, provided they comply with requirements of the Contract Documents, will be among those considered acceptable.

1. Bilco Co.;

2. Halliday Products;

3. Engineer approved equal.

2.02 ACCESS COVERS AND HATCHES

A. Furnish and install access covers and hatches where indicated and according to the dimensions shown on plans.

B. Access covers and hatches shall be pre-assembled from the manufacturer.

C. All access covers shall be able to be secured by a padlock using a heavy duty hasp. OWNER will provide padlocks at the time of acceptance of the station.

2.03 FUNCTIONAL REQUIREMENTS

A. Required Clearances - All access hatches shall be sized large enough for removal of any equipment or piping inside the wet well or vaults.

2.04 MATERIALS

A. Metal cover: Mill finish sheet aluminum; ASTM B209; alloy and temper to suit specified finishes; minimum 1/4 in. thick, diamond pattern plate to withstand a live load of 300 lb./ft.^{2} with a maximum deflection of 1/150th of the span.

B. Frame: Minimum 1/4 in. thick extruded aluminum with strap anchors bolted to the exterior.

C. Fasteners

1. For attachment to supporting structure: stainless steel.

2. For aluminum: Made from the following, according to manufacturer's standard practice:

a. Stainless steel: ASTM A193, B8 series.

b. Aluminum: ASTM B211, alloy 2024-T4 for threaded fasteners; ASTM B316 for rivets.

3. For dissimilar metals: Stainless steel, ASTM A193, B8 series.

D. Structural Supports and Reinforcements: Aluminum; alloy and temper to suit installation.

E. Hinges: Shall be specifically designed for horizontal installation and shall be bolted to the underside of covers.

F. Lifting mechanisms: Cam-action hinges shall pivot on torsion bars to provide, smooth, easy, and controlled cover operation throughout the entire arc of opening and to act as a check in retarding downward motion of the cover when closing.

G. Hold-open arm: set to hold cover at 90 degrees, with detent release.

H. A removable exterior turn/lift handle with a spring loaded ball detent shall be provided to open the covers.

I. Hardware

1. Hinges: Cast steel cam-action hinges which pivot on torsion bars shall be provided.

2. Covers shall be equipped with a steel hold open arm that automatically locks the cover in the open position.

3. Covers shall be fitted with the required number and size of torsion bars.

4. A Type 316 stainless steel snap lock with fixed handle shall be mounted on the underside of the cover.

5. Miscellaneous Hardware: Stainless steel, Type 316.

6. All hatches shall have a means to install a padlock to lock shut the hatch.

2.05 FINISHES

A. Factory finish shall be mill finish aluminum with bituminous coating applied to the exterior of the frame, with welds cleaned and dressed and exposed welds ground smooth.

B. Remove oil, grease, dirt, and weld spatter from finished units.

2.06 ISOLATION COATINGS

A. Zinc molybdate alkyd primer: FS TT-P-645.

B. Bituminous coating: FS TT-C-494, Type II.

2.07 FALL PREVENTION DEVICES

A. Safety grates shall be provided for the access hatches as indicated on the Drawings.

B. The safety grates shall be made of 6061-T6 aluminum with a minimum ultimate strength of 38,000 p.s.i. and a minimum yield strength of 35,000 p.s.i. as per ASTM B221. Grate design shall use safety factors as defined in the specifications for aluminum structures. Grating shall be designed to withstand a minimum live load of 300 pounds per square foot. Deflection shall not exceed 1/150th of the span.

C. The grate openings shall allow for visual inspection and limited maintenance while the safety grate fall through protection is left in place. Each grate shall be provided with the permanent hinging system, which will lock the grate in the 90 degree position once opened.

D. Grates in the open position shall create a physical barrier around the opening, protecting passing pedestrians. Safety grates shall have an opening arm, with a red vinyl grip handle, which will allow opening of the grate, while providing the grate as a barrier between the operator and the pit. The opening arm shall also be equipped with a controlled confined space entry lock. This locking device will prevent unauthorized entry to the confined space. The grating system will allow anyone to make visual inspection and float adjustments (at the Lift Station) without entering the confined space.

E. Grate shall be coated with an OSHA type safety orange color, promoting visual awareness of the hazard. The aluminum safety grate shall receive a two-coat power coat system, applied by the electrostatic spray process. The base coat is a thermosetting epoxy powder coat finish with a minimum thickness of 2-4 mils. The top coat is a mar-resistant, TGIC polyester powder coating with a minimum thickness of 2-4 mils. Each coat shall be baked at 350°F - 375°F until cured.

PART 3 - EXECUTION

3.01 PRODUCT HANDLING

A. All materials shall be delivered in manufacturer's original packaging.

B. Store materials in a dry, protected, well-vented area. The CONTRACTOR shall thoroughly inspect product upon receipt and report damaged material immediately to delivering carrier and note such damage on the carrier's freight bill of lading.

3.02 EXAMINATION

A. Verify that other trades with related work are complete before installing vault access door(s).

B. Verify that substrates and openings are rigidly set, at proper lines and elevation, properly sized, and ready to receive units.

C. Do not proceed with installation until conditions detrimental to proper installation have been corrected.

D. Coordinate installation with other work.

3.03 PREPARATION

A. Coat contact surfaces of dissimilar metals with one or more coats of isolation coating.

B. Apply one 15-mil dry film thickness coat of bituminous isolation coating to metal surfaces other than galvanized steel which will be in contact with cementitious materials.

3.04 INSTALLATION

A. Observe all appropriate OSHA safety guidelines for this work.

B. Check installation conditions and verify the manufacturer's vault access door details for accuracy to fit the application prior to fabrication. The installer shall comply with the vault access door manufacturer's installation instructions.

C. Furnish all mechanical fasteners and appurtenances consistent with the vault access door manufacturer's instructions.

D. Install products in accordance with manufacturer's instructions, except where more stringent requirements are shown or specified, and except where project conditions require extra precautions or provisions to ensure satisfactory performance of the work.

E. Install products in correct location, plumb and true, without warp or twist.

3.05 CLEANING AND PROTECTION

A. Install rigid protective cover on access hatch to protect hatch during concrete casting and construction activity.

B. Touch up marred or abraded areas of finished elements. If satisfactory touch-up cannot be accomplished, remove and replace element.

END OF SECTION

SECTION 09915
PROTECTIVE COATINGS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The work included in this section of the specifications consists of the complete furnishing, application and appurtenances for the protective coatings required at the facility as herein described and as shown on the plans. The objective of these specifications is to provide the material and workmanship necessary to produce a first-class job.

1.02 RELATED WORK

A. Drawings and general provisions of the Contract, including General and Special Conditions and DIVISION 1 - GENERAL REQUIREMENTS sections, apply to this Section.

1.03 SUBMITTALS

A. Product Data: For each paint system indicated. Include block fillers and primers.

1. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material.

2. Number of Copies: Submit six (6) copies of each submittal, unless otherwise indicated. ENGINEER will return two (2) copies.

1.04 QUALITY ASSURANCE

A. General: Quality assurance procedures and practices shall be utilized to monitor all phases of surface preparation, application and inspection throughout the duration of the project. Procedures or practices not specifically defined herein may be utilized provided they meet recognized and accepted professional standards and are approved by the ENGINEER.

B. Surface Preparation: Surface preparation will be based upon comparison with: "Pictorial Surface Preparation Standards for Painting Steel Surfaces: SSPC-VIS 1-89", ASTM Designation D2200-95, "Standard Methods of Evaluating Degree of Rusting on Painted Surfaces", ASTM D 4417-91, Method A and/or Method C or NACE Standard RP0287-87, and ASTM Designation D610 "Visual Standard for Surfaces of New Steel Air blast Cleaned with Sand Abrasive". In all cases the written standard shall take precedence over the visual standard. In addition, NACE Standard SP0178, along with the Visual Comparator, shall be used to verify the surface preparation of welds.

C. Application: No coating or paint shall be applied when:

1. The surrounding air temperature or the temperature of the surface to be coated or painted is below the minimum surface temperature for the products specified herein.

2. Rain, snow, fog or mist is present.

3. The temperature is less than 5°F above the dew point.

4. The air temperature is expected to drop below the minimum temperature for the products specified within six hours after application of coating. Dew point shall be measured by use of an instrument such as a Sling Psychrometer in conjunction with U.S. Department of

Commerce Weather Bureau Psychometric Tables. If any of the above conditions are prevalent, coating or painting shall be delayed or postponed until conditions are favorable. The day's coating or painting shall be completed in time to permit the film sufficient drying time prior to damage by atmospheric conditions.

D. Coating Thickness: Thickness of coatings and paint shall be measured checked according to the procedures outlined in SSPC-PA 2 “Measurement of Dry Film Thickness with Magnetic Gages”, May 2012 Edition. Dry film thickness shall be a Level 2 as defined in Paragraph 9.2, excepting that no single gage reading shall be less than 80 percent of the specified dry film thickness. Areas that fail to meet these criteria shall be corrected at no expense to the OWNER. Use of an instrument such as a Tooke Gauge, precision groove grinder, etc. is permitted if a destructive test is deemed necessary by the ENGINEER and the total DFT is less than 50 mils.

E. Holiday (Pinhole) Testing: The integrity of coated surfaces scheduled for immersion shall be tested for holidays in accordance with NACE Standard SP0188. For dry films less than 20 mils, a non-destructive holiday detector shall not exceed 67.5 volts, nor shall destructive holiday detector exceed the voltage recommended by the manufacturer of the coating system. A solution of 1 oz. non-sudsing type wetting agent, such as Kodak Photo-Flo, and 1 gal. of tap water shall be used to perform the holiday testing. For coating thickness at 20 mils and greater, a high voltage Tinker & Rasor AP/W holiday tester shall be used. Contact coating manufacturer for voltage recommendations and curing parameters.

1. All pinholes and/or holidays shall be marked and repaired in accordance with the manufacturer's printed recommendations and retested. No pinholes or other irregularities will be permitted in the final coating.

F. Inspection Devices: The CONTRACTOR shall furnish, until final acceptance of coating and painting is accepted, inspection devices in good working condition for detection of holidays and measurement of dry film thickness of coating and paint. The CONTRACTOR shall also furnish U.S. Department of Commerce, National Bureau of Standards certified thickness calibration plates and/or plastic shims, depending upon the thickness gauge used, to test the accuracy of dry film thickness gauges and certified instrumentation to test the accuracy of holiday detectors. Dry film gauges and holiday detectors shall be made available for the ENGINEER'S use at all times until final acceptance of application. Holiday detection devices shall be operated in the presence of the ENGINEER.

G. Inspection: Inspection for this project shall consist of ‘hold point’ inspections. The ENGINEER or his representative shall inspect the surface prior to abrasive blasting, after abrasive blasting but prior to application of coating materials, and between subsequent coats of material. Final inspection shall take place after all coatings are applied, but prior to placing the tank in service. CONTRACTOR will insure that sufficient rigging is in place so that the ENGINEER or his representative shall be able to conduct the required inspections.

H. Warranty Inspection: Warranty inspection shall be conducted during the eleventh month following acceptance of all coating and painting work. All defective work shall be repaired in accordance with this specification and to the satisfaction of the ENGINEER and/or OWNER.

1.05 CONTRACTOR

A. The CONTRACTOR shall have three years practical experience and successful history in the application of specified products to surfaces of the treatment plants. Upon request, he shall substantiate this requirement by furnishing a list of references and job completions.

B. The CONTRACTOR shall submit with his bid a written statement by the coatings manufacturer stating that the CONTRACTOR is familiar with the materials specified and has workers capable of performing the work specified herein.

C. C. The personnel performing the work shall be knowledgeable and have the required experience and skill to adequately perform the work for this project, in accordance with SSPC-PA1, “Shop, Field and Maintenance Painting”.

1.06 SAFETY AND HEALTH REQUIREMENTS

A. General: In accordance with requirements set forth by regulatory agencies applicable to the construction industry and manufacturer's printed instructions and appropriate technical bulletins and manuals, the CONTRACTOR shall provide and require use of personal protective lifesaving equipment for persons working on or about the project site.

B. Head and Face Protection and Respiratory Devices: Equipment shall include protective helmets, which shall be worn by all persons while in the vicinity of the work. In addition, workers engaged in or near the work site during sandblasting shall wear eye and face protection devices and air purifying, half-mask or mouthpiece respirators with appropriate filters. Barrier creams shall be used on any exposed areas of skin.

C. Ventilation: Where ventilation is used to control hazardous exposure, all equipment shall be explosion-proof. Ventilation shall reduce the concentration of air contaminants to the degree a hazard does not exist. Air circulation and exhausting of solvent vapors shall be continued until coatings have fully cured.

D. Sound Levels: Whenever the occupational noise exposure exceed maximum allowable sound levels, the CONTRACTOR shall provide and require the use of approved ear protective devices.

E. Illumination: Adequate illumination shall be provided while work is in progress, including explosion-proof lights and electrical equipment. Whenever required by the ENGINEER, the CONTRACTOR shall provide additional illumination and necessary supports to cover all areas to be inspected. The ENGINEER and/or Inspector shall determine the level of illumination.

F. Temporary Ladders and Scaffolding: All temporary ladders and scaffolding shall conform to applicable safety requirements. They shall be erected where requested by the ENGINEER to facilitate inspection and be moved by the CONTRACTOR to locations requested by the ENGINEER.

1.07 PRODUCT DELIVERY, STORAGE & HANDLING

A. All materials shall be brought to the jobsite in original sealed containers. They shall not be used until the ENGINEER has inspected the contents and obtained data from information on containers or label. Materials exceeding storage life recommended by the manufacturer shall be rejected.

B. All coatings and paints shall be stored in enclosed structures to protect them from weather and excessive heat or cold. Flammable coatings and paints must be stored to conform with City, County, State and Federal safety codes for flammable coating or paint materials. At all times coatings and paints shall be protected from freezing.

1.08 DEFINITIONS

A. General: Standard coating terms defined in ASTM D 16 apply to this Section.

1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85 degree meter.

2. Eggshell refers to low-sheen finish with a gloss range between 20 and 35 when measured at a 60 degree meter.

3. Semigloss refers to medium-sheen finish with a gloss range between 35 and 70 when measured at a 60 degree meter.

4. Full gloss refers to high-sheen finish with a gloss range more than 70 when measured at a 60 degree meter.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Materials specified are those that have been evaluated for the specific service. Products of the **Tnemec Company, Inc.** are listed to establish a standard of quality. Equivalent materials of other manufacturer's may be submitted on written approval of the ENGINEER, prior to Bid. As part of the proof of equality, the ENGINEER will require at the cost of the CONTRACTOR, certified test reports from a nationally known, reputable and independent testing laboratory conducting comparative tests as directed by the ENGINEER between the product specified and the requested substitution.

B. Requests for substitution shall include manufacturer's literature for each product giving name, product number, generic type, descriptive information, solids by volume, recommended dry film thickness and certified lab test reports showing results to equal the performance criteria of the products specified herein. In addition, a list of five projects shall be submitted in which each product has been used and rendered satisfactory service.

C. All requests for product substitution shall be made at least fourteen (14) days prior to the bid date.

D. Any material savings shall be passed to the OWNER in the form of a contract dollar reduction.

E. Manufacturer's color charts shall be submitted to the ENGINEER at least thirty (30) days prior to coating and/or paint application. General Contractor and Painting Contractor shall coordinate work so as to allow sufficient time (normally seven to ten days) for paint to be delivered to the job site.

2.02 GENERAL REQUIREMENTS

A. All materials shall be lead-free as defined by the Consumer Product Safety Act, Part 1303.

B. All zinc dust pigment contained in any zinc-rich material shall meet the requirements of ASTM D 520 Type III as regards zinc content and purity.

C. No coatings shall contain Methylene Dianiline (MDA). All coatings, including all colors, shall be lead-free.

D. All catalyzed polyurethane products shall meet the minimum requirements of SSPC Paint Specification Number 36, Level 3 Performance Level.

2.03 HOT DIP GALVANIZING

A. This section applies to all equipment items and related appurtenances specified to be hot dip galvanized, as described herein or as shown on the plans.

B. Galvanizing shall conform to the Standard Specifications of ASTM A-123, A-386-73, and A-120-72A, as applicable latest edition of Zinc (Hot-Galvanized) Coating on Structural Steel Shapes, Plates and Bars and their products. Zinc used for hot dipped galvanizing shall conform to ASTM Designation B-6-70. Galvanizing shall be performed after components are completely fabricated.

C. Pieces shall be fabricated in maximum sizes suitable for shipping and galvanizing. The equipment shall be designed and fabricated per ASTM A-143, A-384, and A-385 for bolt-together field assembly. No field welding on hot dipped galvanized equipment will be permitted.

D. Minor defects in the hot dipped galvanizing coating caused by shipping; handling or installation shall be repaired after equipment installation. The defects shall be thoroughly cleaned and wire brushed to remove all foreign substances, wiped clean with a suitable solvent, thoroughly dried, and coated with at least 3 mils of a zinc rich compound specifically formulated for touch-up galvanizing and conforming to USN Specification MIL-P-21035 or USAF Specification MIL-P-26915A.

E. All galvanized members delivered to the job site shall be stored by the CONTRACTOR in a position whereby they are raised off the ground and separated with strip spacers to provide free access of air to all parts of the surface. Stored members shall also be inclined in such a manner as to give maximum drainage. Resinous wood may not be used for spacers or packing of hot dip galvanized members.

2.04 PAINT COLORS

A. Buildings - Colors for buildings, including Interior, Exterior, and Trimwork, shall be as selected by the OWNER prior to application.

B. Piping - All exposed piping for the project shall be uncoated as delivered from the supplier. No asphalt coatings will be accepted for exposed piping. All exposed piping shall be painted as specified herein. The colors for piping shall be as follows:

PIPE USAGE	COLOR OF PIPE
Potable Water (Hot or Cold)	Lt. Blue
Non Potable Water (Hot or Cold)	Safety Purple
Chlorine Solution	Safety Yellow with Red Bands*
Sodium Hypochlorite (Bleach)	Safety Yellow with Red Bands*
Polymer	White with Safety Green Bands*
Waste Activated Sludge	Med. Brown
Thickened Waste Activated Sludge	Med. Brown
Return Activated Sludge (RAS)	Med. Brown
Grease (Lubrication)	Black with Yellow Bands*
Secondary Scum	Med. Gray
Drain Lines	Med. Gray
Valve Wheels and Tops	Safety Red
Compressed Air	Lt. Green

PIPE USAGE	COLOR OF PIPE
Power Conduit	Safety Orange
Reclaimed Water Lines	Safety Purple
Raw Sewage	Med. Grey
* Bands are six (6) inches wide and spaced five (5) feet apart. The lines that are less than five (5) feet long will have the band centered on the pipe.	

C. Pipe Identification

1. Location. Lettering and flow direction arrows shall be provided on pipe near the equipment served, adjacent to valves, on both sides of wall and floor penetrations, at each branch or tee, and at least every 50 ft. in straight runs of pipe. If, in the opinion of the ENGINEER, this requirement will result in an excessive number of labels or arrows, the number required shall be reduced as directed.

2. Metal Tags. Where the outside diameter of pipe or pipe covering is 5/8 in. or smaller, aluminum or stainless steel tags shall be provided instead of lettering. Tags shall be stamped as specified and shall be fastened to the pipe with suitable chains. Pipe identified with tags shall be color coded as specified.

3. Lettering. Lettering shall be painted or stenciled on piping or shall be applied as snap-on markers. Snap-on markers shall be plastic sleeves, Brady “Bradysnap-On B-915" or Seton “Setmark”. Letter size shall be as follows:

OUTSIDE DIAMETER OF PIPE OR COVERING	MINIMUM HEIGHT OF LETTERS
5/8 in. and smaller	Metal tags – 1/4 in.
3/4 in. to 4 in.	3/4 in.
5 in. and larger	2 in.

D. Miscellaneous – Colors for components not described above shall be as selected by the OWNER prior to application.

2.05 PAINTING

A. The work proposed herein shall consist of all labor, materials, equipment, etc. necessary to provide the painting system specified herein for those components which require a paint system, as described herein and as shown on the plans. The work shall consist primarily of cleaning the surfaces of all scale, loose paint, and sediment, and painting to the treatment unit steel components to the specifications which follow herein.

B. The objective of these specifications is to provide the material and workmanship necessary to produce a first class job. All painting shall be done strictly in accordance with the manufacturer’s instructions and shall be performed in a manner satisfactory to the ENGINEER.

C. CONTRACTOR responsibilities

1. The CONTRACTOR is required to submit the following upon selection:

a. CONTRACTOR qualifications certifying experience and references for the work contemplated.

b. Safety Program in writing and a schedule of regularly scheduled safety orientation meetings.

c. Detailed work schedule.

d. Quality Control program.

2.06 COATING REQUIREMENTS

A. REFERENCE SPECIFICATIONS AND STANDARDS

1. Without limiting the general aspects of other requirements of these specifications, all surface preparation, coating and painting of interior and exterior surfaces and inspection shall conform to the applicable requirements of SSPC (Society for Protective Coatings), NACE International, ASTM (American Society for Testing and Materials), AWWA and the manufacturer's printed instructions.

   a. ASTM (American Society for Testing and Materials)

      1) ASTM D 520; Standard Specification for Zinc Dust Pigment

      2) ASTM D 4417; Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel

      3) ASTM E 337; Standard Practice Test Method for Measuring Humidity with a Psychrometer

      4) ASTM D2200; Standard Methods of Evaluating Degree of Rusting on Painted Surfaces

   b. ANSI (American National Standards Institute)

      1) ANSI/ASC 29.4 Exhaust Systems Abrasive; Blasting Operations - Ventilation and Safe Practice

   c. Consumer Product Safety Act, Part 1303

   d. ICRI (International Concrete Restoration Institute)

      1) Guideline No. 03732; Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays

   e. NACE International

      1) NACE Publication TPC2; Coatings and Linings for Immersion Service: Chapter 1 Safety, Chapter Surface Preparation, Chapter 3 Curing, and Chapter 4 Inspection

      2) NACE Standard SP0178; Standard Recommended Practice – Fabrication Details, Surface Finish Requirements and Proper Design Considerations for Tanks and Vessels to be lined for Immersion Service

      3) NACE Standard SP0188; Standard Recommended Practice – Discontinuity (Holiday) Testing of Protective Coatings

4) NACE Standard RP0287; Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surfaces Using a Replica Tape

5) NACE Standard RP0288; Standard Recommended Practice, Inspection of Linings on Steel and Concrete

f. OSHA (Occupational Safety & Health Administration)

1) 1915.35; Standards – 29 CFR – Painting

g. SSPC (Society for Protective Coatings)

1) SSPC-SP2; Hand Tool Cleaning

2) SSPC-SP3; Power Tool Cleaning

3) SSPC-SP13; Surface Preparation of Concrete

4) SSPC-PA-1; Shop, Field and Maintenance Painting

5) SSPC-PA-2; Measurement of Dry Film Thickness with Magnetic Gages

6) SSPC-PA-3; Guide to Safety in Paint Application

7) SSPC-Guide 12; Guide for Illumination of Industrial Painting Project

8) SSPC-VIS 1-89; Pictorial Surface Preparation Standards for Painting Steel Surfaces

9) SSPC Paint Spec 36; Two-Component Weatherable Aliphatic Polyurethane Topcoat, Performance-Based

h. SSPC/NACE Joint Standards

1) SSPC-SP5/NACE 1; White Metal Blast Cleaning

2) SSPC-SP6/NACE 3; Commercial Blast Cleaning

3) SSPC-SP7/NACE 4; Brush-Off Blast Cleaning

4) SSPC-SP10/NACE 2; Near-White Metal Blast Cleaning

5) SSPC-SP13/NACE 6; Surface Preparation of Concrete

i. NAPF (National Association of Pipe Fabricators)

1) NAPF 500-03-01; Solvent Cleaning

2) NAPF 500-03-04; Abrasive Blast Cleaning for Ductile Iron Pipe

3) NAPF 500-03-05; Abrasive Blast Cleaning for Cast Ductile Iron Fittings

2. The ENGINEER'S decision shall be final as the interpretation and/or conflict between any of the referenced specifications and standards contained herein.

2.07 MATERIAL PREPARATION

A. Mix and thin materials according to manufacturer's latest printed instructions.

B. Do not use materials beyond manufacturer's recommended shelf life.

C. Do not use mixed materials beyond manufacturer's recommended pot life.

D. Do not split kits of multi-component products.

2.08 SUBMERGED & INTERMITTENTLY SUBMERGED COATING SCHEDULE

A. The number of coats called for in this schedule shall be considered minimum. If more coats are required for complete coverage and uniform appearance, they shall be applied. The OWNER from standard manufacturer's color samples will select colors.

1. Pipes, fittings, pumps (not described to be hot dipped galvanized).

a. Surface Preparation Prior to Abrasive Blast Cleaning: Weld flux and spatter shall be removed by power tool cleaning. Sharp projections shall be ground to a smooth contour. All welds shall be ground to a smooth contour as per NACE Standard SP0178, Designation D.

b. Surface Preparation: SSPC-SP10 Near-White Metal Blast Cleaning. Anchor profile shall be angular with a 2.0 mil profile as per ASTM D 4417, Method C or NACE Standard RP0287.

c. Coating System

1) First Coat: Tnemec Series 1 Omnithane applied at 2.5 to 3.5 dry mils.

2) Second Coat: Tnemec Series 446 Perma-Shield MCU applied at 6.0 to 8.0 dry mils.

3) Third Coat: Tnemec Series 446 Perma-Shield MCU applied at 6.0 to 8.0 dry mils.

d. Total minimum dry film thickness shall be 13.0 mils as per Section 1.05, Paragraph D.

2. Ductile Iron Piping, Valves & Fittings in Immersion

a. Surface Preparation

1) Clean all surfaces as per NAPF 500-03-01 Solvent Cleaning to remove all oil, grease, factory-applied tars and/or bitumastic coatings and all other soluble contaminants.

2) Prepare ductile iron pipe as per NAPF 500-03-04 Abrasive Blast Cleaning for Ductile Iron Pipe providing a minimum 1.5 mil angular anchor profile.

3) Prepare ductile iron valves and fittings as per NAPF 500-03-05 Abrasive Blast Cleaning for Cast Ductile Iron Fittings.

4) If existing ductile is factory coated with Tnemec Series N140, please follow recoat windows listed on the current product data sheet.

b. Coating System

1) First Coat: Tnemec Series N69 Hi-Build Epoxoline II applied at 3.0 to 5.0 dry mils.

2) Second Coat: Tnemec Series 446 Perma-Shield MCU applied at 5.0 to 9.0 dry mils.

3) Third Coat: Tnemec Series 446 Perma-Shield MCU applied at 5.0 to 9.0 dry mils.

c. Total minimum dry film thickness shall be 24.0 mils.

2.09 NON-SUBMERGED PAINTING SCHEDULE

A. The number of coats called for in this schedule shall be considered minimum. If more coats are required for complete coverage and uniform appearance, they shall be applied. The OWNER from standard manufacturer's color samples will select colors.

1. Exterior Exposed Ferrous Metal

a. Surface Preparation Prior to Abrasive Blast Cleaning: Weld flux and spatter shall be removed by power tool cleaning. Sharp projections shall be ground to a smooth contour. All welds shall be ground to a smooth contour as per NACE Standard SP0178, Designation D.

b. Surface Preparation: SSPC-SP6 Commercial Blast Cleaning. Anchor profile shall be angular with a 1.5 to 2.0 mil profile as per ASTM D 4417, Method C or NACE Standard RP0287.

c. Coating System

1) First Coat: Tnemec Series 90G-1K97 Tneme-Zinc applied at 2.5 to 3.5 dry mils.

2) Stripe Coat: Tnemec Series 27WB Typoxy applied by brush and scrubbed into all weld seams. In addition to weld seams, all edges, corners, bolts, rivets, pits, etc. shall receive a stripe coat.

3) Second Coat: Tnemec Series 27WB Typoxy applied at 4.0 to 6.0 dry mils.

4) Third Coat: Tnemec Series 740 UVX applied at 3.0 to 5.0 dry mils. (Application by brush or roller may require two coats to achieve specified film thickness.)

d. Total minimum dry film thickness shall be 10.0 mils.

2. Interior Exposed Structural & Miscellaneous Steel, Piping, Valves, Etc. (Not described as hot dipped galvanized)

a. Surface Preparation Prior to Abrasive Blast Cleaning: Weld flux and spatter shall be removed by power tool cleaning. Sharp projections shall be ground to a smooth contour. All welds shall be ground to a smooth contour as per NACE Standard SP0178, Designation D for Lap, Butt & Fillet Welds.

b. Surface Preparation: SSPC-SP6 Commercial Blast Cleaning. Anchor profile shall be angular with a 1.5 to 2.0 mil profile as per ASTM D 4417, Method C or NACE Standard RP0287.

c. Coating System

1) First Coat: Tnemec Series 90G-1K97 Tneme-Zinc applied at 2.5 to 3.5 dry mils.

2) Second Coat: Tnemec Series 66 Hi-Build Epoxoline applied at 4.0 to 6.0 dry mils.

3) Third Coat: Tnemec Series 66 Hi-Build Epoxoline applied at 4.0 to 6.0 dry mils.

d. Total minimum dry film thickness shall be 10.5 mils.

3. Exterior Exposed Ductile Piping, Valves & Fittings

a. Surface Preparation

1) Clean all surfaces as per NAPF 500-03-01 Solvent Cleaning to remove all oil, grease, factory-applied tars and/or bitumastic coatings and all other soluble contaminants.

2) Prepare ductile iron pipe as per NAPF 500-03-04 Abrasive Blast Cleaning for Ductile Iron Pipe providing a minimum 1.5 mil angular anchor profile.

3) Prepare ductile iron valves and fittings as per NAPF 500-03-05 Abrasive Blast Cleaning for Cast Ductile Iron Fittings.

4) If existing ductile is factory coated with Tnemec Series N140, please follow recoat windows listed on the current product data sheet.

b. Coating System

1) First Coat: Tnemec Series N69 Hi-Build Epoxoline II applied at 8.0 to 6.0 dry mils.

2) Second Coat: Tnemec Series N69 Hi-Build Epoxoline II applied at 6.0 to 8.0 dry mils.

3) Third Coat: Tnemec Series 740 UVX applied at 3.0 to 5.0 dry mils.

c. Total minimum dry film thickness shall be 13.0 mils.

4. Interior Exposed Ductile Piping, Valves & Fittings

a. Surface Preparation

1) Clean all surfaces as per NAPF 500-03-01 Solvent Cleaning to remove all oil, grease, factory-applied tars and/or bitumastic coatings and all other soluble contaminants.

2) Prepare ductile iron pipe as per NAPF 500-03-04 Abrasive Blast Cleaning for Ductile Iron Pipe providing a minimum 1.5 mil angular anchor profile.

3) Prepare ductile iron valves and fittings as per NAPF 500-03-05 Abrasive Blast Cleaning for Cast Ductile Iron Fittings.

4) If existing ductile is factory coated with Tnemec Series N140, please follow recoat windows listed on the current product data sheet.

b. Coating System

1) First Coat: Tnemec Series N69 Hi-Build Epoxoline II applied at 6.0 to 8.0 dry mils.

2) Second Coat: Tnemec Series N69 Hi-Build Epoxoline II applied at 6.0 to 8.0 dry mils

c. Total minimum dry film thickness shall be 12.0 mils.

5. Exterior Exposed Factory Primed Metal

a. Surface Preparation: All surfaces shall be dry, clean and free of all contaminants. Clean all surfaces as per SSPC-SP2 or SP3 Hand or Power Tool Cleaning. Apply a test patch to ensure compatibility.

b. Coating System

1) First Coat: Tnemec Series 1 Omnithane applied at 2.5 to 3.5 dry mils.

2) Second Coat: Tnemec Series 740 UVX applied at 3.0 to 5.0 dry mils.

c. Total minimum dry film thickness shall be 6.0 mils.

6. Interior Exposed Factory Primed Metal

a. Surface Preparation: All surfaces shall be dry, clean and free of all contaminants. Clean all surfaces as per SSPC-SP2 or SP3 Hand or Power Tool Cleaning. Apply a test patch to ensure compatibility.

b. Coating System

1) First Coat: Tnemec Series 1 Omnithane applied at 2.5 to 3.5 dry mils.

2) Second Coat: Tnemec Series N69 Hi-Build Epoxoline II applied at 4.0 to 6.0 dry mils.

c. Total minimum dry film thickness shall be 7.0 mils.

7. Exterior CMU Walls

a. Surface Preparation: Allow new mortar and masonry to cure fourteen (14) days. Level all protrusions and mortar spatter. Prepare as per SSPC-SP13/NACE 6 for "Light Service". Fill voids and bugholes with Tnemec Series 215 Epoxy Surfacer or Series 218 MortarClad.

b. Coating System

1) Install two coats of Tnemec Series 660 Prime A Pell 200.

c. Total minimum dry film thickness shall be 14.0 mils.

d. The exterior coating shall apply to all CMU buildings, including the Administration Building."

8. Interior CMU Walls

a. Surface Preparation: Allow new mortar and masonry to cure fourteen (14) days. Level all protrusions and mortar spatter. Prepare as per SSPC-SP13/NACE 6 for "Light Service". Fill voids and bugholes with Tnemec Series 215 Epoxy Surfacer or Series 218 MortarClad.

b. Coating System

1) First Coat: Tnemec Series 1254 EpoxoBlock WB applied at 75-100 sq. ft. per gallon over lightweight block and CMU. Apply at 100 to 150 sq. ft. per gallon over dense concrete and masonry.

2) Second Coat: Tnemec Series 287 Enviro-Pox applied at 2.0 to 3.0 dry mils.

3) Third Coat: Tnemec Series 287 Enviro-Pox applied at 2.0 to 3.0 dry mils.

c. Total minimum dry film thickness shall be 4.0 mils.

9. Interior Wood Doors, Framing, Window Sash and Woodwork.

a. Surface Preparation: Sand rough areas smooth. Seal knots and pitch pockets. Fill cracks and nail holes after primer is dry. All surfaces must be dry clean and free of all oil, grease, dust, dirt and other contaminants.

b. Coating System

1) First Coat: Tnemec Series 151-1051 Elasto-Grip applied at 1.0 to 1.5 dry mils.

2) Second Coat: Tnemec Series 1029 Enduratone applied at 2.0 to 3.0 dry mils.

3) Third Coat: Tnemec Series 1029 Enduratone applied at 2.0 to 3.0 dry mils.

c. Total minimum dry film thickness shall be 6.0 mils.

10. Exterior Wood Walls, Trim And Wood Siding.

a. Surface Preparation: Sand rough areas smooth. Seal knots and pitch pockets. Fill cracks and nail holes after primer is dry. All surfaces must be dry clean and free of all oil, grease, dust, dirt and other contaminants.

b. Coating System

1) First Coat: Tnemec Series 151-1051 Elasto-Grip applied at 1.0 to 1.5 dry mils.

2) Second Coat: Tnemec Series 1029 Enduratone applied at 2.0 to 3.0 dry mils.

3) Third Coat: Tnemec Series 1029 Enduratone applied at 2.0 to 3.0 dry mils.

c. Total minimum dry film thickness shall be 6.0 mils.

B. WARNING

1. The CONTRACTOR is responsible for any and all claims for creating a nuisance and/or paint damage during the progress of the surface preparation and/or painting and is especially forewarned of this responsibility so that he may exert all possible precaution and care for protection of property.

2. The CONTRACTOR shall observe all the applicable parts of the Williams-Steiger Occupational Safety and Health Act of 1970 and ALL its subsequent amendments and revisions while coating the tank.

C. INSPECTION

1. Testing methods for holidays and dry film thickness are explained above. The CONTRACTOR shall furnish and have on site one Holiday Detector and one Mikrotest Gauge to use on this project. The CONTRACTOR shall provide such scaffolding or hanging chairs necessary for the ENGINEER to make routine inspection of all the CONTRACTOR'S work.

PART 3 - EXECUTION

3.01 GENERAL

A. All surface preparation, coating and painting shall conform to applicable standards of the Society for Protective Coatings, and the manufacturer's printed instructions. Material applied prior to approval of the surface by the ENGINEER, shall be removed and re-applied to the satisfaction of the ENGINEER at the expense of the CONTRACTOR.

B. All work shall be performed by skilled craftsmen qualified to perform the required work in a manner comparable with the best standards of practice. Continuity of personnel shall be maintained and transfers of key personnel shall be coordinated with the ENGINEER.

C. The CONTRACTOR shall provide a supervisor at the work site during cleaning and application operations. The supervisor shall have the authority to sign change orders, coordinate work and make decisions pertaining to the fulfillment of the contract.

D. Dust, dirt, oil, grease or any foreign matter that will affect the adhesion or durability of the finish must be removed by washing with clean rags dipped in an approved cleaning solvent and wiped dry with clean rags.

E. Coating and painting systems include surface preparation, prime coating and finish coatings. Unless otherwise approved in writing by the ENGINEER, prime coating shall be field applied. Where prime coatings are shop applied, the CONTRACTOR shall instruct suppliers to provide the prime coat compatible with the finish coat specified. Any off-site work, which does not conform to this specification, is subject to rejection by the ENGINEER. Shop applied prime coatings, which are damaged during transportation, construction or installation shall be thoroughly cleaned and touched up in the field as directed by the ENGINEER. The CONTRACTOR shall use repair procedures, which insure the complete protection of all adjacent primers. The specified repair method and equipment may include wirebrushing, hand or power tool cleaning or dry air blast cleaning. In order to prevent injury to surrounding painted areas, blast cleaning may require use of lower air pressure, smaller nozzle and abrasive particle sizes, or shorter blast nozzle distance or uneconomical to touch-up, then the item shall be re-cleaned and coated or painted as directed by the ENGINEER.

F. The CONTRACTOR'S coating and painting equipment shall be designed for application of materials specified and shall be maintained in first class working condition. Compressors shall have suitable traps and filters to remove water and oils from the air. The CONTRACTOR'S equipment shall be subject to approval of the ENGINEER.

G. Application of the first coat shall follow immediately after surface preparation and cleaning and stripe coat, if applicable, before rust bloom occurs or the same day, whichever is less. Any cleaned areas not receiving first coat within this period shall be re-cleaned prior to application of first coat. Use of dehumidification equipment shall be first reviewed by the ENGINEER prior to deviating from this provision.

H. Prior to assembly, all surfaces made inaccessible after assembly shall be prepared as specified herein and shall receive the coating or paint system specified.

3.02 SURFACE PREPARATION

A. The latest version of the following surface preparation specifications of the Society for Protective Coatings shall form a part of this specification:

1. Solvent Cleaning (SSPC-SP1): Removal of oil, grease, soil and other contaminants by use of solvents, emulsions, cleaning compounds, steam cleaning or similar materials and methods, which involve a solvent or cleaning action.

2. Hand Tool Cleaning (SSPC-SP2): Removal of loose rust, loose mil scale and other detrimental foreign matter to degree specified by hand chipping, scraping, sanding and wirebrushing.

3. Power Tool Cleaning (SSPC-SP3): Removal of loose rust, loose mil scale and other detrimental foreign matter to degree specified by hand chipping, scraping, sanding and wirebrushing.

4. White Metal Blast Cleaning (SSPC-SP5/NACE 1): Blast cleaning to a gray-white uniform metallic color until each element of surface area is free of all visible residues.

5. Commercial Blast Cleaning (SSPC-SP6/NACE 3): The removal of all visible oil, grease, dirt, dust, mil scale, rust, paint, oxides, corrosion products and other foreign matter by compressed air nozzle blasting centrifugal wheels or other specified method. Discoloration caused by certain stains shall be limited to no more than 33 percent of each square inch of surface.

6. Brush-Off Blast Cleaning (SSPC-SP7/NACE 4): Blast cleaning to remove loose rust, loose mil scale and other detrimental foreign matter degree specified.

7. Near White Blast Cleaning (SSPC-SP10/NACE 2): The removal of all visible oil, grease, dirt, dust, mil scale, rust, paint, oxides, corrosion products and other foreign matter by compressed air nozzle blasting, centrifugal wheels or other specified method. Discoloration caused by certain stains shall be limited to no more than 5 percent of each square inch of surface area.

8. Power Tool Cleaning to Bare Metal (SSPC-SP11): Power tool cleaning to produce a bare metal surface and to retain or produce a minimum 1.0 mil surface profile. This standard is suitable where a roughened, clean, bare metal surface is required, but where abrasive blasting is not feasible or permissible.

9. Surface Preparation of Concrete (SSPC-SP13/NACE 6): Surface preparation of concrete by mechanical, chemical, or thermal methods prior to the application of bonded protective coating or lining systems.

B. Slag, weld metal accumulation and spatters not removed by the Fabricator, Erector or Installer shall be removed by chipping and/or grinding. All sharp edges shall be peened, ground or otherwise blunted as required by the ENGINEER. All grinding and finishing of welds, edges, etc. shall be performed prior to solvent cleaning and abrasive blasting. Welds shall be prepared as per NACE Standard SP0178 for all interior and exterior surfaces. Minimum acceptable level of finish shall be Designation “D” unless specified otherwise.

C. Concrete surfaces shall be abrasive blasted to produce a minimum surface profile of equal to 40-grit sandpaper with no loose concrete remaining. This preparation will be followed by vacuum cleaning to remove all dust, dirt or friable substances leaving clean, dust free surfaces for resurfacing. Concrete surfaces rubbed smooth shall not be considered an acceptably prepared surface.

1. Prepare concrete surfaces in accordance with manufacturer’s instructions, SSPC-SP 13/NACE 6 and ICRI 03732.

2. Allow concrete to cure for a minimum of twenty-eight (28) days.

3. Test concrete for moisture in accordance with ASTM D 4263 and F 1869.

4. Abrasive blast surface to remove laitance and solid contaminants and to provide clean, sound substrate with uniform anchor profile.

5. Fill holes, pits, voids, and cracks with Tnemec Series 215 Epoxy Surface or Series 218 MortarClad.

6. Ensure surfaces are clean, dry, and free of oil, grease, chalk, form release agents, and other contaminants.

D. Field blast cleaning for all surfaces shall be by dry method unless otherwise directed. Blast nozzles shall be venturi-type nozzles with a minimum pressure at the nozzle of 90 psi.

E. Particle size of abrasives used in blast cleaning shall be that which will produce a 1.5 – 3.0 mil (37.5 microns - 65.0 microns) surface profile or in accordance with recommendations of the manufacturer of the specified coating or paint system to be applied.

F. If the profile of the blasted steel exceeds the profile specified above, the CONTRACTOR shall be required to do one or both of the following:

1. Re-blast the surface using a finer aggregate in order to produce the required profile.

2. Apply a thicker prime coat, if possible given the limitations of the products being applied, in order to adequately cover the blast profile

G. Abrasive used in blast cleaning operations shall be new, washed, graded and free of contaminants that would interfere with adhesion of coating or paint and shall not be reused unless specifically approved in writing by the ENGINEER.

H. During blast cleaning operations, caution shall be exercised to insure that existing coatings or paint are not exposed to abrasion from blast cleaning.

I. The CONTRACTOR shall keep the area of his work and the surrounding environment in a clean condition. He shall not permit blasting materials to accumulate as to constitute a nuisance or hazard to the accomplishment of the work, the operation of the existing facilities or to the surrounding environment.

J. Blast cleaned surfaces shall be cleaned prior to application of specified coatings or paint. All surfaces shall be free of dust, dirt, and other residue resulting from the abrasive blasting operation. No coatings or paint shall be applied over damp or moist surfaces.

K. All welds shall be neutralized with a suitable chemical compatible with the specified coating or paint.

L. Pitted areas on ferrous metal scheduled for immersion shall be repaired by either filling with Tnemec Series 215 Epoxy Surfacer or by welding. Epoxy filler shall be feathered smooth. No protrusions or spatter will be allowed. Pits deeper than 1/8 in. shall be filled by welding.

M. Specific Surface Preparation: Surface preparation for the specific systems shall be as noted in Sections 2.08 and 2.09 under the specific systems.

3.03 GENERAL APPLICATION

A. Coating and paint application shall conform to the requirements of the Society for Protective Coatings Paint Application Specification SSPC-PA1, latest revision, for "Shop, Field and Maintenance Painting", the American Water Works Association and the manufacturer of the coating and paint materials.

B. Thinning shall be permitted only as recommended by the manufacturer and approved by the ENGINEER.

C. Each application of coating or paint shall be applied evenly, free of brush marks, sags, runs, with no evidence of poor workmanship. Care shall be exercised to avoid lapping on glass or hardware. Coatings and paints shall be sharply cut to lines. Finished surfaces shall be free from defects or blemishes.

D. Protective coverings or drop cloths shall be used to protect floors, fixtures, and equipment. Care shall be exercised to prevent coatings or paints from being spattered onto surfaces, which are not to be coated or painted. Surfaces from which materials cannot be removed satisfactorily shall be recoated or repainted as required to produce a finish satisfactory to the ENGINEER.

E. When two coats of coating or paint are specified, where possible, the first coat shall contain sufficient approved color additives to act as an indicator of coverage or the two coats must be of contrasting color.

F. Film thickness per coat specified in Sections 2.08 and 2.09 are the minimum required. If brush or roller application is deemed necessary, the CONTRACTOR shall apply additional coats as to achieve the specified thickness.

G. All materials shall be applied as specified.

3.04 COATING SYSTEM APPLICATION

A. After completion of surface preparation as specified for the specific system, materials shall be applied as noted in Sections 2.08 and 2.09.

B. Care shall be taken so as to eliminate overspray and dry spray. Where such conditions are encountered, the surface shall be cleaned of all over spray and dry spray prior to the application of the succeeding coat.

C. Areas rendered inaccessible after erection shall receive the full coating system prior to erection and/or assembly.

D. Structures Within One-Half Mile of Coast: Exterior surfaces that have been coated on a previous day shall be rinsed with clean potable water and allowed to dry before applying subsequent coat(s). Cleaned surfaces, which are not coated the day of cleaning shall be re-cleaned prior to applying coatings.

3.05 COLOR SCHEME

A. The ENGINEER shall select colors for the project. The CONTRACTOR shall submit current charts of the manufacturer's available colors to the ENGINEER thirty-days (30) prior to the start of coating and painting.

3.06 SOLVENT VAPOR REMOVAL

A. All solvent vapors shall be completely removed by suction-type exhaust fans and blowers before placing closed structures in operating service.

B. All solvent vapors will be exhausted both during and after coating application as per AWWA D 102 to allow the proper curing of the coating material.

C. Ventilation shall be continued until such time as the coating has reached “full cure” as specified by the coating manufacturer.

3.07 REPAIRS

A. After the interior coating system has been installed and holiday tested, repair pinholes and voids as follows:

1. Abrasive blasting shall be in accordance with SSPC-SP10/NACE No.2 Near White Blast Cleaning obtaining a minimal surface profile as specified herein.

2. Power tool cleaning shall be in accordance with SSPC-SP11 Power Tool Cleaning to Bare Metal. Surface profile shall be angular and not less than the surface profile as specified herein.

3. All edges of remaining sound, tightly adhering coating shall be feathered back (beveled) to create a smooth transition from the substrate to the coatings surface. The coating may be considered tightly adhering if an edge cannot be lifted with a dull putty knife.

4. Install the coating system as specified herein to provide a complete and monolithic system, free of voids and pinholes.

B. For exterior surfaces, repair as follows:

1. Hand or Power Tool Sand as per SSPC-SP2 or SP3 to remove the defect. In cases where the defect extends to the substrate, prepare the surface as per SSPC-SP11 Power Tool Cleaning to Bare Metal, obtaining a minimum anchor profile as specified herein.

2. All edges of remaining sound, tightly adhering coating shall be feathered back (beveled) to create a smooth transition from the substrate to the coatings surface. The coating may be considered tightly adhering if an edge cannot be lifted with a dull putty knife.

3. Install the coating system as specified herein to provide a complete and monolithic system, free of voids and pinholes.

3.08 CLEAN-UP

A. Upon completion of the work, all staging, scaffolding and containers shall be removed from the site or destroyed in a manner approved by the ENGINEER. Coating or paint spots, oil or stains upon adjacent surfaces shall be removed and the jobsite cleaned. All damage to surfaces resulting from the work of this section shall be cleaned, repaired, or refinished to the satisfaction of the ENGINEER at no cost to the OWNER.

END OF SECTION

SECTION 11020
GENERAL EQUIPMENT REQUIREMENTS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The work included in this section of the specifications is applicable to all equipment specifications (DIVISION 11 - EQUIPMENT) and related sections as noted. If this section is not consistent with the individual equipment sections or the contract drawings, the individual equipment sections and contract drawings shall govern.

1.02 SUBMITTAL DATA AND O & M DATA

A. Submittal Data and Operation and Maintenance Data for the items of equipment as specified herein shall be furnished in accordance with DIVISION 0 - CONTRACT REQUIREMENTS and DIVISION 1 - GENERAL REQUIREMENTS specifications.

B. Installation Manuals containing complete information in connection with the assembly, operation, adjustment, maintenance, and repair of the equipment, and a detailed parts list with drawings or photographs shall be furnished in four (4) copies with each unit or part thereof.

1.03 QUALITY ASSURANCE

A. All royalties and fees for patents covering materials, articles, apparatus, devices, or equipment (as distinguished from processes) shall be included in prices quoted by equipment suppliers. Attention is directed to the requirements of the General Conditions concerning patents.

1.04 EQUIPMENT DELIVERY, STORAGE AND HANDLING

A. All pieces shall be delivered in the largest pieces practical for field assembly by the CONTRACTOR. Individual pieces shall be permanently tagged with welded erection marks or stainless steel tags cross referenced with information on the manufacturer's erection and assembly drawings. Gear boxes, mechanical and electrical components shall be protected from the weather and suitably packaged to facilitate handling and storage. Special lubricating and rust preventative oils shall be provided to prevent internal corrosion of gear assemblies. All mechanical equipment shall be kept thoroughly dry at all times and shall be stored indoors.

B. All equipment stored on the job shall be protected and maintained in accordance with the manufacturer's recommendations. Electrical equipment must be stored in weatherproof, ventilated enclosures. Structural materials may be stored outdoors on pallets or other wooden supports provided there is proper support and drainage. Equipment shall not be allowed to contact the ground directly.

C. Fabricated assemblies shall be shipped in the largest sections permitted by carrier regulations, properly match-marked for ease of field erection.

D. Electric motors, gears, etc. shall be periodically rotated to prevent freezing, as directed by OWNER.

E. Anti-friction bearings, if pre-lubricated, shall be protected in accordance with the bearing manufacturer's recommendations against formation of rust during a long period of storage while awaiting completion of installation and start-up of the machine in which they are used. Anti-friction bearings which are not pre-lubricated shall be properly treated in accordance with the bearing

manufacturer's recommendation against formation of rust during a long period of storage while waiting completion of installation and start-up by the application of Exxon Rust-Ban No. 392, or equal treatment.

PART 2 - PRODUCTS

2.01 ANCHORAGE AND FASTENERS

A. ANSI/ASTM A-153-78.

B. Stainless steel fasteners shall be AISI Type 316 stainless steel, unless otherwise directed.

C. All cast-in-place equipment anchorage, including nuts and washers shall be of AISI Type 316 stainless steel, unless otherwise directed. Anchorage shall be sized, designed and furnished by the equipment manufacturer. The minimum size of any cast-in-place anchor shall be 3/4 in. diameter.

D. All installed anchors shall be recommended by the equipment manufacturer. Anchorage shall be sized, designed and furnished by the equipment manufacturer. Design calculations of each anchor system, to include hole diameter, anchor diameter, embedment, shear and pull-out forces shall be by a licensed Professional Engineer. All anchors shall be minimum Type 316 Stainless Steel and embedded with two-part epoxy by Hilti or equal. Expansion anchors shall not be allowed.

2.02 MOTOR CONTROLS

A. Motor Controls and associated Electrical Work to be provided for the items of equipment as specified herein shall conform to the requirements as outlined in DIVISION 16 - ELECTRICAL of these specifications.

B. Original Equipment Manufacturer (OEM) provided control panels shall be constructed as specified by DIVISION 11 - EQUIPMENT and shall incorporate the input/output devices shown on the electrical control panel diagrams.

C. Shop built control panels shall operate as specified by DIVISION 11 - EQUIPMENTS or DIVISION 16 - ELECTRICAL and shall be constructed in accordance with DIVISION 16 - ELECTRICAL of these specifications and as shown on the electrical schematic diagrams.

2.03 MISCELLANEOUS

A. Each major piece of equipment shall be furnished with a stainless steel nameplate with embossed data securely mounted to the body of the equipment. As a minimum, the nameplate for the pumps shall include the manufacturer's name and model number, serial number, rated flow capacity, head, speed and all other pertinent data. As a minimum, nameplates for motors shall include the manufacturer's name and model number, serial number, horsepower, speed, input voltage, amps, number of cycles and power and service factors.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The equipment shall be furnished complete by the manufacturer and shall be assembled, erected and installed by the General Contractor as directed by the manufacturer in his working drawings and written instructions. The installation, alignment, testing, and grouting (if applicable) shall be

checked and approved by a factory representative before acceptance (as required in the individual equipment sections):

1. The manufacturer's representative shall inspect the completed installation, and assist the CONTRACTOR in aligning, start-up, and testing. The representative shall also instruct plant personnel in operation and maintenance of the equipment.

2. A written report shall be furnished by the equipment manufacturer and shall describe the representative's observations. This report shall describe in detail any deficiencies noted. All such deficiencies, whether by the manufacturer or CONTRACTOR, shall be corrected at no expense to the OWNER.

3. Prior to final approval, the manufacturer shall submit a letter certifying that the installation meets all requirements of the manufacturer.

B. Certain equipment items require grouting. Grouting shall be to the dimensions shown on the plans and in accordance with the recommendations of the equipment manufacturer. Unless otherwise specified, minimum acceptable grout thickness shall be 2 in.

C. Lubricants of the type recommended by the equipment manufacturer shall be furnished and applied by the CONTRACTOR. The CONTRACTOR shall certify that the equipment components have received the proper amount of recommended lubricant.

D. Except where specifically stated otherwise, all plate and structural members used in the construction of the process equipment shall have a minimum material thickness of 1/4 in.

E. All welding shall conform to the latest AWS Standards and shall be performed by certified welders. All welding shall use a minimum of 3/16 in. fillets, and shall completely seal all mating surfaces. Skip welding will not be allowed.

F. All field connections shall be bolted connections designed to resist all static, live and erection loads. Field-welding assemblies will not be allowed. All bolted structural connections shall be gusseted with minimum 3/8 in. thick steel plate. Main structural connections shall use a minimum of two 3/4 in. diameter bolts. Secondary structural connections shall use a minimum of two 5/8 in. diameter bolts.

END OF SECTION

SECTION 11203
SLIDE GATES

PART 1. GENERAL

1.1 SECTION INCLUDES

A. Furnish all labor, materials, equipment and incidentals required and install gates, supports and appurtenances as shown on the drawings and as specified herein.

B. Gates suppled under this section shall be Series 20 and Series 40 Stainless Steel Gates as manufactured by H Fontaine Ltd., or engineer-approved equal.

1.2 REFERENCES AND RELATED WORK

A. All gates and operators shall conform to the applicable requirements of AWWA C513 – Open Channel, Fabricated Metal Slide Gates.

B. Concrete work is included in DIVISION 3 – CONCRETE.

C. Anchorage is included in SECTION 11020 – GENERAL EQUIPMENT REQUIREMENTS.

D. O&M Requirements are included in SECTION 01782 – OPERATION AND MAINTENANCE DATA.

1.3 SUBMITTALS

A. Copies of all materials required to establish compliance with the specifications shall be submitted in accordance with the provisions of SECTION 01330 – SUBMITTALS. Submittals shall include at least the following:

1. Certified shop and erection drawings and data regarding all gates.

2. Literature on drawings describing the equipment and showing all important details of construction, dimensions, anchors and anchor bolt locations, including safety factors.

3. Results of all shop tests and field leakage tests.

4. A complete bill of materials including generic model number and all bearings.

5. List of manufacturer's recommended spare parts.

6. Weight of each component.

7. Provide equipment warranty data.

8. Provide O&M Data.

9. Provide nameplate data and arrangement for OWNER'S Representative approval.

10. In the event that it is impossible to conform to certain details of the Specifications due to different manufacturing techniques, describe completely all nonconforming aspects.

11. Calculations used to find the critical buckling load on the operating stems. Provide operator and stem sizing calculations and forces.

12. Calculations showing handwheel or handcrank pull force, seating / unseating head, and leakage.

13. Details and drawings of operators.

14. Drawings showing the construction, spacing, and alignment of the operator support brackets, and the bracket and floor mounted stem guides.

1.4 QUALITY ASSURANCE

1. The manufacturer shall have experience in the production of substantially similar equipment, and shall show evidence of satisfactory operation in at least 50 installations. The manufacturer's shop welds, welding procedures and welders shall be qualified and certified in accordance with the requirements of the latest edition of ASME, Section IX.

2. Gates shall be shop inspected for operation prior to shipping.

3. The manufacturer shall be ISO 9001: 2000 certified.

PART 2. PRODUCTS

2.1 GATES

A. GENERAL DESIGN. Gates shall be either self-contained or non self-contained, and of the rising stem or non-rising stem configuration, as indicated on the gate schedule.

B. FRAME. The gate frame shall be constructed of structural members or formed plate welded to form a rigid one-piece frame. The frame shall be of the flange back design, suitable for mounting on a concrete wall (CW). The guide slot shall be made of UHMWPE (ultra high molecular weight polyethylene).

C. SLIDE. The slide shall consist of a flat plate reinforced with formed plates or structural members to limit its deflection to 1/720 of the gate's span under the design head.

D. GUIDES AND SEALS. The guides shall be made of UHMWPE (ultra high molecular weight polyethylene) and shall be of such length as to retain and support at least two thirds (2/3) of the vertical height of the slide in the fully open position.

The bottom and side seals shall be made of UHMWPE (ultra high molecular weight polyethylene) of the self-adjusting type. A continuous compression cord shall ensure contact between the UHMWPE guide and the gate in all positions. The sealing system shall maintain efficient sealing in any position of the slide and let the water flow only in the open part of the gate. Seals shall maintain the specified leakage rate in both seating and unseating conditions.

2.2 OPERATORS AND STEM

A. STEM AND COUPLINGS. The operating stem shall be of stainless steel designed to transmit in compression at least two (2) times the rated output of the operating manual mechanism with a 40-lb (178 N) effort on the crank or handwheel.

The stem shall have a slenderness ratio (L/r) less than 200. The threaded portion of the stem shall have machine cut threads of the Acme type.

Where a hydraulic, pneumatic or electric operator is used, the stem design force shall not be less than 1.25 times the output thrust of the hydraulic or pneumatic cylinder, with a pressure equal to the maximum working pressure of the supply or 1.25 times the output thrust of the electric motor in the stalled condition.

1. For stems in more than one piece and with a diameter of 1 ¾ inches (45 mm) and larger, the different sections shall be joined together by solid bronze couplings. Stems with a diameter smaller than 1 ¾ inches, shall be pinned to an extension tube.

   The couplings shall be grooved and keyed and shall be of greater strength than the stem.

2. Gates having width equal to or greater than two times their height shall be provided with two lifting mechanisms connected by a tandem shaft.

B. STEM GUIDES. Stem guides shall be fabricated from type 316L stainless steel. The guide shall be equipped with an UHMWPE bushing. Guides shall be adjustable and shall be spaced in accordance with the manufacturer's recommendation. The L/r ratio shall not be greater than 200.

C. STEM COVER. Rising stem gates shall be provided with a clear polycarbonate stem cover. The stem cover shall have a cap and condensation vents as well as a clear mylar position indicating tape. The tape shall be field applied to the stem cover after the gate has been installed and positioned.

D. LIFTING MECHANISM. Manual operators of the types listed in the schedule shall be provided by the gate manufacturer.

All bearings and gears shall be totally enclosed in a weather tight housing. The pinion shaft of crank-operated mechanisms shall be constructed of stainless steel and supported by roller or needle bearings.

Each manual operator shall be designed to operate the gate under the maximum specified seating and unseating heads by using a maximum effort of 40 lbs (178 N) on the crank or handwheel, and shall be able to withstand, without damage, an effort of 80 lbs (356 N).

The crank shall be removable and fitted with a corrosion resistant rotating handle. The maximum crank radius shall be 15 inches (381 mm) and the maximum handwheel diameter shall be 24 inches (610 mm).

E. YOKE. Self-contained gates shall be provided with a yoke made of structural members or formed plates. The maximum deflection shall be 1/360 of the gate's span.

2.3 MATERIALS

PART	MATERIAL
Frame, yoke, stem guides, slide, stem extension	Stainless steel ASTM A-240 type 316L
Guides, side and bottom seals, stem guide liner	Ultra high molecular weight polyethylene (UHMWPE) ASTM D-4020
Compression cord	Nitrile ASTM D2000 M6BG 708, A14, B14, E014, E034
Threaded stem	Stainless steel ASTM A-276 type 316
Fasteners	ASTM F593 and F594 GR2 for type 316
Pedestal, handwheel and crank	Tenzaloy aluminum
Gasket (between frame and wall)	EPDM ASTM 1056
Stem cover	Polycarbonate ASTM D-3935
Lift nut, couplings	Manganese bronze ASTM B584 UNS-C86500

2.4 SCHEDULE

Gate Identification		
Gate Type		
Size Width x Height		
Operating Floor Elevation		
Invert Elevation		
Head (Seating; Unseating)		
Mounting	Concrete Wall Mount	Concrete Wall Mount

2.5 PERFORMANCE

A. Leakage. Gates shall be substantially watertight under the design head conditions. Leakage shall not exceed 0.05 U.S. gallon per minute per foot (0.60 l/min per meter) of seal periphery under the design seating head and 0.1 U.S. gallon per minute per foot (1.25 l/min per meter) of seal periphery for the design unseating head.

B. Design Head. Gates shall be designed to withstand the design head (maximum design head shall be taken as the height of the slide unless otherwise shown in the schedule).

C. Seal Performance Test. The gate's sealing system shall be tested through a cycle test in an abrasive environment and show that the leakage requirements are still obtained after 25,000 cycles with minimal deterioration.

PART 3. EXECUTION

3.1 INSTALLATION

A. Gates and appurtenances shall be stored, handled and installed in accordance with the manufacturer's recommendations.

3.2 FIELD TESTS

A. Following the completion of each gate installation, the gates shall be operated through at least two complete open/close cycles. If an electric or hydraulic operator is used, limit switches shall be adjusted following the manufacturer's instructions

B. Gates should be checked for leakage by the contractor (refer to the "Performance" section for approval criteria).

END OF SECTION

SECTION 11315
VERTICAL CANTILEVER PUMPS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section of the specifications covers the complete furnishing and installation of the slurry pumps for the transfer of pond waste.

B. Description of System

1. There shall be furnished and installed as shown on the drawings and described below one (1) complete system.

2. All components of the pump system shall be designed in compliance with ISO 13709 and API 610.

3. The pumps shall be manufactured by Lawrence or pre-approved equal.

C. Design Requirements

1. Slurry Pumps

a. The pumps shall be designed and constructed to resist abrasion from slurry/grit applications. The pump shall be mounted as a vertical shaft cantilever as described in PART 2 - PRODUCTS. Suction piping shall be 6 inch diameter with screened intake extended from the impeller volute assembly to the bottom of basin. Discharge piping shall be 4 inch diameter.

1)	Number of Pumps:	2
2)	Designations:	WSGP-2A, WSGP-2B
3)	Flow, gpm:	410
4)	Total Head, ft.:	110
5)	Motor Size, hp:	40 (min.)

1.02 RELATED WORK

A. Concrete work is included in DIVISION 3 - CONCRETE.

B. Miscellaneous metals are included in SECTION 05500 – METAL FABRICATIONS.

C. Field painting is included in SECTION 09915 - PROTECTIVE COATINGS.

D. Anchorage is located in SECTION 11020 - GENERAL EQUIPMENT REQUIREMENTS.

E. Electrical work except as hereinafter specified is included in DIVISION 16 - ELECTRICAL.

F. Valves, mechanical piping and appurtenances and pipe hangers and supports are included in DIVISION 15 - MECHANICAL.

G. Instrumentation is included in DIVISION 17 - INSTRUMENTATION AND CONTROLS.

1.03 SUBMITTALS

A. All Submittals shall comply with SECTION 01330 – SUBMITTALS.

B. Shop Drawings: All equipment and materials shall be new and shall be designed for the function and service specified. No equipment or materials shall be used except as specified or as approved by the ENGINEER. Approval for installation and incorporation into the project will be made only after the submittal and examination of shop drawings, specifications and other information as required below. The following information shall be provided:

1. Shop drawings complete with all dimensions showing anchor bolt details, the location of anchor bolts or other mounting devices; openings in structures required for installation of equipment and connecting piping; and, if required the size and location of electrical conduits and conduit openings.

2. Specifications for all electrical and mechanical components with complete schematics for the control system.

3. Detailed drawings of the major fabricated components labeled with member sizes and materials of construction.

4. Manufacturer's recommended procedures for job site storage of equipment, handling and erection.

C. Operating and maintenance instructions and detailed maintenance schedule shall be furnished to the ENGINEER as provided in SECTION 01782 - OPERATION AND MAINTENANCE DATA. The instructions shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions that are required to instruct operating and maintenance personnel unfamiliar with such equipment. Operation and Maintenance Manuals shall include the following information as a minimum requirement:

1. Name, address and phone number of the nearest competent service organization who can supply parts and service. If this is not the manufacturer's own service department, then furnish a letter certifying that the named organization is authorized to represent the manufacturer and to perform warranty service.

2. Complete descriptive literature and drawings of all material furnished. This is to include "as built" wiring diagrams of all electrical equipment, "as built" erection drawings providing up-to-date information on the actual construction of the equipment furnished and documentation of any field modifications made during installation, start-up and testing.

3. Installation, operation and maintenance brochures from the original manufacturers of all mechanical components such as gear reducers, drive couplings, bearings, etc., incorporated into the completed installation.

4. Recommended spare parts list.

5. All required assembly, installation, alignment, adjustment and checkout instructions.

6. All required operating instructions.

7. All required maintenance instructions including schedules of routine maintenance and lubrication checks.

D. Number of Copies: Submit six (6) copies of each submittal, unless otherwise indicated. ENGINEER will return two (2) copies.

1.04 QUALITY ASSURANCE

A. To assure compatibility, all items of equipment furnished under this section shall be furnished by a single manufacturer who shall be responsible for the adequacy of design and provide a complete operating system.

B. Manufacturer's Quality Control: All fabricated equipment shall be carefully inspected at the site of fabrication by factory inspectors who shall use whatever means are necessary, including shop assembly, to assure the proper fit of all field components and compliance with all material requirements of the specifications.

C. Services of Manufacturer's Representative

1. A factory representative who has a complete knowledge of the proper operation and maintenance shall be provided as specified herein. Qualifications of the representative shall be submitted for approval. Workday requirements listed are exclusive of travel time and do not relieve the CONTRACTOR of obligation to provide sufficient service to place equipment in satisfactory operation.

Services Provided by Factory Representative	Minimum[a] No. of Trips	Minimum Time On Site Per Trip (hours)
1. Supervise installation	1	8
2. Inspect and approve installation [b]	1	4
3. Supervise initial adjustment [c]	1	4
4. Supervise and assist in testing [d]	1	12
5. Instruct Owner and Engineer in proper start-up and O&M [e]	1	4

(a) The manufacturer's factory representative shall be present at frequent enough intervals to ensure proper installation, testing, and initial operation of the equipment.
(b) The manufacturer's factory representative shall provide to the Engineer a written certification that the system has been installed in accordance with the manufacturer's recommendations.
(c) May be done upon completion of Item 2 if acceptable to the Engineer.
(d) May be done upon completion of Items 2 and 3 if acceptable to the Engineer.
(e) Instruction may be given upon completion of Item 4, provided that the test is successful and the O&M manuals have been submitted to and accepted by the Engineer.

1.05 TOOLS AND SPARE PARTS

A. Special tools, if required for normal operation and maintenance, shall be furnished with the equipment by the manufacturer. All tools shall be supplied in a wooden crate.

B. Supply of spare parts will not be required. The O&M Manual furnished for the project shall list the recommended spare parts.

1.06 WARRANTY

A. Manufacturer shall provide a one (1) year warranty from the date of acceptance of the installation by the OWNER. The warranty shall include replacement of all defective equipment at no cost to the OWNER.

PART 2 - PRODUCTS

2.01 SLURRY TRANSFER PUMP

A. Two (2) transfer pumps shall be furnished and installed. The pumps shall be 4" Non-Clogging Cantilever Shaft Slurry Pump, model number VPL3200 as manufactured by Lawrence Pumps, Inc., (a division of Flowserve Corp.) or pre-approved equal. The pump shall be self-venting to prevent air binding and shall not be damaged when operated dry. The pump shall be supported from concrete basin as shown in the Drawings and detailed therein.

B. The pump shall be direct drive. Suction and discharge piping shall be as shown on Drawings. Provide any required fittings to connect pumps to suction and discharge piping.

C. The pump casing shall be constructed of abrasion-resistant ASTM-A532, Class IIIA cast iron alloy and will be a one piece casting with integral suction and discharge nozzles.

D. The pump discharge elbows shall be constructed of abrasion-resistant ASTM-A532, Class IIIA cast iron alloy. Elbows shall be flanged on both ends for easy replacement.

E. The pump impeller shall be constructed of abrasion-resistant ASTM-A532, Class IIIA cast iron alloy. The impeller to casing clearances shall be adequate to minimize abrasion. Impeller clearances shall be easily adjustable external to the pump without dismantling any of the pump components or removing the motor. The impeller adjusting device shall be designed to assure concentricity of the shaft and impeller within the casing after adjustment. The impeller shall be of the open type and shall be suitable for passage of foreign objects as specified herein. The impeller shall be threaded directly on the shaft, with threads which tighten the impeller on the shaft when pumping. Impellers shall not be the minimum or the maximum size for the casing furnished.

F. The casing wearplate shall be constructed of abrasion-resistant ASTM-A532, Class IIIA cast iron alloy.

G. The pump shafts shall be constructed of ASTM-A582, Type 416SS, turned, ground, and polished at the bearings and protected from wear. Pump shaft must operate at least 25% below any critical speeds to avoid vibration. This must be accomplished by mass rather than the use of dampening material. An adjustable thrust bearing shall be provided above the baseplate capable of supporting the maximum hydraulic thrust load of the pump together with the weight of all revolving parts of the pumps. A suitable flexible coupling shall be provided between the pump and motor shafts. The thrust bearing and coupling shall be located as to be easily accessible for maintenance and adjustment without dismantling any part of the pumping unit. Shafts shall be provided with removable shaft sleeves. Shaft runout shall be less than 0.001 inches. Shaft sleeve runout shall be less than 0.002 inches. The shaft sleeve diameter shall be in 1/8 inch increments. The shaft deflection shall be less than 0.002 inches. Pumps that depend on the hydraulic balance to overcome end thrust shall not be acceptable. Safety guards shall be provided on all exposed rotating shafts.

H. All pump bearings shall be designed for a minimum B-10 life of 40,000 hours. Pump bearings shall be grease lubricated, dust-tight, and watertight and shall have adequate means of retaining

the correct amount of lubricant without dripping or leakage. A drain plug shall be provided for flushing out old lubricant when adding new lubricant. Grease fittings must be readily accessible above the baseplate.

I. Bearings shall be accessible for replacement without dismantling the pumps. Bearings, bushings, or other rubbing parts below the pump baseplate will not be permitted.

J. The pump and motor base shall be of fabricated steel, designed to provide rigid support of the units. Each base is furnished with suitable bolt and grout holes to facilitate mounting at the site.

K. The pump shall be provided complete with a minimum 40 horsepower TEFC motor, 1800 rpm, 3 ph, 60 cycle, 460 volt, type F insulation and 1.15 SF.

L. Pump manufacturer shall furnish all required shaft seal accessories, including stuffing box with packing material where applicable.

2.02 SURFACE PREPARATION

A. All carbon steel surfaces shall be hot-dipped galvanized after fabrication. Surface preparation and finish painting of mechanical devices shall be as specified in DIVISION 9 - FINISHES.

2.03 ANCHORAGE AND FASTENERS

A. All anchorage bolts shall be designed and furnished by the equipment manufacturer and shall be ASTM A276, Type 316 stainless steel in accordance with SECTION 11020 - GENERAL EQUIPMENT REQUIREMENTS.

B. All fasteners and erection bolts shall be ASTM A276, Type 316 stainless steel.

C. No field welding will be allowed for assembly of any of the equipment in this specification section.

PART 3 - EXECUTION

3.01 PREPARATION

A. Inspect all concrete work to determine if all dimensions and elevations relating to these units are correct. Consult the ENGINEER before modifying any concrete work.

B. Obtain sufficient copies of manufacturer's installation instructions and have them on the jobsite prior to erection.

3.02 INSTALLATION

A. The CONTRACTOR shall install all equipment in exact accordance with the manufacturer's written instructions and as directed on the site during inspection visits by the manufacturer's representative.

B. Deviations from the manufacturer's written or verbal instructions shall be subject to approval by the ENGINEER.

END OF SECTION

SECTION 15050
BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.

2. Transition fittings.

3. Mechanical sleeve seals.

4. Sleeves.

5. Grout.

6. Equipment installation requirements common to equipment sections.

7. Painting and finishing.

8. Concrete bases.

9. Supports and anchorages.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and DIVISION 1 - GENERAL REQUIREMENTS sections, apply to this Section.

1.03 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.

2. Mechanical sleeve seals.

B. Welding certificates.

1.04 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.06 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.

1.07 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.

2. NBR: Acrylonitrile-butadiene rubber.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 PIPE, TUBE, AND FITTINGS

A. Refer to individual DIVISION 15 - MECHANICAL piping sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.03 JOINING MATERIALS

A. Refer to individual DIVISION 15 - MECHANICAL piping sections for special joining materials not listed below.

B. Contractor shall obtain gaskets and flange-bolt recommendations and technical support from VSP Technologies of Prince George, Virginia at (804) 541-0812 or (800) 334-6013.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

E. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.

2. CPVC Piping: ASTM F 493.

3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

4. PVC to ABS Piping Transition: ASTM D 3138.

G. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.04 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Manufacturers

a. Cascade Waterworks Mfg. Co.

b. Dresser Industries, Inc.; DMD Div.

c. JCM Industries.

2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.

3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.

4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers

a. Eslon Thermoplastics

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers

a. Thompson Plastics, Inc.

D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

1. Manufacturers

a. NIBCO Inc.

b. NIBCO, Inc.; Chemtrol Div.

E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

1. Manufacturers

a. Cascade Waterworks Mfg. Co.

b. Fernco, Inc.

c. Mission Rubber Company

d. Plastic Oddities, Inc.

2.05 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Metraflex Co.

d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Carbon steel. Include two (2) for each sealing element.

4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.06 SLEEVES

A. Galvanized-Steel Sheet: 0.0239 in. minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

F. PVC Pipe: ASTM D 1785, Schedule 40.

G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.07 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

2. Design Mix: 5000-psi, twenty-eight (28) days compressive strength.

3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 PIPING SYSTEMS

A. Install piping according to the following requirements and applicable DIVISION 15 - MECHANICAL sections.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Sleeves are required for core-drilled holes.

M. Permanent sleeves are required for holes formed by removable PE sleeves.

N. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

O. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 in. above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

3. Install sleeves that are large enough to provide 1/4 in. annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

   a. Steel Pipe Sleeves: For pipes smaller than NPS 6.

   b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.

   c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 in. above finished floor level.

      1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint.

P. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1 in. annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 in. in diameter.

2. Install cast-iron "wall pipes" for sleeves 6 in. and larger in diameter.

3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

Q. Underground, exterior-wall pipe penetrations: Install cast-iron “wall pipes” for sleeves.

R. Verify final equipment locations for roughing-in.

S. Refer to equipment specifications in other sections of these specifications for roughing-in requirements.

3.02 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and DIVISION 15 - MECHANICAL sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.

2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.

3. CPVC Pressure Piping: Join according to ASTM D 2846/D 2846M Appendix.

4. PVC Nonpressure Piping: Join according to ASTM D 2855.

5. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.

2. Plain-End Pipe and Socket Fittings: Use socket fusion.

M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.03 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.04 EQUIPMENT INSTALLATION

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.05 PAINTING

A. Painting of mechanical systems, equipment, and components is specified in SECTION 09915 - PROTECTIVE COATINGS.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.06 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18 in. centers around the full perimeter of the base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to supported equipment.

6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

7. Use 4000-psi, twenty-eight (28) days compressive-strength concrete and reinforcement as specified in SECTION 03300 - CAST-IN-PLACE CONCRETE.

3.07 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS D1.1.

3.08 GROUTING

A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION

SECTION 15071
PIPE AND PIPE FITTINGS (GENERAL)

PART 1 - GENERAL

1.01 WORK INCLUDED

A. This section provides requirements for furnishing and installing piping. Refer to related work specified in other sections to coordinate the complete installation. All piping shall be appropriate for petroleum designated service unless otherwise noted.

1.02 RELATED WORK

A. Division 1 – General Requirements.

B. Division 2 - Site Work.

C. Division 3 - Concrete.

D. Division 5 - Metals.

E. Division 9 - Finishes.

F. Division 15 - Mechanical.

1.03 PROJECT RECORD DOCUMENTS

A. Upon completion of all work, furnish prints and tracings showing location and principal details and modifications of piping systems as built.

1.04 SUBMITTALS

A. Product Data and Shop Drawings: Submit product data and shop drawings on each type of pipe, valves, fittings and accessories.

B. Welder Certification: Employ welders qualified by current certification of testing to perform welding operations per American Welding Society requirements. CONTRACTOR shall submit documentation for all welders on the job.

C. Leak Tests: CONTRACTOR shall submit results of leak tests as specified in "Leak Tests: below.

1.05 COUNTRY OF ORIGIN

A. All major equipment and components shall be manufactured and assembled in the U.S.A unless specific approval is obtained from the ENGINEER prior to submitting the proposed equipment.

PART 2 - PRODUCTS

2.01 PIPING

A. Pipe is separated under specific sections; as a minimum pipe shall conform to the following.

B. Ductile Iron Pipe:

1. Ductile iron pipe shall conform to the requirements of AWWA C150 and AWWA C151. Use thickness Class 53 (minimum) flanged or grooved-end pipe.

2. Provide manufacturer's standard bituminous coating outside all ductile iron pipes

unless otherwise noted.

C. Cast Iron Pipe: CL22, AWWA C106 (ANSI A21.6).

D. Steel Pipe: Carbon Steel Pipe for pressures up to 275 psi at ambient temperatures. Threaded pipe up to 1" to be ASTM A 106, Grade B threaded Sch. 160. Electric-resistance welded pipe 1-1/2" and larger to be ASTM A 53, Grade B standard weight.

E. Chlorinated Polyvinyl Chloride Pipe (CPVC): Suitable for above ground applications only. Min. Schedule 80, manufactured in accordance with ASTM D1784 and ASTM D2846/ D2648M.

F. Polyvinyl Chloride Pipe (PVC): Suitable for above ground non-pressure applications only. Type 1, Grade 1, manufactured in accordance with ASTM D 1785 (ANSI B72.7) and ASTM D 1784. All PVC pipe shall be manufactured from virgin plastic.

G. High Density Polyethylene Pipe:

1. The Manufacturer shall have manufacturing and quality assurance facilities capable of producing and assuring the quality of the pipe and fittings required by these Specifications. The Manufacturer's production facilities shall be open for inspection by the OWNER or ENGINEER.

2. Manufacturers that are qualified and approved by the ENGINEER are listed below. Products from unapproved manufacturers are prohibited. All pipes shall be new, and shall be manufactured within the Continental Limits of the United States of America, and shall be approved by Underwriters Laboratories, Inc. or Factory Mutual and acceptable to the OWNER and ENGINEER. Performance Pipe, a division of Chevron Philips Chemical Company LP.

3. Black PE materials used for the manufacture of polyethylene pipe and fittings shall be PE 3408 high density polyethylene meeting ASTM D3350 cell classification 345464C and shall be listed in the name of the pipe and fitting Manufacturer in PPI (Plastics Pipe Institute) TR-4 with a standard grade HDB rating of 1600 psi at 73° R. Color material, when used, shall be the same except for meting ASTM D 3350 cell classifications 345464E. The material shall be listed and approved for potable water in accordance with NSF Standard 61. When requested on the order, the Manufacturer shall certify that the materials used to manufacture pipe and fittings meet these requirements.

4. Polyethylene pipe shall be manufactured in accordance with AWWA C901-96 for sizes 1-1/4-inches thru 3-inches IPS diameters and to the requirements of ASTM D3035 and D2239. Pipe 4-inches IPS and DIPS sizes 4-inches and above shall be manufactured to the requirements of ASTM F714 and AWWA C906-99 (IPS).

5. DIPS sized pipes shall have three equally spaced pairs of longitudinal blue color stripes co-extruded into the pipe outside surface. Stripes printed on the outside surface shall not be acceptable.

2.02 PIPE JOINTS AND COUPLINGS

A. The particular type of joint for each system is called out in the specific piping section.

B. Screwed Joints: Make screwed joints using machine-cut ANSI taper pipe threads. All-thread nipples are not permitted. NPT taper pipe threads in accordance with ANSI B.1.20.1

C. Welded Joints: Make welded joints as recommended by the standards of the American Welding Society. Ensure complete penetration of deposited metal with base metal. Provide filler metal suitable for use with base metal. Keep inside of fittings free from accumulation of weld metal. DO NOT use mitered joints.

D. Flanged Joints:

1. Use flat-face companion flanges only with flat-faced fittings, valves or equipment. Use flat-faced flanges for cast iron and ductile iron pipe and raised-faced flanges for all steel pipes unless otherwise noted. Use flange material to match pipe material.

2. Use ASTM A 307, Grade B hex bolts and heavy hex nuts conforming to ANSI B18.2.1 and B18.2.2, respectively. Use hot-dipped galvanized nuts and bolts for galvanized pipe and flanges. Use type 304 stainless steel and bolts for all below-ground flanges.

3. Flanges shall be installed generally where indicated on drawings and shall conform to the following specifications:

   a. Carbon steel flanges shall conform to ANSI B16.5 with materials conforming to ASTM A 105 or ASTM A 181, Grade II, 150 psi service.

   b. Stainless steel flanges shall conform to ANSI B16.5 with materials conforming to ASTM A 182, Grade F304L, 150 psi service.

   c. Gray iron and ductile iron flanges shall be rated for 250 psi service and drilled with 125-pound bolt circle, conforming to ANSI B16.1 with materials conforming to AWWA C115.

   d. CPVC flanges shall be manufactured from Schedule 80, CPVC, with material conforming to ANSI D1784, 150-pound service, and dimension conforming to ANSI B16.5.

   e. Polyethylene flanges adapters shall be made with sufficient through-bore length to be clamped in a butt fusion-jointing machine without the use of a stub-end holder. The sealing surface of the flange adapter shall be machined with a series of small v-shaped grooves (serrations) to promote gasketless sealing, or restrain the gasket against blowout.

   f. Flange adapters shall be fitted with back-up rings that are pressure rated equal to or greater than the mating pipe. The back-up ring bore shall be chamfered or radiused to provide clearance to the flange adapter radius. Flange bolts and nuts shall be Grade 3 or higher.

4. Flanges for ductile iron pipe may be cast integrally with the pipe, or they may be screwed on threaded ends of the pipe except where weld-necked flanges are required. Screwed-on flanges shall be attached to the pipe in the shop and, after attachment, the faces of the flanges and the ends of the pipe will be refaced so that the ends of the pipe will be even with the faces of the flanges, and the faces of the flanges will be truly perpendicular to the axis of the pipe.

5. Flanges for steel pipe with screwed joints shall be cast iron companion flanges in accordance with ANSI B16.1, Class 125. Welding flanges for steel pipe shall be steel flanges in accordance with AWWA C207, Class D, or welding slip-on flanges conforming to ANSI B16.5, Class 150, with flat face.

E. <u>CPVC Joints</u>:

1. In accordance with applicable ASTM Standards D2846/D2648M.

2. With Schedule 80 or heavier, use threaded joints. Provide sharp, clean pipe dies and Teflon thread tape. Make joints in strict accordance manufacturer's recommendation.

3. Flanged joints may be used in larger pipe sizes, 3 inches and up, in lieu of threaded joints or where specified. Flanges shall be in accordance with Paragraph 2.2(d) of this specification.

F. <u>Flexible (Dresser-Type) Couplings</u>:

1. Flexible couplings shall be installed where shown on the drawings or elsewhere where allowed by the ENGINEER for the CONTRACTOR'S convenience. Flexible couplings shall be galvanized when on galvanized pipe or on pipe which is epoxy, or when underground. Gaskets for flexible couplings shall be Buna-N or VITON.

2. For ductile iron pipe, sleeve-type flexible couplings shall be Dresser Style 53, Rockwell 430 Series, or equal. For steel pipe, sleeve-type flexible couplings shall be Dresser Style 38, Rockwell Type 411, or equal.

3. Flanged adapter couplings for ductile iron pipe shall be Dresser Style 127, Rockwell Type 912, or equal; flanged adapter couplings for steel pipe shall be Dresser Style 128, Rockwell Type 913, or equal. Flanged adapter couplings shall have not less than two anchor studs each.

4. Where Flexible couplings are installed underground, type 316 stainless steel bolts shall be used. The entire coupling shall be given a 20-mil coat of T.C. Mastic as manufactured by the Tape Coat Company, Inc., Bitumastic No. 50 as manufactured by Koppers Company, Inc., or equal.

G. Expansion Joints:

1. Expansion joints for steel pipe used inside the containment slab shall be OAL A240 T-321 as manufactured by DME Incorporated or approved equal.

H. Restrained Joint: Provide a restrained joint of push-on design in accordance with ANSI/AWWA C111/A21.11. Joints as manufactured by U.S. Pipe (TR Flex), American Pipe (Lok-Fast and Lok-Set). Retainer glands and locking gaskets will be acceptable. Any exposed or buried bolts and hardware to be 316 stainless steel.

I. Mechanical Joints:

1. Provide a stuffing box type mechanical joint adapted to use gasket, cast iron gland and bolts. Coat bolts with bitumastic enamel. Use Joints conforming to AWWA C111-72.

2. Polyethylene pipe and fittings may be joined together or to other materials by means of MJ Adapters. MJ Adapters 4-inches thru 16-inches must be provided with Stainless Steel Stiffener. MJ Adapters 14-inches and above shall be provided with Heavy Duty Back-up Ring Kits. All MJ adapters 18-inches and above must be provided with Stainless Steel stiffeners.

J. Push-on Type Joints: Use push-on type joints for cast iron and ductile iron pipe in accordance with AWWA C111-72 (ANSI A21.11-1972).

2.03 FITTINGS

A. Use fittings of same size as pipe they serve. Reducers are not permitted to facilitate an off-size fitting. Reducing bushings are also prohibited. Reduction in piping size will be made by reducing fittings. Fittings shall be lined and coated as specified for pipe they serve. Fittings for use with galvanized pipe shall be galvanized in accordance with ASTM A 153.

B. Screwed Fittings: Fittings for use with steel pipe with threaded joints shall be 150-pound malleable iron screwed fittings in accordance with ANSI B16.3. Provide pipe with American Standard Taper pipe threads. Drainage fittings for use with drain lines and other lines which are required to be graded shall be cast iron drainage screwed fittings in accordance with ANSI B16.12.

C. Flanged Fittings: Fittings for use with flanged joints on ductile iron pipe or on steel pipe shall be cast iron or ductile iron fittings conforming to ANSI B16.1 or AWWA C110. Flanges

shall be faced and drilled in accordance with ANSI B16.1, Class 125.

D. Butt-Welded Fitting: ASTM A234 WPB wrought steel butt-weld fitting manufactured in accordance with ANSI B16.9. For stainless steel pipe, use ASTM A 403, Grade WP 316L butt-welded fittings.

E. CPVC Fittings: Type IV, Grade I, Schedule 80, unless otherwise noted. Material and joining shall be in accordance with ASTM D2846/ D2846M. Suitable for above-ground applications only.

F. PVC Fittings: Suitable for above ground non-pressure applications only. Type I, Schedule 80, unless otherwise noted. Material shall meet the requirements of ASTM D 1784 and ASTM D 1785, fittings shall be in accordance with applicable ASTM Standards D2464, D2467, and D3311.

G. Restrained Joint Fittings: Restrained joint fittings shall be ductile iron in accordance with applicable requirements of ANSI/AWWA C110/A21.10 with the exception of the manufacturer's proprietary design dimensions. Push-on joints for such fittings shall be in accordance with ANSI/AWWA C11/A21.11. Lining and seal coating of fittings shall be in accordance at the specific pipe specification section.

H. Mechanical or Push-on Fittings: Fittings for use with mechanical joint or push-on joint ductile iron pipe shall be cast iron/ductile iron fittings conforming to AWWA C110 with joints conforming to AWWA C111, unless specified otherwise.

I. Polyethylene Fittings and Custom Fabrications:

1. Fittings shall be molded or fabricated by the Approved Pipe Manufacturer. All fittings and custom fabrications shall be pressure rated for the same internal pressure rating as the mating pipe.

a. Molded fittings:

i. Fittings shall be manufactured and tested in accordance with ASTM D 3261 and shall be so marked. Molded fittings shall be tested in accordance with AWWA C906.

ii. The Manufacturer shall submit samples from each molded fittings production lot to x-ray inspection.

b. Fabricated fittings:

iii. Fittings shall be made by heat fusion jointing specially machined shapes cut from pipe, polyethylene sheet stock or molded fittings.

iv. Fabricated fittings shall be rated for internal pressure service at least equal to the full service pressure rating of the mating pipe.

v. Fabricated fittings shall be tested in accordance with AWWA C906.

2.04 BRANCH CONNECTIONS

A. Galvanized Steel Pipe: Use threaded or grooved couple straight size reducing tee, hot-dipped galvanized. When branch is smaller than header, a hot-dipped galvanized nipple and reducing coupling or swaged nipple may be used.

B. Black Steel Pipe:

1. For pipe 2-1/2-inches and smaller, use threaded straight size reducing tee. When branch is smaller than header, a nipple and reducing coupling or swaged nipple may be used.

2. For 3 inches and larger welding pipe, when branch size is the same size as header,

use welding tee. When the branch is smaller than the header, use weldolets. For threaded branch connections, use 3,000-pound threadolets.

C. Cast or Ductile Iron Pipe: For 2 inches and smaller, use branch connections for drain tappings in conformance with ANIS B16.1-1967. For all other branch connections, use fitting makeup.

2.05 UNIONS

A. Malleable Iron Unions: Use 150-pound standard (300-pound WOG) malleable iron, ground joint unions with bronze seat. Provide flanged union joints on piping 2-1/2-inches or larger. Use service galvanized unions for galvanized pipe. Use insulating unions where indicated or required where joining dissimilar metals.

B. PVC Unions: Use Schedule 80 threaded PVC unions.

2.06 GASKETS

A. Contractor shall obtain gaskets recommendations and technical support from VSP Technologies of Prince George, Virginia at (804) 541-0812 or (800) 334-6013.

B. Provide gaskets of Buna-N, unless otherwise noted. All gaskets shall be designated for petroleum service.

C. Provide full-face gaskets for flat-faced flanges and ring gaskets for raised-face flanges. Use 1/16-inch-thick gaskets for pipe smaller than 6-inches and 1/8-inch thick gaskets for pipe 6-inches and larger. Gaskets' dimensions shall conform to ANSI B16.21.

D. Provide insulating flange gasket kit where indicated or required where joining dissimilar metals.

PART 3 - EXECUTION

3.01 PIPE LAYOUT AND INSTALLATION

A. Layout and Preparation:

1. Make piping layout and installation as shown on the plan documents, but also taking into consideration the most advantageous use of headroom, valve access, opening and equipment clearance and clearance for other work. Give particular attention to piping in the vicinity of equipment. Preserve the maximum access to various equipment parts for maintenance.

2. DO NOT cut or weaken any structural member.

3. Cut pipe accurately to measurement determined at the site. After cutting pipe, ream it to remove burrs to full inside diameter.

B. Installation:

1. Install piping neatly, free from unnecessary traps and pockets. Work into place without springing or forcing. Use fittings to make all changes in direction. Field bending is prohibited. Make all connections to equipment using flanged joints, unions, or grooved coupled joints. Make reducing connections with reducing fittings only.

2. Install all other pipe according to manufacturer's recommendations using the recommended tools.

3. Do not exceed manufacturer’s recommendations for curvature of lines and/or deflection of pipe joints.

C. Handling: Handle pipe, fittings, and accessories in a manner that will ensure their installation in the work in sound, undamaged condition. In unloading, reloading, hauling, and laying pipe and fittings use proper equipment, tools, and methods to prevent damage. Hooks inserted in ends of pipe must have broad, well-padded contact surfaces.

D. Cutting Pipe: Perform cutting of cast iron pipe in a neat manner, without damage to pipe or to the cement lining. Cut pipe smooth, straight and at right angles to pipe axis with mechanical pipe cutters. In locations where use of mechanical cutters would be difficult or impractical, existing pipe may be cut with diamond point chisels, saws or other tools which will cut pipe without damaging impact or shock.

E. Cleaning: Clean interior of all pipe and fittings thoroughly of all foreign matter before installing and keep clean until the work has been accepted. Remove all lumps, blisters, and excess coating from exterior and spigot and interior bell surfaces. Wire brush such surfaces and wipe clean and dry, free from oil and grease, before placing spigot into bell. Keep joint contact surfaces clean until jointing is complete. Take every precaution to prevent foreign material from entering pipe while it is being installed. DO NOT place debris, tools, clothing, or other materials in pipe.

F. Laying Pipe:

1. Protect pipe from lateral displacement by means of pipe embedment material installed as provided in trench backfill specifications.

2. DO NOT under any circumstances lay pipe in water or under unsuitable weather or trench conditions.

3. Lay pipe with bell ends facing direction of laying except when making closures.

4. Lay pipe on bedding as specified in the section on Excavation, Trenching, and Backfilling for Utilities, as required in individual pipe material specification.

5. Excavate trenching for underground piping to the required depth to ensure 4 feet minimum cover over the pipe unless otherwise indicated on the drawings. Excavation and backfill shall be performed in accordance with Division 2.

G. Plastic Pipe: Installation shall be in accordance with applicable ASTM Standards D2774, D2855, and F402.

H. Polyethylene Pipe:

1. Installation shall be in accordance with ASTM D 2774, Manufacturer's recommendations and this specification. All necessary precautions shall be taken to ensure a safe working environment in accordance with all applicable safety codes and standards.

2. A stiffener shall be installed in the bore of the polyethylene pipe when an outside diameter compression mechanical coupling is used and when connecting plain end EP pipe to a mechanical joint pipe, fitting or appurtenance. External clamp and tie rod restraint shall be installed when PE pipe is connected to the socket of a mechanical joint pipe, fitting or appurtenance.

3. Mechanical joint and flange connections shall be installed in accordance with the Manufacturer's recommended procedure. MJ Adapters and flanges shall be centered and aligned to the mating component before assembling and tightening bolts. In no case shall MJ gland or flange bolts be used to draw the connection into alignment. Bolted threads shall be lubricated, and flat washers should be used under the nuts. Bolts shall be evenly tightened according to the tightening pattern and torque step recommendations of the Manufacturer. At least 1 hour after initial assembly, flange connections shall be re-tightened following the tightening pattern and torque step recommendations of the Manufacturer. The final tightening torque

shall be as recommended by the Manufacturer.

4. When lifting with slings, only wide fabric choker slings capable of safely carrying the load shall be used to lift, move, or lower pipe and fittings. Wire rope and chain are prohibited. Slings shall be of sufficient capacity for the load, and shall be inspected before use. Worn or damaged equipment shall not be used.

5. The CONTRACTOR shall ensure the field set-up and operation of the fusion equipment, and the fusion procedure used by the CONTRACTOR'S fusion operator while on-site. CONTRACTOR shall verify filed fusion quality by making and testing a trial fusion. The trial fusion shall be allowed to cool completely; then test straps shall be cut out and bent strap tested in accordance with ASTM D 2657. If the bent strap test of the trial fusion fails at the joint, the field fusions represented by the trial fusion shall be rejected. The CONTRACTOR at his expense shall make necessary corrections to equipment, set-up, operation and fusion procedure, and shall re-make the rejected fusions.

3.02 PIPE JOINT INSTALLATION

A. Make joints between dissimilar metal pipe and equipment using insulating unions or insulating flange gasket assembly. Joints between aboveground piping and below-ground piping are to be considered the same as dissimilar metal pipe.

B. Screwed Joints: Make up all threaded joints using a suitable joint lubricating compound applied to male threads only. Thoroughly ream all field cuts and carefully make all connections so that thread engagement will be secured.

C. Welded Joints:

1. Weld and fabricate piping in accordance with ANSI Standard B31.1, latest edition, Code for Pressure Piping. Machine beveling in shop is preferred. Field beveling may be done by flame cutting to acceptable standards.

2. Align piping and equipment so that no part is offset more than 1/16-inch. Set all fittings and joints square and true and preserve alignment during welding operation. Use of alignment rods inside pipe is prohibited.

3. DO NOT permit any weld to project within the pipe so as to restrict it. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during welding operations.

4. DO NOT split, bend, flatten, or otherwise damage piping before, during or after installation.

5. Remove dirt, scale, and other foreign matter form inside piping before tying in sections, fittings, valves or equipment.

D. Flanged Joints:

1. Contractor shall obtain gaskets and flange-bolt recommendations and technical support from VSP Technologies of Prince George, Virginia at (804) 541-0812 or (800) 334-6013.

2. Prior to installation of bolts, accurately center and align flanged joints to prevent mechanical prestressing of flanges, pipe, and equipment. Align bolt holes to straddle the vertical, horizontal or north-south center line. DO NOT exceed 3/64-inch per foot inclination of the flange face from true alignment.

3. Install ENGINEER approved gaskets, factory cut to proper dimensions. Secure with ENGINEER approved gasket cement.

4. Tighten bolts progressively to prevent unbalance stress. Draw bolts tight to ensure

proper seating of gaskets.

5. Take special care when attaching suction and discharge piping to pumping equipment to ensure that no stresses are transmitted to or imposed on pump suction and discharge flanges by connected piping. Install and permanently support all piping to accurately match bolt holes and to provide uniform contact over entire installation of bolts in flanges. In addition, pump connections piping shall be free to move parallel to its longitudinal center line while bolts in pump connections flanges air tightened.

E. Butt and Saddle Fusion:

1. Joints between plain end pipes and fittings shall be made by butt fusion. Joints between the main and saddle branch fittings shall be made using saddle fusion. The butt fusion and saddle fusion procedures used shall be procedures that are recommended by the pipe and fitting Manufacturer. The CONTRACTOR shall ensure that persons making heat fusion joints have received training in the Manufacturer's recommended procedure. The CONTRACTOR shall maintain records of trained personnel, and shall certify that training was received not more than twelve (12) months before commencing construction. External and internal beads shall not be removed.

2. Butt fusions shall be performed between pipe ends, or pipe ends and fitting outlets that have the same outside diameter and are not different in wall thickness by more than one Standard DR, for example, SDR 13.5 to SDR 17, or SDR 11 to SDR 13.5. Transitions between unlike wall thickness greater than one SDR shall be made with a transition nipple (a short length of the heavier wall pipe with one end machined to the lighter wall) or by mechanical means or electrofusion. SDR's for polyethylene pipe are 7.3,9,11,13.5,17,21,26,32.5, and 41.

3.03 OFFSETS AND FITTINGS

A. Because of the small scale of drawings, the indicating of all offsets and fittings is not possible. Carefully investigate the structural and finish conditions affecting the work and take such steps as may be required to meet such conditions.

B. Provide proper space for covering and removal of pipe, and special clearances for offsets and fittings.

3.04 SECURING AND SUPPORTING

A. Support piping as shown on drawings and as required to maintain line and grade, with due provisions for expansion and contraction. Use approved hot-dipped galvanized hangers, rollers, anchors and guides properly connected to structural members. DO NOT support piping from other piping except where shown on drawings.

B. Hangers and Straps:

1. Place hangers not more than 6 feet apart on 1/2-inch and 3/4-inch pipes or 10 feet apart on larger pipes unless otherwise indicated. Place hangers not more than 6 feet apart for all sizes of PVC pipe.

2. Support vertical risers with hot-dipped galvanized steel strap pipe clamps properly supported at every floor unless otherwise shown on drawings. Piping assemblies in chases shall be adequately supported to be rigid and self-supporting before the chase is closed. Provide adequate structural support for piping penetrating chase walls to plumbing fixtures.

3. Where insulation occurs, design hangers to protect insulation from damage.

4. Perforated bar hangers, straps, wires or chains are not permitted.

C. Rollers: Provide 3-point cast iron rollers where shown on piping drawings.

D. Uni-strut Pipe Supports: Provide standard Uni-strut metal framing members and appurtenances for pipe support as required. Mult-A-Frame and Power-Strut pipe support systems also are acceptable. Hot-dip galvanize all such members and appurtenances. Paint all cut edges and damage with a zinc spray such as Research Laboratory type "LPS," Mobil "Zinc-spray," or equal.

E. Anchors:

1. Provide anchors as indicated or required. Unless otherwise detailed on drawings, use pipe anchors consisting of heavy steel collars with lugs and bolts for clamping to pipe and attaching anchor braces. Install anchor braces in the most effective manner to secure desired results.

2. DO NOT install supports, anchors or similar devices where they will damage construction during installation or because of the weight or the expansion of the pipe.

F. Pipe Guides:

1. For plant piping, provide pipe alignment guides as detailed on drawings and as required by pipe manufacturer.

2. Guide expansion joints with two guides on the side opposite the anchor.

3. Guide pipe installed and supported by Uni-strut supports using a duplicate set of pipe rolls on the top of the pipe.

3.05 PIPE SLEEVES

A. Unless shown as a wall pipe on the plans, fit with sleeves all pipes passing through masonry and concrete construction. Fabricate sleeves of hot-dipped galvanized steel pipe unless otherwise indicated. Size sleeve for minimum clearance between pipe or insulation and sleeve.

B. Extend each sleeve through the floor or wall. Cut the sleeve flush with each surface, except that in exposed locations, extend floor sleeves 2 inches above finished floor line.

C. Caulk all sleeves watertight and airtight. Seal annular space between pipes and sleeves with Thunderline Link-Seal or equal.

3.06 ISOLATION VALVES, DRAIN VALVES AND INSTRUMENT TAPS

A. Isolation Valves: Provide piping systems with line-size shutoff valves located at the risers, at main branch connections to mains for all equipment and at other locations as indicated and required.

B. Drain Valves: For plant services, install drain valves where shown, or at all piping low points.

C. Instrument Taps:

1. Instrument taps for Liquid Process Service. Provide 3/4-inch size tap process pipe branch connection as specified above with 3/4-inch nipple terminated with a 3/4-inch shutoff valve. The nipple and shutoff valve shall be as specified in the individual piping material specifications.

2. Instrument Taps for Gas Process Service is the same as for liquid process service except size of taps, nipple, and shutoff valve shall be 1/2-inch.

3. Location of instrument taps shall be generally shown on piping drawings.

3.07 PIPE LABELING

A. The CONTRACTOR shall label all aboveground piping with labels that clearly indicate the direction of flow and contents. Each line shorter than 10-feet shall be labeled at the beginning and end of the pipe. Each line longer than 10 feet shall be labeled at each end and at least every 50 feet in the middle of the line. The contents of each line are presented in the line list.

3.08 PIPE SUPPORT AND ANCHORS

A. The majority of the plant process piping shall be installed aboveground and placed on pipe supports as shown on the detailed engineering drawings. The CONTRACTOR shall furnish all labor, equipment, and materials necessary for the installation of the pipe stands.

B. The pipe supports shall be installed every 15 feet (maximum), or as required for the proper support of the header pipes rigid conduits. In certain locations, pipe supports and anchors have been indicated on the detailed engineering drawings, but no attempt has been made to indicate every pipe support and anchor. It shall be the CONTRACTOR'S responsibility to provide a complete system of pipe supports and to anchor all piping, in accordance with the requirements set forth herein. Additional pipe supports may be required adjacent to flow meters, flanges, couplings, or valves.

C. Pipe supports shall withstand all static and dynamic conditions of loading to which the piping and associated equipment may be subjected. As a minimum, consideration should be given to the following conditions:

1. Weights of pipe, valves, fittings, insulating materials, and fluid contents.
2. Reaction forces due to the operation of valves.
3. Wind loadings.

D. At least one support shall be located within 2 feet from a pipe change in direction.

E. Where piping is connected to equipment, valves, flow meter, piping assembly, etc., it will require removal for maintenance, the piping shall be supported in such a manner that temporary supports shall not be necessary for this procedure.

F. The CONTRACTOR shall locate supports as near as possible to the concentrated loads such as valves, flanges, etc.

G. All piping shall be rigidly supported and anchored so there is no movement or visible sagging between supports and expansion loops.

END OF SECTION

SECTION 15075
MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:

1. Adjust list below to suit Project.

2. Equipment nameplates.

3. Equipment markers.

4. Equipment signs.

5. Access panel and door markers.

6. Pipe markers.

7. Duct markers.

8. Stencils.

9. Valve tags.

10. Valve schedules.

11. Warning tags.

1.03 SUBMITTALS

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

B. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in maintenance manuals. Reproduce on 8-1/2 x 11 bond. Tabulate valve number, piping system, system abbreviation as shown on tag, room or space location of valve, and variations for identification. Mark valves intended for emergency shutoff and similar special uses. Indicate normal operating positions (open, closed, modulating, or balance).

1.04 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

1.05 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 GENERAL

A. Products specified are for applications referenced in other Mechanical sections. If more than a single type is specified for listed applications, selection is installer's choice; however, all equipment shall have an engraved nameplate.

2.02 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment. Equipment shall be tagged with construction document mark reference (i.e. AHU-1, VAV-1, UH-1, etc.).

1. Data:

a. Manufacturer, product name, model number, and serial number.

b. Capacity, operating and power characteristics, and essential data.

c. Labels of tested compliances.

2. Location: Accessible and visible.

3. Fasteners: As required to mount on equipment.

4. Material: 316SS.

B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.

1. Terminology: Match schedules as closely as possible.

2. Data:

a. Name and plan number.

b. Equipment service.

c. Design capacity.

d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.

3. Size: 2-1/2 by 4 inches) for control devices, dampers, and valves; 4-1/2 by 6 inches or equipment.

C. Equipment Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.

1. Data: Instructions for operation of equipment and for safety procedures.

2. Engraving: Manufacturer's standard letter style, of sizes and with terms to match equipment identification.

3. Thickness: 1/8 inch, unless otherwise indicated.

4. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

D. Access Panel and Door Markers: 1/16-inch thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment.

1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.03 2.3 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Manufacturers standard preprinted, semi-rigid, snap-on type.

1. Colors: Comply with ASME A13.1, unless otherwise indicated.

2. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.

3. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.

4. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

5. Lettering: Manufacturers standard preprinted.

2.04 DUCT IDENTIFICATION DEVICES

A. Duct Markers: Engraved, color-coded laminated plastic. Include direction and quantity of airflow and duct service (such as supply, return, and exhaust). Include contact-type, permanent adhesive. See Execution section for color scheme.

2.05 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inchsequenced numbers. Provide 5/32-inch hole for fastener.

1. Retain one of first three subparagraphs below.

2. Material: 0.032-inch thick 316 stainless steel.

3. Valve-Tag Fasteners: 316SS S-hook.

4. Size: 1½ inches in diameter, unless otherwise indicated.

2.06 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum.

2. Fasteners: Brass grommet and wire.

3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.

4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.01 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Mechanical Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.02 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:

1. Edit five subparagraphs below to suit Project.

2. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.

3. Pumps, compressors, chillers, condensers, and similar motor-driven units.

4. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.

5. Fans, blowers, primary balancing dampers, and mixing boxes.

6. Packaged HVAC central-station and zone-type units.

B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.

1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches), ½ inch for viewing distances up to 72 inches), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.

3. Locate markers where accessible and visible. Include markers for the following general categories of equipment: Edit 10 subparagraphs below to suit Project.

   a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.

   b. Fire department hose valves and hose stations.

   c. Meters, gages, thermometers, and similar units.

   d. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.

   e. Pumps, compressors, chillers, condensers, and similar motor-driven units.

   f. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.

   g. Fans, blowers, primary balancing dampers, and mixing boxes.

   h. Packaged HVAC central-station and zone-type units.

   i. Tanks and pressure vessels.

   j. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

C. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.

1. Identify mechanical equipment with equipment markers in the following color codes:

   a. Green: For cooling equipment and components.

   b. Yellow: For heating equipment and components.

   c. Green and Yellow, Orange: For combination cooling and heating equipment and components.

   d. Brown: For energy-reclamation equipment and components.

2. Letter Size: Minimum 1/2 inch for name of units if viewing distance is less than 24 inches), 3/4 inch for viewing distances up to 72 inches), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

3. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.

4. Include signs for the following general categories of equipment:

   a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.

b. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.

c. Pumps, compressors, chillers, condensers, and similar motor-driven units.

d. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.

e. Fans, blowers, primary balancing dampers, and mixing boxes.

f. Packaged HVAC central-station and zone-type units.

g. Tanks and pressure vessels.

h. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

D. Install access panel markers with screws on equipment access panels.

3.03 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

1. Pipes with OD, Including Insulation, Less Than 6 Inches): Snap-on application of pretensioned, semi-rigid plastic pipe marker.

2. Pipes with OD, Including Insulation, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with manufacturer's stainless steel bands.

3. Fasten Option: Laminated or bonded application of pipe marker to pipe or insulation.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; in machine rooms; in accessible maintenance spaces such as shafts, tunnels and plenums; and in exterior nonconcealed locations such as rooftops and chiller yards, as follows:

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.

4. At access doors, manholes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

7. On piping above removable acoustical ceilings.

3.04 DUCT IDENTIFICATION

A. Install duct markers with permanent adhesive on air ducts in the following color codes:

1. Green: For cold-air supply ducts.

2. Yellow: For hot-air supply ducts.

3. Blue: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

5. Letter Size: Minimum 1/2 inch for name of units if viewing distance is less than 24 inches), 3/4 inch for viewing distances up to 72 inches), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

B. Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system. Reduce intervals to 25 feet in areas of high duct congestion.

3.05 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule on wall in accessible location in each major equipment room.

3.06 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.07 VALVE TAGS

A. Install on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, plumbing fixture supply stops, shutoff valves, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in valve schedule.

B. Valve Tag Application Schedule: Tag valves according to size, shape, color scheme, and with captions similar to those indicated in the following:

C. Tag Material: 316SS.

D. Tag Size and Shape: 1-1/2 inches, round.

E. Tag Color: According to the following:

1. Chilled Water: Blue.

2. Cold Water: Black.

3. Hot Water: Red.

4. Fire Protection: Red.

5. Sprinkler: White.

6. Gas: Yellow.

7. Steam: Red.

F. Letter Color: White.

G. Install mounted valve schedule in each major equipment room.

3.08 EQUIPMENT SIGNS AND MARKERS

A. Install engraved plastic-laminate signs or equipment markers on or near each major item of mechanical equipment. Include signs for the following general categories of equipment:

1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.

2. Meters, gages, thermometers, and similar units.

3. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.

4. Pumps, compressors, chillers, condensers, and similar motor-driven units.

5. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.

6. Fans, blowers, primary balancing dampers, and mixing boxes.

7. Packaged HVAC central-station and zone-type units.

8. Tanks and pressure vessels.

9. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

10. Any concealed appurtenances requiring access for maintenance shall be clearly identified by sign (to include but not be limited to unions, strainers, valves, etc.).

B. Duct Systems: Identify air supply, return, exhaust, intake, and relief ducts with duct markers; or provide stenciled signs and arrows showing service and direction of flow.

1. Location: Locate signs near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.09 ADJUSTING AND CLEANING

A. Relocate mechanical identification materials and devices that have become visually blocked by work of this or other Divisions.

B. Clean faces of identification devices and glass frames of valve charts.

END OF SECTION

SECTION 15102
VALVES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and DIVISION 1 - GENERAL REQUIREMENTS sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following general-duty valves and accessories:

1. Valve Actuators - General
2. Valve Actuators - Powered
3. Resilient Seated Gate Valves
4. Plug Valves
5. Butterfly Valves
6. Swing Check Valves
7. Mud Valves
8. Flap Valves
9. Globe Valves
10. Plastic Valves
11. Pressure Regulating Valves
12. Pressure Relief & Surge Anticipator Valves
13. Reduced Pressure Zone (RPZ) Backflow Preventer Valves
14. Booster Pump Control Valve
15. Air Release Valves
16. Hose End Valves
17. Solenoid Valves
18. Extension Stems.
19. Valve boxes.

1.03 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.04 QUALITY ASSURANCE

A. ASME Compliance: ASME B31.9 for building services piping valves.

1. Exceptions: Domestic hot- and cold-water, sanitary waste, and storm drainage piping valves unless referenced.

B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.

2. Protect threads, flange faces, grooves, and weld ends.

3. Set ball and plug valves open to minimize exposure of functional surfaces.

4. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.

2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 VALVE ACTUATORS- GENERAL

A. The valve manufacturer shall supply and integrally, rigidly mount all actuators, including any type of manual or powered actuators, on valves at the factory. The valves and their individual actuators shall be shipped as a unit.

B. Unless otherwise noted, valves shall be manually actuated; non-buried valves shall have an operating wheel, handle or lever mounted on the operator. Those with operating nuts shall have a non-rising stem with an AWWA 2 in. nut.

C. Except as otherwise shown on the Drawings or specified herein, all valves 3 in. diameter or larger, with the valve center line located 7 ft. or more above the operating floor, shall be provided with chain wheel operators complete with chain guides and stainless steel chain, which loop within 4 ft. of the operating floor.

D. All actuators shall be capable of moving the valve from the full open to full close position and in reverse and holding the valve at any position part way between full open or closed.

E. Each operating device shall have cast on it the word "OPEN" and an arrow indicating the direction of operation.

F. Floor boxes for operating nuts recessed in concrete shall be standard cast iron type, cast-in-place, with fastening top by Clow or equal.

G. Stem guides shall be of the adjustable wall bracket type, bronze bushed, with maximum spacing of 10 ft. as manufactured by Clow; Rodney Hunt or equal. Extended operating nuts and/or stems shall have universal joints and pin couplings, if longer than 10 ft. and a rating of at least five (5) times the maximum operating torque. Stem adaptors shall be provided.

H. Where required by the installation, or as specified, provide the following: extended stem; floor stand and handwheel; position indicator and etched or cast arrow to show direction of rotation to open the valve; resilient seal around stem penetration of slab.

I. Gear Actuators

1. Unless otherwise noted, gear actuators shall be provided for the following: all valves of larger than 8 in. nominal diameter; all valves with operating shaft mounted horizontally (butterfly, plug, etc.); where specified and/or indicated on the Drawings; where manual operator effort is greater than 80 ft./lbs. rim pull.

2. Gear actuators shall be of the worm or helical gear type with output shaft perpendicular to valve shaft, having a removable hand wheel mounted on the output shaft. Unless noted they shall conform to AWWA C504, except that butterfly valves need not be certified.

3. Actuators shall be capable of being removed from the valve without dismantling the valve or removing the valve from the line.

4. Gearing shall be machine-cut steel designed for smooth operation. Bearings shall be permanently lubricated, with bronze bearing bushings provided to take all thrusts and seals and to contain lubricants. Housings shall be sealed to exclude moisture and dirt, allow the reduction mechanisms to operate in lubricant and be of the same material as the valve body.

5. Manual operator input effort to the handwheel shall be a maximum of 40 ft./lbs. for operating the valve from full open to full close, under any conditions. Gear actuators shall indicate valve position and have adjustable stops. Maximum handwheel size shall be 24 in. diameter.

J. Additional valve actuators shall be as specified herein.

K. All position indication and direction of opening arrows shall be embossed, stamped, engraved, etched or raised decals.

L. Unless otherwise noted, all valves larger than 3 in. nominal diameter shall be provided with position indicators at the points of operation.

2.03 GATE VALVES - RESILIENT SEATED

A. All Gate Valves for Industrial Slurry service shall be constructed in accordance with AWWA Standard C-509-80, or latest revision thereof, and shall have the following design features:

B. All valves shall have a working pressure of 200 psi and shall by hydrostatically tested at this pressure from both directions and shall be tested at 400 psi. Zero leakage shall be required in all tests. The body, bonnet, and stuffing box shall be flanged together with ASTM A-307 Grade B bolts and nuts to insure reparability.

C. Stems shall be machined from modified manganese bronze rod with an integral forged thrust collar machined to size and shall be interchangeable with existing double disc gate valves of the same size and manufacture.

D. Stem seals shall be one "O" ring above and one stem "O" ring below the thrust collar forming a lubricant reservoir between to isolate and lubricate the thrust collar, bearing surfaces, and "O" rings. An anti-friction washer shall also be placed above the thrust collar to further accommodate operating torque.

E. Valve discs shall have an integrally cast ASTM B-62 bronze stem nut to provide disc rigidity and a positive travel stop to prevent over-compression of the resilient seat. The disc shall be open to flow on one side to prevent collection of corrosive products and debris.

F. The disc seat rings shall be molded natural rubber, internally steel reinforced, and shall seat against a machined, epoxy coated mating surface in the body of the valve. The disc seat rings shall be retained to the disc by self-setting type 304 stainless steel screws, making them replaceable.

G. All internal ferrous metal surfaces (machined or cast) shall be factory spray coated with two-component thermoset epoxy to a nominal thickness of 4 mils and the exterior shall be coated with asphalt varnish.

H. Resilient seat valves shall be Mueller A-2370, or approved equal, with end connections as specified.

2.04 PLUG VALVES

A. "Plug Valves" shall be of the non-lubricated, eccentric type with resilient faced plugs, and screwed, flanged, or mechanical joint ends as shown on the plans. Port areas of valves shall be at least 80 percent of full pipe area. Bodies shall be semi-steel with raised seats. Seats in 3" and larger valves shall have a welded-in overlay of not less than 90 percent pure nickel on all surfaces contacting the plug face. Valves through 20" shall have stainless steel permanently lubricated upper and lower lug stem bushings. All valves 4" and larger shall be of the bolted bonnet design. Valves shall be designed so that they can be repacked without removing bonnet from valve. Packing on all valves shall be adjustable. All exposed nuts, bolts, springs, and washers shall be zinc plated.

B. All valves 10" and larger, or as designated, shall be equipped with gear actuators. All gearing shall be enclosed, suitable for running oil with seals provided on all shafts, to prevent entry of dirt and water into the actuator. All shaft bearings shall be furnished with permanently lubricated bronze bearing bushings. Actuator shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque. Valve packing adjustment on non-submerged valves shall be accessible without removing the actuator from the valve. Construction of actuator housing shall be semi-steel. All exposed nuts, bolts, and washers shall be zinc plated. Valves located more than 6 ft. above the floor shall be provided with chainwheel actuator. The chain shall be stainless steel.

C. Valves and actuators for submerged/buried service shall have seals on all shafts, and gaskets on valve and actuator covers, to prevent the entry of water. Actuator mounting brackets for submerged service shall be totally enclosed and shall have gasket seals. All exposed nuts, bolts, springs, and washers for submerged valves shall be stainless steel. Valve stem extension shall be extended to within 12" of finished grade or operating level.

D. Cylinder actuated valves shall be furnished with cylinders sized to operate with a minimum of 50 psi air supply. The actuator shall be an on-off double acting with rack and gear drive. The actuator shall clearly indicate valve position and an adjustable stop to provide closed position for plug. All actuator air tubing shall be non-metallic, flexible hose by Parker "Push-Lok", or equal. Valves actuators shall be provided complete 4-way solenoid (120/60/1, NEMA IV) with manual override. Actuator shall be equipped with operating nut to allow manual valve operation in case of air supply failure.

E. Plug valves shall be as manufactured by DeZurik, Keystone, GA or approved equal.

2.05 SWING CHECK VALVES

A. Unless otherwise designated in the plans, check valves 4" in diameter and larger shall be iron body, bronze seated, swing-type check valves with outside air cushion cylinder and designed for 150 lbs. working pressure.

B. Check valves on small piping shall be as noted on the plans.

C. Check valves shall be GA Industries, Figure 250-D, APCO Valve & Primer Corp. Series 6000, or approved equal.

2.06 AIR RELEASE VALVES

A. Valves shall be supplied with shutoff gate or ball valves with operator handle or lever removed. Valves shall be properly vented and piped to drain.

B. Attention is directed to the requirement that valve's pressure rating be at least equal to the attached pipe's rating.

C. Unless otherwise referenced in the Drawings, valves shall be proper model by Val-Matic; APCO, GA or equal.

2.07 HOSE END VALVES

A. Hose end valves shall be globe pattern valves, equal to Fairbanks Fig. 074; Jenkins Fig. 112; or equal. Furnish cap and chain.

2.08 FLANGES

A. Flanges shall be cast solid and faced accurately at right angles to the axis of the casting. Dimensions and drilling of flanges shall be in accordance with the American Standards Association for a working pressure of 125 lbs. per square inch. Special drilling shall be provided where necessary.

2.09 EXTENSION STEMS & OPERATING WRENCHES

A. All valves to be furnished for buried installation shall be furnished with extension stems to reach a point not deeper than 1'-0" below finished grade elevation adjacent to the valve and valve box. Each set of valves shall be furnished with not less than two (2) operating wrenches of a size and length appropriate to operate the valves.

2.10 VALVE BOXES

A. Valves buried in the ground shall be provided with cast iron valve boxes of proper dimensions to fit over the valve bonnets, and to extend to such elevation, at or slightly above the finished ground line, as directed by the ENGINEER. Tops shall be complete with covers and shall be adjustable. Valve boxes shall be vertical and concentric with the valve stem. Any valve box which has so moved from its original position as to prevent the application of the valve key shall be satisfactorily reset by the CONTRACTOR at his own expense.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves in positions from fully open to fully close. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Piping installation requirements are specified in other DIVISION 15 - MECHANICAL sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem movement.

F. Install chainwheel operators on valves NPS 4 and larger and more than 72 in. above floor. Extend chains to 36 in. above finished floor elevation.

G. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.

3. Lift Check Valves: with stem upright and plumb.

3.03 JOINT CONSTRUCTION

A. Refer to SECTION 15050 - BASIC MECHANICAL MATERIALS AND METHODS for basic piping joint construction.

B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.04 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION

SECTION 15120
PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section specifies piping appurtenances which are not specifically covered in other sections.

B. Specific piping materials, systems and related installation and testing requirements are included in other sections of DIVISION 2 - SITE WORK and DIVISION 15 - MECHANICAL.

C. The items shall include the following:

1. Unions
2. Flanged Joints
3. Dielectric Connectors
4. Plugs and Caps
5. Miscellaneous Adaptors
6. Vents and Drains
7. Line Strainers
8. Self-Backwashing Filter
9. Service Clamps
10. Cleanouts
11. Floor Drains
12. Quick Connect Couplings
13. Mechanical Sleeve Seals
14. Flexible Connectors
    a. Sleeve Couplings
    b. Split or Grooved Couplings
    c. Flange Adapters
    d. Pump and Equipment Flexible Connectors
    e. Flexible Connectors
15. Harnessing and Restraints

16. Pressure Gauges

17. Diaphragm Seals for Gages

18. Rotameters and Flow Indicators

19. Spray Nozzle

20. Appurtenances and Miscellaneous Items

21. Color Coding and Labeling

1.02 RELATED WORK

A. Piping materials and systems are included in other sections of DIVISION 15 - MECHANICAL.

B. Valves are included in SECTION 15102 - VALVES.

1.03 SUBMITTALS

A. General submittals for piping, piping systems and pipeline appurtenances are listed below. Submittals shall be in accordance with SECTION 01330 - SUBMITTALS. It is not intended that all submittals listed below be provided for all piping materials and systems. Refer to individual System or Piping Sections for specific submittals.

B. Shop Drawings and Product Data

1. Piping layouts in full detail.

2. Location of pipe hangers and supports.

3. Location and type of backup block or device to prevent joint separation.

4. Large scale details of wall penetrations and fabricated fittings.

5. Schedules of all pipe, fittings, special castings, couplings, expansion joints and other appurtenances.

6. Catalog cuts of joints, couplings, harnesses, expansion joints, gaskets, fasteners and other accessories.

7. Catalog cuts of all pipeline appurtenances specified herein.

8. Brochures and technical data on coatings and linings and proposed method for application and repair.

C. Samples

D. Design Data

E. Test Reports

1. Six (6) copies of certified shop tests showing compliance with appropriate standard.

2. Six (6) copies of all field test reports, signed by CONTRACTOR and ENGINEER.

F. Certificates

1. Copies of certification for all welders performing work in accordance with ANSI B31.1.

G. Manufacturer's Installation (or application) instructions.

H. Statement of Qualifications

I. Manufacturers Field Report

J. Project Record Document

K. Operation and Maintenance Data in accordance with SECTION 01782 - OPERATION AND MAINTENANCE DATA.

L. Warranties

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A36 - Standard Specification for Structural Steel.

2. ASTM A126 - Gray Iron Casting for Valves, Flanges and Pipe Fittings.

3. ASTM A183 - Carbon Steel Track Bolts and Nuts.

4. ASTM A278 - Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 50°F.

5. ASTM A307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

6. ASTM A325 - Standard Specification for High-Strength Bolts for Structural Steel Joints.

7. ASTM A536 - Ductile Iron Castings

8. ASTM A575 - Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grade.

9. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.

10. ASTM B88 - Standard Specification for Seamless Copper Water Tube.

B. American National Standards Institute (ANSI)

1. ANSI A13.1 - Scheme for the Identification of Piping Systems.

2. ANSI B1.1 - Unified Inch Screw Threads (UN and UNR Thread Form)

3. ANSI B2.1 - Specifications, Dimensions, Gauging for Taper and Straight Pipe Threads (except dry seals).

4. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125,250 and 800.

5. ANSI B16.5 - Pipe Flanges and Flange Fittings

6. ANSI B18.2 - Square and Hex Bolts and Screws Inch Series Including Hex Cap Screws and Lag Screws.

7. ANSI B31 - Code for Pressure Piping, B31 Interpretation.

8. ANSI B31.1 - Power Piping

C. American Welding Society (AWS)

1. AWS B3.0 - Welding Procedure and Performance Qualifications

D. American Water Works Association (AWWA)

1. AWWA C-110 - Ductile-Iron and Gray-Iron Fittings 3 in. Through 48 in., for Water and Other Liquids.

2. AWWA C-111 - Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.

3. AWWA C-201

4. AWWA C-206 - Grooved and Shouldered Type Joints.

5. AWWA Manual Mil -Steel Pipe - A Guide for Design and Installation.

E. Plumbing and Drainage Institute (PDI)

1. WH 201 - Water Hammer Arrestors

F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. All materials shall be new and unused.

B. Install piping to meet requirements of local codes.

C. Provide manufacturer's certification that materials meet or exceed minimum requirements as specified. Reference to standards such as ASTM and ANSI shall apply to those versions in effect at the time of bid opening.

D. Coordinate dimensions and drilling of flanges with flanges for valves, pumps and other equipment to be installed in piping systems. Bolt holes in flanges to straddle vertical centerline.

E. Reject materials contaminated with gasoline, lubricating oil, liquid or gaseous fuel, aromatic compounds, paint solvent, paint thinner and acid solder.

F. Pipe-joint compound, for pipe carrying flammable or toxic gas, must bear approval of Underwriters' Laboratories or Factory Mutual Engineering Division.

G. Unless otherwise specified, pressures referred to in all Piping Sections are expressed in pounds per square in gage above atmospheric pressure, psig and all temperatures are expressed in degrees Fahrenheit.

1.06 DELIVERY, STORAGE AND HANDLING

A. During loading, transportation and unloading take care to prevent damage to pipes and coating.

B. Carefully load and unload each pipe under control at all times. Place skids or blocks under each pipe in the shop and securely wedge pipe during transportation to ensure no injury to pipe and lining.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Specific piping materials and appurtenances are specified in the respective Piping or System Sections. The use of a manufacturer's name and/or model number is for the purpose of establishing the standard of quality and general configuration desired.

B. Equipment shall be of the size shown on the Drawings or as noted and as far as possible equipment of the same type shall be identical and from one manufacturer.

C. Equipment shall have the name of the maker, nominal size, flow directional arrows (if applicable), working pressure for which they are designed and standard referenced specifications cast in raised letters or indelibly marked upon some appropriate part of the body.

D. Unless otherwise noted, items shall have a minimum working pressure of 150 psi or be of the same working pressure as the pipe they connect to, whichever is higher and suitable for the pressures noted where they are installed.

2.02 UNIONS

A. Unions shall be brass or bronze unions for joining nonferrous pipe; malleable brass or bronze-seated iron or steel unions for joining ferrous pipe; PVC unions for joining PVC pipe; CPVC unions for joining CPVC pipe.

2.03 FLANGED JOINTS

A. Flanged Joints. Bolt and nuts, ASTM A307 Grade B (unless noted otherwise or submerged conditions exist), bolt number and size same as flange standard; studs - same quality as machine bolts; 1-/8 in. minimum thick nylon-reinforced or cloth-reinforced rubber gasket; rust-resistant coatings. Submerged conditions require 316SS bolts and nuts.

2.04 DIELECTRIC CONNECTORS

A. Dielectric pipe fittings/insulators and unions shall be used to prevent galvanic action wherever valves or piping of dissimilar metals connect. This shall be particularly the case for copper, brass and bronze piping connecting to cast iron or steel piping systems.

B. Dielectric unions shall be used for 2 in. and smaller connections. Steel union nuts shall meet ASTM A575 requirements. The steel or ductile iron connection end shall have a steel body and shall have accurately machined taper tapped pipe threads in accordance with ANSI B2.1. The copper connection end shall be a copper solder joint that meets requirements of ASTM B88. Dielectric unions shall be rated for at least 250 psi at 210°F.

C. Dielectric flange unions shall be used for connections 2-1/2 in. and larger. Cast iron flanges shall meet ASTM A126; the copper solder end shall meet ASTM B62 and the pipe thread shall meet ANSI B2.1. Dielectric flange unions shall be rated for at least 175 psi at 210°F.

D. Dielectric unions and flange unions shall be as manufactured by Epco Inc., Cleveland, OH or equal.

E. Flange insulating kits shall be as acceptable to the ENGINEER, as manufactured by PSI or equal.

F. Insulated sleeve couplings and flange adaptors shall be similar to those units as specified elsewhere.

2.05 PLUGS AND CAPS

A. Provide standard plug or cap as required for testing; plugs, caps suitable for permanent service.

B. Plug or cap or otherwise cover all piping work in progress.

2.06 MISCELLANEOUS ADAPTORS

A. Between different types of pipe and/or fittings special adapters may be required to provide proper connection. Some of these may be indicated on the Drawings or specified with individual types of pipe or equipment. However, it is the CONTRACTOR'S responsibility to ensure proper connection between various types of pipe, to structures and between pipe and valves, gates, fittings and other appurtenances. The CONTRACTOR shall provide all adapters as required, whether specifically noted or not.

B. As required, these adapters shall be suitable for direct bury, with proper dielectric insulation and as a minimum, if metallic (not stainless steel or galvanized), with two (2) coats of Coal Tar Epoxy.

2.07 LINE STRAINERS

A. "Y" Type Strainers

1. Manual strainers furnished for pipe diameters smaller than 2 in. shall be "Y" type, capable of removing solids 0.01 in. diameter and larger. The strainer body shall be of steel construction for steel pipe and brass or bronze for copper pipe and shall conform to the latest revision of ASTM A278, Class 30. Strainer elements, including woven wire mesh, shall be constructed of stainless steel.

2. The design of the strainer body shall be such that the cleanout plug and screen may be easily removed to permit inspection and cleaning without disassembly of the inlet and outlet piping. End connections shall be ANSI screwed pipe threads.

3. Sufficient spare screen shall be furnished for replacement of all "Y" type units at least once.

4. The strainers shall be designed for a maximum operating pressure of 150 psig. They shall be as manufactured by GA Industries Inc., Pittsburgh, PA or equal.

2.08 SERVICE CLAMPS

A. Service clamps for outlet sizes up to 2 in. shall have malleable or ductile iron bodies which extend at least 160 degrees around the circumference of the pipe and shall have neoprene gaskets cemented to the saddle body. Bodies shall be tapped for IPS. Clamps shall be of the double

strap design. Service clamps shall be Style 91 as manufactured by Dresser Industries, Inc. or equal as manufactured by Smith Blair; Mueller or equal.

B. Service clamps for outlet sizes 4 in. through 12 in. where the outlet size is not greater than half the size of the main pipe shall have ductile iron bodies and a neoprene circular cross section O-ring gasket confined within the body. Outlet shall be AWWA C-110 flange or AWWA C-111 mechanical joint as required for the application. Straps shall be alloy steel, minimum 1/4 in. by 12 in. in cross section and fabricated with 3/4 in. threaded ends. Service clamps shall be Fig. A-10920 or A-30920 as manufactured by American Cast Iron Pipe Company or equal.

2.09 CLEANOUTS

A. Interior flush floor cleanouts shall consist of a coated cast iron ferrule, a tapered threaded bronze cleanout plug, adjustable housing and a scoriated round cast iron tractor cover with bronze top. Interior flush floor cleanouts shall be Type No. 56056 as manufactured by Josam Manufacturing Co., Michigan City, IN, similar models by Tyler, or equal.

B. Exterior cleanouts shall be installed as noted on the Drawings.

C. Cleanouts shall be located where shown on the Drawings.

D. Cleanout connections to 6 in. cast iron bell and spigot soil pipe and cleanout connections to 6 in. ductile iron bell and spigot pipe shall be caulked.

2.10 FLOOR DRAINS

A. Floor drains shall have 8 in. diameter, adjustable, bronze top strainers and coated cast iron bodies.

B. Floor drains shall have outlet connections for 4 in. cast iron bell and spigot soil pipe except where required by other type pipe and/or indicated on the Drawings. They shall be W-1344 as manufactured by Wade, equal by Josam, or equal.

C. All floor drains located inside buildings shall be provided with a P-trap connection. They shall be W-1364 as manufactured by Wade, or equal.

D. As shown on the Drawings, the floor drains shall be provided with sediment traps. They shall be W-1344-ID or W-1364-ID as manufactured by Wade, or equal.

E. All floor drain P-traps shall be self-primed. Primer valve shall be MIFAB MI-300 or equal. Mount primer valve as shown in the Drawings. Extend minimum NPW 1/2” copper supply tubing inside 6-mil poly sleeve, cast within foundation, around the wall to primer valve location and terminate at each floor drain primer tap. Provide 120 VAC circuit as described in Drawings.

2.11 QUICK CONNECT COUPLINGS

A. Couplings shall be of the cam and groove type consisting of a male adapter conforming to Specification MIL-C-27487. Male adapters shall be designed to receive a female coupler without requiring threading, bolting, or tools. Connections shall remain tight and leak-proof under pressures up to 100 psig. Each adapter shall be furnished with a dust cap complete with a 18 in. long security chain of corrosion resistant material. Couplings shall be as manufactured by Dover Corporation; Ever-tite, or equal. Units shall be "drip proof,’’ providing totally dry connections and disconnections.

B. Adapters shall be furnished in accordance with the Drawings, or as required by the installation.

2.12 MECHANICAL SLEEVE SEALS

A. Mechanical sleeve seals shall be used to secure and seal the annular space around all new sleeved and core-drilled wall penetrations.

B. A single seal shall be provided for all sleeve and cores in walls up to 14 in. thick; dual sleeves shall be provided in larger walls.

C. Galvanized steel wall sleeves and concrete core diameter shall be sized sufficiently larger to accommodate the modular elements, per the manufacturers recommendations.

D. Bolts and hardware shall be carbon steel, zinc-plated. Pressure plates shall be corrosion-resistant acetal resin.

E. Mechanical sleeve seals shall consist of modular bolted, synthetic rubber sealing elements, Link Seal, manufactured by Thunderline Corp., or equal.

2.13 FLEXIBLE CONNECTORS

A. Sleeve Couplings

1. Provide plain end type ends to be joined by sleeve couplings as stipulated in AWWA C201.

   a. Join welds on ends by couplings without pipe stops. Grind flush to permit slipping coupling in at least one direction to clear pipe joint.

   b. Outside diameter and out-of-round tolerances shall be within limits specified by coupling manufacturer.

   c. Provide lugs in accordance with ASTM A36.

   d. Provide hardened steel washers in accordance with ASTM A325.

   e. Plastic plugs shall be fitted in coupling to protect bolt holes.

   f. Nuts and bolts:

      1) Provide bolts and bolt-studs in accordance with ASTM A307 and ANSI B1.1 with hexagonal or square heads, coarse thread fit, threaded full length with ends chamfered or rounded.

      2) Project ends 1/4 in. beyond surface of nuts.

      3) Hexagonal nuts with dimensions in accordance with ANSI B18.2 and coarse threads in accordance with ANSI B1.1.

2. For AWWA C200 Welded Steel Pipe, middle ring of each mechanical coupling shall have a thickness at least equal to that specified for size of pipe on which coupling is to be used and shall not be less than 10 in. long for pipe 30 in. and larger and not less than 7 in. long for pipe under 30 in. diameter.

a. Omit pipe stop from inner surface of middle rings of couplings whenever necessary to permit removal of valves, flowmeters and other installed equipment.

b. Provide pipe stops in other couplings.

3. Clean and shop prime with manufacturer's standard rust inhibitive primer.

4. Furnish gaskets of a composition suitable for exposure to the fluid service.

5. Where shown on the Drawings, anchor sleeve-coupled joints with harness bolts. Weld harness lugs to steel pipe.

a. Joint harness bolts shall be of sufficient length, with harness lugs placed so that coupling can be slipped at least in one direction to clear joint. Provide harnesses of sufficient number and strength to withstand test pressure.

b. Each harness shall have a minimum of two 5/8 in. diameter bolts.

6. Unless otherwise specified with the individual type of pipe, sleeve couplings (mechanical couplings) shall be ITT (formerly Smith Blair) Style 411; Dresser Style 38, similar models by Baker or equal, with the pipe stop removed.

7. Similar insulation type couplings shall be provided at the face of buildings, between different type metals or where otherwise noted.

8. In addition to those locations noted on the Drawings, sleeve coupling shall be provided on all piping where it connects with a structure or buried directly under a structure at the structure's expansion joints. Special treatment will be required where pipe is encased in concrete, utilizing minimum 3 in. thick Styrofoam placed perpendicular to the horizontal centerline of the coupling.

B. Split or Grooved Couplings

1. Split couplings shall be cast in two or more parts. When secured together with ASTM A183 bolts and nuts, couplings shall engage grooved or shouldered pipe ends and encase an elastomeric gasket to create a pipe seal. Gasket material shall be as recommended by the manufacturer for the service required.

2. Split couplings shall be as manufactured by Victaulic Company of America; Gustin-Bacon or equal. Numbers below refer to Victaulic Co. items, for reference only.

3. Unless otherwise specified with the individual type of pipe:

a. Flexible split ring couplings shall be:

1) grooved ends- Style 77

2) shouldered ends - Style 44

b. Rigid split ring couplings shall be:

1) Grooved ends - rigid groove with Style HP-70 couplings on ductile iron less than 18 in. diameter with sufficient wall thickness per AWWA C606, on standard groove with Style 77 coupling on manufactured steel or other pipe.

2) Shouldered ends - Style 44 coupling on ductile iron over 16 in. diameter or without sufficient wall thickness per AWWA C606 or on manufactured steel pipe or thin wall stainless steel pipe.

4. Ductile iron pipe for use with split-type coupling joints shall have radius grooved ends conforming to AWWA C606. Pipe shall have grooved ends to provide either a rigid joint or flexible joint as shown on the Drawings and as specified herein. Flexible joint grooving shall permit expansion and contraction, and angular deflection. Rigid joint grooving shall allow no angular or linear movement. Minimum pipe wall thickness for grooved pipe shall be the following class:

Size	Class
4 thru 16	53
18	54
20	55
24	56

5. Grooved couplings for steel and stainless steel piping shall have roll grooving, machine-grooving, or ring collars fully welded to the pipe or fitting.

6. Rigid split couplings may be substituted for flanges as noted on the Drawings and in the individual pipe specifications.

7. Certain minimum thickness of pipe walls are required by AWWA C606 and coupling manufacturers for use of various type split couplings with certain pipes. The CONTRACTOR shall be responsible for utilizing at least those minimum wall thicknesses required (unless a greater thickness is specified or required in the individual pipe specifications) with split couplings.

8. If minimum thicknesses are not utilized with grooving, then a shouldered end treatment with couplings as noted shall be utilized.

C. Flanged Adaptors

1. Flanged adaptor connections for grooved or shouldered end pipe compatible with split couplings at fittings, valves and equipment shall be VIC-Flange Style 341 as manufactured by the Victaulic Company of America, or equal product as manufactured by Gustin-Bacon.

2. Flanged adaptor connections for plain end pipe at fittings, valves and equipment shall be Dresser Style 127 or 128, similar models by ITT (formerly Smith-Blair); Baker or equal.

D. Pump and Equipment Flexible Connectors

1. The flexible connectors shall be expansion/vibration joints of the single arch type of butyl rubber construction with carcass of high grade woven cotton or suitable synthetic fiber and individual solid steel ring reinforcement. Soft rubber fillers shall be integrally cured into the arches to provide a smooth flow path to prevent settling of material into the arch. Joints shall be constructed to pipeline size and to meet working pressures and corrosive conditions similar to the line where installed. Joints shall have full faced fabric reinforced butyl flanges integral with the body.

2. Split steel or ductile iron back-up rings shall be provided to ensure a good joint. Rings shall be designed for mating with ANSI Standard minimum 150 lbs. flanges. All joints shall be finish coated with Hypalon, or equal paint.

3. Expansion/vibration joints shall be furnished with control (harness) units. Harness units shall consist of minimum two drilled plates, stretcher bolts, and rubber washers backed by metal washers. The stretcher bolts shall prevent over-elongation of the joint. Extra nuts shall be provided on the stretcher bolts on the inside of the plate to prevent over compression. All nuts, bolts and plates shall be galvanized.

4. The manufacturer of the expansion joints shall be a member of the Rubber Expansion Joint Division of the Fluid Sealing Association. Expansion joints shall be Style 1025 filled arch as manufactured by General Rubber Corp., South Hackensack, NJ or similar products of Mercer Rubber; Goodall Rubber; Garloc; Proco Products Inc., Stockton, CA or equal.

5. In addition to other locations shown on the Drawings, expansion joints shall be utilized in all exposed piping, within one foot of a building expansion joint, and on the suction and discharge side of all positive displacement pumps, compressors and rotating machinery, as close to the unit as possible.

E. Flexible Connectors

1. Provide one flexible connector for the seal water connection to each pump stuffing box. Connectors shall be of hose of Buna-N or similar resilient material, with fiber reinforcement, rated minimum 150 psi with bronze or Type 316 stainless steel NPT end fittings and shall be 12 in. in length. Connectors shall be for the purpose of isolating pump vibration from the seal water piping.

2.14 HARNESSING AND RESTRAINT

A. Where harnessed couplings or adapters are noted, they shall conform to AWWA Manual M11 except as modified by the Drawings or this Specification.

B. Unless otherwise noted, size and material for tie rods, clamps, plates and hex nuts shall be as shown on the Drawings, or, if not shown on the Drawings, shall be as required in AWWA Manual Mil. Manufactured restraining clamp assemblies shall be as manufactured by Stellar Corporation, Columbus, OH, or fabricated equal.

C. Restrained joints (such as welded, locking mechanical joints) shall be of the type specified with the individual type of pipe. If not specified, restrained (locking) mechanical joint pipe shall be of the manufacturer's standard design utilizing a locking device (ring or ears) integrally cast with the pipe.

D. For up through 18 in. diameter ductile iron pipe only, the following may be used as an alternative to other restraint system:

1. The optional mechanical joint restraints shall be incorporated in the design of a follower gland. The gland shall be manufactured of ductile iron conforming to ASTM A536. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell and tee-head bolts as specified with the pipe.

2. The restraint mechanism shall consist of numerous individually activated gripping surfaces to maximize restraint capability. The gripping surfaces shall be wedges designed to

spread the bearing surfaces on the pipe. Twist-off nuts, sized same as tee-head bolts, shall be used to ensure proper actuating of restraining devices. When the nut is sheared off, standard hex nut shall remain.

3. The mechanical joint restraint device for ductile iron pipe shall have a working pressure of at least 250 lbs. per square inch with a minimum safety factor of 2:1.

4. The mechanical joint restraint devices shall be of the type listed below or equal.

5. For Ductile Iron Pipe: EBAA Iron, Inc. Megalug 1100 series for up to 12 in. only.

E. The CONTRACTOR shall be responsible for anchorage including restraint as noted elsewhere in DIVISION 15 - MECHANICAL.

2.15 PRESSURE GAGES

A. Bosses, connections, or nipples for gages shall be provided as acceptable to the ENGINEER.

B. Unbossed tappings shall not be acceptable. Where gage tappings are not available in the suction or discharge nozzle, the necessary tapping in the adjacent piping shall be made.

C. In addition to the locations shown on the Drawings, pressure gages shall be furnished and installed on the upstream and downstream sides of pressure reducing stations and in the suction and discharge nozzle of all pumps, compressors and similar equipment. Additional pressure gages shall be furnished and installed as specified with individual equipment.

D. Gages shall be furnished as part of a complete factory assembly, including gage, snubber, liquid fill, bar stock ball valve isolation valve and threaded red brass connecting piping.

E. Unless otherwise noted, gage rating shall be from 0 to at least 2.5 percent higher than the rating of the pipe it is connected to.

F. For Liquid Service

1. Pressure gages shall have an aluminum case and shall be 4-1/2 in. nominal diameter with a full-sized Type 316 stainless steel Bourdon tube and a 300 series stainless steel movement. The gages shall be liquid filled with glycerin and shall be provided with a filler/breather cap. The socket shall be 1/4 in. NPT Type 316 stainless steel with a bottom connection and the dial shall be a white background with black markings. Gages shall be ANSI Grade A plus or minus 1 percent of scale and shall have a blow-out back design.

2. Gages for the above services shall be Model 344Y liquid filled as manufactured by Crosby Valve & Gage Co. or equal by U.S. Gage; Ashcroft or Trerice.

G. Air Service

1. Unless otherwise noted, pressure gages for low pressure air pipelines shall have a range of 0 to 15 psig.

2. Pressure gages shall have an aluminum case and shall be 4-1/2 in. nominal diameter with a Type 316 stainless steel Bourdon tube and a 300 series stainless steel movement. The socket shall be 1/2 in. NPT Type 316 stainless steel with a bottom connection. Gages shall have an accuracy of at least plus or minus 0.25 percent of scale. Gages shall be furnished with needle valve isolation.

3. Gages for air service shall be Model 5840 as manufactured by Marsh Instrument Co., Skokie, IL or equal.

H. Gages shall be furnished from standard ranges of the manufacturer, with dual range (ft. and psi) scales, and with scales as approved during submittals.

2.16 DIAPHRAGM SEALS FOR GAGES

A. Diaphragm seals shall be installed for all pressure gages and pressure switches not on clean water lines, to protect pressure gages and pressure switches from contact with the fluid in the pipeline. Gages shall be furnished as part of a complete factory assembly, including gage, snubber, diaphragm seal, liquid fill, bar stock isolation valve and threaded red brass interconnecting piping. Furnish also a 1/4 in. backflushing connection and ball valve.

B. Diaphragm seals shall be minimum 2-1/2 in. diameter, or as required for the connected pressure gages. The diaphragm shall be "thread attached" to both piping and pressure switches or gages. Furnish mineral oil fill between the diaphragm seal and the gage.

1. Diaphragm seals shall have an upper housing of cadmium plated carbon steel, with the lower housing of material specifically chosen according to the fluid type and pressure being monitored with Type 316 stainless steel bolts. Diaphragms shall be Teflon.

2. Each diaphragm seal shall be connected to its respective piping or equipment with threaded red brass pipe and fittings. Pipe size and diaphragm tap size shall match the size of the gage tap on the equipment, but shall not be less than 3/4 in., except for connections to plant water piping which shall be minimum 1/2 in. Furnish a ball valve shut-off valve between the pipeline or equipment and the diaphragm seal.

3. Each diaphragm seal shall have a minimum 1/4 in. NPT flush connection with ball valve and gage tap to match the size of the gage.

4. Furnish pulsation dampeners adequate to prevent pulsation and/or vibration of the gage indicator under all system operating conditions.

5. Pump gages shall connect to the diaphragm seal by a flexible Type 316 stainless steel capillary tube. Gages shall be mounted on a support stand independent of the pump and piping, to minimize vibration of the gages caused by vibration of the equipment or piping. Mount both the suction and discharge gages at the same elevation. Furnish supports as specified in SECTION 15140 - PIPE HANGERS AND SUPPORTS, or attach gages to the seal water assembly support (where applicable).

6. Diaphragm seals shall be Type SG by Mansfield and Green, equal by Ashcroft, or equal.

2.17 ROTAMETERS AND FLOW INDICATORS

A. Rotameters for the systems listed below shall be of the glass tube type with Borosilicate glass tubes, Type 302 stainless steel frames with slip-on covers, 10 in. detached type aluminum scales graduated in gallons per minute, 10:1 flow range, accuracy of 2 percent of full scale and vertical screwed end connections. Capacity, size and materials of construction shall be in accordance with the following table. Tube size shall be the same size as the end connections. Pressure drop at rated capacity shall not exceed 32 in. of water.

B. Number and size of rotameters shall be as specified in individual Sections.

C. Flow indicators for shaft seal/flushing water systems shall be brass body, glass or plastic tube, stainless steel float, 125 psi pressure rating. Accuracy shall be at least 5 percent of full scale.

2.18 SPRAY NOZZLES

A. Nozzles shall be of the size, with feed rates as noted on the Drawings. Nozzles shall be attached to the distribution header, as indicated on the Drawings, via split-eyelet connections. Unless otherwise noted nozzles shall be Type 316 stainless steel.

B. Each nozzle shall be furnished with a stainless steel adjustable ball fitting.

C. The distribution piping to the nozzles shall be sloped for drainage and shall be adequately supported to prevent sagging, while facilitating access for nozzle replacement. The CONTRACTOR shall test the system to demonstrate to the ENGINEER that it is entirely self-draining prior to acceptance.

D. All nozzles shall be the appropriate model, as manufactured by Spraying Systems Incorporated or equal.

2.19 APPURTENANCES AND MISCELLANEOUS ITEMS

A. All gaskets, glands, bolts, nuts and other required hardware shall be provided for connection of piping and appurtenances. Bolts and nuts shall be high strength, Type 316 stainless steel if submerged, buried, or subject to splashing and cadmium plated otherwise, with tee-head and hexagon nut. All other hardware shall be of the size, type and number as required and recommended by the piping or appurtenance manufacturer and as specified herein.

B. All gaskets for flanges shall be full face and suitable for 200°F operating temperature, unless higher temperature required on individual systems and the fluids carried. See also DIVISION 1 - GENERAL REQUIREMENTS.

C. Plugs, caps and similar accessories shall be of the same material as the pipe and of the locking type, unless otherwise noted.

D. Unions shall be of the same material as the pipe, except for dielectric connections.

2.20 COLOR CODING AND LABELING

A. General

1. Provide a complete color coding system consisting of preprinted labels and banding as manufactured by Brady; Seton or equal. Field painting shall be specified in SECTION 09915 - PROTECTIVE COATINGS.

2. Piping system identification shall comply with the requirements of ANSI A13.1.

3. Colors listed are general. Actual colors will be selected based on a comparison to the existing plant color codes, except as otherwise indicated; samples shall be furnished for all pipe paint colors; with chips from existing piping where new service lines are connecting.

4. Banding

a. Unless special spacing is listed in schedule, apply banding to pipe at connections to equipment, valves, branch fittings, at wall, floor, or ceiling boundaries and at intervals not greater than 36 ft.

5. Labels and Directional Arrows

a. Apply labels with directional arrows at connections to equipment, valves, branch fittings, at least one wall, floor, or ceiling boundary within a room and at intervals not greater than 36 ft.

b. At each label, arrows indicating direction of flow shall point away from label. If flow may be in both directions, use double headed arrows.

c. Lettering shall bear the full pipe system name as scheduled.

d. Lettering height shall be as follows:

Outside Pipe Diameter	Minimum Letter Height
3/4 in. to 13 in.	1/2 in.
12 in. to 2 in.	3/4 in.
22 in. to 6 in.	1-1/4 in.
8 in. to 10 in.	2-1/2 in.
Over 10 in.	3-1/2 in.

e. Two labels minimum each room, crawl space or compartment, unless otherwise approved.

PART 3 - EXECUTION

3.01 GENERAL

A. All dirt, scale, weld splatter, water and other foreign matter shall be removed from the inside and outside of all pipe and sub-assemblies prior to installing.

B. All pipe joints and connections to equipment shall be made in such a manner as to produce a minimum of strain at the joint.

C. Install piping in a neat manner with lines straight and parallel or at right angles to walls or column lines and with risers plumb. Run piping so as to avoid passing through ductwork or directly under electric light outlets and/or interference with other lines. All work shall be accomplished using recognized methods and procedures of pipe fabrication and in accordance with the latest revision of applicable ANSI Standards, ASME Codes and Pipe Fabrication Institute Standards.

1. Use full length of pipe except where cut lengths are necessary. Do not spring or deform piping to make up joints.

2. Pipe shall be cut square, not upset, undersize or out of round. Ends shall be carefully reamed and cleaned before being installed. Bending of pipe is not permitted. Use fittings for all changes in direction.

3. Do not use bushings except where specifically approved by the ENGINEER. Reducers shall be eccentric to provide for drainage from all liquid-bearing lines and facilitate air removal from water lines.

4. Verify the locations and elevations of any existing piping and manholes before proceeding with work on any system. Any discrepancies between the information shown on the Drawings and the actual conditions found in the field shall be reported at once to the ENGINEER. No claim for extra payment will be considered if the above provision has not been complied with.

5. Where lines of lower service rating tie into services or equipment of higher service rating the isolation valve between the two shall conform to the higher rating.

6. Mitering of pipe to form elbow is not permitted.

7. All piping interiors shall be thoroughly cleaned after installation and kept clean by approved temporary closures on all openings until the system is put in service. Closures should be suitable to withstand the hydrostatic test.

8. End caps on pre-cleaned pipe shall not be removed until immediately before assembly. All open ends shall be capped immediately after completion of installation.

D. Test Connections

1. Provide 1/2 in. female NPT test connection equipped with 1/2 in. brass plug on all pump suction and discharge lines. Where indicated on the Drawings, test connections should be equipped with bar stock valve and gage. Provide test connections at all steam traps. The connection shall be located on the discharge side of the trap between the trap and the first valve. It shall consist of a 1/2 in. branch connection terminated with a gate valve.

E. Unions

1. Unions screwed or flanged shall be provided where indicated and in the following locations even if not indicated.

a. In long runs of piping to permit convenient disassembly for alterations or repairs.

b. In by-passes around equipment.

c. In connections to tanks, pumps and other equipment between the shut-off valve and the equipment.

d. In connections on both sides of traps, controls and automatic control valves.

F. Vents and Drains

1. Provide vents and drains in the following places:

a. Water Lines- Vents at high points and drains at low points.

b. Air Lines - Drains at low points.

3.02 UNIONS

A. Use unions to allow dismantling of pipe, valves and equipment.

3.03 WELDING

A. Welding in accordance with ANSI Standard B31 and AWS B3.0.

B. Install welding fittings on all welded lines. Make changes in direction and intersection of lines with welding fittings. Do not miter pipes to form elbows or notching of straight runs to form tees, or any similar construction. Do not employ welder who has not been fully qualified in above specified procedure and so certified by approved welding bureau or similar locally recognized testing authority.

3.04 FLANGED JOINTS

A. Make flanged joints with bolts; bolt studs with nut on each end; or studs with nuts where one flange is tapped. Use number and size of bolts conforming to same ANSI Standard as flanges. Before flange pieces are assembled, remove rust resistant coating from machined surfaces, clean gaskets and smooth all burrs and other defects. Make up flanged joints tight, care being taken to prevent undue strain upon valves or other pieces of equipment.

3.05 SLEEVE COUPLINGS

A. Install tierods, pipe clamps or bridles when sleeve type couplings or fittings are used in piping systems where indicated, and at changes in direction or other places as necessary, to prevent joints from pulling apart under pressure. Use bridles and tierods at least 3/4 in. diameter, except where tierods replace flange bolts of smaller size; in which case, fit with nut on each side of pair of flanges. Joint harnessing shall conform, as a minimum, to the requirements for the bolts and tie bolt lugs as set forth in AWWA Manual Mil.

3.06 WALL SLEEVE SEALS

A. Use expandable rubber segmented sealing device with corrosion-resistant fasteners to make watertight the annular space between pipe and sleeve. Determine the required inside diameter of each individual wall opening or sleeve to fit the pipe and seal to assure a watertight joint as recommended by the manufacturer, before ordering, fabricating or installing. Install pipe concentrically through wall sleeve. Install and tighten seal per manufacturer's instructions.

3.07 TESTING

A. Test all pipelines for water/gas tightness as specified in the Piping or System sections. Furnish all labor, testing plugs or caps, pressure pumps, pipe connections, gages and all other equipment required. Testing shall be performed in accordance with procedures specified or set forth by the ENGINEER. All testing shall be performed in the presence of the ENGINEER.

B. Repair faulty joints or remove defective pipe and fittings and replace as approved by the ENGINEER. Retest.

END OF SECTION

SECTION 15140
PIPE HANGERS AND SUPPORTS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals and install pipe hangers, supports, concrete inserts, and anchor bolts, including all metallic hanging and supporting devices for supporting non-buried piping as specified herein and as shown on the Drawings.

B. Unless otherwise specified herein, all supports shall be hot dip galvanized after fabrication.

1.02 RELATED WORK NOT INCLUDED

A. Concrete is included in DIVISION 3 - CONCRETE.

B. Miscellaneous Metal is included in DIVISION 5 - METALS.

C. Field Painting is included in DIVISION 9 - FINISHES.

D. Pipe and Fittings are included in respective sections of DIVISION 15 - MECHANICAL.

E. Valves and Appurtenances are included in SECTION 15102 - VALVES.

1.03 SUBMITTALS

A. Submit to the ENGINEER as provided in SECTION 01330 - SUBMITTALS, complete sets of shop drawings of all items to be furnished under this Section. Submittals shall include complete layouts, schedules, location plans and complete total bill of materials for all pipe support systems.

B. Submittals shall include a representative catalog cut for each different type of pipe hanger or support indicating the materials of construction, important dimensions and range of pipe sizes for which that hanger is suitable. Where standard hangers and/or supports are not suitable, submit detailed drawings showing materials and details of construction for each type of special hanger and/or support.

C. Submittals shall include complete piping drawings indicating type of hanger and/or support, location, magnitude of load transmitted to the structure and type of anchor, guide and other pipe supporting appurtenances.

D. Types and locations of pipe hangers and/or supports shall also be shown on the piping layouts for each piping submittal as specified in the respective DIVISION 15 - MECHANICAL pipe specifications.

E. Submit complete design data for pipe support systems to show conformance with this Specification.

1.04 QUALIFICATIONS

A. All hangers, supports and appurtenances shall conform to the latest applicable requirements of ANSI 31.1.0, except as supplemented or modified by the requirements of this Specification.

B. All hangers, supports and appurtenances shall be of approved standard design where possible and shall be adequate to maintain the supported load in proper position under all operating conditions. The minimum working factor of safety for all supporting equipment, with the exception of springs, shall be five (5) times the ultimate tensile strength of the material, assuming a supported weight of a length of water-filled pipe equal to half the distance to the next supports. Valves and other concentrated loads shall be accounted for.

C. All pipe and appurtenances connected to equipment shall be supported in such a manner as to prevent any strain being imposed on the equipment. When manufacturers have indicated requirements that piping loads shall not be transmitted to their equipment, submit certification stating that such requirements have been complied with.

PART 2 - PRODUCTS

2.01 GENERAL

A. All of the equipment specified herein is intended to support the various types of pipe and piping systems. The details shown on the Drawings are intended to indicate the generally desired methods of support under normal conditions. It shall be the responsibility of the CONTRACTOR to develop final details and any details associated with special conditions not already covered to meet the system conditions specified in the respective DIVISION 15 - MECHANICAL pipe specifications.

B. All pipe and tubing shall be supported as required to prevent significant stresses in the pipe or tubing material, valves, fittings and other pipe appurtenances and to support and secure the pipe in the intended position and alignment. All supports shall be designed to adequately secure the pipe against excessive dislocation due to thermal expansion and contraction, internal flow forces, and all probable external forces such as equipment, pipe, and personnel contact. Any structural steel members required to brace any piping from excessive dislocation shall conform to the applicable requirements of DIVISION 5 - METALS and shall be furnished and installed under this Division.

C. Hangers and supports shall be spaced in accordance with ANSI B31.1, except that the maximum unsupported span shall not exceed 10 ft. unless otherwise specified herein or unless specifically allowed on the Drawings.

D. Where flexible couplings are required at equipment, tanks, etc., the end opposite to the piece of equipment, tank, etc., shall be rigidly supported.

E. All pipe and appurtenances connected to the equipment shall be supported in a manner to prevent any strain from being imposed on the equipment or piping system.

F. All rods, clamps, hangers, inserts, anchor bolts, brackets, and components for interior pipe supports shall be furnished with galvanized finish, hot dipped or electro-galvanized coated, except where field welding is required. Interior clamps on plastic pipe shall be plastic coated. Supports for copper pipe shall be copper plated or shall have a 1/16 in. plastic coating. All rods, clamps, hangers, inserts, anchor bolts, brackets, and components for submerged pipe, pipe subject to splashing, exterior pipe, and pipe within outdoor structures shall be of Type 316 stainless steel.

G. Supports shall be sufficiently close together such that the sag of the pipe is within limits that will permit drainage and avoid excessive bending stresses from concentrated loads between supports.

H. All uninsulated non-metallic piping such as PVC, CPVC, etc., shall be protected from local stress concentrations at each support point. Protection shall be provided by galvanized steel protection shields or other method as approved by the ENGINEER. Where pipes are bottom supported 180 degrees, arc shields shall be furnished. Where 360 degree arc support is required, such as U bolts, protection shields shall be provided for the entire pipe circumference. Protection shields shall have an 18 gage minimum thickness, not be less than 12 in. in length and be securely fastened to pipe with stainless steel or galvanized metal straps not less than 1/2 in. wide.

I. All insulated pipe shall be furnished with a rigid foam insulating saddle at each pipe support location as specified under respective pipe insulation. Provide galvanized protection shields as specified in Paragraph 2.01H above at each location.

J. Where pipe hangers and supports come in contact with copper piping provide protection from galvanic corrosion by: wrapping pipe with 1/16 in. thick neoprene sheet material and galvanized protection shield; isolators similar to Elcen Figure No. 228; or copper plated or PVC coated hangers and supports.

K. Pipe supports shall be provided as follows:

1. Cast iron and ductile iron piping shall be supported with a minimum of one support per pipe section at the joints.

2. Steel and stainless steel piping 2-1/2 in. or larger diameter shall be supported with a minimum of one support per pipe section at the joints.

3. Support spacing for steel and stainless steel piping 2 in. and smaller diameter and copper tubing shall not exceed 5 ft.

4. Flexible couplings and valves shall be supported near both ends.

5. Supports for multiple PVC plastic piping shall be continuous wherever possible. Individually supported PVC pipes shall be supported as recommended by the manufacturer except that support-spacing shall not exceed 3 ft. Multiple, suspended, horizontal plastic PVC pipe runs, where possible, shall be supported by ladder type cable trays such as the Electray Ladder by Husky-Burndy, the Globetray by the Metal Products Division of United States Gypsum, or equal. Ladder shall be of galvanized mild steel construction. Rung spacing shall be 12 in. Tray width shall be approximately 6 in. for single runs and 12 in. for double runs. Ladder type cable trays shall be furnished complete with all hanger rods, rod couplings, concrete inserts, hanger clips, etc., required for a complete support system. Individual plastic pipes shall be secured to the rungs of the cable tray by strap clamps or fasteners equal to Globe Model M-CAC, Husky-Burndy Model SCR, or approved equal. Spacing between clamps shall not exceed 9 ft. The cable trays shall provide continuous support along the length of the pipe. Individual clamps, hangers, and supports in contact with plastic PVC pipe shall provide firm support, but not so firm as to prevent longitudinal movement due to thermal expansion and contraction.

6. All vertical pipes shall be supported at each floor or at intervals of not more than 12 ft. by approved pipe collars, clamps, brackets, or wall rests, and at all points necessary to ensure rigid construction.

7. Pipe supports shall not induce point loadings, but shall distribute pipe loads evenly along the pipe circumference.

8. Effects of thermal expansion and contraction of the pipe shall be accounted for in the pipe support selection and installation.

L. Unless otherwise specified herein, pipe hangers and supports shall be as manufactured by Grinnell Co., Inc., Providence, RI; Carpenter & Patterson, Inc., Woburn, MA; Elcen Metal Products Co., Franklin Park, IL; and Unistrut Building Systems, Wayne, MI; or equal. Any reference to a specific figure number of a specific manufacturer is for the purpose of establishing a type and quality of product and shall not be considered as proprietary. Any item comparable in type, style, quality, design and performance shall be considered as equal.

M. Any required pipe supports for which the supports specified in this Section are not applicable shall be fabricated or constructed from standard structural steel shapes, concrete and anchor hardware similar to items previously specified herein and shall be subject to the approval of the ENGINEER.

N. Anchor bolts shall be stainless steel and equal to Kwik-Bolt as manufactured by the Hilti Fastening Systems, Tulsa, OK, or Wej-it manufactured by Wej-it Expansion Products, Inc., Bloomfield, CO. The length of expansion bolts shall be sufficient to place the wedge portion of the bolt a minimum of 1 in. behind the steel reinforcement. Expansion type anchors shall not be used in locations where the normal loading will be direct tension.

O. Cast-in-place anchor bolts for interior supports shall meet the requirements of ASTM A307. All anchor bolts, nuts and washers shall be hot dip galvanized or cadmium plated.

2.02 SINGLE AND MULTIPLE PIPE SUPPORTS

A. Single pipes located in a horizontal plane close to the floor shall be supported by one of the methods specified herein or as shown on the Drawings.

B. Pipes 3 in. in diameter and larger shall be supported by adjustable stanchions similar to Carpenter & Patterson Figure No. 101. Stanchions shall provide at least 4-inches adjustment and be flange mounted to floor.

C. Pipes less than 3 in. diameter shall be held in position by supports fabricated from steel "C" channel, welded post base similar to Unistrut Figure P2072A and pipe clamps similar to Unistrut Figures P1109 through P1126. Where required to assure adequate support, fabricate supports using two vertical members and post bases connected together by horizontal member of sufficient load capacity to support pipe. Wherever possible supports shall be fastened to nearby walls or other structural member to provide horizontal rigidity. More than one pipe may be supported from a common fabricated support. All supports, unless specified elsewhere, shall be galvanized.

D. Where shown on the Drawings, pipe shall be supported using concrete anchor posts. Pipe shall be securely fastened to concrete anchor posts using suitable metal straps as required and approved by the ENGINEER.

2.03 WALL SUPPORTED PIPES

A. Single or multiple pipes located adjacent to walls, columns or other structural members, whenever deemed necessary, shall be supported using welded steel wall brackets similar to Carpenter & Patterson Figure Nos. 69-78, 84, or 139; or "C" Channel with steel brackets similar to Unistrut pipe clamps. All members shall be securely fastened to wall, column, etc., using double expansion shields or other method as approved by the ENGINEER. Additional wall bearing plates shall be provided where required.

B. Pipe shall be attached to supports using methods hereinbefore specified to meet the intent of this Specification.

2.04 BASE ANCHOR SUPPORT

A. Where pipes change direction from horizontal to vertical via a bend, a welded or cast base anchor support shall be installed at the bend to carry the load. The bend anchor shall be fastened to the floor with double expansion shields or other method as approved by the ENGINEER.

B. Where shown on the Drawings, pipe bends shall be supported using concrete anchor posts. Pipes shall be securely fastened to concrete supports with suitable metal bands as required and approved by the ENGINEER.

2.05 VERTICAL PIPE SUPPORTS

A. Where vertical pipes are not supported by a Unistrut system as specified in Paragraph 2.08, they shall be supported in one of the following methods.

1. For pipes 1/4 in. to 2 in. diameter, an extension hanger ring shall be provided with an extension rod and hanger flange. The rod diameter shall be as recommended by the manufacturer for the type of pipes to be supported. The hanger ring shall be galvanized steel or PVC clad depending on the supported pipe. The hanger ring shall be equal to Carpenter & Paterson Figure No. 81 or 81CT. The anchor flange shall be galvanized malleable iron similar to Carpenter & Patterson Figure No. 85.

2. For pipes equal to or greater than 1/2 in. diameter extended pipe clamps similar to Carpenter & Patterson Figure No. 267 may be used. The hanger shall be attached to concrete structures using double expansion shields, or to steel support members using welding lugs similar to Carpenter & Patterson Figure No. 220.

3. Pipe riser clamps shall be used to support all vertical pipes extending through floor slabs. Riser clamps shall be galvanized steel similar to Carpenter & Patterson Figure No. 126. Copper clad or PVC coated clamps shall be used on copper pipes. Insulation shall be removed from insulated pipes prior to installing riser clamps.

4. Unless otherwise specified, shown, or specifically approved by the ENGINEER, vertical runs exceeding 12 ft. shall be supported by approved pipe collars, clamps, brackets or wall rests at all points required to ensure a rigid installation.

2.06 SPECIAL SUPPORTS

A. Pipe supports shall be provided for closely spaced vertical piping systems as shown on the Drawings or as otherwise required to provide a rigid installation. The support system shall consist of a framework suitably anchored to floors, ceilings and walls and be as manufactured by the Unistrut Corporation, Globe-Strut as manufactured by the Metal Products Division of U.S. Gypsum, or equal.

B. Vertical and horizontal supporting members shall be U-shaped channels similar to Unistrut Series P1000. Vertical piping shall be secured to the horizontal members by pipe clamps or pipe straps equal to Unistrut Series P1100M and Series P2558. All components shall be of galvanized mild steel.

C. The assemblies shall be furnished complete with all nuts, bolts, and fittings required for a complete assembly including end caps for all members.

D. The design of each individual framing system shall be the responsibility of the CONTRACTOR. Shop drawings, as specified above, shall be submitted and shall show all details of the installation, including dimensions and types of supports. In all instances the completed frame shall be adequately braced to provide a complete rigid structure when all the piping has been attached.

E. Any required pipe supports for which the supports specified in this Section are not applicable shall be fabricated or constructed from standard structural steel shapes in accordance with applicable provisions of DIVISION 5 - MECHANICAL, have anchor hardware similar to items previously specified herein, shall meet the minimum requirements listed below, and be subject to the approval of the ENGINEER.

1. Pipe support systems shall meet all requirements of this Section and all related Sections of this Specification.

2. Complete design details of the entire pipe support system shall be provided for review by the ENGINEER in the submittals specified in subsection 1.03.

3. The pipe support system shall not impose loads on the supporting structures in excess of the loads for which the supporting structure is designed.

PART 3 - EXECUTION

3.01 DELIVERY AND STORAGE

A. All supports and hangers shall be crated, delivered and uncrated so as to protect against any damage.

B. All parts shall be properly protected so that no damage or deterioration shall occur during a prolonged delay from the time of shipment until installation is completed.

3.02 INSTALLATION

A. All pipes, horizontal and vertical, requiring rigid support shall be supported from the building structure by approved methods. Supports shall be provided at changes in direction and elsewhere as shown in the Drawings or specified herein. No piping shall be supported from metal stairs, ladders and walkways unless specifically directed or authorized by the ENGINEER.

B. All pipe supports shall be designed with liberal strength and stiffness to support the respective pipes under the maximum combination of peak loading conditions to include pipe weight, liquid weight, liquid movement, and pressure forces, thermal expansion and contraction, vibrations, and all probable externally applied forces. Prior to installation, all pipe supports shall be approved by the ENGINEER.

C. Pipe supports shall be provided to minimize lateral forces through valves, both sides of split type couplings and sleeve type couplings, and to minimize all pipe forces on pump housings. Pump housings shall not be utilized to support connecting pipes.

D. Inserts for pipe hangers and supports shall be installed on forms before concrete is placed. Before setting these items, all Drawings and figures shall be checked which have a direct bearing on the pipe location. Responsibility for the proper location of pipe supports is included under this Section.

E. Continuous metal inserts shall be embedded flush with the concrete surface.

3.03 TESTING

A. All pipe support systems shall be tested for compliance with the Specifications. After installation, each pipe support system shall be tested in conjunction with the respective piping pressure tests. If any part of the pipe support system proves to be defective or inadequate, it shall be repaired or augmented under this Section to the satisfaction of the ENGINEER at no additional cost to the OWNER.

END OF SECTION

SECTION 15250
THERMAL INSULATION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide mechanical insulation and appurtenances as specified and as shown on the Drawings.

B. Piping systems to insulate shall include all visible and/or exposed piping.

C. Label all piping according to SECTION 15120 - PIPING SPECIALTIES after installation of insulation and jacketing.

1.02 QUALITY ASSURANCE

A. Provide components that are the standard product of a manufacturer regularly engaged in the production of the required materials.

B. A single manufacturer shall provide all piping insulation and appurtenances.

C. The manufacturer shall be responsible for the design, and production of all insulation products provided.

D. Comply with applicable standards including, but not limited to the most recent edition of the following:

1. ASTM E 84, B-209, C 534 and C 553

2. NFPA 255

E. Design to provide satisfactory performance under the specified operating conditions.

F. Flame/Smoke Ratings

1. Provide composite mechanical insulation (insulation, jackets, coverings, s sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.

1.03 SUBMITTALS

A. Comply with SECTION 01330 - SUBMITTALS. Include the following information:

1. Type of materials and application of all insulation provided with appurtenances.

2. Manufacturer's catalog information that describes each type of insulation material/system provided. Include Specifications

a. A complete bill of materials that identifies all materials of construction.

b. Submit manufacturer's technical product data and installation recommendations for the products specified, indicating thermal conductivity (K factor), density, fire and smoke ratings, as applicable, for the various materials and composites.

c. Demonstrate acceptable performance for specified application conditions.

3. Special shipping, storage, protection, and handling instructions.

4. Manufacturer's installation instructions.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver, handle, and store the equipment in accordance with manufacturer's recommendations.

B. Insulation, mastics and adhesives to be stored indoors in dry location and unopened.

C. Remove damaged materials from the project site.

PART 2 - MATERIALS

2.01 GENERAL

A. Necessary accessory products not available from the insulation manufacturer shall be of a type and brand as recommended by the insulation manufacturers literature or representative.

B. All insulating materials and accessories used shall be of asbestos-free material.

C. All materials and integrated insulation assemblies furnished shall have flame spread ratings of not over 25 (fire resistive), smoke developed rating of not over 50 and fuel contributed rating of not over 50, as established by tests conducted in accordance with Interior Federal Standard Number 00136B, entitled 'Interior Federal Standard Flame-Spread Properties for Materials' and the National Fire Code of the NFPA. The treatment of jackets or facings to impart flame and smoke safety must be permanent. (The use of water-soluble treatment is prohibited.) Exception allowed for closed cell foam insulation arid PVC fitting covers.

D. The toxicity of the solvents used shall not exceed a maximum allowable concentration of 200 ppm or the latest value published by the American Conference of Governmental Industrial Hygienists and OSHA.

E. Adhesives, coatings and vapor barrier materials shall be compatible with the insulation as recommended by the insulation manufacturer. CONTRACTOR shall be able to submit a certified statement attesting to the approval of the materials by the insulation manufacturer. Adhesives and coatings shall be manufactured by Foster Div.; H.B. Fuller Co.; Childers Products Co. or equal. H.P. Fuller and Childers Products Nos. are listed below by adhesive/coating types.

1. Lagging adhesive: 30-40, CP50.

2. Vapor barrier coating: 30-35, CP30.

3. Vaporseal adhesive: 85-75, CP82.

4. Duct adhesive: 85-20, CP82.

5. Sealing compound adhesive: 30-45, CP70.

6. Weatherproof mastic: 35-01, CP10-1.

2.02 PIPING INSULATION-ELASTOMERIC FOAM

A. Conform to ASTM C534, Type I.

B. Preformed, closed cell tubular material with inner and outer surface skin; 5'-0", 6'-0", or continuous lengths.

C. Use where shown on the drawings or required to prevent condensation or freezing.

D. For fittings and valves, miter cut and fabricate from materials employed for pipe insulation.

E. Manufacturer

1. Armstrong Cork Co. "Armaflex 2000"

2. Rubatex Corporation

3. or Equal

2.03 PIPE INSULATION JACKET

A. Conform to ASTM B-209, Type 3003 aluminum, 0.016 in. thick, smooth finish, with moisture barrier.

B. Provide with preformed shapes 36 in. long or roll stock 36 in. wide.

C. For fittings and valves, aluminum, preformed for 45 and 90 degree elbows, tees, valves, and caps; material, color, and finish match pipe jacket.

D. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

E. For insulated piping that extends below ground, an 18 in. square by 4 in. deep concrete collar shall be installed at ground level with the pipe centered in the collar.

2.04 ACCESSORIES

A. Provide staples, bands, wires, cement, adhesive, sealer, and protective finishes as recommended by the insulation manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. Do not apply insulation prior to testing and acceptance of piping. Nameplates and equipment certification and data tags affixed to any piece of apparatus shall not be covered. Where two layers of insulation are used, stagger all joints both ways. Secure each layer independently.

2. Surface to be insulated must be free of dust, grease, oil or loose particles.

3. Neatly finish insulation at supports, protrusion, and interruptions.

4. For valve insulation, completely insulate valves up to, but not including the packing nut.

B. Pipe Insulation Installation (Elastomeric Foam)

1. Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

2. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

3. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

4. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.

5. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut units except where specific form or type is indicated.

6. Extend piping insulation and jacketing without interruption through walls, floors, pipe sleeves and similar piping penetrations, except where otherwise indicated.

7. Butt pipe insulation against pipe hanger insulation inserts.

END OF SECTION

SECTION 16015
GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE

A. The General Conditions and Requirements, Special Provisions, are hereby made a part of this section.

B. The Electrical Drawings and Specifications under this section shall be made a part of the contract documents. The Drawings and specifications of this contract, as well as supplements issued thereto, information to bidders and pertinent documents issued by the Owner's representative are a part of these drawings and specifications and shall be complied with in every respect. All of the above documents will be on file at the office of the Owner's representative and shall be examined by all bidders. Failure to examine all documents shall not relieve the responsibility or be used as a basis for additional compensation due to omission of details of other sections from the electrical documents.

C. Furnish all work, labor, tools, superintendence, material, equipment, and operations necessary to provide for a complete and workable electrical system as defined by the contract documents.

D. Be responsible for visiting the site and checking the existing conditions. Ascertain the conditions to be met for installing the work and adjust bid accordingly.

E. It is intent of the contract document that upon completion of the electrical work, the entire system shall be in a finished, workable condition.

F. All work that may be called for in the specifications but not shown on the drawings; or, all work that may be shown on the drawings but not called for in the specifications, shall be performed by the Contractor as if described in both. Should work be required which is not set forth in either document, but which work is nevertheless required for fulfilling of the intent thereof; then, the contractor shall perform all work as fully as if it were specifically set forth in the current documents.

G. The definition of terms used throughout the contract documents shall be as specified by the following agencies:

1. Underwriters Laboratories
2. National Electrical Manufacturers Association
3. American National Standard Institute
4. Insulated Power Cable Engineers Association
5. National Electrical code
6. National Fire Protection Association

1.2 PERMITS, CODES AND UTILITIES

A. Secure all permits, licenses, and inspections as required by all authorities having jurisdiction. Give all notices and comply with all laws, ordinances, rules, regulations and contract requirements bearing on the work.

B. The minimum requirements of the electrical system installation shall conform to the latest edition of the National Electrical Code as well as state and local codes.

C. Codes and ordinances having jurisdiction and specified codes shall serve as minimum requirements; but, if the Contract Documents indicate requirements which are in excess of those minimum requirements then the requirements of the Contract Documents shall be followed. Should there be any conflicts between the Contract Documents and codes, or any ordinances, report these with bid.

D. Determine the exact requirements for the utility service connections and metering facilities as set forth by the utilities that will serve the project, and pay for and perform all work as required by those utilities.

1.3 STANDARDS

A. All materials and equipment shall conform to the requirements of the Contract Documents. They shall be new, free from defects, and they shall conform to the following standards where these organizations have set standards:

1. Underwriters Laboratories, Inc. (UL)
2. National Electrical Manufacturer's Association. (NEMA)
3. American National Standards Association. (ANSI)
4. Insulated Cable Engineers Association. (ICEA)
5. Institute of Electrical and Electronic Engineers (IEEE)

B. All material and equipment, of the same class, shall be supplied by the same manufacturer unless specified to the contrary.

C. All products shall bear UL labels where standards have been set for listing.

1.4 SUBMITTALS

A. Shop drawings shall be taken mean detailed drawings with dimensions, schedules, weights, capacities, installation details and pertinent information that will be needed to describe material or equipment in detail.

B. Submittal procedures are described in Section 01330.

1.5 ACCEPTANCE AND SUBSTITUTIONS

A. All manufacturers named are a basis as a standard of quality and substitutions of any equal product will be considered for acceptance. The judgment of equality of product substitution shall be made by the Engineer.

B. Substitutions after award of contract shall be made only within sixty (60) days after the notice to proceed. Furnish all required supporting data. The submittal of substitutions for review shall not be cause for time extensions.

C. Where substitutions are offered, the substituted product shall meet the product performance as set forth in the specified manufacturer's current catalog literature, as well as meeting the details of the Contract Documents.

D. The details on the drawings and the requirements of the specifications are based on the first listed item of material or equipment; if any other than the first listed materials or equipment is furnished, then assume responsibility for the correct function, operation, and accommodation of the substituted item. In the event of misfits or changes in work required, either in this Section or

other Sections of the Contract, or in both; bear all costs in connection with all changes arising out of the use of other than the first listed item specified.

1.6 RECORD DRAWINGS

A. At the start and during the progress of the job, keep one separate set of blue-line prints for making construction notes and mark-ups.

B. Show conduit routing and wiring runs as constructed and identify each.

C. Record all deviations from the Contract Documents.

D. Submit set of marked-up drawings for review.

1.7 OPERATIONS AND MAINTENANCE MANUALS

A. Six (6) weeks prior to the completion of the project, compile an operations and maintenance manual on each item of equipment. These manuals shall include detailed instructions and maintenance, as well spare parts lists.

B. Submit six (6) copies for review.

PART 2 - PRODUCTS

2.1 MATERIALS AND WORKMANSHIP

A. All materials, unless otherwise specified, shall be current United States manufacture, new, free from all defects, and of the best quality. Foreign goods specifically approved for use by the Owner's Representative prior to bidding may be furnished.

B. Materials and equipment shall be installed in accordance with the manufacturers' recommendations and the best standard practice for the type of work involved. All work shall be executed by electricians skilled in their respective trades, and the installations shall present a neat, precise appearance.

C. The responsibility for the furnishing and intended installation of the proper electrical equipment and/or material as intended rests entirely upon the Contract. The Contractor shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.

2.2 MATERIAL AND EQUIPMENT REQUIREMENTS

A. Manufacturer's Instructions: The manufacturer's published instructions shall be followed for preparing, assembling, installing, erecting, and cleaning manufacturer materials or equipment, unless otherwise indicated. The Contractor shall promptly notify the Owner's Representative in writing of any conflict between the requirements of the Contract Documents and the manufacturer's direction and shall obtain the clarification of the Owner's Representative before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturer's directions or such clarification by the Owner's Representative, he shall bear all costs arising in connection with the correction of the deficiencies.

B. Storage at Site: The Contractor shall not receive material or equipment at the jobsite until there is suitable space provided to properly protect equipment from rust, drip, humidity, and dust damage from surrounding work. All new or relocated equipment shall be stored inside or protected from the environment. Equipment that is not properly stored shall be replaced by the contractor at no cost to the owner.

C. Capacities shall be not less than those indicated and shall be such that no component or system becomes inoperative or is damaged because of startup or other overload conditions.

D. Conformance to Agency Requirements: Where materials or equipment are specified to be approved, listed, tested, or labeled by the Underwriters Laboratories, Inc., or constructed and/or tested in accordance with the standards as listed in the NEC, the Contractor shall submit proof that the items furnished under this section of the specifications conform to such requirements. The label of the Underwriters Laboratories, Inc. applied to the item will be acceptable as sufficient evidence that the items conform to such requirements.

E. Nameplates: Each major component of equipment shall have the manufacturer's name, address, and model-identification number embossed on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of Final Inspection. All equipment starters and disconnects shall be tagged with the equipment designated mark and circuit.

F. Prevention of Rust: Standard factory finish will be acceptable on equipment specified by model number, otherwise surfaces of ferrous metal shall be given a rust-inhibiting coating. The treatment shall withstand 200 hours in salt-spray fog test, in accordance with Method 6061 of Federal Standard No. 141. Immediately after completion of the test, the specimen shall show no signs of wrinkling or cracking and no signs of rust creepage beyond 1/8 inch on either side of the scratch mark. Where rust inhibitor coating is specified hereinafter, any treatment that will pass the above test is acceptable unless a specific coating is specified, except that coal tar or asphalt-type coatings will not be acceptable unless so stated for a specific item. Where steel is specified to be hot-dip galvanized, mill-galvanized sheet steel may be used provided all raw edges are painted with a zinc-pigmented paint conforming to Military Specification MIL-P-26915.

G. Protection of Connections: Switches, breaker handles, keys setscrews, handles and other parts not listed for normal occupied operation (light switches, etc.) shall be located accessible to but out of paths to prevent their accidental shutoff.

H. Verifications of Dimensions: The Contractor shall be responsible for the coordination and proper relation of his work to the Equipment and to the work of all trades. The Contractor shall visit the premises and thoroughly familiarize himself with all details of the work and working conditions, to verify all dimensions in the field, and to advise the Owner's Representative of any discrepancy before performing any work. Adjustments to the work required in order to facilitate a coordinated installation shall be made at no additional cost to the Owner, or Engineer.

I. Standard Products: Materials and equipment to be provided shall be the standard catalog products of manufacturers regularly engaged in the manufacture of products conforming to these specifications, and shall essentially duplicate materials and equipment that have been in satisfactory use at least two years.

PART 3 - EXCAVATION

3.1 EXCAVATION AND BACKFILLING

A. Do all excavating and backfilling necessary for the installation of the work. This shall include shoring and pumping in ditches to keep them dry until the work in question has been installed. All shoring required to protect the excavation and safeguard employees shall be properly performed.

B. All excavations shall be made to the proper depth, with allowances made for floors, forms, beams, piping, finished grades, etc. Ground under conduits shall be well compacted before conduits are installed.

C. All backfilling shall be made with selected soil; free of rock and debris and shall be pneumatically tamped in six (6") inch layers to secure a field density ratio of 90%.

D. All excavated material not suitable and not used in the backfill shall be removed offsite at the Contractors expense.

E. Field check and verify the locations of all underground utilities prior to any excavating. Avoid disturbing these as far as possible. In the event existing utilities are broken into or damaged, they shall be repaired so as to make their operation equal to that before the trenching was started.

F. Where the excavation requires the opening of existing walks, drives, or other existing pavement, these facilities shall be cut as required to install new lines and to make connections to existing lines. The sizes of the cut shall be held to a minimum consistent with the work to be installed. After installation of new work is completed and the excavation has been backfilled in accordance with above, repair existing walks, drives or other existing pavement to match existing installation.

3.2 CUTTING AND PATCHING

A. Cutting and patching required under this section shall be done in a neat workmanlike manner. Cutting lines shall be uniform and smooth.

B. Use concrete saws for large cuts in concrete and core drills for small round cuts in concrete.

C. Where openings are cut through masonry walls, provide lintel or other structural supports to protect the remaining masonry. Adequate support shall be provided during the cutting operation to prevent damage to masonry.

D. Where large openings are cut through metal surfaces, attach metal angles around the opening.

E. Patch concrete openings that are to be filled with non-shrinking cementing compound. Finish concrete patching shall be troweled smooth and shall be uniform with surrounding surfaces.

3.3 WATERPROOFING

A. Provide waterproof flashing for each penetration of exterior walls and roofs.

B. Flashing for conduit penetrations through built-up roofs shall be made with pitch pans filled with pitch. Conduit penetrations through poured concrete roofs shall be made with sleeves and annulus caulked.

C. Penetrations through walls at below ground elevations shall be waterproofed by conduit sealing fittings or other methods as indicated.

D. Interiors of raceways that are likely to have water ingress such as runs from hand holes into below-grade installations shall have water stops installed to prevent water from entering into installations.

3.4 METAL BUILDING SYSTEMS / ELECTRICAL SUPPORTS

A. Metal building systems are required to be designed by the manufacturer to accommodate and support the electrical systems indicated on the electrical drawings and specified in Division 16.

B. The metal building systems manufacturer is required to provide the following:

1. Framed openings through the roofs with supports, roof curbs, and flashings for roof-mounted equipment, fans, vents, and air intakes.
2. Structural support for piping, conduits, and suspended equipment consisting of beam, joists, purlins, and/or blocking above and perpendicular to conduit routes and equipment hangers at intervals not to exceed 8 feet.
3. Structural support for suspended ceilings and light fixtures, including associated raceways.

C. The electrical trade shall:

1. Provide all routes, weights, installation heights, opening locations, etc. for all equipment, conduits, sleeves, etc. to the metal building system manufacturer and coordinate requirements for structural supports, hangers, attachments, etc. with the metal building systems manufacturer.
2. Provide all supporting devices (hangers, attachments, brackets, cross beams, etc.) to attach to the metal building structural system.

3.5 CONDUIT SUPPORT

A. Conduit Support: All conduits throughout the building, both horizontal and vertical, shall be adequately supported from the construction to line of grade, with proper provision for expansion, contraction, vibration elimination, and anchorage. Vertical conduits shall be supported from floor lines with riser clamps sized to fit the lines and to adequately support their weight. At the bases of lines, where required for proper support, provide anchor base fittings or other approved supports.

3.6 HANGERS

A. General: Each hanger shall be properly sized to fit the supported pipe or to fit the outside of the insulation on lines where specified.

B. Attachment:

1. The load on each hanger and/or insert shall not exceed the safe allowable load for any component of the support system, including the concrete which holds the inserts. Reinforcement at inserts shall be provided as required to develop the strength required.
2. Where pipes are supported under steel beams, approved-type beam clamps shall be used.
3. Where conduit is supported under wood joists, hanger rods shall be attached to joists with side beam brackets or angle clips.

C. Spacing: All hangers shall be so located as to properly support horizontal lines without appreciable sagging of these lines. All PVC shall be supported at intervals recommended by the manufacturer, or as otherwise specified or indicated.

D. Trapezes: Where multiple lines are run horizontally at the same elevation and grade, they may be supported on trapezes of Kindorf, Elcen, or approved equal, channel-suspended on rods or pipes. Trapeze members including suspension rods shall each be properly sized for the number, size, and loaded weight of the lines they are to support.

E. Ceiling-Mounted Devices: All lighting and devices or assemblies mounted in lay-in-type ceilings and which are supported by the ceiling grid, directly or indirectly, and which weigh in excess of 2 lbs., shall be provided with at least two 12-gauge minimum wire supports connected securely between the device or assembly and the structure, to serve as a safety support in the event of the collapse of or a disturbance in the support of the ceiling system that might cause the device or assembly to fall through the ceiling. This includes, but is not limited to, light fixtures, J-boxes, and

heavy speakers. Provide additional support as required where the weight of the device or assembly will exceed the safe limits of the wire supports.

F. Miscellaneous: Provide any other special foundations, hangers, and supports indicated on the drawings, specified elsewhere herein, or required by conditions at the site. Hangers and supporting structures for suspended equipment shall be provided as required to support the load from the building structure in a manner acceptable to the Owner's Representative.

3.7 EQUIPMENT PROTECTION

A. Provide suitable protection for all equipment, work and property against damage during construction.

B. Assume full responsibility for material and equipment stored at the site.

C. Conduit openings shall closed with caps or plugs during installation. All outlet boxes and cabinets shall be kept free of concrete, plaster, dirt, and debris.

D. Equipment shall be and tightly sealed against entrance of dust, dirt, and moisture.

3.8 CLEAN-UP

A. Remove all temporary labels, dirt, paint, grease and stains from all exposed equipment. Upon completion of work, clean equipment and the entire installation so as to present a first class job suitable for occupancy. No loose parts or scraps or equipment shall be left on the premises.

B. Equipment paint scars shall be repaired with paint kits supplied by the equipment manufacturer, or with an approved paint.

C. Clean interiors of each item of electrical equipment. At completion of work all equipment interiors shall be free from dust, dirt, and debris.

3.9 TESTS AND INSPECTIONS

A. All equipment shall put through a trial run-in test to ascertain the performance complies with the intent of the specifications. All-in tests shall be made in the presence of the Owner's Representative. All cables shall have an insulation test performed.

B. Cables installed with an unacceptable insulation reading shall be removed and new cable installed and retested at no additional cost to the owner. The Contractor shall make all tests deemed necessary by the inspection departments of the authority having jurisdiction, Board of Underwriters, etc. He shall provide all equipment, materials, and labor for making such tests. Fuel, test equipment materials for system operational tests shall be paid for by the contractor.

C. Other: Additional tests specified hereinafter under the various specifications sections shall be made.

D. Notification: The Owner's Representative shall be notified at his office 36 hours prior to each test and other specifications requirements requiring action on the part of the Owner, Engineer, and/or Owner's Representative.

E. Test Logs: All tests which the Contractor conducts shall have pertinent data logged by the Contractor at the time of testing. Data shall include date, time, personnel, description and extent of system tested, test conditions, test results, specified results, and any other pertinent data.

Data shall be delivered to the Owner's representative as specified under "Requirements for Final Acceptance".

3.10 CONDITIONS OF EQUIPMENT AT FINAL ACCEPTANCE

A. At the time of acceptance, the Contractor shall have inspected all installed systems to assure the following has been completed:

1. Fixtures are operating, and lenses and reflectors are free of dust, debris, and fingerprints.
2. Panelboards have all conductors neatly formed, bundled, and made-up tight. Cans shall be vacuum cleaned and surfaces cleaned of stray paint, dust, grease, and fingerprints. All circuit directories to be neatly typed and in place.
3. Wall plates and exposed switch and receptacle parts to be clean, free of paint, plaster, etc.
4. Safety and disconnect switches and motor control centers, Control Panels, etc. to be vacuum cleaned of debris and dust, and all surfaces free of stray paint, grease, and fingerprints.
5. Switchgear, transformers, and system devices shall be cleaned internally and externally and have all surfaces restored to original surface conditions.
6. Touch-up all scratched surfaces using paint matching the existing equipment paint. Where paint cannot be matched, the entire surface shall be repainted in a color and manner approved by the Engineer.

END OF SECTION

SECTION 16050
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Raceways.
2. Wire and connectors.
3. Supporting devices for electrical components.
4. Concrete equipment bases.
5. Electrical demolition.
6. Cutting and patching for electrical construction.
7. Touchup painting.

1.3 SUBMITTALS
Supporting Devices

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in structure during progress of construction to facilitate the electrical installations that follow.

1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

B. Coordinate electrical service connections to components furnished by utility companies.

1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.
2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.

C. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

PART 2 - PRODUCTS

2.1 RACEWAYS

A.
A.See Section 16130 “Raceways and Boxes.”

2.2 CONDUCTORS

A. See Section 16120 “Conductors and Cables.”

2.3 SUPPORTING DEVICES

A. Mounting hardware, nuts, bolts, lock washers, and washers, shall be grade 304 stainless steel.

B. Unless otherwise indicated, slotted channel framing and supporting devices shall be manufactured of ASTM 6063, T-6 grade aluminum; 1-5/8" wide x 3-1/4" deep (double opening type). Clamp nuts for use with slotted channels shall be grade 304 stainless steel.

C. Conduit straps for use with slotted channels shall be aluminum with stainless steel hardware.

D. After-set concrete inserts shall consist of stainless steel expansion bolts, 1/4: minimum diameter, 500 lbs. minimum pull-out resistance. Furnish Phillips, Wej-it, or equal.

E. Hanger rod shall be 3/8": minimum diameter galvanized steel all-thread.

F. Nest-back or clamp-back conduit supports shall be two-piece hot-dip galvanized malleable iron devices. Furnish Crouse-Hinds "MW + CB", Gedney 140 series, or equal.

G. One-hole conduit clamps shall be hot-dipped galvanized malleable iron type, Crouse-Hinds type "MW", T&B 1270/1280 series, or equal.

H. Conduit "U" bolts shall be hot-dip galvanized steel with galvanized hex-head bolts.

I. Plastic saddles for supporting buried conduits shall be interlocking type that provides separation between conduits vertically and laterally and between bottom of conduits and trench floor.

J. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

K. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.

2.4 EQUIPMENT FOR UTILITY COMPANY’S ELECTRICITY METERING

A. Current-Transforming Cabinets: Comply with requirements of electrical power utility company.

B. Meter Sockets: Comply with requirements of electrical power utility company.

C. Provide power utility company communication conduit to meter.

2.5 CONCRETE BASES

A. Concrete: As specified in Division 3 Section "Concrete." Provide minimum 4 inches beyond equipment.

B. Bollards: Provide bollards around transformer. Protect equipment on road or driveway sides.

2.6 TOUCHUP PAINT

A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.

B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 - EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

A. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

B. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

3.2 ELECTRICAL SUPPORTING DEVICE APPLICATION

A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.

B. Dry Locations: Steel materials.

C. Support Clamps for PVC Raceways: Click-type clamp system.

D. Selection of Supports: Comply with manufacturer's written instructions.

E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb design load.

3.3 SUPPORT INSTALLATION

A. Install support devices to securely and permanently fasten and support electrical components.

B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.

C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.

D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.

E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

F. Install 1/4-inch-diameter or larger threaded steel hanger rods, unless otherwise indicated.

G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch) and smaller raceways serving lighting and

receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.

H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

I. Simultaneously install vertical conductor supports with conductors.

J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches from the box.

K. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.

L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:

1. Wood: Fasten with wood screws or screw-type nails.
2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
3. New Concrete: Concrete inserts with machine screws and bolts.
4. Existing Concrete: Expansion bolts.
5. Steel: Welded threaded studs or spring-tension clamps on steel.
   a. Field Welding: Comply with AWS D1.1.
6. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
7. Light Steel: Sheet-metal screws.
8. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.4 FIRESTOPPING

A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly.

3.5 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 6 inches larger, in both directions, than supported unit and bollards. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. See Section 03300 – CONCRETE for concrete and reinforcement requirements.

3.6 DEMOLITION

A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.

B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.

C. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.

D. Remove demolished material from Project site.

E. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

3.7 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.8 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:

1. Raceways.
2. Building wire and connectors.
3. Supporting devices for electrical components.
4. Electrical identification.
5. Electricity-metering components.
6. Concrete bases.
7. Electrical demolition.
8. Cutting and patching for electrical construction.
9. Touchup painting.

3.9 REFINISHING AND TOUCHUP PAINTING

A. Refinish and touch up paint. Paint materials and application requirements are specified in Section 09915 – PROTECTIVE COATINGS.

1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.10 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 16060
GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 General Requirements, apply to this Section.

1.2 SUMMARY

A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections or on the drawings.

1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1. Comply with UL 467.

C. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Grounding Conductors, Cables, Connectors, and Rods:
   a. Apache Grounding/Erico Inc.
   b. Boggs, Inc.
   c. Chance/Hubbell.
   d. Copperweld Corp.
   e. Dossert Corp.
   f. Erico Inc.; Electrical Products Group.
   g. Framatome Connectors/Burndy Electrical.
   h. Galvan Industries, Inc.
   i. Harger Lightning Protection, Inc.
   j. Hastings Fiber Glass Products, Inc.
   k. Heary Brothers Lightning Protection Co.
   l. Ideal Industries, Inc.
   m. ILSCO.
   n. Kearney/Cooper Power Systems.
   o. Korns: C. C. Korns Co.; Division of Robroy Industries.
   p. Lightning Master Corp.

q. Lyncole XIT Grounding.
r. O-Z/Gedney Co.; a business of the EGS Electrical Group.
s. Raco, Inc.; Division of Hubbell.
t. Robbins Lightning, Inc.
u. Salisbury: W. H. Salisbury & Co.
v. Superior Grounding Systems, Inc.
w. Thomas & Betts, Electrical.

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 16 Section "Conductors and Cables."

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.

E. Grounding Electrode Conductors: Stranded cable.

F. Underground Conductors: Bare, stranded, unless otherwise indicated.

G. Bare Copper Conductors: Comply with the following:

1. Solid Conductors: ASTM B 3.
2. Assembly of Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.

H. Copper Bonding Conductors: As follows:

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

I. Ground Conductor and Conductor Protector for Wood Poles: As follows:

1. No. 4 AWG minimum, soft-drawn copper conductor.
2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir, or cypress or cedar.

J. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.3 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.

C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel.

B. Ground Rods: Sectional type; copper-clad steel.

1. Size: 3/4 by 120 inches.

C. Test Wells: Provide handholes for test wells.

PART 3 - EXECUTION

3.1 APPLICATION

A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. In raceways, use insulated equipment grounding conductors.

C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells.

D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

E. Ground Rod Clamps at Test Wells: Use bolted pressure clamps with at least two bolts.

F. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Use insulated spacer; space 1 inch from wall and support from wall 6 inches above finished floor, unless otherwise indicated.
2. At doors, route the bus up to the top of the door frame, across the top of the doorway, and down to the specified height above the floor.

G. Underground Grounding Conductors: Use bare stranded-copper conductor, No. 4/0 AWG minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.

3.2 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Install equipment grounding conductors in all feeders and circuits.

C. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

D. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.

E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate grounding conductor from raceway and

from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate equipment grounding conductor. Isolate equipment grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

G. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

H. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.

I. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.

J. Common Ground Bonding with Lightning Protection System: Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

3.4 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

END OF SECTION

SECTION 16075
ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 General Requirements, apply to this Section.

1.2 SUMMARY

A. This Section includes electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Schedule of Nomenclature: An index of electrical equipment and system components used in identification signs and labels

1.4 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

PART 2 - PRODUCTS

2.1 LABELS

A. Colored banding tape shall be 5 mil stretchable vinyl with permanent solid color. Color shall be as hereinafter specified. Tape shall be Plymouth “Slipknot 45”, 3M Scotch #35, or equal.

B. Numbered wire marking labels shall be colored vinyl markers, T&B, Brady, or equal. With clear heat shrinking tubing placed over the marking labels.

C. Cable identification labels shall be water resistant polyester with blank write-on space, T&B, Brady or equal. For use in handholds, manholes and boxes.

D. Underground-Conduit Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape.

1. Not less than 6 inches wide by 4 mils thick
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend indicating type of underground line.

2.2 NAMEPLATES AND SIGNS

A. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.

B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.

C. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for the application. 1/4-inch grommets in corners for mounting.

D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for the application. 1/4-inch grommets in corners for mounting.

E. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Phase label black pigmented power wires with color banding tape. Color of tape applies shall be that specified below:

CONDUCTOR	120/240V SYSTEMS	480V SYSTEMS
Phase A	Black	Purple
Phase B	Red	Brown
Phase C	Blue	Yellow
Neutral	White	Gray
Equipment Ground	Green	Green

B. Numbered labels shall be installed to identify circuit numbers from panel boards. Install labels on each wire in each panel board, junction, pullbox, and device.

C. Label each wiring run with write-on waterproof labels inside each motor control center and in service switchboard. Install write-on label ties around wire group at conduit entrance and write-on label the wire size, and service.

D. Install numbered marking on each control wiring termination at each terminal strip and at each device. Do this in motor control center, terminal cabinets, safety switches, remote controllers, pilot operators, and instrumentation equipment. Number selected shall correspond to number on terminal strip.

E. Phase bank each power wire and cable with colored banding tape. Do this at each termination

F. Apply numbered wire marking labels to control wires; power wiring in Panelboards, pull and junction boxes, and at outlets to identify circuit numbers. Each control wire shall be labeled at each connection.

G. Apply write-on identification labels to wiring sets in each hand-hole to identify function. Use waterproof labels.

H. Apply write-on identification labels to empty conduits to identify each with information as to terminus of other end and also trade size of conduit.

I. Install micarta nameplates with engraving to identify function and/or load served for the following:

1.	Starters	5.	Control Panels
2.	Overcurrent Devices	6.	Motor Control Centers
3.	Safety Switches	7.	Panel Boards
4.	Instruments	8.	Switchgear and Switchboards

Micarta nameplates shall be attached with stainless steel screws, use two(2) per each nameplate.

Submit for review a schedule for engraving along with size for each proposed micarta nameplate. Do not fabricate nameplate until review has been completed.

J. Type circuit directory information on circuit directory cards on all panelboards.

END OF SECTION

SECTION 16120
CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 General Requirements, apply to this Section.

1.2 SUMMARY

A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.3 SUBMITTALS

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

B. Qualification Data: For testing agency.

C. Field Quality-Control Test Reports: Megohn Meter Test Report

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 WIRE AND CABLE

A. All conductors shall be soft-drawn, stranded annealed copper that meets ANSI 44, ASTM B3-74/38-72.

B. Insulation for all power and controls conductors not used in cable trays shall be type THHN-THWN and complying with NEMA WC 5 or 7, UL-83 and UL-1063.

C. Conductors shall be color coded for voltage and phase as per NEC and any local amendments.

D. Large conductors shall have taped color coding.

E. Jacket shall be polyamide outer nylon covering per UL-83 and UL-1063.

F. Multiconductor shielded cables shall be polyethylene insulated tinned copper conductors within an aluminum-polyester shield tinned copper drain wire and a chrome PVC jacket. Shield shall provide 100% coverage. Cables shall be UL style 2092 and shall be BeldonBeldfoil #8760 or equal, with number of conductors shown.

G. Multiconductor signal cables shall consist of twisted pairs of insulated copper conductors, size and number of pairs as indicated, with a petroleum-polyethylene compound which fills all cable interstices, a non-hydroscopic core tape, .005” copper shield and a polyethylene jacket. Cable

shall be manufactured to REA Specification PE-39 for REA designation BJCF cables and shall be Okonite type KTC-F or equal.

H. Multiconductor cords shall consist of rubber insulated high-strained copper conductors contained within a neoprene jacket. Furnish type SJO/300V class for 120/240V class applications.

I. Multiconductor cables for installation in cable trays shall consist of stranded tinned copper conductors, 30 mils Rome FR-EPR flame-retardant ethylene-propylene-rubber insulation, color coded, two conductors flat, three or more conductors twisted with CPE jacket overall. Furnish Rome tray cable, type TC, or equal.

J. Variable Frequency Drive (VFD) power cables shall consist of stranded, tinned-copper power conductors contained within a cross-linked polyolefin, 2kV insulation meeting the requirements for Type P of IEEE 1580 and Type X110 of UL 1309/CSA 245. Each conductor shall have printed phase I.D. Cable shall include 3 ground conductors consisting of stranded, tinned-copper insulated with insulation equivalent to the power conductor insulation. The shield shall be constructed of tinned-copper braid with an aluminum/polyester tape providing 100% coverage. The jacket shall meet UL 1309/CSA 245 as well as IEEE1580.

2.2 CONNECTORS

A. Power connectors shall be insulated tap connectors. Furnish NSI Polaris connectors with no equals.

B. Insulated spring-wire connectors, “wire-nuts”, for small building wire taps and splices shall be plated spring steel with thermoplastic jacket. Connector shall be rated at 150 degrees Celsius continuous. Furnished 3M “Hyflex”, T&B “PT” or equal.

C. Insulated set-screw connectors shall consist of copper body with flame-retardant plastic insulated shield. Furnished Ideal, T&B, or equal.

D. Connectors for control conductor connections to screw terminals shall be crimp-type with vinyl insulated bvarrell and tin-plated copper ring-tongue style connector. Furnish T&B, “Sta-kon”, 3M “Scothlok”. Or equal.

2.3 INSULATING PRODUCTS

A. Tape products shall be furnished as hereinafter specified and shall be Plymouth, Okonite, F.E., 3M, or equal.

B. General purpose electrical tape shall be 7 mil thick stretchable vinyl plastic, pressure adhesive type, “slipknot Grey”, 3M Scotch 33+, or equal.

C. Insulating void-filling tape and high voltage bedding tape shall be stretchable thylene propylene rubber with high-tack and fast fusing surfaces. Tape shall be rated for 90 degrees Celsius continuous, 130 degrees Celsius overload, and shall be moisture proof void filling tape shall be “plysafe”, 3M Schotch 23, or equal.

D. High temperature protective tape shall be rated 180 degrees Celsius continuous indoor/outdoor, stretchable, self-bonding silicone rubber. High temperature tape shall be “plysil #3445”, 3M Scotch 70, or equal.

PART 3- EXECUTION

3.1 WIRING

A. Conductors shall be sized as shown and where no size is indicated, the conductor size shall be size #12 AWG.

B. All control wiring, 120/240V wiring and insulated equipment grounding conductors shall be type XHHW insulated stranded copper conductors.

C. All 480V wiring in sizes #4/0 and larger shall be made with type RHH, RH, USE, VW-1 wire with stranded copper conductors that has EPR insulation and flame retardant jacket.

D. All 480V wiring in sizes smaller than #4/0 shall be installed with type RHH, RHW, USE insulated stranded copper conductors.

E. Branch circuits may be spliced for receptacle, lighting and small appliances load inside appropriate junction boxes. All control and power cables shall be run continuous without splices except where approved by the engineer.

F. Except as otherwise specified, taps and splices with #10 AWG and smaller shall be made with insulated spring wire connectors. Such connectors in damp or wet locations shall be further insulated with an envelope of stretched piece of EPR tape around each wire to fill the interstices between the wires. Then, apply one-half lapped layer of electrical tape over all.

G. Motor connections made with #10 AWG and smaller wire shall be made up with set-screwed copper lugs with threaded-on insulating jacket. After make-up of each connector, install two (2) layers half-lapped, high temperature tape over connector barrel and down over wires into connector on (1") inch.

H. Motor connections made with #8 AWG and larger wire shall be made up with cast copper alloy splice connector. Apply over each connector and down 1.5 inches over each wire entry, wrapping in high temperature tape. Apply at least three (3) layers, half-lapper each layer of such tape with maximum built-up over the connector. Then apply final wrapping of at least three (3) layers, half-lapped each layer of electrical tape.

I. Taps, splices, and connection in #8 AWG and larger wires shall be made with copper alloy bolted pressure connectors. Each such connector shall be insulated by means of applying insulation putty over sharp edges so as to present a smooth bonding surface. Next, apply at least four (4) layers, half-lapped each layer of EPR tape. Then, make final wrapping of at least three (3) layers, half-lapped each layer of electrical tape.

J. Control wiring connections to stud type and screw type terminals shall be made with ring-tongue type crimp connectors. Label each terminal jacket with wire marking label at each connection.

K. Each wire connection shall be made up tightly so that resistance of connection is as low as equivalent length of associated conductor resistance.

L. Phase label black pigmented power wires with color banding tape. Color of tape applies shall be that specified below.

CONDUCTOR	120/240V SYSTEMS	480V SYSTEMS
Phase A	Black	Purple
Phase B	Red	Brown
Phase C	Blue	Yellow
Neutral	White	Gray
Equipment Ground	Green	Green

M. Numbered labels shall be installed to identify circuit numbers from panel boards. Install labels on each wire in each panelboard, junction, and pullbox, and device connection.

N. Label each wiring run with write-on waterproof labels inside each motor control center and in service switchboard. Install write-on label ties around wire group at conduit entrance and write-on label the wire size, and service.

O. Install numbered marking on each control wiring termination at each terminal strip and at each device. Do this in motor control center, terminal cabinets, safety switches, remote controllers, pilot operators, and instrumentation equipment. Number selected shall correspond to number on terminal strip.

P. All wiring inside enclosures will be neatly trained and laced with nylon tie-wraps.

Q. All wiring shall be installed in raceways unless otherwise noted; however, no wire shall be drawn into a conduit until all work of a nature which may cause injury is completed. Do not exceed wire and cable manufacturer's recommended pulling tensions. A cable pulling compound shall be used as a lubricant and its composition shall not affect the conductor or its insulation.

END OF SECTION

SECTION 16130
RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 General Requirements, apply to this Section.

1.2 SUMMARY

1.3 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: Show fabrication and installation details of components for raceways, fittings, boxes, enclosures, and cabinets.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 RACEWAYS

A. Above ground conduit shall be schedule 40 aluminum and shall comply with Article 346 of NEC and U.L. standard UL-6.

B. Below grade conduit shall be non-metallic rigid PVC Schedule 40, rated 90 degrees Celsius and conform to NEMA TC-2 and UL-651 Standards, transitions to above ground to be made with PVC coated hot dipped rigid steel conduit.

C. Connections to motors shall be made using liquid tight flexible conduit and shall consist of galvanized flexible interlocking steel core with thermoplastic cover.

2.2 CONDUIT FITTINGS

A. NEMA 1 lock nuts for indoor rigid metallic conduit shall be galvanized steel.

B. Outdoor field applied hubs for sheet metal enclosures shall be galvanized steel ring, nylon throat, threaded NPT insert and shall be MYERS "SCRU-TITE", or equal.

C. Conduit hubs for non-metallic enclosures shall be fiberglass polyester reinforced with galvanized steel core, complete with lockout and grounding bushing and shall be Square D Type NH, or equal.

D. Rigid metallic conduit chase nipples, slip fittings, unions, reducers shall be hot dipped galvanized steel.

E. Rigid metallic conduit grounding bushings shall be hot dipped galvanized steel with threaded hub, nylon insulated throat, and ground lug.

F. Liquid tight flexible conduit fittings shall be hot dipped galvanized steel body with internal locking ring.

2.3 CONDUIT BODIES, BOXES, AND ENCLOSURES

A. Conduit bodies such as "C", "LB", "T" and the like pulling fittings shall be sand-cast copper free aluminum. Covers shall be gasketed cast metal with stainless steel cover screws and clamp style attachment. Furnish Crouse-Hinds Form 7, or equal.

B. Conduit bodies such as "GUA", "GUAT", "GUAL", and the like pulling/splicing fittings shall be copper free aluminum with cast metal covers. All such conduit bodies shall be Crouse-Hinds GU/EA series, Appleton "GR" series, equal.

C. Cast metal outlet boxes, pullboxes, and junction boxes whose volume is smaller than 100 cubic inches, and cast metal device boxes, shall be sand-cast copper free aluminum. All boxes shall have threaded hubs. Furnish Crouse-Hinds "FD" style Condulets, Appleton "FD" style Unilets, or equal.

D. Covers for cast metal boxes shall be gasketed cast metal covers with stainless steel screws

E. Enclosures shall be NEMA types as indicated. NEMA 4X types shall be 316 stainless steel with gasketed door and 316 stainless steel hardware.

F. Conduit hubs for NEMA 4X enclosed safety switches shall be steel body type with fiberglass reinforced polyester covering and with grounding bushing inside.

G. Conduit hubs for NEMA 3 and NEMA 4 and NEMA 4X enclosures shall be water-tight threaded hubs with grounding bushing inside.

H. Each enclosure shall be equipped with ground lug.

2.4 MISCELLANEOUS MATERIAL

A. Double bushing for insulating wiring through sheet metal panels shall consist of mating male and female threaded phenolic bushings. Phenolic insulation shall be high-impact "ABB", Gedney type "ABB", or equal.

B. Cable grips shall be grip-type wire mesh with machined metal support. Furnish Kellems, Appleton, or equal products.

C. Conduit pull-cords for use in empty raceways shall be glass-fiber reinforced tape with foot-marked along its length. Furnish Thomas, Greenlee, or equal products.

D. Conduit thread coating compound shall be conductive, non-galling, and corrosion-inhibiting. Furnish Crouse-Hinds type "STL", Appleton type "ST", or equal.

E. Wire pulling compound shall be non-injurious to insulation and to conduit and shall be lubricating, non-crumbling, and non-combustible. Furnish Gedney "Wire-Quick", Ideal "Yellow", or equal.

F. Plastic compound for field-coating of ferrous material products shall be PVC in liquid form that sets-up semi-hard upon curing. Furnishing Rob Roy "rob Kote", Sedco "Patch Coat", or equal.

G. Zinc spray for coating electrogalvanized steel products shall be Research Laboratory type "LPS", Mobil "Zinc-spray", or equal.

H. Splicing kit shall be provided with insulating and sealing compound to provide a moisture-tight splice. Provide Scotchcast Series 82 or equal splicing kit.

I. Conduit straps for use with slotted channels shall be aluminum with stainless steel hardware.

J. After-set concrete inserts shall consist of stainless steel expansion bolts, 1/4: minimum diameter, 500 lbs. minimum pull-out resistance. Furnish Phillips, Wej-it, or equal.

K. Hanger rod shall be 3/8": minimum diameter galvanized steel all-thread.

L. Nest-back or clamp-back conduit supports shall be two-piece hot-dip galvanized malleable iron devices. Furnish Crouse-Hinds "MW + CB", Gedney 140 series, or equal.

M. One-hole conduit clamps shall be hot-dipped galvanized malleable iron type, Crouse-Hinds type "MW", T&B 1270/1280 series, or equal.

N. Conduit "U" bolts shall be hot-dip galvanized steel with galvanized hex-head bolts.

O. Plastic saddles for supporting buried conduits shall be interlocking type that provides separation between conduits vertically and laterally and between bottom of conduits and trench floor.

PART 3 - EXECUTION

3.1 RACEWAYS

A. Install the conduit system to provide the facility with the utmost degree of reliability and maintenance free operation. The conduit system shall have the appearance of having been installed by competent workmen. Kinked conduit, conduit inadequately supported or carelessly installed, do not give such reliability and maintenance free operation and will not be accepted.

B. Raceways shall be installed for all wiring runs except as otherwise indicated.

C. Conduit sizes, where not indicated, shall be N.E.C. code-sized to accommodate the number and diameter of wires to be pulled into the conduit. Unless otherwise indicated, 3/4" trade-size shall be minimum size conduit.

D. Unless otherwise noted, conduit runs shall be installed exposed. Such runs shall be made parallel to the lines of the structure. Where aluminum conduit or supporting devices come in contact with concrete, the conduit and or supporting devices shall be coated with zinc chromate or other suitable coating to prevent galvanic action.

E. Conduit runs installed below-grade in earth shall be PVC. Use manufacturer's approved cement for joining couplings and adapters. Runs shall be installed so that tops of conduits

are at least twenty-four (24") inches below finished grade. Support runs on plastic spacers and backfill to three (3") inches above topmost conduits with washed sand. Wash down all sand backfill with water so as to completely fill interstices and to compact sand. Backfill to finished grade with selected soil that is free from clods, debris, rocks and the like. Pneumatically tamp backfill in six (6") inches to eight (8") inches below finished grade, install continuous run of "BURIED CABLE" marking taped.

F. Below-grade to above-grade upturns in non-metallic runs shall be made with PVC coated rigid metallic conduit.

G. Rigid metallic conduit runs shall have their couplings and connections made with screwed fittings and shall be made up wrench-tight. Check all threaded conduit joints prior to wire pull.

H. All conduit runs shall be watertight over their lengths of run except where drain fittings are indicated. In which cases, install specified breather-drain fittings.

I. Plastic jacketed flexible steel conduit shall be used to connect wiring to motors, limit switches, bearing thermostats, and other devices that may have to be removed for servicing. Unless otherwise indicated, maximum lengths of flex shall be six (6') feet.

J. Each flex connector shall be made-up tightly so that the minimum pull-out resistance is at least 150 lbs.

K. Empty conduits shall have pull-tape installed. Identify each terminus as to location of other end. Use blank plastic waterproof write-on label and write information on each label with waterproof ink. Cap exposed ends of empty conduit with plastic caps.

L. Conduit runs into boxes, cabinets, and enclosures shall be set in a neat manner. Vertical runs shall be set plumb. Conduits set cocked or out of plumb will not be acceptable.

M. Conduit entrances into equipment shall be carefully planned. Cutting away of enclosure structure, torching out sill or braces, and removal of enclosure structural members, will not be acceptable.

N. Use approved hole cutting tools for entrances into sheet metal enclosure. Use of cutting torch or incorrect tools will not be acceptable. Holes shall be cleanly cut and they shall be free from burrs, fagged edges, and torn metal.

O. All raceways shall be swabbed clean after installation. There shall be no debris left inside. All interior surfaces shall be smooth and free from burrs and defects that would injure wire insulation. All conduits shall be sealed after cable installation with electrical insulation putty.

3.2 CONDUIT BODIES AND BOXES

A. Conduit bodies such as "LB", "T", etc., shall be installed in exposed runs of conduit wherever indicated and where required to overcome obstructions and to provide pulling access to wiring. Covers for such fittings shall be accessible and unobstructed by the adjacent construction.

B. Covers for conduit bodies installed shall be gasketed cast metal type.

C. All conduit boxes installed shall be cast metal type. Covers for all such boxes shall be gasketed cast metal type.

D. Install enclosures plumb

3.3 RACEWAY SUPPORT

A. All raceway systems shall be adequately and safely supported. Loose, sloppy and inadequately supported raceways will not be acceptable. Supports shall be installed at intervals not greater than those set forth under Article 300 of N.E.C., unless shorter intervals are otherwise indicated, or unless conditions require shorter intervals of supports.

B. Surface mounted runs of conduit on concrete or masonry surfaces shall be supported off the surface by means of aluminum slotted channels and conduit clamps. Attach each slotted channel support to concrete surface by means of two (2) 1/4" diameter stainless steel bolts into drilled expansion shields. Coat surface contacting concrete or masonry with zinc chromate.

C. Conduit runs that are installed along metallic structures shall be supported by means of beam clamps or other methods as may be indicated. Coat each beam clamp with PVC prior to installation.

D. Below-grade conduits shall be supported with plastic saddles.

3.4 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.5 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION

SECTION 16411
SAFETY SWITCHES

PART 1 - GENERAL

1.1 SCOPE

A. Furnish and install heavy duty safety switches of the types, sizes and quantities indicated on the contract drawings. Provide all lugs and accessories necessary for proper installation and operation.

1.2 RELATED DOCUMENTS

A. All drawings and general provisions of the Contract including Division 1 requirements apply to this section.

1.3 SUBMITTALS

A. Provide product information prior to fabrication and installation. Product data shall include all dimensions, weights, electrical ratings and maintenance data.

1.4 RELATED STANDARDS

A. The safety switches and all accessories shall be designed, manufactured and tested in accordance with the latest applicable standards of the following:

1. UL98 – Enclosed and Dead Front Switches
2. UL50 – Enclosures for Electrical Equipment
3. Federal specification W-S 865C (Type HD for heavy duty, Type ND for general duty)
4. NEMA KS-1, Enclosed Switches

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The heavy duty safety switches shall be manufactured by Siemens or pre-approved equal by:

1. Siemens
2. Eaton

2.2 SWITCH MECHANISM/HANDLE

A. Switch operating mechanism shall be non-teasible, positive, quick-make, quick-break such that during normal operation of the switch, the operation of the contacts shall not be capable of being restrained by the operating handle after the closing or opening action of the contacts has started.

B. The operating handle shall be an integral part of the box and not the cover.

C. The handle position, combined with large “ON” and “OFF” lettering on the nameplate, shall clearly indicate the switch position.

D. The operating handle must be made of steel, with no plastic parts other than the handle grip.

E. The operating handle shall be provided with a highly visible red plastic grip and must allow for hook stick operation.

F. The operating mechanism must be made of steel, with no plastic parts.

G. All switches shall have a dual cover interlock mechanism to prevent unintentional opening of the switch cover when the switch is ON and prevent turning the switch ON when the cover is open. The cover interlock mechanism shall have an externally operated override but the override shall not permanently disable the interlock mechanism. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

H. 30-200A 4X stainless steel switches shall have stainless steel interior parts as standard.

I. All switches shall have provisions to accept up to three 5/16 in. hasp padlocks to lock the operating handle in the OFF position.

2.3 SWITCH INTERIOR

A. All switches shall have switch blades, which are visible when the switch is OFF and the cover is open.

B. Lugs shall be front removable and UL-listed for Cu/Al 60° or 75°C conductors in 30-100 ampere ratings and for 75°C conductors in 200-1200 ampere ratings. Line and load lugs shall be removable with no need to remove line shields and arc suppressors.

C. 30 to 100 ampere switches shall be capable of accepting field installed fuse puller kits.

D. Optional copper body and crimp type lugs are to be UL approved for field installation in 30-1200A ratings.

E. Heavy Duty Switches all shall have all copper current carrying parts.

F. All current carrying parts shall be plated to resist corrosion.

2.4 SWITCH ENCLOSURES

A. Switch covers shall be attached with pin-type hinges. Top hinged doors are not acceptable.

B. Enclosures for Type 3R switches through 200 ampere shall have provisions of for interchangeable bolt-on hubs in the top endwall. Hubs shall be Siemens Type “HS” or “HA” hubs sized as indicated on the plans.

C. Switches shall have wire-bending space lug capacity for one size larger Al/Cu wire than NEC and UL minimum requirements.

D. The enclosure shall be finished with a brush finish on type 316 stainless steel (Type 4 / 4X-5 stainless steel).

E. All switch enclosures shall have a formed front flange to provide additional strength and rigidity.

F. Tangential knockouts shall be provided for switches rated 30-600A in Type 1 and 3R enclosures where permitted.

G. Cover latching means for Type 4 / 4X & 12 switches in metal enclosures rated through 1200 amperes shall be quick release lift lever type.

H. Type 12 enclosures shall be dual rated as Type 3S to allow their use in outdoor applications.

I. All heavy duty switches shall have plastic nameplates.

J. Where indicated, furnish disconnect mechanism with auxiliary control disconnect contact rated 10 amp make, 6 amp break 120VAC.

K. Where indicated, furnish Safety switches with integrally mounted oil tight pilot operators and control switches.

2.5 SWITCH RATINGS

A. All switches shall be Underwriters' Laboratories, Inc. listed and meet Federal Specification WS865C and NEMA Specification KS-1.

B. Switches shall also be horsepower rated for AC and/or DC as indicated on the plans.

C. Switches shall be horsepower rated for Design G motors on internal labeling.

D. All switches, intended for service entrance, shall be UL approved for this application.

E. All switches shall be I^2t rated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The contractor shall install all equipment in accordance with the contract drawings and manufacturers recommendations.

3.2 ADJUSTMENTS

A. The contractor shall install the necessary accessories in order to place the safety switches in final operating condition.

END OF SECTION

GEOTECHNICAL REPORT

Emergency Sludge Storage Ponds Retrofit Geotechnical Exploration

Clover Power Station
Clover, Virginia

January 2016

Emergency Sludge Storage Ponds Retrofit Geotechnical Exploration

Clover Power Station
Clover, Virginia

January 2016

Prepared For
Dominion Resources Services, Inc.

COMMONWEALTH OF VIRGINIA
3/1/16
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Section 1
Introduction

1.1 Project Description

The Clover Power Station operates two emergency sludge storage ponds to manage coal combustion residuals (CCR). The existing ponds are currently lined with a polyvinyl chloride geomembrane, but does not meet the liner requirements for existing surface impoundments in Federal Register §257.72. Dominion Resources, Inc. (Dominion) is planning to retrofit the two existing surface impoundments by removing all CCR and the existing liner system and installing a liner system meeting the requirement of Federal Register §257.72. The new liner system will be composed of from the bottom up: prepared subgrade, 8 inches of compacted clay, a geosynthetic clay liner, a 60-mil high density polyethylene (HDPE) geomembrane and a protective covering.

1.2 Site Description

The site is located along the Staunton River, in Halifax County northeast of Clover, Virginia, refer to the Site Location Map in Figure 1. The station is located at approximately latitude 36°52'11.79"N, longitude 78°42'6.47"W. The evaporation ponds currently lie east of the power station. The topographic map shows the site varies from elevation 360 to 375 feet North American Vertical Datum 1988 (NAVD88).

1.2.1 Existing Structures

The existing sludge ponds are two side-by-side surface impoundments. Each sludge pond is approximately 1.3 acres in surface area with a volume of approximately 13.7 acre-feet. The maximum depth of the ponds is currently 9 feet from the top of the perimeter berm to the base. The geometry of the sludge ponds will be maintained during the retrofit. The existing sludge ponds have riprap protective layer on the sideslopes and a concrete pad at the base.

Surrounding improvements include underground piping, concrete inlet and outlet structures, concrete access pads, ramps, and gravel access roads.

1.2.2 Site Geology

The site falls within the Piedmont physiographic region composed of low rolling hills representing the coastal plain leading up to the Blue Ridge and Valley and Ridge physiographic units.

The interactive geologic map for the state (VDMME, 2015; Figure 2) indicates the area is underlain by Paleozoic era metamorphic rocks. Specifically the area is mapped as a mylonite, a highly deformed metamorphic rock. This description is consistent with the high strain zones mapped surrounding the mylonite unit.

Previous subsurface explorations performed near the Clover Power Station (Golder, 1999) document metavolcanic rocks occurring at 23 feet below the ground surface and deeper.

1.2.3 Soil Survey

The National Soil Conservation Service Soil Survey for the site maps the area of the impoundments as loamy Udorthents. A Soil Map for Halifax County and the City of South Boston, Virginia is attached to this document (Appendix A). Engineering properties are not provided for the Udorthents unit (maps areas of cut and fill), but adjacent soil survey map units are composed of lean to fat clay, silt, silt sand, and clayey sand.

Section 2
Site Exploration

2.1 Subsurface Exploration and In-situ Testing

Six soil borings were performed at the site on June 29, 2015 by TRC using a truck-mounted Mobile B57 drill rig. Figure 3 provides the soil boring locations determined using a handheld global positioning receiver. The soil borings were terminated at a depth of 20 feet below the ground surface (bgs).

TRC obtained disturbed soil samples using a split-barrel sampler driven during Standard Penetration Tests (SPT) in accordance with the American Society of Testing and Materials International (ASTM) D1586, Standard Method of Penetration Test and Split Barrel Sampling of Soils. Split barrel sampling was performed at 2 foot intervals to a depth of 10 feet bgs followed by sampling at 5 foot intervals to termination. A total of seven samples were collected at each boring. An undisturbed sample (U-1) was collected at boring B-4 from 4 to 6 feet using a Shelby tube in accordance with ASTM D1587, Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes.

A TRC representative visually classified the split-barrel (split-spoon; SS) samples in the field to estimate the distribution of grain sizes, plasticity, consistency, moisture condition, color, and presence of lenses and seams. This classification is in general conformance with ASTM D 2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Representative sample material was sealed in containers for transport to the laboratory. Boring logs provide "field" SPT N-values without correction factors for hammer energy or overburden stresses. Soil boring logs are provided in Appendix B.

2.2 Laboratory Testing

After reviewing the description of the soil samples and the in-situ test data, laboratory testing was performed on select samples recovered from the soil borings. The laboratory testing was assigned based on the proposed construction. The testing was performed in general conformance with the applicable ASTM standards. Table 1 in Appendix C provides a summary of the laboratory test results. Laboratory test results are provided in Appendix C.

2.3 Subsurface Conditions

2.3.1 Soil Conditions

The soil borings encountered silty topsoil ranging from 0.2 to 0.7 feet bgs. Below topsoil, very stiff to hard lean clay (Unified Soil Classification System (USCS) symbol CL) and fat clay (CH) was observed from 6 feet bgs to 18 feet bgs. At soil boring location B-3, fat clay (CH) was observed below the topsoil to termination at 20 feet bgs. Medium dense silt (ML) to silty sand (SM) was observed below the clay soils to termination at 20 feet bgs. At borings B-4 and B-5, high plasticity silt (MH) was observed below the topsoil to 8 and 6 feet bgs, respectively. Field descriptions and classifications updated based on laboratory test results are provided on the soil boring logs in Appendix B.

2.3.2 Groundwater Conditions

Groundwater was not observed during drilling. Historical groundwater monitoring at the site indicates that the maximum groundwater elevation in the area of the sludge storage ponds is 354 feet NAVD 88. This groundwater elevation is 9 feet lower than the base of the retrofitted ponds or approximately 20 feet below the existing top of berm elevation.

2.4 Site Access

The area surrounding the ponds was accessed easily by the existing roads and ramps. No poor surface conditions were observed during the subsurface exploration.

Section 3
Geotechnical Recommendations

3.1 Recommended Soil Parameters

Based on the in-situ testing, laboratory test results, and previous investigations, engineering soil parameters for the soils observed at the site are provided in Table 2. These parameters are applicable for the proposed construction at the site described in Section 1.1 and the design assumptions presented below.

3.2 Design Assumptions

This report and the recommendations provided are based on the following assumptions on the design and construction of the evaporation ponds.

- Pond sideslopes will be 3H (horizontal) to 1V (vertical).
- Total depth of the pond is 9 feet (this includes 2 feet of freeboard).
- Minimum top of the berm is 10 feet wide.
- Ponds will be constructed within the existing footprint with minimal cut.
- Ponds will be constructed with a composite liner system composed of (from top to bottom) a 60-mil-thick HDPE geomembrane, a geosynthetic clay liner, and an 8-inch-thick compacted clay liner

3.3 Slope Stability

The design of the retrofit includes sideslopes at a slope of 3 horizontal to 1 vertical (approximately 18.4 degrees). From a global stability standpoint, seepage forces should not impact the slope due to the composite liner system and groundwater levels are below the slope. Considering the infinite slope stability of the sideslopes without fluid in the ponds results in a factor of safety greater than 1.5 for global stability conditions.

Evaluation of the stability of the composite liner system should be performed during design of the impoundments when materials are selected. Slopes of 3H:1V are common for geosynthetic lined containment systems; therefore, the design can be implemented.

3.4 Seismic Considerations

Based on probabilistic maps developed by the US Geological Survey, there is minimal risk of ground motions due to seismic events; maximum peak ground acceleration of 0.07 g for a 2

percent probability in 50 years (Petersen, et al., 2008). Liquefaction is not a concern at the site due to the stiff, fine-grained soils observed during the subsurface exploration and the low seismic risk.

3.5 Bearing Capacity and Settlement Analysis

The proposed ponds will provide similar loading conditions as the existing conditions. The observed soil conditions suggest that an allowable bearing capacity of 3,000 psf will result in acceptable settlements. Frost depth for the area is 24 inches.

Section 4
Construction Considerations

4.1 Subgrade Preparation

Surficial topsoil, vegetation, organic matter, and debris should be removed from areas where work is being performed by the contractor. Frozen, saturated, disturbed, and unstable subgrade should also be removed immediately prior to fill placement and berm construction.

Subgrade preparation and proof-rolling should be performed under the observation of the engineer's representative to document acceptable subgrade conditions. It is recommended that the subgrade for the berms and structures be proof-rolled to confirm that it is stable subgrade prior to fill placement. The proof-roll can be performed using a loaded haul truck or smooth drum compactor.

Fine-grained soils encountered in this exploration are susceptible to weakening and disturbance from repeated construction traffic and increased water contents. The susceptibility will depend largely on climatic conditions (i.e., the amount of precipitation) during construction.

The high plasticity soils observed at the site may swell and heave if exposed to excess moisture. Construction excavations and grading should be performed to sheet flow stormwater away from exposed subgrade or pump water from low areas. Do not allow water to pond in exposed areas.

The subgrade should be inspected to remove gravel sized particles greater than 3 inches in diameter prior to placing the clay liner component of the composite liner.

4.2 Soil Placement and Compaction

The majority of the near surface soils encountered during the subsurface exploration were high plasticity clay and high plasticity silt. The moisture-density relationships for the high plasticity clay are provided in Appendix B.

Soil and fill should be moistened to near-optimum moisture content, and placed in loose lifts not exceeding 9 inches in thickness. Surfaces to receive fill should be scarified to a depth of 6 inches prior to fill placement and compacted to at least 95 percent of its maximum dry unit weight (Standard Proctor Density). The soil/fill should be compacted using suitable equipment for the soil type to the required density. The soil/fill should be compacted to at least 95 percent

of its maximum dry unit weight (Standard Proctor Density) at a moisture content ranging between the optimum moisture content and the optimum minus 3 percent.

Fill provided for the 8-inch thick clay layer at the base of the composite liner (clay fill) should be should be categorized as CL, CH, ML, or MH according to the USCS and have a maximum particle size of 2 inches in diameter. The clay fill should be compacted to the moisture density conditions required to achieve a hydraulic conductivity of $1x10^{-7}$ cm/s. The compaction specifications should be based on laboratory testing performed on material from the borrow source. Generally, a minimum unit weight of 95 percent of its maximum dry unit weight (Standard Proctor Density) moisture conditioned to the optimum moisture content or above is acceptable. The clay fill should be compacted using pad or wedge foot compaction equipment with a pad depth that fully penetrates the lift thickness. The clay fill may need to be placed in layers up to 12 inches thick to allow placement. Alternatively, on the sideslopes the clay fill can be placed in horizontal layers with excess material cut to form the slopes. Prior to placement of geosynthetics, it is recommended that the clay liner be rolled with a smooth drum roller to provide a firm, smooth, uniform surface for geosynthetic placement.

It is recommended that the moisture-density conditions of the fill compaction be verified using in-situ test methods.

4.3 Geosynthetic Recommendations

It is recommended that a construction quality assurance quality control plan (CQA/QCP) for geosynthetic liner construction be developed to identify the required materials, geosynthetic acceptance requirements, acceptable construction procedures, and field seaming procedures. The CQA/QCP should also address any penetrations in the liner system and identify the acceptable method of sealing the penetration. It is recommended that the construction of the geosynthetic liner system be observed and documented by a technician experienced in geosynthetics under the guidance of a professional engineer.

Geosynthetic liner systems perform well when used to impound fluids. Equipment should not operate on exposed geosynthetics. Geosynthetics are not suitable for supporting point loads and are easily punctured and damaged. Care should be taken to protect the geosynthetics where contact with another material/object is anticipated. Precautions to protect the liner may include a sacrificial geomembrane “scuff sheet”, geotextile cushion, or other protective layers approved by the engineer.

4.4 Drainage and Erosion Control

Positive drainage of surface water to properly maintained ditches, culverts, and channels should be used to control stormwater from entering the subgrade and pond excavations. Construction and maintenance of temporary drainage ditches, sedimentation facilities, and/or sumps may be necessary. Subgrade conditions can quickly deteriorate under saturated conditions. Maintaining surface water controls during construction will reduce construction delays and subgrade modification.

Appropriate sediment control devices (such as silt fences) should be placed at the start of construction and periodically maintained to minimize movement of eroded soil.

Ditches, slopes, and other areas susceptible to erosion and disturbed by construction activities should be protected with erosion control devices as early as possible. Erosion checks and/or riprap may be used for erosion control and should be used in areas where high flow rates are anticipated.

In addition, consideration should be given to long-term performance of the exposed soil slopes. It is recommended that vegetation is established in disturbed areas as practicable.

4.5 Access Roads

A typical low-volume access road can be constructed (from subgrade up) by scarifying subgrade soils to at least 12 inches and compacting subgrade soils to at least 95 percent of its maximum dry unit weight (Standard Proctor Density), installing an 8-ounce non-woven geotextile separation layer, and placing and compacting 8 inches of aggregate base material.

4.6 Dewatering

Groundwater was not encountered during this exploration. However, the excavations will likely collect water during precipitation events. It is anticipated that dewatering can be performed using typical sump and pump methods to remove storm water and perched water, if encountered.

4.7 Utilities

The site is located at an active power station. Overhead and underground utilities are present throughout the site. The location of all utilities in the project area should be identified prior to construction and excavation with the Dominion project manager.

4.8 Temporary Shoring and Excavation

Excavation safety is the responsibility of the Contractor. Contractors should be aware of, and follow, applicable local, state, and federal laws regulating on-site safety in accordance with the current Occupational Safety and Health Administration (OSHA) Excavation and Trench Safety Standards. These standards are outlined in 29 CFR Part 1926 Subpart P. Excavations within unstable soil conditions or extending five feet or more deep should be adequately sloped or braced according to these standards. Material stockpiles or heavy equipment should not be placed near the edge of the excavation slopes.

Section 5
Limitations

This report provides the results of the geotechnical subsurface exploration and recommendations for the Clover Power Station Emergency Sludge Storage Ponds for the specific project and use discussed in this report. The analysis, results, and recommendations are based on the observations at a limited number of subsurface boring locations performed at the site, and the interpreted engineering characteristics of the soil based on in-situ and laboratory testing at the time of the report. Subsurface conditions can change over time. If variations from the subsurface conditions described in this study are noted during construction, the recommendations in this report must be re-evaluated.

The recommendations provided in this report are based on the interpreted subsurface conditions, the engineer's experience and professional opinion, and generally accepted geotechnical engineering practices at the time of this report. No other warranties are expressed or implied. The recommendations in this report are related and are not mutually exclusive of one another; therefore, no portion of this report can be removed and used as a single component. This report has been prepared for the exclusive use of TRC Environmental Corporation and Dominion Resources Services, Inc.

After plans for the facility are completed in sufficient detail, a geotechnical engineer should be consulted regarding any additional subsurface information that may be required to arrive at additional recommendations for design.

Section 6
References

Federal Register. 1989. Occupational Health and Safety Administration, Part 1926.

Peterson, M.D., A.D. Frankel, S.C. Harmsen, C.S. Mueller, K.M. Haller, R.L. Wheeler, R.L. Wesson, Y. Zeng, O.S. Boyd, D.M. Perkins, N. Luco, E.H. Field, C.J. Wills, K.S. Rukstales. 2008. Documentation for the 2008 update of the United States national seismic hazard maps. U.S. Geological Survey. 54 p.

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Virginia Department of Mines Minerals and Energy. 2015. "Division of Geology and Mineral Resources Interactive Map." Available Online at http://dmme.virginia.gov/webmaps/dgmr/. Accessed [7/9/2015].

Table 1
Recommended Soil Properties

SOIL	γ_{total} (pcf)	S_u (psf)	c'_a (psf)	ϕ' (deg.)	COEFFICIENT OF ACTIVE EARTH PRESSURE	COEFFICIENT OF PASSIVE EARTH PRESSURE[1]	COEFFICIENT OF AT REST EARTH PRESSURE
Low Plasticity Clay	120	4,000	100	32	0.31	3.3	0.47
High Plasticity Clay and Silt	116	1,400	50	28	0.36	2.8	0.53
Low Plasticity Silt	121	1,300	--	32	0.31	3.3	0.47
Silty Sand	128	--	--	35	0.27	3.7	0.43

Footnotes:

(1) A factor of safety of 2 is recommended when using passive earth pressures for retaining wall design due to strain incompatibility.

Prepared By: J. Hotstream
Checked By: R. Nilsson

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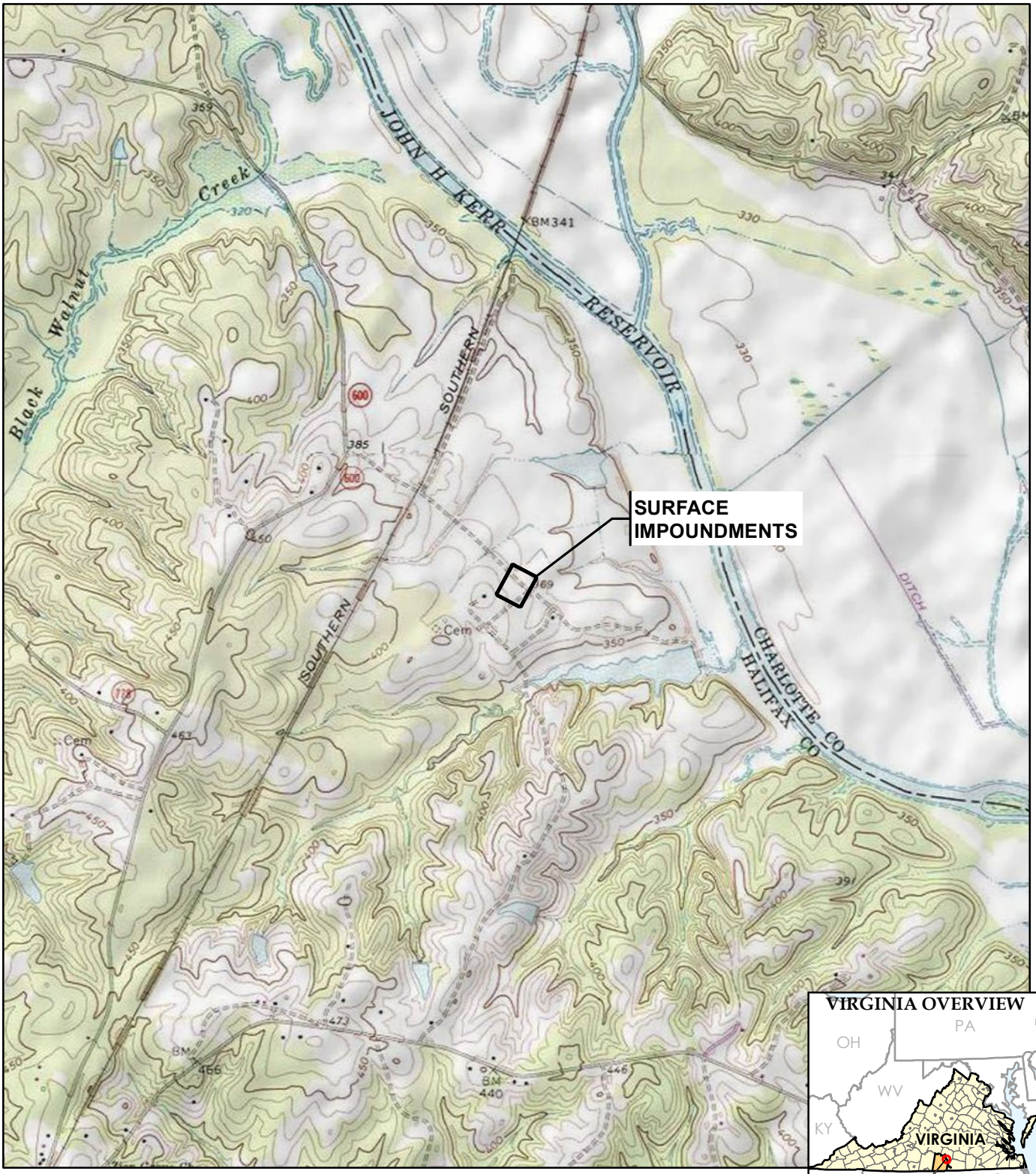

BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES, 1982.

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1 " = 2,000 '
1:24,000

0 2,000 4,000 FEET

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TRC

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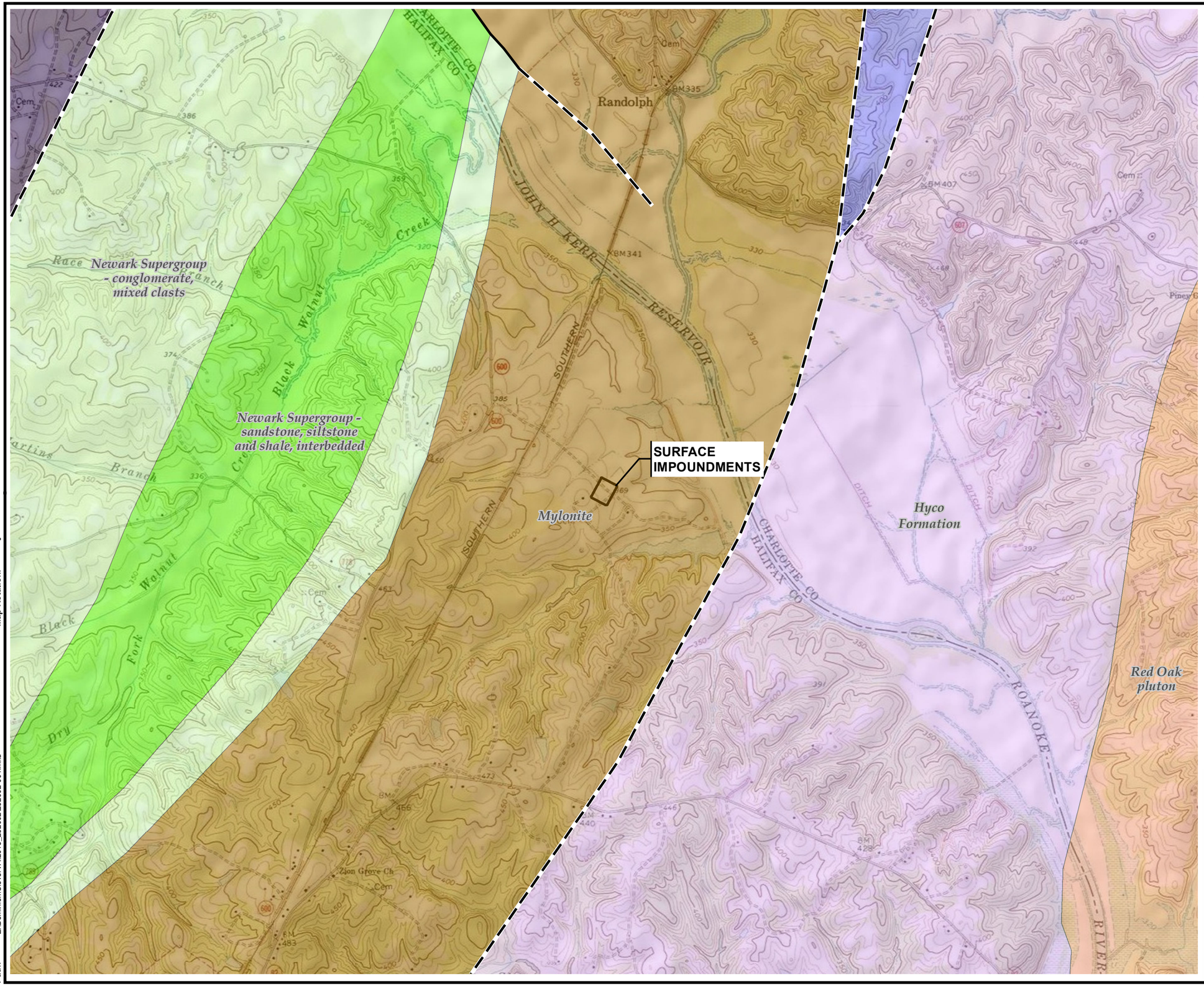
DOMINION
CLOVER POWER STATION
CLOVER, HALIFAX COUNTY, VIRGINIA

SITE LOCATION MAP

DRAWN BY:	RHODE B
APPROVED BY:	RKN
PROJECT NO:	232002
FILE NO.	232002-001slm.mxd
DATE:	JANUARY 2016

FIGURE 1



LEGEND

FAULTS

- DUCTILE HIGH-STRAIN ZONE
- GENERIC FAULT

BEDROCK UNIT DESCRIPTIONS

- HYCO FORMATION
- INTERLAYERED MAFIC AND FELSIC METAVOLCANIC ROCKS - QUARTZOFELDSPATHIC BIOTITE GNEISS
- MYLONITE
- NEWARK SUPERGROUP - CONGLOMERATE, MIXED CLASTS
- NEWARK SUPERGROUP - SANDSTONE, SILTSTONE AND SHALE, INTERBEDDED
- RED OAK PLUTON
- MIGMATITIC PARAGNEISS

NOTES

1. BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.
2. GEOLOGIC INFORMATION FROM VIRGINIA DEPARTMENT OF MINES MINERALS AND ENERGY, GEOLOGY AND MINERAL RESOURCES WEB MAPPING SERVICE.

N

0 2,000 4,000 Feet

1 " = 2,000 '

1:24,000

PROJECT:

DOMINION
CLOVER POWER STATION
CLOVER, HALIFAX COUNTY, VIRGINIA

TITLE:

GEOLOGIC MAP

DRAWN BY:	PAPEZ J	PROJ NO.:	232002
CHECKED BY:	JNH		
APPROVED BY:	RKN		
DATE:	JANUARY 2016		

FIGURE 2

TRC
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FILE NO.: 232002-004.mxd

TRC - GIS
Coordinate System: NAD 1983 StatePlane Virginia South FIPS 4502 Feet (Foot US)
Map Rotation: 0
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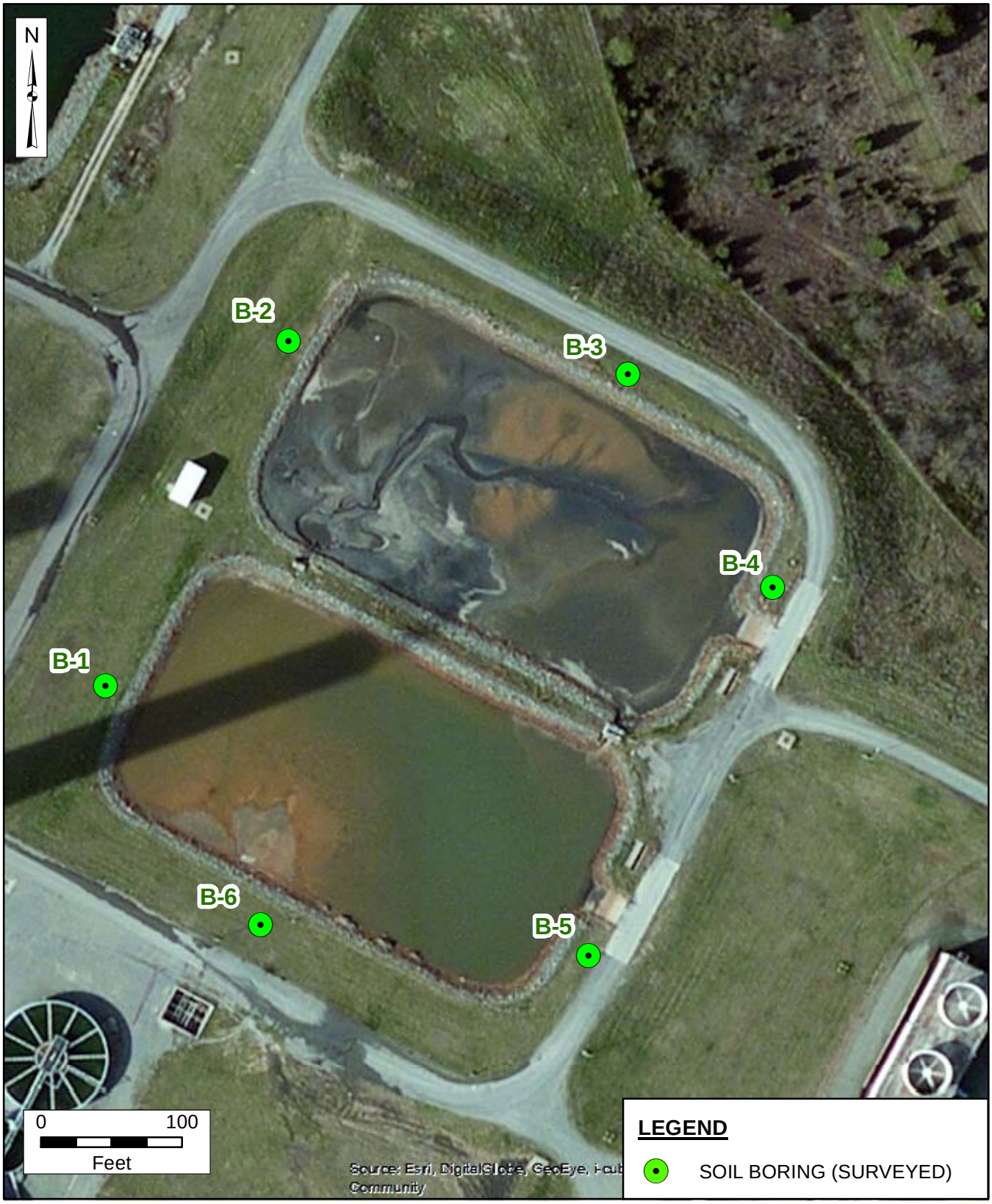

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DOMINION
CLOVER, VIRGINIA

FIGURE 3
DATA POINT WELL LOCATIONS

Drawn By:	RSW
Checked By:	JNH
Approved By:	NWA
Project No.:	232002.0.0
Date:	AUGUST 2015

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Appendix A
Background Information

Table of Contents

- Aerial Photo
- Soil Survey Map

Aerial Photo

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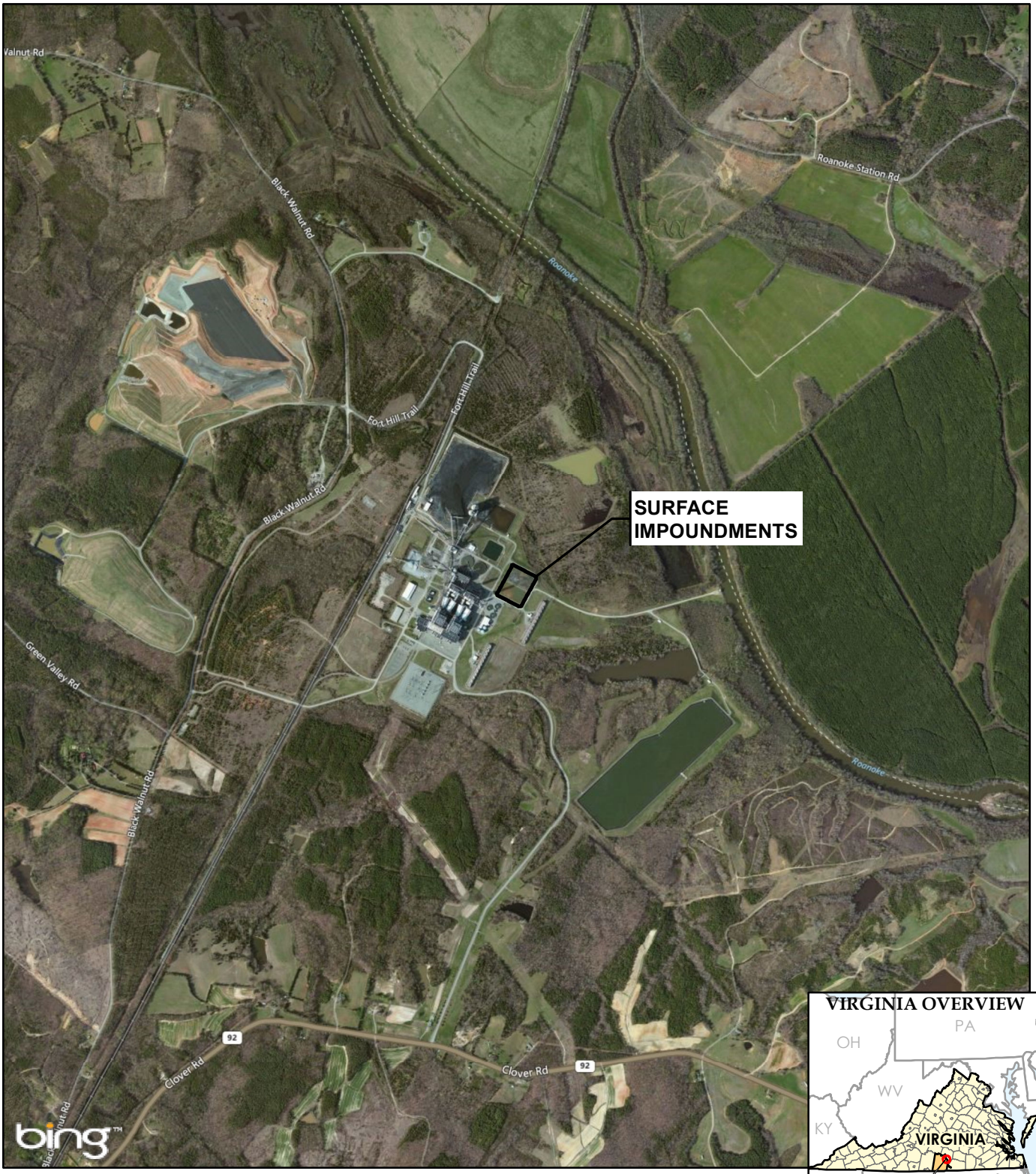
TRC - GIS



BASE MAP IMAGERY FROM ESRI/BING, 2010.

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1 " = 2,000 '
1:24,000

0 2,000 4,000 FEET

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DOMINION
CLOVER POWER STATION
CLOVER, HALIFAX COUNTY, VIRGINIA

SITE LOCATION MAP

DRAWN BY:	RHODE B
APPROVED BY:	
PROJECT NO:	232002
FILE NO.	232002-003slm.mxd
DATE:	APRIL 2015

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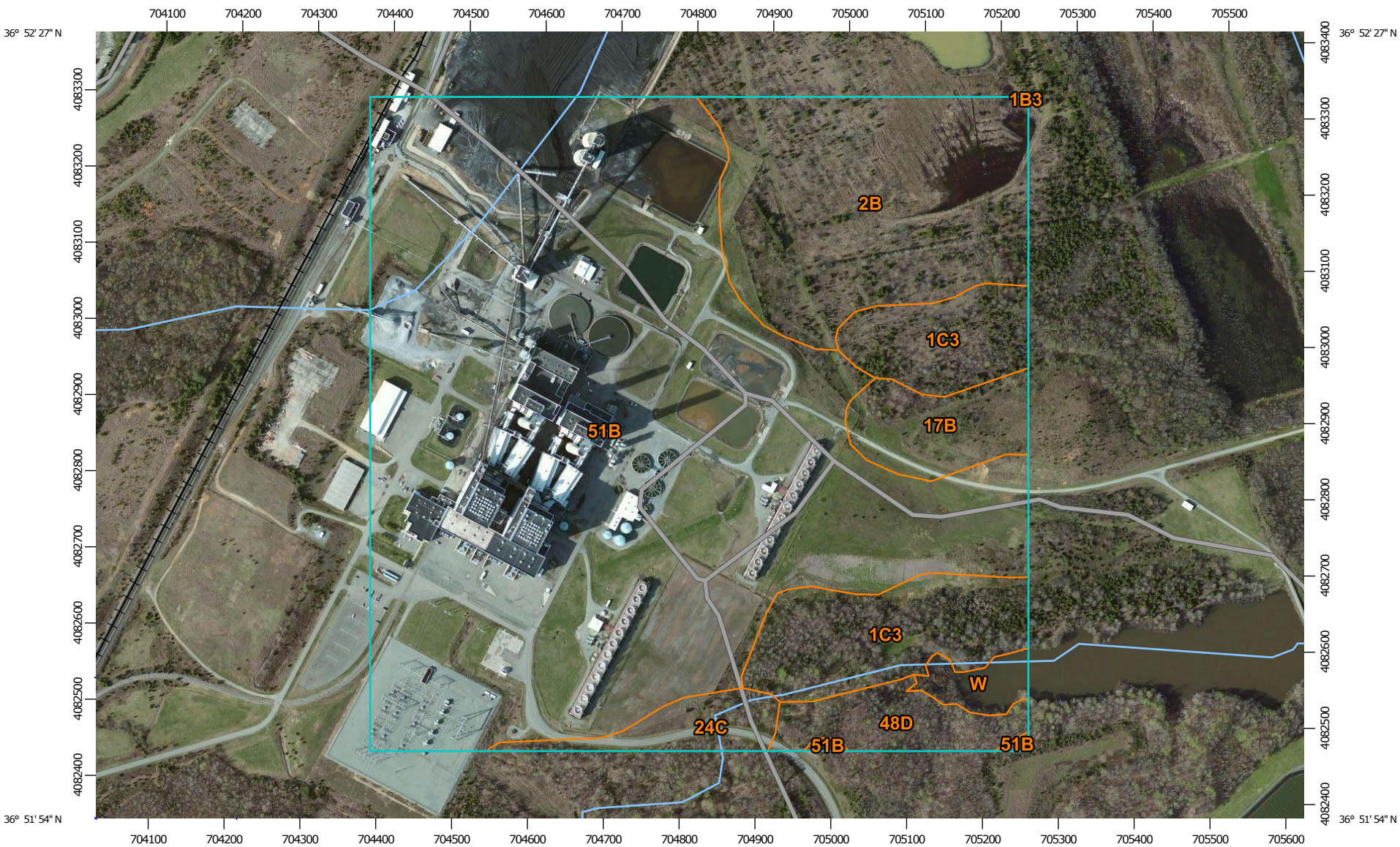
FIGURE 3

Soil Survey Map

Soil Map—Halifax County and the City of South Boston, Virginia
(Clover)



Map Scale: 1:7,280 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 100 200 400 600

Feet: 0 350 700 1400 2100

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Halifax County and the City of South Boston, Virginia
Survey Area Data: Version 13, Dec 13, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 10, 2010—Apr 4, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Halifax County and the City of South Boston, Virginia (VA083)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
1B3	Appomattox clay loam, 2 to 8 percent slopes, severely eroded	0.0	0.0%
1C3	Appomattox clay loam, 8 to 15 percent slopes, severely eroded	17.9	9.7%
2B	Banister-Kinkora complex, 0 to 4 percent slopes, rarely flooded	28.1	15.2%
17B	Danripple sandy loam, 2 to 8 percent slopes, very rarely flooded	6.2	3.4%
24C	Halifax sandy loam, 8 to 15 percent slopes	4.0	2.1%
48D	Toast sandy loam, 15 to 25 percent slopes	5.4	2.9%
51B	Udorthents loamy, 2 to 8 percent slopes	121.1	65.5%
W	Water	2.1	1.2%
Totals for Area of Interest		**184.9**	**100.0%**

Table 15.—Engineering Properties

(Absence of an entry indicates that data were not estimated)

Map symbol and soil name	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag-ments 3-10 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas-ticity index
	In				Pct					Pct	
1B3:											
Appomattox------	0-8	Clay loam	CL	A-6	0	85-100	80-100	75-100	55-80	35-52	18-28
	8-54	Clay, clay loam, sandy clay, sandy clay loam	CL, SC, CH	A-6, A-7	0-5	85-100	80-100	65-100	30-95	31-67	13-44
	54-79	Loam, sandy loam, clay	SC-SM, SC	A-2, A-4	0-5	85-100	80-100	50-100	25-95	16-57	2-36
1C3:											
Appomattox------	0-8	Clay loam	CL	A-6	0	85-100	80-100	75-100	55-80	35-52	18-28
	8-54	Clay, clay loam, sandy clay, sandy clay loam	CL, SC, CH	A-6, A-7	0-5	85-100	80-100	65-100	30-95	31-67	13-44
	54-79	Loam, sandy loam, clay	SC-SM, SC	A-2, A-4	0-5	85-100	80-100	50-100	25-95	16-57	2-36
2B:											
Banister--------	0-14	Loam	CL-ML, SM, SC-SM, ML, CL	A-4	0	85-100	80-100	65-95	45-75	20-40	3-18
	14-58	Clay, clay loam, sandy clay, silty clay loam, silty clay, sandy clay loam	SC, CL, CH	A-7, A-2-6	0	85-100	80-100	65-100	30-95	31-67	13-44
	58-65	Clay loam, sand, loamy sand, sandy loam, loam, sandy clay loam, gravelly sand	SC, CL	A-7, A-2-6	0	75-100	65-100	30-100	5-80	0-50	NP-29

Table 15.—Engineering Properties—Continued

Map symbol and soil name	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments 3-10 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
2B:											
Kinkora---------	0-4	Silt loam	CL, CL-ML, SC-SM	A-4, A-6	0	85-100	80-100	70-100	55-90	21-43	6-18
	4-45	Silty clay, clay, sandy clay, clay loam, silty clay loam, sandy clay loam	CH, CL	A-7	0	85-100	80-100	60-100	60-95	31-67	13-44
	45-62	Sandy loam, sandy clay loam, clay loam, silty clay loam, silt loam	CL, GC-GM, CL-ML, SM	A-1, A-6, A-4	0	85-100	80-100	50-100	25-95	18-50	2-29
3B:											
Bentley---------	0-17	Loamy sand	SC-SM, SM	A-2	0-2	85-100	80-100	40-75	10-30	17-30	2-9
	17-23	Sandy loam, loamy sand, fine sandy loam, loam, sandy clay loam, clay loam, gravelly sandy loam	SC, CL, CL-ML	A-2, A-4	0	65-100	50-100	25-100	8-80	16-32	2-13
	23-61	Clay, sandy clay, clay loam, sandy clay loam, gravelly sandy clay loam	CH, CL, SC	A-6, A-7	0	65-100	50-100	40-100	18-95	31-72	13-47
	61-80	Sandy clay, clay, sandy clay loam, gravelly sand	CH, CL, SC	A-6, A-7	0	65-100	50-100	25-100	2-95	0-67	NP-44

Table 15.—Engineering Properties—Continued

Map symbol and soil name	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments 3-10 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
15A:											
Comus----------	0-10	Fine sandy loam	SM, SC-SM	A-2, A-4	0	95-100	90-100	65-85	35-55	16-33	2-12
	10-35	Fine sandy loam, sandy loam, loam	CL-ML, ML, SC-SM, SM	A-2-4, A-4	0	95-100	90-100	55-95	25-75	16-30	2-12
	35-65	Loamy sand, loamy fine sand, sandy loam, fine sandy loam, sand	CL, CL-ML, ML, SC, SC-SM, SM	A-1, A-2-4, A-4	0	95-100	90-100	45-85	4-55	0-30	NP-12
16A:											
Dan River-------	0-9	Loam	CL, CL-ML	A-6	0	90-100	85-100	70-95	50-75	22-43	6-17
	9-30	Loam, fine sandy loam	CL-ML, ML, SC, CL	A-4, A-6	0	90-100	85-100	60-95	35-75	16-39	2-19
	30-56	Sandy clay loam, clay loam	CL, SC	A-6	0	90-100	85-100	65-100	30-80	29-44	13-25
	56-62	Sandy loam, fine sandy loam, loamy fine sand, loamy sand, sand	SM, SC	A-2, A-1, A-4	0	90-100	85-100	40-85	4-55	0-31	NP-13
17B:											
Danripple-------	0-10	Sandy loam	SC	A-6	0	90-100	80-100	50-70	25-40	22-37	6-13
	10-48	Clay, clay loam, sandy clay, sandy clay loam	CH, CL	A-6, A-7	0	90-100	85-100	70-100	30-95	37-63	19-40
	48-72	Sandy clay loam, clay loam, loam, sandy loam, gravelly sandy loam	CL	A-6, A-7	0	70-100	60-100	35-100	20-80	22-48	6-27
18B:											
Delila----------	0-8	Sandy loam	SC	A-2, A-4, A-6	0	90-100	80-100	50-70	25-40	17-35	2-12
	8-30	Clay, sandy clay, clay loam	CH, CL, SC	A-6, A-7	0	90-100	80-100	70-100	40-95	39-63	21-40
	30-65	Sandy loam, sandy clay loam, clay loam	CL, SC	A-2, A-4, A-6, A-7	0	90-100	80-100	50-100	25-80	18-41	2-21

Table 15.—Engineering Properties—Continued

Map symbol and soil name	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments 3-10 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
23E:											
Montonia--------	0-8	Channery silt loam	CL-ML, CL	A-6	0-12	70-85	60-75	50-75	35-70	22-43	7-18
	8-30	Channery clay loam, channery silty clay loam, very channery loam	CL, GC, SC	A-6	0-25	60-85	50-75	40-75	30-70	20-44	6-25
	30-41	Bedrock			---	---	---	---	---	---	---
	41-51	Bedrock			---	---	---	---	---	---	---
24B:											
Halifax---------	0-13	Sandy loam	SC, SC-SM, SM	A-2, A-4	0-3	85-100	80-100	50-70	25-40	17-35	2-13
	13-58	Clay, sandy clay, clay loam, sandy clay loam	CH	A-7	0	85-100	80-100	65-100	30-95	41-69	21-44
	58-65	Clay loam, sandy clay loam, loam, sandy loam, fine sandy loam, loamy sand	SC-SM, SC	A-6, A-4	0	85-100	80-100	40-100	10-80	0-44	NP-25
24C:											
Halifax---------	0-13	Sandy loam	SC, SC-SM, SM	A-2, A-4	0-3	85-100	80-100	50-70	25-40	17-35	2-13
	13-58	Clay, sandy clay, clay loam, sandy clay loam	CH	A-7	0	85-100	80-100	65-100	30-95	41-69	21-44
	58-65	Clay loam, sandy clay loam, loam, sandy loam, fine sandy loam, loamy sand	SC, SC-SM	A-6, A-4	0	85-100	80-100	40-100	10-80	0-44	NP-25
25B:											
Herndon---------	0-8	Silt loam	ML	A-4	0	90-100	85-100	75-100	60-90	9-25	NP-3
	8-57	Clay, silty clay, silty clay loam, clay loam	ML	A-5	0	95-100	85-100	75-100	60-95	25-52	3-13
	57-65	Silt loam, loam, silty clay loam	ML	A-4	0	95-100	85-100	70-100	50-95	13-25	NP-3

Table 15.—Engineering Properties—Continued

Map symbol and soil name	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments 3-10 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
47D:											
Badin----------	0-2	Silt loam	CL	A-4, A-6	0-2	85-95	80-92	70-90	55-80	24-43	7-18
	2-6	Silt loam, channery silt loam, channery loam	CL, ML	A-4, A-6	0-2	60-97	50-92	40-90	30-80	18-37	3-19
	6-25	Silty clay loam, clay, silty clay, clay loam, channery silty clay loam	CL	A-7	0-2	60-97	50-92	45-90	35-85	37-63	19-40
	25-38	Very channery silty clay loam, clay loam, silt loam, channery silty clay loam	CL, GC	A-2	0-2	40-75	25-70	20-70	18-65	24-50	7-29
	38-48	Bedrock			---	---	---	---	---	---	---
	48-58	Bedrock			---	---	---	---	---	---	---
48D:											
Toast----------	0-6	Sandy loam	SC-SM, SM	A-2, A-4	0-3	85-100	80-100	50-70	25-40	9-20	NP-2
	6-12	Sandy loam, coarse sandy loam, loam	SC-SM, SM	A-2, A-4	0-3	85-100	80-100	45-95	20-75	9-20	NP-2
	12-38	Clay, sandy clay loam, clay loam, sandy clay	ML	A-4, A-6	0	85-100	80-100	65-100	30-95	25-45	3-11
	38-65	Sandy loam, sandy clay loam, loam, loamy sand	SM	A-2, A-4	0	85-100	80-100	40-95	12-75	9-25	NP-3
49A:											
Toccoa----------	0-12	Fine sandy loam	SM, CL-ML	A-4	0	90-100	80-100	55-85	30-55	0-30	NP-10
	12-62	Fine sandy loam, loam, sandy loam, loamy sand, sand	ML, SC-SM	A-2, A-4	0	90-100	80-100	40-95	4-75	0-31	NP-13

Table 15.—Engineering Properties—Continued

Map symbol and soil name	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments 3-10 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
50B:											
Turbeville------	0-8	Loam, fine sandy loam	SM	A-4	0-2	85-100	80-100	70-95	30-50	8-19	NP-1
	8-60	Clay, sandy clay, clay loam, sandy clay loam	ML	A-4	0	90-100	85-100	70-100	30-95	30-49	5-12
50C:											
Turbeville------	0-8	Loam, fine sandy loam	SM	A-4	0-2	85-100	80-100	70-95	30-50	8-19	NP-1
	8-60	Clay, sandy clay, clay loam, sandy clay loam	ML	A-4	0	90-100	85-100	70-100	30-95	30-49	5-12
51B. Udorthents											
52B. Urban land											
53B:											
Virgilina-------	0-3	Gravelly silt loam	CL, CL-ML, ML, SM, SC	A-4	0-3	75-85	65-75	60-75	45-70	17-35	2-13
	3-11	Gravelly silt loam, gravelly loam	CL, CL-ML, ML, SM, SC	A-4	0-3	75-85	65-75	55-75	40-70	16-31	2-13
	11-32	Clay, silty clay, silty clay loam	CH	A-7	0	90-100	85-100	75-100	65-95	47-75	25-48
	32-42	Bedrock			---	---	---	---	---	---	---
54B:											
Virgilina-------	0-3	Gravelly silt loam	CL, CL-ML, ML, SM, SC	A-4	0-3	75-85	65-75	60-75	45-70	17-35	2-13
	3-11	Gravelly silt loam, gravelly loam	CL, CL-ML, ML, SM, SC	A-4	0-3	75-85	65-75	55-75	40-70	16-31	2-13
	11-32	Clay, silty clay, silty clay loam	CH	A-7	0	90-100	85-100	75-100	65-95	47-75	25-48
	32-42	Bedrock			---	---	---	---	---	---	---

Appendix B
Soil Boring Logs

TEST BORING LOG

PROJECT: DOMINION CLOVER STATION
LOCATION: CLOVER, VA

BORING **B-1**
G.S. ELEV.
FILE 232002
SHEET 1 OF 1

GROUNDWATER DATA			
FIRST ENCOUNTERED NA			
DEPTH	HOUR	DATE	ELAPSED TIME

METHOD OF ADVANCING BOREHOLE				
a	FROM	0.0 '	TO	10.0 '
d	FROM	10.0 '	TO	20.0 '

DRILLER E. CARUSO
HELPER C. SMART
INSPECTOR C. HURT
DATE STARTED 06/29/2015
DATE COMPLETED 06/29/2015

DEPTH		A	B	C	DESCRIPTION	Wn	REMARKS
					0.4 ***BROWN SILTY TOPSOIL***		
		S-1	3 5 9 9		***BROWN CLAY, SOME BLACK INTERLAYERING, SM SILT, TR F/M SAND***		
		S-2	8 11 11 11				
5		S-3	9 9 12 16		6.0		
		S-4	5 8 12 12				
10		S-5	11 12 13 12		***BROWN TO GREENISH BROWN SILT, SM MICA FLAKES, TR F/M SAND***		
15		S-6	5 5 5 7				
20		S-7	5 6 17 25		20.0		
					END OF BORING AT 20'		
25							
30							
35							

DRN. CJH
CKD. MLG

NEW PROJECTS TEST BORING LOG 232002_DOMINION CLOVER STATION.GPJ SITE BLAUVELT.GDT 7/28/15

TEST BORING LOG

PROJECT: DOMINION CLOVER STATION
LOCATION: CLOVER, VA

BORING	**B-2**
G.S. ELEV.	
FILE	232002
SHEET	1 OF 1

GROUNDWATER DATA			
FIRST ENCOUNTERED NA			
DEPTH	HOUR	DATE	ELAPSED TIME

METHOD OF ADVANCING BOREHOLE				
a	FROM	0.0 '	TO	10.0 '
d	FROM	10.0 '	TO	20.0 '

DRILLER	E. CARUSO
HELPER	C. SMART
INSPECTOR	C. HURT
DATE STARTED	06/29/2015
DATE COMPLETED	06/29/2015

DEPTH	A	B	C	DESCRIPTION	Wn	REMARKS
				0.4 ***BROWN SILTY TOPSOIL***		
				1.0 ***BROWN TO WHITE SILT, TR M/F SAND***		
	S-1	8 9 10 12		***RED CLAY, MOTTLED YELLOWISH BROWN, TR M/C SAND***		PP = 4.5 TSF
	S-2	10 15 20 22				
5	S-3	14 12 13 16		6.0		
	S-4	8 8 9 10				PP = 4.0 TSF
10	S-5	9 10 11 14		***RED TO BROWN CLAY, SM SILT, TR F/M SAND***		PP = 3.0 TSF
				13.0		
15	S-6	16 19 23 26		***BLACK TO BROWN MICACEOUS SILT, SM F/M SAND***		
20	S-7	9 10 13 13		20.0		
				END OF BORING AT 20'		
25						
30						
35						

DRN.	CJH
CKD.	MLG

NEW PROJECTS TEST BORING LOG 232002_DOMINION CLOVER STATION.GPJ SITE BLAUVELT.GDT 7/28/15

TEST BORING LOG

PROJECT: DOMINION CLOVER STATION
LOCATION: CLOVER, VA

BORING **B-3**
G.S. ELEV.
FILE 232002
SHEET 1 OF 1

GROUNDWATER DATA			
FIRST ENCOUNTERED NA			
DEPTH	HOUR	DATE	ELAPSED TIME

METHOD OF ADVANCING BOREHOLE				
a	FROM	0.0 '	TO	10.0 '
d	FROM	10.0 '	TO	20.0 '

DRILLER E. CARUSO
HELPER C. SMART
INSPECTOR C. HURT
DATE STARTED 06/29/2015
DATE COMPLETED 06/29/2015

DEPTH	A	B	C	DESCRIPTION	Wn	REMARKS
				0.7 ***BLACK SILTY TOPSOIL***		
	S-1	6 9 13 16				ROCK FRAGMENT AT 2 FT
	S-2	10 10 12 15		***RED CLAY, BROWN TO WHITE MOTTLING, SM SILT, TR F/M SAND***		
5	S-3	14 14 15 18				PP = 2.5 TSF
	S-4	6 10 11 10		8.0		PP = 2.5 TSF
				GRAY TO BROWN CLAY		PP =4.25 TSF IN BROWN CLAY, 2.0 TSF IN GRAY CLAY
10	S-5	9 14 15 16		10.0		
				RED TO BROWN CLAY, TR F GRAVEL		PP = 3.0 TSF
15	S-6	11 10 11 13				
				18.0		PP = 2.5 TSF
				BROWN CLAY		
20	S-7	11 13 15 16		20.0		
				END OF BORING AT 20'		
25						
30						
35						

DRN. CJH
CKD. MLG

NEW PROJECTS TEST BORING LOG 232002_DOMINION CLOVER STATION.GPJ SITE BLAUVELT.GDT 7/28/15

TEST BORING LOG

PROJECT: DOMINION CLOVER STATION
LOCATION: CLOVER, VA

BORING	**B-4**
G.S. ELEV.	
FILE	232002
SHEET	1 OF 1

GROUNDWATER DATA			
FIRST ENCOUNTERED NA			
DEPTH	HOUR	DATE	ELAPSED TIME

METHOD OF ADVANCING BOREHOLE				
a	FROM	0.0 '	TO	10.0 '
d	FROM	10.0 '	TO	20.0 '

DRILLER	E. CARUSO
HELPER	C. SMART
INSPECTOR	C. HURT
DATE STARTED	06/29/2015
DATE COMPLETED	06/29/2015

DEPTH	A	B				C	DESCRIPTION	Wn	REMARKS
							0.3 ***BLACK SILTY TOPSOIL***		
							0.5 ***LIGHT BROWN SILTY M/C SAND***		
	S-1	5	5	6	6				
	S-2	6	6	10	10		***RED TO BROWN SILT, SM BLACK AND WHITE INTERLAYERING, SM CLAY, SM F GRAVEL***		PP = 3.75 TSF
5	S-3	10	10	12	16				PP = 2.75 TSF
	U-1						8.0		
10	S-4	13	14	18	22				PP = 3.0 TSF
							RED CLAY, MOTTLED BROWN TO WHITE, SM SEAMS OF GRAY SILT		
15	S-5	5	7	9	13				PP = 2.5 TSF
							18.0		
20	S-6	13	15	32	24		***BLACK TO BROWN MICACEOUS SILT, TR F GRAVEL*** 20.0		
							END OF BORING AT 20'		
25									
30									
35									

DRN.	CJH
CKD.	MLG

NEW PROJECTS TEST BORING LOG 232002_DOMINION CLOVER STATION.GPJ SITE BLAUVELT.GDT 7/28/15

TEST BORING LOG

PROJECT: DOMINION CLOVER STATION
LOCATION: CLOVER, VA

BORING	**B-5**
G.S. ELEV.	
FILE	232002
SHEET	1 OF 1

GROUNDWATER DATA			
FIRST ENCOUNTERED NA			
DEPTH	HOUR	DATE	ELAPSED TIME

METHOD OF ADVANCING BOREHOLE				
a	FROM	0.0 '	TO	10.0 '
d	FROM	10.0 '	TO	20.0 '

DRILLER	E. CARUSO
HELPER	C. SMART
INSPECTOR	C. HURT
DATE STARTED	06/29/2015
DATE COMPLETED	06/29/2015

DEPTH	A	B				C	DESCRIPTION	Wn	REMARKS
							0.2 ***BLACK SILTY TOPSOIL***		
	S-1	4	6	6	9		***REDDISH BROWN SILT, SM CLAY, SM F GRAVEL***		
	S-2	8	11	13	14				
5	S-3	15	20	19	28		6.0		
	S-4	8	14	19	20		***RED TO GRAY CLAY, SMALL YELLOW MOTTLES, SM SILT*** 8.0		PP = 4.0 TSF
10	S-5	18	20	30	32		***GRAY CLAY, SM RED MOTTLES, SM SILT, TR M SAND***		PP > 4.5 TSF
							13.0		
15	S-6	17	22	24	26		***LIGHT BROWN SILTY M/F SAND, SM BLACK, WHITE, AND PINK MOTTLES***		
20	S-7	1	7	10	12		20.0		
							END OF BORING AT 20'		
25									
30									
35									

DRN.	CJH
CKD.	MLG

NEW PROJECTS TEST BORING LOG 232002_DOMINION CLOVER STATION.GPJ SITE BLAUVELT.GDT 7/28/15

TEST BORING LOG

PROJECT: DOMINION CLOVER STATION
LOCATION: CLOVER, VA

BORING	**B-6**
G.S. ELEV.	
FILE	232002
SHEET	1 OF 1

GROUNDWATER DATA			
FIRST ENCOUNTERED NA			
DEPTH	HOUR	DATE	ELAPSED TIME

METHOD OF ADVANCING BOREHOLE				
a	FROM	0.0 '	TO	10.0 '
d	FROM	10.0 '	TO	20.0 '

DRILLER	E. CARUSO
HELPER	C. SMART
INSPECTOR	C. HURT
DATE STARTED	06/29/2015
DATE COMPLETED	06/29/2015

DEPTH	A	B	C	DESCRIPTION	Wn	REMARKS
				0.3 ***BROWN SILTY TOPSOIL***		
				1.0 ***REDDISH BROWN SILT, SM M/C SAND, SM F GRAVEL***		
	S-1	4 4 7 8				
	S-2	9 9 8 9		***BROWN TO WHITE CLAY, SM F SAND***		
5	S-3	7 8 11 13		6.0		
	S-4	6 8 11 14				
10	S-5	12 14 24 22		***YELLOWISH BROWN TO WHITE AND PINK SILTY M/F/C SAND***		
15	S-6	15 20 30 40				
20	S-7	40 50/0.4'		20.0		
				END OF BORING AT 20'		
25						
30						
35						

DRN.	CJH
CKD.	MLG

NEW PROJECTS TEST BORING LOG 232002_DOMINION CLOVER STATION.GPJ SITE BLAUVELT.GDT 7/28/15

KEY TO SYMBOLS

Symbol	Description
Strata symbols	
	Clay with High Plasticity
	Clay with Low Plasticity
	Silt with High Plasticity
	Silt with Low Plasticity
	Silty Sand
	Topsoil

Symbol	Description
Misc. Symbols	
	Water table first encountered
	Water table first reading after drilling
	Water table second reading after drilling
	Water table third reading after drilling
NR	Not Recorded
Soil Samplers	
	Split Barrel
	Undisturbed Sample

Lab Symbols

FINES = Fines %

LL = Liquid Limit %

PI = Plasticity Index %

U_c = Unconfined Compressive Strength

Notes:

COLUMN A) Soil sample number.

COLUMN B) FOR SOIL SAMPLE (ASTM D 1586): indicates number of blows obtained for each 6 ins. penetration of the standard split-barrel sampler. FOR ROCK CORING (ASTM D2113): indicates percent recovery (REC) per run and rock quality designation (RQD). RQD is the % of rock pieces that are 4 ins. or greater in length in a core run.

COLUMN C) Strata symbol as assigned by the geotechnical engineer.

DESCRIPTION) Description including color, texture and classification of subsurface material as applicable (see Descriptive Terms). Estimated depths to bottom of strata as interpolated from the borings are also shown.

DESCRIPTIVE TERMS: F = fine M = medium C = coarse

RELATIVE PROPORTIONS:

-Descriptive Term-	-Symbol-	-Est. Percentages-
Trace	TR	1-10
Trace to Some	TR to SM	10-15
Some	SM	15-30
Silty, Sandy, Clayey, Gravelly	-	30-40
And	and	40-50

REMARKS) Special conditions or test data as noted during investigation. Note that W.O.P. indicates water observation pipes.

* Free water level as noted may not be indicative of daily, seasonal, tidal, flood, and/or long term fluctuations.

Appendix C
Laboratory Test Data

SUMMARY OF LABORATORY TEST DATA

Project Name: Dominion Clover Power
Client Name: Dominion
TRC Project #: 232002

SAMPLE IDENTIFICATION			Soil Group (USCS System)	GRAIN SIZE DISTRIBUTION				PLASTICITY				Moisture Content (%)	COMPACTION CHARACTERISTICS			Unconfined Compressive Strength (TSF)
Boring #	Sample #	Depth (ft)		Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)		Type of Test	Maximum Density (PCF)	Optimum Moisture Content (%)	
B-1 & B-6	BULK	-	CH	-	-	-		71	25	46	0.0	25.6	D698, A	103.8	21.2	-
B-1	S-2	2.0-4.0	CL	-	-	-		35	24	11	-0.1	22.8	-	-	-	-
	S-4	6.0-8.0	-	-	-	-		-	-	-	-	33.2	-	-	-	-
	S-6	13.0-15.0	ML	0.0	17.6	82.4		41	29	12	1.0	41.4	-	-	-	-
B-2	S-4	6.0-8.0	CH	-	-	-		87	38	49	0.0	36.0	-	-	-	-
	S-7	18.0-20.0	ML	3.6	37.1	59.3		32	27	5	-0.1	26.4	-	-	-	-
B-3	S-1	0.0-2.0	-	-	-	-		-	-	-	-	10.7	-	-	-	-
	S-4	6.0-8.0	-	-	-	-		-	-	-	-	30.9	-	-	-	-

DRAWN BY: TBT 07/22/15

CHECKED BY: JPB 07/22/15

SUMMARY OF LABORATORY TEST DATA

Project Name: Dominion Clover Power
Client Name: Dominion
TRC Project #: 232002

SAMPLE IDENTIFICATION			Soil Group (USCS System)	GRAIN SIZE DISTRIBUTION				PLASTICITY				Moisture Content (%)	COMPACTION CHARACTERISTICS			Unconfined Compressive Strength (TSF)
Boring #	Sample #	Depth (ft)		Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)		Type of Test	Maximum Density (PCF)	Optimum Moisture Content (%)	
B-3	S-5	8.0-10.0	CH	-	-	-		66	25	41	-0.1	20.9	-	-	-	-
	S-6	13.0-15.0	-	-	-	-		-	-	-	-	33.3	-	-	-	-
	S-7	18.0-20.0	-	-	-	-		-	-	-	-	31.6	-	-	-	-
B-4	S-1	0.0-2.0	-	-	-	-		-	-	-	-	12.6	-	-	-	-
	U-1	6.0-8.0	MH	-	-	-		68	38	30	-0.1	35.0	-	-	-	1.41
	S-5	13.0-15.0	CH	-	-	-		67	26	41	0.1	29.2	-	-	-	-
B-5	S-2	2.0-4.0	MH	-	-	-		58	32	26	-0.2	27.8	-	-	-	-
	S-4	6.0-8.0	-	-	-	-		-	-	-	-	24.5	-	-	-	-
	S-7	18.0-20.0	SM	0.0	65.0	35.0		-	-	-	-	23.8	-	-	-	-

DRAWN BY: TBT 07/22/15

CHECKED BY: JPB 07/22/15

SUMMARY OF LABORATORY TEST DATA

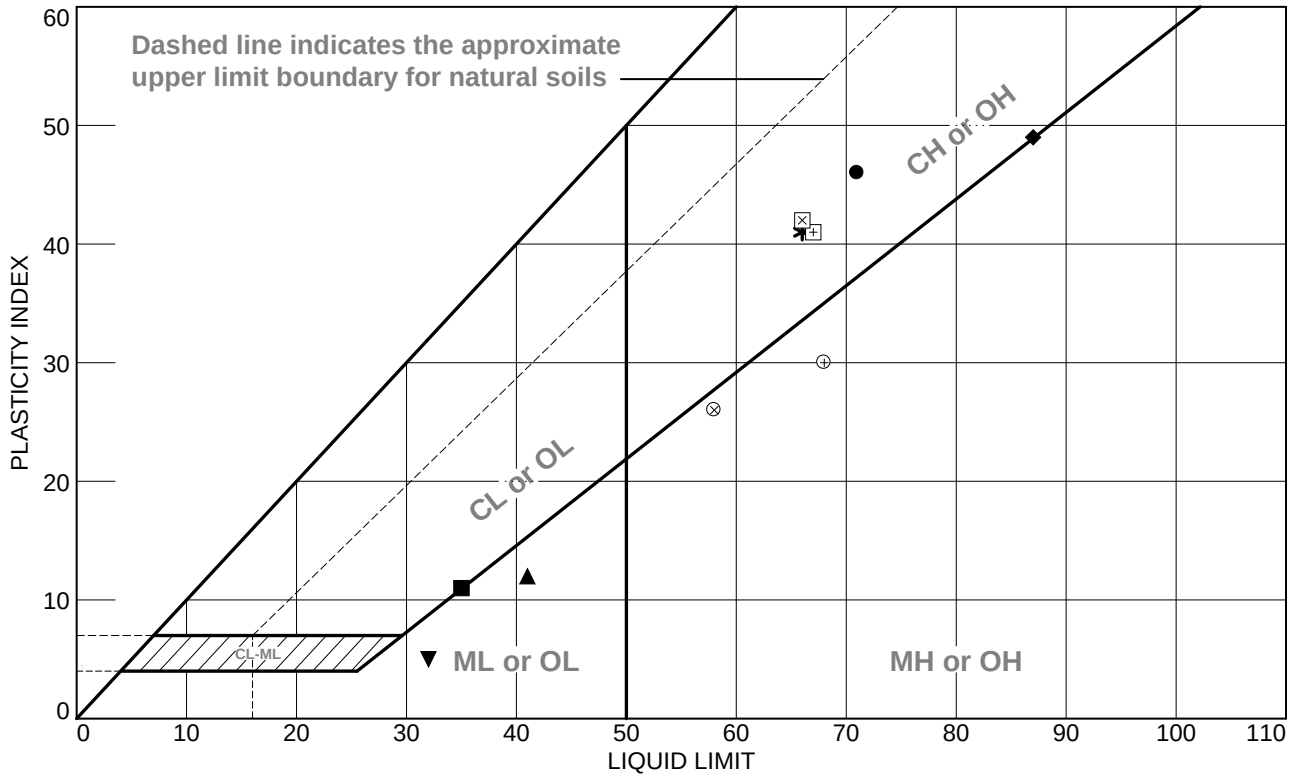
Project Name: Dominion Clover Power
Client Name: Dominion
TRC Project #: 232002

SAMPLE IDENTIFICATION			Soil Group (USCS System)	GRAIN SIZE DISTRIBUTION				PLASTICITY				Moisture Content (%)	COMPACTION CHARACTERISTICS			Unconfined Compressive Strength (TSF)
Boring #	Sample #	Depth (ft)		Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Liquidity Index (%)		Type of Test	Maximum Density (PCF)	Optimum Moisture Content (%)	
B-6	S-2	2.0-4.0	CH	-	-	-		66	24	42	0.0	25.5	-	-	-	-
	S-5	8.0-10.0	SM	1.0	71.5	27.5		-	-	-	-	12.5	-	-	-	-

DRAWN BY: TBT 07/22/15

CHECKED BY: JPB 07/22/15

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

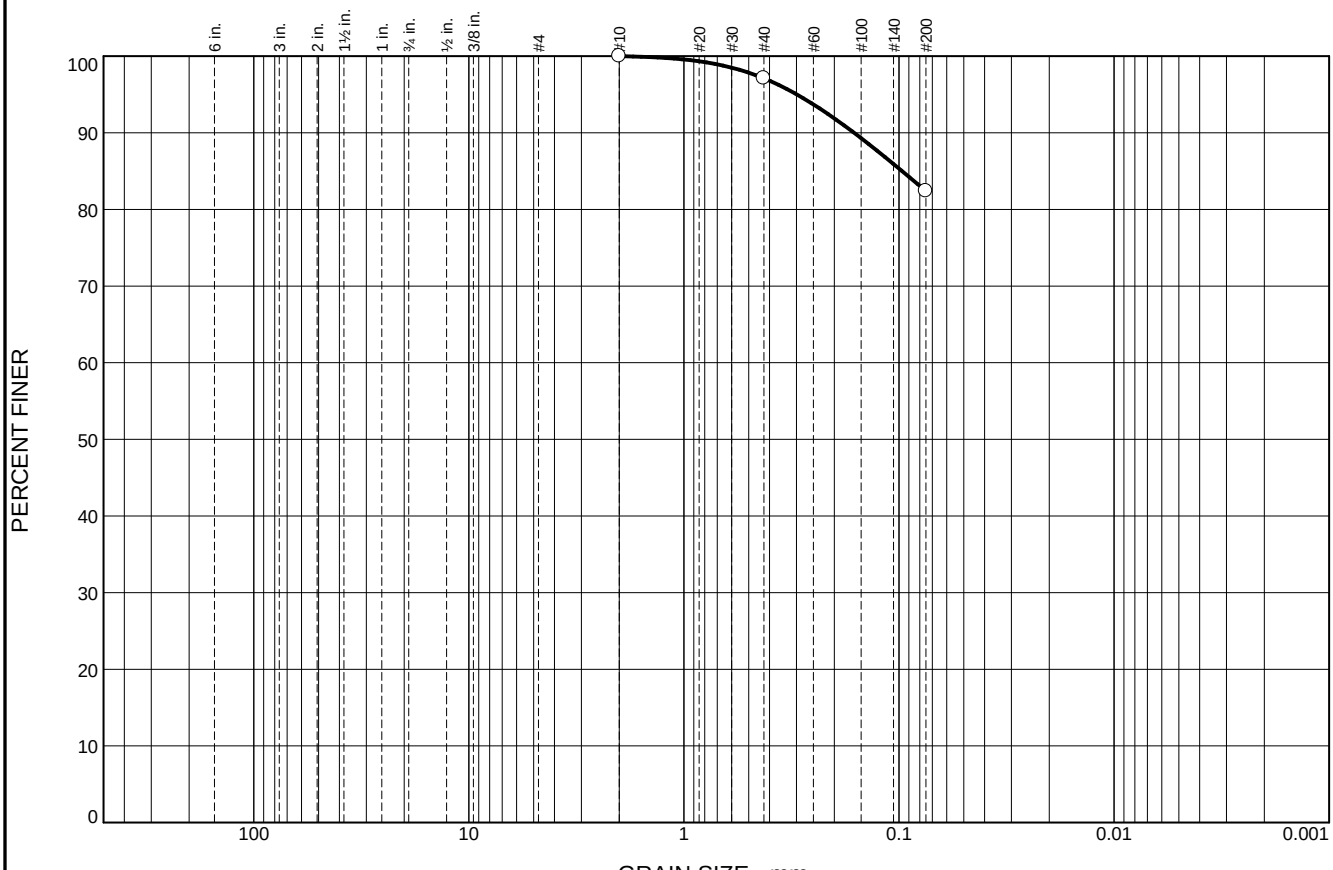
	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LIQUIDITY INDEX	USCS
●	B-1 & B-6	BULK		25.6	25	71	46	0.0	CH
■	B-1	S-2	2.0-4.0 FT	22.8	24	35	11	-0.1	CL
▲	B-1	S-6	13.0-15.0 FT	41.4	29	41	12	1.0	ML
◆	B-2	S-4	6.0-8.0 FT	36.0	38	87	49	0.0	CH
▼	B-2	S-7	18.0-20.0 FT	26.4	27	32	5	-0.1	ML
✱	B-3	S-5	8.0-10.0 FT	20.9	25	66	41	-0.1	CH
⊕	B-4	U-1	6.0-8.0 FT	35.0	38	68	30	-0.1	MH
⊞	B-4	S-5	13.0-15.0 FT	29.2	26	67	41	0.1	CH
⊗	B-5	S-2	2.0-4.0 FT	27.8	32	58	26	-0.2	MH
⊠	B-6	S-2	2.0-4.0 FT	25.5	24	66	42	0.0	CH

TRC Engineers, Inc.
Mt. Laurel, NJ

Client: DOMINION
Project: DOMINION - CLOVER POWER STATION

Project No.: 232002 **Figure** 1

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	2.9	14.7	82.4	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	41	29	0.0967							

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ LIGHT ORANGE-BROWN SILT WITH SAND	07/22/15	ML	41.4

Project No. 232002 **Client:** DOMINION

Project: DOMINION - CLOVER POWER STATION

○ **Source of Sample:** B-1 **Depth:** 13.0-15.0 FT **Sample Number:** S-6

Remarks:
○SAMPLE DESCRIPTION BASED ON USCS

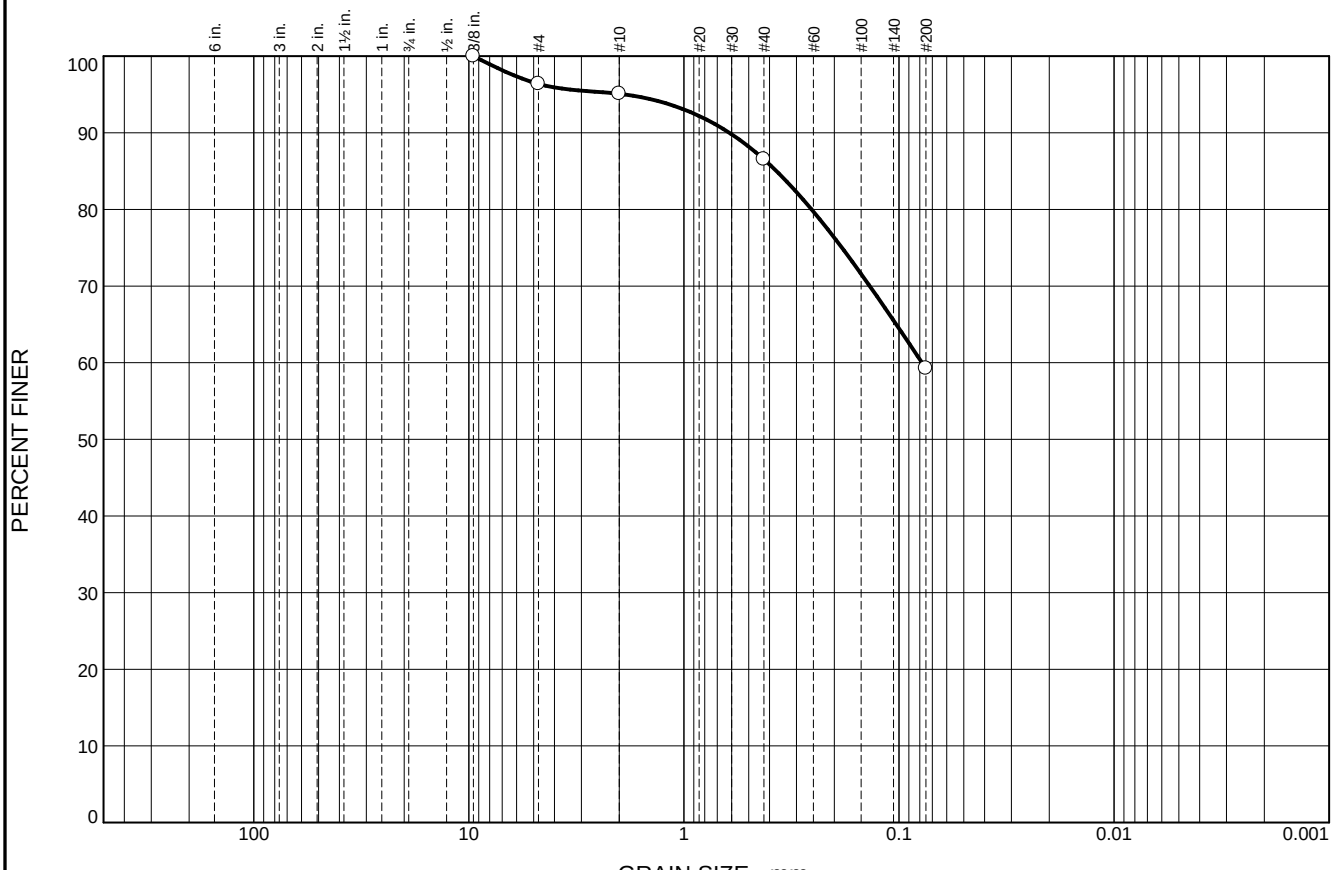
TRC Engineers, Inc.

Mt. Laurel, NJ

Figure 2

Tested By: TBT 07/22/15 **Checked By:** JPB 07/22/15

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	3.6	1.3	8.6	27.2	59.3	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	32	27	0.3713	0.0781						

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ DARK BROWN TO BLACK SANDY SILT	07/22/15	ML	26.4

Project No. 232002 **Client:** DOMINION

Project: DOMINION - CLOVER POWER STATION

○ **Source of Sample:** B-2 **Depth:** 18.0-20.0 FT **Sample Number:** S-7

Remarks:

○SAMPLE DESCRIPTION BASED ON USCS

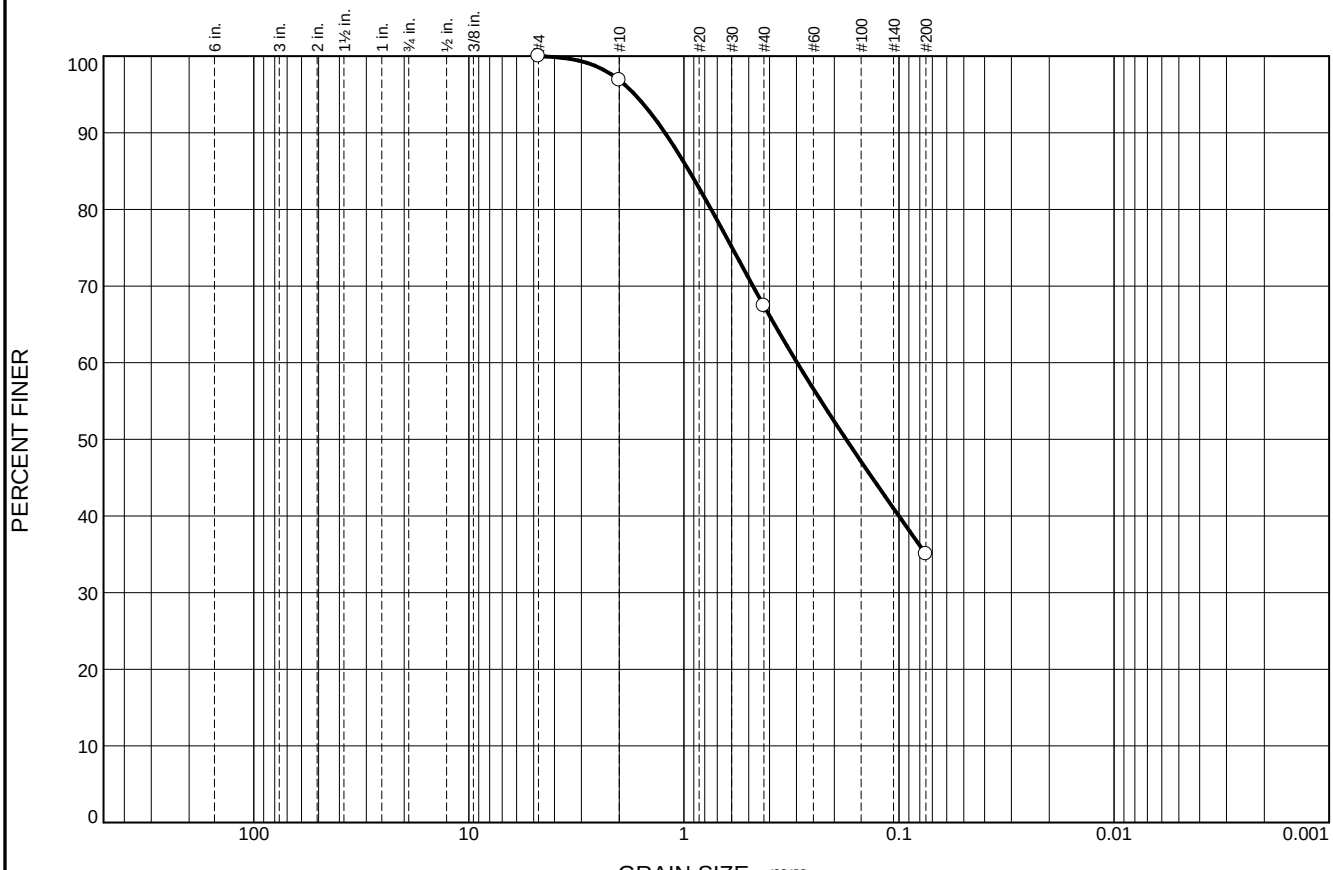
TRC Engineers, Inc.

Mt. Laurel, NJ

Figure 3

Tested By: TBT 07/22/15 **Checked By:** JPB 07/22/15

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	3.1	29.5	32.4	35.0	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.9448	0.2975	0.1761					

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ BROWN SILTY SAND	07/21/15	SM	23.8

Project No. 232002 **Client:** DOMINION

Project: DOMINION - CLOVER POWER STATION

○ **Source of Sample:** B-5 **Depth:** 18.0-20.0 FT **Sample Number:** S-7

Remarks:

○SAMPLE DESCRIPTION BASED ON USCS

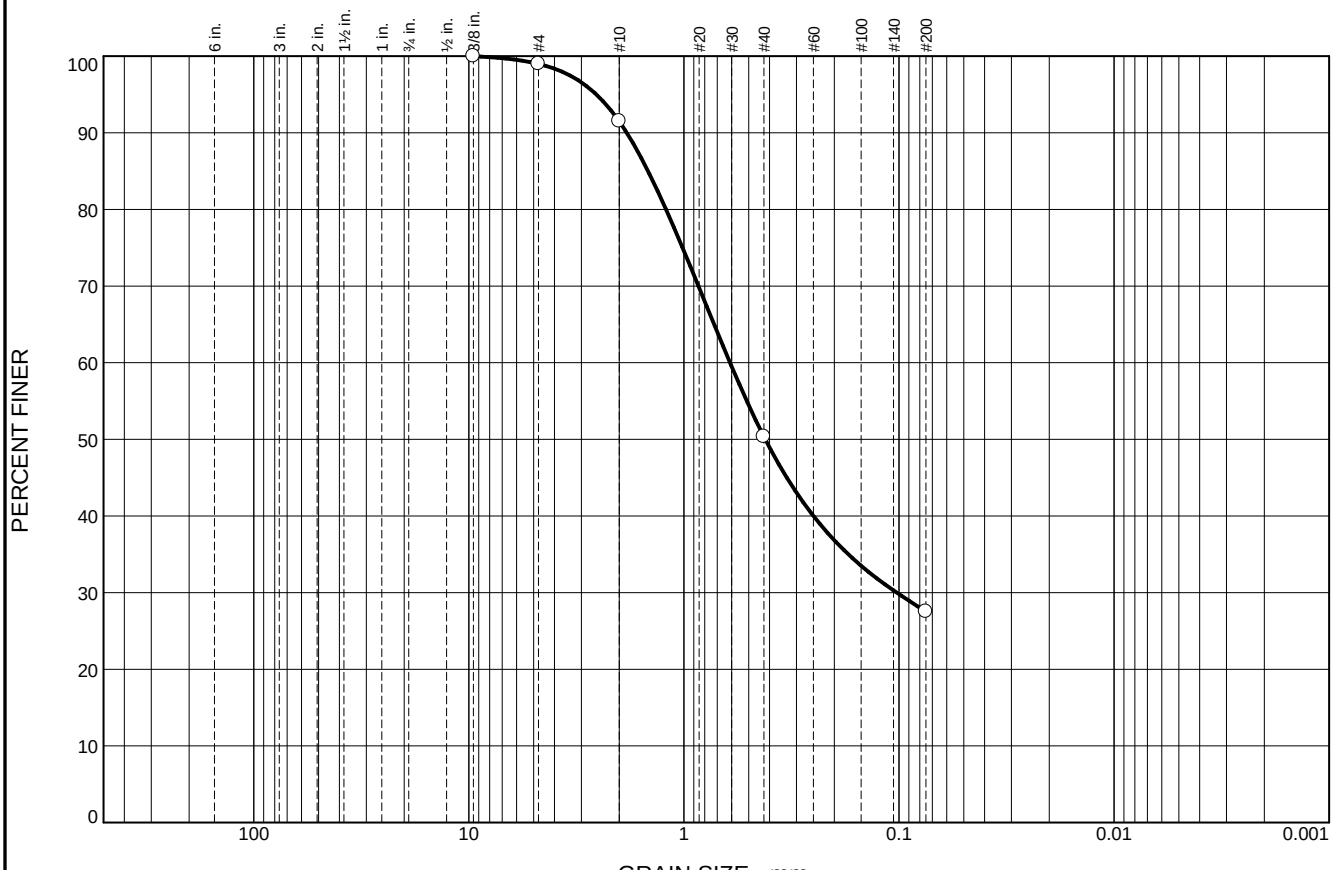
TRC Engineers, Inc.

Mt. Laurel, NJ

Figure 4

Tested By: TRM 07/21/15 **Checked By:** JPB 07/22/15

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	1.0	7.5	41.1	22.9	27.5	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			1.4696	0.6102	0.4188	0.1024				

MATERIAL DESCRIPTION	TEST DATE	USCS	NM
○ LIGHT RED-GRAY TO BROWN SILTY SAND	07/21/15	SM	12.5

Project No. 232002 **Client:** DOMINION

Project: DOMINION - CLOVER POWER STATION

○ **Source of Sample:** B-6 **Depth:** 8.0-10.0 FT **Sample Number:** S-5

Remarks:
○SAMPLE DESCRIPTION BASED ON USCS

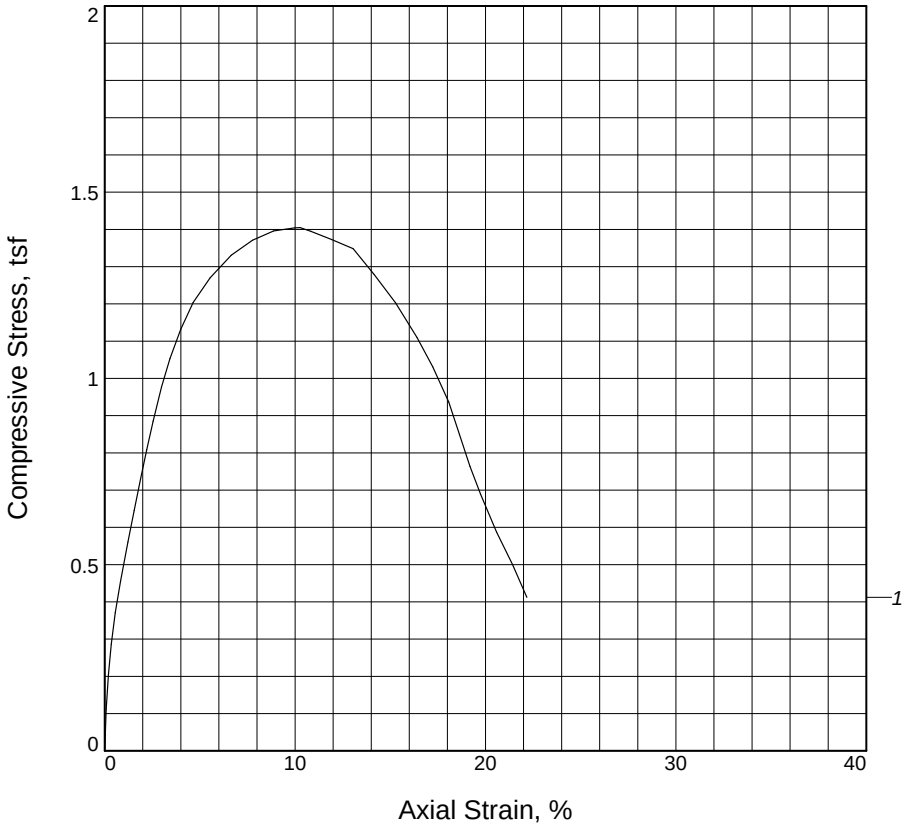
TRC Engineers, Inc.

Mt. Laurel, NJ

Figure 5

Tested By: TRM 07/21/15 **Checked By:** JPB 07/22/15

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, tsf	1.405			
Undrained shear strength, tsf	0.702			
Failure strain, %	10.3			
Strain rate, in./min.	1.80			
Water content, %	35.0			
Wet density, pcf	116.6			
Dry density, pcf	86.4			
Saturation, %	99.4			
Void ratio	0.9517			
Specimen diameter, in.	2.84			
Specimen height, in.	5.57			
Height/diameter ratio	1.96			

Description: ORANGE-RED-BROWN SILT

LL = 68	**PL =** 38	**PI =** 30	**Assumed GS=** 2.70	**Type:** SHELBY TUBE

Project No.: 232002

Date Sampled:

Remarks:
SAMPLE DESCRIPTION BASED ON USCS

Figure 6

Client: DOMINION

Project: DOMINION - CLOVER POWER STATION

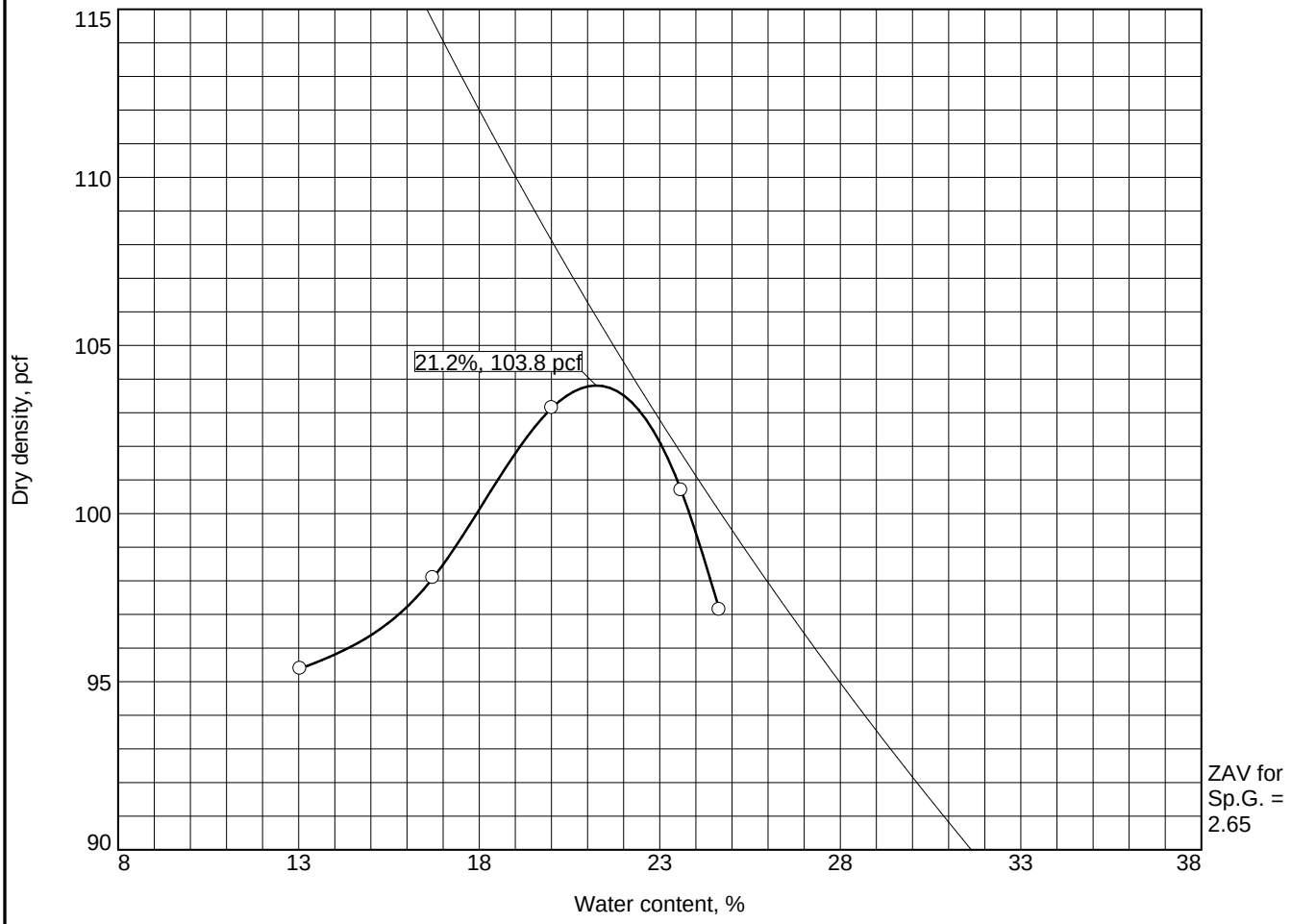
Source of Sample: B-4 **Depth:** 6.0-8.0 FT

Sample Number: U-1

UNCONFINED COMPRESSION TEST
TRC Engineers, Inc.
Mt. Laurel, NJ

Tested By: TBT 07/21/15 **Checked By:** JPB 07/22/15

COMPACTION TEST REPORT



Test specification: ASTM D 698-12 Method A Standard

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > #4	% < No.200
	USCS	AASHTO						
	CH		25.6		71	46	0.0	

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 103.8 pcf Optimum moisture = 21.2 %	ORANGE-BROWN CLAY
Project No. 232002 **Client:** DOMINION **Project:** DOMINION - CLOVER POWER STATION ○**Source of Sample:** B-1 & B-6 **Sample Number:** BULK	**Remarks:** SAMPLE DESCRIPTION BASED ON USCS
TRC Engineers, Inc. **Mt. Laurel, NJ**	**Figure** 7

Tested By: TRM 07/21/15

CONSTRUCTION QUALITY ASSURANCE PLAN FOR LINER SYSTEM

Construction Quality Assurance Plan (CQA)
For Liner System

Dominion Resources, Inc.
Clover Power Station
Retrofit – Sludge Sedimentation Basins
Clover, Virginia

November 2016

Construction Quality Assurance Plan (CQA) For Liner System

Dominion Resources, Inc.
Clover Power Station
Retrofit – Sludge Sedimentation Basins
Clover, Virginia

November 2016

NOTE:
If conflicts between this CQA Plan and the Technical Specifications are observed, the more stringent requirements of the two items will be implemented.

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Section 1
Introduction

1.1 Project Background

This CQA Plan has been prepared for, and is included in, the project manual for the Retrofit of the Sludge Sedimentation Basins at the Clover Power Station[1], Clover, Virginia. This CQA Plan is intended to be a "working" document, in other words, one that is updated to reflect changes in specific materials, installation practices, industry standards, or tests and testing methods as the site develops.

1.2 Purpose and Scope

The purpose of this CQA Plan is to address the quality assurance procedures and requirements for the construction, including all earthen materials (clay and general soil) and synthetic materials (geomembrane and geotextile).

This CQA Plan provides procedures that will ensure that all components are constructed to perform as designed and components are safeguarded from damage during construction. The CQA Plan is intended to outline procedures for constructing, testing, and documenting the composite liner in accordance with the design criteria and regulatory requirements.

The scope of this Plan also includes general CQA requirements in regard to the roles, responsibilities, and qualifications of the parties involved; the preconstruction activities; and the general inspection and documentation procedures. Specifically, this Plan establishes requirements for construction procedures and observation, field and laboratory testing frequencies and methods, and acceptance criteria for each component of the composite liner. Geosynthetics testing and acceptance criteria are based on the Geosynthetic Research Institute (GRI) Standards, American Society for Testing and Materials (ASTM) standards and on current generally acceptable industry standards of practice.

The CQA Plan addresses the construction of the following systems within the site:

- Composite liner

[1] The Clover Power Station and associated CCR units are jointly and equally owned by Dominion Virginia Power and Old Dominion Electric Cooperative (ODEC).

The following sources were used in the development of this Plan:

- EPA Technical Guidance Document, EPA/530-SW-86-031, titled "Construction Quality Assurance for Hazardous Waste Land Disposal Facilities"
- EPA Technical Guidance Document, EPA/530-SW-86-007, titled "Design, Construction, and Evaluation of Clay Liners For Hazardous Waste Facilities"
- Geosynthetic Research Institute, "GRI Test Method GM 10," revision 4 – 07/23/15
- Geosynthetic Research Institute, "GRI Test Method GM 13," revision 14 –01/06/16
- Geosynthetic Research Institute, "GRI Test Method GM 17," revision 12 – 11/04/15
- Geosynthetic Research Institute, "GRI Test Method GM 19," revision 8 – 02/12/15
- American Society of Testing and Materials, *Annual Book of ASTM Standards*.

1.3 Quality Assurance and Quality Control

Quality assurance and quality control are defined as follows:

- ***Quality assurance*** - A planned and systematic pattern of all means and actions designed to provide adequate confidence that materials or services meet contractual and regulatory requirements. This is typically performed to assure the purchaser, owner, and/or regulatory agencies that delivered materials or services are of desired quality.
- ***Quality control*** - Those actions that provide a means to measure and regulate the characteristics of a material or service to meet contractual and regulatory requirements. This typically is performed by, or for, the provider of materials or services as a control mechanism on the quality of the provider's efforts.

In the context of this manual, the terms are further defined as follows:

- ***Quality assurance*** refers to the means and actions employed by the CQA Officer to ensure conformity of the systems' installation with the CQA Plan and the construction plans and specifications. Quality assurance is primarily provided by an independent third party (consultant or laboratory) under the oversight of the CQA Officer.
- ***Quality control*** refers to those actions taken by the Manufacturer, Fabricator, or Contractor/Installer to provide materials and workmanship that meet the requirements of the CQA Plan and the construction plans and specifications. Some testing efforts required by this CQA Plan may serve as both quality control and quality assurance measures.

1.4 General Testing Requirements

This CQA Plan includes references to test procedures of the American Society for Testing and Materials (ASTM) and the Geosynthetics Research Institute (GRI). Test procedure references are always to the latest approved version up to the date of this document, unless specifically stated otherwise in this document.

Tests will be performed in strict accordance with the referenced test procedure and the description included in this Plan, unless indicated otherwise. Deviations to test procedures called out in this Plan must be approved, in writing, by the CQA Officer prior to commencement of any work.

Section 2
CQA Roles, Responsibilities, and Qualifications

2.1 CQA Officer

The CQA Officer will supervise and be responsible for specifying proper testing, and observing and documenting related construction as described in this CQA Plan. The CQA Officer will be responsible for preparing the documentation, construction acceptance, or certification report to certify substantial compliance with the project specifications. The CQA Officer will be a Professional Engineer registered in the State of Virginia.

The CQA Officer may delegate daily observation and documentation, testing, and sampling duties to a qualified technician or engineer with experience in the assigned aspect of construction who will serve as the Resident Project Representative (RPR). Although these duties may be delegated, the CQA Officer will retain the responsibility for these activities.

2.2 Resident Project Representative (RPR)

The RPR will carry out daily observation, direct testing, and assist with sampling duties under the direct supervision of the CQA Officer. The RPR will be a qualified technician or engineer with experience in the assigned aspect of construction. The RPR will observe and document construction and installation procedures. The RPR will prepare daily summary reports and will routinely transmit these to the CQA Officer. The RPR will immediately notify the CQA Officer of problems or deviations from the CQA Plan or the construction plans and specifications. Reporting, documentation, and resolution of problems and deficiencies will be carried out as described in Section 4. The RPR will not have authority to approve design or specification changes without the consent of the CQA Officer.

2.3 Soil Testing Laboratory

The Soil Testing Laboratory will be retained by the Construction Contractor and be experienced in construction soil testing, the American Society of Testing and Materials Standards (ASTM), and other applicable standards. The selected laboratory will be required to be responsive to the project needs by providing test results within reasonable time frames. This will include providing verbal communication on the status of ongoing tests and immediate communication of test results as needed to facilitate ongoing construction. Such information may include hydraulic conductivity test data, maximum dry density and optimum moisture content values, and borrow source characterization data. Final laboratory reports will be checked and approved by the soil testing laboratory and submitted to the CQA Officer.

2.4 Geosynthetics Testing Laboratory/Laboratories

The Geosynthetics Testing Laboratory/Laboratories will be retained by the Construction Contractor and have experience in testing geosynthetics in accordance with standards developed by ASTM and the Geosynthetics Research Institute (GRI), and other applicable test standards. The selected laboratory/laboratories will be required to be responsive to the project needs by providing test results within reasonable time frames. Final laboratory reports will be certified by the geosynthetics testing laboratory/laboratories and will be submitted to the CQA Officer.

2.5 Construction Contractor

The Construction Contractor's role will be to furnish earthwork, construction, and to provide overall construction responsibility for the completion of the project. The Construction Contractor will be experienced in the construction of earthen storage basins, knowledgeable about clay liner construction techniques, and familiar with geosynthetic installations. The term "Contractor" is used interchangeably with "Construction Contractor" in this Plan.

2.6 Geosynthetics Installer

The Geosynthetics Installer is the company hired by the Construction Contractor to install the geosynthetic components referenced in this manual and to perform the nondestructive seam testing of the geomembranes as required by this Plan. The term "Installer" is used throughout this Plan when reference is made to the tasks and responsibilities of a Geosynthetics Installer.

The Installer will be trained and qualified to install the various geosynthetic components covered by this Plan. The Installer of the geomembranes will be approved and/or licensed by the Manufacturer.

Prior to confirmation of any contractual agreements, the Installer of the geosynthetics will provide the CQA Officer and/or Owner with the following written information, which must be approved by the CQA Officer and/or the Owner:

- Corporate background and information.
- Installation capabilities, including the following:
  - Information on equipment and personnel
  - Resumes of personnel
  - Daily anticipated production
  - Quality control manual for installation

- A list of at least 10 completed facilities, totaling a minimum of 10,000,000 square feet for which the Installer has completed the installation of polyethylene geomembrane. For each installation, the following information will be provided:
  - Name and purpose of facility, its location, and date of installation
  - Name of owner, project manager, designer, manufacturer, and fabricator (if any)
  - Thickness and type of polyethylene geomembrane and the surface area of the installed geomembrane

The Installer will provide a copy of the field tensiometer certification, indicating the date in which the tensiometer was calibrated prior to the start of any seaming operations. The Installer is responsible for delays caused to the project until tensiometer certification is delivered to the RPR.

Tensiometers used for this project are required to be calibrated within 6 months prior to the start of geomembrane installation. The Installer is responsible for meeting this requirement, and must supply a copy of the certification at the time of mobilization to the job site.

All personnel performing geomembrane seaming operations will be qualified by experience or by successfully passing seaming tests for the seaming methods to be used. At least one seamer will have experience in seaming a minimum of 5,000,000 square feet of polyethylene geomembrane using the same type of seaming apparatus in use at the site. The most experienced seamer, the "master seamer," will provide direct supervision, as required, over less experienced seamers. No field seaming will take place without an experienced seamer (meeting the seaming criteria stated above) being present.

The Installer will provide the CQA Officer with a list of proposed seaming and testing personnel, and their professional records, prior to installation of the geosynthetics. This document will be reviewed by the CQA Officer. Any proposed seaming personnel deemed insufficiently experienced will not be accepted by the CQA Officer and/or the Owner.

The Installer will designate one representative as the Superintendent, who will represent the Installer at all site meetings and who will be responsible for acting as the Installer's spokesperson on-site. This Superintendent will be prequalified for this role on the basis of experience, management ability, and authority.

Section 3
Preconstruction Activities

3.1 Preconstruction Meeting

Prior to commencement of construction at the facility, a preconstruction meeting will be held. This meeting will include the parties involved in the earth work construction, including the CQA Officer or designated representative, the RPR, the Construction Contractor, and the Owner.

The purpose of this meeting is to begin the planning and coordination of construction tasks; to identify potential problems that might cause difficulties and delays in construction; to properly interpret the design intent by the Contractor(s); and to present the CQA Plan to all of the parties involved. It is important that the rules regarding testing, repairs, etc., be known and accepted by each party to this Plan.

Specific topics considered for this meeting include the following:

- Review critical design details of the project, including the plans and specifications.
- Review measures for storm water runoff and runon diversion control, including sump locations, siltation control, and pumping requirements.
- Make appropriate modifications to the Construction Quality Assurance Plan, and develop project-specific addendums (if necessary).
- Review the responsibilities of each party.
- Review lines of authority and communication.
- Review methods for documenting and reporting, and for distributing documents and reports.
- Review requirements of the soil testing laboratory regarding sample sizes, methods of collection, and shipment. Also, review turn times for sample data and their implications on the construction schedule, pending receipt of acceptance data.
- Review the number and locations of the tests required for soil components.
- Review sub-base acceptance.
- Review precautions to be taken to maximize bonding between lifts of compacted clay.
- Review the method for splicing segments of the compacted clay.
- Review precautions to be taken to minimize desiccation cracking of clay surfaces.

- Review methods of clay layer surface preparation and approval prior to geosynthetics placement.
- Review the time schedule for operations.
- Observe where the site survey benchmarks are located, and review methods for maintaining vertical and horizontal control.
- Review documentation requirements.
- Review the survey documentation tables and plans that identify the locations where survey documentation information is required.
- Conduct a site walk-around to review material storage locations and general conditions relative to construction.
- Set up a time and place for regular construction progress meetings.

The CQA Officer and/or the Owner will document this meeting.

3.2 Preinstallation Meeting

Prior to commencement of the installation of the geomembrane component of the project, a preinstallation meeting will be held. This meeting will include the parties involved in the construction, including the CQA Officer or designated representative, the RPR, the Construction Contractor, the Geosynthetic Installer, and the Owner.

The purpose of this meeting is to begin the planning and coordination of geosynthetic installation tasks, identify potential problems that might cause difficulties and delays in construction, to properly interpret the design intent, and to present the CQA Plan to all of the parties involved. It is important that the requirements regarding testing, seaming, repairs, etc., be known and accepted by each party to this Plan.

Specific topics considered for this meeting include the following:

- Review the proposed panel layouts and critical design details involving geosynthetic installation.
- Review measures for storm water controls and pumping requirements.
- Clarify or confirm design changes.
- Confirm acceptability of selected geosynthetic materials.
- Clarify construction concepts or practices required by the approved plans and preinstallation submittal.
- Review the responsibilities of each party.

- Review lines of authority and communication.
- Review methods for documenting and reporting, and for distributing documents and reports.
- Review requirements of geosynthetics testing laboratory regarding sample size, method of collection, and shipment. Also review turn times for sample data and their implications on the construction schedule, pending receipt of acceptance data.
- Review the number and locations of the tests required for geosynthetic components.
- Review methods of clay layer surface preparation and approval prior to geosynthetics placement.
- Establish rules for writing on the geosynthetic (*i.e.*, who is authorized to write, what can be written, and in which color), and outline procedures for packaging and storing archive samples.
- Review geosynthetics panel and seam layout diagrams and numbering systems.
- Establish procedures for use of the geomembrane welding apparatus, if applicable.
- Finalize field cutout sample sizes.
- Review geosynthetic repair procedures.
- Establish procedures for the deployment of materials over prepared sub-grade and installed geosynthetics emphasizing protection of the geosynthetics. Specific discussion will address deployment of aggregate fill materials and constructing concrete above liner system.
- Review the construction schedule.
- Review survey requirements

The CQA Officer and/or the Owner will document this meeting, and minutes may be distributed to parties involved in the construction project.

Section 4
General Construction Observation and Documentation

This section describes general documentation procedures to be implemented, including the use of forms, the identification and resolution of problems or deficiencies, and photographic documentation.

4.1 Progress Meetings

Progress meetings will be held regularly at the work area. At a minimum, meetings will be attended by field supervisory and CQA personnel. The purposes of the meetings are as follows:

- Review the work activity since the last progress meeting.
- Discuss the Contractor's and Installer's personnel and equipment assignments.
- Review the work schedule.
- Discuss possible issues.
- Review any new test data.
- Review data documentation requirements.

The meetings will be documented by a person designated at the beginning of the meeting.

4.2 Daily Reports

A daily summary report will be prepared by the CQA Officer or the RPR under direct supervision of the CQA Officer, for each day of activity and will include the following information:

- Date, project name, location, report preparer's name, and the names of representatives on-site performing CQA under the supervision of the CQA Officer
- Time work starts and ends each construction work day, along with the duration and reason for work stoppages (*i.e.*, weather delay, equipment shortage, labor shortage, unanticipated conditions encountered, etc.)
- Data on weather conditions, including temperature, wind speed and direction, cloud cover, and precipitation
- Construction contractor's work force, equipment in use, and materials delivered to or removed from the job site
- Chronological description of work in progress, including locations and type of work performed

- A description of materials used and references or results of testing and documentation
- Discussion of problems/deficiencies identified and corrective actions taken as described in Subsection 4.4 (Problem/Deficiency Identification and Corrective Action)
- Identification/List of laboratory samples collected, marked, and delivered to laboratories, or clear reference to the document containing such information
- Subgrade acceptance reports submitted by the geosynthetic installer

Field data sheets for earthwork construction and installation of geosynthetics containing the following information, as necessary, will be prepared daily by each representative:

- Test or sample location and elevation or lift number
- Type of documentation (*i.e.*, field moisture/density test, etc.)
- Procedures used
- Test data (*i.e.*, Proctor value, etc.)
- Results

4.3 Forms, Checklists, and Data Sheets

Additional forms may be developed during the course of the project to provide specific needs, such as geomembrane CQA documentation, or simply to improve the efficiency of data collection.

4.4 Problem/Deficiency Identification and Corrective Action

Problem and/or deficiency identification and corrective action will be documented in the daily report when a construction material or activity is observed or tested that does not meet the requirements set forth in this Plan. Problem and/or deficiency identification and corrective action documentation may include the following information:

- A description of the problem or deficiency, including reference to supplemental data or observations responsible for determining the problem or deficiency.
- The location of the problem or deficiency, including how and when the problem or deficiency was discovered, and an estimate of how long the problem or deficiency has existed.
- An opinion as to the probable cause of the problem or deficiency.
- A recommended corrective action for resolving the problem or deficiency. If the corrective action has already been implemented, then the observations and documentation to show that the problem or deficiency has been resolved should be included. If the problem or deficiency has not been resolved by the end of the day upon which it was discovered, then the report will clearly state that it is an unresolved problem or deficiency. Subsequent daily reports will indicate the status of problems or deficiencies until they are resolved.

If the problem or deficiency has not been resolved, then the CQA Officer and the RPR will discuss the necessary corrective actions. The CQA Officer will work with the Owner and Construction Contractor to implement actions as necessary to resolve the problem or deficiency. A description of such problems or deficiencies and corrective actions implemented will be provided in the Construction Documentation Report.

The CQA Officer, working with the Owner and Construction Contractor, will determine if the problem or deficiency is an indication of a situation that might require changes to the plans and specifications and/or the CQA Plan. Revisions to the plans or specifications or the CQA Plan must be approved by the CQA Officer and the site Owner.

4.5 Photographic Documentation

Photographs will be taken to document observations, problems, deficiencies, corrective actions, and work in progress. Photographs will be in print format or digital and will be filed in chronological order in a permanent protective file or electronic file by the CQA Officer or the RPR.

The following information may be documented in a log book for each photograph:

- Date and time
- Information regarding the orientation of the photograph itself for proper viewing (*i.e.*, looking south)
- Description of the subject matter
- Unique identifying number for reference in reports

4.6 Surveying

Documentation surveying requirements for each component are described in their respective report sections. Required surveying will be performed by personnel experienced in construction surveying. Surveys will be based on survey control points previously established at the site. Elevations will be based on North American Vertical Datum of 1988 (NAVD88) datum, and coordinates will be based on the state plane coordinate system. The location of field tests and samples will be recorded. Generally, these locations can be determined by reference to nearby construction stakes or markings. However, if such convenient reference is not readily available, the CQA Officer or the designated RPR will be responsible for providing or requesting survey control.

Section 5
Compacted Clay fill

5.1 General

This section includes the quality assurance requirements for placement, backfilling, and compaction of clay fill. Compacted clay fill will be used in the following manner:

- Constructing the base and sideslope liner

Field tests and soil sample types will be recorded in the daily construction reports (refer to Subsection 4.2) including locations (by coordinates or survey point reference number) and elevation or lift number of field tests and laboratory sample points.

5.2 Procedures and Observation

The RPR will observe compacted clay fill construction activities and will document relevant observations to support certification of the following requirements:

- The RPR will confirm the subbase is acceptable and ready for clay fill placement prior to placement of clay fill over the subbase. Procedures for determining subbase acceptance are discussed in Subsection 6.2.
- The RPR will confirm the uniformity of the excavated soil to be used as clay fill. Soil placement will be monitored for segregation and removal of unsuitable material and for changes in soil type, color, texture, and moisture content.
- The Construction Contractor will segregate and/or remove unsuitable materials such as granular soil, silty or sandy clay not meeting acceptance criteria, boulders, cobbles, organic material, and other deleterious material.
- The RPR will observe clay placement and direct the contractor on where to perform field testing. The contractor supplied Soil Testing Laboratory will measure field densities and moisture contents, using methods described in Subsection 5.3 (Sampling Requirements and Acceptance Criteria), to document that the compacted clay fill is in substantial conformance with the placement specifications and that soil placement has been conducted in a manner to achieve a uniform, homogeneous clay mass.
- Voids created by nuclear density gauge (NDG) probes or as the result of Shelby tube samples will be backfilled with granular bentonite.

- Areas of unacceptable permeability, density, or moisture content, as defined by Subsection 5.3 (Sampling Requirements and Acceptance Criteria), will be documented by the RPR. Corrective action will consist of moisture-conditioning of the soil and/or additional compactive effort as necessary. Methods for moisture-conditioning soil are described below. Following corrective actions, such areas will be retested.
- If necessary, surfaces of liner or cover to receive successive lifts of clay will be moisture-conditioned either by scarification and addition of water where desiccated, or by discing and air drying where saturated to promote effective bonding of lifts. Following scarification, water will be applied with a spray bar applicator or equivalent method to achieve uniform distribution.
- Clay placement will be performed in a manner to achieve continuous and complete keying together of clay liner construction areas. Stepped joints will be utilized to connect lateral segments of clay liner construction, as shown on the construction plan details.
- No frozen soil will be used for clay fill liner construction. Frozen soil in the compaction work area will be removed or allowed to melt prior to compaction.
- Stones and other penetrating objects 2 inches or larger and stones with sharp edges or points protruding from the surface of the final lift of compacted clay fill will be removed to avoid puncturing the geomembrane. The RPR will observe the liner during this process and will document the removal of stones and other objects by the Contractor. Voids made by the removal of stones will be filled with clay soil or bentonite, and the entire liner surface will be rolled with a smooth-drum compactor.
- Preconstruction planning will be undertaken to sequence construction activities to minimize the length of time any completed clay surface will be exposed prior to receiving protective cover. Protective cover will be provided by the installation of the geomembrane.

5.3 Sampling Requirements and Acceptance Criteria

Field and laboratory sampling frequencies are based on the area or volume of material placed, as specified in the project specifications. This section describes the required analyses, methods, sample frequencies, and acceptance limits. The Soil Testing Laboratory will perform field tests and will collect soil samples for laboratory analysis with the approval from the RPR.

5.3.1 Field Testing

The following field testing methods will be used by the RPR during construction:

PARAMETER	METHOD
Moisture content	ASTM D3017
Soil density	ASTM D2922 Method B

Field density and moisture content tests will be performed on a 100-foot grid pattern for each 8-inch thickness of compacted clay fill placed. In confined areas where compaction equipment is hindered or hand compaction is necessary, a minimum of two field density and moisture content tests will be performed for each 8-inch thickness of clay placed.

Field Testing Acceptance Criteria

Acceptance criteria for field density will require soil compaction to a minimum of 95 percent of the Standard Proctor (ASTM D698) maximum dry density. Moisture content requirements will be at least wet of optimum. The acceptable range will be based on Proctor moisture-density relationships and compaction versus permeability relationships.

5.3.2 Laboratory Testing

Routine laboratory testing of the clay liner soil will be performed on samples from the clay borrow area and on the in-place clay soil samples. Sampling locations will be determined by the CQA Officer or RPR. Samples for determining in-place properties will be collected by pushing Shelby tubes. Soil characteristics will be determined from representative samples and from Shelby tube samples.

Undisturbed Sample Analysis

One undisturbed sample will be taken for each acre or less of clay placed and will be submitted to the Soil Testing Laboratory.

The following analyses will be performed on all undisturbed samples obtained:

PARAMETER	TEST METHOD
Moisture content and dry density	ASTM D2216
Atterberg limits	ASTM D4318
Grain-size analysis	ASTM D422[(a)]

Notes:
[(a)] Distribution is to be reported through 0.002 mm particle size.

One of every three undisturbed samples (with a minimum of one per basin) will also be analyzed for hydraulic conductivity as follows:

PARAMETER	TEST METHOD
Hydraulic conductivity	ASTM D5084 or SW 846 EPA Method 9100

Representative Sample Analysis

Representative (grab) samples will be obtained on the basis of three criteria. First, an initial sample will be obtained from the clay borrow source (if not used in construction of a prior phase) and analyzed prior to construction. This will confirm soil characteristics and provide an initial maximum dry density and optimum moisture content for field moisture/density testing. Second, routine samples will be obtained for every 5,000 cubic yards placed. Third, in the event that changes in physical appearance or soil characteristics are observed, a sample will be obtained and analyzed. The maximum dry density and optimum moisture content values used for compaction testing may be adjusted during the course of liner construction based on the results of the above sampling.

The following laboratory analyses will be performed on all representative samples obtained:

PARAMETER	TEST METHOD
Moisture-density relationship using Standard Proctor compaction	ASTM D698 [a, b]
Atterberg limits	ASTM D4318
Grain-size analysis	ASTM D422[c]

Notes:
[a] Five-point Proctor analysis required for first and second sampling criteria.
[b] A one-point Proctor analysis may be utilized for representative samples collected for the third sampling criterion (apparent changes in soil quality) to verify applicability of previously analyzed moisture-density relationships. If the result does not verify applicability, then a five-point analysis will be performed in accordance with the first sampling criterion.
[c] Distribution is to be reported through the 0.002 mm particle size.

Laboratory Testing Acceptance Criteria

The following acceptance criteria will apply to the compacted clay fill.

- A minimum 50 percent by weight that passes the 200 sieve
- A saturated hydraulic conductivity of 1×10^{-7} cm/s or less, when compacted to required moisture contents and densities based on the standard Proctor method.
- An average liquid limit of 25 or greater, with no values less than 20
- An average plasticity index of 12 or greater, with no values less than 10

5.4 Thickness Documentation

The bottom and top of the clay liner portion of the composite liner will be surveyed at key locations (breaks in slope, toe of slopes, top of slopes, limit of liner construction, etc.) to determine that minimum as-constructed clay liner thicknesses were achieved.

Section 6
General Soil

6.1 General

This section includes the quality assurance requirements for placement, compaction, and grading of general soil (i.e., general fill). General soil may be any inorganic soil. General soil will be used in the construction of the following landfill components:

- Subbase preparation
- Access roads

All field tests, soil sample types, and survey measurements will be recorded as record construction data, including locations (by coordinates) and elevations or lifts of field tests and laboratory sample points.

6.2 Procedures and Observation

The RPR will observe general soil placement activities and will document relevant observations to support certification of the following requirements:

- The RPR will periodically observe loads of general fill for general conformance to material specifications and may randomly sample loads.
- The Soil Testing Laboratory will perform routine conformance sampling as defined in Subsection 6.3.2. Sample collection will be directed by the CQA Officer or RPR.
- No frozen soil will be used for backfilling. Any frozen soil in the compaction work area will be removed.
- Loose lift thickness for general soil compaction will not exceed 18 inches.
- General soil used as structural fill (*i.e.*, subbase preparation, perimeter berms and roads) will be compacted to a minimum of 95 percent of the maximum dry density as determined by the Standard Proctor test.
- Unacceptable compaction density, as defined above, will be reported to the CQA Officer by the RPR. Corrective action will consist of moisture-conditioning of the soil and/or additional compactive effort as necessary.
- The RPR will confirm the subbase is acceptable and ready for clay fill placement prior to placement of clay fill over the subbase. The RPR will notify the Engineer of any soft appearing areas of the subbase during subbase development and prior to clay fill placement.

Field densities using methods described in Subsection 6.3.1 will be measured to document that the in-place soil is in substantial conformance with the required density.

6.3 Sampling Requirements and Acceptance Criteria

Testing is required for general soil used as structural fill (recompacted soil used in subgrade and berm construction). Sampling and testing of structural fill will be conducted in accordance with the project specifications.

6.3.1 Field Testing

The following field testing method will be used during construction:

PARAMETER	TEST METHOD
Moisture content	ASTM D3017
Soil density	ASTM D2922 Method B

Field density and moisture content tests will be performed on a 100-foot grid pattern as much as reasonably possible for each 1-foot thickness of compacted structural fill placed or at a minimum frequency of one test per 500 cubic yards of structural fill placed. The testing pattern will be offset on alternate lifts as much as reasonably possible. In confined areas where compaction equipment is hindered or hand compaction is necessary, a minimum of two field density and moisture content tests will be performed for each 1-foot thickness of structural fill placed.

Field Testing Acceptance Criteria

Acceptance criteria for field density will require soil compaction to a minimum of 95 percent of the Standard Proctor (ASTM D698) maximum dry density.

6.3.2 Laboratory Testing

Routine laboratory testing of the structural fill will be performed on representative samples collected from the general fill borrow area and/or general fill stockpiles. Soil characteristics will be determined from representative samples.

Representative Sample Analysis

Representative (grab) samples of the structural fill will be obtained at a minimum frequency of one sample for every 5,000 cubic yards placed and a sample will be collected in the event that changes in physical appearance or soil characteristics are observed. The maximum dry density values used for

compaction testing may be adjusted during the course construction based on the results of the above sampling.

The following laboratory analyses will be performed on all representative samples obtained:

PARAMETER	TEST METHOD
Moisture-density relationship using Standard Proctor compaction	ASTM D698 [(a)]
Atterberg limits[(c)]	ASTM D4318
Grain-size analysis	ASTM D422[(b)]

Notes:
(a) A one-point Proctor analysis may be utilized for representative samples collected for the third sampling criterion (apparent changes in soil quality) to verify applicability of previously analyzed moisture-density relationships. If the result does not verify applicability, then a five-point analysis will be performed in accordance with the first sampling criterion.
(b) Distribution is to be reported through the 0.002 mm particle size.
(c) Atterberg limits are only applicable when the sample is fine-grained soil.

Laboratory Testing Acceptance Criteria

The results of the grain size analysis (ASTM D422) should result in no particles greater than 6 inches in diameter.

6.4 Thickness Documentation

Top of subbase grades will be documented with a survey reading at key locations, such as breaks in grade, toes of slope, mid-points, and tops of slopes. The allowable tolerance in subbase elevation will be -0.1 foot or as allowed by the CQA Officer.

In addition to survey measurements for elevation, measurements for horizontal location will also be performed using previously established horizontal control to document the boundaries and alignment of the general soil placement.

Section 7
Geomembrane

7.1 General

This section of the CQA Plan applies to the high-density polyethylene (HDPE) geomembrane used in the composite liner. The geomembrane will be 60-mil HDPE (textured and smooth).

The geomembrane will be supplied to the site in factory rolls. No factory seams will be used to prepare larger panels of geomembrane for delivery to the site.

This section is divided into five major subheadings, which cover general information, and the CQA requirements for pre-installation, installation, field seaming, and post-installation. These terms pre-installation, installation, field seaming, and post–installation are applicable only to the geomembrane installation and to not apply to the overall construction of the landfill facility.

7.2 Pre-Installation

This section describes the quality control measures that are applicable to the polyethylene (PE) resin manufacturers, geomembrane manufactures, and finished geomembrane roll delivery to the site prior to installation.

The geomembrane must be fabricated from polyethylene resin and be virgin material with no more than 10 percent rework by weight. Rework material must be of the same formulation as the parent material. No post-consumer resin allowed.

7.2.1 Manufacturing

Material Specifications

The following list specifies the required geomembrane materials for liner construction:

- Sideslopes (3H:1V): 60-mil HDPE-textured
- Base (less than 10 percent slopes): 60-mil HDPE-smooth (textured optional)

Quality Control Requirements

Prior to the delivery of any geomembrane rolls to the site, the contractor will provide the Owner and the CQA Officer with the following information from the Geomembrane Manufacturer:

- The resin supplier, location of supplier's production plant(s), and resin brand name and product number
- Any results of tests conducted by the Geomembrane Manufacturer and/or the Resin Manufacturer's testing laboratories to document the quality of the resin used in fabricating the geomembrane
- The Quality Control Plan that the Geomembrane Manufacturer will be using for the geomembrane being supplied

Every roll of geomembrane for delivery to the site must be manufactured and inspected in accordance with the Geomembrane Manufacturer according to the following requirements:

- First quality polyethylene resin must be used.
- The geomembrane must contain no more than a maximum of 1 percent by weight of additives, fillers, or extenders, excluding carbon black.
- Carbon black for ultraviolet protection shall be added during manufacturing of the geomembrane.
- The geomembrane must be free of holes, blisters, undispersed raw materials, or any other sign of contamination by foreign matter.

The Geomembrane Manufacturer will routinely perform density (ASTM D792, method B or ASTM D1505) and melt index (ASTM D1238) tests on the raw resin to document the quality of the HDPE resin used to manufacture the geomembrane rolls assigned to this project. The minimum specific gravity allowed for the HDPE raw resin is 0.932. The maximum melt index for the HDPE raw resin is 1.0 grams/10 minutes.

Manufacturer's Certification

The Geomembrane Manufacturer will test the geomembrane produced for the site according to the test method and frequencies listed in Tables 7-1 and 7-2 or in accordance with the most current version of GM13 and GM17. The Geomembrane Manufacturer will provided certification, based on tests performed by either the Geomembrane Manufacturer's laboratory or another outside laboratory contracted by the Geomembrane Manufacturer, that the geomembrane supplied under this Plan will meet the specifications presented in Tables 7-1 and 7-2. Additionally, the Manufacturer will provide certification that the Manufacturer's Quality Control Plan was fully implemented for the geomembrane material supplied under this Plan. The Manufacturer will provide documentation to verify results of the Manufacturer's Quality Control Plan implementation if requested by the CQA Officer.

7.2.2 Delivery, Handling, and Storage of Geomembrane Rolls

The geomembrane will be protected during shipment from excessive heat or cold, puncture, cutting, or other damaging or deleterious conditions. The geomembrane rolls will be stored on-site in a designated area and will be protected from long-term ultraviolet exposure prior to actual installation.

- Each geomembrane roll will be marked by the Geomembrane Manufacturer with the following information (on a durable gummed label, or equivalent, on inside of core):
  - Name of Manufacturer
  - Product type and identification number (if any)
  - Roll length and width
  - Nominal product thickness
  - Roll number
  - Batch or lot number
  - Date of manufacture

Table 7-1
High Density Polyethylene (HDPE) Geomembrane – Smooth Test Frequency and Acceptance Criteria

PROPERTIES	TEST METHOD	TEST VALUE (60 mils)	TESTING FREQUENCY
Thickness (min. average) ▪ Lowest individual of 10 values	D5199	Nom. -10%	Per roll
Formulated Density mg/L (minimum)	D1505/D792	0.940 g/cc	200,000 lb
Tensile Properties (min. average)(1) ▪ Yield strength ▪ Break strength ▪ Yield elongation ▪ Break elongation	D6693 Type IV	 126 lb/in. 228 lb/in. 12% 700%	20,000 lb
Tear Resistance (min. average)	D1004	42 lb	45,000 lb
Puncture Resistance (min. average)	D4833	108 lb	45,000 lb
Stress Crack Resistance(2)	D5397 (App.)	500 hr.	per GRI-GM10
Carbon Black Content (range)	D4218(3)	2.0–3.0%	20,000 lb
Carbon Black Dispersion	D5596	Note (4)	45,000 lb
Oxidative Induction Time (OIT) (min. average)(5) ▪ Standard OIT —or— ▪ High Pressure OIT	 D3895 D5885	 100 min. 400 min.	200,000 lb
Oven Aging at 85°C(5)(6) ▪ Standard OIT (min. average) - % retained after 90 days —or— ▪ High Pressure OIT (min. average) - % retained after 90 days	D5721 D3895 D5885	 55% 80%	Per each formulation
UV Resistance(7) ▪ Standard OIT (min. average) —or— ▪ High Pressure OIT (min. average) - % retained after 1,600 hours(9)	D7238 D3895 D5885	 N.R.(8) 50%	Per each formulation

Notes:

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.

— Yield elongation is calculated using a gauge length of 1.3 inches.

— Break elongation is calculated using a gauge length of 2.0 inches.

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D1603 (tube furnace) or D6370 (TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:

— Nine in Categories 1 or 2, and 1 in Category 3.

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.

(7) The condition of the test should be 20-hour UV cycle at 75°C, followed by 4-hour condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

Table 7-2
High Density Polyethylene (HDPE) Geomembrane – Textured Test Frequency and Acceptance Criteria

PROPERTIES	TEST METHOD	TEST VALUE (60 mils)	TESTING FREQUENCY
Thickness (min. average) Lowest individual for 8 out of 10 values Lowest individual for any of the 10 values	D5994	Nom. (-5%) -10% -15%	Per roll
Asperity Height (min. average)	D7466	10 mil.	Every second roll(1)
Formulated Density (min. average)	D1505/D 792	0.940 g/cc	200,000 lb
Tensile Properties (min. average)(2) Yield strength Break strength Yield elongation Break elongation	D6693 Type IV	 126 lb/in. 90 lb/in. 12% 100%	20,000 lb
Tear Resistance (min. average)	D1004	42 lb	45,000 lb
Puncture Resistance (min. average)	D4833	90 lb	45,000 lb
Stress Crack Resistance(3)	D5397 (App.)	500 hr.	per GRI-GM10
Carbon Black Content (range)	D4218(4)	2.0–3.0%	20,000 lb
Carbon Black Dispersion	D5596	Note (5)	45,000 lb
Oxidative Induction Time (OIT) (min. average)(6) Standard OIT —or— High Pressure OIT	 D3895 D5885	 100 min. 400 min.	200,000 lb
Oven Aging at 85°C(6)(7) Standard OIT (min. average) - % retained after 90 days —or— High Pressure OIT (min. average) - % retained after 90 days	D5721 D3895 D5885	 55% 80%	Per each formulation
UV Resistance(9) Standard OIT (min. average) —or— High Pressure OIT (min. average) - % retained after 1,600 hours(10)	D7238 D3895 D5885	 N.R.(9) 50%	Per each formulation

Notes:

(1) Alternate the measurement side for double-sided textured sheet.

(2) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.

— Yield elongation is calculated using a gauge length of 1.3 inches.

— Break elongation is calculated using a gauge length of 2.0 inches.

(3) P-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials. The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(4) Other methods such as D1603 (tube furnace) or D6370 (TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established.

(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:

— Nine in Categories 1 or 2, and 1 in Category 3.

(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90-day response.

(8) The condition of the test should be 20-hour UV cycle at 75°C, followed by 4-hour condensation at 60°C.

(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(10) UV resistance is based on percent retained value regardless of the original HP-OIT value.

When cores are required for preparing geomembrane for shipment, the manufacturer will use cores with sufficient crushing strength to prevent collapse or other damage while in use.

The following practices will be used as a minimum in receiving and storing geomembrane rolls in the designated storage area at the job site:

- While unloading or transferring the geomembrane rolls from one location to another, care will be taken to prevent damage to the geomembrane itself. The preferred method involves using a spreader-bar, straps, and a loader. Rolls will not be dragged.
- Geomembrane rolls will be stored in a manner so as to ensure that they are adequately protected from the following:
    - Equipment damage
    - Strong oxidizing chemicals, acids, or bases
    - Flames, including welding sparks
    - Temperature in excess of 160° Fahrenheit
    - Dust and dirt

The RPR will observe and document, throughout the pre-installation, installation, and post-installation periods that the Installer provided adequate handling equipment for moving geomembrane rolls and that the equipment and the handling methods used do not pose unnecessary risk of damage. The Installer is responsible for the means and methods to implement the work.

The Installer will be responsible for ensuring that all material installed meets specifications (i.e., that the roll marking label information indicates required specifications and properly represents materials). The RPR will maintain a log of geomembrane roll deliveries. The log will contain the roll numbers, the date of delivery, and the batch (lot) numbers.

7.3 Installation

This section includes discussion of geomembrane roll testing requirements, earthwork required for geomembrane placement, placement of the geomembrane, defects and repairs of geomembrane, and requirements applicable to other materials in contact with the geomembrane. Subsection 7.4 describes the installation and testing requirements for geomembrane seams.

All parties involved in the installation of the geomembranes will be familiar with geomembrane properties and will focus on protecting the geomembrane from damage during construction activities.

7.3.1 Testing Requirements

This subsection describes the test methods, including sampling procedures and frequencies, and the role of the geosynthetics testing laboratory in testing the geomembrane roll samples. Subsection 7.2.1, under Quality Control Requirements, describes the test methods that are performed on an infrequent basis to demonstrate the uniformity of resin used to fabricate geomembrane shipped to the job site. Seam testing is described in Subsection 7.4.4 and 7.4.5.

Test Methods

A representative of the geosynthetics testing laboratory at the Geomembrane Manufacturer's plant may collect geomembrane roll samples. Conformance samples will be collected at a rate one sample per 100,000 square feet of geomembrane produced for delivery to the site. At least one sample will also be obtained for each geomembrane production batch. Samples for thickness testing or measurements will be collected on every roll for delivery to the site. The Installer should not ship to, or receive at, the site geomembrane from more than two production batches in any single shipment without the prior written approval of the CQA Officer and the Owner.

Samples collected will be of a size determined by the geosynthetics testing laboratory. The laboratory technician will indicate the machine direction on the sample.

Tables 7-1 and 7-2 list tests and the test methods that may be performed on HDPE geomembrane roll samples. At a minimum, the minimum number of tests required by the project specifications will be conducted on the samples. The specifications and methods used in evaluating the results are discussed below under Procedures for Determining Geomembrane Roll Test Failures. Unless specified otherwise, sample specimens will be prepared in accordance with the referenced test method. The results for tear resistance and each of the tensile property tests will be reported for both the machine and cross direction if these tests are conducted.

Role of Testing Laboratory

The geosynthetics testing laboratory will be responsible for performing the tests on samples submitted to them as described above under Test Methods or as determined by the CQA Officer. The results of the tests performed will be reported to the CQA Officer, the RPR, and the Owner.

Retesting of geomembrane rolls for quality assurance purposes because of failure to meet any or all of the acceptance specifications listed in Tables 7-1 and 7-2 can only be authorized by the CQA Officer.

The Geomembrane Manufacturer and/or Installer may perform their own tests according to the methods and procedures defined in Tables 7-1 and 7-2. However, the results will only be applicable to their own quality control needs. The results will not be substituted for the quality assurance testing describe herein.

Procedures for Determining Geomembrane Roll Test Failures

Tables 7-1 and 7-2 list the acceptance specifications for HDPE geomembrane. The HDPE geomembrane values listed in the acceptance specifications of Tables 7-1 and 7-2 is from GRI Test Method GM 13. The most current version of GM 13 and GM 17 will supersede the acceptance specifications in the tables. Acceptance specifications apply to both textured and smooth geomembranes. For those tests where results are reported for both machine and cross direction, each result will be compared to the listed specification to determine acceptance.

The following procedure will be used for interpreting results:

- If the test values meet the stated specification in Tables 7-1 and 7-2, then the roll and the lot will be accepted for use at the job site. If the sample represents all rolls from an entire shipment, then the entire shipment will also be considered accepted.
- If the result does not meet the specifications, then the roll and the batch may be retested using specimens either from the original roll sample or from another sample collected by the geosynthetics laboratory technician or the RPR. For retesting, two additional tests will be performed for the failed test procedure. (Each additional test will consist of multiple-specimen tests if multiple specimens are called for in the test procedure). If both of the retests are acceptable, then the roll and batch will be considered to have passed this particular acceptance test; if either of the two additional tests fail, then the roll and batch will be considered unsuitable without

further recourse. The CQA Officer and the Owner may obtain samples from other rolls in the batch. On the basis of testing these samples, the CQA Officer and the Owner may choose to accept a portion of the batch while rejecting the remainder.

If retesting does not result in passing test results as defined in the preceding paragraph, or if there is any other nonconformity with the material specifications, then the Installer will withdraw the rolls from use in the project at the Installer's sole risk, and expense. The Installer will be responsible at his/her sole risk, cost, and expense for removing this geomembrane from the site and replacing it with acceptable geomembrane.

7.3.2 Earthwork

The Construction Contractor will be responsible for preparing the supporting soil according to the plans and specifications. For each day of installation of the geomembrane, the Installer, the Contractor, and the RPR will observe the surface and certify that the surface is acceptable for installations. The installer with prepare and sign a subgrade acceptance form for each day of geomembrane deployment.

The soil surface will also be evaluated during geomembrane installation for any areas softened by precipitation or cracked due to desiccation. The Construction Contractor will rework areas determined to be unacceptable until acceptable.

7.3.3 Placement

Location and Panel Layout Drawing

A panel layout drawing for the geomembrane installation covered by this Plan will be prepared by the Installer prior to the installation and submitted to the CQA Officer and the Owner, showing the proposed location and orientation of geomembrane panels to be installed in relation to slope, collection trenches, anchor trench, and phase boundaries. The Owner and the CQA Officer will review the proposed panel layout drawing and document that it is consistent with accepted practice and the construction plans and specifications.

Installation Techniques

Geomembrane panels will be installed by placing one at a time, and each panel will be seamed by the end of the day during which it was deployed.

The RPR will document that the condition of the supporting soil has not changed detrimentally during installation. The RPR will notify the Installer and the Construction Contractor of any damage done (i.e., rutting by equipment used to deploy geomembrane) to the supporting soil prior to panel seaming.

In the event that the subgrade is disturbed during geomembrane deployment, it is the responsibility of the Installer to remove the deployed panel to allow the Construction Contractor to repair the supporting soil. The RPR will observe and document the repair of the supporting soil. The RPR will inform the Installer that the method of deployment will be observed during further deployment, and if damage to supporting soil continues, deployment will be stopped and an alternative means of deployment is to be developed. The RPR will document these events and conversations in the daily report.

The Installer will take the following precautions while installing the geomembrane:

- Ensure that the equipment used does not damage the geomembrane by the way it is handled, by excessive heat, by leakage of hydrocarbons, or by other means.
- Ensure that personnel working on the geomembrane do not smoke, wear damaging clothing, or engage in other activities that could damage the geomembrane.
- Ensure that the method used to deploy the geomembrane does not cause scratches or crimps in the geomembrane.
- Ensure that the method used to deploy the rolls minimizes wrinkles.
- Ensure that the geomembrane is adequately loaded to prevent wind uplift.
- Minimize the amount of direct contact with the geomembrane, by limiting the number of personnel that are allowed on the geomembrane once QC and CQA are completed.
- Ensure that only approved equipment is allowed on the surface of the geomembrane (i.e., generators, test equipment). The use of motorized ATV vehicles is not permitted without approval from the CQA Officer.

Weather Conditions

Geomembrane will not be placed in areas of ponded water, during precipitation events, or in the presence of excess winds. The Installer must receive written approval to deploy geomembrane in temperature below 32°F.

Damages

The RPR will examine each panel for damage after placement and will determine which panels, or panel portions, should be rejected, or accepted. Damaged panels or portions that have been rejected will be marked, removed, and recorded by the RPR.

7.3.4 Defects and Repairs

This section applies to all defects and repairs resulting from examinations, tests, or visual observations performed on the geomembrane material itself and on the seams.

Identification

All seamed and nonseamed areas of the geomembrane will be examined and documented by the RPR for identification of defects, holes, blisters, undispersed raw material, and any signs of contamination by any foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane will be clean at the time of examination. The RPR will complete a final examination of the geomembrane in areas in which both the Installer and the RPR have completed their QC and CQA, respectively. The RPR and the Installer will perform a final examination over the entire geomembrane at the completion of the project. The Installer and/or the Construction Contractor will clean any area that is insufficiently clean to complete the final examination.

Evaluation

Each suspect area identified will be nondestructively tested using the vacuum box test method, an air test, or the spark test method. The RPR will approve the proper test method for each suspect location.

Repair Procedures

Any portion of the geomembrane exhibiting a flaw or failing a destructive or nondestructive test will be repaired. Several procedures exist for the repair of these areas. The procedures available include the following:

- Patching is used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter.
- Grinding and rewelding are used to repair small sections of extruded seams.
- Spot welding or seaming is used to repair small tears; pinholes; or other minor, localized flaws.
- Capping is used to repair large lengths of failed seams.
- Topping is used to repair areas of inadequate seams that have an exposed edge.
- Other procedures may be used at the recommendation of the Installer if agreed upon by the CQA Officer and the RPR.

The repair procedures, materials, and techniques will be approved in advance of the specific repair by the CQA Officer, the RPR, and the Installer. At a minimum, the following provisions will be satisfied:

- Patches or caps will extend at least 6 inches beyond the edge of the defect, and all corners of patches will be rounded with a radius of at least 3 inches.
- The type of geomembrane (i.e., smooth or textured) used for repairs will be approved by the RPR prior to completing repairs.

Examination of Repairs

Each repair will be numbered and logged by the RPR. Each repair will be nondestructively tested according to Subsection 7.4.4. Repairs that pass the above testing will be considered to be adequate, except that large caps may be of sufficient extent to require destructive seam sampling and testing, at the discretion of the RPR, according to the provisions of Subsection 7.4.5.

Failed tests indicate that the repair was inadequate, and the repair will be redone and retested until a passing result is obtained. The RPR will document that all repairs have been subjected to nondestructive testing and will record the number of each repair, the date, and the test outcome.

Large Wrinkles

When seaming of the geomembrane is completed, the RPR will examine the geomembrane for wrinkles and determine which wrinkles (i.e., taller than wide) should be cut out and reseamed by the Installer. The wrinkle repair will be done in accordance with the equipment and procedures described in Subsection 7.4.2 and 7.4.3, respectively, and it will be nondestructively tested using the vacuum box test method described in Subsection 7.4.4.

7.3.5 Material in Contact With Geomembranes – Anchor Trench System and Backfilling

The Construction Contractor will excavate the anchor trench for the geomembrane, unless otherwise specified, to the lines and grades shown on the plans and specifications. The trench will use a "U" cross-sectional configuration. No more than the amount of trench will be excavated than is required for anchoring the geomembrane in 1 day. The trench will be excavated in a single day to minimize the desiccation potential of the anchor trench soil unless moisture content is maintained. The anchor trench will be adequately drained to prevent ponding or softening of the adjacent soil while the trench is open.

The anchor trench will be backfilled and compacted by the Contractor. Care will be taken when backfilling the trenches to prevent any damage to the geomembrane or other geosynthetics that may also be placed in the trench prior to backfilling.

The RPR will observe the backfilling and compacting operations and will advise the Contractor of the adequacy of the soil installation. The RPR will also advise the CQA Officer and the Owner of any problems.

7.4 Field Seaming

This section covers the quality assurance procedures on seams used to join the rolls of geomembrane into a continuous layer. The installation of each of the geomembranes will include 100 percent nondestructive testing of all field seams for joining adjacent rolls of geomembranes to document that no openings or gaps exist between geomembrane sheets. In addition, destructive testing will be performed at a routine interval for determining the strength and mode of failure of field seams in both the shear and peel modes.

The allowable field seam methods, equipment, personnel qualifications, and destructive and nondestructive testing methods are described in this section.

7.4.1 Panel/Seam Layout

No horizontal seams will be allowed on slopes greater than 5 horizontal to 1 vertical. In corners and at other odd-shaped geometric intersections, the number of horizontal seams will be minimized. A seam numbering system comparable and compatible with panel numbering system will be agreed upon at the preconstruction meeting (Subsection 3.3).

7.4.2 Seaming Equipment

The approved methods for field seaming panels and repairs are the dual hot wedge (fusion-type) seam method and the extrusion fillet weld process. Dual hot wedge seaming method will be used on linear seams (production seams). Corners, butt seams, tie-ins, and long repairs will be dual hot wedge seamed. The extrusion fillet or dual hot wedge welding will be used for other repairs detail work and patches (nonproduction). No other processes can be used without prior written authorization from the CQA Officer and the Owner. Only equipment that has been specifically approved by make and model will be used.

Dual Hot Wedge Process

The Installer will meet the following requirements regarding the use, availability, and cleaning of the equipment to be used at the job site:

- An automated self-propelled type of apparatus will be used.
- The welding apparatus will be equipped to continuously monitor applicable temperatures.
- One spare operable seaming device will be maintained on-site at all times.
- Equipment used for seaming will not damage the geomembrane.
- The geomembrane will be protected in areas of heavy traffic to prevent damage discussed in Subsection 7.3.3.
- For cross seams, the intersecting dual hot wedge seam will be patched using the extrusion fillet process described below.
- The electric generator for the equipment will be placed on a smooth base in such a way that no damage occurs to the geomembrane. Similarly, a smooth insulating plate or fabric will be placed beneath the hot equipment after use.

The Installer will keep records for each seamer performing dual hot wedge seaming, including welding machine I.D. number, ambient temperature, and machine operating temperatures. These data will be recorded at intervals as agreed upon at the preconstruction meeting.

Extrusion Fillet Process

The Installer will meet the following requirements regarding the use, availability, and cleaning of the extrusion welding equipment to be used at the job site:

- The welding equipment will be equipped to continuously monitor temperature at the nozzle.
- One spare seaming device will be maintained on-site at all times.
- Equipment used for seaming will not damage the geomembrane.
- The geomembrane will be protected in areas of heavy traffic to prevent damage.
- The extruder will be cleaned and purged prior to beginning seaming, and at any time seaming operations are stopped, until all heat-degraded extrudate has been removed from the barrel.
- The electric generator for the equipment will be placed on a smooth base in such a way that no damage occurs to the geomembrane. Similarly, a smooth insulating plate or fabric will be placed beneath the hot equipment after use.
- Grinding geomembrane surfaces for welding preparation will not be performed more than 1 hour prior to seaming.
- Welding rod shall be kept clean and be of the correct type for the specific material being welded.

The Installer and, if applicable the Geomembrane Manufacturer will provide documentation to the CQA Officer regarding the quality of the extrudate used in the welding apparatus. At a minimum, the extrudate will be compatible with the base liner material and will contain the same grade and quality of polyethylene resins as used in the base material.

The Installer will keep records for each seamer performing extrusion weld seaming, including welding machine I.D. number, and ambient temperature. These data will be recorded at intervals as agreed upon at the preconstruction meeting.

7.4.3 Initial Requirements

Personnel Qualifications

All personnel performing seaming operations will be qualified by experience and by successfully passing seaming tests for the type of seaming equipment to be used. At least one seamer will have experience in seaming a minimum of 5,000,000 square feet of polyethylene geomembrane using the same type of seaming apparatus to be used at the landfill facility. The most experienced seamer, the "master seamer," will have direct supervisory responsibility at the job site.

The Installer will provide a list of proposed seaming personnel and their experience records to the CQA Officer and the RPR for their review and approval.

Weather Conditions

The weather conditions under which geomembrane seaming can be performed are as follows:

- Unless otherwise authorized in writing by the CQA Officer, no seaming will be attempted or performed at an ambient temperature below 32°F (0°C) or above 104°F (40°C).
- Between ambient temperatures of 32°F (0°C) and 50°F (10°C), seaming will be performed only if the geomembrane is preheated by either sun or a hot air device, provided there is no excessive ambient cooling resulting from high winds.
- Above 50°F (10°C), no preheating of the geomembrane will be required.
- Geomembrane will be dry and protected from wind.
- Seaming will not be performed during any precipitation event unless the Installer erects satisfactory shelter to protect the geomembrane areas for seaming from water and/or moisture.
- Seaming will not be performed in areas where ponded water has collected below the surface of the geomembrane.

If the Installer wishes to use methods that may allow seaming at ambient temperatures below 32°F or above 104°F, the Installer will demonstrate and certify that the methods and techniques used to perform the seaming produce seams that are entirely equivalent to seams produced at temperatures above

50°F and below 104°F, and that the overall quality of the geomembrane is not adversely affected.

The RPR will document the following:

- Ambient temperature at which seaming is performed.
- Any precipitation events that occurred at the site, including the time of such occurrences, the intensity, and the amount of the event.

The RPR will inform the CQA Officer and the Owner if any of the weather conditions are not being fulfilled. The CQA Officer will stop or postpone the geomembrane seaming when weather conditions are unacceptable.

Overlapping and Temporary Bond

The Installer will be responsible for ensuring that the following requirements are met:

- Panels of geomembrane will have a finished overlap of a minimum of 3 inches for extrusion welding and 4 inches for fusion welding; but, in any event, sufficient overlap will be provided to allow peel tests to be performed on the seam.
- No solvents or adhesives will be used on the geomembrane unless the CQA Officer and the Owner have approved the product in writing. Approval can only be obtained by submitting samples and data sheets to the CQA Officer and the Owner for evaluation.
- Procedures used to temporally bond adjacent geomembrane panels must not damage the geomembrane; in particular, the temperature of the hot air at the nozzle of any spot welding apparatus will be controlled such that the geomembrane is protected at all times against potential damage.

Trial Seams

Trial seams will be made on fragments of geomembrane to document that seaming conditions are adequate. Trial seams will be performed on the surface the geomembrane will be deployed on (i.e., top of compacted clay liner). Such trial seams will be made at the beginning of each seaming period, following work interruptions, at changes in weather, and at least once every 5 hours of seaming activities, for each seaming apparatus used that day with additional test run following work interruptions, weather changes, changes in machine settings for temperature or speed or as directed by the CQA officer or RPR.

Each seamer is required to complete a trial seam prior to seaming. Trial seams are to be run using the materials for which the seaming will be used (i.e., smooth to smooth, smooth to textured, textured to textured). At a minimum, one trial seam per welding machine will be made at the start of each day by each seaming technician performing welding that day.

The trial seams will be examined by the Installer and the RPR for squeeze-out, foot pressure applied by the seaming equipment, and general appearance, and will be tested using a field tensiometer. If the seam fails any of these examinations, it will be repeated. If the second trial seam fails these examinations, the welding apparatus and seamer are not allowed to seam until the Installer can demonstrate the cause of the failure. Once the Installer has made the necessary corrections to the welding equipment, the seamer and the apparatus are required to pass two trial seams prior to beginning seaming. The RPR will document the reason for the failure and all subsequent trial seams.

The trial seam samples will be at least 42 inches long by 1 foot wide after seaming, with the seam centered lengthwise. Seam overlap will be as indicated in the "Overlapping and Temporary Bond" subsection. Trial seams shall be welded under the same conditions as production seaming is to take place.

Five adjoining specimens, each 1 inch wide, will be cut from each end of the trial seam sample by the Installer. The specimens will be tested by the Installer in shear (5 field shear) and peel (5 field peel [inner and outer seams for dual hot wedge]), respectively, using a field tensiometer.

The remainder of the trial seam sample will be identified and marked by the RPR as follows:

- The sample will be assigned a number and marked as to the welding apparatus used and the seamer's name.
- The date, time, applicable welding equipment operating temperatures, and ambient temperature at the time of seaming will be noted.
- Whether the sample passes or fails will be recorded.

The RPR will observe trial seam procedures, and record them on the field log forms. The sample itself will be cut into three pieces, one for the Owner's record, one to be retained by the RPR, and one to be made available to the Installer.

The RPR may randomly select trial seam samples for destructive testing by the geosynthetics testing laboratory according to the test procedures described in Subsection 7.4.5. The frequency for trial seam laboratory testing will be at the discretion of the RPR and the CQA Officer.

If a trial seam sample fails a destructive test performed by the geosynthetics testing laboratory, according to the acceptance criteria stated in Subsection 7.4.5, then a destructive test seam sample(s) will be taken from each of the seams completed by the seamer during the shift related to the failed trial seam test. These samples will be forwarded by the RPR to the geosynthetics testing laboratory and, if any of them fails the tests, then the procedures described in Subsection 7.4.5 will apply. The conditions of this paragraph will be considered met if a destructive seam test sample, collected and tested according to the provisions under Location and Sampling Frequency and Sampling Procedure of Subsection 7.4.5, has already been taken and has passed.

Seam Preparation

The Installer will ensure that the following conditions for each of the geomembrane installations covered by this Plan are met:

- Prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material.
- If seam overlap grinding is required, then the grinding process will be completed according to the Geomembrane Manufacturer's instructions within 1 hour of the seaming operation, and in a way that will not damage the geomembrane or cause excessive striation of the geomembrane surface.
- Seams will be aligned so as to minimize the number of wrinkles and "fishmouths."

General Seaming Procedures

Unless otherwise specified, the general seaming procedures to be used by the Installer for each of the geomembrane installations covered by this Plan, and observed by the RPR, will be as follows:

- A firm subbase will be provided to achieve proper support for seaming.
- Fishmouths or wrinkles at the seam overlaps will be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles will be seamed, and any portion where the overlap is inadequate

will then be patched with the same geomembrane (including thickness) extending a minimum of 6 inches beyond the cut in all directions.

- If seaming operations are to be conducted at night, adequate illumination will be provided.
- Seaming will be completed to the end of the panel to prevent tearing or fraying.

7.4.4 Nondestructive Testing

Each field seam will be nondestructively tested over its full length using one of the methods described in this section. The purpose of nondestructive testing is to determine the continuity of the seams. Nondestructive testing, at this stage of development, does not provide any information on the strength of seams. Seam strengths will be determined by destructive testing methods that are described in Subsection 7.4.5. Failure of any of the nondestructive or destructive tests will require the repair of the failed section according to the procedures contained in Subsection 7.3.4.

Nondestructive testing as described in this section will be performed on seams for every geomembrane installation covered by this Plan. The recommended test methods for conducting the nondestructive seam testing are the air pressure test for dual hot wedge seams and the vacuum box test for extrusion fillet welds. These two nondestructive testing methods are described below.

The RPR will perform the following documentation tasks:

- Observe nondestructive seam testing, and examine seams for squeeze-out, foot pressure, and general appearance. Failure of these criteria will be considered as failure of the seam, and repair or reconstruction will be required.
- Document location, date, test unit number, name of tester, and outcome of all testing.
- Inform the Installer and CQA Officer of any required repairs.
- Document that appropriate repairs are made and that the repairs are retested nondestructively with passing results.

Air Pressure Testing

The following test procedures are applicable only to dual hot wedge seams. The equipment for performing the test should meet the following minimum requirements:

- An air compressor or hand pump equipped with a pressure gauge and regulator capable of producing and sustaining a pressure between 25 and 30 psig and mounted on a cushion to protect the geomembrane surface

- Fittings, rubber hose, valves, etc., to operate the equipment, and a sharp hollow needle or other approved pressure feed device

Air pressure testing will be performed according to the following procedure:

1. Seal both ends of the seam to be tested.
2. Insert a needle or other approved pressure feed device into the airspace at one end of the dual hot wedge seam.
3. Energize the air compressor or hand pump to a pressure of 25-30 psig. Close the valve, and monitor the pressure in the seam airspace for approximately 7 minutes.
4. Record the pressure in the seam at the end of 2 minutes and again at the end of 7 minutes.
5. If the pressure difference between the 2-minute and 7-minute readings exceeds 2 psi for 60 mil, or if the pressure does not stabilize within the 7-minute period, one more 5-minute pressure-monitoring interval is allowed.
6. If the pressure loss over both 5-minute intervals exceeds 2 psi for 60 mil HDPE, or if the pressure does not stabilize, then the seam fails the test.
7. If the pressure loss over either 5-minute interval does not exceed 2 psi for 60 mil HDPE, then the seam may be deemed by the Installer to have passed the test.
8. The Installer must verify that the air channel tested was not obstructed by noting a release of air pressure at the end of the tested seam interval opposite the pressure gauge.

For any seam interval that fails the air pressure nondestructive test, additional nondestructive testing or visual inspection will be used to identify, if possible, the faulty area of the seam. The faulty area will be repaired and retested. If the faulty area cannot be identified, then the entire seam will be repaired and retested.

Vacuum Box Test

Vacuum box testing is to be used on those seams made by the extrusion fillet process, to locate the defects identified from air pressure testing, or to evaluate suspect seam and nonseam areas as discussed in Subsection 7.3.4.

Vacuum box testing equipment must meet the following minimum standards:

- A five-sided vacuum box with an open bottom, a clear viewing panel on top and a pliable gasket attached to the bottom
- A pump assembly equipped with pressure controller and pipe connections capable of achieving a vacuum of 10 inches of water.
- A vacuum gauge on the tank with an operating range from 0 to 26 inches of vacuum, and a vacuum gauge on the vacuum box with an operating range from 0 to 10 inches of water vacuum

The following procedure will be used in performing the vacuum box test:

1. Clean the seams to be tested so that they are relatively free from soil or foreign objects that might prohibit a good seal from being formed between the vacuum chamber and the geomembrane.
2. Energize the vacuum pump, and reduce the tank pressure to approximately 5 to 10 inches of water vacuum.
3. Wet a strip of geomembrane approximately twice the size of the vacuum box with the soapy solution.
4. Place and center the vacuum box with the gasket in contact with the geomembrane surface over the wetted area of the seam.
5. Applying a normal force to the top of the vacuum box, close the bleed valve, and open the vacuum valve. Check to make certain that a tight seal is created between the geomembrane and the vacuum box. A minimum vacuum of 5 inches will be used for testing with the maximum allowable testing pressure never exceeding 10 inches of vacuum.
6. With the vacuum drawn, use the viewing panel to examine the geomembrane seam for bubbles resulting from the flow of air through the seam. Continue this examination for not less than 5 seconds.
7. Remove the vacuum box by first closing the vacuum valve and then opening the bleed valve. Proceed to Step 8 if bubbles appear in Step 6. If no bubbles appear in Step 6, then proceed directly to Step 9.
8. If bubbles appear through the geomembrane, mark the defective area for repair according to the provisions of Subsection 7.3.4. All repairs will be tested until nondestructive results are passing.
9. Move the vacuum box along the seam to be tested, overlapping the previously tested area by no less than 3 inches.

7.4.5 Destructive Seam Testing

Destructive seam testing will be performed on the geomembrane seams covered by this Plan. Destructive seam testing is performed to determine the strength of the seam in both shear and peel failure modes. Destructive seam testing will be performed within 48 hours of sampling either in an on-site laboratory by personnel under the direction of the CQA Officer or at the geosynthetics testing laboratory.

Location and Sampling Frequency

The RPR will select locations where seam samples will be cut out for the destructive testing. The RPR will mark the locations and record on the seam sample the assigned sample number, seam number, welder ID, machine number, and date welded. Test locations will be determined during seaming at the RPR's discretion. Suspicion of excess crystallinity, contamination, offset welds, or any other potential causes of an imperfect seam may prompt selection of such locations. The Installer will not be informed in advance of any location where seam samples will be taken.

The minimum frequency of sample collection will be one test location for every 500 linear feet of seam length.

Sample Procedure

Samples will be cut under the direction of the RPR as the seaming progresses. For each sample location, the following information will be documented:

- Assigned sample number and reason for collecting the sample (e.g., as part of statistical testing program, suspicious seam, etc.)
- Seam number
- Welder ID
- Machine #
- Date Welded
- Sample location on layout drawing
- For the peel test, which geomembrane is the top and which is the bottom with respect to seams performed using dual hot wedge (fusion) weld techniques

Specimens for qualitative field testing will be taken prior to the removal of the laboratory sample. Samples for field tensiometer testing will be 1 inch wide by 8 inches long, with the seam centered parallel to the width. A total of

10 samples will be collected for field testing. Five samples will be tested in peel (inner and outer seams for dual hot wedge samples) and five samples will be tested in shear. If all 10 samples pass the field tensiometer test described below under Field Test Methods, then the sample for laboratory testing will be taken according to the procedure described below.

The sample for laboratory testing will be located between samples used for field-testing. The destructive sample will be 12 inches wide by a minimum 42 inches long with the seam centered lengthwise. The sample will be cut by the Installer into three parts and distributed as follows:

- A sample 12 inches by 14 inches will be kept by the Installer for testing.
- A sample 12 inches by 12 inches will be given to the Owner for record storage.
- A sample 12 inches by 16 inches will be transmitted to the geosynthetics testing laboratory or on-site testing laboratory by the RPR.

The Installer in accordance with the repair procedures described in Subsection 7.3.4 will immediately repair all holes cut into the geomembrane resulting from destructive seam sampling. The repaired area will be nondestructively tested in accordance with the requirements of Subsection 7.4.4.

End-of-Seam Sampling

In addition to the 42-inch sample cut for laboratory testing, an additional sample will be cut from at least one end of each fusion seam weld greater than 100 feet in length for field-testing as described below. The end-of seam sample will consist of a minimum of two 1 inch wide samples, often referred to as bones, can be cut from the portion of the seam that extends into/passed the anchor trench so as not to require an additional repair. A minimum of one bone will be field tested in shear mode and a minimum of one bone will be field tested in peel mode (inner and outer seam).

Field Test Methods

The 1-inch–wide samples described above under Sampling Procedure, as well as the end-of-seam samples described above under End-of-Seam Sampling, will be field-tested in both peel mode and shear mode. Testing will be performed using a field tensiometer or equivalent device. Seam testing acceptance criteria

for the field testing of the destructive samples and end of seam samples is contained in Table 7-3. If the samples fail the field tensiometer test, then the repair procedures of Subsection 7.3.4 for the holes left by the cutout samples, and the seam reconstruction procedures for the repair of the defective seam, discussed later in this subsection, will be implemented.

Laboratory Test Methods

Laboratory testing of the destructive seam samples will be performed by the geosynthetics testing laboratory or on-site testing laboratory under the direction of the CQA Officer. All destructive seam tests, whether performed on trial seam samples (as described above) or on samples cut out from production seams, will be performed in general accordance with the methodology of ASTM D6392, which stipulates that at least five specimens will be tested in shear and five in peel. All specimens will be cut as 1-inch–wide strips.

The following tests will be performed on each seam sample submitted for laboratory testing:

- Shear and peel maximum tension is the maximum load per unit width of a 1-inch–wide specimen expressed in pounds per inch of width in both the shear and peel mode, according to ASTM D6392.
- Shear elongation at break is the extension at break expressed as a percentage of the initial distance between the edge of the fused track and the nearer grip. This distance should be the same on both sides of the seam and is usually 2 inches.
- Peel seam separation estimates the length of seam bond separation expressed as a percentage of the original bond length.

Also, for both the seam shear and peel tension tests, an indication will be given for each specimen tested that defines the locus of the failure.

For shear tests, the following values will be reported for each specimen tested:

- Maximum tension in pounds per inch
- Elongation at break indicating at what percentage the specimen failed (up to a tested maximum of 50%)
- The locus of failure

Table 7-3
60-mil HDPE Geomembrane Seam Acceptance Criteria

PROPERTY	TEST METHOD	UNITS	TYPE OF CRITERION	ACCEPTANCE VALUES	
				NON-TEXTURED[1]	TEXTURED [1]
Shear strength [2]	ASTM D6392	ppi	Minimum	120	120
Shear elongation [2]	--	%	Minimum	50	50
Peel strength [3],[4] Fusion	ASTM D6392	ppi	Minimum	91	91
Peel strength [3],[4] Extrusion	ASTM D6392	ppi	Minimum	78	78
Peel separation [5],[6]	--	%	Maximum	25	25

Notes:
(1) Values apply for both textured and smooth HDPE geomembranes.
(2) Five out of the five test specimens must meet these requirements. In addition, failure type must be film-tear (FTB) for all five specimens.
(3) Four of the five specimens must meet these requirements. The fifth specimen shall achieve 80 percent of the listed peel strength.
(4) Failure type must be film-tear bond (FTB) for five out of the five specimens.
(5) Maximum Acceptance Value for five out of the five test specimens.
(6) The following are unacceptable break codes:
- Hot wedge: AD and AD-Brk >25%
- Extrusion fillet: AD1, AD2 and AD-WLD (unless strength is achieved)

For peel tests, the following values will be reported for each specimen tested:

- Maximum tension in pounds per inch
- Seam separation expressed as percent of original seam bond length
- Locus of failure

For each set of five specimens, the mean will be calculated and reported for the shear maximum tension and the peel maximum tension.

Role of Testing Laboratory

The geosynthetics testing laboratory or on-site testing laboratory will be responsible for performing the tests on samples submitted to them as described above. The results of tests performed will be reported to the Owner, the CQA Officer, and the RPR. Retesting of seams because of failure to meet any or all of the specifications listed below can only be authorized by the CQA Officer and the Owner.

The Geomembrane Manufacturer and/or the Installer may perform their own quality control testing in accordance with the methods and procedures defined above under Laboratory Test Methods; however, the results, if substantially different from those obtained by the geosynthetics testing laboratory or on-site laboratory, may only be used to request a retesting by the geosynthetics testing laboratory or on-site testing laboratory. All quality assurance test results from the geosynthetics testing laboratory or on-site laboratory govern over any test results from the Geomembrane Manufacturer or the Installer. Only the CQA Officer and the Owner are authorized to approve a retesting request.

Procedures for Determining Destructive Seam Test Failures

The procedures described in this section apply to the destructive testing procedures defined above under Field Test Methods and Laboratory Test Methods. Procedures for repairing failed seams are given in Subsection 7.3.4 of this Plan.

The results from the shear and peel tests for HDPE geomembrane will be evaluated against the criteria tabulated in Table 7-3.

All of the tabular criteria must be met for a given seam to be considered acceptable.

The Installer has the following two options in determining the repair boundary whenever a seam has failed either the field tensiometer testing or the laboratory destructive testing:

1. The seam can be reconstructed between any two previously tested and passed destructive seam test locations.
2. The Installer can trace the welding path to an intermediate location (at a 10-foot minimum from the point of the failed test in each direction) and request that the field tensiometer tests be performed at these intermediate locations. If the field tensiometer sample results are acceptable, then the seam sample will be sent to the geosynthetics testing laboratory. If either sample fails, then the process will be repeated until acceptable destructive seam tests have been performed in both directions away from the original failed sample location. All retesting of seams according to this procedure will use the sampling methodology described earlier in this Plan under Sampling Procedure.

   The tracing of a failed seam test will continue until the seaming path boundaries are located, tracking will continue into the previous day's work if needed and into the next day's welding as well.

Seams reconstructed due to a failing destructive seam sample that are in excess of 100 feet long will be destructed tested, and any additional samples taken from the reconstructed zone must pass destructive seam testing.

The RPR will be responsible for documenting all actions, including test results submitted by the geosynthetics testing laboratory, taken in conjunction with seam testing. The RPR will also be responsible for keeping the CQA Officer informed on seam testing results and seaming progress.

7.5 Post-Installation

Each component covered by this Plan will be examined by the RPR. Any defects, whether due to failed seams, pinholes, or other penetrations, will be repaired.

Placement of the geotextile cushion and concrete pavement will proceed as soon as practicable following the RPR's testing and acceptance of completed geomembrane areas. Prior to installation of concrete pavement, a liner integrity survey will be performed to document the integrity of the geomembrane liner system. Methods such as electrical leak location (ASTM D7002 or ASTM D7007) or a submitted alternate approved by the engineer are suitable. Defects identified by the integrity survey will be repaired and approved by the RPR prior to placing concrete pavement. The geotextile cushion and concrete pavement will provide ultraviolet protection, thermal insulation, and protection from physical damage.

Section 8
Geotextile

8.1 General

This section of the CQA Plan applies to nonwoven geotextile used throughout the facility. Geotextile will be installed in the following locations:

- Cushion geotextile
- Separation geotextile

This section is further divided into three major subheadings, which cover the quality assurance requirements for pre-installation (which includes Geotextile Manufacturers), installation, and post-installation (which includes the final examination of the geotextiles prior to placing the appropriate material above the geotextile). The terms pre-installation, installation, and post-installation are applicable only to the geotextile and do not apply to the overall construction of the facility.

8.2 Pre-Installation

8.2.1 Manufacturing

The geotextile will be supplied to the site in factory rolls. Prior to the delivery of any geotextile rolls, the Geotextile Manufacturer will provide the CQA Officer and the Owner with the manufacturer's Quality Control Plan used for the production of the geotextile.

Every roll of geotextile for delivery to the site will be manufactured and inspected by the Geotextile Manufacturer, according to the following requirements:

- The geotextile must contain no needles used for punching.
- The geotextile must be free of holes and any other sign of contamination by foreign matter.

The Geotextile Manufacturer will provide certification, based on tests performed in accordance with the methods listed in Table 8-1 that the geotextile supplied under this Plan will meet the material specifications listed on Tables 8-2 and 8-3. These tests may be performed by the Geotextile Manufacturer's laboratory or a laboratory contracted by the Manufacturer. Additionally, the Geotextile Manufacturer will provide certification that the Manufacturer's Quality Control Plan was fully implemented for the geotextile materials supplied under this plan and that the geotextile delivered to the site does not contain needles. The Geotextile Manufacturer will provide documentation to verify the results of the Manufacturer's CQA Plan implementation required by the CQA Officer and the Owner.

The geotextile rolls will be tested and evaluated prior to acceptance. The CQA Officer may perform/require additional testing (i.e., conformance testing) as required by detailed specifications or as required in the judgment of the CQA Officer to verify that the geotextile meets the specifications.

8.2.2 Delivery, Handling, and Storage of Geotextile Rolls

Each geotextile roll to be used at the site will be marked by the Geotextile Manufacturer with the following information and in the following manner:

When fabric is rolled on a core, each roll will be identified with a durable gummed label, or an equivalent, on the inside of the core and on the outside of the protective wrapping for the roll.

- Each roll label will contain the following information at a minimum:
  - Name of manufacturer
  - Style and type number
  - Roll length and width
  - Batch (or lot) number
  - Nominal product thickness
  - Date of manufacture
  - Roll number

Table 8-1
Geotextile Tests and Test Methods

PROPERTY	TEST METHOD
Grab tensile strength(1) (2)	ASTM D4632
Grab elongation(1) (2)	ASTM D4632
Puncture (CBR) strength(1) (2)	ASTM D6241
Trapezoidal tear(1) (2)	ASTM D4533
Apparent opening size(1)	ASTM D4751
Permittivity(1)	ASTM D4491
Mass per unit area(2)	ASTM D5261
UV resistance(3)	ASTM D4355 or D7238

Notes:
(1) Testing is required for separation geotextile.
(2) Testing is required for cushion geotextile.
(3) Testing is required only if the geotextile is to be uncovered for more than 30 days. Evaluation to be on 50 mm strip tensile specimens after 500 hour exposure.

Table 8-2
Separation Geotextile

PROPERTIES AND REQUIREMENTS	QUALIFIER	UNITS	SPECIFIED VALUES[1]	TEST METHOD
Polymer composition	Minimum	Percent	95 percent polypropylene or polyester by weight	
Permittivity	Minimum	1/s	0.05	ASTM D4491
Apparent opening size (AOS)	Maximum	Sieve	40	ASTM D4751
Grab strength[2][3]	Minimum	lb	315/203	ASTM D4632
Tear strength[2][3]	Minimum	lb	112/79	ASTM D4533
CBR Puncture strength[3]	Minimum	lb	630/440	ASTM D6241
UV Resistance	Minimum	%	50	ASTM D4355 or D7238

Notes:

(1) All values represent minimum average roll values (i.e., all rolls in a lot shall meet or exceed the values in this table).

(2) Minimum value measured in machine and cross machine direction.

(3) Two values are provided for strength requirements. The first value is applicable to woven geotextiles. The second value is applicable to geotextiles that break at elongations ≥ 50% (e.g., nonwoven geotextiles).

Table 8-3
Cushion Geotextile

PROPERTIES AND REQUIREMENTS	QUALIFIER	UNITS	SPECIFIED VALUES[1]	TEST METHOD
Type	--	--	Nonwoven	--
Polymer composition	Minimum	Percent	95 percent polypropylene or polyester by weight	
Mass per unit area	Minimum	oz/yd^2	32	ASTM D5261
Grab strength[2]	Minimum	lb	600	ASTM D4632
Tear strength[2]	Minimum	lb	270	ASTM D4533
CBR Puncture strength	Minimum	lb	2,200	ASTM D6241
UV Resistance	Minimum	%	70	ASTM D4355 or D7238

Notes:

(1) All values represent minimum average roll values (i.e., all rolls in a lot shall meet or exceed the values in this table).

(2) Minimum value measured in machine and cross machine direction.

The Geotextile Manufacturer will use the following guidelines in packaging, wrapping, and preparing all geotextile rolls for shipment:

- When cores are required, those that have a crushing strength sufficient to avoid collapse or other damage while in use will be used.
- Each roll will be covered with a wrapping material that will protect the geotextile from damage due to shipment, water, sunlight, or contaminants.

The following practices will be used as minimum in receiving and storing geotextile rolls in the designated storage area at the job site:

- While unloading or transferring the geotextile rolls from one location to another, care will be taken to prevent damage to the wrapping or the geotextile itself. If practicable, the Installer/Contractor may use forklift trucks fitted with poles that can be inserted into the cores of rolls. The poles will be at least two-thirds the length of the rolls, to prevent breaking the cores and possibly damaging the geotextile. Rolls will not be dragged.
- The geotextile rolls will be stored in such a manner so as to ensure that they are adequately protected from the following:
    - Precipitation
    - Ultraviolet radiation, including sunlight
    - Strong oxidizing chemicals, acids or bases
    - Flames, including welding sparks
    - Temperatures in excess of 160°Fahrenheit
    - Soiling

The RPR will observe and document, throughout the pre-installation, installation, and post-installation periods, that the Installer provides adequate handling equipment used for moving geotextile rolls and that the equipment and handling methods used do not pose unnecessary risk of damage. The Installer/Contractor is responsible for the means and methods to implement the work.

- The Installer will responsible for ensuring that all materials installed meet specifications. The RPR will maintain a log of the geotextile rolls delivered. The following information, at a minimum, will be recorded on the log for each shipment received at the job site:
    - Date of delivery at the job site
    - For each roll of geotextile, the roll number and the batch (lot) number

8.3 Installation

This section describes the quality assurance requirements applicable to the installation, observation, and documentation of geotextile.

8.3.1 Placement

The Installer will install all geotextile in such a manner so as to ensure that it is not damaged and that it complies with the following requirements:

- On sideslopes, the geotextile will be securely anchored and then rolled down the slope in such a manner so as to continually keep the geotextile in tension.
- In the presence of wind, all geotextile will be secured by suitable methods. The temporary securing material will be left in place until replaced with cover material, if applicable.
- In-place geotextile will be cut with special care to protect other materials from damage that could be caused by the cutting of the geotextile.
- The Installer will take the necessary precautions to prevent damage to any underlying layers during placement of the geotextile.
- During placement of the geotextile, care will be taken not to entrap in the geotextile any stones, excessive dust, or moisture that could damage the geotextile or the underlying geosynthetics, or that could clog drains or filters.
- A visual examination of the geotextile will be carried out over the entire surface after the installation by the Installer to ensure that no potentially harmful objects, such as needles, are present.
- The edges of the geomembrane between phases will be protected with a geotextile wrap and/or an overlying protective material until the edges are spliced together with the liner system of the adjacent phase.

8.3.2 Seams and overlaps

- Geotextile placed as geotextile cushion (to protect the geomembrane liner from the concrete) will be continuously sewn, heat-bonded or seamed using another method approved by the CQA Officer. Geotextile will be overlapped 6 inches prior to seaming. The sewing method and stitch type will be per the Manufacturer's recommendation, but must be approved by the CQA Officer and the Owner. Overlapping of geotextile without sewing may be acceptable for certain applications (*i.e.*, seams under riprap, access roads) with approval from the CQA Officer.
- No horizontal seams will be allowed on slopes steeper than 5 horizontal to 1 vertical (i.e., seams will be along, not across, the slopes), except as part of a geotextile repair.

- Sewing will be performed with thread made from the same base material as the geotextile, or suitable equivalent.
- The Installer will pay particular attention to seams to ensure that materials are not inadvertently trapped beneath the geotextile.

The RPR will be responsible for observing and documenting that the above provisions are performed by the Installer in an acceptable manner.

8.4 Post-Installation

8.4.1 Final Examination

The RPR will perform a final geotextile examination after the installation of each geotextile layer has been completed. The objectives of the final examination are as follows:

- To examine for the presence of holes, tears, or other deterioration
- To examine for excessive tension due to stretching of the fabric during installation
- To examine for the presence of foreign objects (i.e., stones, soil clods) beneath the geotextile

If there will be an extended time delay between completion of the geotextile and the start of the installation of any other cover, then the Installer will make provisions by temporarily securing the geotextile using suitable methods to protect it from wind uplift. The RPR will document in the daily report the placement of the temporary securing methods used.

8.4.2 Placement of Materials

The Construction Contractor will place concrete or soil on top of a geotextile in such a manner so as to minimize the following:

- Damage to the geosynthetics
- Slippage of the geotextile on underlying layers
- Excessive tensile stresses imposed on the geotextile

COORDINATE GEOMETRY TABLES

Table 1
Thickness and Elevation Information
NORTH POND LINER CONSTRUCTION COORDINATES
Retrofit - Sludge Sedimentation Basins
Clover, Virginia

POINT NO.	DESIGN LOCATION		SUBBASE GRADES		TOP OF 2' THICK CLAY LINER - BASE GRADES			TOP OF CONCRETE GRADES			COMMENTS
	NORTH	EAST	DESIGN (ft)	ACTUAL (ft)	DESIGN (ft)	ACTUAL (ft)	DELTA (ft)	DESIGN (ft)	ACTUAL (ft)	DELTA (ft)	
100	3476602.51	11423851.33	374.00		NA			NA			Subbase Top of Berm at Corner
101	3476542.06	11423963.46	374.00		NA			NA			Subbase Top of Berm
102	3476496.19	11424048.79	374.00		NA			NA			Subbase Top of Berm
103	3476453.99	11424127.17	374.00		NA			NA			Subbase Top of Berm
104	3476410.60	11424159.66	374.00		NA			NA			Subbase Top of Berm
105	3476367.26	11424153.43	374.00		NA			NA			Subbase Top of Berm
106	3476348.66	11424143.43	374.00		NA			NA			Subbase Top Berm/Intersection 3:1 Slopes
107	3476324.41	11424143.62	369.67		371.67			NA			Intersect 3:1 & 16% Slope (see Note 1)
108	3476305.92	11424133.66	369.67		371.67			NA			Intersect 3:1 & 16% Slope (see Note 1)
109	3476292.73	11424113.31	374.00		NA			NA			Subbase Top Berm/Intersection 3:1 Slopes
110	3476277.58	11424105.15	374.00		NA			NA			Subbase Top of Berm/End of Liner
111	3476282.46	11423968.98	374.00		NA			374.33			Subbase Top of Berm/Top 4" Concrete
112	3476297.24	11423941.53	374.00		NA			374.33			Subbase Top of Berm/Top 4" Concrete
113	3476343.10	11423856.35	374.00		NA			374.33			Subbase Top of Berm/Top 4" Concrete
114	3476403.48	11423744.18	374.00		NA			374.33			Subbase Top of Berm/Top 4" Concrete
115	3476499.33	11423795.78	374.00		NA			NA			Subbase Top of Berm
116	3476416.13	11423786.31	363.63		365.63			366.46			Subbase Toe of Slope (see Note 2)
117	3476484.62	11423823.17	363.63		365.63			366.46			Subbase Toe of Slope (see Note 2)
118	3476560.40	11423863.96	363.64		365.64			366.47			Subbase Toe of Slope (see Note 2)
119	3476513.47	11423948.07	363.16		365.16			365.99			Subbase Toe of Slope (see Note 2)
120	3476466.27	11424032.66	362.67		364.67			365.50			Subbase Toe of Slope (see Note 2)
121	3476422.89	11424110.42	362.23		364.23			365.06			Subbase Toe of Slope (see Note 2)
122	3476404.16	11424124.60	362.12		364.12			364.95			Subbase Toe of Slope (see Note 2)
123	3476383.06	11424121.34	362.08		364.08			364.91			Subbase Toe of Slope (see Note 2)
124	3476346.89	11424101.86	362.08		364.08			365.91			Subbase Toe of Slope (see Note 2 & 3)
125	3476328.40	11424091.90	362.08		364.08			365.91			Subbase Toe of Slope (see Note 2 & 3)

Table 1
Thickness and Elevation Information
NORTH POND LINER CONSTRUCTION COORDINATES
Retrofit - Sludge Sedimentation Basins
Clover, Virginia

POINT NO.	DESIGN LOCATION		SUBBASE GRADES		TOP OF 2' THICK CLAY LINER - BASE GRADES			TOP OF CONCRETE GRADES			COMMENTS
	NORTH	EAST	DESIGN (ft)	ACTUAL (ft)	DESIGN (ft)	ACTUAL (ft)	DELTA (ft)	DESIGN (ft)	ACTUAL (ft)	DELTA (ft)	
126	3476294.47	11424073.64	362.08		364.08			364.91			Subbase Toe of Slope (see Note 2)
127	3476325.35	11424015.97	362.41		364.41			365.24			Base of Pond/End of Liner
128	3476316.68	11423987.32	362.51		364.51			365.34			Base of Pond/End of Liner
129	3476312.87	11423985.20	362.51		364.51			365.34			Subbase Toe of Slope (see Note 2)
130	3476327.16	11423957.67	362.67		364.67			365.50			Subbase Toe of Slope (see Note 2)
131	3476371.75	11423871.77	363.15		365.15			365.98			Subbase Toe of Slope (see Note 2)
132	3476439.07	11423908.01	363.15		365.15			365.98			Base Liner
133	3476393.18	11423993.47	362.67		364.67			365.50			Base Liner
134	3476594.39	11423853.77	372.00		374.00			NA			Top of Clay at Berm Start 3:1 Slope
135	3476536.84	11423960.65	372.00		374.00			NA			Top of Clay at Berm Start 3:1 Slope
136	3476490.91	11424045.94	372.00		374.00			NA			Top of Clay at Berm Start 3:1 Slope
137	3476448.70	11424124.32	372.00		374.00			NA			Top of Clay at Berm Start 3:1 Slope
138	3476409.44	11424153.70	372.00		374.00			NA			Top of Clay at Berm Start 3:1 Slope
139	3476369.79	11424147.99	372.00		374.00			NA			Top of Clay at Berm Start 3:1 Slope
140	3476348.36	11424136.45	372.00		374.00			NA			Top of Clay at Berm Start 3:1 Slope
141	3476298.71	11424109.72	372.00		374.00			NA			Top of Clay at Berm Start 3:1 Slope
142	3476280.38	11424099.87	372.00		374.00			NA			Top of Clay at Berm Start 3:1 Slope
143	3476287.74	11423971.83	372.00		374.00			374.33			Top of Clay at Berm Start 3:1 Slope
144	3476302.52	11423944.38	372.00		374.00			374.33			Top of Clay at Berm Start 3:1 Slope
145	3476348.38	11423859.19	372.00		374.00			374.33			Top of Clay at Berm Start 3:1 Slope
146	3476405.92	11423752.31	372.00		374.00			374.33			Top of Clay at Berm Start 3:1 Slope
147	3476496.54	11423800.98	372.00		374.00			NA			Top of Clay at Berm Start 3:1 Slope

Notes:
1. 12 inch aggregate layer between geosynthetic layer/24 inch compacted clay - see Detail 3 on Sheet S3115.
2. Toe of slope for top of concrete is offset approximately 0.9 feet from the toe of slope for the subgrade and top of clay due to 10 inch thick concrete base intersecting with 6 inch thick concrete on 3:1 sideslope - see Detail 7 on Sheet S3114. Surveyor document coordinate and elevation for top of concrete at offset toe of slope.
3. Top of concrete elevation includes concrete for ramp.

Prepared By: L. Stormer
Checked By: D. Marshall, J. Hotstream 11/4/2016

Table 2
Thickness and Elevation Information
SOUTH POND LINER CONSTRUCTION COORDINATES
Retrofit - Sludge Sedimentation Basins
Clover, Virginia

POINT NO.	DESIGN LOCATION		SUBBASE GRADES		TOP OF 2' THICK CLAY LINER - BASE GRADES			TOP OF CONCRETE GRADES			COMMENTS
	NORTH	EAST	DESIGN (ft)	ACTUAL (ft)	DESIGN (ft)	ACTUAL (ft)	DELTA (ft)	DESIGN (ft)	ACTUAL (ft)	DELTA (ft)	
200	3476204.72	11423637.17	374.00		NA			NA			Subbase Top of Berm at Corner
201	3476305.41	11423691.38	374.00		NA			NA			Subbase Top of Berm
202	3476374.34	11423728.49	374.00		NA			NA			Subbase Top of Berm
203	3476390.28	11423750.77	374.00		NA			374.33			Subbase Top Berm/Top 4" Conc. on Berm
204	3476386.73	11423771.07	374.00		NA			374.33			Subbase Top of Berm/Top 4" Concrete
205	3476341.46	11423855.16	374.00		NA			374.33			Subbase Top of Berm/Top 4" Concrete
206	3476295.48	11423940.57	374.00		NA			374.33			Subbase Top of Berm/Top 4" Concrete
207	3476273.49	11423981.42	374.00		NA			374.33			Subb Top Bm/Top 4" Conc./3:1 intersec
208	3476275.25	11423982.37	374.00		NA			374.33			Subb Top Bm/Top 4" Conc./3:1 intersec
209	3476282.46	11423968.98	374.00		NA			374.33			Subbase Top of Berm/Top 4" Concrete
210	3476312.80	11423985.32	362.51		364.51			365.34			Subbase Toe of Slope (see Note 2)
211	3476289.57	11424030.08	362.26		364.26			365.09			Subbase Toe of Slope (see Note 2)
212	3476298.84	11424035.07	362.26		364.26			365.09			Top/Corner 8% Ramp (see Note 3)
213	3476279.98	11424065.90	362.10		364.10			364.93			Top/Corn. 8% Ramp (see Notes 2 & 3)
214	3476262.83	11424097.28	374.00		NA			NA			Subbase Top of Berm
215	3476154.75	11424039.01	374.00		NA			NA			Subbase Top Berm/Intersect 3:1 Slopes
216	3476130.49	11424039.20	369.67		371.67			NA			Intersect 3:1 & 16% Slope (see Note 1)
217	3476112.00	11424029.25	369.67		371.67			NA			Intersect 3:1 & 16% Slope (see Note 1)
218	3476098.81	11424008.88	374.00		NA			NA			Subbase Top Berm/Intersect 3:1 Slopes
219	3476078.60	11423998.01	374.00		NA			NA			Subbase Top of Berm
220	3476048.49	11423958.24	374.00		NA			NA			Subbase Top of Berm
221	3476054.22	11423916.74	374.00		NA			NA			Subbase Top of Berm
222	3476099.23	11423833.13	374.00		NA			NA			Subbase Top of Berm
223	3476145.21	11423747.72	374.00		NA			NA			Subbase Top of Berm
224	3476217.37	11423679.32	363.63		365.63			366.46			Subbase Toe of Slope (see Note 2)
225	3476290.69	11423718.79	363.63		365.63			366.46			Subbase Toe of Slope (see Note 2)
226	3476359.59	11423755.87	363.63		365.63			366.46			Subbase Toe of Slope (see Note 2)
227	3476312.92	11423839.53	363.15		365.15			365.98			Subbase Toe of Slope (see Note 2)
228	3476265.66	11423924.25	362.67		364.67			365.50			Subbase Toe of Slope (see Note 2)

Table 2
Thickness and Elevation Information
SOUTH POND LINER CONSTRUCTION COORDINATES
Retrofit - Sludge Sedimentation Basins
Clover, Virginia

POINT NO.	DESIGN LOCATION		SUBBASE GRADES		TOP OF 2' THICK CLAY LINER - BASE GRADES			TOP OF CONCRETE GRADES			COMMENTS
	NORTH	EAST	DESIGN (ft)	ACTUAL (ft)	DESIGN (ft)	ACTUAL (ft)	DELTA (ft)	DESIGN (ft)	ACTUAL (ft)	DELTA (ft)	
229	3476225.78	11423995.74	362.26		364.26			365.09			Subbase Toe of Slope (see Note 2)
230	3476216.53	11423990.76	362.26		364.26			365.09			Top/Corner 8% Ramp (see Note 3)
231	3476247.76	11424018.67	359.00		361.00			362.50			Bot/Corner 8% Ramp (see Note 3)
232	3476258.32	11424024.36	359.00		361.00			362.50			Bot/Corner 8% Ramp (see Note 3)
233	3476250.27	11424039.33	359.00		361.00			362.50			Bot/Corner 8% Ramp (see Note 3)
234	3476239.70	11424033.64	359.00		361.00			362.50			Bot/Corner 8% Ramp (see Note 3)
235	3476201.37	11424023.51	362.08		364.08			364.91			Top/Corn. 8% Ramp (see Notes 2 & 3)
236	3476152.98	11423997.43	362.08		364.08			365.91			Subbase Toe of Slope (see Note 2 & 4)
237	3476134.49	11423987.48	362.08		364.08			365.91			Subbase Toe of Slope (see Note 2 & 4)
238	3476095.56	11423966.51	362.08		364.08			364.91			Subbase Toe of Slope (see Note 2)
239	3476083.28	11423950.45	362.12		364.12			364.95			Subbase Toe of Slope (see Note 2)
240	3476085.40	11423933.52	362.20		364.20			365.03			Subbase Toe of Slope (see Note 2)
241	3476129.04	11423849.45	362.67		364.67			365.50			Subbase Toe of Slope (see Note 2)
242	3476173.75	11423763.34	363.16		365.16			365.99			Subbase Toe of Slope (see Note 2)
243	3476245.64	11423802.69	363.15		365.15			365.98			Base Liner
244	3476199.75	11423888.15	362.67		364.67			365.50			Base Liner
245	3476207.16	11423645.30	372.00		374.00			NA			Top of Clay at Berm Start 3:1 Slope
246	3476302.57	11423696.66	372.00		374.00			NA			Top of Clay at Berm Start 3:1 Slope
247	3476371.49	11423733.77	372.00		374.00			NA			Top of Clay at Berm Start 3:1 Slope
248	3476384.36	11423751.75	372.00		374.00			374.33			Top of Clay at Berm Start 3:1 Slope
249	3476381.45	11423768.22	372.00		374.00			374.33			Top of Clay at Berm Start 3:1 Slope
250	3476336.20	11423852.28	372.00		374.00			374.33			Top of Clay at Berm Start 3:1 Slope
251	3476290.22	11423937.69	372.00		374.00			374.33			Top of Clay at Berm Start 3:1 Slope
252	3476287.74	11423971.83	372.00		374.00			374.33			Top of Clay at Berm Start 3:1 Slope
253	3476277.69	11423990.50	372.00		374.00			374.33			Top of Clay at Berm Start 3:1 Slope
254	3476265.36	11423983.86	372.00		374.00			374.33			Top of Clay at Berm Start 3:1 Slope
255	3476265.71	11424091.94	372.00		374.00			NA			Top of Clay at Berm Start 3:1 Slope
256	3476154.46	11424032.04	372.00		374.00			NA			Top of Clay at Berm Start 3:1 Slope
257	3476104.79	11424005.29	372.00		374.00			NA			Top of Clay at Berm Start 3:1 Slope

Table 2
Thickness and Elevation Information
SOUTH POND LINER CONSTRUCTION COORDINATES
Retrofit - Sludge Sedimentation Basins
Clover, Virginia

POINT NO.	DESIGN LOCATION		SUBBASE GRADES		TOP OF 2' THICK CLAY LINER - BASE GRADES			TOP OF CONCRETE GRADES			COMMENTS
	NORTH	EAST	DESIGN (ft)	ACTUAL (ft)	DESIGN (ft)	ACTUAL (ft)	DELTA (ft)	DESIGN (ft)	ACTUAL (ft)	DELTA (ft)	
258	3476081.45	11423992.72	372.00		374.00			NA			Top of Clay at Berm Start 3:1 Slope
259	3476054.43	11423956.91	372.00		374.00			NA			Top of Clay at Berm Start 3:1 Slope
260	3476059.50	11423919.58	372.00		374.00			NA			Top of Clay at Berm Start 3:1 Slope
261	3476104.49	11423836.01	372.00		374.00			NA			Top of Clay at Berm Start 3:1 Slope
262	3476150.47	11423750.60	372.00		374.00			NA			Top of Clay at Berm Start 3:1 Slope

Notes:

Prepared By: L. Stormer

Checked By: D. Marshall/J. Hotstream 11/4/2016

1. 12 inch aggregate layer between geosynthetic layer/24 inch compacted clay - see Detail 3 on Sheet S3115.
2. Toe of slope for top of concrete is offset approximately 0.9 feet from the toe of slope for the subgrade and top of clay due to 10 inch thick concrete base intersecting with 6 inch thick concrete on 3:1 sideslope - see Detail 7 on Sheet S3114. Surveyor document coordinate and elevation for top of concrete at offset toe of slope.
3. Subgrade at corner of pump station intersects with liner subgrade - see Detail 1 on Sheet S3116.
4. Top of concrete elevation includes concrete for ramp.

Table 3
Thickness and Elevation Information
NORTH AND SOUTH BASIN RAMPS AND LOADOUT CONSTRUCTION COORDINATES
Retrofit - Sludge Sedimentation Basins
Clover, Virginia

POINT NO.	DESIGN LOCATION		SUBBASE GRADES		TOP OF 2' THICK LINER - BASE GRADES		TOP OF CONCRETE GRADES		COMMENTS
	NORTH	EAST	DESIGN (ft)	ACTUAL (ft)	DESIGN (ft)	ACTUAL (ft)	DESIGN (ft)	ACTUAL (ft)	
NORTH BASIN RAMP - See Details 1, 2 and 3 on Plan Sheet S3115									
1	3476352.49	11424091.47	362.14		364.14		364.97		End of Ramp 8%
2	3476334.00	11424081.51	362.14		364.14		364.97		End of Ramp 8%
3	3476328.40	11424091.90	362.08		364.08		365.91		Intersection of 8% and 16% Ramp
4	3476346.89	11424101.86	362.08		364.08		365.91		Intersection of 8% and 16% Ramp
5	3476288.75	11424124.41	370.00		372.00		374.00		Corner of Ramp
6	3476305.92	11424133.65	369.67		371.67		373.50		Corner of Ramp
7	3476324.41	11424143.61	369.67		371.67		373.50		Corner of Ramp
8	3476359.19	11424162.34	370.07		372.07		374.00		Corner of Ramp
9	3476349.70	11424179.95	370.57		372.57		374.40		Corner of Ramp
10	3476314.93	11424161.22	370.17		372.17		374.00		Start of 2.5% slope
11	3476296.44	11424151.26	370.17		372.17		374.00		Start of 2.5% slope
12	3476279.27	11424142.01	370.37		372.37		374.20		Corner of Ramp
SOUTH BASIN RAMP - See Details 1, 2 and 3 on Plan Sheet S3115									
13	3476158.67	11423987.12	362.14		364.14		364.97		End of Ramp 8%
14	3476140.02	11423977.08	362.14		364.14		364.97		End of Ramp 8%
15	3476134.50	11423987.47	362.08		364.08		365.91		Intersection of 8% and 16% Ramp
16	3476152.99	11423997.43	362.08		364.08		365.91		Intersection of 8% and 16% Ramp
17	3476094.83	11424020.00	370.00		372.00		374.00		Corner of Ramp
18	3476112.00	11424029.25	369.67		371.67		373.50		Corner of Ramp
19	3476130.49	11424039.21	369.67		371.67		373.50		Corner of Ramp
20	3476165.26	11424057.94	370.07		372.07		374.00		Corner of Ramp
21	3476155.78	11424075.55	370.57		372.57		374.40		Corner of Ramp
22	3476121.00	11424056.82	370.17		372.17		374.00		Start of 2.5% slope
23	3476102.52	11424046.86	370.17		372.17		374.00		Start of 2.5% slope
24	3476085.35	11424037.61	370.37		372.37		374.20		Corner of Ramp

Table 3
Thickness and Elevation Information
NORTH AND SOUTH BASIN RAMPS AND LOADOUT CONSTRUCTION COORDINATES
Retrofit - Sludge Sedimentation Basins
Clover, Virginia

POINT NO.	DESIGN LOCATION		SUBBASE GRADES		TOP OF 2' THICK LINER - BASE GRADES		TOP OF CONCRETE GRADES		COMMENTS
	NORTH	EAST	DESIGN (ft)	ACTUAL (ft)	DESIGN (ft)	ACTUAL (ft)	DESIGN (ft)	ACTUAL (ft)	
LOADOUT PAD - See Detail 1 on Plan Sheet S3117									
25	3476069.72	11423830.77	375.11		N/A		376.44		Corner of Loadout Pad
26	3476053.62	11423822.72	375.11		N/A		376.44		Corner of Loadout Pad
27	3476035.74	11423858.50	375.11		N/A		376.44		Corner of Loadout Pad
28	3476051.84	11423866.55	375.11		N/A		376.44		Corner of Loadout Pad

Prepared By: D. Marshall 11/3/16

Checked By: J. Hotstream 11/4/2016