

APPENDIX A

Site Life and Cell/Phase/Area Capacity Calculations

INTRODUCTION

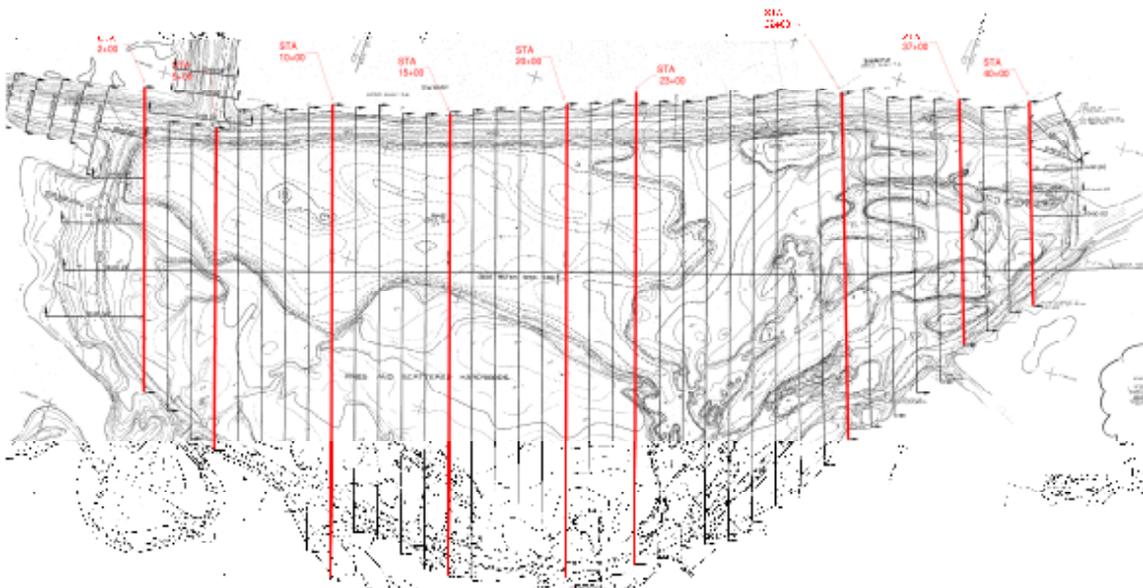
Estimate the Maximum CCR Placement capacity with the Upper (East) Pond. Three scenarios will be evaluated:

- Original pumped impoundment placement, to the approximate dike elevation;
- Placement during ongoing closure activities since 1996, modified in 2003; and
- Modifications to the closure activities as part of the 2015 CCR Closure Plan.

ORIGINAL PLACEMENT

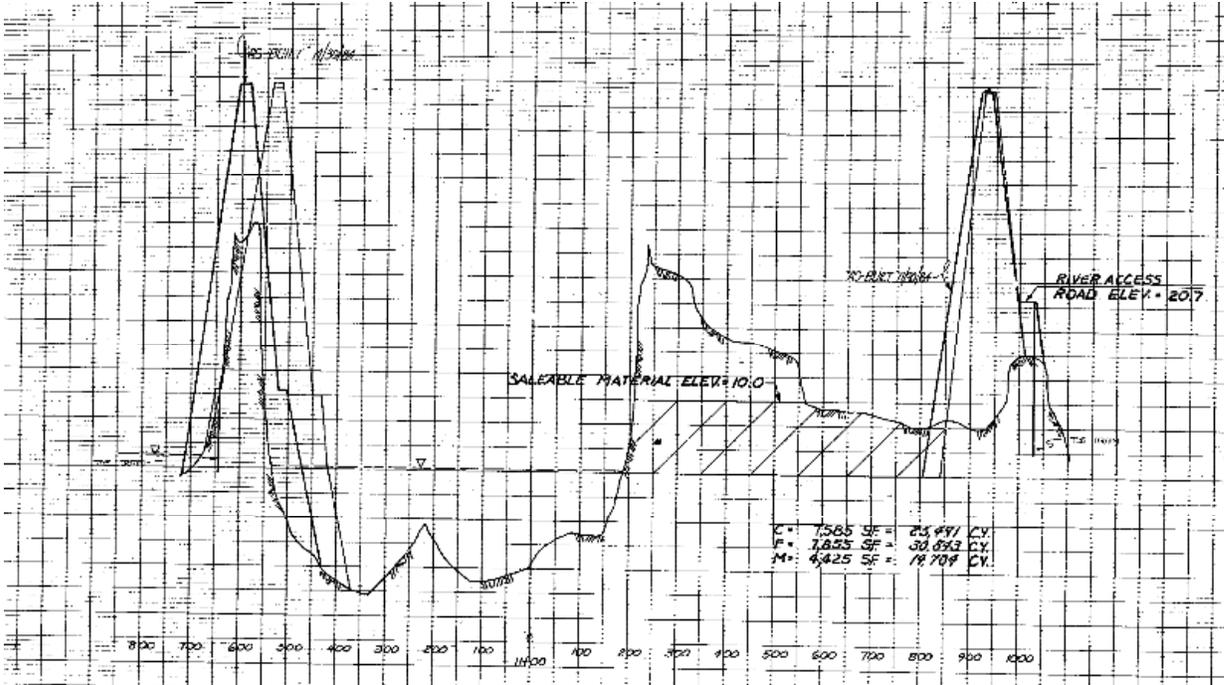
Original Upper (East) Pond (UEP) construction drawings were used to estimate the volume of CCR material placed to the embankment dike elevation. Cross sections from the drawings were used with the Average End Area method to estimate volume.

Cross section locations are:





A typical cross section is shown:



Summarizing the areas at the selected cross sections:

	STATION									
	2+00	5+00	10+00	15+00	20+00	23+00	32+00	33+00	37+00	40+00
Area (SF)	1,753	2,250	2,755	3,045	3,181	2,989	1,711	1,617	1,116	596
True Area (SF)	35,066	45,008	55,092	60,906	63,622	59,788	34,228	32,336	22,314	11,922
Ag. Area (SF)		40,037	50,050	57,999	62,264	61,705	47,008	33,282	27,325	17,118
Distance (FT)		300	500	500	500	300	900	100	400	300
Inc. Volume (CF)	0	12,011,100	25,025,000	28,999,500	31,132,000	18,511,500	42,307,200	3,328,200	10,930,000	5,135,400
Cumulative Vol. (CF)	0	12,011,100	37,036,100	66,035,600	97,167,600	115,679,100	157,986,300	161,314,500	172,244,500	177,379,900
Cumulative Vol. (CY)	0	444,856	1,371,707	2,445,763	3,598,800	4,284,411	5,851,344	5,974,611	6,379,426	6,569,626

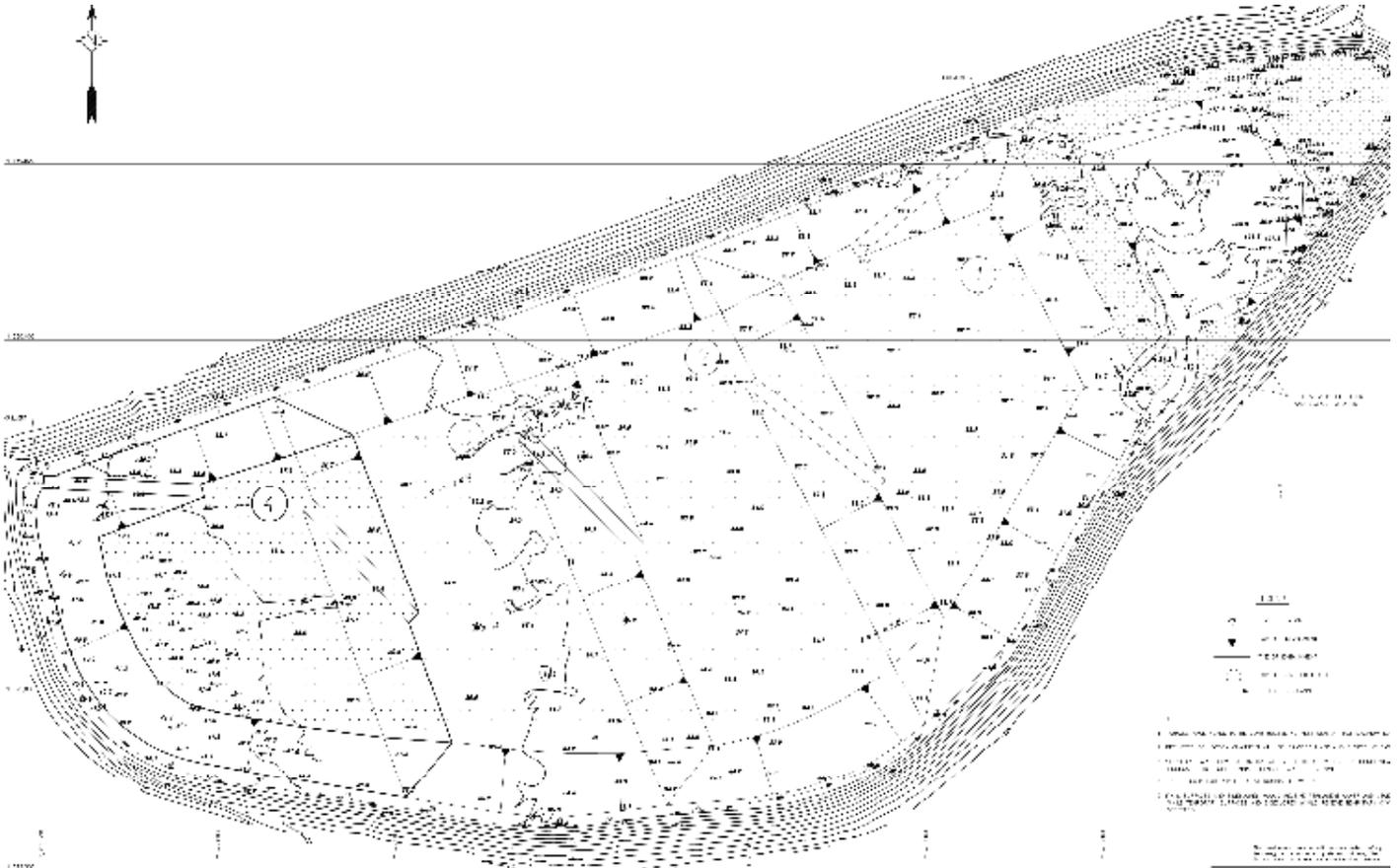
The UEP was not completely filled to elevation 41 at the time the 1996/2003 closure began. Adjusting the volume based on the 2003 closure plan projected volumes and current topographic models of the UEP gives:

Total volume placed prior to implementation of 1996/2003 closure plan = 5.48 million cubic yards.



2003 CLOSURE

In 2003, a closure configuration was approved for the UEP, consisting of placement of CCR material in 7 cells. As of the grading used at the initiation of the CCR Closure Plan, Cells 1-4 were completed. From the 2003 plan, the material to be placed in these cells was 5.39 million cubic yards as shown:



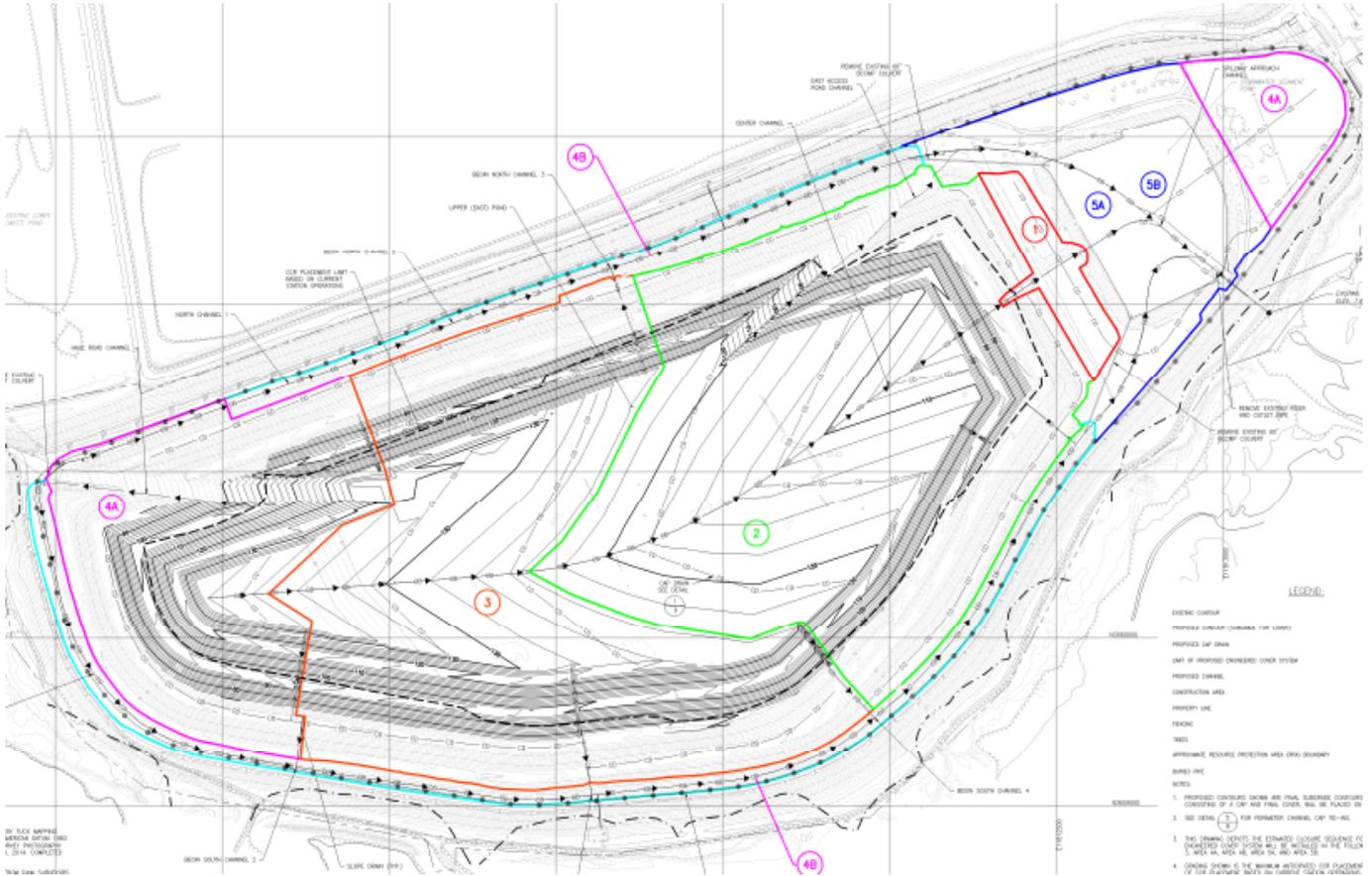
Cells 1-4

Cell	Volume (Ac-ft)	Volume (yd ³)	Life Expectancy (yr) *	Closure Year *
1	625.55	1,009,298	3.4	2001
2	827.05	1,334,417	4.4	2005
3	979.18	1,579,874	4.8	2010
4	911.24	1,470,253	3.5	2014
Subtotal (Phase I)	3,343.02	5,393,842	16.1	2014



CCR CLOSURE

Under the CCR Closure plan, the material would be placed as shown:



This consists of CCR placement and grading activities in Areas 1, 2, 3, 4A, 4B, 5A, and 5B. The net CCR placement in these areas is 3.40 million cubic yards.

SUBJECT DOMINION – CHESTERFIELD POWER STATION
UPPER (EAST) POND - CAPACITY

BY KMB2 DATE 08/11/2015

PROJ. NO. C150035.00

CHKD. BY KMB DATE 12/10/2015 SHEET NO. 5 OF 5



CCR placement will consist of:

CCR PLACEMENT, CCR Closure Plan

CCR Closure Total	3,400,000 cy
Cells 1-4	5,393,842 cy
Original Placement	5,480,000 cy
TOTAL VOLUME	14,300,000 cy

APPENDIX B
Construction Quality Assurance Plan
Upper (East) Pond CCR Closure



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Construction Quality Assurance Plan Upper (East) Pond CCR Closure

Virginia Electric and Power Company
Chesterfield Power Station
Chesterfield County, Virginia

GAI Project Number: C150035.00

January 2016



Prepared by: GAI Consultants, Inc.
Richmond Office
4198 Cox Road, Suite 114
Richmond, Virginia 23060

Prepared for: Virginia Electric and Power Company
5000 Dominion Boulevard
Glen Allen, Virginia 23060

Construction Quality Assurance Plan Upper (East) Pond CCR Closure

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Table of Contents

1.0 Acronyms1

2.0 Introduction2

3.0 Implementation.....2

Appendix A Construction Quality Assurance Plan – Chesterfield Integrated Ash Project

1.0 Acronyms

CCR	Coal Combustion Residuals
CQA	Construction Quality Assurance
CCR CQA Plan	CCR Closure Construction Quality Assurance Plan
UEP	Upper (East) Pond
Station	Chesterfield Power Station
Dominion	Dominion Virginia Power
CCB	Coal Combustion Byproducts
VDEQ	Virginia Department of Environmental Quality
EPA	United States Environmental Protection Agency

2.0 Introduction

This document, the Upper (East) Pond Coal Combustion Residuals (CCR) Closure Construction Quality Assurance Plan (CCR CQA Plan), provides the Construction Quality Assurance (CQA) Plan for closure of the Upper (East) Pond (UEP) impoundment located at the Chesterfield Power Station (Station) in Chesterfield County, Virginia. The Station, including the UEP, is owned by the Virginia Electric and Power Company d/b/a as Dominion Virginia Power (Dominion). The UEP was constructed by Dominion in 1984 as a component of the Station's wastewater treatment system, serving as a settling pond for wastewater containing Coal Combustion Byproducts (CCB), which include Coal Combustion Residuals (CCR).

The UEP is currently being closed in accordance with Virginia Department of Environmental Quality (VDEQ) Virginia Pollutant Discharge Elimination System (VPDES) Permit No. VA004146, which includes the 2003 Revised Closure Plan, Upper (East) Pond, dated September 2003 (2003 Closure Plan), as modified in 2015. The closure of the UEP is transitioning from the VPDES program to the Solid Waste Management program, and will be completed in accordance with a Virginia Solid Waste Closure Permit that meets the requirements of the United States Environmental Protection Agency's (EPA's) "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments," (CCR Rule) and Virginia's Solid Waste Management Regulations (VSWMR). This CCR CQA Plan replaces the CQA Plan included in the 2003 Closure Plan, as modified in 2015, and conforms to the requirements of the CCR Rule and applicable sections of the VSWMR.

3.0 Implementation

The Construction Quality Assurance (CQA) Plan for the Chesterfield Integrated Ash Project was prepared by GAI Consultants, Inc. (GAI), Golder Associates, Inc. and Geosyntec Consultants, Inc. under contract to Dominion for use on various CCR projects at Chesterfield Power Station, known as the Chesterfield Integrated Ash Project. GAI performed a thorough review of the Construction CQA Plan for the Chesterfield Integrated Ash Project and determined the plan to be appropriate for use as the Construction Quality Assurance Plan for the CCR Closure of the Chesterfield Upper (East) Pond.

The Construction CQA Plan for the Chesterfield Integrated Ash Project which will be used as the Construction Quality Assurance CQA Plan for the CCR Closure for the Upper (East) Pond is located in Appendix A.

APPENDIX A
Construction Quality Assurance Plan – Dominion
Integrated Ash Project

**CONSTRUCTION QUALITY ASSURANCE (CQA) PLAN
CHESTERFIELD INTEGRATED ASH PROJECT
Upper (East) Pond CCR Closure Construction Quality Assurance Plan**

Virginia Electric and Power Company
Chesterfield Power Station
Chesterfield County, Virginia



Prepared for:
Virginia Electric and Power Company
5000 Dominion Boulevard
Glen Allen, VA 23060

November 25, 2015

TABLE OF CONTENTS

SECTION	PAGE
1.0 INTRODUCTION	1
1.1 PROJECT DESCRIPTION	1
1.2 DEFINITIONS.....	2
1.3 PARTIES.....	3
2.0 CQA PERSONNEL.....	4
3.0 CQA LABORATORIES	5
3.1 GEOTECHNICAL CQA LABORATORY	5
3.1.1 Experience and Qualifications	5
3.1.2 Responsibilities	5
3.2 GEOSYNTHETIC CQA LABORATORY	5
3.2.1 Experience and Qualifications	5
3.2.2 Responsibilities	6
4.0 CQA TESTING AND INSPECTION CRITERIA	6
4.2 EARTHWORK.....	7
4.2.1 Earthwork Inspection Activities.....	7
4.2.2 Defects and Repairs	8
4.3 POLYETHYLENE GEOMEMBRANE (LLDPE).....	8
4.3.1 Transportation and Delivery.....	8
4.3.2 Construction	9
4.3.2.1 Non-Destructive Testing	10
4.3.2.2 Destructive Testing.....	11
4.3.2.3 Repairs	11
4.3.2.4 Final Inspection	11
4.3.2.5 Survey.....	11
4.5 GEOTEXTILES	11
4.6 GEONET COMPOSITE	12
4.6.1 Transportation and Delivery.....	12
4.6.2 Construction	12
4.7 CAP DRAIN/DRAINAGE LAYER.....	12
4.7.2 Drainage Layer Inspection Activities	12
4.7.2 Defects and Repairs	13
4.8 HDPE PIPING	13

4.8.1	Manufacture of HDPE Pipe.....	13
4.8.2	TRANSPORTATION AND DELIVERY.....	14
4.8.3	CONSTRUCTION	14
5.0	RECORDS AND REPORTING.....	14
5.1	RECORDKEEPING DURING CONSTRUCTION.....	14
5.2	SURVEYING	15
5.3	REPORTING	15
6.0	REQUIREMENTS FOR FABRIC-FORMED CONCRETE INSTALLATION (UNIFORM SECTION MAT).....	16
6.1	GENERAL.....	16
6.2	SUBMITTALS.....	16
6.3	TESTING.....	16
7.0	REQUIREMENTS FOR CAST-IN-PLACE CONCRETE.....	16
7.1	GENERAL.....	16
7.2	SUBMITTALS.....	17
7.3	TESTING.....	17

1.0 INTRODUCTION

This Construction Quality Assurance (CQA) Plan was prepared by Golder Associates Inc. (Golder) to assist Virginia Electric and Power Company (also known as Dominion, OWNER) in performing construction of the projects included in the Integrated Ash Project at the Chesterfield Power Station in Chester, Virginia according to the Construction Drawings and Technical Specifications. This plan and the related technical specifications are intended to meet the requirements of 9VAC20-81-130.Q.

To implement the construction project, a CONTRACTOR, familiar with earthwork and geosynthetics construction, will serve as a general CONTRACTOR (CONTRACTOR) providing construction services and a CQA Consultant will be retained by the OWNER to ensure project conformance of construction activities to established CQA standards. In most instances, the CONTRACTOR will perform all earthwork activities, and will retain a Geosynthetics Installer for installation of geosynthetic materials. The CQA Plan provides guidance information and procedures that should be undertaken by all parties so the work will be of the quality necessary to meet the project objectives and will be responsive to the requirements of the OWNER.

This CQA Plan is a supplemental document to the Construction Drawings and Technical Specifications for each project. Where a conflict arises, the contract documents will govern.

1.1 PROJECT DESCRIPTION

The activities addressed under this CQA Plan include the following activities:

- Earthwork;
- Subgrade preparation;
- Geosynthetic Clay Liner (GCL) installation;
- Polyethylene Geomembrane (HDPE and LLDPE) installation;
- Geonet Composite and Geotextile installation;
- Drainage/Protection Layer installation; and
- HDPE Pipe installation.

1.2 DEFINITIONS

- Quality Control: A planned system of activities, or the use of such a system, whose purpose is to provide a level of quality that meets the needs of users. The objective of quality control is to provide a quality product that is safe, adequate, dependable, and economical. The overall system involves integrating the quality factors of several related steps including: the proper specification of what is wanted, production to meet the full intent of the specification, inspection to determine whether the resulting material, product, service, etc. is in accordance with the Specifications, and review of usage to determine necessary revisions of Specifications.

In practice, Quality Control refers to those procedures, criteria, and tests employed and paid for by the CONTRACTOR(s) to confirm that the work satisfies the CONTRACTOR's standards and is in compliance with the Construction Drawings and Technical Specifications. Quality Control is paid for and the responsibility of the CONTRACTOR. This CQA plan does not address quality control procedures, criteria, and/or tests employed by the CONTRACTOR.

- Quality Assurance: A planned system of activities whose purpose is to provide assurance that the overall quality control program is in fact being effectively implemented. The system involves a continuing evaluation of the adequacy and effectiveness of the overall quality control program with the ability to have corrective measures initiated where necessary. For a specific material, product, service, etc., this involves verifications, audits, and the evaluation of the quality factors that affect the specification, production, inspection, and use of the product, service, system, or environment.

In practice, Quality Assurance refers to those procedures, criteria, and tests required and paid for by the OWNER to confirm that the work performed by the CONTRACTOR(s) is in compliance with the approved Construction Drawings and Technical Specifications and any additional requirements of this plan.

- Lot: A quantity of resin (usually the capacity of one rail car) used in the manufacture of geosynthetic material. The finished geosynthetic product (e.g., polyethylene geomembrane roll or geocomposite roll) will be identified by a unique number traceable to the resin lot used.
- Panel: The unit area of GCL or geomembrane that will be seamed in the field. A panel is identified as a roll or portion of a roll that is larger than 100 square feet.
- Subgrade Surface: The soil layer surface which immediately underlies the geosynthetic material(s).

1.3 PARTIES

- OWNER: The OWNER is the individual, corporation, entity, public body, or authority with whom the CONTRACTOR has entered into the Agreement and for whom the Work is performed. For this project, the OWNER is Virginia Electric and Power Company (also known as Dominion).
- ENGINEER: The ENGINEER is the official representative of the OWNER. The ENGINEER is responsible for the preparation of the Construction Drawings, Technical Specifications, and the CQA Plan. The ENGINEER will be responsible for reviewing the required CONTRACTOR submittals for conformance to the Technical Specifications, Construction Drawings, and this CQA Plan. The ENGINEER is also responsible for the interpretation of those documents and for resolution of technical matters that arise during construction. The ENGINEERS for the Landfill, Upper (East) Pond (UEP), Lower (West) Pond (LWP), and Low Volume Wastewater Treatment System are Golder Associates, GAI Consultants, Geosyntec Consultants, and Geosyntec Consultants, respectively.
- CONTRACTOR: The CONTRACTOR has the primary responsibility for ensuring that the construction is in accordance with the Construction Drawings and Technical Specifications developed by the ENGINEER and approved by the permitting agency. Other responsibilities include the performance of all construction activities at the site including site facilities, administration, material purchasing, safety, supervision, construction quality control, installation, and subcontracting. The CONTRACTOR is responsible for the protection of completed work until it is accepted by the OWNER. The CONTRACTOR is also responsible for informing the OWNER and CQA Consultant of the scheduling and occurrence of all construction activities. The CONTRACTOR shall be fully responsible for scheduling and coordinating the work of Subcontractors and for ensuring that the Subcontractor adheres to the requirements of this CQA Plan.
- CQA Consultant: The CQA Consultant (or QA Consultant) is an entity, independent from the OWNER, CONTRACTOR(s), Manufacturer, and Installer, that is responsible for observing, testing and documenting activities related to the quality assurance at each project site. The CQA Consultant shall be knowledgeable of soil properties, geosynthetics properties, and the practices typical of the Work. This party will perform field and laboratory testing of soils and other earth materials for evaluation and verification purposes. This party will also observe installation of the geosynthetic liner and coordinate sampling and testing of the geosynthetics with the Geosynthetic

CQA Laboratory. The CQA Consultant is also responsible for issuing a certification report, sealed by a registered Professional Engineer, licensed in the Commonwealth of Virginia. The OWNER may assign the duties of the ENGINEER to the CQA Consultant provided the CQA Consultant is qualified.

- Geomembrane Manufacturer (Manufacturer): The party responsible for manufacturing the geomembrane rolls.
- Geosynthetic CQA Laboratory (Testing Laboratory): Party, independent from the OWNER or CONTRACTOR, Manufacturer and Installer, responsible for completing laboratory tests on samples of geosynthetics obtained at the site or during manufacturing.
- Geotechnical CQA Laboratory: Party, independent from the OWNER or CONTRACTOR, responsible for completing laboratory tests on soil samples obtained at the site or source.
- Geosynthetic Installer: The Geosynthetic Installer is responsible for field handling, sorting, placing, seaming, loading (against wind), and other aspects of the geosynthetics installation, including geomembranes, geotextiles, geonets, and geonet composites. The Installer is responsible for the protection of the materials once they arrive on site until the work is accepted by the OWNER.
- Subcontractor: The Subcontractor is an entity or individual who has a direct contract with the CONTRACTOR for the performance of a part of the Work. The Subcontractor shall communicate with the OWNER or ENGINEER through the CONTRACTOR. The Subcontractor shall adhere to the requirements of the Technical Specifications and this CQA Plan as it relates to the Subcontractor's part of the Work.

2.0 CQA PERSONNEL

The OWNER will retain a CQA Consultant to assure that proper construction techniques and procedures are used and to verify that the materials used meet the Technical Specifications. The CQA Consultant must employ engineer(s) licensed to practice in the Commonwealth of Virginia and personnel experienced in the field of solid waste management, landfill construction, and landfill closure. At the completion of the work, the program requires certification reports indicating that the facilities have been constructed in accordance with the Technical Specifications and approved permit. It is the responsibility of the CQA Consultant to prepare these reports.

3.0 CQA LABORATORIES

3.1 GEOTECHNICAL CQA LABORATORY

3.1.1 Experience and Qualifications

The Geotechnical CQA Laboratory must have experience in testing soils and aggregates, and be familiar with ASTM International (ASTM) test standards and other applicable test standards as required in the Technical Specifications. The geotechnical laboratory must have proven their abilities on previous work with the ENGINEER or shall provide the ENGINEER with their Qualifications and Experience (Q&E) package demonstrating their experience as it relates to the Technical Specifications. The Q&E package shall include a project list showing the name, address, and telephone number of the appropriate party to contact for reference. The Geotechnical CQA Laboratory must be capable of providing preliminary permeability test results within 48 hours and final permeability test results within 72 hours of receipt of sample. The laboratory must be capable of providing all other test results within five days of receipt of samples.

The Geotechnical CQA Laboratory shall provide a contract administrator/project manager for the project as the responsible person to contact. This person shall oversee the analytical procedures and testing as well as review and reporting of the results.

3.1.2 Responsibilities

The Geotechnical CQA Laboratory is responsible for performing all geotechnical laboratory tests and formally submitting results to the ENGINEER as required in the Technical Specification. These tests may include, but are not limited to, those indicated in the Technical Specifications.

3.2 GEOSYNTHETIC CQA LABORATORY

3.2.1 Experience and Qualifications

The Geosynthetic CQA Laboratory must have experience in testing geosynthetics, and must conform to ASTM, National Sanitation Foundation (NSF), Geosynthetic Research Institute (GRI), and other applicable test standards, as required in the Technical Specifications. The geosynthetic laboratory must have proven their abilities on previous work with the ENGINEER or shall provide the ENGINEER with their Qualifications

and Experience (Q&E) package demonstrating their experience as it relates to the Technical Specifications. The Q&E package shall include a project list showing the name, address, and telephone number of the appropriate party to contact for reference. The Geosynthetic CQA Laboratory must be capable of providing test results within 48 hours from receipt of samples.

The Geosynthetic CQA Laboratory shall provide a contract administrator/project manager for the project as the responsible person to contact. This person shall oversee the analytical procedures and testing as well as review and reporting of the results.

3.2.2 Responsibilities

The Geosynthetic CQA Laboratory is responsible for performing all geosynthetic laboratory tests and formally submitting results to the ENGINEER as required in the Technical Specifications. These tests may include, but are not limited to, those indicated in the Technical Specifications.

4.0 CQA TESTING AND INSPECTION CRITERIA

This section of the CQA Plan describes the general preconstruction and construction inspection activities that will be performed to ensure that the facility is constructed to meet or exceed all design criteria, plans, and specifications. CQA testing and inspection criteria are provided in the technical specifications for the construction, including material installation and the manufacture/fabrication of the following specific components:

- Earthwork;
- Subgrade preparation;
- Polyethylene Geomembrane (LLDPE) installation;
- Geonet Composite and Geotextile installation;
- Drainage/Protection Layer installation;
- HDPE Pipe installation; and
- Concrete.

4.1 GENERAL PRECONSTRUCTION ACTIVITIES

Prior to the start of construction, a preconstruction meeting shall be held among the OWNER, the ENGINEER, CQA Consultant, Geosynthetics Installer (Installer) and the CONTRACTOR responsible for completing the work. The topics covered at this meeting shall include, but not be limited to:

- CQA documents and supporting information;

- The site-specific CQA plan, its role relative to accomplishing the intent of the design, as well as review of the Construction Drawings and Technical Specifications;
- Responsibilities of each party;
- Lines of authority and communication for each organization;
- Procedures or protocol for construction, change orders, deficiencies, repairs, and retesting;
- Methods of documenting and reporting inspection data;
- Work area security and safety protocol;
- Location and protection of construction materials, and the prevention of damage of the materials from inclement weather or other adverse events;
- Conducting a site walk to review site conditions as well as material staging and storage locations;
- The construction plan, schedule, and procedures; and
- Installation, testing, and acceptance criteria and procedures.

4.2 EARTHWORK

4.2.1 Earthwork Inspection Activities

Observation of excavation and structural fill placement shall be coordinated with construction testing. Acceptance criteria for construction work shall be as identified in the Technical Specifications. At a minimum, the CQA Consultant shall monitor and record the following during the construction:

- Consistency of the materials during processing and placement; and,
- Deleterious material that may hinder proper soil compaction.

Structural fill grades shall be surveyed by the designated surveyor in accordance with the Technical Specifications.

CQA testing during construction shall be conducted in accordance with Table 3 of Section 02200 of the Technical Specifications. All field and laboratory tests shall be conducted on samples taken during the course of the construction work. Testing and sampling procedures shall be observed and documented by the CQA Consultant.

The CQA Consultant will be on-site at all times construction is ongoing, observing and documenting all relevant activities. The ENGINEER will visit the site periodically as construction progress warrants. Such visits will be frequent enough to allow the ENGINEER to be fully knowledgeable of the construction methods and performance. The ENGINEER may then determine if CQA observation and testing activities are adequate to meet the terms and intent of this CQA Plan.

Visual observation shall include, but not be limited to, the following:

- Consistency of materials and

- Areas where damage due to excess moisture, insufficient moisture, or freezing may have occurred.

4.2.2 Defects and Repairs

If a defect is identified in the structural fill, the CQA Consultant shall determine the extent and the nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Consultant shall determine the extent of the deficient area by additional tests, observations, a review of records, or other means that the CQA Consultant deems appropriate.

After determining the extent and nature of the defect, the CQA Consultant shall promptly notify the CONTRACTOR and the ENGINEER. The CONTRACTOR shall correct all deficiencies in accordance with the Technical Specifications. The CQA Consultant shall schedule appropriate retests when the work deficiencies have been corrected. All retests by the CQA Consultant must verify that the deficiencies have been corrected before additional work may be performed by the CONTRACTOR in the area of the deficiency. The CQA Consultant shall observe any repair and report any noncompliance with the above requirements in writing to the ENGINEER.

4.3 POLYETHYLENE GEOMEMBRANE (LLDPE)

The CQA Consultant shall issue a written daily report of activities. These reports shall include, at a minimum, observations, test results, problems encountered, and resolutions. Construction reports summarizing significant events and addressing problems encountered and their resolutions shall be issued to the ENGINEER. The format of these reports and frequency shall be established at the preconstruction meeting.

Prior to the installation, the Manufacturer will provide the CQA Consultant with the information listed in Technical Specification 02597. The CQA Consultant will verify that:

- The property values certified by the Manufacturer meet all of the Technical Specifications; and
- The measurements of properties by the Manufacturer are properly documented, the test methods used are acceptable, and the geomembrane meets the Manufacturer specifications and the Technical Specifications.

4.3.1 Transportation and Delivery

Upon delivery at the site, the CQA Consultant shall inventory all rolls and conduct a surface observation of each roll or factory panel for defects or damage. The inspection will be performed without unrolling rolls or unfolding factory panels unless defects or damages are found or suspected. The CQA Consultant will indicate those rolls with severe flaws that should be removed from the site.

The CQA Consultant will verify that storage space selected is in a well-drained area and that cribbing techniques have been used as needed to ensure that the materials will not be sitting in ponded water in the event of adverse weather.

4.3.2 Construction

The Installer shall provide written certification that the subgrade surface on which the geomembrane will be installed is acceptable. During placement, the CQA Consultant will verify that:

- Any equipment used does not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons, or other means;
- The prepared surface underlying the geomembrane has not deteriorated since previous acceptance and is still acceptable immediately prior to geomembrane placement;
- Any geosynthetic elements immediately underlying the geomembrane are of acceptable cleanliness and free of debris;
- All personnel working on the geomembrane do not smoke, wear damaging shoes, or engage in other activities that could damage the geomembrane;
- The method used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil;
- The method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels);
- Adequate temporary loading and/or anchoring (e.g., sand bags, tires), not likely to damage the geomembrane, has been placed to prevent uplift by wind (in case of high winds, the loading should be continuous along the edges of panels to minimize the risk of wind flow under the panels); and
- Direct contact of equipment with the geomembrane is minimized; i.e., the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials, in areas where excessive traffic may be expected. Portable generators may not be placed directly on the geomembrane, but shall be placed on a rub sheet.

The CQA Consultant will notify the Installer and Contractor if the above conditions are not fulfilled. After placement and prior to seaming, the CQA Consultant will visually examine each panel for damage. The CQA Consultant will advise the Geomembrane Installer which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels that have been rejected will be marked, and their removal from the work area shall be recorded by the CQA Consultant.

Prior to seaming, the CQA Consultant shall verify that the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material. The CQA Consultant shall verify that the bonding surfaces

are thoroughly cleaned by mechanical abrasion prior to extrusion welds. QC testing of the seams shall be conducted by the Installer under the observation of the CQA Consultant. The CQA Consultant or Geosynthetic CQA Laboratory may perform additional testing to verify that the seams meet the requirements of the Technical Specifications.

During geosynthetics construction, the CQA consultant shall maintain records on the following items:

- Geosynthetic roll inventory (geomembrane, geocomposite, geotextile, etc.)
- Laboratory testing of geosynthetic materials (conformance and seam strength)
- Geosynthetic panel installation logs, including subgrade acceptance
- Seam testing logs, both destructive and nondestructive
- Geomembrane repair logs
- General construction activity logs for daily reports

4.3.2.1 Non-Destructive Testing

Non-destructive testing shall be conducted according to Technical Specification Section 02597, Paragraph 3.04.C. Production seams shall be continuously tested by the Installer using non-destructive techniques. The Installer shall perform all air pressure (fusion-welded seams) and vacuum testing (extrusion-welded seams) under the observation of the CQA Consultant as follows:

- Extrusion Weld Testing – Non-destructive testing of the extrusion weld shall be conducted with a vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft gasket attached to the bottom, a valve assembly, and a vacuum gauge. The test shall be conducted according to Technical Specification Section 02597, Paragraph 3.04.C.(2). The viewing window should be regularly cleaned to ensure a clear view of the seam section being tested. All areas where soap bubbles appear shall be marked, repaired, and retested.
- Fusion Weld Testing – Non-destructive testing of the fusion weld shall be conducted with an air pump or tank capable of generating and sustaining pressure over 30 psig; a sharp, hollow needle, or other approved pressure-feed device equipped with a pressure gauge; a utility knife with hook blade; a hot air gun or other device, and clamps to seal the ends of the air channel. The test shall be conducted according to Technical Specification Section 02597, Paragraph 3.04.C.(3).

4.3.2.2 Destructive Testing

Destructive testing shall be conducted according to Technical Specification Section 02597, Paragraph 3.03.H.

4.3.2.3 Repairs

Repairs shall be conducted according to Technical Specification Section 02597, Paragraph 3.04.D. The CQA Consultant shall number and log each patch repair, and the Installer shall non-destructively test each repair using methods specified in this plan.

4.3.2.4 Final Inspection

A final inspection shall be completed by the Installer, ENGINEER, CQA Consultant, and OWNER prior to placement of additional layers of geosynthetic materials or the Installer demobilizing from the site. All identified problem areas shall be repaired by the Installer and accepted by the CQA Consultant.

4.3.2.5 Survey

As geomembrane installation progresses, identification of all panels, seams, locations of destructive test locations, and anchor trenches shall be made by survey. Survey reporting requirements for geomembrane installation are outlined in Section 01564 of the Technical Specifications.

4.4 Geosynthetic Clay Liner

This section is not pertinent to closure of the Upper (East) Pond.

4.5 GEOTEXTILES

Upon delivery to the site, the CQA Consultant shall inventory the rolls and conduct a surface observation of each roll or factory panel for defects or damage. The inspection will be performed without unrolling rolls or unfolding factory panels unless defects or damages are found or suspected. The CQA Consultant will indicate those rolls with severe flaws that should be removed from the site.

The OWNER will provide storage space in a location (or several locations) that will minimize on-site transportation and handling. The storage space should be protected from theft, vandalism, passage of vehicles, etc. The CQA Consultant will verify that the storage space selected is in a well-drained area and that cribbing techniques have been used as needed, ensuring that the materials will not be sitting in moisture in the event of adverse weather.

During deployment, the CQA Consultant shall inspect the geotextile for damage due to equipment, to dragging across the geomembrane, or other potentially damaging activities.

4.6 GEONET COMPOSITE

This section presents general inspection activities for the CQA Consultant prior to and during geonet composite (or geocomposite) construction. The geonet composite approved for use at the site consists of a geonet core with 8 oz/yd² nonwoven geotextile bonded to both sides of the geonet. Prior to the installation, the Manufacturer will provide the CQA Consultant with the information listed in Technical Specification 02590. The CQA Consultant will verify that:

- The property values certified by the Manufacturer meet all of the Specifications; and
- The measurements of properties by the Manufacturer are properly documented, and the test methods used are acceptable.

4.6.1 Transportation and Delivery

Upon delivery to the site, the CQA Consultant shall inventory all rolls and conduct a surface observation of each roll or factory panel for defects or damage. The inspection will be performed without unrolling rolls or unfolding factory panels unless defects or damages are found or suspected. The CQA Consultant will indicate those rolls with severe flaws that should be removed from the site. The CQA Consultant will verify that storage space selected is in a well-drained area and that cribbing techniques have been used as needed to ensure that the materials will not be sitting in ponded water or mud.

4.6.2 Construction

During deployment, the CQA Consultant shall inspect the geonet composite for damage due to equipment, deployment across the geomembrane, or other potentially damaging activities.

Adjacent geonet composites shall be joined according to the Manufacturer's recommendations, the Manufacturer's Installation Guide, construction drawings and Specifications. As a minimum, the following requirements shall be met:

4.7 CAP DRAIN/DRAINAGE LAYER

4.7.2 Drainage Layer Inspection Activities

At a minimum, the CQA Consultant shall observe and record the following during the placement of the drainage/protection layer:

- Consistency of the materials during processing and placement;
- Lift thickness; and
- Deleterious material that may damage underlying geosynthetic components.

- Equipment used for placing drainage/protection layer materials is not driven directly onto the geomembrane.
- A minimum thickness of 12 inches of drainage material is maintained between a light dozer (ground pressure of 5 psi or lighter) and the geosynthetics (or as required by the Technical Specifications).

When placing overlying material on the geomembrane, every effort must be made to minimize wrinkle development. Small wrinkles should be isolated and covered as quickly as possible to prevent their growth. The placement of cover materials shall be observed by the CQA Consultant to ensure that wrinkle formation is minimized and in all cases that the geomembrane is not folded over on itself. The minimum thickness shall be certified by the surveyor in accordance with the Technical Specifications.

4.7.2 Defects and Repairs

If a defect is identified in the structural fill, the CQA Consultant shall determine the extent and the nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQA Consultant shall determine the extent of the deficient area by additional tests, observations, a review of records, or other means that the CQA Consultant deems appropriate.

After determining the extent and nature of the defect, the CQA Consultant shall promptly notify the CONTRACTOR and the ENGINEER. The CONTRACTOR shall correct all deficiencies in accordance with the Technical Specifications. The CQA Consultant shall schedule appropriate retests when the work deficiencies have been corrected. All retests by the CQA Consultant must verify that the deficiencies have been corrected before additional work may be performed by the CONTRACTOR in the area of the deficiency. The CQA Consultant shall observe any repair and report any noncompliance with the above requirements in writing to the ENGINEER.

4.8 HDPE PIPING

The work addressed under this section shall facilitate proper construction of all HDPE piping for the collection and removal of infiltrated water from the cap and final cover system of the UEP. All work shall be constructed to the lines, grades, and dimensions indicated on the Construction Drawings, in accordance with the Technical Specifications, or as required by the OWNER or ENGINEER.

4.8.1 Manufacture of HDPE Pipe

The CQA Consultant will verify that:

- The property values certified by the Manufacturer meet all of the Technical Specifications; and,
- The measurements of properties by the Manufacturer are properly documented, the test methods used are acceptable, and the HDPE pipe meets the Manufacturer's specifications and the Technical Specifications.

4.8.2 Transportation and Delivery

Upon delivery at the site, the CQA Consultant shall conduct a surface observation of the pipe as is feasible for defects or damage. The inspection will be performed without unstacking pipe unless defects or damage are found or suspected. The CQA Consultant will indicate those pipes with severe flaws that should be removed from the site.

4.8.3 Construction

During placement, The CQA Consultant will verify that:

- Equipment used does not damage the HDPE pipe by handling, excessive heat, or other means;
- The prepared surface and trench underlying the HDPE pipe has not deteriorated since previous preparation and is still acceptable immediately prior to pipe placement;
- Personnel do not engage in activities that could damage the pipe;
- Methods used to place the pipe do not damage the pipe or supporting soil;
- The pipe is backfilled in a method to completely support the pipe with bedding; and
- Methods used to backfill the pipe do not displace the pipe.

5.0 RECORDS AND REPORTING

This section of the CQA Plan describes the recordkeeping requirements of the CQA consultant during construction activities and the reporting requirements to document the completion of construction. Following construction of the Upper (East) Pond closure, a certification report signed by a Virginia Professional Engineer must be submitted to the DEQ.

5.1 RECORDKEEPING DURING CONSTRUCTION

During construction, the CQA consultant shall maintain records on the following items:

- Laboratory testing of soil materials
- Field Soil testing logs (compaction testing)
- Geosynthetic roll inventory (geomembrane, geocomposite, geotextile, etc.)
- Laboratory testing of geosynthetic materials (conformance and seam strength)
- Geosynthetic panel installation logs, including subgrade acceptance
- Seam testing logs, both destructive and nondestructive
- Geomembrane repair logs

- Laboratory testing of drainage material
- General construction activity logs for daily reports

5.2 SURVEYING

As part of the certification report submitted to the DEQ, as-built drawings sealed by a Virginia Licensed Land Surveyor will be included. These drawings must be to scale, have a contour interval of 2 feet or less, and be on a 24"x36" sheet size.

As a minimum, drawings for a Closure Construction Certification Report will include:

1. Existing Conditions
2. Top of Base Grade
3. Geomembrane panel layout and destructive sample locations
4. Geomembrane panel layout including panel numbers, roll numbers and repair locations
5. Top of Final Cover, including thickness verification of layer

5.3 REPORTING

At the completion of construction a report must be submitted to the DEQ documenting the construction activities. The certification report must contain the following sections:

- PE certification (for closure) as required by the VAC.
- A site location map and a cross section of constructed layers (closure cap)
- Narrative describing the construction activity, testing performed, and conformance with the permit requirements
- Structural Fill Data, including:
 - Laboratory testing of fill materials
 - Records of field density testing, with location maps of field tests
- Geosynthetic Installation Data, including (as applicable):
 - Material inventory
 - MQC and CQC testing results
 - Subgrade acceptance forms
 - Panel deployment logs
 - Seaming logs
 - Seam defect and repair logs
 - Non-destructive testing logs
 - Destructive testing logs
- Drainage Layer Data (if applicable), including laboratory test results
- Final Cover Soil Data (if applicable), including:

- Laboratory testing of soil materials
- Records of field density testing, with location maps of field tests
- Resumes of key personnel
- As-Built drawings as described in Section 5.2

6.0 REQUIREMENTS FOR FABRIC-FORMED CONCRETE INSTALLATION (UNIFORM SECTION MAT)

6.1 GENERAL

All products furnished shall: (1) be provided by a manufacturer who has been regularly engaged in the design and manufacture of the products; and (2) meets the requirements of the CCR Construction Specifications.

6.2 SUBMITTALS

- Shop Drawings: drawings of the materials, equipment, installation details, manufacturer's product literature and specifications will be submitted to Dominion's representative for review.
- Channel Lining: a certified report from the material manufacturer stating the properties of the materials to be used will be submitted to Dominion's representative for review.
- Fine Aggregate Concrete Grout Submittals: proposed concrete grout mixes will be designed and tested by an acceptable testing laboratory. Test results and the mix design will be submitted to Dominion's representative for review.

6.3 TESTING

Grout will be tested once per 50 cubic yards, or once per truckload, or as directed otherwise by Dominion. The grout mix shall exhibit a compressive strength of 2,000 pounds per square inch (psi) at 28 days, when made and tested in accordance with ASTM C31 and ASTM C109.

7.0 REQUIREMENTS FOR CAST-IN-PLACE CONCRETE

7.1 GENERAL

All concrete work shall comply with the following:

- All materials used will comply with ACI 301, "Specifications for Structural Concrete for Buildings".
- All concrete will be Portland cement conforming to ASTM C150, type II and shall have a minimum compressive strength at 28 days of 4,000 psi
- Water reducing admixtures will conform to ASTM C494.
- Air entraining admixtures will conform to ASTM C260 and shall produce a maximum air by volume of $6.5\% \pm 1.5\%$ for foundations and foundation walls.
- Fine aggregate will be washed natural sand conforming to ASTM C33. Coarse aggregate shall be well graded crushed stone or washed gravel conforming to ASTM C33 with a minimum size of 1 inch.
- The maximum water-cement ratio will be 0.45 for foundations

- Maximum slump will be 2"-4" for foundation walls and footings.

All concrete that contains fly ash must be properly cured and must attain 4,000 psi minimum strength (verified by testing) prior to allowing water to come in contact with the concrete.

7.2 SUBMITTALS

Concrete mix designs will be submitted to Dominion's representative for review. Concrete acceptance shall be on the basis of "trial mixtures" as described in ACI 350, section 5.3. Trial mixtures will be provided for three different water-cement ratios indicating 7-day and 28-day compressive strength; 1200 psi greater than required shall be accepted.

7.3 TESTING

Concrete will be tested once per 50 cubic yards, or once per truckload, or as directed otherwise by the Dominion's representative.

APPENDIX C

Construction Specifications

Upper (East) Pond CCR Closure



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Construction Specifications Upper (East) Pond CCR Closure

Virginia Electric and Power Company
Chesterfield Power Station
Chesterfield County, Virginia

GAI Project Number: C150035.00

January 2016



Prepared by: GAI Consultants, Inc.
Richmond Office
4198 Cox Road, Suite 114
Glen Allen, Virginia 23060

Prepared for: Virginia Electric and Power Company
5000 Dominion Boulevard
Glen Allen, Virginia 23060

Construction Specifications Upper (East) Pond CCR Closure

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Prepared for:
Dominion Resources Services
5000 Dominion Boulevard
Glen Allen, Virginia 23060

Prepared by:
GAI Consultants, Inc.
Richmond Office
4198 Cox Road, Suite 114
Glen Allen, VA 23060

Table of Contents

1.0 Introduction1

2.0 CCR Placement2

Appendix A Construction Specifications

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1.0 Introduction and Purpose

This document provides the Construction Specifications (Specifications), for the Coal Combustion Residuals (CCR) Closure for the Upper (East) Pond (UEP) located at Chesterfield Power Station (Station), in Chesterfield County, Virginia. The Virginia Department of Environmental Quality (VDEQ) is regulating the closure of the UEP under a Solid Waste Closure Permit in accordance with the requirements in the United States Environmental Protection Agency's (EPA's) "Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments" (CCR Rule), which was published in the Federal Register on April 17, 2015 (with an effective date of October 19, 2015) (40 CFR257).

The Station, including the UEP, is owned by the Virginia Electric and Power Company d/b/a Dominion Virginia Power (Dominion).

2.0 Implementation

The Construction Specifications were prepared by Golder Associates, Inc. under contract to Dominion. GAI Consultants, Inc. (GAI) performed a thorough review of the Construction Specifications prepared by Golder Associates, Inc. and determined them to be appropriate for use with the closure of the Chesterfield Upper (East) Pond. GAI prepared one additional Construction Specification, Section 0225, CCR Placement.

The Construction Specifications are located in Appendix A.

DIVISION 1 - GENERAL SPECIFICATIONS

- 01050 – Field Engineering/Surveying
- 01300 – Submittals
- 01400 – Quality Assurance
- 01410 – Testing Laboratory Services
- 01500 – Construction Facilities
- 01562 – Contract Closeout
- 01564 – Project Record Documents

DIVISION 2 - SITEWORK SPECIFICATIONS

- 02070 – Chain Link Fencing and Gates
- 02100 – Site Preparation
- 02110 – Site Clearing and Grubbing
- 02120 – Stripping of Ash-Laden Soil
- 02125 – Temporary and Permanent Erosion and Sedimentation Control
- 02140 – Construction Dewatering
- 02141 – Surface Decanting/Dewatering
- 02150 – Shoring and Bracing
- 02220 – Earthwork
- 02225 – CCR Placement
- 02233 – Coarse Aggregate
- 02235 – Vegetative Layer
- 02271 – Stone Riprap and Grouted Riprap
- 02279 – Articulated Concrete Block (ACB) Mat
- 02286 – Geomembrane Pipe Boots and Pipe Sleeves
- 02380 – Fabric-Formed Concrete
- 02419 – Demolition
- 02590 – Geocomposite and Geogrid

02595 – Geotextile

02597 – Polyethylene Geomembrane

02607 – Concrete Manholes / Drop Boxes / Vaults

02650 – Leachate Collection and Conveyance Pipe

02651 – HDPE Pipe and Manhole Leak Testing

02936 – Seeding

DIVISION 3 - CONCRETE

03100 – Concrete Formwork

03200 – Concrete Reinforcement

03300 – Cast-In-Place Concrete

DIVISION 5 - METALS

55000 – Miscellaneous Metals

55213 – Pipe and Tube Railings

DIVISION 15 – MECHANICAL

26052 – Submersible Effluent Pumps

DIVISION 16 - ELECTRICAL

16050 – Basic Electrical Requirements

16054 – Underground Electrical Systems

APPENDIX A

Construction Specifications

SECTION 01050

FIELD ENGINEERING/SURVEYING

PART 1 - GENERAL

1.01 Description of Work

Work under this Section includes all surveying services for accurate location of all features of construction and establishing proposed grades.

1.02 Related Sections

A. Project Record Documents - Section 01564

1.03 Quality Control

CONTRACTOR is responsible for all surveying necessary for control of its work at the site. His Surveyor shall be a qualified and Registered Land Surveyor in the Commonwealth of Virginia. This Surveyor shall also have a minimum of two years experience in Construction Surveying layout and maintenance of as-built construction drawings with a record of performing horizontal and vertical control requirements as stated in the contract.

1.04 Submittals

- A. Name, address, and telephone number of Surveyor shall be submitted to OWNER before starting survey work by CONTRACTOR.
- B. On request, documentation verifying accuracy of survey work shall be submitted to OWNER by CONTRACTOR.

1.05 Survey Requirements

- A. CONTRACTOR shall utilize existing control points and establish new control points as needed to complete work under this section.
- B. CONTRACTOR shall provide field engineering services and use recognized engineering survey practices.
- C. Establish elevations, lines and levels. Locate and layout by instrumentation and similar appropriate means site improvements including roadways, stakes for grading and fill placement, utility locations, slopes, and invert elevations.
- D. Periodically verify layouts by same means.

1.06 Survey Tolerances

Grading Tolerances shall be as defined in Division 2 of these specifications.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.01 Inspection

CONTRACTOR shall verify locations of site reference and survey control points prior to starting work. OWNER must be promptly notified of any discrepancies discovered.

3.02 Survey Reference Points

- A. CONTRACTOR shall take measures to protect site reference and survey control points prior to starting site work, and must preserve permanent reference points during construction. Site reference points may not be relocated without prior written notice to OWNER.
- B. The OWNER shall be immediately notified of loss, damage or destruction of any reference point, or relocation required because of changes in grades or other reasons. CONTRACTOR shall replace disturbed survey control points based on original survey control at no extra cost.
- C. X, Y and Z coordinates of benchmarks and survey control points shall be determined (and recorded) with a maximum permissible error of 0.10 feet (\pm) in any coordinate direction.
- D. All X and Y coordinates are to be referred to the Virginia State Plane coordinate system with an accuracy of 0.10 feet (\pm).
- E. All Z coordinates are to be referred to nearest NGVD benchmark with an accuracy of 0.10 feet (\pm).

3.03 Survey Requirements

- A. CONTRACTOR shall reference survey and data reference points to permanent benchmarks and record locations of survey control points, with horizontal and vertical data.
- B. CONTRACTOR shall reverify layouts periodically during construction by same means.

END OF SECTION

SECTION 01300

SUBMITTALS

PART 1 - GENERAL

1.01 Description of Work

- A. Wherever submittals are required hereunder, all such submittals by the CONTRACTOR shall be submitted to the OWNER.
- B. Prior to mobilization onto the Site;
 - (1) A preliminary schedule of Shop Drawing, sample, and proposed substitutes or "or equal" submittals.
 - (2) Layout data.
 - (3) CONTRACTOR shall submit a Health and Safety Plan in accordance with Section 4.7 (Project Site Safety) and Exhibit F - On-Site Safety and Environmental..
 - (4) CONTRACTOR shall submit an Environmental Protection Plan (Paragraph 1.11).
- C. Any details deemed by the CONTRACTOR as required for construction but not indicated on the Contract drawings shall be submitted for review by the ENGINEER at least 10 calendar days prior to construction. Responsibility for identifying such details is the responsibility of the CONTRACTOR.

1.02 Shop Drawing Submittal

- A. Whenever called for in the Contract Documents, or where required by the OWNER, CONTRACTOR shall furnish an electronic copy of the shop drawing to the OWNER for distribution to the responsible project ENGINEER. The term "Shop Drawings" as used herein shall be understood to include detailed design calculations, shop drawings, fabrication and installation drawings, erection drawings, lists, graphs, operating instructions, catalog sheets, data sheets, and similar items.
- B. All Shop Drawing submittals shall be accompanied by a submittal transmittal form.
- C. Except as may otherwise be provided herein, the ENGINEER will return each submittal to the OWNER for distribution to the CONTRACTOR with its comments noted thereon, within 15 calendar days following their receipt by the OWNER.
- D. All CONTRACTOR shop drawing submittals shall be carefully reviewed by an authorized representative of the CONTRACTOR, prior to submission to the OWNER. Each submittal shall be dated and signed by the CONTRACTOR, as being correct and in conformance with the Contract Documents. In the case of shop drawings, each sheet shall be so dated and signed. No consideration for review by the ENGINEER of any CONTRACTOR submittals will be made for any items which have not been so certified by the CONTRACTOR. All noncertified submittals will be returned to the CONTRACTOR without action taken by the ENGINEER, and any delays caused thereby shall be the total responsibility of the CONTRACTOR.

1.03 Requests for Information

- A. Whenever additional design information or clarification is required CONTRACTOR shall submit a Request for Information (RFI) to the OWNER for distribution to the responsible project ENGINEER, if needed.
- B. RFI submittals shall be submitted with an RFI tracking form cover. The tracking form shall include the RFI number, description, submittal date, response date, and comments.
- C. Except as may otherwise be provided herein, the OWNER will acknowledge receipt of the RFI within three days. The ENGINEER will return each RFI response to the OWNER for distribution to the CONTRACTOR within 10 calendar days following their receipt by the OWNER.

1.04 CONTRACTOR's Progress Schedule Submittals

Progress Schedule Submittals shall adhere to Exhibit L – Form of Contractor's Schedules and Reporting Requirements..

1.05 Proposed Substitutes of "Or Approved Equal" Items. In addition to the requirement of Section 4.2.1 of the Contract, the requirements of this Section 1.05 apply to any Contractor-proposed substitution or alternatives.

- A. Whenever materials or equipment are specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular supplier, the naming of the item is intended to establish the type, function, and quality required. If the name is followed by the words "or approved equal" indicating that a substitution may be permitted, materials or equipment of other suppliers may be accepted by the OWNER if sufficient information is submitted by the CONTRACTOR to allow the ENGINEER to determine that the material or equipment proposed is equivalent or equal to that named, subject to the following requirements:
 - (1) The burden of proof as to the type, function, and quality of any such substitute material or equipment shall be upon the CONTRACTOR.
 - (2) The ENGINEER will determine as to the type, function, and quality of any such substitute material or equipment.
 - (3) The ENGINEER may require the CONTRACTOR to furnish at the CONTRACTOR's expense additional data about the proposed substitute.
 - (4) The OWNER may require the CONTRACTOR to furnish at the CONTRACTOR's expense a special performance guarantee or other surety with respect to any substitution.
 - (5) Acceptance by the OWNER of a substitute item proposed by the CONTRACTOR shall not relieve the CONTRACTOR of the responsibility for full compliance with the Contract Documents and for adequacy of the substitute item.
 - (6) The CONTRACTOR shall be responsible for resultant changes and all additional costs which the accepted substitution requires in the CONTRACTOR's work, the work of its subcontractors and of Others, and shall effect such changes without cost to the OWNER.
- B. The procedure for review by the ENGINEER will include the following:
 - (1) If the CONTRACTOR wishes to furnish or use a substitute item of material or equipment, the CONTRACTOR shall make written application to the OWNER.

- (2) The CONTRACTOR shall certify that the proposed substitute will perform adequately the functions and achieve the results called for by the general design, be similar and of equal substance to that specified, and be suited to the same use as that specified.
 - (3) The ENGINEER will be allowed a reasonable time within which to evaluate each proposed substitute.
 - (4) As applicable, no Shop Drawing submittals will be made for a substitute item nor will any substitute item be ordered, installed, or utilized without the ENGINEER's prior written acceptance of the CONTRACTOR's substitution request
- C. The CONTRACTOR's application shall contain the following statements and/or information which shall be considered by the ENGINEER in evaluating the proposed substitution:
- (1) The evaluation and acceptance of the proposed substitute will not prejudice the CONTRACTOR's achievement of substantial completion on time.
 - (2) Whether or not acceptance of the substitution for use in the Work will require a change in any of the Contract Documents to adapt the design to the proposed substitute.
 - (3) Whether or not incorporation or use of the substitute in connection with the Work is subject to payment of any license fee or royalty.
 - (4) All variations of the proposed substitute for that specified shall be identified.
 - (5) Available maintenance, repair, and replacement service shall be indicated.
 - (6) Itemized estimate of all costs that will result directly or indirectly from acceptance of such substitute, including cost of redesign and claims of other contractors affected by the resulting change.

1.06 Manufacturer's Instructions

- A. When specified in individual specification sections, submit manufacturer's printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, in quantities specified for Product Data.
- B. Identify conflicts between manufacturer's instructions and Contract Documents.

1.07 Manufacturer's Certificates

- A. When specified in individual specification sections, submit manufacturer's certificate to ENGINEER for review, in quantities specified for Product Data.
- B. Indicate if the material or product conforms to or exceeds specified requirements. Submit supporting reference date, affidavits, and certifications as appropriate.
- C. Certificates may be recent or previous test results on material or product, but must be acceptable to the ENGINEER.

1.08 Daily, Weekly, and Monthly Reports

Periodic reports shall comply with the requirements in Exhibit L – Form of Contractor’s Schedules and Reporting Requirements.

1.09 Health and Safety Plan

The CONTRACTOR shall prepare and submit a Health and Safety Plan to the OWNER in accordance with Section 4.7 (Project Site Safety) and Exhibit F - On-Site Safety and Environmental.

1.10 Layout Data

- A. General - The CONTRACTOR is responsible for coordinating work of all trades on the job. He shall confer with OWNER and provide guidance and information to all trades as required for proper progress of the work.
- B. Conflicts - Where the work of two (2) trades will be installed in close proximity to each other, or where there is evidence that work of one (1) trade will interfere with another trade, CONTRACTOR shall prepare composite working drawings if directed by OWNER. Such drawings shall indicate how all work is to be installed before coordinating with other trades so as to cause interference with work of other trades, shall make necessary changes in his work to correct conditions to the satisfaction of the OWNER without extra charge.
- C. Procedures - If requested, by OWNER, CONTRACTOR shall provide detailed drawings as required to indicate construction procedures.

1.11 Environmental Protection Plan

- A. General – The CONTRACTOR shall prepare an Environmental Protection Plan (EPP) per the requirements of Paragraph 20, Part Three of Exhibit F - On-Site Safety and Environmental of the Contract. The Plan shall be submitted to the OWNER two weeks prior to mobilization and must be approved by the OWNER prior to commencement of the Work.
- B. The OWNER’s Environmental Compliance Coordinator (ECC) will conduct daily monitoring of the CONTRACTOR’s compliance with the EPP and has the authority to stop WORK when non-compliance is observed. CONTRACTOR shall correct non-compliance at no cost to the OWNER prior to commencing the non-compliant portion of the Work.
- C. Required Plan Components – Along with the requirements in the Supplemental Terms and Conditions for the EPP components, the following documents shall be included as stand-alone attachments to the EPP.
 - (1) Waste Disposal Plan – The CONTRACTOR shall submit a Waste Disposal Plan that will include a list of potential wastes to be disposed at a waste management facility, procedures for preparing Waste Determinations, and a list of proposed disposal facilities. Waste Determinations shall be approved by the ECC prior to waste leaving the Work area, and the OWNER reserves the right to reject the use of certain waste management facilities.
 - (2) Spill Prevention, Control, and Countermeasure (SPCC) Plan – CONTRACTOR shall prepare an SPCC Plan that meets the federal regulations in 40 CFR 112 regardless of the quantity of petroleum products at the Work site. The Plan shall address project specific items including, but not limited to, protection against hydraulic hose failure, fueling station containment, work along sensitive areas such as wetlands or water bodies, and protection of outfalls.

- (3) Fugitive Dust Emissions Plan – CONTRACTOR shall prepare a Fugitive Dust Emissions Plan that addresses the intent of 40 CFR 257.80(b)(1) and (2) for any activities involving the use of ash by the CONTRACTOR. In addition, the CONTRACTOR shall be prepared to assume responsibility for fugitive dust emissions of the entire Lower and Upper Ash Ponds after July 2017.
- (4) Surface Water Discharge and Treatment Plan – CONTRACTOR shall prepare a plan to demonstrate compliance with any surface water discharge from the WORK site. Surface water discharges shall comply with Technical Specification Sections 02140 and 02141, VPDES Permit No. VA0004146, and the contract drawings. CONTRACTOR shall also demonstrate adequate protection of the general stormwater outfalls as part of VPDES Permit No. VAR051023. CONTRACTOR shall submit the Stormwater Pollution Prevention Plan required as part of the VSMP permit to the ECC for approval.
- (5) Training Plan – CONTRACTOR shall submit a Training Plan with procedures for training new employees in the requirements of the EPP, providing refresher training for regular employees, and documentation of the training.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION

SECTION 01400
QUALITY ASSURANCE

PART 1 - GENERAL

1.01 Description of Work

- A. Quality Assurance and the control of construction.
- B. Inspection and testing laboratory services.

1.02 Related Sections

- A. Section 01300 - Submittals
- B. Section 01410 - Testing Laboratory Services

1.03 Quality Assurance of Installation

- A. The Owner shall appoint a Quality Assurance Consultant (QAC) to monitor and report construction activities and the CONTRACTOR shall monitor quality control over products, services, Site conditions, and workmanship, for conformance with the Contract Documents.
- B. CONTRACTOR shall comply fully with manufacturers' instructions, including each step in sequence.
- C. Should manufacturers' instructions conflict with Contract Documents, CONTRACTOR shall request clarification from the ENGINEER or OWNER before proceeding.
- D. CONTRACTOR shall comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. CONTRACTOR shall perform Work by persons qualified to produce workmanship of specified quality.

1.04 References

- A. Conform to the reference standard defined in each Specification section, which is in effect as of the date for receiving bids.
- B. Obtain copies of standards when required by Contract Documents.
- C. Should specified reference standards conflict with Contract Documents, request clarification from ENGINEER or OWNER before proceeding.
- D. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by either mention or inference in any reference document.

1.05 Inspection and testing laboratory services

- A. The CONTRACTOR is responsible for performing all Quality Control tests. OWNER will appoint, employ, and pay for services of a Quality Assurance Consultant (QAC) to perform

quality assurance inspection and testing. The site specific QA Plan contains minimum testing criteria in addition to the testing defined in these Specifications. Where there is a conflict between the QA Plan and these Specifications, the more stringent requirement will be maintained.

- B. The QAC will perform inspections, tests, and services as required by the QA Plan and the Project Specifications.
- C. Reports will be submitted by the QAC to the OWNER, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.
- D. The CONTRACTOR, when required, shall cooperate with QAC to furnish samples of materials, design mix, equipment, tools, storage and assistance as requested.
 - (1) Notify QAC 24 hours prior to expected time for operations requiring services.
 - (2) Make arrangements with QAC and pay for additional samples and tests required for CONTRACTOR's use.
- E. Retesting or reinspection required because of non-conformance to specified requirements shall be performed by the QAC on instructions by the OWNER.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION

SECTION 01410

TESTING LABORATORY SERVICES

PART 1 - GENERAL

1.01 Description of Work

- A. The OWNER will select and employ an Independent Testing Laboratory to perform services as required by these Technical Specifications.
- B. The OWNER shall pay all charges of the Testing Laboratory.

1.02 Related Sections

- A. Section 01300 - Submittals
- B. Section 01564 - Project Record Documents

1.03 Laboratory Duties

- A. Cooperate with OWNER, ENGINEER and QAC and provide qualified personnel promptly on notice. Perform specified inspections, sampling and testing of materials and methods of construction; ascertain compliance with requirements of Contract Documents.
- B. Promptly notify OWNER, ENGINEER and QAC of irregularities or deficiencies of work which are observed during performance of services. Submit two (2) copies of reports of inspections and tests to OWNER, including:
 - (1) Date issued
 - (2) Project title and number
 - (3) Testing Laboratory name and address
 - (4) Name and signature of Inspector
 - (5) Date of inspection or sampling
 - (6) Record of temperature and weather
 - (7) Date of test
 - (8) Identification of product and specification section
 - (9) Location in project
 - (10) Type of inspection or test
 - (11) Observations regarding compliance with Contract Documents
- C. Laboratory is not authorized to release, revoke, alter or enlarge on requirements of Contract Documents; to approve or accept any portion of work, or perform any duties of the CONTRACTOR.

1.04 Laboratory Reports

- A. After each inspection and test, WITHIN 72 HOURS, submit two (2) copies of laboratory report to QAC, ENGINEER and to the OWNER.
- B. Include:
 - (1) Date issued
 - (2) Project title and number
 - (3) Name of inspector
 - (4) Date and time of sampling or inspection
 - (5) Identification of product and Specifications Section
 - (6) Location in the Project
 - (7) Type of inspection or test
 - (8) Date of test
 - (9) Results of tests
 - (10) Conformance with Contract Documents
- C. When requested by OWNER, provide interpretation of test results.

1.05 CONTRACTOR's Responsibility

- A. Cooperate with Laboratory personnel and provide access to work.
- B. Provide to Laboratory, preliminary representative samples of materials to be tested, in required quantities.
- C. Furnish casual labor and facilities to provide access to work to be tested, to obtain and handle samples at the site, and to facilitate inspections and tests.
- D. Notify Laboratory sufficiently in advance of operations to allow for his assignment of personnel and schedule of tests.
- E. Arrange with Laboratory, and pay for, any additional samples and testing required for CONTRACTOR's convenience.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION

SECTION 01500

CONSTRUCTION FACILITIES

PART 1 - GENERAL

1.01 Description of Work

The CONTRACTOR shall furnish temporary construction facilities as required for the use of all trades during the construction period.

1.02 Access and Parking

OWNER shall provide adequate and safe access to site and work, and CONTRACTOR shall maintain designated parking areas. All construction personnel must park in designated areas.

1.03 Trash Removal

Clean up and trash removal shall be performed in accordance with Section 4.9 (Clean-up and Waste Removal) and Exhibit F Exhibit F - On-Site Safety and Environmental of the Contract..

1.04 Temporary Sanitary Facilities

Provide and maintain chemical type self-contained temporary toilet accommodations on the premises for use of workmen employed during the project. After completion of the project they shall be removed. The temporary toilets shall be enclosed and weather-proof and kept in a sanitary condition at all times.

1.05 Temporary Utilities

The CONTRACTOR shall provide all temporary electric, water and lighting utilities necessary for the proper performance of the work, except for the construction trailer power and water only.

1.06 NOT USED

1.07 Removal of Utilities, Facilities, and Controls

- A. Remove temporary above-grade or buried utilities, equipment, facilities, materials, prior to Final application for Payment inspection.
- B. Remove temporary underground installations.
- C. Clean and repair damage caused by installation or use of temporary work.
- D. Restore existing facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

1.08 Protection of Existing Utilities and Facilities

- A. Protect and maintain in-service all existing utilities.
- B. Provide temporary services where required to provide uninterrupted utility services for on-going site operations.

- C. Prevent damage to existing facilities structures and buildings - repair damage or replace immediately on direction of OWNER.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION

SECTION 01562
CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 Final Cleaning

- A. Execute final cleaning prior to final inspection.
- B. Clean debris from drainage system, sedimentation ponds, roads and work areas.
- C. Clean remainder of the Site of any deleterious material as directed by OWNER.
- E. Remove waste and surplus materials, rubbish, and construction facilities from the Site.

1.05 Final Review

- A. CONTRACTOR shall submit in writing that:
 - (1) Work has been completed in accordance with Contract Documents.
 - (2) Equipment and systems have been tested in presence of OWNER and are operational.
 - (3) All inspections by local or regional agencies have been satisfactorily completed.
 - (4) Project is completed, and ready for final review.
 - (5) The project record documents have been maintained in accordance with Section 01564 and accurately describe the complete work.
- B. Upon Virginia Department of Environmental Quality review of the Work, OWNER will request CONTRACTOR to make project closeout submittals.
- C. Should OWNER consider that work is not finally complete:
 - (1) He will notify CONTRACTOR, in writing, stating reasons.
 - (2) CONTRACTOR shall take immediate steps to remedy the stated deficiencies, and send second written notice to OWNER certifying that work is complete.
 - (3) OWNER will again review the work.

1.06 Closeout Submittals

- A. Project Record Documents: In accordance with requirements of Section 01564.
- B. Deliver evidence of compliance with requirements of governing authorities, e.g. building permit closeout and stormwater inspections.
- C. Deliver Certificate of Insurance for Products and Completed Operations.
- D. Applicable requirements of federal, state, and local agencies having jurisdiction.

END OF SECTION

SECTION 01564

PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.01 Description of Work

- A. The work under this Section includes, but is not necessarily limited to, the maintenance, recording and submittal of Project Record Documents as herein specified.
- B. The CONTRACTOR shall maintain in designated locations at the Site for the OWNER one record copy of:
 - (1) Drawings and Addenda.
 - (2) Specifications and Addenda.
 - (3) Change orders and other modifications to the Contract
 - (4) OWNER field orders or written instructions
 - (5) Reviewed shop drawings, product data and samples
 - (6) Field test records
 - (7) Manufacturer's certificates
 - (8) Weekly Reports
 - (9) Monthly Reports
- C. Other Documents: Manufacturer's certifications, inspection certifications, field test records required by individual Specifications Sections.
- D. The CONTRACTOR shall keep and maintain at the Site, one set of progress drawings for each project. On these, it shall mark all project conditions, locations, configurations, and any other changes or deviations which may vary from the details represented on the original Drawings, including buried or concealed construction and utility features which are revealed during the course of construction. Special attention shall be given to recording the horizontal and vertical location of all buried utilities that differ from the locations indicated, or which were not indicated on the Contract Drawings. The record drawings shall be supplemented by any detailed sketches as necessary or directed to indicate, fully, the Work as actually constructed. These progress drawings of the CONTRACTOR's representation of as-built conditions, including all revisions made necessary by addenda, change orders, and the like shall be maintained up-to-date during the progress of the Work.
- E. Progress drawings shall be accessible to the CQA consultant at all times during the construction period and shall be delivered to the CQA consultant upon completion of the Work.
- F. Upon Substantial Completion of the Work and prior to Final Acceptance, the CONTRACTOR shall complete and deliver 6 complete sets of record drawings and two compact disks containing electronic versions of the record drawings in TIF, PDF or AutoCAD (DWF or DWG) Format to the CQA Consultant, conforming to the construction records of the CONTRACTOR. This set of drawings shall consist of corrected drawings showing the reported location of the Work. The information submitted by the CONTRACTOR and incorporated by the CQA consultant into the Record Drawings will be assumed to be reliable, and the CQA consultant

will not be responsible for the accuracy of such information, nor for any errors or omissions which may appear on the Record Drawings as a result.

As part of each certification report submitted to the DEQ, as-built drawings sealed by a Virginia Licensed Land Surveyor will be included. These drawings must be to scale, have a contour interval of 2 feet or less, and be on a 24"x36" sheet size.

- As a minimum, drawings will include (as appropriate for the project):
- Existing (pre-construction) Conditions;
- Top of Geosynthetic subgrade;
- Geosynthetic panel layout and destructive sample locations;
- Geosynthetic panel layout including panel numbers, roll numbers and repair locations;
- Top of Leachate Drainage Layer, including thickness verification of layer;
- Or -
- Top of Final Cover Layer, including thickness verification of layer;
- Other project-specific construction items

G. Specific to the Lower Ash Pond (LAP), the following information shall be identified on the record drawings:

- Location and top elevation of steel sheet pile walls
- Location of Capping System Geosynthetic Anchor Trench
- Profile of the Crest of the Stormwater Management Basin
- Profile and Section of the Outlet Spillway Structure
- Limit of Compacted Soil Cap
- Profile of UAP Toe Drain Force Main
- Location of Anchor Trench Outlet Drains
- Locations of Fabric-Formed Concrete Channel Lining
- Location, size, material for all culverts

H. Specific to the Low Volume Waste Water Pond (LVWW), the following information shall be identified on the record drawings:

- Top of pipe every 50 feet and at fittings.
- Top of geosynthetic subgrade
- Geosynthetic panel layout
- Top of forebay and O&G tanks
- Lift station locations

1.02 Maintenance of Documents and Samples

A. Storage

- (1) Store documents and samples in CONTRACTOR's field office apart from documents used for construction.
- (2) Provide files and racks for storage of documents.
- (3) Provide locked cabinet or secure storage space for storage of samples.

B. File documents and samples in accordance with format of these Specifications.

C. Maintenance

- (1) Maintain documents in a clean, dry, legible condition and in good order.
- (2) Do not use record documents for construction purposes.

D. Make documents and samples available at all times for inspection by OWNER.

1.03 Recording

A. Label each document "PROJECT RECORD" in neat, large printed letters.

B. Recording

(1) Record information concurrently with construction progress.

(2) Do not conceal any work until required information is recorded.

C. Drawings: Progress drawings shall be reproducible, shall have a title block indicating that the drawings are record drawings, the name of the company preparing the progress drawings and the date the progress drawings were prepared. The CONTRACTOR will be provided paper and/or digital copies of the Contract Drawings, at the cost of reproduction, or he may elect to provide reproducible drawings via another method. Legibly mark drawings to record actual construction:

(1) Field changes of dimension and detail.

(2) Changes made by Requests for Information (RFI), field order or by change order.

(3) Details not on original Contract Drawings.

D. Specifications: Legibly mark each section to record:

(1) Manufacturer, trade name, catalog number, and supplier of each product and item of equipment actually installed.

(2) Changes made by Requests for Information (RFI), field order or by change order.

1.04 Submittal

A. At Contract closeout, deliver record documents in the form of a Final Construction Report to the OWNER for each project.

B. Accompany submittal with transmittal letter, in duplicate, containing:

(1) Date

(2) Project title and number

(3) CONTRACTOR's name, address, and telephone number

(4) Title and number of each record document

(5) Signature of CONTRACTOR's authorized representative.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION

SECTION 02070

CHAIN LINK FENCE AND GATES

PART 1- GENERAL

1.01 SUMMARY

- A. This Section includes industrial/commercial chain link fence and gates specifications:
 - 1. Zinc 5% Aluminum alloy coated steel chain link fabric
 - 2. Galvanized steel framework and fittings
 - 3. Gates: swing and cantilever slide
 - 4. Barbed wire
 - 5. Installation
- B. Related Sections:
 - 1. 02200 Earthwork
 - 2. 02936 Seeding
 - 3. 03300 Cast-in-Place Concrete

1.02 REFERENCES

- A. ASTM A121 Specification for Metallic-Coated Carbon Steel Barbed Wire
- B. ASTM A392 Specification for Zinc-Coated Steel Chain-Link Fence Fabric
- C. ASTM A780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
- D. ASTM F552 Standard Terminology Relating to Chain Link Fencing
- E. ASTM F567 Standard Practice for Installation of Chain Link Fence
- F. ASTM F626 Specification for Fence Fittings
- G. ASTM F900 Specification for Industrial and Commercial Swing Gates
- H. ASTM F1043 Specification for Strength and Protective Coatings of Steel Industrial Chain Link Fence Framework
- I. ASTM F1083 Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
- J. ASTM A824 Specification for Metallic-Coated Steel Marcellled Tension Wire for Use With Chain Link

1.03 SUBMITTALS

- A. Certifications: The CONTRACTOR shall submit manufacturer's material certifications in compliance with the current ASTM specifications.
- B. Domestic certifications: The CONTRACTOR shall submit material certifications, Made in U.S.A., Buy American Act or Buy America when required.

1.04 QUALITY ASSURANCE

- A. Fence contractor: Company with demonstrated successful experience installing similar projects and products in accordance with ASTM F567 having at least 5 years' experience.
- B. Tolerances: Current published edition of ASTM specifications tolerances apply. ASTM specification tolerances supersede any conflicting tolerance.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Delivery: Deliver products to site.
- B. Storage: Store and protect products off the ground.

PART 2 – PRODUCTS

2.01 CHAIN LINK FABRIC

Steel Chain Link Fabric: Height or heights indicated on drawings, shall be 8 feet tall, with 2-inch mesh, Class 1(1.02 oz/ft²) zinc coated steel fabric per ASTM A392 hot dipped galvanized before weaving.

2.02 ROUND STEEL PIPE FENCE FRAMEWORK

Round steel pipe and rail: Schedule 40 standard weight pipe, in accordance with ASTM F1083, 1.8 oz/ ft² (550 g/m²) hot dip galvanized zinc exterior and 1.8 oz/ft² (550 g/m²) hot dip galvanized zinc interior coating.

Regular Grade: Minimum steel yield strength 30,000 psi (205 MPa)

1. Line post: 2.375 OD, zinc coated, 3.65 lb./ft.
2. End, Corner, Pull post: 2.875 OD, zinc coated, 5.79 lb./ft.
3. Top, brace, bottom and intermediate rails, 1.660 in. OD: zinc coated, 2.27 lb./ft.

2.03 TENSION WIRE

Metallic Coated Steel Marcellled Tension Wire: 7 gauge (0.177 in.) (4.50 mm) marcellled wire complying with ASTM A824, Type II Zinc-Coated, ASTM A817 Class 4 - 1.2 oz/ft².

2.04 BARBED WIRE

Metallic Coated Steel Barbed Wire: Comply with ASTM A121, Design Number 12-4-5-14R, double 12-½ gauge 0.099 in. twisted strand wire, with 4 point 14 gauge 0.080 in. round barbs spaced 5 inches on center. Coating Type Z - Zinc-coated: Strand wire coating Type Z, Class 3, 0.80 oz/ft², barb coating 0.70 oz/ft².

2.05 FITTINGS

- A. Tension and Brace Bands: Galvanized pressed steel complying with ASTM F626, minimum steel thickness of 12 gauge (0.105 in.), minimum width of 3/4 in. and minimum zinc coating of 1.20 oz/ft². Secure bands with 5/16 in. galvanized steel carriage bolts.
- B. Terminal Post Caps, Line Post Loop Tops, Rail and Brace Ends, Boulevard Clamps, Rail Sleeves: In compliance to ASTM F626, pressed steel galvanized after fabrication having a minimum zinc coating of 1.20 oz/ft².
- C. Truss Rod Assembly: In compliance with ASTM F626, 3/8 in. diameter steel truss rod with a pressed steel tightener, minimum zinc coating of 1.2 oz/ft², assembly capable of withstanding a tension of 2,000 lbs.

- D. Tension Bars: In compliance with ASTM F626. Galvanized steel one-piece length 2 in. (50 mm) less than the fabric height. Minimum zinc coating 1.2 oz. /ft². Bars shall have a minimum cross section of 3/16 in. by 3/4 in.
- E. Barbed Wire Arms: In compliance with ASTM F626, pressed steel galvanized after fabrication, minimum zinc coating of 1.20 oz. /ft², capable of supporting a vertical 250 lb load. Type I – three strand 45 degree arm

2.06 TIE WIRE and HOG RINGS

Tie Wire and Hog Rings: Galvanized minimum zinc coating 1.20 oz/ft², 9 gauge (0.148 in.) steel wire in compliance with ASTM F626.

2.07 SWING GATES

Swing Gates: Galvanized steel pipe welded fabrication in compliance with ASTM F900. Gate frame members 1.900 in. OD ASTM F 1083 schedule 40 galvanized steel pipe. Frame members spaced no greater than 8 ft. apart vertically and horizontally. Welded joints protected by applying zinc-rich paint in accordance with ASTM Practice A780. Positive locking gate latch, pressed steel galvanized after fabrication. Galvanized malleable iron or heavy gauge pressed steel post and frame hinges. Provide lockable drop bar and gate holdbacks with double gates. Match gate fabric to that of the fence system. Gateposts per ASTM F1083 schedule 40 galvanized steel pipe. 4.000 in.OD. 9.11 lb./ft.

2.08 CONCRETE

Concrete for post footings shall have a 28-day compressive strength of 2,500 psi.

PART 3 EXECUTION

3.01 CLEARING FENCE LINE

Clearing: Surveying, clearing, grubbing, grading and removal of debris for the fence line or any required clear areas adjacent to the fence is included in the earthwork contractor's contract under Section 02200. The contract drawings indicate the extent of the area to be cleared and grubbed.

3.02 FRAMEWORK INSTALLATION

- A. Posts: Posts shall be set plumb in concrete footings in accordance with ASTM F567. Minimum footing depth, 36 inches. Minimum footing diameter shall be 16 inches. Top of concrete footing shall be crowned to shed water away from the post. Line posts installed at intervals not exceeding 10 ft. on center.
- B. Top rail: Install 21 ft. lengths of rail continuous thru the line post or barb arm loop top. Splice rail using top rail sleeves minimum 6 in. long. Rail shall be secured to the terminal post by a brace band and rail end. Bottom rail or intermediate rail shall be field cut and secured to the line posts using boulevard clamps or brace band with rail end.
- C. Terminal posts: End, corner, pull and gate posts shall be braced and trussed. The horizontal brace rail and diagonal truss rod shall be installed in accordance with ASTM F567.
- D. Tension wire: Shall be installed 4 in. from the bottom of the fabric. Tension wire to be stretched taut, independently and prior to the fabric, between the terminal posts and secured to the terminal post using a brace band. Secure the tension wire to each line post with a tie wire.

3.03 CHAIN LINK FABRIC INSTALLATION

Chain Link Fabric: Install fabric to inside of the framework. Attach fabric to the terminal post by threading the tension bar through the fabric; secure the tension bar to the terminal post with tension bands and 5/16 in. carriage bolts spaced no greater than 12 inches on center. Chain link fabric to be stretched taut free of sag. Fabric to be secured to the line post with tie wires spaced no greater than 12 inches on center and to horizontal rail spaced no greater than 18 inches on center. Secure fabric to the tension wire with hog rings spaced no greater than 18 inches on center. Tie wire shall be wrapped around the post or rail and attached to the fabric wire picket on each side by twisting the tie wire around the fabric wire picket two full turns. Excess wire shall be cut off and bent over to prevent injury. The installed fabric shall have a ground clearance on no more than 2 inches.

3.04 BARBED WIRE INSTALLATION

Barbed Wire: Stretched taut between terminal posts and secured in the slots provided on the line post barb arms. Attach each strand of barbed wire to the terminal post using a brace band. Barb arm shall be Type I and direction inward.

3.05 GATE INSTALLATION

Swing Gates: Installation of swing gates and gateposts in compliance with ASTM F 567. Direction of swing shall be outward. Gates shall be plumb in the closed position having a bottom clearance of 3 in., grade permitting. Hinge and latch offset opening space shall be no greater than 3 in. in the closed position. Double gate drop bar receivers shall be set in a concrete footing minimum 6 in. diameter 24 in. deep. Gate leaf holdbacks shall be installed for all double gates.

3.06 NUTS AND BOLTS

Bolts: Carriage bolts used for fittings shall be installed with the head on the secure side of the fence. All bolts shall be peened over to prevent removal of the nut.

3.7.1 CLEAN UP

Clean Up: The area of the fence line shall be left neat and free of any debris caused by the installation of the fence.

END OF SECTION

SECTION 02100
SITE PREPARATION

PART 1 - GENERAL

1.01 Description of Work

- A. The CONTRACTOR shall furnish all materials, labor, equipment, tools and appurtenances required to complete the work.
- B. Comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, State or Federal authorities having jurisdiction.
- C. Remove and dispose of all debris, bulky items, waste materials, etc. existing in the area to be constructed and encountered on the surface. All bulky items such as large debris, stumps, cars, old fencing, etc. are to be disposed off-site at CONTRACTOR's expense. Material containing ash or coal shall be disposed of in a regulated landfill as approved by the OWNER.
- D. Protect and maintain bench marks, monuments and other reference points. Re-establish, at no cost to the OWNER, any such reference points if disturbed or destroyed. The CONTRACTOR's surveyor shall conduct a survey of all monuments and property markers within proposed cover areas prior to any disturbance such as they can be re-established after completion of the cover by the CONTRACTOR as part of this Contract.
- E. Remove, demolish, excavate, haul and dispose of any on-site structures, pavement, roads, drainage pipes, utilities, etc. per C above and as identified in the project-specific Scope of Work (SOW) for specific items.

1.02 Related Sections

- A. Dust Control - Section 01540
- B. Health and Safety Specifications for Construction - Section 01550
- C. Site Clearing and Grubbing - Section 02110
- D. Earthwork - Section 02220

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION

SECTION 02110

SITE CLEARING AND GRUBBING

PART 1 - GENERAL

1.01 Description of Work

- A. The CONTRACTOR shall furnish all materials, labor, equipment, tools and appurtenances required to complete the work as described below.
- B. Site clearing includes, but is not limited to, removing from the limits of work and disposing of trees, stumps, roots, brush, structures (at and below ground), abandoned utilities, trash, asphalt, debris and all other materials found on or near the surface of the ground in the construction area. Precautionary measures that prevent damage to existing features to remain are part of the work.
- C. Comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, State or Federal authorities having jurisdiction.
- D. No clearing and grubbing will be allowed without adequate erosion and sedimentation control measures in place and to the satisfaction of the OWNER

1.02 Related Sections

- A. Dust Control - Section 01540
- B. Health & Safety Specifications for Construction - Section 01550
- C. Temporary and Permanent Erosion and Sediment Control - Section 02125
- D. Earthwork - Section 02220

1.03 Job Conditions

- A. Location of the Work - Landfill: The area to be cleared and grubbed includes all areas designated for cell construction, access road construction, channel construction and required construction access areas.
- B. Location of the Work - LAP: The area to be cleared and grubbed includes all areas of the Lower Ash Pond, including open water area and the phragmites marsh mat.
- C. Location of the Work - LVWW: The area to be cleared and grubbed includes the LVWW area, forebay tank and equalization basin areas.
- D. Location of the Work - UAP: The area to be cleared and grubbed includes all Upper Ash Pond areas, to receive final cover, the sediment basin and associated outfall area to the James River.

PART 2 - PRODUCTS

The CONTRACTOR shall furnish equipment of the type normally used in clearing and grubbing operations including, but not limited to, dozers, shears, skidders, loaders, root rakes, chipping equipment and stump grinders.

PART 3 - EXECUTION

3.01 Scheduling Of Clearing

- A. CONTRACTOR shall install all temporary Soil Erosion and Sedimentation Control Plan per CONTRACTOR's plan to the acceptance of OWNER prior to start up of clearing operations.
- B. CONTRACTOR shall maintain all survey controls.

3.02 Construction Area Clearing and Grubbing

- A. Materials to be cleared, grubbed, and removed from the construction areas include, but are not limited to, the following: all trees, stumps, roots, brush, trash, organic matter, miscellaneous structures, debris and abandoned utilities.
- B. Grubbing shall consist of completely removing roots, stumps, trash and other debris from all graded areas so that surface material is free of roots and debris. Surface material is to be left sufficiently clean so that further picking and raking will not be required.
- C. All stumps, roots, foundations and planking embedded in the ground shall be removed and disposed.
- D. Surface rocks and boulders shall be grubbed from the soil and removed to the area on Site as directed by the OWNER.
- E. All construction areas shall be grubbed by tractors with root rakes.
- F. Where tree limbs interfere with utility wires, or where the trees to be felled are in close proximity to utility wires, the tree shall be taken down in sections to eliminate the possibility of damage to the utility. The CONTRACTOR shall be responsible for damages to utilities and shall replace/repair damaged utilities at no cost to OWNER.
- G. Any work pertaining to utility poles and guy wires shall comply with the requirements of the appropriate utility.
- H. Stumps and roots shall be grubbed and removed to a depth not less than two feet below grade. All holes or cavities which extend below the subgrade elevation of the proposed work shall be filled with crushed rock or other suitable material, compacted to a similar density as the surrounding material.
- I. The CONTRACTOR shall exercise special precautions for the protection and preservation of identified trees and shrubs with the construction area or those situated adjacent to the limits of the construction area. The CONTRACTOR shall be held liable for any damage the CONTRACTOR's operations have inflicted on such property.
- J. The CONTRACTOR shall be responsible for all damages to existing structures and/or improvements resulting from CONTRACTOR's operations.

3.03 Overhead Utility Line Right of Way Clearing

- A. All tree trimming operations within the right of way of overhead utility lines shall be completed in accordance with Dominion Virginia Power Specifications.
- B. Trees at edge of right of way shall be side-walled ground to sky.
- C. Stumps shall be cut to within 3" of ground level.

- D. Brush shall be chipped and windrowed out of right of way, or ground up with a brush hog in the right of way.
- E. No wood shall be left in right of way (stack it out of right of way).

3.04 Disposal of Debris

- A. All wood debris (stumps, roots, branches, and leaves) resulting from the clearing and grubbing operation shall be disposed of by chipping, grinding, or by other methods as approved by OWNER, in accordance with the Drawings and Specifications.
- B. All large debris, pipe, large metal objects, and bulky items will be removed and hauled to an off-site approved disposal facility.

END OF SECTION

SECTION 02120
STRIPPING OF ASH LADEN SOILS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Exhibit A Technical Drawings.

1.2 SUMMARY

- A. Section Includes:

- 1. Protecting existing vegetation to remain.
- 2. Stripping and off-site disposal of ash-laden vegetation.

- B. Related Requirements:

- 1. Section 02125 - T&P Erosion and Sediment Control.
- 2. Section 02200 - Earthwork

1.3 DEFINITIONS

- A. Ash Laden Soils: Top layer of the soil profile consisting of existing native surface topsoil and ash materials within top 6-inches of site; the zone where plant roots grow.

1.4 QUALITY ASSURANCE

- A. Topsoil Stripping and Disposal Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include proposed disposal facility, transportation routes, and disposal facility requirements.

1.5 FIELD CONDITIONS

- A. Utility Locator Service: Notify **Miss Utility of Virginia (1-800-552-7001)** within 7 days of commencement of work.
- B. Soil Stripping, Handling, and Disposal: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Satisfactory Soil Material: Consists of the top six-inches of existing site soils within the area as shown on the Contract Drawings.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 ASH-LADEN SOIL STRIPPING

- A. Strip ash-laden soil to a depth of 6-inches in a manner to prevent intermingling with underlying subsoil or other waste materials.

3.3 DISPOSAL OF ASH-LADEN SOIL

- A. Remove as-laden soil material, demolished materials, and waste materials including trash and debris, and legally dispose of them at an OWNER approved disposal facility.

END OF SECTION

SECTION 02125

TEMPORARY AND PERMANENT EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.01 Description of Work

- A. The CONTRACTOR shall provide all materials and promptly take all actions necessary to achieve effective erosion and sedimentation control in accordance with all applicable federal, state, and local enforcing agency guidelines and these Specifications.
- B. The work shown on the Contract Drawings and working drawings shall be considered a minimum requirement. What is shown shall not relieve the CONTRACTOR of the responsibility to actively take all steps necessary to control soil erosion and sedimentation.
- C. Comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, State or Federal authorities having jurisdiction.
- D. CONTRACTOR shall repair any material or existing surface conditions damaged by erosion or covered with sedimentation at the CONTRACTOR's expense.
- E. Erosion Control Measures shall be provided for all construction activities in the landfill area and other related work throughout the site. CONTRACTOR shall maintain at least 20% overstock of erosion control items stockpiled on-site for ease of use to replace installed items as deemed necessary, or provide evidence that necessary amounts of materials are readily available from local suppliers.
- F. The temporary erosion control features installed by the CONTRACTOR shall be maintained by the CONTRACTOR until no longer needed as determined by the OWNER, or permanent erosion control methods are installed.
- G. It shall be the sole responsibility of the CONTRACTOR to properly schedule and coordinate all necessary labor, equipment and materials such that the specified work is performed in accordance with the project schedule and the Contract requirements. At the discretion of the OWNER, the OWNER may reject or direct the CONTRACTOR to repair (at the CONTRACTOR's sole expense) those items which are detrimental to the project or not in compliance with the Contract Documents. Such direction or rejection by the OWNER shall not relieve the CONTRACTOR of his obligation to properly schedule and perform other specified work items in conformance with the Contract Documents.

1.02 Related Sections

- A. Site Clearing and Grubbing - Section 02110
- B. Earthwork - Section 02200
- C. Coarse Aggregate - Section 02233
- D. Stone Riprap - Section 02271
- E. Geotextile - Section 02595
- F. Seeding - Section - 02936

1.03 References

- A. Virginia Erosion & Sediment Control Handbook (VESCH), Third Edition, 1992.

1.04 Submittals

At the preconstruction conference, the CONTRACTOR shall submit for OWNER's approval, a schedule and construction drawing for accomplishment of temporary and permanent erosion control work, as are applicable for clearing and grubbing, grading, structures at watercourses, and general construction. No work shall be started until the erosion control schedules and methods of operations for each phase of construction have been accepted by the OWNER. This plan will be referred to as the CONTRACTOR's Soil Erosion and Sediment Control Plan.

PART 2 - PRODUCTS

2.01 Silt Fence

Silt fence shall be Filter X, Mirafi 100X, Stabilinka T140N, or approved equal. Super Silt Fence shall include chain link backing fence fabric and steel posts as required.

2.02 Bales

Straw bales shall be clean, seedfree oat or wheat type.

2.03 Seed

Seed type shall meet the requirements of Section 02936 "Seeding".

2.04 Temporary Erosion Control Mat

Temporary Erosion Control Mat shall be as specified in the drawings or approved equal, meeting the requirements of EC-2 matting.

2.05 Permanent Erosion Control Mat

Permanent Erosion Control Mat shall be as specified in the Drawings or approved equal, meeting the requirements of EC-3 matting.

2.06 Hydraulically Applied Products (Flexible Growth Medium)

Hydraulically applied FGM products such as Flexterra and others, may be used in lieu of temporary erosion control mat (EC-2). FGM with a geofabric backing may be used in lieu of permanent erosion control matting with the approval of the OWNER and ENGINEER. If FGM is used in conjunction with seeding, provide the required soil testing to manufacturer for seed and fertilizer mix design.

PART 3 - EXECUTION

3.01 General

- A. Conduct earthwork and excavation activities in such a manner to fit the topography, soil type and weather conditions.
- B. Minimize the area being disturbed and the duration of exposure to erosion elements.
- C. Stabilize disturbed areas immediately.
- D. Retain on-site, sediment that was generated on-site. Place sediments under cover after dewatering, during construction, and dispose of sediments as cover soil at landfill if not laden with seeps or perched groundwater.

- E. Prevent silt and sediment from entering any watercourse if soil erosion cannot be prevented.
- F. Prevent silt and sediment from migrating downstream in the event it cannot be prevented from entering the watercourse.
- G. Where provisions of pertinent rules and regulations conflict with these Specifications, the more stringent provisions shall govern.
- H. The OWNER has the authority to limit the surface area of erodible material exposed by clearing and grubbing, and to direct the CONTRACTOR to provide immediate temporary or permanent control measures to prevent sediment impact on adjacent watercourses.
- I. Where erosion is likely to be a problem, clearing and grubbing operations should be so scheduled and performed that grading operations and permanent erosion control features can follow immediately thereafter if the Project conditions permit; otherwise, erosion control measures may be required between successive construction stages.
- J. The OWNER will limit the area of excavation, and embankment operations in progress commensurate with the CONTRACTOR's capability and progress in keeping the finish grading, mulching, seeding and other such permanent control measures current in accordance with the accepted schedule. Should seasonal limitations make such coordination unrealistic, temporary erosion control measure shall be taken immediately to the extent feasible and justified.
- K. In the event that additional temporary erosion and sedimentation control measures are required due to the CONTRACTOR's negligence, carelessness or failure to install permanent controls as a part of the work schedule, and are ordered by the OWNER, such work shall be performed by the CONTRACTOR at the CONTRACTOR's expense, and no time extension shall be given.

3.02 Temporary Erosion and Sedimentation Control

- A. Temporary erosion control measures shall be used to correct conditions that develop during construction that lead to soil erosion or deposition of waterborne sediments; that are needed prior to installation of permanent erosion control features; or that are needed temporarily to control erosion that develops during normal construction practices, but are not associated with permanent control features on the Project.
- B. Temporary erosion and sedimentation control devices shall be installed and maintained prior to the initial land disturbance activity until the satisfactory completion and establishment of permanent erosion control measures. At that time, temporary devices shall be removed.
- C. The CONTRACTOR shall coordinate the installation of temporary erosion and sedimentation control provisions contained herein with the permanent erosion control features, to ensure economical, effective and continuous erosion control throughout the construction and post-construction period.
- D. Temporary erosion and sedimentation control procedures should be initially directed toward preventing silt, and sediment from entering the watercourses. The preferred method is to provide an undisturbed natural buffer, extending a minimal 5 feet from the top of the bank, to filter the run-off.
- E. Silt fences, barriers, temporary sedimentation basins and other temporary measures and devices shall be installed, and shall be maintained until no longer needed, as determined by the OWNER. At that time, the items shall be removed by the CONTRACTOR. All temporary items and devices must be removed with the OWNER's approval prior to final demobilization from the Site.

- F. Where permanent vegetation is not appropriate, and where the CONTRACTOR's temporary erosion and sedimentation control practices are inadequate, the CONTRACTOR shall provide temporary vegetative cover. Such temporary vegetative cover shall be provided by the CONTRACTOR in compliance with Section 02936 "Seeding" of these specifications.
- G. All erosion and sedimentation control devices shall be inspected by the CONTRACTOR at least weekly and after each rainfall occurrence, and cleaned out and repaired by the CONTRACTOR as necessary.

3.03 Temporary Erosion and Sediment Control Techniques

A. Temporary Diversion Berms

- (1) A temporary diversion berm is constructed of compacted soil, with or without a shallow ditch, at the top of fill slopes.
- (2) These diversion berms are used temporarily at the top of newly constructed slopes to prevent excessive erosion until permanent controls are installed or slopes stabilized.
- (3) A temporary diversion berm shall be constructed of compacted soil, with a minimum width of 24-inches at the top and a minimum height of 12-inches with or without a shallow ditch. Side slopes shall be three horizontal to one vertical (3H:1V) or flatter.

B. Temporary Slope Drains

- (1) A temporary slope drain may consist of stone downchutes, fiber mats, plastic sheets, half-round pipe, metal pipe, plastic pipe, sod or other material acceptable to the OWNER that may be used to carry water down slopes to reduce erosion prior to installation of permanent facilities or growth of adequate ground cover on slopes.
- (2) Fiber matting and plastic sheeting shall not be used on slopes steeper than 4H:1V except for short distances of 20 feet or less.
- (3) All temporary slope drains shall be adequately anchored to the slope to prevent disruption by the force of the water flowing in the drains. The base of temporary slope drains shall be compacted and concavely formed to channel water or hold the slope drain in place. The inlet end shall be properly constructed to channel water into the temporary slope drain.
- (4) Energy dissipators, sediment basins or other approved devices shall be constructed at the outlet end of the slope drains to reduce erosion downstream.

C. Sediment Control Structures

- (1) Sediment basins, ponds and traps, are prepared storage areas constructed to trap and store sediment from erodible areas in order to protect stream channels below the construction areas from excessive siltation.
- (2) When use of temporary sediment structures is to be discontinued, all sediment accumulation shall be removed and all excavation backfilled and properly compacted. The existing ground shall be restored to its natural or intended condition.

D. Riprap

- (1) Riprap used for permanent stabilization of channels, slopes and culvert outlets shall be installed in accordance with the Contract Drawings and Section 02271 "Stone Riprap" of these specifications.

- (2) Placing of riprap at locations other than those specified on the Contract Drawings shall be done only with approval or by the direction of the OWNER.
- (3) The ground surface around which the riprap is to be placed shall be brought in reasonably close conformity to the correct lines and grades before placement is commenced.
- (4) Geotextile shall be placed in all areas to receive riprap, unless otherwise specified. The surface to receive geotextile shall be prepared to a relatively smooth condition free from obstructions, depressions and debris. Geotextile shall be overlapped at least three feet between panels or the geotextile seams shall be continuously sewn or thermally bonded. The geotextile shall be anchored in place with securing pins of the type recommended by the geotextile manufacturer, or anchored at the edges in an anchor trench. The geotextile shall be placed loosely so as to give and, therefore, avoid stretching and tearing during placement of riprap. Riprap shall be dropped no more than three feet during construction. The geotextile shall be protected at all times during construction from runoff containing clay, silts, chemicals or other substances. Any geotextile damaged during its installation or during placement of riprap shall be removed and replaced with undamaged geotextile at no expense to OWNER.

E. Straw Bales

- (1) Straw bales are temporary measures to control erosion and retain the suspended silt particles in the runoff water leaving disturbed areas under sheet flow conditions. Bales shall not be placed in areas of concentrated flow such as channels.
- (2) Straw bales shall be embedded in the ground 4 to 6-inches to prevent water flowing under them. The bales shall also be anchored securely to the ground by wooden stakes driven through the bales into the ground. Bales shall be removed after they have served their purpose, as determined by the OWNER.
- (3) The CONTRACTOR shall keep the bales in good condition by replacing broken or damaged bales immediately after damage occurs. Normal debris clean-out will be considered routine maintenance.
- (4) Straw bales shall be used at the toe of fill slopes or other areas where siltation, erosion or water run-off is a problem.

F. Silt Fences / Wattles / Terra Tubes, etc.

- (1) Silt fences and wattles are temporary measures utilizing geofabrics or other approved materials attached to posts with filter cloth attached to the upstream side of the fence to retain the suspended silt particles in the runoff water.
- (2) Temporary silt fences and wattles shall be placed on the natural ground, at the toe of fill slopes, in ditches or other areas where siltation is a problem. Materials shall be anchored per VESCH or manufacturer specifications.
- (3) The CONTRACTOR shall be required to maintain the silt fence or wattle in a satisfactory condition for the duration of the Project or until its removal is requested by the OWNER. The silt accumulation at the control must be removed and placed on Site as directed by the OWNER.

G. Temporary Vegetation

- (1) Temporary vegetation are measures consisting of seeding, mulching, fertilizing and matting utilized to reduce erosion. All cut and fill slopes shall be seeded when and where necessary to eliminate erosion. Disturbed or bare soil areas shall not be left without stabilization for more than 7 days.
- (2) Seeding, mulching and fertilizing shall be performed in accordance with Section 02936 "Seeding" of these Specifications.
- (3) If late fall completion prevents germination. Disturbed areas shall be protected by mulching without application of seed as a minimum.

3.04 Permanent Erosion and Sediment Control

- A. The CONTRACTOR shall incorporate all permanent erosion control features into the Project at the earliest practicable time as outlined in the CONTRACTOR's Soil Erosion and Sediment Control Plan accepted schedule or as land disturbance for each segment of the Project has been completed.
- B. Restore the work site to its original contours, unless shown otherwise on the Drawings or directed by the OWNER.
- C. All references to permanent vegetation, unless noted otherwise, shall relate to establishing permanent vegetative cover and be in accordance with Section 02936 "Seeding" of these specifications.
- D. When final grade has been established, all bare soil, unless otherwise required by the Contract Documents, shall be seeded, fertilized and mulched in an effort to restore to a protected condition. Areas that are not stabilized with seed and mulch shall be sodded as approved or directed by the OWNER.
- E. Specified permanent vegetation shall be established at the first appropriate season following establishment of final grading in each section of the Site.
- F. Where sod is removed or damaged, such areas shall be replanted using sod of the same species of grass at the first appropriate season.
- G. Permanent vegetative cover activities shall comply with local soil and water conservation guidelines.
- H. Where permanent vegetative cover cannot be immediately established (due to season or other circumstances) the CONTRACTOR shall provide temporary vegetative cover.

3.05 Permanent Erosion and Sediment Control Techniques

A. Permanent Vegetation

All references to permanent vegetation, unless noted otherwise, shall relate to establishing permanent vegetative cover and be in accordance with Section 02936 "Seeding" of these specifications.

B. Riprap

- (1) Riprap used for permanent stabilization of channels, slopes and culvert outlets shall be installed in accordance with the Contract Drawings and Section 02271 "Stone Riprap" of these specifications.

- (2) Placing of riprap at locations other than those specified on the Contract Drawings shall be done only with approval or by the direction of the OWNER.
- (3) The ground surface around which the riprap is to be placed shall be brought in reasonably close conformity to the correct lines and grades before placement is commenced.
- (4) Geotextile shall be placed in all areas to receive riprap, unless otherwise specified. The surface to receive geotextile shall be prepared to a relatively smooth condition free from obstructions, depressions and debris. Geotextile shall be overlapped at least three feet between panels or the geotextile seams shall be continuously sewn or thermally bonded. The geotextile shall be anchored in place with securing pins of the type recommended by the geotextile manufacturer, or anchored at the edges in an anchor trench. The geotextile shall be placed loosely so as to give and, therefore, avoid stretching and tearing during placement of riprap. Riprap shall be dropped no more than three feet during construction. The geotextile shall be protected at all times during construction from runoff containing clay, silts, chemicals or other substances. Any geotextile damaged during its installation or during placement of riprap shall be removed and replaced with undamaged geotextile at no expense to OWNER.

END OF SECTION

SECTION 02140

CONSTRUCTION DEWATERING

PART 1 - GENERAL

1.01 Description of Work

- A. This section specifies the requirements for handling and management of dewatering activities for both Non-Contact and Contact waters.
- B. CONTRACTOR shall design, construct and maintain all dikes, sumps, and diversion and drainage channels as necessary to complete the construction and to protect the areas to be occupied by permanent work from water damage. CONTRACTOR shall remove temporary works after they have served their purpose.
- C. CONTRACTOR shall be responsible for the stability of all temporary and permanent slopes, grades, foundations, materials and structures during the course of the Contract. Repair and replace all slopes, grades, foundations, materials and structures damaged by water, both surface and subsurface, to the lines, grades and conditions existing prior to the damage, at no additional cost to OWNER.
- D. NOT USED.
- E. The CONTRACTOR shall submit a description of its methods for accomplishing construction dewatering to OWNER and ENGINEER for approval.
- F. CONTRACTOR shall provide measures to minimize accumulation of surface water in the work area.
- H. CONTRACTOR will segregate all surface runoff and waters from perched groundwater and seeps encountered by CONTRACTOR during excavation or filling operations. Perched groundwater and seeps encountered by CONTRACTOR will be collected, pumped, transferred and hauled to an on-site discharge point as directed by OWNER.

1.02 Related Sections

- A. Temporary and Permanent Erosion and Sediment Control - Section 02125
- B. Shoring and Bracing - Section 02150
- C. Earthwork - Section 02220

PART 2 - PRODUCTS

Piping, pumping equipment, and all other equipment and materials required for dewatering shall be suitable for the intended purpose. Standby pumping units shall be maintained at the Site to be used in case of failure of the normal pumping units.

PART 3 - EXECUTION

3.01 Handling of Non-Contact Water

- A. Design, furnish, install, maintain, monitor, operate and remove necessary pumping and other equipment for dewatering the various parts of the Work and for maintaining the work areas free from water as required for constructing each part of Work.
- B. Install all drainage ditches, sumps, and pumps to control excessive seepage on excavated slopes, to drain isolated zones with perched water tables and to drain impervious surfaces at final excavation elevation.
- C. Non-Contact Water shall be filtered by a dewatering structure to remove sediment prior to discharge by means of a filter box, sediment tank, Dirtbag®, or other means compliant with Std. & Spec 3.26 of the Virginia Erosion and Sediment Control Handbook, Third Edition. Do not allow filtered water to leave site except through an approved stormwater outfall point.
- D. Dewater by means which will enable completion of the Work and preserve final lines and grades. Do not disturb or displace adjacent soil.
- E. All pumping and drainage shall be done with no damage to property or structures and without interference with the rights of the public, owners of private property, pedestrians, vehicular traffic or the Work of other contractors, and in accordance with all Federal, State, and local laws, ordinances and regulations.
- F. Do not overload or obstruct existing drainage facilities.
- G. After they have served their purpose, remove all temporary protective work at a time and in a manner approved by the OWNER. All temporary diversion channels and other temporary excavations in areas where the compacted fill or other structures will be constructed shall be cleaned out, backfilled and processed under the same specifications as those governing the compacted fill (Section 02200).
- H. When the temporary works will not adversely affect any item of permanent work on the planned usage of the project, CONTRACTOR may be permitted to leave such temporary works in place. In such instances, breaching of dikes and other temporary works may be required.

3.02 Dewatering

- A. By the use of pumps, siphons, tile drains or other approved methods, CONTRACTOR shall control the flow and accumulation of water in excavated areas to prevent excessive softening and disturbance of exposed soils in excavations as necessary for completion of the Work.
- B. The system used shall not cause settlement damage to adjacent structures. The CONTRACTOR shall carry out the Work by the use of other methods which will not endanger adjacent structures; all such Work shall be done at the CONTRACTOR's expense.

3.03 Handling of Contact Water

- A. Manage effluent concentrations within the outfall permit limits provided by OWNER, including the use of turn-key water treatment systems, as necessary.

END OF SECTION

SECTION 02141

SURFACE IMPOUNDMENT DECANTING/DEWATERING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section applies to decanting and dewatering activities associated with the subgrade construction for capping purposes of the ash ponds. Decanting shall refer to the removal of free water ponded above the ash. Dewatering shall refer to the removal of water from the interstitial space of the ash.
- B. The Contractor shall be responsible for the design, construction, operation, and removal of decanting and dewatering systems as required for the design of a decanting and dewatering system to remove ponded water and interstitial water from the ash ponds. Ponded water shall be decanted from the ponds and discharged through the regulated outfall.

1.02 RELATED SECTIONS

- A. Section 01012 - General Requirements
- B. Section 01300 - Submittals
- C. Section 02200 - Earthwork

1.03 SUBMITTALS

- A. The Contractor shall describe decanting and dewatering activities and discharge limits in the Environmental Protection Plan to be submitted and approved by the OWNER. Descriptions of the system shall include the design, operation, and maintenance activities for the de-watering and decanting systems. The Contractor shall also provide a detailed plan and operation schedule for dewatering of excavations.
 - 1. Provide descriptive literature of the dewatering system.
 - 2. Provide a plan for erosion and sedimentation control during dewatering.
 - 3. Provide copies of all permits/approvals for disposal/discharge of water during dewatering.

1.04 PERFORMANCE CRITERIA - GENERAL

- A. The Contractor shall ensure that decanting and dewatering methods meet the performance requirements contained herein.
- B. Any reworking or repairs or additional removal of affected sediments required as a result of operation of the dewatering or decanting system will be performed at the Contractor's expense.
- C. Trucks relocating on-site materials shall be subject to regular inspection by the OWNER or CQA Consultant and shall remain within the limits of the Work when transporting materials.
- D. The Contractor shall ensure that the discharge is not corrosive and does not carry any visible traces of sediment into the receiving stream.

- E. Contractor shall conduct work in a manner that will not impair the operational capabilities of essential elements of the pond closure or cause to violate the water quality limitations specified in the discharge permit.
- F. The Contractor shall be required to monitor the performance of the dewatering system during the progress of the Work and make such modifications as may be required to assure that the systems will perform satisfactorily. The dewatering system shall be designed in such a manner as to preserve the undisturbed bearing capacity of the sub-grade soils at the bottom of the excavation.

1.05 PERFORMANCE CRITERIA - EXCAVATIONS

- A. The decanting/dewatering system shall be designed to maintain the pond in a dewatered condition during work activities. Any assumptions made for the purpose of bid preparation shall be clearly identified in the Contractor's bid.
- B. The decanting/dewatering system shall be designed to remove surface water, rainwater, and seepage that may enter the active work area.
- C. The decanting/dewatering system shall convey collected water to the Contractor's Wastewater Treatment System for subsequent treatment and eventual discharge through the weir structure at Outfall 004 at the Lower Ash Pond or the discharge structure at Outfall 005 at the Upper Ash Pond for work at the respective locations.
- D. The decanting/dewatering system shall remove free water from the active work area sufficiently to allow stabilization of ash and sediments without inundation of the work area.

1.06 DEWATERING METHODS

- A. The Contractor shall select decanting or dewatering methods to suit selected method of work.
- B. The decanting/dewatering system may include sumps, wells, well points or other extraction systems as required to maintain a dewatered working area.
- C. Engineering controls shall be utilized to minimize sediment transport. Liquids discharged from the Contractor's Wastewater Treatment System during decanting shall meet the effluent criteria in Table 02140-1. Liquids discharged from the Contractor's Wastewater Treatment System during dewatering shall meet the effluent criteria in Table 02140-2.

PART 2 – PRODUCTS

2.01 WASTEWATER ADDITIVES

- A. Flocculents and coagulants may be utilized if required to meet specified requirements. OWNER's written approval shall be obtained prior to use of any additive.

PART 3 – EXECUTION

3.01 RELEASE OF WATER FROM ACTIVE REMOVAL AREA

- A. The Contractor will be allowed to perform direct pumping of ponded water to the approved discharge point or to the water treatment system for subsequent treatment and discharge.
- B. The Contractor shall provide engineering controls to prevent ash migration during dewatering.

3.02 MAINTENANCE OF ACTIVE REMOVAL AREAS

- A. The Contractor shall maintain the dewatering system in continuous operation to keep the active area free of surface water, groundwater, and seepage.
- B. All collected liquids from the working area shall be conveyed to the Contractor's Wastewater Treatment System for subsequent treatment and discharge.
- C. The Contractor shall maintain the dewatering system until the active area has been excavated, inspected, and backfilling has commenced. Following receipt of written acceptance, the Contractor shall remove dewatering equipment.

Table 02140-1
Decanting Effluent Standards

EFFLUENT CHARACTERISTICS	LIMITS		MONITORING REQUIREMENTS		
	Monthly Average	Daily Maximum	Measurement Frequency	Sample Type	Sample Location
Flow, MGD	1	5	Daily	Measured	Influent
Temperature, 0C	NL	NL	Monitor Only	Grab	Influent
pH	6.0 ≤ pH ≤ 9.0		Daily	Grab	Effluent
Total Suspended Solids, mg/L	23	75	Daily	Grab	Effluent
Oil and Grease, mg/L	15	20	Daily	Grab	Effluent
Total Mercury, ng/L	220	1,100	Weekly	Grab	Effluent
Total Arsenic, µg/L	54.0	270.0	Weekly	Grab	Effluent
Total Selenium, µg/L	68.0	127.0	Weekly	Grab	Effluent
Total Iron, mg/L	1.0	1.0	Weekly	Grab	Effluent
Total Copper, mg/L	1.0	1.0	Weekly	Grab	Effluent
Total Zinc, µg/L	10.0	50.0	Weekly	Grab	Effluent
Turbidity, NTU	25	50	Weekly	Grab	Effluent

Table 02140-2
Dewatering Effluent Standards

EFFLUENT CHARACTERISTICS	LIMITS		MONITORING REQUIREMENTS		
	Monthly Average	Daily Maximum	Measurement Frequency	Sample Type	Sample Location
Flow, MGD	1	5	Daily	Measured	Influent
Temperature, 0C	NL	NL	Monitor Only	Grab	Influent
pH	6.0 ≤ pH ≤ 9.0		Daily	Grab	Effluent
Total Suspended Solids, mg/L	15	30	Daily	Grab	Effluent
Total Nitrogen (NO ₂ + NO ₃ + TKN), mg/L	0.65	0.85	Weekly	Grab	Effluent
Total Phosphorus, mg/L	2.0	2.0	Daily	Grab	Effluent
Oil and Grease, mg/L	11	15	Daily	Grab	Effluent
Acute Toxicity	NA	1.0 acute toxic units or LC50 > 100%	Biweekly		Effluent
Total Mercury, ng/L	47.0	47.0	Weekly	Grab	Effluent
Total Arsenic, µg/L	10.5	14.5	Weekly	Grab	Effluent
Total Selenium, µg/L	13.6	16.0	Weekly	Grab	Effluent
Total Iron, mg/L	1.0	1.0	Weekly	Grab	Effluent
Total Aluminum, µg/L	750.0	750.0	Weekly	Grab	Effluent
Total Copper, mg/L	1.0	1.0	Weekly	Grab	Effluent
Total Zinc, µg/L	10.0	12.0	Weekly	Grab	Effluent
Turbidity, NTU	25	50	Weekly	Grab	Effluent

END OF SECTION

SECTION 02150

SHORING AND BRACING

PART 1 - GENERAL

1.01 Description of Work

- A. The CONTRACTOR shall furnish all labor, materials, equipment, tools and appurtenances required to complete the work of shoring, bracing, and sheeting or sheet piling, necessary to complete the construction, protect structures, and prevent the loss of ground or caving of embankments, excavations, or cut slopes, as shown, specified or required, and shall meet all applicable building and safety codes.
- B. CONTRACTOR shall be solely responsible for proper excavation procedures including, but not limited to, safe slope angles and the design and use of properly designed and installed shoring and bracing systems in accordance with OSHA and other applicable standards and requirements. As required, shoring and bracing shall be designed by the CONTRACTOR's engineer who is a registered Professional Engineer in the Commonwealth of Virginia. Remove all shoring and bracing without disturbing backfill, bedding, haunching, pipes or structures. The presence of the CQA Consultant, Owner or the ENGINEER shall not relieve the CONTRACTOR of his responsibility to properly design, install and maintain shoring and bracing.
- C. Pressures on sheeting and the stability of the sheeting and bottom of the excavation are dependent not only on soil conditions but upon many procedures and options available to the CONTRACTOR, such as dewatering, staging of excavation and installation of bracing, flexibility of sheeting, construction equipment used, and time of completing the work. All such factors shall be considered and investigated as necessary in the design of the sheeting and bracing.
- D. Comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, State or Federal authorities having jurisdiction.

1.02 Related References

- A. Recommended Technical Provisions for Shoring and Sloping of Trenches and Excavations, U.S. Department of Commerce.
- B. Construction Safety and Health Regulations, U.S. Department of Labor, Occupational Safety and Health Administration.
- C. Occupational Safety and Health Regulations- Excavations, U.S. Department of Labor, Occupational Safety and Health Administration, 29 CFR Part 1926.

1.03 Related Sections

- A. Health and Safety Specifications for Construction - Section 01550
- B. Earthworks - Section 02220

1.04 Submittals

- A. In cases where the excavation cannot be open cut to a safe working angle in accordance with applicable requirements or where excavation may jeopardize adjacent site areas or the stability of nearby structures or facilities, the CONTRACTOR shall submit drawings, computations and substantiating data, prepared, signed, and sealed by a Professional Engineer licensed in the Commonwealth of Virginia, showing the proposed shoring and

bracing design and method of construction for the information of the OWNER prior to the start of such construction.

- B. Shoring and bracing systems shall be designed such that removal shall not jeopardize work already performed. Shoring and bracing systems shall not remain permanently in place without the written approval of the OWNER.
- C. Any review or comments by the OWNER shall not relieve the CONTRACTOR of his responsibility for sheeting and bracing.
- D. In trenches, the sheeting shall be designed so that the lowest brace is no closer than 12 inches above the base of the structure to be installed.

1.05 Quality Control

During the installation of the sheeting and bracing and as long as the excavation is open, the CONTRACTOR shall monitor the work to ensure that it is carried out in accordance with his design and procedures.

PART 2 - PRODUCTS

All materials shall meet, or exceed, the minimum requirements of the applicable codes and those assumed in the design submitted by the CONTRACTOR.

PART 3 - EXECUTION

3.01 Verifying Existing Conditions

Before commencing work, the CONTRACTOR shall check and verify all governing dimensions and elevations, including field measurements of existing and adjoining work on which his work is dependent, to assure proper fit and clearance of each part of the work to the new and existing structures.

3.02 Coordination With Other Operations

The schedule and progress of the shoring, bracing, and sheeting work shall be coordinated with the excavation and backfilling work. If, during the progress of the excavation, lateral movement of the surrounding soils, or any other evidence of instability is discovered, further excavation or backfilling work in the excavation shall cease and corrective measures shall be taken immediately to prevent further movement.

3.03 Removal of Shoring and Bracing Materials

- A. Where the CONTRACTOR elects and is permitted not to remove shoring and bracing material, all such material shall be removed to the extent that the top of the material shall be a minimum of 5 feet below the proposed finished grade. No shoring or bracing may remain in place within the limits of the proposed geomembrane liner placement.
- B. Removal of shoring and bracing shall be carried out in a manner such that no structure shall be disturbed or damaged during or after removal. Protection of structures during the removal of shoring and bracing shall be the sole responsibility of the CONTRACTOR, and any disturbance or damage shall be rectified at no expense to the OWNER.

3.04 Safety

Installation and removal methods of shoring and bracing shall meet, or exceed, the minimum requirements of the applicable codes and safety precautions as outlined in such codes, and shall be enforced by the CONTRACTOR.

END OF SECTION

SECTION 02200

EARTHWORK

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. The work under this section includes the furnishing of all labor, equipment and materials, and completing all operations in connection with excavating, backfilling, compacting, grading, and placing soil materials and all other incidental work necessary for construction according to Drawings and Technical Specifications.
- B. The CONTRACTOR shall comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, state or federal authorities having jurisdiction.
- C. The CONTRACTOR shall locate all existing active and abandoned utilities and structures in work areas prior to commencing any excavation activities and shall protect from damage those utilities and structures which are to remain in place

1.02 RELATED WORK

- A. Carefully examine all of the Contract Documents for requirements affecting the work of this section.
- B. Other specification sections containing requirements relating to this section include, but are not limited to, the following:
 - 1. Section 02140 – Construction Dewatering
 - 2. Section 02125 – Temporary and Permanent Erosion and Sediment Control
 - 3. Section 02235 – Vegetative Support Layer
 - 4. Section 02233 – Coarse Aggregate

1.03 DEFINITIONS

- A. Excavation shall mean the removal from place of all materials and shall include soil, facilities, structures above and below ground, rock, pavements, topsoil, boggy waste, rubbish, tree stumps, boulders, logs, ashes, cinders, organic material such as peat, humus or organic silt, softened or disturbed soils or other unsuitable bearing materials determined in the field by the ENGINEER.
- B. Mucking or mucking-out shall mean excavation, as defined herein before, without prior dewatering.

1.04 PROTECTION OF PEOPLE AND PROPERTY

- A. The CONTRACTOR shall plan and conduct operations in accordance with OSHA and local codes and ordinances so as to prevent damage to existing structures, safeguard people and property, minimize traffic inconvenience, protect the structures to be installed, and provide safe working conditions.
- B. The CONTRACTOR shall control stormwater such that run-on and run-off do not affect the quality of receiving wetlands, brooks, streams, or rivers. The CONTRACTOR shall be responsible for cleaning (removal of silt) stormwater structures (swales, culverts, basins) as needed during construction, after stabilization of project areas, and at the conclusion of work prior to demobilization.
- C. The CONTRACTOR shall be responsible for protecting existing environmental monitoring devices such as groundwater monitoring wells within the limits of work. Any damage to existing environmental monitoring devices resulting from construction activities shall be the responsibility of the CONTRACTOR to correct at no additional cost to the OWNER.
- D. Excavations, except as specified, shall be adequately shored and braced. Where the installation of shoring is impractical or might cause damage, as a result of, but not limited to, vibration, settlement or lateral movement, the CONTRACTOR shall utilize other methods.
- E. CONTRACTOR shall be solely responsible for proper excavation procedures including, but not limited to, safe slope angles and the design and use of properly designed and installed shoring and bracing systems in accordance with OSHA and other applicable standards and requirements. As required, shoring and bracing shall be designed by the CONTRACTOR's engineer who is a registered Professional Engineer in the Commonwealth of Virginia. Remove all shoring and bracing without disturbing backfill, bedding, haunching, pipes or structures. The presence of the ENGINEER shall not relieve the CONTRACTOR of his responsibility to properly design, install and maintain shoring and bracing.
- F. In cases where excavation without shoring and bracing is not permissible solely because of protection of workers, trench boxes may be used.
- G. The CONTRACTOR shall not stockpile any excavated material without OWNER approval. Stockpile location shall be approved by the ENGINEER or OWNER.

1.05 REFERENCES

- A. ASTM D6913 Grain Size Analysis of Soils
- B. ASTM D698 Laboratory Compaction Characteristics of Soil Using Standard Compaction Effort
- C. ASTM D2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- D. ASTM D6938 Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
- E. ASTM D5321 Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
- F. ASTM D4318 Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- G. Construction Quality Assurance Plan

1.06 SUBMITTALS

A. Shoring and Bracing

1. In cases where the excavation cannot be open cut to a safe working angle in accordance with applicable requirements or where excavation may jeopardize adjacent site areas or the stability of nearby structures or facilities, the CONTRACTOR shall submit drawings, computations and substantiating data, prepared, signed, and sealed by a Professional Engineer licensed in the Commonwealth of Virginia, showing his/her proposed shoring and bracing design and method of construction for the information of the OWNER prior to the start of such construction.
2. Shoring and bracing systems shall be designed such that removal shall not jeopardize work already performed. Shoring and bracing systems shall not remain permanently in place without the written approval of the OWNER.
3. Any review or comments by the OWNER shall not relieve the CONTRACTOR of his responsibility for sheeting and bracing.
4. In trenches, the sheeting shall be designed so that the lowest brace is no closer than 12 inches above the base of the structure to be installed.

B. The CONTRACTOR shall submit the technical data sheet for the proposed compaction equipment to the OWNER or ENGINEER for review and approval.

C. The CONTRACTOR shall provide the OWNER samples from each borrow source to be used as structural fill.

From each borrow source, two representative composite sample(s) shall be tested for the following:

1. Soil Classification (ASTM D2487, which includes Grain Size Analysis - ASTM D6913 and Atterberg Limits - ASTM D4318); two per source or material type
2. Compaction Testing (Proctor) (ASTM D698); two per source or material type

If the OWNER or ENGINEER determines that the source contains more than one soil type, as determined by the Unified Soil Classification System (USCS), the tests listed shall be completed for each soil type.

1.07 TOLERANCES

Grading tolerance for all fill and backfill shall be ± 0.1 feet.

1.08 QUALITY ASSURANCE

- A. The CONTRACTOR shall be an experienced earthwork CONTRACTOR who has at least five years' experience. The CONTRACTOR shall have completed at least three projects with the same material and of similar scope as that indicated for this project with a successful installation and maintenance record of in-service performance.
- B. The CONTRACTOR is required to demonstrate compliance to the above requirements to the satisfaction of the ENGINEER and OWNER.

PART 2 – PRODUCTS

2.01 MATERIALS

- A. All backfill and fill materials, unless otherwise specified, shall consist of suitable, selected, and approved (by the OWNER) soil from borrow areas.
- B. Maximum particle size, unless otherwise specified or approved by the ENGINEER, shall be as given in Paragraph 2.02.

- C. Structural Fill shall be placed and compacted in accordance with Table 2 in Paragraph 3.06.B.
- D. No frozen earth shall be used for backfill and fill, and no fill or backfill shall be placed over frozen surfaces. All backfill and fill materials shall be free from all perishable and objectionable (as described below) materials. All fill shall be protected from frost if the ENGINEER judges frost will prevent the material from performing as required.
- E. All required fill materials shall be free from organic materials, wood, trash, and other objectionable materials which may be compressible or which cannot be properly compacted. It shall not contain rock fragments, broken concrete, masonry rubble, or other similar materials. It shall have physical properties such that it can be readily spread and compacted to the specified density. Snow, ice, and frozen soil shall be removed from fill material prior to placement.
- F. Preconstruction material testing of proposed structural fill materials shall be performed for each source of material. Samples shall be tested as per Table 1.

Table 1 - Structural Fill Preconstruction Testing Schedule

TEST	METHOD	FREQUENCY
Sieve Analysis	ASTM D6913	2 per source/type
Standard Proctor Compaction	ASTM D698	2 per source/type
Atterberg Limits	ASTM D4318	2 per source/type
USCS Classification	ASTM D2487	2 per source/type
Interface Friction Angle	ASTM D5321	1 per project

- G. Where structural fill soil types vary substantially and are not segregated, representative blends of the soils anticipated for construction use should also be sampled and tested. The material tested shall comply with a maximum particle size of less than 2 inches, except when materials are used for liner subgrade or landfill final cover protective cover where the maximum particle size shall be 3/8 inch.

2.02 STRUCTURAL FILL

- A. Structural fill materials shall be used as subgrade to the bottom of the liner grades, clean backfill, pipe bedding, final cover construction, and as other material as shown on the Drawings. Structural fill shall be free of rubble, wood, stumps, brush, metal, cinders, trash, demolition debris, garbage, topsoil, organic soil, loam, sludge and other deleterious materials. The maximum stone size shall be two inches in any dimension and shall not comprise more than five percent of the total soil mass. Structural fill materials shall be classified according to the USCS as GM, GC, SM, SC, ML, CH, CL or MH (ASTM D2487). Structural fill shall be approved by the OWNER for each application.
- B. Structural fill materials to be used for embankment construction of basins or ponds shall be free of rubble, wood, stumps, brush, metal, cinders, trash, demolition debris, garbage, topsoil, organic soil, loam, sludge and other deleterious materials. The maximum stone size shall be two inches in any dimension and shall not comprise more than five percent of the total soil mass. Structural fill materials shall be classified according to the USCS as SM, SC, ML, CH, CL or MH (ASTM D2487) and have a Plasticity Index (PI) of at least 7. Structural fill for embankment use shall be approved by the ENGINEER for each application.
- C. The Liner Subgrade fill shall consist of the top twelve inches of fill material underlying a geosynthetic liner. It shall contain particles no larger than 3/8" in their greatest dimension and be free of organic materials.
- D. The interface friction angle between the structural fill and the bottom liner geosynthetic layer shall be greater than or equal to 26.5° as determined by ASTM D5321. Each test shall

determine interface strength at normal stresses of 100 pounds per square foot (psf), 300 psf, and 500 psf. The interface shear test shall be completed using installation procedures used under actual field conditions. Tests shall be completed under fully saturated conditions (saturation time of 15 minutes), have a seat time of 15 minutes, and have a shear rate of 0.04 inches per minute (in/min). Additional samples shall be collected and tested if the material does not meet the minimum requirements of this technical specification.

- E. The interface friction angle between the structural fill and the cap geocomposite layer shall be greater than or equal to 26.4° as determined by ASTM D5321. Each test shall determine interface strength at normal stresses of 100 pounds per square foot (psf), 300 psf, and 500 psf. The interface shear test shall be completed using installation procedures used under actual field conditions. Tests shall be completed under fully saturated conditions (saturation time of 15 minutes), have a seat time of 15 minutes, and have a shear rate of 0.04 inches per minute (in/min). Additional samples shall be collected and tested if the material does not meet the minimum requirements of this technical specification.

2.03 SAND AND AGGREGATE

Sand and Aggregate shall conform to the requirements of the Virginia Department of Transportation (VDOT) Road and Bridge Specifications, latest edition.

2.04 LANDFILL FINAL PROTECTIVE COVER

- A. Fill for the Final Protective Cover layer shall consist of Structural Fill material that is void of deleterious materials, has no particles over 3/8" in their greatest dimension and meets the requirements of Paragraph 2.02 of this specification.
- B. The interface friction angle between the cap liner geosynthetic layer and the underlying material shall be greater than or equal to 26.5° as determined by ASTM D5321. Each test shall determine interface strength at normal stresses of 100 pounds per square foot (psf), 300 psf, and 500 psf. The interface shear test shall be completed using installation procedures used under actual field conditions. Tests shall be completed under fully saturated conditions (saturation time of 15 minutes), have a seat time of 15 minutes, and have a shear rate of 0.04 inches per minute (in/min). Additional samples shall be collected and tested if the material does not meet the minimum requirements of this technical specification.

2.05 VEGETATIVE SUPPORT LAYER

Fill for the Vegetative Support Layer shall consist of soil material that is void of deleterious materials, has no particles over 3/8" in their greatest dimension and meets the requirements of Section 02235 of the Technical Specifications.

PART 3 – EXECUTION

3.01 PREPARATION

- A. The CONTRACTOR shall establish and identify required lines and levels.
- B. The CONTRACTOR shall maintain benchmarks, monuments, and other reference points and reestablish them if disturbed or destroyed, at no cost to OWNER.
- C. Before start of grading, the CONTRACTOR shall establish the location and extent of utilities in the work areas. The CONTRACTOR shall notify utilities to remove and relocate lines that are in the way of construction and are not to be relocated as a part of the work covered by these specifications.
- D. The CONTRACTOR shall maintain, protect, reroute, or extend as required existing utilities to remain in place that pass through the work area.

- E. The CONTRACTOR shall develop access to the construction area in accordance with the requirements of the drawings.
- F. The CONTRACTOR shall install silt fences as needed to prevent erosion immediately downslope of each area to be disturbed prior to the beginning of work in that area. The CONTRACTOR shall maintain the silt fences for the duration of construction. Accumulated sediment behind the silt fences shall be disposed of on-site by the CONTRACTOR in a manner approved by the OWNER.
- G. Diversion ditches, either permanent or temporary, shall be constructed in accordance with the drawings and as necessary to control surface water. The CONTRACTOR shall be responsible for constructing diversion ditches as required to divert run-on around the construction area and maintain the diversions until approved by the OWNER.
- H. The CONTRACTOR shall install barriers and other devices to protect areas adjacent to construction.

3.02 STOCKPILING

- A. Excavated materials classified suitable for use as structural fill shall be stockpiled in designated areas free of incompatible soil, clearing debris, or other objectionable materials. Stockpile areas shall be approved by the OWNER.
- B. Excavated material classified as topsoil shall be segregated from fill and stockpiled in the manner shown on the Drawings or as specified by the OWNER.
- C. Stockpiles of fill or topsoil shall be no steeper than 3:1 (horizontal:vertical), graded to drain, sealed by tracking parallel to the slope with a dozer or other means approved by the ENGINEER, and dressed daily during periods when fill is taken from the stockpile.

3.03 EXCAVATION - GENERAL

- A. Excavation shall be performed, at a minimum, to the lines and grades indicated on the Drawings. Additional excavation shall only be performed to achieve a stable working base or to "bridge" over weak subgrade materials if approved by the ENGINEER. The limits of additional excavation shall be determined by the ENGINEER.
- B. Excavated materials shall be transported to stockpile or placement locations, as indicated on the Drawings or as directed by the OWNER.
- C. In areas where the subgrade is to be reached by excavation, the area shall be excavated to the design grades, then proofrolled in the presence of the CQA Consultant who will make a review of conditions.
 - (1) If the excavated subgrade is found to be suitable for liner installation, no further excavation is required.
 - (2) If unsuitable bearing materials are encountered at required subgrade elevations, carry excavations to develop suitable bearing and replace excavated material as directed by the ENGINEER. At least 12 inches of the unsuitable bearing material shall be removed and replaced with Structural Fill suitable for Liner Subgrade (Paragraph 2.02.A).
 - (3) Further removal of unsuitable material and its replacement as directed will be made based on results of proofrolling and as directed by the OWNER.

3.04 GRADING - GENERAL

- A. Uniformly grade areas to a smooth surface, free of irregular surface changes, to the lines and grades indicated on the Drawings. Provide a smooth transition between existing grades and new grades.
- B. Unless otherwise specified, place borrow fill and trench backfill material in lifts of not more than nine inches in compacted thickness for material compacted by heavy construction equipment, and not more than four inches in loose depth for material compacted by hand-operated tampers. Compact material as specified in Paragraph 3.06.B.

3.05 TRENCH EXCAVATION AND BACKFILL

- A. Excavation for all drainage, piping, and other structures shall conform to the lines and grades shown on the Construction Drawings. Excess or unsuitable material removed from the excavations shall be replaced with approved material. The CONTRACTOR will be responsible for all shoring, bracing, trench boxes, etc., necessary to complete the excavation and pipe installation in a safe manner.
- B. Stability of Excavations: Slope sides of excavations shall comply with OSHA and local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Comply with all OSHA and other applicable safety requirements.
- C. Unless directed otherwise by the OWNER excavations shall not be backfilled until the work as installed conforms to all requirements specified in these Technical Specifications. Each lift of trench backfill material shall be moistened as necessary and compacted in such a manner as to permit the proper and desired compaction of the filled excavation to provide the necessary support and protection for the pipe.
- D. Placement of pipe bedding shall be done in accordance with the following procedures.
 - 1. The bottoms of excavations shall be thoroughly compacted and in an approved condition prior to placing pipe bedding. Pipe bedding shall be placed in layers not exceeding four inches in loose depth. Each layer shall be compacted by at least two passes of an approved plate-type vibratory compactor.
 - 2. Pipe bedding shall be graded, compacted, and shaped so that the full length of pipe barrel has complete and uniform bearing for the bottom quadrant of each pipe.
 - 3. The CONTRACTOR shall exercise care in all operations to prevent disturbing joints, displacement of or damage to the pipes already installed, and tearing of geotextile. As the work progresses, the pipelines will be checked by the OWNER or ENGINEER to determine whether any disturbance, displacement, or damage has occurred. If inspection shows poor alignment, displaced or damaged pipe, disturbed joints, or any other defects, all defects designated by the OWNER or ENGINEER shall be remedied in a satisfactory manner by the CONTRACTOR, at no additional expense to the OWNER.
- E. The balance of backfill, as shown on the Drawings and specified in this section, shall be structural fill or other compactable materials as approved by the OWNER and as detailed. All trench backfilling shall be carefully placed to avoid disturbance of new work.
- F. Backfill trench with clean backfill in accordance with the details shown on the Drawings. The moisture content of backfill shall be such that proper compaction will be obtained. Backfill shall be compacted to the minimum requirements specified. It is the responsibility of the CONTRACTOR to ensure that the minimum specified densities are obtained. Puddling or jetting of backfill with water will not be permitted.
- G. Compact soil materials using equipment suitable for materials to be compacted and work area locations. Hand-operated plate type vibratory or other suitable equipment may be used

in areas not accessible to larger rollers or compactors, and to avoid damaging pipes or structures. Any pipe that is damaged shall be replaced at the CONTRACTOR's expense.

- H. Backfill material shall be compacted to achieve the compaction specified in Paragraph 3.06.B.
- I. During filling and backfilling operations, pipelines will be checked by the OWNER or ENGINEER to determine whether any displacement of the pipe has occurred. If the inspection of the pipelines shows poor alignment, displaced pipe or any other defects, the defects designated by the OWNER shall be remedied in a satisfactory manner by the CONTRACTOR at no additional expense to the OWNER.
- J. Any backfill that fails to comply with the minimum compaction requirements specified shall be recompacted or, if necessary, removed to the limits directed by the OWNER or ENGINEER. The trench shall then be refilled with approved materials and by approved methods. The backfill shall be compacted by approved methods to the minimum requirements specified. All of this work shall be completed by the CONTRACTOR at no additional expense to the OWNER.
- K. After backfilling, the CONTRACTOR shall maintain the filled surfaces in good condition with a smooth surface level with adjacent undisturbed surfaces. Any subsequent settling shall be immediately repaired by the CONTRACTOR in a manner satisfactory to the OWNER. Such maintenance shall be provided by the CONTRACTOR for the remainder of this contract at no additional expense to the OWNER.

3.06 STRUCTURAL FILL

A. Surface Preparation

- 1. Prepare areas to receive structural fill by:
 - a. Clearing and grading areas required for access to site and execution of the work. Clearing shall be limited to areas within the limits of construction that need to be cleared in order to execute the work.
 - b. Grubbing areas within a 10-foot zone bordering all proposed structures and pipelines.
 - c. In areas to be cleared, removing all stumps, roots ½-inch or larger, organic material, and debris to a depth of approximately one foot below existing grade, or one foot below the proposed subgrade elevation, whichever is lower.
 - d. Stockpiling topsoil material on site in areas designated by the Owner or facility personnel.
 - e. Burning will be permitted when allowed by local ordinance. No burning will be allowed within 100 feet of waste disposal areas or site access roads.
 - f. At the end of the construction period, the CONTRACTOR shall restore to existing grade those areas disturbed by construction activities that lie beyond the limits of construction shown on the drawings and that are outside the borrow area. Areas to be filled shall be nominally compacted as may be achieved with construction equipment, and permanently seeded in accordance with the requirements of Section 02936.
- 2. Grade areas to receive fill to a uniform surface. Scarify surface if directed by the Owner's Representative.
- 3. Dry or wet subgrade at the discretion of the Owner's Representative to establish subgrade with acceptable moisture content.
- 4. Do not construct structural fill layer until the subgrade has been approved by the Owner's Representative..

B. Construction

1. Construct project features to the lines and grades shown on the drawings.
2. Place fill material in lifts no greater than nine inches compacted depth.
3. Compact fill material to a minimum percentage of the maximum dry density as determined by a standard Proctor (ASTM D698) as shown in Table 2 below:

Table 2 - Minimum Compaction Requirements for Structural Fill

Material Type / Use	Compaction Requirement
Structural Fill / Liner Subgrade	95%
Structural Fill / Road Subgrade	98%
Structural Fill / Trench Backfill & Stockpile	90% **
Structural Fill / Final Cover	90%
Structural Fill / Embankments	95%
Structural Fill / Foundations	95%
Structural Fill / All other uses	95%
Vegetative Soil / Final Cover	Do not compact

** 95% when under road or structure

4. Fill material which does not meet the density requirements shall be recompacted or removed and reworked to meet density objectives.
5. Do not place or compact fill material during sustained period of temperatures below 32° F.
6. Employ a professional land surveyor licensed in Virginia to conduct a topographic survey of the top of the structural fill layer, and prepare a survey drawing showing contours at maximum two-foot intervals.
7. Furnish the OWNER with three copies of the topographic survey drawing. This drawing shall become part of the record drawings required by this contract.

C. Geosynthetic Liner Subgrade

1. The prepared surface for geosynthetic liner shall be graded to fill in all voids and cracks, and then compacted with a smooth-drum roller to provide the best practicable surface for the geosynthetic liner. At the completion of this activity, no wheel ruts, footprints or other irregularities shall exist in the subgrade.
2. All protrusions extending more than one-half inch from the surface shall be removed, crushed or pushed into the surface with a smooth-drum compactor.

3.07 PROTECTION AND ACCEPTANCE

- A. Protect the finished surface from erosion, desiccation, or other damage.
- B. Develop a contingency plan for responding to construction deficiencies due to inclement weather, defective materials, and construction inconsistent with the Technical Specifications. The plan shall provide a methodology for selecting and implementing corrective action.
- C. Portions of the work damaged due to exposure shall be reworked to meet the Technical Specifications or, at the discretion of the ENGINEER, removed and replaced with conforming material at no additional cost to the OWNER.

3.08 REMOVAL OF SHORING AND BRACING MATERIALS

- A. Where the CONTRACTOR elects and is permitted not to remove shoring and bracing material, all such material shall be removed to the extent that the top of the material shall be a minimum of 5 feet below the proposed finished grade. No shoring or bracing may remain in place within the limits of the proposed geomembrane liner placement.
- B. Removal of shoring and bracing shall be carried out in a manner such that no structure shall be disturbed or damaged during or after removal. Protection of structures during the removal of shoring and bracing shall be the sole responsibility of the CONTRACTOR, and any disturbance or damage shall be rectified at no expense to the OWNER.

3.09 QUALITY ASSURANCE

- A. Under the supervision of the ENGINEER, a soils technician from a commercial geotechnical testing company approved by the OWNER shall perform soil tests described herein and in the Construction Quality Assurance (CQA) Plan. Samples shall be collected by field testing personnel at the minimum frequencies presented below.
- B. Structural fill shall be tested during construction to verify material compliance and proper installation in accordance with Table 3.**

Table 3 - Structural Fill Construction Testing Schedule

TEST	METHOD	MINIMUM FREQUENCY
Sieve Analysis	ASTM D6913	one test per 5,000 cubic yards in place
Atterberg Limits	ASTM D4318	one test per 5,000 cubic yards in place
USCS Classification	ASTM D2487	one test per 5,000 cubic yards in place
Standard Proctor Compaction	ASTM D698	one test per 10,000 cubic yards of material in place
Nuclear Field Density and Moisture	ASTM D6938	one test per 10,000 square feet per lift and one per lift per 100 L.F of pipe trench
Drive Cylinder	ASTM D2937	1 test per 20 nuclear density tests

- D. The CONTRACTOR shall cooperate with the OWNER and his representative in obtaining samples for testing and conducting in-situ tests during the construction period. The CONTRACTOR shall provide all necessary labor, equipment, and material to refill sample locations as directed.
- E. If the tests conducted on a particular lift and section do not meet required specifications, the CONTRACTOR shall be responsible for any expenses incurred performing additional tests following recompaction of the material until passing test results are achieved.

* * * * * END OF SECTION * * * * *

SECTION 02225
CCR PLACEMENT

PART 1 - GENERAL

1.01 Description of Work

- A. The work under this section includes the furnishing of all labor, equipment and materials, and completing all operations in connection with excavating, backfilling, compacting, grading, and placing Coal Combustion Residuals (CCR) and related material and all other incidental work necessary for construction according to Drawings and Technical Specifications.
- B. This work includes ongoing CCR Placement at the Upper (East) Pond (UEP), as well as CCR excavation and placement needed to implement the CCR Closure.
- C. Comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, State or Federal authorities having jurisdiction.

1.02 Related Sections

- A. Section 02140 – Construction Dewatering
- B. Section 02125 – Temporary and Permanent Erosion and Sediment Control
- C. Section 02200 – Earthwork
- D. Section 02235 – Vegetative Support Layer

1.03 References

- A. ASTM D698 Laboratory Compaction Characteristics of Soil Using Standard Compaction Effort

PART 2 - PRODUCTS

2.01 Material

- A. Material placed in the UEP includes, coal combustion byproducts, which includes CCR; coal; coal mill rejects; and pyrites.

PART 3 - EXECUTION

3.01 Placement

- A. Around the perimeter of the UEP, and for a distance of at least 50 feet inward from the final surface:
 - 1. Place and grade CCR in lifts not exceeding one foot.
 - 2. Compact at optimum moisture, within a tolerance of plus four (4) percent or minus six (6) percent of optimum, to a minimum dry density of not less than 95 percent of Standard Proctor maximum dry density.
- B. Elsewhere within the UEP:

1. Place and compact at optimum moisture, within a tolerance of plus or minus eight (8) percent of optimum, to a minimum dry density of not less than 92 percent of Standard Proctor maximum dry density. Surcharging techniques, such as storing CCR in stockpiles at least 15 feet high, may be used to achieve the compaction and moisture requirements.
- C. All activities shall be subject to the Fugitive Dust Control Plan for the Station and/or the UEP.

END OF SECTION

SECTION 02233
COARSE AGGREGATE

PART 1 - GENERAL

1.01 Description of Work

- A. The CONTRACTOR shall furnish all labor, materials, equipment, tools and appurtenances required to complete the work of furnishing, placing and compacting the stone as shown, specified or required.
- B. Comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, State or Federal authorities having jurisdiction.

1.02 Related Sections

- A. Earthwork - Section 02200
- B. Geotextile - Section 02595

PART 2 - PRODUCTS

2.01 Material

- A. The material shall be clean, sound, tough, durable, angular, subangular, subrounded or round stone, not lumpy, and free from slag, cinders, ashes, rubbish, or other deleterious material. Subangular, angular, subrounded, and round shall be as defined in ASTM D2488 entitled "Standard Practice for Description and Identification of Soils [Visual-Manual Procedure].
- B. The CONTRACTOR shall maintain a uniform gradation of coarse aggregate.
- C. Aggregate shall be stored in designated areas approved by the OWNER. The CONTRACTOR is responsible for maintaining the stone free of contamination, and any stone determined by the OWNER to be contaminated shall not be incorporated into the work.

2.02 Testing

- A. The CONTRACTOR shall submit to the ENGINEER and OWNER for approval, certification that the materials proposed for use as coarse aggregate comply with specification for the proposed application. The certification shall include, but not necessarily be limited to testing or certification of testing provided by the supplier.
- D. Additional confirmatory testing may be required by the QAC to confirm compliance with the specifications.
- C. No material shall be placed unless approved by the QAC.

PART 3 - EXECUTION

3.01 Placement

- A. A uniform layer of coarse aggregate shall be placed to the lines, depths and grades as shown on the Drawings.
- B. Backfilling of coarse aggregate shall be performed by the CONTRACTOR in a manner such that the material is kept clean and free of foreign materials.

- C. For pipe bedding, the bedding and backfill shall be compacted with the compaction effort acceptable to the QAC. The compaction effort shall be applied to both the bedding and the backfill around the pipes. The method of compaction shall not damage the pipe, geotextile or the flexible membrane liner.
- D. The QAC will at any time inspect the stone in the trenches or in stockpile on-Site for contamination and, if necessary, reject all or portions of the stone.
- E. The CONTRACTOR shall use extreme care in the placing of the material over geosynthetics. The material shall be placed in a manner to maintain a minimum thickness of 1 foot between the geosynthetics and the spreading equipment. All coarse aggregate, placed within the limits of the geosynthetics, shall be placed by low pressure equipment. Equipment with ground pressure less than 5 psi may travel on a minimum 12-inch thick leachate collection layer. Equipment with a ground pressure equal to or greater than 5 psi must travel on a minimum 36-inch thick layer.

END OF SECTION

SECTION 02235
VEGETATIVE LAYER

PART 1 - GENERAL

1.01 Description of Work

- A. Furnish all labor, materials, equipment and incidentals necessary to perform all fill and grading required to complete the placement of vegetative support soil shown in the Exhibit A technical drawings and specified herein. The work shall include, but not necessarily be limited to, the earthwork required for vegetative layer placement and all related work.
- B. Comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, State or Federal authorities having jurisdiction.

1.02 Related Sections

- A. Earthwork - Section 02200
- B. Seeding - Section 02936

1.03 Tolerances

The minimum thickness of soil is as shown on the Contract Drawings. Tolerance for the thickness of vegetative layer is -0.0 to +0.2 feet.

PART 2 - PRODUCTS

2.01 Materials

- A. Soil material used as topsoil shall be loamy fine sand, loamy sand, sandy clay, sandy clay loam, fine sandy loam, clay loam, silty clay, or sandy loam as defined by the U.S. Department of Agriculture textural classification chart, and shall be suitable to support vegetative growth.
- B. The vegetative layer shall not contain trash, debris, stones, lumps, roots, or similar objects larger than 1-½ inches in any dimension.
- C. Soil material used as the vegetative layer must be capable of sustaining vegetation as specified in Section 02936 - Seeding.

2.02 Testing

- A. The CONTRACTOR shall submit, to the OWNER for approval, evidence that the material proposed for use as topsoil meets the requirements of Section 2.01.
- B. No material shall be placed unless approved by the OWNER..

PART 3 - EXECUTION

3.01 Installation

- A. This item shall consist of the placement of the vegetative layer in all areas disturbed during the course of construction.
- B. The CONTRACTOR shall provide all the required materials, labor, and equipment to perform the Work in accordance with these Specifications.

- C. No vegetative layer soils shall be placed until soil placement (backfill, fill, etc.) is complete and approved by the OWNER.
- D. The vegetative layer shall be installed in a single, 6-inch thick lift.
- E. The CONTRACTOR shall take care to ensure that underlying soil remains intact and does not become mixed with the vegetative layer during installation.

END OF SECTION

SECTION 02271

STONE RIPRAP AND GROUTED RIPRAP

PART 1 - GENERAL

1.01 Description of Work

- A. The CONTRACTOR shall provide all labor, materials, equipment, tools and appurtenances required to complete the work of furnishing and placing stone riprap, as shown, specified or required.
- B. Comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, State or Federal authorities having jurisdiction.

1.02 Related Sections

- A. Temporary and Permanent Erosion and Sedimentation Control - Section 02125
- B. Geotextile - Section 02595

PART 2 - PRODUCTS

2.01 Material

- A. Stone riprap shall consist of hard, durable, subangular material. It shall be free from any considerable amount of flat, laminated or elongated particles; and shall be free from cracks, overburden shells, clay, organic matter, or other deleterious matter.
- B. The riprap shall be composed of an evenly distributed mixture such that 50 percent of the mixture by weight shall be larger than the d_{50} size as indicated on the Contract Drawings. The diameter of the largest stone size in such a mixture shall be at least 2.0 times the d_{50} size. The diameter of the smallest stone size in such a mixture shall be greater than 0.5 times the d_{50} size.
- C. The breadth or thickness of a single stone shall not be less than 1/3 its length.
- D. Cement grout for grouted riprap shall consist of one part cement and three parts VDOT A, B, or C sand, thoroughly mixed with water to produce grout having a thick, creamy consistency.

2.02 Submittals

Submit manufacturer's certification of material properties as outlined in Part 2.01 to the ENGINEER.

PART 3 - EXECUTION

3.01 Installation – loose riprap

- A. Stone riprap shall be placed to thicknesses as indicated on Contract Drawings.
- B. With the exception of grouted riprap, all riprap shall be placed on a nonwoven geotextile underlayment of at least 8oz per square yard. The edges of the geotextile shall be sufficiently anchored to prevent movement during rock placement.
- C. Stone riprap shall be placed in a manner that will not damage geotextile, synthetics, utilities or other facilities. Riprap shall not be dropped from a height exceeding three feet.

- D. The tolerance in riprap thickness in place shall be -0 to +0.3 feet.
- E. No material shall be placed unless approved by the OWNER.

3.02 Installation – grouted riprap

- A. Grout shall consist of 1 part hydraulic cement and 3 parts sand, thoroughly mixed with water to produce grout having a thick, creamy consistency.
- B. Stones shall be of the same sizes and placed in the same manner as specified for dry riprap, Class I. Care shall be taken during placing to keep earth or sand from filling spaces between stones. After stones are in place, spaces between them shall be filled with grout from bottom to top and the surface swept with a stiff broom.
- C. Riprap shall not be grouted in freezing weather. In hot, dry weather, the work shall be protected from sunlight and kept moist for at least 3 days after grouting by the use of saturated burlap or other suitable method.

END OF SECTION

SECTION 02279

ARTICULATED CONCRETE BLOCK (ACB) MAT

PART 1 - GENERAL

1.01 Description of Work

- A. The CONTRACTOR shall provide all labor, materials, equipment, tools and appurtenances required to complete the work of furnishing and performing all operations in connection with the installation of articulated concrete block (ACB) mattresses as shown, specified or required.
- B. Comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, State or Federal authorities having jurisdiction.

1.02 Related Sections

- A. Section 02125 - Temporary and Permanent Erosion and Sedimentation Control
- B. Section 02595 - Geotextile

1.03 Submittals

- A. The CONTRACTOR shall submit manufacturer's calculation package for block selection and project-specific mattress suitability to the OWNER at least 3 weeks prior to production of proposed ACB mat.
- B. The CONTRACTOR shall submit Shop Drawings showing proposed construction methods.

PART 2 - PRODUCTS

2.01 Material

- A. The articulated concrete block mattress shall be Petraflex, Shoreblock or approved equal. Equals must be approved by the OWNER a minimum of ten (10) days prior to bid date. Two (2) integral vertical cables per block are required, as well as one (1) integral horizontal cable. If a proposed system does not have an integral horizontal cable, all vertical cables shall be increased in size to provide additional equivalent horizontal restraint. Additionally, no partial or "half" blocks will be allowed without a horizontal cable. The final revetment system must be tied continuously throughout with cables in both directions. The OWNER or the ENGINEER reserves the right to accept or reject any proposed equal cellular concrete mattress system for reasons including but not limited to previous performance record, appropriate and applicable testing, and qualified technical support.
- B. Aggregate shall meet the requirements of ASTM C 33. Aggregate grading shall be reasonably consistent and shall be well graded from the maximum size which can be conveniently handled with available equipment.
- C. The concrete blocks shall remain stable when subjected to the below noted shear stresses determined by test methodology developed by the Federal Highway Administration testing protocol, FHWA-RD-89-199, "Hydraulic Stability of Articulated Concrete Block Revetment Systems During Overtopping Flow".
- D. The assembled mattresses shall have a range of 18 to 23 percent open areas to be achieved by penetrations within the block for open cell applications. For closed cell applications the amount open area shall be 7 percent.

- E. The cellular concrete blocks and cables and fittings shall be fabricated at the manufacturer's plant or another approved location into mattresses with a width of up to 8 feet and a length that is capable of being transported without special permitting.
- F. The concrete blocks shall be bound into mats by the use of polyester revetment cable fittings.
- G. Polyester revetment cable shall be constructed of high tenacity, low elongation, and continuous filament polyester fibers. Cable shall consist of a core construction comprised of parallel fibers contained within an outer jacket or cover. The weight of the parallel core shall be between 65 to 70 percent of the total weight of the cable. Vertical cables shall be sized to provide a minimum cable strength to mat weight ratio of 5:1 for safe material lifting/handling. Additionally, all revetment cable shall have the following minimum physical characteristics:

<u>Location</u>	<u>Nominal Cable Diameter</u>	<u>Approx. Avg. Strength lbs.</u>	<u>Weight/100ft (lbs.)</u>
Vertical & Horizontal	1/4"	3100	2.2

- H. Elongation Requirements: Specified below are based upon stabilized new, dry cable. Stabilization refers to a process in which the cable is cycled fifty (50) times between a load corresponding to $20D^2$ and a load equal to 10,20, or 30 percent of the cable's approximate average breaking strength. Relevant elongation values are shown on the table below. The tolerance of these values is plus or minus 5 percent.

	% Breaking Strength		
	<u>10%</u>	<u>20%</u>	<u>30%</u>
Permanent Elongation	0.7	1.8	2.6
Elastic Elongation	0.6	1.4	2.2
Total Stretch	0.3	3.2	4.8

- I. The revetment cable shall exhibit good to excellent resistance to most concentrated acids, alkalis and solvents. Cable shall be impervious to rot, mildew and degradation associated with marine organisms. The materials used in the construction of the cable shall not be affected by continuous immersion in fresh or salt water.
- J. Selection of cable and fittings shall be made in a manner that ensures a minimum of 5:1 design safety factor for mattresses being lifted from both ends, thereby forming a catenary. Consideration shall be taken for the bending of the cables around hooks or pins during lifting. Revetment cable splicing fittings shall be selected so that the resultant splice shall provide a minimum of 75% of the minimum rated cable strength. Fittings such as sleeves, stops and washers shall be in accordance with manufacturer's recommendations unless otherwise shown on the drawings.
- K. The CONTRACTOR shall submit to the owner for approval of a sample of each type and size of earth anchor to be used.

PART 3 - EXECUTION

3.01 Installation

- A. Areas on which filter fabric and cellular concrete mattresses are to be placed shall be constructed to the lines and grades shown on the drawings. The subgrade for the cellular concrete mats shall be free of voids, pits, or depressions shall be brought to grade by backfilling in accordance with the applicable portions of the project specifications. All obstructions, such as roots and projecting stones larger than 1 inch remaining on the surface, shall be removed and all of the soft or low density pockets of material removed must be filled with selected material and compacted in accordance with Section 02200.
- B. Immediately prior to placing the filter fabric and cellular concrete mattresses, the prepared area shall be inspected by the CQA consultant and approval obtained before any fabric or mattresses are placed thereon.
- C. The cellular concrete mats or blocks shall be placed on the filter fabric in such a manner as to produce a relatively planar surface. No more than 200 linear feet of filter fabric shall be laid before being covered with concrete mattresses, and any fabric installed more than 2 days shall be lifted and the surface of the slope inspected for any defects. The OWNER may require any uncovered fabric to be lifted after heavy rainfall to inspect for slope damage.
- D. Placement of prefabricated mattresses shall be done with mats attached to a spreader bar or other approved device to aid in the lifting and placing of the mats in their proper position by the use of a crane or other approved equipment. The mats shall be placed side by side and/or end to end so that the mats abut each other. The maximum space or gap between mattresses shall be 3 inches, except that local wider gaps may be accepted if the length of the gap is grouted. No overlapping of mats will be accepted and no blocks shall project vertically more than one inch beyond the adjacent blocks. All placement of mats shall be in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 02286

GEOMEMBRANE PIPE BOOTS AND SLEEVES

PART 1 GENERAL

1.01 Description

Furnish and install HDPE or LLDPE pipe boot or pipe sleeve for use in areas where the geomembrane liner must be penetrated by pipes as shown on plans or as directed by the ENGINEER and in accordance with these specifications.

1.02 Quality Assurance

The CONTRACTOR shall assist the QAC in all testing required; the CONTRACTOR will supply any laborers and equipment necessary for assistance in the testing at no additional cost. This work may include, but is not limited to providing material, samples and revising work to meet the intent of the plans and specifications.

1.03 Submittals

- A. The CONTRACTOR shall supply material certificates for the boots, sleeves and stainless steel straps.
- B. If the boot or sleeve is fabricated by the manufacturer, shop drawings must be submitted for approval by the OWNER. The boot or sleeve shall not be shipped until the shop drawings are approved.

1.04 Related Work

- A. Section 02597 - Polyethylene Geomembrane
- B. Section 02650 - Leachate Collection and Conveyance Pipe

PART 2 - PRODUCTS

2.01 HDPE or LLDPE Pipe Boots and Pipe Sleeves

The pipe boot or sleeve shall be constructed or manufactured with smooth sheet HDPE or LLDPE to match the geomembrane being used.

PART 3 - EXECUTION

3.01 Construction Methods

- A. The pipe boot and sleeve shall be installed in areas where the geomembrane liner must be penetrated as shown on the Contract Drawings or as directed by the ENGINEER.
- B. Prior to constructing the boot or sleeve, the CONTRACTOR shall assure that the material in the area of the penetration is properly compacted and that the area is clean. The CONTRACTOR shall take extreme care in work to assure the geomembrane liner is not damaged.
- C. The size of the boot or sleeve shall be adequate to provide 6" overlap of the geomembrane liner.
- D. Extrusion welding shall be as shown on the Contract Drawings.

- E. When tightening the stainless steel adjustment bands, the CONTRACTOR shall be careful not to over tighten the bands, thereby causing damage to the boot or sleeve.

3.02 Inspection and Testing

- A. The CONTRACTOR shall employ non-destructive testing of all welds to the geomembrane liner. A vacuum box test or spark test would provide adequate testing.
- B. The CONTRACTOR is responsible for providing all necessary test equipment and shall conduct the test. The testing of welds shall be observed by the QAC.

END OF SECTION

SECTION 02380

FABRIC FORMED CONCRETE

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes minimum requirements relating to materials, equipment, transportation, labor, and other items necessary to perform operations in connection with the installation of the fabric formed uniform section mat at the Site.
- B. The Work shall consist of installing an unreinforced concrete lining by positioning specially woven, double-layer synthetic fabric forms on the surface to be protected and filling them with a pumpable fine aggregate concrete (structural grout) in such a manner as to form a stable, uniform section mat of required thickness, weight and configuration.

1.02 SUBMITTALS

- A. At least fourteen (14) days prior to delivery to the Site, CONTRACTOR shall submit the following information for OWNER's review:
 - 1. Manufacturer's material data sheets showing minimum material properties indicating compliance with material properties listed in Table 02380-1.
 - 2. Manufacturer recommendations for placement and filling.
 - 3. Shop drawings, if required, for the layout and installation of the concrete lining panels.
- B. At least fourteen (14) days prior to commencing delivery of structural grout to fill the fabric forms, CONTRACTOR shall submit the proposed grout supplier and mix to OWNER for review.

1.03 CONSTRUCTION QUALITY ASSURANCE

- A. Installation of the fabric formed articulating concrete block will be monitored by OWNER.
- B. CONTRACTOR shall be aware of construction quality assurance activities required by OWNER and shall account for these activities in the Construction Schedule.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Approved Fabric Form materials include:
 - 1. Hyrdotex
 - 2. Texicon
 - 3. Armorform
- B. Fabric Form Requirements:
 - 1. Fabric formed concrete lining(s) shall be a "unimat" construction providing a continuous grout layer. The material shall consist of double-layer woven fabric joined together by spaced, interwoven cords of uniform length to form a concrete lining with a finished average thickness as specified on the drawings.
 - 2. The fabric shall meet the physical, mechanical, and hydraulic properties provided in Table 02380-1.

3. Each selvage edge of the top and bottom layers of fabric shall be reinforced for a width of not less than 1 inch by adding a minimum of 5 warp yarns to each selvage construction. Mill width rolls shall be cut to the length required, and the double-layer fabric separately joined, bottom layer to bottom layer and top layer to top layer, by means of sewing thread, to form multiple mill width panels with sewn seams.
4. Fabric forms shall be factory sewn into predetermined custom sized panels. All factory sewn seams shall be downward facing. Factory sewn seams and zipper attachments shall be made using a double line of U.S. Federal Standard Type 401 stitch. Both lines of stitches shall be sewn simultaneously and be parallel to each other, spaced between 0.25 and 0.75 inch apart. Each row of stitching shall consist of 4 to 7 stitches per inch. Thread used for seaming shall be nylon and/or polyester. All factory sewn seams strengths shall not be less than 80 lbf/in when tested in accordance with ASTM D 4884.
5. Materials not meeting the requirements of this Section shall be rejected by OWNER.

B. Structural Grout Requirements:

1. Structural grout shall consist of a proportioned mixture of Portland cement, fine aggregate (sand) and water. The consistency of the structural grout delivered to the concrete pump shall be proportioned and mixed as to have a flow time of 9 to 12 seconds when passed through the 0.75 inch (19 mm) orifice of the standard flow cone that is described in ASTM C 6449. Pozzolan and/or admixtures may be used with approval of ENGINEER. The grout mix shall exhibit a compressive strength of 2,000 psi at 28 days, when made and tested in accordance with ASTM C 31 and ASTM C 109.
2. Portland cement shall conform to ASTM C 150, Type I or Type II.
3. Fine aggregate shall conform to ASTM C 33, except as to grading. Aggregate grading shall be reasonably consistent and shall not exceed the maximum size which can be conveniently handled with available pumping equipment.
4. Water for mixing shall be clean and free from injurious amounts of oil, acid, salt, alkali, organic matter or other deleterious substances.
5. Pozzolan, if used, shall conform to ASTM C 618, Class C, F or N.
6. Plasticizing and air entraining admixtures, if used, shall conform to ASTM C 494 and ASTM C 260, respectively.

2.02 SHIPPING AND STORAGE

- A. Fabric forms shall be shipped in a manner that keeps them dry, and following unloading at the Site, shall be stored on pallets or other means to keep them off the ground.
- B. During storage, fabric forms shall be covered by an opaque, water resistant tarp to keep them dry and out of direct sunlight. Any additional storage procedures required by the Manufacturer shall be observed by CONTRACTOR.

PART 3 EXECUTION

3.01 SURFACE PREPARATION

- A. Prior placement of fabric forms, the surface shall be inspected to ensure that it meets the lines, grades, and cross-section shown on the Drawings.
- B. The surface shall be free of stones, litter, roots, organic matter, irregularities, protrusions, or loose soils. Fabric form shall not be placed on frozen surfaces, standing water, or areas that have been softened by precipitation.
- C. CONTRACTOR shall make efforts to grade the area to direct surface water away from the installation area until structural grout has set for at least 5 days in the finished fabric form.

- D. Any damage to the surface prior to fabric form installation shall be repaired at CONTRACTOR's expense.

3.02 PLACEMENT

- A. Factory assembled fabric form panels shall be placed within the limits shown on the Contract Drawings. Perimeter termination of the fabric forms shall be accomplished through the use of anchor trenches as shown on the Contract Drawings.
- B. Adjacent fabric form panels shall be joined in the field by means of sewing or zippering closures. Sewed joints shall use two lines of U.S. Federal Standard Type 101 stitches.
- C. At locations where conventional joining of fabric forms cannot be performed or where shown on the Drawings, adjacent forms shall be overlapped a minimum of 3 feet to form a lap joint. Based on the predominant flow direction, the downstream edge of the form shall overlap the upstream edge of the next form. In no case shall simple butt joints between fabric forms be allowed.
- C. When placing panels, CONTRACTOR shall make an allowance for approximately 10% contraction of the form in each direction which occurs as a result of filling with structural grout. CONTRACTOR shall coordinate with fabric form manufacturer for specific instructions regarding contraction.
- D. Immediately prior to filling with structural grout, the assembled fabric forms shall be inspected by OWNER. No grout shall be pumped therein until the fabric placement and field seams have been approved.
- E. Unfilled fabric forms shall not be exposed to direct sunlight for a period exceeding five days.

3.03 FILLING

- A. Structural grout shall be pumped between the top and bottom layers of the fabric form through small slits cut in the top layer of the fabric form. These slits shall be of the minimum length to allow proper insertion of a filling pipe inserted at the end of the fine aggregate concrete pump hose. Structural grout shall be pumped between the top and bottom layers of fabric, filling the forms to the recommended thickness and configuration.
- B. Grout shall be pumped in such a manner that excessive pressure on the fabric forms and cold joints are avoided. A cold joint occurs when pumping of the structural grout into a given fabric form is discontinued or interrupted for an interval of forty-five (45) or more minutes.
- C. The filling sequence of structural grout shall be such as to ensure complete filling of the fabric formed concrete lining to the thickness specified by the Drawings.
- D. The flow of the fine aggregate concrete shall first be directed into the upper edge of the fabric form which has been placed in the anchor trench, followed by redirecting the flow into the lower edge, working back up the slope.
- E. Prior to removing the filling pipe from the current concrete lining section and proceeding to the fine aggregate concrete filling of the adjacent lining section, the thickness of the current lining section shall be measured by inserting a length of stiff wire through the lining at several locations from the crest to the toe of the slope. The average of all thickness measurements shall be not less than the specified average thickness of the concrete lining. Should the measurements not meet the specified average thickness, pumping shall continue until the specified average thickness has been attained.
- FI. Holes in the fabric forms left by the removal of the filling pipe shall be temporarily closed by inserting a piece of fabric. The fabric shall be removed when the concrete is no longer fluid and the concrete surface at the hole shall be cleaned and smoothed by hand. Foot traffic will not be permitted on the freshly pumped concrete lining when such traffic will cause permanent indentations in the lining surface. Walk boards shall be used where necessary.

- G. Excessive grout that has been inadvertently spilled on the concrete lining surface shall be removed. The use of a water hose to remove spilled grout from the surface of the freshly pumped concrete lining is not permitted.
- H. After the structural grout has set, all anchor, flank and toe trenches shall be backfilled and compacted.

TABLE 02380-1**REQUIRED PROPERTY VALUES FOR FABRIC FORM**

PROPERTIES	QUALIFIERS	UNITS	VALUES	METHOD
Yarn Composition			Nylon or Polyester	
Thickness	minimum	mils	24	ASTM D5199
Mass Per Unit Area (double layer)	minimum	oz/yd ²	12	ASTM D5261
Apparent Opening Size	minimum	US sieve	O ₉₅ ≥ 40	ASTM D4751
Flow Rate	minimum	gal/min/ft ²	90	ASTM D4491
Wide-Width Tensile Strength	minimum	lb/in	110	ASTM D4595
Elongation at Break	minimum	%	20	ASTM D4595
Trapezoidal Tear Strength	minimum	lb	100	ASTM D4533

Notes:

1. Conformance of fabric to specification property requirements shall be based on ASTM D 4759, "Practice for Determining the Specification Conformance of Geotextiles."

END OF SECTION

SECTION 02419

DEMOLITION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to perform all demolition activities.

B. Coordination:

1. Review demolition procedures with the OWNER.

1.2 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Department ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 SUBMITTALS

A. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property for dust and noise control.

B. Indicate proposed locations and construction of barriers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with local and State regulations before beginning demolition.

B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting demolition operations.

3.1 UTILITY SERVICES /ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
- C. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of demolition and that maintain continuity of services/systems.

3.2 PREPARATION

- A. Site Access and Temporary Controls: Conduct demolition and debris-removal operations to ensure minimum interference with roads and used facilities.
- B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to facilities to remain.

3.4 DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required and as indicated. Use methods required to complete the Work within limitations of governing regulations. Dispose of demolished items and materials promptly.

3.5 DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Asphalt: Demolish in sections. Cut asphalt full depth at junctures with construction to remain and at regular intervals using power-driven saw, then remove asphalt between saw cuts.
- B. Piping: Saw cut pipe at limit of removal, then cut pipe into manageable/transportable sections and remove from site. Cap end sections of pipe to remain. Pipe indicated to be abandoned in-place shall be capped at termination point or at ground surface as directed by OWNER.
- C. Electrical: Electrical demolition shall comply with OWNER requirements as directed by the OWNER.
 - 1. Utility Poles and Appurtenances: utility poles shall be cut at ground surface and disposed at the direction of the OWNER. Cross ties, and appurtenances shall be removed from utility poles prior to utility pole demolition. Cross ties and appurtenances shall be disposed at the direction of the OWNER.
 - 2. Fencing: Fence fabric and wire shall be removed, rolled and disposed on-site at the direction of the OWNER. Fencing hardware, i.e. latches, hinges shall be disposed off site or as directed by the OWNER.

3.4 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Remove demolished materials from Project site and dispose of them as directed by the OWNER.

END OF SECTION

SECTION 02590

GEOCOMPOSITE AND GEOGRID

PART 1 - GENERAL

1.01 Description of Work

- A. The Contractor shall furnish all labor, materials, tools, supervision, transportation, and equipment necessary for the installation of geocomposite (or geonet composite) or geogrid as specified herein, as shown on the Drawings, and in accordance with the Construction Quality Assurance Program.
- B. The Contractor shall be prepared to install the geocomposite drainage layer in conjunction with earthworks and other components of the liner system.

1.02 Related Sections

- A. Section 02200 – Earthwork
- B. Section 02232 – Leachate Collection Layer
- C. Section 02233 – Coarse Aggregate
- D. Section 02597 – Polyethylene Geomembrane

1.03 Qualifications

- A. The Contractor shall provide the services of a Geocomposite Manufacturer and Installer, who shall meet the following qualifications. The Contractor shall, however, accept and retain full responsibility for all materials and installation and shall be held responsible for any defects in the completed system.

1. Manufacturer

- a. The Geocomposite Manufacturer shall be responsible for the production and delivery of geocomposite rolls and shall be a well-established firm with more than one year of experience in the manufacture of geocomposite. The Manufacturer shall submit a statement to the QA Consultant listing:
 - 1) Certified minimum property values of the proposed geocomposite and the tests used to determine those properties.
 - 2) Production capacity available and projected delivery dates for this project.

2. Installer

- a. The Installer shall be responsible for field handling, storing, deploying, seaming or joining, temporary restraining (against wind), anchoring systems, and other site aspects of the geocomposite drainage layers.
 - b. The Installer shall be trained and qualified to install geocomposite. The installer's qualifications will require the QA Consultant approval.
- B. Prior to confirmation of any contractual agreements, the potential installer shall provide the QA Consultant with the written information that corresponds to the information required in this Part.

1.04 Submittals

- A. The Contractor shall submit to the QA Consultant in writing the following documentation on the raw materials used to manufacture the geocomposite prior to transporting any geocomposite to the site:
 - 1. Copies of quality control certificates issued by the resin supplier including production dates of the resin.
 - 2. Results of tests conducted to verify the quality of the resin used to manufacture the geonet and geotextile material assigned to the project.
 - 3. Certification that no reclaimed polymer is added to the resin during the manufacture of the geonet and geotextile material to be used in this project.

- B. The Contractor shall submit to the QA Consultant the following information on the geotextile:
 - 1. Copies of quality control certificates issued by the geotextile manufacturer. The certificate should include roll number and identification.
 - 2. The quality control certificate shall include:
 - a. roll numbers, lot or batch numbers, and identification;
 - b. sampling procedures; and
 - c. results of quality control tests, including descriptions of test methods used.
 - 3. The geotextile shall meet the requirements of Table 02590-1. Quality Control Testing of the geotextile shall be in conformance with the frequencies specified in Table 02590-2.

- C. The Contractor shall submit to the QA Consultant the following information on geocomposite production:
 - 1. Manufacturing quality control certificates for each shift's production, signed by responsible parties employed by the Manufacturer (such as the production manager), and notarized.
 - 2. The quality control certificate shall include:
 - a. roll numbers and identification;
 - b. sampling procedures; and
 - c. results of quality control tests, including descriptions of test methods used.
 - 3. The quality control testing to be performed by the manufacturer is presented in Part 2.03 of this Section.

1.05 Construction Quality Assurance

- A. The installation of the geocomposite shall be monitored as outlined in the CQA Plan.
- B. The Contractor shall be aware of the activities outlined in the CQA Plan and shall account for these CQA activities in the installation schedule.

PART 2 - PRODUCTS

2.01 Geocomposite

- A. The Manufacturer shall furnish geocomposite having properties that comply with the required property values shown in Table 02590-1. The Manufacturer shall provide test results for these procedures, as well as certification that the materials meet or exceed the specified values.
- B. In addition to the property values listed in Table 02590-1, the geocomposite shall:
 - 1. Retain their structure during handling, placement, and long-term service.
 - 2. Be capable of withstanding outdoor exposure for a minimum of 30 days with no measurable deterioration.
 - 3. Be chemically inert when immersed in the leachate from a typical landfill.

2.03 Geogrid

- A. The geogrid used for the containment of the stone underdrain of the Articulated Concrete Block (ACB) channels shall be a biaxial geogrid with apertures sizes less than one inch (1"), but greater than 1/8". Geogrid shall be manufactured from polyester (PET) or polypropylene (PP) and have an inert outer coating.

2.03 Manufacturing Quality Control

- A. The geocomposite shall be manufactured with quality control procedures that meet generally accepted industry standards.
- B. The Contractor shall require that the Geocomposite Manufacturer sample and test the geocomposite to demonstrate that the material conforms to the requirements of this Section.
- C. Any geocomposite sample that does not comply with this Section shall result in rejection of the roll from which the sample was obtained. The Contractor shall replace any rejected rolls at no additional cost to The Owner.
- D. Additional sample testing may be performed, at the Geocomposite Manufacturer's discretion and expense, to more closely identify any non-complying rolls and/or to qualify individual rolls.
- E. Sampling shall, in general, be performed on sacrificial portions of the geocomposite material such that repair is not required. The Contractor shall require that the Geocomposite Manufacturer sample and test the geocomposite at the frequencies presented in the Geocomposite Manufacturer's Quality Control Plan.
- F. The manufacturer shall test the materials at the frequencies shown in Table 02590-2 to demonstrate that its properties conform to the values specified in Table 02590-1.
- G. The Contractor shall require that the Geocomposite Manufacturer comply with the certification and submittal requirements of the CQA Plan.
- H. Samples of the geomembrane material shall be taken from the leading edge of the roll and shall be three feet wide by the length of the roll. QA Samples shall be taken at the factory prior to shipment or upon delivery at the site.

2.04 Labeling

- A. Geocomposite shall be supplied in rolls wrapped in relatively impermeable and opaque protective covers.

- B. Geocomposite rolls shall be labeled with the following information.
 - 1. manufacturer's name;
 - 2. product identification;
 - 3. lot or batch number;
 - 4. roll number; and
 - 5. roll dimensions.
- C. If any special installation is required, it shall be so marked on the geotextile component e.g., "This Side Up" or "This Side Against Soil".

2.05 Handling and Storage

- A. Handling, storage, and care of the geocomposite prior to and following installation at the site, is the responsibility of the Contractor. The Contractor shall be liable for all damages to the materials incurred prior to final acceptance of the lining system by the Owner.
- B. OWNER will provide on-site storage area for geomembrane rolls from time of delivery until deployment.
- C. All on-site storage and handling is the responsibility of the CONTRACTOR or INSTALLER.
- D. Upon arrival to the site the INSTALLER shall protect geomembrane from dirt, water, and other sources of damage.

PART 3 - EXECUTION

3.01 Familiarization

- A. Prior to implementing any of the work described in this Section, the Contractor shall become thoroughly familiar with all portions of the work falling within this Section and the CQA Plan.
- B. Inspection
 - 1. Prior to implementing any of the work in this Section, the Contractor shall carefully inspect the installed earthwork, liner and other related Sections and verify that all work is complete to the point where the installation of this Section may properly commence without adverse impact.
 - 2. If the Contractor has any concerns regarding the installed work of other Sections, he/she shall notify the QA Consultant in writing within 48 hours of his site inspection. Failure to inform the QA Consultant in writing or installation of the geocomposite will be construed as Contractor's acceptance of the related work of all other Sections.

3.02 CQA Conformance Testing

- A. Upon delivery to the site or at the location of the manufacturer, samples of the geocomposite shall be removed by the QA Consultant and sent to the laboratory selected by the QA Consultant for testing to ensure conformance to this Section.
- B. Geocomposite samples and tests shall be selected by the QA Consultant in accordance with this Section and the procedures outlined in the CQA Plan.

- C. Geocomposite samples shall be taken at the rate of one sample per 200,000 square feet with a minimum of one sample per lot. Samples shall be tested for the properties presented in Table 02590-3.
- D. The QA Consultant may increase the frequency of sampling in the event that test results do not comply with Part 2.01 of this Section. This additional testing shall be performed at the expense of the Contractor.
- E. Any geocomposites that are not certified in accordance with Part 1.03 and 1.04 of this Section, or that conformance testing indicates do not comply with Part 2.01 of this Section shall be rejected and replaced with new material by the Contractor at no additional cost to the Owner.

3.03 Handling and Placement

- A. The Contractor shall handle the geocomposite in such a manner as to ensure the geocomposite drainage layers are not damaged in any way.
- B. The Contractor shall take any necessary precautions to prevent damage to underlying layers during placement of the geocomposite.
- C. In the presence of wind, the geocomposite shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with cover material.
- D. On side slopes, the geocomposite shall be secured in the anchor trench and then rolled down the slope in such a manner as to continually keep the geocomposite in tension. Geonet composite shall not be placed in the horizontal direction (i.e., across the slope).
- E. If necessary, the geocomposite shall be positioned by hand after being unrolled to minimize wrinkles.
- F. Care shall be taken during placement of geocomposite not to entrap dirt or excessive dust in the geonet core that could cause clogging of the drainage system, and/or stones that could damage the adjacent liner. If dirt or excessive dust is trapped in the geocomposite, it should be cleaned prior to placement of the next material on top of it.
- G. Geocomposite shall only be cut using Manufacturer's recommended procedures.
- H. Unless otherwise specified, geocomposite shall not be welded to liners.
- I. Tools shall not be left on, in, or under the geocomposite.
- J. After unwrapping the geocomposite from its opaque cover, the geocomposite shall not be left exposed for a period in excess of 30 days unless a longer exposure period is approved by the ENGINEER, based on a formal demonstration from the Contractor that the geotextile component of the geocomposite is stabilized against U.V. degradation for a period in excess of 30 days.
- K. If white colored geotextile is used in the geocomposite, precautions shall be taken against "snowblindness" of personnel.

3.04 Installation

- A. Each component of the geocomposite (i.e., geotextile(s) and geonet) will be secured or seamed to the like component at overlaps.
- B. Geonet Components

1. Adjacent edges of geonet shall be overlapped at least 6 inches. These overlaps shall be secured by tying with white nylon ties at 5 foot intervals in the direction of the roll length.
2. Geonet roll ends (butt seams) shall be shingled down in the direction of the slope, with the geonet portion of the top overlapping the geonet portion of the bottom geocomposite a minimum of 12 inches across the roll width. White nylon ties shall be applied at 6 inch intervals.
3. Geonet shall be tied at 6 inch intervals with white nylon ties in the anchor trench.

C. Geotextile Components

1. The bottom layer of geotextile shall be overlapped. The top layer of geotextile shall be continuously sewn with contrasting color thread or continuously heat bonded in the direction of the roll length. Geotextiles shall be overlapped a minimum of 4 inches prior to seaming.
2. Polymeric thread, with chemical resistance properties equal to or exceeding those of the geotextile component, shall be used for all sewing. The thread shall be a contrasting color (white or other light color) to facilitate seam inspection. The seams shall be sewn to provide a flat (prayer) seam, "J" seam, or "butterfly-folded" seam and shall be a two-thread, double-lock stitch or a double row of single-thread, chain stitch.

3.05 Repair

- A. Any holes or tears in the geocomposite shall be repaired by placing a patch extending 2 feet beyond the edges of the hole or tear. The patch shall be secured by tying fasteners through the bottom geotextile and the geonet of the patch, and through the top geotextile and geonet on the slope. The patch shall secure every 6 inches with approved tying devices. The top geotextile component of the patch shall be heat sealed to the top geotextile of the geocomposite needing repair. If the hole or tear width across the roll is more than 50 percent of the width of the roll, the damaged area shall be cut out and the two portions of the geonet shall be joined in accordance with Subsection 3.04 above.

3.06 Placement of Soil Materials

- A. The Contractor shall place the soil materials in such a manner as to ensure that:
1. no construction equipment operates directly on the geocomposite;
 2. the geocomposite and underlying lining materials are not damaged;
 3. minimal slippage occurs between the geocomposite and underlying layers; and
 4. excess tensile stresses are not produced in the geocomposite.

3.07 Product Protection

- A. The Contractor shall use all means necessary to protect all prior work, and the materials and completed work of other Sections.
- B. In the event of damage, the Contractor shall immediately make all repairs and replacements necessary, to the approval of the QA Consultant and at no additional cost to the Owner.

TABLE 02590-1 GEOCOMPOSITE PROPERTY VALUES (MARV)				
PROPERTIES AND REQUIREMENTS	QUALIFIER	UNITS	SPECIFIED VALUES	TEST METHOD
HDPE GEONET CORE				
Thickness	Minimum	mil	250 (base liner) 200 (cap)	ASTM D 5199
Geonet Density	Minimum	g/cm ³	0.94	ASTM D 1505
Carbon Black Content	Range	%	2 - 3.5	ASTM D 1603
GEOTEXTILE COMPONENT				
Mass Per Unit Area	Minimum	oz/yd ²	8	ASTM D 3776
Apparent Opening Size	Maximum	Std sieve	80	ASTM D 4751
Permittivity	Minimum	sec ⁻¹	1.0	ASTM D 4491
Grab Tensile Strength	Minimum	lb	200	ASTM D 4632
Puncture Strength	Minimum	lb	400	ASTM D 6241
UV Resistance	Minimum	%@hr	70@500	ASTM D 4355
GEOCOMPOSITE				
Transmissivity(1)	Minimum	m ² /s	(250 mil) 5.0x10 ⁻⁴ (200 mil) 1.0x10 ⁻⁴	ASTM D 4716
Ply Adhesion	Minimum	lb/in	1.0	ASTM F 904 or ASTM D 7005
Interface Friction Angle(2,3)	Minimum	degrees	GC vs. Sand 25.3 GC vs. Soil 26.4	ASTM D 5321

NOTES:

- (1) The design transmissivity is the transmissivity of the geocomposite drainage layer measured using water at 70°F with a gradient of 0.1, under a compressive stress of 10,000 psf.
- (2) Interface friction angle testing shall be completed using project-specific soil and geocomposite materials. Testing parameters are described in Section 02200 for GC vs. soil and Section 02232 for GC vs. sand.
- (3) Interface friction angle testing for the LAP materials (slopes <=10%) is not required.

TABLE 02590-2 REQUIRED MANUFACTURER QUALITY CONTROL TEST FREQUENCIES		
PROPERTY	TEST METHOD	FREQUENCY
GEONET CORE		
Geonet Density	ASTM D 1505	Every 100,000 ft ²
Geonet Carbon Black Content	ASTM D 1603	Every 100,000 ft ²
Geonet Thickness	ASTM D 5199	Every 100,000 ft ²
GEOTEXTILE COMPONENT		
Mass Per Unit Area	ASTM D 3776	Every 100,000 ft ²
Grab Tensile	ASTM D 4632	Every 100,000 ft ²
Apparent Opening Size	ASTM D 4571	Every 540,000 ft ²
Permittivity	ASTM D 4491	Every 540,000 ft ²
Puncture Strength	ASTM D 6241	Every 100,000 ft ²
GEOCOMPOSITE		
Transmissivity	ASTM D 4716	One per production lot
Ply Adhesion	ASTM F 904	Every 200,000 ft ²

TABLE 02590-3 REQUIRED CQA QUALITY CONTROL TEST FREQUENCIES		
PROPERTY	TEST METHOD	FREQUENCY
GEOCOMPOSITE		
Transmissivity	ASTM D 4716	One per production lot
Ply Adhesion	ASTM F 904	Every 200,000 ft ²
Interface Friction Angle	ASTM D 5321	One per project

END OF SECTION

SECTION 02595

GEOTEXTILE

PART 1 - GENERAL

1.01 Description of Work

- A. The CONTRACTOR shall furnish all labor, materials, equipment, tools and appurtenances required to complete the work of furnishing, and placing geotextile, complete with appurtenances, as shown, specified or required
- B. Comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, state or federal authorities having jurisdiction.

1.02 Related Sections

- A. Section 02200 – Earthwork
- B. Section 02232 – Leachate Collection Layer
- C. Section 02233 – Coarse Aggregate
- D. Section 02271 – Stone Riprap and Grouted Riprap
- E. Section 02597 – Polyethylene Geomembrane

1.03 Submittals

- A. The CONTRACTOR shall furnish a written certification signed by an officer of the company or the Manufacturer's QC Manager for the woven and non-woven geotextile attesting that the geotextile meets the chemical, physical, and manufacturing requirements specified. The certification shall include:
 - Product identification,
 - Lot number,
 - Geotextile roll numbers affected by shipment, and
 - Manufacturer's QC test results.
- B. Geotextiles shall be rejected by the ENGINEER and replaced by the CONTRACTOR if they are found to have defects, rips, holes, flaws, deterioration or other damage.
- C. The contractor shall submit shop drawings to the QAC showing proposed construction methods: geosynthetics panel arrangements; and tie-in details between geosynthetics, drainage structures, fill materials, and the like.

1.04 Product Handling

- A. The CONTRACTOR shall protect the work described in this Section before, during, and after installation, and shall protect the installed work covered by other Sections.
- B. The CONTRACTOR shall, during all periods of shipment and storage, protect the geotextile from direct sunlight, ultraviolet light, temperatures greater than 120 degrees F, mud, dirt, dust, debris and other deleterious sources. Geotextiles shall be maintained, wrapped in a heavy-duty protective covering until it is installed.
- C. If the QAC determines material is damaged or has excessive sunlight exposure, the CONTRACTOR shall immediately make all repairs and replacements, at no additional cost to the OWNER.

1.05 Definitions

On the Drawings and in the Specifications, the word geotextile is used and refers to either a woven or non-woven geotextile as described in Section 2.01.

PART 2 - MATERIALS

2.01 Woven Geotextile

- A. Woven geotextiles used in the perimeter roadways shall be manufactured by Mirafi, Amoco, Exxon, Nicolon, Hoechst or other approved manufacturers.
- B. Woven geotextiles shall be placed at the roadway subgrade elevations as indicated on the Contract Drawings. Woven geotextile shall meet the following MARV minimum properties:

Property	Test Method	Value
Polymer Composition	-	95% polypropylene or polyester by weight
Grab Tensile Strength	ASTM D4632	200 lbs
Grab Tensile Elongation	ASTM D4632	10% - 15%
Apparent Opening Size	ASTM D4751	U.S. Sieve #40
Puncture Strength	ASTM D6241	700 lbs

- C. Woven geotextiles used as roadway stabilization fabric shall meet the requirements of AASHTO M288 Survivability Class 2 or better.
- D. To keep the number of seams to a minimum, the geotextile shall be provided in sections not less than 12 feet wide.

2.02 Nonwoven Geotextile

Nonwoven geotextile shall be used for wrapping the leachate collection stone, pipe construction, separation layer below fabric-formed concrete, riprap underlayment, or as otherwise indicated on the Contract Drawings. The geotextile shall meet the following MARV minimum properties:

Property	Test Method	Value	Manufacturer's QC Testing Frequency	QA Testing Frequency
Polymer Composition	-	95% polypropylene or polyester by weight	Certified by Manufacturer	N/A
Grab Tensile Strength	ASTM D4632	160 lbs	1 test per 50,000 sf	1 test per 100,000 sf
Grab Tensile Elongation	ASTM D4632	50 %	1 test per 50,000 sf	1 test per 100,000 sf
Trapezoidal Tear Strength	ASTM D4533	60 lbs	1 test per 50,000 sf	1 test per 100,000 sf
Puncture Strength	ASTM D6241	400 lbs	1 test per 50,000 sf	1 test per 100,000 sf
Apparent Opening Size	ASTM D4751	70 sieve	1 per production lot	1 test per 200,000 sf
Permittivity	ASTM D4491	1.0 sec ⁻¹	1 per production lot	1 test per 200,000 sf
UV Resistance	ASTM D4355	70 %	Certified by Manufacturer	N/A

The geotextile used for wrapping the leachate collection stone shall be a nonwoven geotextile conforming to AASHTO M288 Survivability Class 2.

PART 3 - EXECUTION

3.01 Site Preparation

- A. Site subgrade preparation shall conform to the requirements of this Section, and Section 02200 - Earthwork.
- B. The surface to receive geotextile shall be cleared of sharp objects, boulders, stumps, or any materials that may contribute to fabric punctures, shearing, rupturing or tearing to the satisfaction of the OWNER.
- C. The base surface or surface of embankments shall be graded as smooth as possible. The subgrade shall be inspected for unstable areas or soft spots, before the geotextile is placed and additional fill shall be placed and compacted to eliminate those unstable areas.

3.02 Installation

- A. The geotextile shall be placed in the manner and at the locations shown. Geotextile shall be laid smooth and free of tension, stress, folds, wrinkles, or creases.
- B. Woven geotextile will be overlapped a minimum of 2 feet, with the upgradient rolled lapped over the downgradient roll.
- C. All nonwoven geotextile seams shall be continuously sewn or otherwise secured by means approved by the ENGINEER. Nonwoven geotextiles will be overlapped a minimum of 6 inches prior to seaming.
- D. If geotextile is damaged during any step of installation, a piece of geotextile material shall be cut and placed over the damaged area and overlap the undamaged material a minimum of 3 feet in each direction. If the hole or tear width across the roll is more than 50 percent the width of the roll, the damaged area shall be cut out and the two portions of the geotextile shall be sewn together.
- E. The geotextile shall be placed on side slopes as shown on the contract drawings. If necessary, the geotextile shall be positioned by hand after being unrolled to minimize wrinkles. The geotextile shall not be placed in the horizontal direction (i.e. across the slope) on slopes steeper than 10 (horizontal): 1 (vertical), except as part of a patch.

3.03 Protection

- A. After installation, the geotextile should be visually inspected to assure that no objects are present that could potentially harm the geotextile.
 - B. Any geotextile damaged during its installation or during placement of cover material, as deemed by the QAC, shall be replaced by the CONTRACTOR at no additional cost to the OWNER.
- C. The work shall be scheduled so that the covering of the geotextile with the material to be placed over it is accomplished within 30 days after placement of the geotextile. Failure to comply with this requirement shall require replacement of an additional geotextile at no additional cost to the owner.
- D. When spot-repairing geotextile with patches, a 3-foot lystered overlap will be used or by a means approved by the OWNER.

END OF SECTION

SECTION 02597

POLYETHYLENE GEOMEMBRANE

PART 1 - GENERAL

1.01 Summary

This Section includes textured High Density Polyethylene (HDPE) and textured Linear low Density Polyethylene (LLDPE) geomembranes.

1.02 Submittals

A. Pre-installation: Submit prior to geomembrane deployment:

- (1) Origin (supplier's name and production plant) and identification (brand name and number) of resin used to manufacture geomembrane.
- (2) Copies of dated quality control certificates issued by resin supplier.
- (3) Results of tests conducted by geomembrane manufacturer to verify that resin used to manufacture geomembrane meets Specifications.
- (4) Statement that amount of reclaimed polymer added to resin during manufacturing did not exceed 2% by weight.
- (5) List of materials that comprise geomembrane, expressed in following categories as percent by weight: polyethylene, carbon black, and other additives.
- (6) Manufacturer's specification for geomembrane that includes properties listed and measured using appropriate test methods.
- (7) Written certification that minimum values given in manufacturer's specification are guaranteed by geomembrane manufacturer.
- (8) Quality control certificates, signed by geomembrane manufacturer. Each quality control certificate shall include applicable roll identification numbers, testing procedures, and results of quality control tests.
- (9) Panel layout and identification code including dimensions and details (2 weeks prior to INSTALLER mobilization).
- (10) Resumes of Geomembrane superintendent and master seamer including dates and duration of employment.
- (11) Installation schedule.
- (12) List of personnel performing seaming operations including experience information.
- (13) Certificate that extrudate to be used is comprised of same resin as geomembrane to be used.
- (14) List of seaming devices with identification numbers.

B. Installation: Submit as installation proceeds.

- (1) Quality control documentation recorded during installation.
- (2) Subbase surface acceptance certificates signed by LINER INSTALLER for each area that will be covered directly by geomembrane.
- (3) Deployment of geomembrane will be considered acceptance of subgrade if certificate is not submitted.
- (4) Material and Installation Warranty from manufacturer.

1.03 Prequalifications

A. Manufacturer:

- (1) Manufacturer shall have minimum 5 yrs continuous experience in manufacture of HDPE or LLDPE geomembrane or experience totaling 10,000,000 sq ft of manufactured HDPE or LLDPE geomembrane for minimum of 10 completed facilities.

- B. Fabricator (if applicable):
 - (1) Fabricator shall have minimum 5 yrs continuous experience in fabrication of HDPE or LLDPE geomembrane or experience totaling 2,000,000 sq ft of fabricated HDPE or LLDPE geomembrane for minimum of 10 completed facilities.
- C. Installer:
 - (1) Installer shall have minimum 5 yrs continuous experience in installation of HDPE or LLDPE geomembrane or experience totaling 2,000,000 sq ft of installed HDPE or LLDPE geomembrane for minimum of 10 completed facilities.
 - (2) Personnel performing seaming operations shall be qualified by experience or successfully passing seaming tests. Minimum of one seamer shall have experience seaming minimum 2,000,000 sq ft of HDPE or LLDPE geomembrane using same type of seaming apparatus in use at site. Most experienced seamer, "master seamer," shall provide direct supervision over less experienced seamers.

1.04 Quality Assurance Program

- A. Manufacturer, fabricator, and installer shall participate in and conform to items and requirements of a quality assurance program as outlined in this section.

1.05 Delivery, Storage, and Handling

- A. Packing and Shipping:
 - (1) Manufacturer shall identify each roll delivered to site with following:
 - a. Manufacturer's name.
 - b. Product Identification.
 - c. Thickness.
 - d. Roll number.
 - e. Roll dimensions.
 - (2) Protect geomembrane from excessive heat, cold, puncture, cutting, or other damaging or deleterious conditions during loading, transport, and unloading at site.
 - (3) The CONTRACTOR or INSTALLER is responsible for the submittal of shipping manifests and all other relevant documents to the CQA Consultant.
- B. Acceptance at Site:
 - (1) Conduct surface observations of each roll for defects and damage. This examination shall be conducted without unrolling rolls unless defects or damages are found or suspected.
 - (2) Defected or damaged rolls or portions of rolls will be rejected and shall be removed from site and replaced with new rolls.
 - (3) Rolls or portions of rolls without proper identification or labeling will be rejected and shall be removed from site.
- C. Storage and Protection:
 - (1) OWNER will provide on-site storage area for geomembrane rolls from time of delivery until deployment.
 - (2) All on-site storage and handling is the responsibility of the CONTRACTOR or INSTALLER.
 - (3) Upon arrival to the site the INSTALLER shall protect geomembrane from dirt, water, and other sources of damage.
 - (4) Preserve integrity and readability of geomembrane roll labels.
 - (5) Rolls which do not have proper identification at delivery will not be accepted.

PART 2 - PRODUCTS

2.01 Materials

A. Textured HDPE Geomembrane Properties:

Testing Properties	Testing Method	40 mil HDPE Value	60 mil HDPE Value
Thickness mils (min ave.) <ul style="list-style-type: none"> Lowest individual for 8 out of 10 values Lowest individual for any of the 10 values 	ASTM D 5994	38 mils 36 mils 34 mils	57 mils 54 mils 51 mils
Density g/cc	ASTM D1505 or ASTM D792	0.940 (min ave) (either method)	0.940 (min ave) (either method)
Asperity Height (min ave.) (1) (2)	ASTM D7466	10 mils	10 mils
Tensile Properties (min. ave.) (3) <ul style="list-style-type: none"> Break strength – lb/in Break elongation - % 	ASTM D638 Type IV	60 100	90 100
Tear Resistance – lb (min. ave.)	ASTM D1004	28	42
Puncture Resistance – lb (min. ave.)	ASTM D4833	60	90
Stress Crack Resistance (11)	ASTM D5397	300 hr	300 hr
Carbon Black Content - %	ASTM D1603 (4)	2.0 to 3.0	2.0 to 3.0
Carbon Black Dispersion	ASTM D 5596	Note (5)	Note (5)
Oxidative Induction Time (OIT) (min ave.) (6) <ul style="list-style-type: none"> Standard OIT, or High Pressure OIT 	ASTM D3895 ASTM D5885	100 400	100 400
Oven Aging at 85°C (7) <ul style="list-style-type: none"> Std. OIT (min. ave.), % retained after 90 days or <ul style="list-style-type: none"> High Pressure OIT (min. ave.), % retained after 90 days 	ASTM D5721 ASTM D3895 ASTM D5885	55 80	55 80
UV Resistance (8) <ul style="list-style-type: none"> Std. OIT (min. ave.), or High Pressure OIT (min ave.) % retained after 1600 hrs 	ASTM D3895 ASTM D5885	N.R. (9) 50	N.R. (9) 50

- (1) Of 10 readings, 8 out of 10 must be ≥ 7 mils, and lowest individual reading must be ≥ 5 mils
- (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. Break elongation is calculated using a gauge length of 2.0 in. at 2.0 in./min.
- (4) Other methods such as D4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D1603 (tube furnace) can be established.
- (5) Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 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 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
- (9) Not recommended since 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.
- (11) The SP-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 sheet made from the same formulation as being used for the textured sheet materials.

B. Textured LLDPE Geomembrane Properties:

Testing Properties	Testing Method	40 mil LLDPE Value
Thickness mils (min ave.) <ul style="list-style-type: none"> • Lowest individual for 8 out of 10 values • Lowest individual for any of the 10 values 	ASTM D 5994	38 mils 36 mils 34 mils
Density g/cc	ASTM D1505 or ASTM D792	0.939 (max) (either method)
Asperity Height (min ave.) (1) (2)	ASTM D7466	10 mils
Tensile Properties (min. ave.) (3) <ul style="list-style-type: none"> • Break strength – lb/in • Break elongation - % 	ASTM D638 Type IV	60 250
Tear Resistance – lb (min. ave.)	ASTM D1004	22
Puncture Resistance – lb (min. ave.)	ASTM D4833	44
Carbon Black Content - %	ASTM D1603 (4)	2.0 to 3.0
Carbon Black Dispersion	ASTM D 5596	Note (5)
Oxidative Induction Time (OIT) (min ave.) (6) <ul style="list-style-type: none"> • Standard OIT, or • High Pressure OIT 	ASTM D3895 ASTM D5885	100 400
Oven Aging at 85°C (7) <ul style="list-style-type: none"> • Std. OIT (min. ave.), % retained after 90 days or <ul style="list-style-type: none"> • High Pressure OIT (min. ave.), % retained after 90 days 	ASTM D5721 ASTM D3895 ASTM D5885	35 60
UV Resistance (8) <ul style="list-style-type: none"> • Std. OIT (min. ave.), or • High Pressure OIT (min ave.) % retained after 1600 hrs 	ASTM D3895 ASTM D5885	N.R. (9) 35

- (1) Of 10 readings, 8 out of 10 must be ≥ 7 mils, and lowest individual reading must be ≥ 5 mils
- (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. Break elongation is calculated using a gauge length of 2.0 in. at 2.0 in./min.
- (4) Other methods such as D4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D1603 (tube furnace) can be established.
- (5) Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 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 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
- (9) Not recommended since 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.

C. Geomembrane shall be manufactured from new polyethylene resin, except as noted below:

- (1) Use of geomembrane recycled during manufacturing process shall be permitted with written approval from OWNER and if recycled geomembrane does not exceed 2% by weight.
- (2) Geomembrane manufactured from non-complying resin shall be rejected.

- D. Samples of the geomembrane material shall be taken from the leading edge of the roll and shall be three feet wide by the length of the roll. QA Samples shall be taken at the factory prior to shipment or upon delivery at the site.

2.02 Contractor-Provided Seaming and Testing Equipment

A. Welding:

- (1) Maintain on-site minimum of 2 spare operable seaming apparatus, unless otherwise agreed upon at pre-construction meeting.
- (2) Seaming equipment shall not damage geomembrane.
- (3) Use extrusion welding apparatus equipped with gauges giving temperature of extrudate at nozzle of apparatus, or utilize hand-held gauges to measure extrudate temperatures.
- (4) Use fusion-welding apparatus that are self-propelled devices equipped with gauges indicating temperature of the heating element and speed of travel.
- (5) Place electric generator on smooth base with rub sheet such that no damage occurs to geomembrane.

B. Vacuum Testing Equipment:

- (1) Vacuum box assembly consisting of: rigid housing, transparent viewing window, soft neoprene gasket attached to bottom of housing, porthole or valve assembly, and vacuum gauge.
- (2) Pump assembly equipped with pressure controller and pipe connections.
- (3) Pressure/vacuum rubber hose with fittings and connections.
- (4) Soapy solution to wet test area.
- (5) Means of applying soapy solution.

C. Air Pressure Testing Equipment:

- (1) Air pump (manual or motor driven), equipped with pressure gauge, capable of generating, sustaining, and measuring pressure between 24 and 35 psi, and mounted on rub sheet to protect geomembrane.
- (2) Rubber hose with fittings and connections.
- (3) Sharp hollow needle, or other approved pressure feed device.
- (4) Air pressure monitoring device.

D. Tensiometer Testing Equipment:

- (1) Tensiometer shall be capable of maintaining constant jaw separation rate of 2 in. per minute, and shall be calibrated, with certificate of calibration less than 1 yr old kept with tensiometer.

2.03 Source Quality Control

(a) Tests, Inspections shall be performed by geomembrane manufacturer as follows:

- (1) Test geomembranes to demonstrate that resin meets this Specification.
- (2) Continuously monitor geomembrane during manufacturing process for inclusions, bubbles, or other defects. Geomembranes which exhibit defects shall not be acceptable for installation.
- (3) Monitor thickness continuously during manufacturing process.
- (4) Tests shall be conducted for following properties in accordance with test methods specified in the following table. Samples not complying with Specifications shall result in rejection of rolls. At geomembrane manufacturer's discretion and expense, additional testing of individual rolls may be performed to identify and reject non-complying rolls and to approve individual rolls.

Required Manufacturer Testing Frequency (HDPE and LLDPE)

Testing Properties	Testing Method	Manufacturer QC Testing Frequency
Thickness	ASTM D 5994	1 per Roll;
Density	ASTM D1505 or ASTM D792	1 per 500,000 sf
Asperity Height (1) (2)	GM-12	Every 2 nd roll
Tensile Properties (3)	ASTM D638 Type IV	1 per 50,000 sf
Tear Resistance	ASTM D1004	1 per 100,000 sf
Puncture Resistance	ASTM D4833	1 per 100,000 sf
Stress Crack Resistance (9)	ASTM D5397	per GRI GM10
Carbon Black Content - %	ASTM D1603 (4)	1 per 50,000 sf
Carbon Black Dispersion (5)	ASTM D 5596	1 per 100,000 sf
Oxidative Induction Time (OIT) (6) <ul style="list-style-type: none"> • Standard OIT, or • High Pressure OIT 	ASTM D3895 ASTM D5885	(9)
Oven Aging at 85°C (7) <ul style="list-style-type: none"> • Std. OIT, % retained after 90 days or <ul style="list-style-type: none"> • High Pressure OIT, % retained after 90 days 	ASTM D5721 ASTM D3895 ASTM D5885	(9)
UV Resistance (8) <ul style="list-style-type: none"> • Std. OIT, or • High Pressure OIT % retained after 1600 hrs 	ASTM D3895 ASTM D5885	(9)

- (1) Of 10 readings, 8 out of 10 must be ≥ 7 mils, and lowest individual reading must be ≥ 5 mils
- (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.
 - Break elongation is calculated using a gauge length of 2.0 in. at 2.0 in./min.
- (4) Other methods such as D4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D1603 (tube furnace) can be established.
- (5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
 - 9 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 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
- (9) Manufacturer may provide a certification letter

PART 3 - EXECUTION

3.01 QUALITY ASSURANCE SAMPLING

- A. INSTALLER or MANUFACTURER shall make rolls available and assist GEOSYNTHETIC CONSTRUCTION QUALITY ASSURANCE CONSULTANT (CQAC) in obtaining material inventory and material samples. Samples shall be tested in accordance with the test methods specified in the following table:

Required Quality Assurance Testing Frequency (HDPE and LLDPE)

Testing Properties	Testing Method	Conformance QA Testing Frequency
Thickness	ASTM D 5994	1 per 200,000 sf
Density	ASTM D1505 or ASTM D792	1 per 200,000 sf
Asperity Height (1) (2)	GM-12	1 per 200,000 sf
Tensile Properties (3)	ASTM D638 Type IV	1 per 200,000 sf
Tear Resistance	ASTM D1004	1 per 200,000 sf
Puncture Resistance	ASTM D4833	1 per 200,000 sf
Carbon Black Content - %	ASTM D1603 (4)	1 per 200,000 sf
Carbon Black Dispersion (5)	ASTM D 5596	1 per 200,000 sf

- (1) Of 10 readings, 8 out of 10 must be ≥ 7 mils, and lowest individual reading must be ≥ 5 mils
- (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.
 - Break elongation is calculated using a gauge length of 2.0 in. at 2.0 in./min.
- (4) Other methods such as D4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D1603 (tube furnace) can be established.
- (5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
 - 9 in Categories 1 or 2 and 1 in Category 3

- B. Rolls represented by quality assurance testing shall be rejected if test failure occurs. INSTALLER may at their expense request additional testing to validate individual rolls. Rolls bracketed by passing tests will be allowed to be deployed and seamed.

3.02 Preparation

- A. Surface Preparation:

- (1) EARTHWORK CONTRACTOR is responsible for preparing supporting surface for geomembrane placement.
- (2) After prepared surface has been accepted in accordance with Quality Assurance Plan, report to OWNER any change in supporting surface condition that may require repair work. Maintain prepared surface.
- (3) Do not place geomembrane onto an area that has become softened by precipitation or cracked due to desiccation. Observe and report surface condition daily to evaluate degree of softening and desiccation cracking.
- (4) Repair damage to prepared surface caused by installation activities at INSTALLER'S expense.

3.03 Geomembrane Installation

A. Panel Nomenclature:

- (1) Field panel is defined as a roll or portion of roll cut and seamed in field, excluding patches and cap strips.
- (2) Identify each field panel with identification code (number or letter-number) consistent with INSTALLER'S layout plan. This identification code shall be agreed upon by OWNER, INSTALLER, and GEOSYNTHETIC CQAC.
- (3) Writing on liner with colored markers shall be as agreed upon in the Pre-Construction Meeting. Only authorized personnel shall be permitted to write on liner.

B. Protection:

- (1) Do not use equipment that damages geomembrane.
- (2) Ensure prepared surface underlying geomembrane has not deteriorated since previous acceptance, and remains acceptable immediately prior to geomembrane deployment.
- (3) Keep geosynthetic elements immediately underlying geomembrane clean and free of debris.
- (4) Do not permit personnel to smoke or wear shoes that can damage geomembrane while working on geomembrane. Personnel shall not bring glass bottles on geomembrane.
- (5) Unroll panels in manner that does not cause excessive scratches or crimps in geomembrane and does not damage supporting soil.
- (6) Place panels in manner that minimizes wrinkles (especially differential wrinkles between adjacent panels).
- (7) Prevent wind uplift by providing adequate temporary loading and/or anchoring (e.g., sandbags) that shall not damage geomembrane. In case of high winds, continuous loading is recommended along panel edges.
- (8) Protect geomembrane in areas where excessive traffic is expected with geotextiles, extra geomembrane, or other suitable materials.

C. Field Panel Deployment:

- (1) Install field panels at locations indicated on INSTALLER'S layout plan.
- (2) Replace seriously damaged (torn, twisted or crimped) field panels, or portions thereof, at no cost to OWNER. Repair less serious damage as specified herein. GEOSYNTHETIC CQAC shall determine if material shall be repaired or replaced.
- (3) Remove damaged panels or portions of damaged panels that have been rejected from work area.
- (4) Do not proceed with deployment at ambient temperature below 32 F or above 104 F unless otherwise authorized in writing by OWNER.
- (5) Do not deploy during precipitation, in presence of excessive moisture, (fog, dew), in areas of ponded water or in presence of excessive winds.
- (6) Do not undertake deployment if weather conditions will preclude material seaming on same day as deployment.
- (7) Do not deploy more geomembrane field panels in one day than can be seamed during that day.

D. Seam Layout:

- (1) When possible, orient seams parallel to line of maximum slope, i.e., oriented along, not across, slope.
- (2) When possible, no horizontal seam shall be closer than 5 ft from toe of slope.
- (3) In general, maximize lengths of field panels and minimize number of field seams.
- (4) Align geomembrane panels to have nominal overlap of 3 in. for extrusion welding and 4 to 6 in. for fusion welding. Final overlap shall be sufficient to allow peel tests to be performed on seam.

E. Temporary Bonding:

- (1) Hot air device (Liester) may be used to temporarily bond geomembrane panels to be extrusion welded.
- (2) Do not damage geomembrane when temporarily bonding adjacent panels. Apply minimal amount of heat to lightly tack geomembrane panels together. Control temperature of hot air at nozzle of any temporary welding apparatus to prevent damage to geomembrane.
- (3) Do not use solvent or adhesive.

F. Seaming Methods:

- (1) Approved processes for field seaming are extrusion fillet welding and fusion welding. Proposed alternate processes shall be documented and submitted to OWNER for approval. Alternate procedures shall be used only after being approved in writing by OWNER.
- (2) Seams shall meet following requirements:

MINIMUM POLYETHYLENE SEAM PROPERTIES (per GRI GM-19)

PROPERTY	METHOD	40 MIL LLDPE	40 MIL HDPE	60 MIL HDPE
Shear Strength	ASTM D6392	60 ppi	80 ppi	120 ppi
Peel Adhesion:				
Fusion	ASTM D6392	50 ppi	60 ppi	91 ppi
Extrusion	ASTM D6392	44 ppi	52 ppi	78 ppi
<input type="checkbox"/> The strength of four out of five specimens shall meet or exceed the value shown in this table. The fifth must meet or exceed 80% of the given value in order to be considered a passing test. <input type="checkbox"/> Unacceptable break codes are: <input type="checkbox"/> Fusion: AD and AD-Brk>25% <input type="checkbox"/> Extrusion: AD1, AD2, AD-WLD (unless strength is achieved)				

- (3) Use fusion welding as primary method of seaming adjacent field panels.
 - a. For cross seam tees, associated with fusion welding or extrusion welding, shall be patched to a minimum distance of 6-in. on each side of tee.
 - b. Place welder on protective pad to prevent geomembrane damage between seaming.
 - c. When subgrade conditions dictate, use movable protective layer (e.g. extra piece of geomembrane) directly below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between sheets and prevent debris from collecting around pressure rollers.
- (4) Use extrusion fillet welding as secondary method for seaming between adjacent panels and as primary method of welding for detail and repair work.
 - a. Purge heat-degraded extrudate from barrel of extruder under following conditions:
 - 1) Prior to beginning seam.
 - 2) Whenever extruder has been inactive.
 - a. Place smooth insulating plate or fabric beneath hot welding apparatus after usage.
 - b. Use clean and dry welding rods or extrudate pellets.
 - c. Complete grinding process without damaging geomembrane within 1 hr of seaming operation.
 - d. Minimize exposed grinding marks adjacent to extrusion weld. Do not allow exposed grinding marks to extend more than 1/4 in. outside finished seam area and grind perpendicular to seam.

G. Seaming Procedures:

(1) General Seaming Procedures: (Ambient temperature between 32°F and 104°F).

- a. Do not field seam without master seamer being present.
- b. Dry conditions, i.e., no precipitation nor other excessive moisture, such as fog or dew.
- c. No excessive winds.
- d. If required, provide firm substrate by using extra piece of geomembrane, or similar hard surface directly under seam overlap to achieve proper support for seaming apparatus.
- e. Align seams with fewest possible number of wrinkles and fishmouths.
- f. Extend seams to outside edge of panels placed in anchor trench.
- g. Prior to seaming, ensure that seam area is clean and free of moisture, dust, dirt, debris or foreign material.
- h. Fishmouths or wrinkles at seam overlaps shall be cut along ridge of wrinkle in order to achieve flat overlap. Cut fishmouths or wrinkles shall be seamed and any portion where overlap is inadequate shall be patched with an oval or round patch of same geomembrane extending minimum of 6-in. beyond cut in each direction.

(2) Cold Weather Seaming Procedures (ambient temperature is below 32° F).

- a. GEOSYNTHETIC CQAC shall determine geomembrane surface temperatures at intervals of at least once per 100 ft of seam length to determine if preheating is required. For extrusion welding, preheating required if surface temperature of geomembrane is below 32° F.
- b. Preheating may be waived by OWNER based on recommendation from GEOSYNTHETIC CQAC, if demonstrated to GEOSYNTHETIC CQAC'S satisfaction that welds of equivalent quality may be obtained without preheating at expected temperature of installation.
- c. If preheating is required, GEOSYNTHETIC CQAC shall observe areas of geomembrane that have been preheated by hot air device prior to seaming, to ensure they have not been subjected to excessive melting.
- d. GEOSYNTHETIC CQAC shall confirm that surface temperatures have not lowered below minimum surface temperatures specified for welding due to winds or other adverse conditions. It may be necessary to provide wind protection for seam area.
- e. Preheating devices used shall be pre-approved by OWNER prior to use.
- f. Additional destructive seam tests shall be taken at interval between 500 ft and 250 ft of seam length, at GEOSYNTHETIC CQAC'S discretion.
- g. Sheet grinding may be performed before preheating, if applicable.
- h. Trial seaming shall be conducted under same ambient temperature and preheating conditions as actual seams. New trial seams shall be conducted if ambient temperature drops by more than 10° F from initial trial seam test conditions. New trial seams shall be conducted upon completion of seams in progress during temperature drop.

(3) Warm Weather Procedures (ambient temperature is above 104° F).

- a. No seaming of geomembrane is permitted unless demonstrated to GEOSYNTHETIC CQAC that geomembrane seam quality will not be compromised.
- b. Trial seaming shall be conducted under same ambient temperature conditions as actual seams. New trial seams shall be conducted if ambient temperature rises by more than 5° F from initial trial seam test conditions. Such new trial seams shall be conducted upon completion of seams in progress during temperature rise.
- c. At option of GEOSYNTHETIC CQAC, additional destructive seam tests may be required for any suspect areas.

H. Repair Procedures:

- (1) Repair portions of geomembrane exhibiting flaw, or failing destructive or nondestructive test.
- (2) Final decision as to repair procedure shall be agreed upon between OWNER, INSTALLER, and GEOSYNTHETIC CQAC.
- (3) Acceptable repair procedures include following:
 - a. Patching: Piece of same geomembrane material extrusion welded into place. Use to repair large holes, tears, nondispersed raw materials, and contamination by foreign matter. All panel intersections shall be patched.
 - b. Spot welding or seaming: Bead of molten extrudate placed on flaw. Use to repair small tears, pinholes, or other minor, localized flaws.
 - c. Capping: Strip of same geomembrane material extrusion welded into place over inadequate seam. Use to repair large lengths of failed seams.
 - d. Removal and replacement: Remove bad seam and replace with strip of same geomembrane material welded into place. Use to repair large lengths of failed seams.
 - e. Extrusion welding flap: Repairs of this type shall not be used unless approved by GEOSYNTHETIC CQAC and shall not exceed 100 ft in length.
- (4) For each repair method:
 - a. Ensure surfaces are clean, dry, and prepared in accordance with specified seaming process.
 - b. Surfaces of the geomembrane that are to be repaired by extrusion welds shall be lightly abraded with a disc grinder or equivalent to ensure cleanliness.
 - c. Ensure seaming equipment used in repairing procedures meet requirements of this Specification.
 - d. Extend patches or caps at least 6 in. beyond edge of defect. Round corners of patches with radius of approximately 6 in.
- (5) Do not place overlying layers over locations, which have been repaired until appropriate acceptable nondestructive and destructive (laboratory) test results are obtained.

I. Anchor Trench:

- (1) EARTHWORK CONTRACTOR shall excavate anchor trenches, unless otherwise specified, to lines and grades shown on design construction drawings, prior to geomembrane placement. Anchor trench shall be drained to prevent ponding or softening of adjacent soils while trench is open.
- (2) Slightly rounded corners shall be provided in anchor trench to avoid sharp bends in geomembrane.
- (3) If anchor trench is excavated in clay material susceptible to desiccation, amount of trench open at any time should be minimized.
- (4) Remove construction-related debris from anchor trench.
- (5) Earthwork Contractor shall backfill and compact anchor trench as soon as practical after geomembrane installation is completed. Take care when backfilling trenches to prevent damage to geosynthetics.

3.04 Field Quality Control

A. Visual Inspection:

- (1) GEOSYNTHETIC CQAC will examine seam and non-seam areas of geomembrane for identification of defects, holes, blisters, nondispersed raw materials, and any sign of contamination by foreign matter.

- (2) Clean and wash geomembrane surface if GEOSYNTHETIC CQAC determines that amount of dust or mud inhibits examination.
- (3) Do not seam any geomembrane panels that have not been examined for flaws by GEOSYNTHETIC CQAC.
- (4) Nondestructively test seams and any non-seam areas identified by GEOSYNTHETIC CQAC.

B. Trial Seams:

- (1) Make trial seams on fragment pieces of geomembrane liner to verify that conditions are adequate for production seaming.
- (2) Make trial seams at beginning of each seaming period, following restart of welding equipment, upon change of seamers, and at least once each 5 hrs, for each production seaming apparatus used that day. Each seamer shall make at least one trial seam each day.
- (3) Make trial seams under same conditions as actual seams.
- (4) Make trial seams only under observation of GEOSYNTHETIC CQAC.
- (5) Seam overlap shall be as indicated for finished seam.
- (6) Make trial seam sample shall be at least 5 ft long by 1 ft wide (after seaming) with seam centered lengthwise.
- (7) Cut 6 specimens from sample with 1 in. wide die. These specimen locations shall be selected randomly along trial seam sample by GEOSYNTHETIC CQAC. Test 3 specimens in peel and 3 specimens in shear using field tensiometer. Samples shall fail in sheet or exceed the specified peel and shear criteria stated in this Specification.
- (8) If specimen fails, entire trial seam operation shall be repeated. If additional specimen fails, do not use seaming apparatus and seamer until deficiencies are corrected and two (2) consecutive successful trial welds are achieved.
- (9) Cut remainder of successful trial seam into three pieces; one to be retained in OWNER'S archives, one to be retained by INSTALLER, and one to be retained by GEOSYNTHETIC CQAC for possible laboratory destructive seam testing. If required by OWNER, remaining portion of trial seam sample may be subjected to destructive testing.

C. Nondestructive Seam Testing:

(1) General:

- a. Purpose of nondestructive tests is to check continuity of seams. It will not provide quantitative information on seam strength.
- b. Nondestructively test field seams over their full length using vacuum test for extrusion seams, air pressure for double-fusion seams or other OWNER approved method. Document results.
- c. Perform nondestructive testing as seaming work progresses.

(2) Vacuum Testing for extrusion seam:

- a. Energize vacuum pump and reduce tank pressure to approximately 5 psi gauge pressure.
- b. Wet strip of geomembrane approximately 12 in. by 48 in. with soapy solution.
- c. Place box over wetted area.
- d. Close bleed valve and open vacuum valve.
- e. Ensure that leak-tight seal is created.
- f. For minimum of 10 sec, apply vacuum and examine geomembrane through viewing window for presence of soap bubbles.
- g. If no bubbles appear within 10 sec, close vacuum valve and open bleed valve, move box over to next adjoining area with minimum 3 in. overlap and repeat process.
- h. Mark and repair areas where soap bubbles appear.

(3) Air Pressure Testing for double-fusion seam:

- a. Seal both ends of seam to be tested.
- b. Insert needle or other approved pressure feed device into air channel created by fusion weld.
- c. Insert protective cushion between air pump and geomembrane.
- d. Pressurize air channel to 30 psi. Close valve and allow pressure to stabilize for approximately 2 minutes.
- e. Observe air pressure 5 min after initial 2-min stabilization period ends. If pressure loss exceeds 2 psi or pressure does not stabilize, locate faulty area and repair.
- f. Cut opposite end of tested seam area once testing is completed to verify continuity of air channel. If air does not escape, locate blockage and retest unpressurized area. Repair cut end of air channel.
- g. Remove needle or other approved pressure feed device and repair hole in geomembrane.

(4) Inaccessible Seams:

- a. Cap-strip seams that cannot be nondestructively tested.
- b. Cap-strip material shall be composed of same type and thickness geomembrane as geomembrane to be capped.
- c. Examine cap-stripping operations with GEOSYNTHETIC CQAC for uniformity and completeness. Document observations.

D. Destructive Seam Testing:

(1) General:

- a. Perform destructive seam test as seaming progresses.
- b. The destructive seam sample shall fail if the grips of testing machine cannot be closed on sample test flap (available flap is 1/2 in. long or less) due to excessive temporary welding.
- c. Destructive seam tests shall satisfy the seam strength requirements in Paragraph 3.03.F.(2). Failing seams shall be tracked and repaired according to Paragraph 3.04.D.(5).

(2) Location and frequency:

- a. Test at minimum frequency of one test location per 500 ft of welding length performed by each fusion welding machine, and one test per 150 ft of extrusion welding.
- b. Test locations shall be determined during seaming, at GEOSYNTHETIC CQAC'S discretion.
- c. INSTALLER will not be informed in advance of locations where seam samples will be taken.
- d. OWNER reserves right to increase frequency of testing in accordance with performance results of samples previously tested.

(3) Sampling Procedures:

- a. Cut samples at locations chosen by GEOSYNTHETIC CQAC.
- b. GEOSYNTHETIC CQAC shall number each sample and record sample number and location in panel layout drawing.
- c. Repair holes in geomembrane resulting from destructive seam sampling immediately in accordance with repair procedures described in this Specification.
- d. Continuity of repair and seams shall be tested in accordance with vacuum testing requirements.

(4) Sample Dimensions: Take two 1-in. wide samples for field testing prior to cutting full laboratory sample.

- a. Field Testing: Cut 1 in. wide samples, 8 inches long with seam centered parallel to width. Distance between these 2 samples shall be 42 in. Test both samples on field tensiometer in peel. If both samples pass field test, take sample for laboratory testing.
- b. Laboratory Testing: Take laboratory test sample from between samples taken for field testing. Cut sample for laboratory testing 12 in. wide by a minimum 42 in. long with seam centered lengthwise. Cut this sample into three parts. GEOSYNTHETIC CQAC shall distribute parts as follows:
 - 1) One part to INSTALLER for optional laboratory testing, a minimum 12 in. by 12 in.
 - 2) One part to Geosynthetic Quality Assurance Laboratory for testing, a minimum 12 in. by 18 in.
 - 3) One part to OWNER for archive storage, a minimum 12 in. by 12 in.
- c. Final determination of sample sizes shall be agreed upon at pre-construction meeting.
- d. Submit laboratory sample for quantitative testing

(5) Destructive Test Failure Procedures:

When sample fails destructive testing, whether test is conducted by Geosynthetic QAL or by field tensiometer, CONTRACTOR has following options:

- a. Repair seam between any 2 passing destructive test locations.
- b. Trace welding path to intermediate point (10 ft minimum from point of failed test in each direction) and take small sample with 1 in. wide die for an additional field test at each location. If these additional samples pass test, then take full laboratory samples. If these laboratory samples pass tests, repair seam between these locations. If either sample fails, repeat process to establish zone in which seam should be repaired.
- c. Acceptable repaired seams shall be bound by 2 locations from which samples passing laboratory destructive tests have been taken. In cases exceeding 150 ft of repaired seam, GEOSYNTHETIC CQAC may have INSTALLER destructive test repair seam.
- d. When sample fails, OWNER may require additional testing of seams that were welded by same welder and/or welding apparatus during same time shift.

E. Repair Verification:

- (1) GEOSYNTHETIC CQAC shall observe number and log each repair.
- (2) Nondestructively test each repair.
- (3) Nondestructive test results that pass shall indicate adequate repair.
- (4) Repairs more than 150 ft long require destructive test sampling.
- (5) Failed destructive or nondestructive tests indicate that repair shall be redone and retested until passing test results.

F. Large Wrinkles: Wrinkle is considered to be large when geomembrane can be folded over onto itself.

- (1) When seaming of geomembrane is completed, and prior to placing overlying materials, GEOSYNTHETIC CQAC shall identify all excessive geomembrane wrinkles, which should be cut and resealed.
- (2) Cut and reseat all wrinkles identified by GEOSYNTHETIC CQAC. Seams produced while repairing wrinkles shall be nondestructively tested.
- (3) Repair wrinkles identified by GEOSYNTHETIC CQAC. Repair during coldest part of installation period.

END OF SECTION

SECTION 02607

CONCRETE MANHOLES/DROP BOXES/VAULTS

PART 1 - GENERAL

1.01 Description of Work

- A. CONTRACTOR shall furnish all materials, labor, tools and appurtenances required to complete the precast concrete manholes, concrete valve boxes and concrete vaults as described herein and/or shown on the Contract Drawings.
- B. CONTRACTOR shall comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, state or federal authorities having jurisdiction.

1.02 Related Sections

- A. Section 02650 - HDPE Pipe
- B. Section 03300 - Cast-In-Place Concrete

1.03 Design Requirements

Manholes/drop boxes/vaults shall be constructed of specified materials to the sizes, shapes and dimensions and at the locations shown on the Contract Drawings or as otherwise directed by OWNER. The height or depth of manholes/drop boxes/vaults will vary with the location. The top and bottom elevations of manholes/drop boxes/vaults shall be as shown on the Contract Drawings.

1.04 Submittals

- A. CONTRACTOR shall submit to OWNER shop drawings and engineering data on frames, covers, grates, steps and precast manholes/drop boxes/vaults sections.
- B. CONTRACTOR shall submit to OWNER details showing joints and seals between precast manhole/drop box/vault riser sections and showing joints between pipes and manholes/drop box/vault walls.

1.05 Quality Assurance

- A. Prior to delivery, all basic materials specified herein shall be tested and inspected by an approved independent commercial testing laboratory or, if approved by OWNER, certified copies of test reports prepared by the manufacturer's testing laboratory will be acceptable. All materials which fail to conform to these Specifications shall be rejected.
- B. After delivery to the Site, any materials, which have been damaged in transit or are otherwise unsuitable for use in the Work shall be rejected and removed from the Site, at no additional cost to OWNER.

PART 2 - PRODUCTS

2.01 Materials and Construction

- A. Cast-in-Place Concrete and Reinforcement
 - (1) Cast-in-Place Concrete used in manhole, drop box, vault construction shall be VDOT Class "A" concrete (or equivalent) conforming to the requirements of Section 03300 - Cast-In-Place Concrete of these Specifications.

- (2) Steel reinforcement shall be epoxy coated and conform to the requirements of Section 03200 - Concrete Reinforcement of these Specifications.

B. Precast Concrete Manholes:

- (1) Precast concrete manholes shall consist of precast reinforced concrete sections, a conical or flat slab top section, and a base slab section conforming to the typical manhole details as shown on the Contract Drawings.
- (2) Precast manhole sections shall be manufactured, tested and marked in accordance with the latest provisions of ASTM C 478.
- (3) The minimum 28-day compressive strength of the concrete for all sections shall be 4,000 psi.
- (4) The maximum allowable absorption of the concrete shall not exceed eight percent of the dry weight.
- (5) The circumferential reinforcement in the riser sections, conical top sections and base wall sections shall consists of one line of steel and shall be not less than 0.17 square inch per lineal foot.
- (6) The ends of each reinforced concrete manhole riser section and the bottom end of the manhole top section shall be so formed that when the manhole risers and the top are assembled, they will make a continuous and uniform manhole.
- (7) Joints of the manhole sections shall be of the tongue and groove type. Sections shall be joined using O-ring rubber gaskets conforming to the applicable provisions of ASTM C443, latest revision, or filled with an approved preformed plastic gasket meeting the requirements of Federal Specifications SS-S-00210, "Sealing Compound, Preformed Plastic for Pipe Joints", Type 1, Rope Form.
- (8) Each section of the precast manhole shall have not more than two holes for the purpose of handling and laying. These holes shall be tapered and shall be plugged with rubber stoppers or mortar after installation.
- (9) Stainless steel manhole steps shall be installed in each section of the manhole in accordance with the details on the Contract Drawings.

C. Frames, Covers, Attachments, and Steps:

- (1) Frames and covers shall be cast iron conforming to the minimum requirements of Federal Specifications WW01-652 or to ASTM A 48 for Class 30 Gray Iron Castings. All castings shall be made accurately to the required dimensions, fully interchangeable, sound, smooth, clean, and free from blisters and/or other defects. Defective castings which have been plugged or otherwise treated shall not be used. All castings shall be thoroughly cleaned and painted or coated with a bituminous paint. Each casting shall have its actual weight in pounds stenciled or painted on it in white paint.
- (2) Manhole access hatches/doors shall be cast-in-place in concrete top unit and shall be of type and dimension indicated on the Contract Drawings.
- (3) Interior concrete anchors, embedment plates, and fall protection system connection eyes shall be stainless steel with stainless steel hardware.
- (4) The contact surfaces of all manhole covers and hatches and the corresponding supporting frames shall be machined to provide full perimeter contact.
- (5) Interior manhole steps shall be stainless steel and conform to the applicable provisions of ASTM Standard Specification Serial Designation C478.

D. Precast Concrete Drop Boxes and Vaults:

- (1) Precast concrete drop boxes shall consist of precast reinforced concrete sections, flat slab top section, and a base slab section conforming with the typical drop box details as shown on the Contract Drawings.
- (2) Precast drop box sections shall be manufactured, tested and marked in accordance with the latest provisions of ASTM C 478.
- (3) The minimum 28-day compressive strength of the concrete for all sections shall be 4,000 psi.
- (4) The maximum allowable absorption of the concrete shall not exceed eight percent of the dry weight.

- (5) The reinforcement in the wall sections, top section and base section shall consist of one line of steel and shall not be less than 0.17 square inch per lineal foot.
- (6) Each section of the precast drop box shall have not more than two holes for the purpose of handling and laying. These holes shall be tapered and shall be plugged with rubber stoppers or mortar after installation.
- (7) Joints of the drop box sections, if any, shall be of the tongue and groove type. Sections shall be joined using O-ring rubber gaskets conforming to the applicable provisions of ASTM C443, latest revision, or filled with an approved preformed plastic gasket meeting the requirements of Federal Specifications SS-S-00210, "Sealing Compound", Preformed Plastic for Pipe Joints", Type 1, Rope Form.

PART 3 - EXECUTION

3.01 Placement of Precast Concrete Manholes

- A. Prior to placing precast manholes, a minimum 9-inch-thick layer of coarse aggregate shall be placed as bedding. After approval of bedding by OWNER, manholes shall be placed and inverts/bottom elevations established and verified.
- B. After placing manhole base, inverts shall be constructed using VDOT Class "A" concrete in accordance with details on the Contract Drawings and inverts shall have the same cross section as the invert of the culverts which they connect. The manhole invert shall be carefully formed to the required size and grade by gradual and even changes in sections.
- C. After the base section has been set, and inverts formed, the precast manhole sections shall be placed thereon, care being exercised to form the incoming and outgoing pipes into the wall of the manhole at the required elevations.
- D. The top unit with cast-in-place access hatch/door for the manhole shall be set at the required elevation and properly anchored to the masonry. Where manholes are constructed in paved areas, the top surface of the frame and cover shall be tilted to conform to the exact slope, crown and grade of the existing adjacent pavement.

3.02 Placement of Precast Concrete Drop Boxes and Vaults

- A. Prior to placing precast concrete drop boxes and vaults, a minimum 9-inch-thick layer of coarse aggregate shall be placed as a level bedding for the drop box.
- B. After approval of bedding by OWNER, drop boxes and vaults shall be placed, and their inverts shall be established and verified.
- C. Covers, grates, hatches as indicated on the Contract Drawings shall be set at the required elevation and properly anchored to the drop box, as shown on the Contract Documents.

END OF SECTION

SECTION 02650

LEACHATE COLLECTION AND CONVEYANCE PIPE

PART 1 - GENERAL

1.01 Description of Work

- A. The CONTRACTOR shall furnish all labor, materials, equipment, tools and appurtenances required to complete the work of furnishing, placing and compacting the drainage conveyance pipe as shown, specified or required.
- B. Comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, State or Federal authorities having jurisdiction.

1.02 Related Sections

- A. Earthwork - Section 02220
- B. Leachate Collection Layer - Section 02232
- C. HDPE Pipe Leak Testing - Section 02651

1.03 Submittals

The CONTRACTOR shall submit manufacturer's data sheets, certification of compliance with specifications for all pipes, fittings and appurtenances and leak testing requirements.

1.03 Quality Assurance

- A. Pipe installation shall be performed by skilled workers. Each pipe laying crew shall have a pipe laying foreman.
- B. Pipe shall be accurately installed to the lines and grades shown on the Construction Drawings, or as approved by the OWNER, so that inverts are smooth.
- C. Deflections in horizontal alignment at joints are not permitted without the written consent of the OWNER. If so approved, the deflections shall not exceed one-half the manufacturer's recommendation.
- D. The OWNER shall be notified in advance whenever an existing pipeline location conflicts with the proposed locations of the Work.
- E. Pipe and fittings of the same type shall be the products of a single manufacturer.
- F. All piping shall be of the type and size as shown on the Construction Drawings and described in this Section of the Specifications.

1.04 Delivery, Storage, and Handling

- A. All pipes and fittings shall be carefully handled when loading and unloading. Lift by hoists or lower on skidways in a manner to avoid shock.
- B. Where required, due to weight of material and for the safety and protection of workmen, materials, equipment, property, and the work, use derricks, ropes, or other suitable equipment for lowering pipe into trenches. Take particular care to avoid damaging the pipe.
- C. Pipe and fittings shall be protected against the damaging ultraviolet rays of the sun when stored for any period. Such protection shall consist of canvas covering, or other material as

recommended by the manufacturer. Plastic sheets shall not be used which may allow excessive temperatures to develop where pipe is stored. All pipe which has been distorted or otherwise negatively affected by high temperatures shall be rejected, regardless of the pipe's appearance after return to ambient temperatures. Rejected pipe shall be marked by the QAC and removed from the site of the work at the sole expense the CONTRACTOR.

- D. The manufacturer's recommended procedures for pipe stacking shall be followed. When pipe is stacked for storage, the heaviest series of pipe shall be placed at the bottom.
- E. Pipe and fittings shall be protected from damage by sharp objects through all phases of work.
- F. If any defective pipe is discovered after being laid or placed, removal and replacement with a sound pipe will be required without cost to the OWNER.

PART 2 - MATERIALS

2.01 Pipe and Fittings

- A. Piping resins shall be high performance, high molecular weight, high density polyethylene conforming to ASTM D1248 (Type III, Class C, Category 5, Grade P34), and ASTM D3350 (Cell Classification PE345434C). The pipe and fittings shall be manufactured from pre-compounded resin manufactured by the pipe manufacturer, with a minimum of two percent carbon black to withstand outdoor exposure without loss of properties. In-plant blending of non-compounded resins is not acceptable. All polyethylene pipe shall meet the requirements of ASTM F714 for SDR-11, SDR-17, or SDR-21 pipe. Each pipe length shall be marked with the manufacturer's name or trademark, size, material code, and standard dimension ratio.
- B. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. The pipe shall be homogeneous throughout and free of visible cracks, holes (other than those manufactured), foreign inclusions, or other deleterious defects, and shall be identifiable in color, density, melt index, and other physical properties.
- C. The manufacturer shall provide a product supplying a minimum hydrostatic design basis (HDB) of 1,600 psi at 63.4 degrees F, as determined in accordance with ASTM D2837.

2.02 Tracer Wire

- A. For open cut pipe installations, tracer wire shall be #12 AWG solid copper with 30 mil HMWPE or 60 mil PVC insulation, green in color.
- B. For trenchless pipe installations, tracer wire shall be #12 AWG solid copper clad steel core with 45 mil HMWPE insulation, green in color. Wire shall be expressly specified for use in trenchless tracer wire applications.

PART 3 - EXECUTION

3.01 Inspection - General

- A. Each length of pipe and each fitting shall be carefully inspected prior to placement. All materials not meeting the requirements of these Specifications, or otherwise found defective or unsatisfactory by the QAC, shall be rejected and immediately marked and removed from the job site by the CONTRACTOR.
- B. Bedding, sub-bedding, and other trench conditions shall be carefully inspected prior to laying pipe in each stretch of open trench. All conditions shall be made available to the QAC for inspection purposes, and the QAC shall be further advised where, in the CONTRACTOR's opinion, unstable or otherwise deleterious conditions exist.

- C. Each stretch of completed pipeline shall be inspected prior to backfilling. Backfilling operations shall not be initiated prior to inspection by the QAC.
- D. All non-perforated sections of pipe shall be pressure tested prior to acceptance.

3.02 Preparation

Pipe and fitting interiors and joint surfaces, shall be thoroughly cleaned prior to installation. Pipe and fittings shall be maintained clean.

3.03 Pipe Installation

- A. Pipes and fittings shall be carefully lowered into place.
- B. Pipe and fittings shall be installed so that there will be no deviation at the joints and so that inverts present a smooth surface. Pipe and fittings which do not fit together to form a tight fitting joint are not permitted.
- C. All HDPE joints shall be welded.
- D. Pipes shall be installed in the locations and to the required lines and grades as shown on the Construction Drawings and provided in these Specifications, using an approved method of control. The OWNER has the authority to order the removal or relaying of all pipe laid contrary to the specifications, his instructions, or during his absence.
- E. Excavations shall be maintained free of water during the progress of the Work. No pipes shall be laid in water nor shall there be any joints made up in water. All slides or cave-ins of the trenches or cuts shall be remedied to the satisfaction of the OWNER.
- F. Cleanliness of installed pipe and fitting interiors shall be maintained throughout the Work.
- G. All adjustments to the line and grade of pipe shall be done by scraping away or compacted filling of the bedding stone under the barrel of the pipe, and not by blocking or wedging.
- H. Fittings shall be installed as required and in accordance with the Construction Drawings and Specifications. The installation of fittings after the pipeline has been laid will not be permitted without the written approval of the OWNER. In such cases, complete details pertaining to the proposed type of fittings and the installation procedure shall be submitted by the CONTRACTOR to the OWNER for review and approval before such work can be performed.
- I. Approval by the OWNER is required prior to changing the location of any of the Work due to field conditions. Changes in pipe sizes are prohibited without prior written consent from the OWNER.
- J. All installed piping shall form completely connected systems including connections to and appurtenances specified in other sections to result in a satisfactorily operating installation.
- K. All pipe shall be so laid that after the line is completed, the interior surface thereof shall conform accurately to the established grade and alignment. No deflections shall be allowed at joints.
- L. Pipe lengths of at least 20 feet shall be utilized, except that shorter random lengths may be utilized where wyes and tees, and similar circumstances are present, only inasmuch as is necessary to properly effect the joint(s) in the desired location. In all cases, the number of pipe joints shall be minimized. In the case of random lengths of pipe, the CONTRACTOR shall provide proper smooth and square ends prior to assembling.
- M. All pipe ends not terminated by another specific fitting shall be capped with a slip cap. Caps shall not be bonded to the pipe unless otherwise specifically noted on the Construction Drawings.

- N. The Contractor shall perform hydrostatic testing under the observation of the CQA Consultant according to Section 02651 of the Technical Specifications. Any portion of piping failing the pressure test shall be repaired. Damaged pipe shall be removed and replaced when pipe damage cannot be satisfactorily repaired. If the test fails, the failing section shall be located, removed, and rejoined.

3.04 Tracer Wire

- A. Install tracer wire for all non-perforated, non-metallic underground piping installations where indicated on the Contract Drawings and where allowed by code. Use on other perforated pipes (e.g. toe drain) where shown on the Contract Drawings.
- B. Do not install tracer wire on the perforated leachate collection pipes or sideslope risers within the landfill lined area.
- C. Secure wire to top of pipe at maximum 8-foot intervals using plastic tape or cable ties. Run wire to the side of fittings and valves where required.
- D. Provide terminal access to each end of tracer wire at convenient locations (e.g. cleanouts, pump vaults, etc.).
- E. After installation of pipe with tracer wire, verify the electrical continuity of the installed wire run.

END OF SECTION

SECTION 02651

HDPE PIPE & MANHOLE LEAK TESTING

PART 1 - GENERAL

1.01 Scope of Work

- A. CONTRACTOR shall furnish all labor, material, equipment, tools, and appurtenances required to setup and pressure test non-perforated HDPE pipe.
- B. CONTRACTOR shall conduct all pressure testing using water as the testing method. The piping manufacturer and the ENGINEER shall be consulted before using pressure testing methods other than those presented here. Other pressure testing procedures may or may not be applicable, depending upon piping products and/or piping applications.
- C. CONTRACTOR shall comply with all applicable codes, ordinances, rules, regulations and laws of local, municipal, State, or Federal authorities having jurisdiction. CONTRACTOR shall also comply with all applicable health and safety regulations as required by OSHA and in accordance with the CONTRACTOR's Health and Safety Plan.
- D. CONTRACTOR shall conduct all tests in a manner to minimize as much as possible any interference with the day-to-day operations of existing facilities or other contractors working on site.

1.02 Related Sections

- A. Section 01564 - Project Record Documents
- B. Section 02607 – Manholes
- C. Section 02650 - Leachate Collection and Conveyance Pipe

1.03 Submittals

A. Testing Report

Prior to placing the leachate conveyance system into service, submit for review and approval a detailed report summarizing the leakage test data, describing the test procedure and showing the calculations on which the leakage test data is based. The report shall include, at a minimum, the following information:

- (1) The length and diameter of the section of line tested.
- (2) A complete description of test procedures and methods, including:
 - a. Trench backfilling and pipe cleaning status
 - b. Types of plugs used and where
 - c. Stabilization time period and water pressure
 - d. The allowed time by specifications
 - e. The actual test time
 - f. The water pressure at the beginning and end of the test.
- (3) The name of the inspector / tester and the date and time of all testing, including any retesting
- (4) A description of any repairs made.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.01 Leakage Testing for Pipes

A. General

All new non-perforated leachate conveyance pipe installed shall be tested for leakage. The test used will be **hydrostatic** testing. Pressure testing with air is not allowed. Testing to be performed will be indicated by the ENGINEER and witnessed by the ENGINEER and the OWNER's representative.

B. Flushing

All pipe shall be flushed to remove all sand and other foreign matter. The velocity of the flushing water shall be at least 4 fps. Flushing shall be terminated at the direction of the ENGINEER. Dispose of the flushing water in accordance with the project permits.

C. Test Preparation and Inspection

- (1) Perform hydrostatic testing of the system as set forth in the following, and perform such testing in the presence of the ENGINEER and the OWNER's representative. Give 48 hours notice of planned testing.
- (2) Piping and appurtenances to be tested shall be sections of at least 250 feet in length, unless unavoidable. All piping shall be thoroughly cleaned and flushed prior to testing to clear the lines of foreign matter. While the piping is being filled with water, care shall be exercised to permit the escape of air from the extremities of the test section, with additional release cocks (provided by the CONTRACTOR) if required. Venting may be provided by loosening flanges. Re-tighten any loosened flanges before applying test pressure.
- (3) Test equipment and the pipeline should be examined before pressure is applied to ensure that connections are tight, necessary restraints are in place and secure, and components that should be isolated or disconnected are isolated or disconnected. All low pressure filling lines and other items not subject to the test pressure should be disconnected or isolated.
- (4) If a lower pressure rated component the system cannot be removed or isolated, then the maximum allowable test pressure is the allowable pressure of the component.

D. Monitored Make-Up Water Test

- (1) The test procedure consists of initial expansion and test phases. During the initial expansion phase, the test section is pressurized to the test pressure, and sufficient make-up water is added each hour for three (3) hours to return to test pressure.
- (2) After the initial expansion phase, the test phase begins. The test phase may be one (1), two (2), or three (3) hours, after which a measured amount of water is added to return to test pressure. If the amount of water does not exceed the amount shown in Table 1, leakage is not indicated.
- (3) The testing procedure shall consist of the continued application of the specified pressure to the test system for the duration of the test period, by way of a pump taking supply from a container suitable for measuring water loss. The amount of loss shall be determined by measuring the volume of water taken from said container.

- (4) Hydrostatic testing shall be performed with a sustained pressure after the expansion phase for a minimum of one (1) hour at 1-1/2 times the working pressure of the pipe, unless otherwise approved by the OWNER. The allowable leakage shall be less than the number of gallons per hour determined from the following table:

Table 1 - Test Phase Make-Up Amount

Nominal Pipe Size, in.	Make-Up Water Allowance (U.S. Gallons per 100 ft of Pipe)		
	1 Hour Test	2 Hour Test	3 Hour Test
2	0.07	0.11	0.19
3	0.10	0.18	0.29
4	0.13	0.25	0.4
6	0.3	0.6	0.9
8	0.5	1.0	1.5
10	0.8	1.3	2.1
12	1.1	2.3	3.4
14	1.4	2.8	4.2
16	1.7	3.3	5.0
18	2.0	4.3	6.5

- (5) The testing duration, including initial pressurization, initial expansion and time at test pressure must not exceed eight (8) hours. If the pressure test is not completed due to leakage, equipment failure, etc. the test section shall be depressurized and allowed to "relax" for eight (8) hours before bringing the test section up to test pressure again.

3.01 Leakage Testing for HDPE Structures

- (a) Perform leakage testing for vaults, wet wells and manholes prior to backfilling by filling the structure with water to the overflow level and observing the water level for the following 24 hours.
- (b) Make an inspection for leakage of the exterior surface of the structure, especially in areas around construction joints.
- (c) Leakage will be accepted as within allowable limits for structures from which there are no visible leaks and the leakage rate does not exceed 0.1 gallon per foot of diameter per foot of depth per hour. Method for testing leakage shall be submitted to the ENGINEER prior to testing.
- (d) If visible leaks appear, repair the structure by removing and replacing the leaking portions of the structure, waterproofing the inside, or by other methods approved.
- (e) Water for testing will be provided by the CONTRACTOR
- (f) Owner's Representative must be given 24 hours notice prior to test and must witness all tests.
- (g) Submit a report describing the manhole description, duration of test, results of testing, and any repairs made.

END OF SECTION

SECTION 02936

SEEDING

PART 1 - GENERAL

1.01 Description

- A. Supply all material, labor, equipment required for soil preparations and placement of seeding in location as directed by the OWNER or as shown on the plans. This work shall include maintenance of established vegetation until final acceptance. The CONTRACTOR shall be expected to provide and place all topsoil necessary to complete the work.
- B. Apply lime, fertilizer, seed and mulch to all areas disturbed by the work not receiving a specific surfacing.

1.02 Requirements of Regulatory Agencies

Pesticides, herbicides and fungicides shall be used in accordance with the specifications of the prevailing Public Health Authority or Agricultural Extension Service.

1.03 Related Work

- A. Section 01540 – Dust Control
- B. Section 02125 - Temporary and Permanent Erosion and Sedimentation Control
- C. Section 02235 - Vegetative Layer

1.04 Submittals

- A. Submit full and complete information on topsoil sampling and fertility testing results prior to amending topsoil with lime and fertilizer.
- B. Submit to the Owner's Representative affidavits certifying that seed comply with the specifications.
- C. If used, submit Flexible Growth Medium (FGM) or hydroseed procedure and application rates for approval by Owner's Representative.
- D. Submit full and complete written maintenance instructions for proper care and development of seeded areas to OWNER prior to substantial completion.
- E. Submit material certification for seed mulch to the Owner's Representative.

1.05 Product Handling

Deliver seed, lime and fertilizer in new, clean, sealed containers.

1.06 Scheduling

- A. Schedule planting of seeding areas for optimum germination as follows:
 - (1) Spring planting schedule is March 15th to June 15th
 - (2) Fall planting schedule is August 15th to October 15th
- B. Seeding dates other than listed above are to be approved by the OWNER.

PART 2 - PRODUCTS

2.01 Fertilizer

The fertilizer shall consist of 12-12-12 commercial grade fertilizer, unless otherwise needed based on fertility test of soil.

2.02 Seed

A. Seed shall be brought on site unmixed unless the mixture is certified and stated on the package as to the quality and mixture. Mixing shall be done at the project site from the original unopened packages. Unless otherwise indicated from soil-specific analysis, seed mixtures and application rates shall be as follows:

<u>Common Name</u>	<u>Total Lbs per Acre</u>
Kentucky 31 Fescue	128 lbs
Red Top Grass	2 lbs
Season Nurse Crop *	20 lbs

* Use seasonal nurse crop in accordance with seeding dates as stated below:

February through April	Annual Rye
May 1 st through August	Foxtail Millet
September through November 15 th	Annual Rye
November 16 th through January	Winter Rye

Weeping Lovegrass may be added to the seeding mix during the warmer seeding periods; add 10-20 lbs./acre in mixes.

B. Labels and contents shall conform to all State and Federal regulations.

2.03 Agricultural Ground Dolomitic Limestone

A. Agricultural ground dolomitic limestone shall conform to the standards of the Association of Official Agricultural Chemists, and must comply with all existing State and Federal regulations.

B. The material must comply with the following gradation:

<u>Square Mesh Sieves</u>	<u>Percent Passing by Weight</u>
Pass # 10	100
Pass # 20	90
Pass #100	40

C. The minimum calcium carbonate equivalent shall be 90.

D. The OWNER reserves the right to draw such samples and perform such tests as he deems necessary to assure that these Specifications are met.

2.04 Seed Mulch

A. Provide erosion control or hydromulch as required in areas to be seeded.

B. Seeding mulch shall be wood fiber, straw or non-woven fibers free from weeds and coarse matter.

PART 3 - EXECUTION

3.01 General

Construction methods shall be those established as agronomically acceptable and feasible and which are approved by the OWNER.

3.02 Seed Bed Preparation

- A. The areas shall be made friable and receptive to seeding by approved methods, which will not disrupt the line and grade of the slope surface. In no event will seeding be permitted on hard or crusted soil surface.
- B. Fine grade areas to a firm even surface, free from lumps or stones 1 inch or more in any dimension. Installation of grass areas may be done immediately after finish grading provided the seeding bed is in a good condition and not muddy or hard. If it is hard, till to a friable condition again.

3.03 Seeding Operations

- A. Seed areas within the areas disturbed by CONTRACTOR as directed by the OWNER and Contract Drawings. After cleaning the seeding area of coarse material, maintain finish grades as shown on the Contract Drawings and spread fertilizer and lime uniformly over the areas using an approved mechanical spreader. The rate of application of fertilizer shall be commercial fertilizer as required to provide 1 lb. of nitrogen per 1,000 square feet or as indicated by soil test results.
- B. The lime application rate will be based on fertility test results and will be broadcasted prior to harrowing and raking of topsoil prior to fertilizing to achieve a minimum soil pH of 6.5. The maximum application rate allowed is 100 lbs per 1,000 square feet.
- C. Do not undertake seeding in windy or unfavorable weather or when the ground is too wet to rake easily, frozen, or too dry. Uniformly sow seed at a rate specified, using drills or seeders or hydroseeding. If hydroseeded, add 10 percent to seeding mixture requirement.
- D. Drill in the specified seed mixture uniformly at the rate specified, using a press drill equipped with individually mounted, adjustable spring load, double disk furrow openers fitted with depth control banks or drums. Make two passes at right angles to one another.

3.04 Replanting

- A. The CONTRACTOR shall be required to replant areas damaged by water, wind, fire, equipment or pedestrian traffic as necessary or when ordered by the OWNER at no cost to the OWNER.
- B. All areas and spots that do not show a prompt catch of vegetation shall be reseeded at fifteen day intervals until a growth of grass is established. Contractor shall reseed as required to establish a minimum of 95% vegetation coverage within 1 year of initial planting. Remedial seeding, fertilizer and lime will be applied at no additional cost to the OWNER.

3.05 Compaction

The CONTRACTOR shall keep all equipment and vehicular and pedestrian traffic off areas that have been seeded to prevent excessive compaction and damage to young plants. Where such compaction has occurred, the CONTRACTOR shall rework the soil to make a suitable seedbed; then reseed and reblanket such areas with the full amounts of the specified materials, at no extra expense to the OWNER.

3.06 Mulching

- A. If seeding is done with hydromulching, then seeding mixture shall be increased 10 percent.

- B. Hydromulching of seeding areas shall have approved mulch applied at a rate as recommended by the manufacturer for tacking agent.
- C. Other methods of mulching shall not be applied prior to approval by the ENGINEER.

3.07 Maintenance of Grass Areas

- A. Water and reseed throughout the construction contract and/or acceptance by the OWNER after seeding areas are substantially established turf areas.
- B. Install and maintain temporary protection fences, barriers, and signs where deemed necessary.

END OF SECTION

SECTION 03100

CONCRETE FORMWORK

PART 1 - GENERAL

1.01 Description of Work

- A. The CONTRACTOR shall furnish and install concrete formwork as required to form reinforced concrete as shown and indicated on the Contract Drawings, as specified herein, or as otherwise required to complete the Work.
- B. The CONTRACTOR shall comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, and/or Commonwealth authorities having jurisdiction.

1.02 Related Sections

- A. 01050 – Field Engineering/Surveying
- B. 03200 - Concrete Reinforcement
- C. 03300 - Concrete

1.03 Related References

The latest edition of the publications listed below are included as a part of these Specifications.

- A. ACI 318 Building Code Requirements for Reinforced Concrete
- B. ACI 347 Recommended Practice for Concrete Formwork
- C. PS 1 US Department of Commerce Product Standard (PS)
Construction and Industrial Plywood

1.04 Form Design

- A. The design of forms and their performance, as required by this Section, is the CONTRACTOR's responsibility. Formwork shall comply with ANSI A10.9 and OSHA Construction Standards, Part 1926, Subpart Q, Concrete, Concrete Forms, and Shoring.

PART 2 - PRODUCTS

2.01 Form Materials

- A. Formwork for all concrete, unless otherwise specified, shall not be less than 5/8-inch, 5-ply Douglas fir plywood of exterior structural grade especially processed to resist moisture and conforming to PS 1, B-B Concrete Form Panels. Patented forms may be used, subject to approval by the ENGINEER, provided they are in new, or like-new condition so as to produce a smooth, even surface free from blemishes, defects, and depressions; this approval is for the finish these forms will leave on the contact surfaces and will not relieve the CONTRACTOR of the responsibility for the design and structural soundness of the forms.

2.02 Accessories

- A. Form tie assemblies shall be form clamps with smooth tie rods, with a waterstop at the center, permitting tightening of the forms and be of such type as to leave no metal or other material within 1-1/2-inch of the surface after use. The assembly should provide cone-shaped depressions in the cast surface at least 1-inch in diameter and 1-1/2-inch deep to allow filling and patching.

- B. Form releasing agent shall be a non-staining form coating compound such as "Cast-Off" by Sonneborn Products Division (Contech, Inc.), or an equal product as approved by the ENGINEER.

PART 3 - EXECUTION

3.01 Form Construction

- A. Formwork shall be in accordance with ACI 347 and as follows:
- (1) Forms shall conform to shape, lines and dimensions of members required and shall be sufficiently rigid and tight to prevent leakage of the cement binder. Forms shall be properly braced or tied together so as to maintain position and shape. Construct forms so that they can be removed readily without hammering or prying against the concrete. Forms for exposed concrete shall be carefully made and accurately placed to obtain correct shape and lines.
 - (2) Joints shall be butted tight on solid bearings. Arrangements of panels shall be orderly and symmetrical, and use of small pieces shall be avoided. Forms shall be chamfered for external corners of concrete, including top of walls, which will be exposed in the finished work.
 - (3) The CONTRACTOR shall be fully responsible for the adequacy of formwork in its entirety. Forms shall support the anticipated loading while maintaining their dimensional and surface correctness to produce members with the required geometry.
 - (4) Block-outs for slots, chases, recesses or other openings shall be provided by the CONTRACTOR as needed by the work of this and any other trades.
 - (5) Install all the inserts to be supported by the formwork as required by the work of this and other trades as needed.

3.02 Tolerance for Formed Surfaces

- A. Variation from Plumb: Not more than $\pm 1/4$ inch in any 10 feet of length with a maximum for the entire length of $\pm 1/2$ inch.
- B. Variation from the Level or from the Grades Specified in the Contract Drawings: Not more than $\pm 1/4$ inch in any 10 feet of length with a maximum for the entire length of $\pm 3/4$ inch.
- C. Variation in the Sizes and Location of Openings and Thickness of Walls: $\pm 1/4$ -inch.

3.03 Inspection

- A. CONTRACTOR shall give the ENGINEER at least 48 hours notice before any concrete is to be cast. Concrete shall not be cast until the ENGINEER has observed and given approval of the Work to be cast including, but not limited to, the placement of all the reinforcing, accessories, forms and the surfaces to be cast against. Such observations are in the nature of assisting the CONTRACTOR to minimize errors and in no case will they serve to relieve the CONTRACTOR of the responsibility to provide the materials and workmanship required by the Contract Documents.

3.04 Application of Form Coating

- A. Immediately before the placing of reinforcing, faces of all forms in contact with the concrete shall receive a thorough coating of the liquid form-releasing agent specified, applied in compliance with the Manufacturer's instructions.

3.05 Removal of Forms

- A. The CONTRACTOR shall assume full responsibility for removal of formwork and forms shall be removed in such a manner as to insure complete integrity and safety of the structure. Forms and shoring for mass concrete, walls, columns, and beams shall remain in place a minimum period of 7 days after casting the concrete. Forms for slabs shall remain in-place a minimum of 24 hours after casting.

- B. Wood forms shall be completely removed from all concrete cast to avoid termite infestation.

3.06 Surveying

- A. Prior to pouring concrete, accurately survey and measure the size and location of all structures to be placed in the concrete. Survey and record measurements in accordance with Section 01050 of these Specifications.
- B. Provide drawings showing surveyed measurements, dimensions, and locations necessary to locate accurately anchors, pipes, tanks, conduit, and other structures buried in or below concrete.

END OF SECTION

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 Description of Work

- A. CONTRACTOR shall furnish and install the concrete reinforcement as shown and indicated on the Drawings, as required by these Specifications, and as specified in this Section.
- B. CONTRACTOR shall comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, state or federal authorities having jurisdiction.

1.02 Related Sections

- A. Cast-In-Place Concrete – Section 03300

1.03 Referenced Publications

The latest edition of the publications listed below are included as part of these Specifications.

- A. ACI 318 Building Code Requirements for Reinforced Concrete
- B. ACI 315 Manual of Standard Practice for Detailing Reinforced Concrete Structures
- C. ASTM A82 Specification for Cold Drawn Steel Wire for Concrete Reinforcement
- D. ASTM A185 Specification for Welded Steel Wire Fabric for Concrete Reinforcement
- E. ASTM A1064 Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed for Concrete
- F. ASTM A615 Specification for Deformed and Billet-Steel Bars for Concrete Reinforcement
- G. AASHTO-M284 – Epoxy Coating

1.04 Submittals

- A. Shop Drawings to be submitted with the CONTRACTOR's Detailed Design submittal. Shop drawings shall show the required bar sizes, spacing, and splice length for all reinforcement; reinforcement placing plans; and, bending details and complete bar lists. Shop drawings will not be reviewed without such information. Wall reinforcing shall be shown in elevation. Location and arrangement of accessories shall be clearly indicated. Placing drawings, detail drawings and bar lists shall be checked by the fabricator and the CONTRACTOR before being submitted to the OWNER for review.
- B. Mill tests of reinforcing steel shall be submitted prior to use for each 15 tons or less shipped to the Site. Tests shall be conducted in conformance with ASTM A615, and methods prescribed therein.
 - (1) Cost of tests shall be borne by the CONTRACTOR.
 - (2) Three copies of each test report stating whether the material meets the requirements of the ASTM specifications shall be submitted to the ENGINEER.
 - (3) Certified copies of the mill tests may be considered evidence of compliance provided such tests are regularly conducted by the reinforcement supplier by experienced,

competent personnel using appropriate testing equipment. In case of doubt as to the adequacy or accuracy of the mill tests, the ENGINEER may require the CONTRACTOR to furnish, at no additional cost to the RESPONDENTS, test results from an independent testing laboratory acceptable to the ENGINEER on mill samples or delivered steel reinforcement.

PART 2 - PRODUCTS

2.01 Reinforcing Bars

- A. Bar reinforcement shall be deformed-type bars conforming to ASTM A615. Reinforcement shall be manufactured from new billet steel of American manufacture, Grade 60, yield strength 60,000 psi minimum.

2.02 Welded Wire Fabric

- A. Welded wire fabric shall be in flat sheets conforming to ASTM A185 (A497), with wire conforming to ASTM A82 (A496).

2.03 Accessories

- A. All chairs and bolsters shall have plastic-covered or galvanized steel legs.
- B. For slabs on grade, all reinforcing shall be supported on continuous chairs and/or bolsters as required to properly support the reinforcing steel. The chairs and/or bolsters shall be supported on precast concrete pads bearing on the subgrade. The concrete pads shall be at least 6-inch x 6-inch and no more than 1-inch thick. Pads shall be cast from Class "A" concrete or from mortar made up of one part cement and two parts sand, with tie wires embedded.

PART 3 - EXECUTION

3.01 Storage of Materials

- A. Reinforcing steel delivered to the Site shall be stored on clean well draining flat surface. All reinforcing steel shall be stored in bundles with tags. Reinforcing steel shall not be exposed to the elements.

3.02 Inspection of Steel Placement

- A. CONTRACTOR shall give the OWNER at least 48 hours notice before any concrete is to be cast. Concrete shall not be cast until the ENGINEER has observed and given approval of the work to be cast including, but not limited to, the placement of all the reinforcing, accessories, forms and the surfaces to be cast against. Such observations are in the nature of assisting the CONTRACTOR to minimize errors and in no case will they serve to relieve the CONTRACTOR of the responsibility to provide the materials and workmanship required by the Contract Documents.

3.03 Tolerances

- A. Allowable tolerances for fabricating steel reinforcement shall be as follows:

Item	Maximum Tolerance
Sheared length of bars	± 1-inch
Location of bends	± 1-inch

- B. Allowable tolerances for placing steel reinforcement shall be as follows:

Item	Maximum Tolerance
Concrete cover from outside of bar to finished surface	+ 1/4-inch
Lateral spacing of bars in plane of reinforcement in slabs and walls	± 1-inch
Height of bottom bars in slabs	± 1/4-inch
Height of top bars in slabs	± 1/4-inch

3.04 Shop Fabrication

- A. Reinforcing steel shall be fabricated to required shapes and dimensions in compliance with applicable provisions of ACI 315 and ACI 318.
- B. Bars shall be bent cold. Bars shall be prefabricated to detail and delivered to the site plainly tagged and ready to set.

3.05 Epoxy Coating

- A. Reinforcing bars shall be coated after fabrication is complete.
- B. Epoxy coating shall be satisfactory repaired by wire brush cleaning and painting with an approved epoxy paint provided by the bar coater, using the manufacturers approved procedure.
- C. Bars with more than 5% of the coating damage shall be replaced.
- D. Bars shall be fastened by the use of epoxy coated wire only.

3.06 Field Fabrication

- A. Field fabrication of reinforcing steel will not be permitted without the approval of the ENGINEER.
- B. Field cutting of reinforcing steel shall be performed by shearing or abrasive cutting wheel. Cutting by flame is prohibited.
- C. Damaged epoxy coating shall be removed and coating repaired

3.07 Placement and Anchorage

- A. Space metal chairs, bolsters, spacers and hangers in accordance with ACI 315.
- B. Reinforcement, at the time concrete is placed, shall be free from any abrasions or damage to the epoxy coating. Repairs shall be made immediately upon discovery.
- C. Reinforcement shall be accurately placed in accordance with the shop drawings and shall be adequately secured in position with not less than 16-gauge annealed wire or suitable clips at no less than 50% of the bar intersections. Reinforcement shall be held securely at the required distance from the forms. Nails shall not be driven into outside forms to support reinforcement.
- D. Install welded wire fabric reinforcement for concrete sidewalks, equipment pads, and as otherwise indicated. Lap all joints 6-inches and wire securely. Extend mesh to within 2-inches of sides and ends of slabs. Unless otherwise specified, place welded wire fabric between the upper third-point and the mid-point of the slab. Sheets that do not lay flat when in their intended position will be rejected. Tags designating the wire size and spacing

shall be left on each sheet until ready for use. Tuck ends of welded mesh well down into edge of beams or walls. Do not leave unreinforced border strips. Welded wire fabric shall not contain loose rust.

3.08 Concrete Cover

- A. Metal reinforcement shall be protected by concrete cover in accordance with ACI 318.

3.09 Splicing

- A. Splices shall be Class "B" splice minimum. The location and type of splices desired by the CONTRACTOR must be specifically requested and must meet the approval of the OWNER before they can be used.
- B. Splices shall not be made at point of maximum stress and shall provide sufficient lap to transfer stress between bars by bond.
- C. Splices in top reinforcement shall be made as shown of the reinforcement drawing and approved by the OWNER.
- D. Mechanical splices may be used instead of lap splices provided that their location and type meets with the approval of the OWNER.
- E. Splice locations shall be staggered with adjacent bars and bar bundles.

END OF SECTION

SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 Description of Work

Furnish and install miscellaneous cast-in-place concrete as shown and indicated on the Contract Drawings and as specified in this Section. This specification does not include structural concrete as in bridge or roadway uses.

1.02 Related References

A. The latest edition of the publications listed below form a part of these Specifications:

- (1) American Concrete Institute (ACI) Publications
 - 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
 - 301 Specifications for Structural Concrete for Buildings
 - 302.1R Guide for Concrete Floor and Slab Construction
 - 304 Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete
 - 305R Hot Weather Concreting
 - 306R Cold Weather Concreting
 - 318 Building Code Requirements for Reinforced Concrete
- (2) U.S. Army Corps of Engineers (COE) Waterways Experiment Station Publication CRD-C-621: Handbook for Concrete and Cement, Specifications for Non-shrink Grout, Volume II
- (3) American Association of State Highway and Transportation Officials (AASHTO) Publication M 182 Burlap Cloth Made From Jute or Kenaf
- (4) American Society for Testing and Materials (ASTM) Publications
 - C 31 Making and Curing Concrete Test Specimens in the Field
 - C 33 Concrete Aggregates
 - C 39 Compressive Strength of Cylindrical Concrete Specimens
 - C 94 Ready-Mixed Concrete
 - C 143 Slump of Portland Cement Concrete
 - C 150 Portland Cement
 - C 171 Sheet Materials for Curing Concrete
 - C 172 Sampling Freshly Mixed Concrete

C 173	Air Content of Freshly Mixed Concrete by the Volumetric Method
C 231	Air Content of Freshly Mixed Concrete by the Pressure Method
C 260	Air-Entraining Admixtures for Concrete
C 309	Liquid Membrane-Forming Compounds for Curing Concrete
C 494	Chemical Admixtures for Concrete
C 595	Blended Hydraulic Cements
C 618	Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
C 881	Epoxy-Resin-Base Bonding Systems for Concrete

1.03 Action Submittals

- A. Product Data: For each type of product.
- B. Mix Designs: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Construction Joint Layout: Indicate proposed construction joints required to construct the structure. Location of the construction joints is subject to the approval of the OWNER.

1.04 Informational Submittals

- A. Material Certificates: For each of the following, signed by manufacturers:
 - 2. Cementitious materials.
 - 3. Admixtures.
 - 4. Form materials and form-release agents.
 - 5. Steel reinforcement and accessories.
 - 6. Waterstops.
 - 7. Curing compounds.
 - 8. Bonding agents.
 - 9. Adhesives.
 - 10. Semirigid joint filler.
 - 11. Joint-filler strips.
 - 12. Repair materials.
- B. Material Test Reports: For the following, from a qualified testing agency:
 - 1. Aggregates
- C. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer, detailing fabrication, assembly, and support of formwork.
 - 1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.

PART 2 - PRODUCTS

2.01 Cement

Cement shall be standard Portland cement of American manufacture, conforming to ASTM C-150, Type I. Only one brand of commercial Portland cement shall be used in the exposed concrete of the structure. Cement reclaimed by cleaning bags or from leaking containers shall not be used.

2.02 Concrete Aggregates

- A. Fine aggregate shall be sand having clean, hard, durable, uncoated grains and free from deleterious substances and shall conform to ASTM C-33.
- B. Coarse aggregate shall be crushed stone having clean, hard, durable, uncoated particles conforming to ASTM C-33.

2.03 Water

Water used in mixing concrete shall be clean, potable and free from deleterious amounts of acids, alkalis or organic materials.

2.04 Waterstops

Where shown on the Contract Drawings in expansion joints and construction joints, waterstops shall be polyvinyl chloride (PVC) and shall incorporate a galvanized steel wire along both edges which shall be used to secure the waterstop in position, by tying to reinforcement, during concrete placement. The waterstop shall be of the size noted on the Contract Drawings. The waterstop shall be equal to Wirestop CR-9380 or Burke. The waterstop shall extend the entire length of the joint and all splices shall be heat welded and tested in accordance with the manufacturer's instructions.

2.05 Non-Shrink Grout

Non-shrink grout shall be a ready-to-use non-metallic aggregate product requiring only the addition of water at the jobsite, and shall conform to COE CRD-C-621.

2.06 Fly Ash

All concrete that contains fly ash must be properly cured and must attain 4,000 psi minimum strength (verified by testing) prior to allowing water to come in contact with the concrete.

2.07 Admixtures

- A. Water reducing admixture shall conform to ASTM C-494, Type A.
- B. Water reducing, retarding admixture shall conform to ASTM C-494, Type D.
- C. Non-Corrosive, Non-Chloride Accelerator: The admixture shall conform to ASTM C-494, Type C.
- D. Air entraining admixture shall conform to ASTM C-260.
- E. High range water reducer (HRWR) shall conform to ASTM C494, Type F or G.
- F. Calcium Chloride: Calcium chloride or admixtures containing more than 0.1 percent chloride ions are not permitted.

2.08 Curing and Sealing Compounds

- A. Curing compound shall be acrylic based, conforming to ASTM C-309.
- B. Sealing-hardener compound shall conform to ASTM C-309.

2.09 Bonding Compounds

Bonding Compound shall conform to ASTM 881.

PART 3 - EXECUTION

3.01 Concrete Quality

All mix designs shall be proportioned in accordance with ACI 211.1. The proportioning shall be based on the requirements of a well-graded high density plastic and workable mix within the slump range and strengths required. The following class of concrete is required:

<u>Class of Concrete</u>	<u>Compressive Strength @ 28 Days</u>	<u>Slump Range</u>	<u>Max Aggregate Size</u>
VDOT A4	4000 psi	2 – 4 inches	1 inch

- A. Air Content: All concrete shall have an air content of 6½ percent, +/- 1½ percent.
- B. Water-Cement Ratio: All concrete shall have a maximum water-cement ratio of 0.45.
- C. Admixture Usage: All concrete shall contain a water reducing admixture or water reducing-retarding admixture, and an air entraining agent. All concrete placed at air temperatures below 50 degrees F shall contain the specified non-corrosive non-chloride accelerator.

3.02 Mix Designs

- A. The testing laboratory shall be paid for by the CONTRACTOR.
- B. The CONTRACTOR shall submit samples, in adequate quantities for each mix design and verification, of all concrete materials to be used on the project to the designated testing laboratory. The CONTRACTOR shall not use any concrete in this work without acceptance and verification of design mix by the testing laboratory and the approval of the OWNER.
- C. The testing laboratory shall make strength tests from trial batches in the laboratory using materials and mix designs proposed for use by the CONTRACTOR. The testing laboratory shall prepare trial batches in accordance with ACI 211.1.
- D. The proposed mix design and supporting data must be submitted, in triplicate, to the testing laboratory for their review and comments at least 21 days prior to the expected start of concreting operations. Within 10 days of receiving this information, the testing laboratory will forward two copies of the submittal to the OWNER with their comments. The OWNER will review the submittal and return one copy to the CONTRACTOR with the OWNER's comments.
- E. Compression test specimens made to verify the mixes shall be made in accordance with ASTM C-192. Aggregates shall be tested in accordance with ASTM C-33. All compression test specimens shall be tested in accordance with ASTM C-39.

3.03 Plant Mixing

- A. Proportioning Concrete
 - (1) Proportions shall be in compliance with approved design mix for each class of concrete.
 - (2) The mixing plant shall be provided with adequate equipment and facilities for accurate measurement and control of the quantities of material and water used in the concrete.
 - (3) Concrete materials shall be measured by weight except that admixtures shall be measured by volume.
- B. Batching
 - (1) The CONTRACTOR shall provide all necessary equipment to accurately determine and control actual amount of materials entering into the concrete mix. Individual ingredients

shall be weighed separately for each batch. Accumulative weighing will be allowed if equipment is in working order as determined by the testing laboratory and approved by the OWNER. Accuracy of all weighing devices shall be such that successive quantities can be measured to within one percent of the desired amount.

- (2) Completely discharge contents of the mixer before each new batch is loaded. Use of retempered concrete is not permitted.
- (3) Ready-mixed concrete shall be mixed and delivered in accordance with requirements of ASTM C-94 and to the following:
 - a. A separate water metering device (not truck tank) shall be used for measuring water added to the original batch.
 - b. Use of wash water as a portion of the mixing water is not permitted. Wash water added to empty drums after discharging shall be dumped before a new batch is received.
 - c. Centrally mixed concrete shall be mixed for the length of time specified herein, not "shrink-mixed".
 - d. Mixing drums shall be watertight.
 - e. Concrete shall be discharged within one and a half hours from the time concrete was mixed, if centrally mixed, or from time the original water was added, if transit-mixed.
 - f. Furnish delivery ticket with each load of concrete delivered under these Specifications. Delivery ticket shall show clearly the class and strength of concrete, size of coarse aggregate, water per cubic yard, the slump ordered, quantities of all admixtures, and the date and time of departure from the batching plant.

3.04 Conveying Equipment

- A. If concrete is to be transported in carts or buggies, the carts or buggies shall be equipped with pneumatic tires.
- B. Equipment for chuting or other methods of conveying concrete shall be of such size and design as to insure a practically continuous flow of concrete at delivery without segregation of materials.

3.05 Conveying

- A. Concrete shall be conveyed from mixer to place of final deposit by methods which will prevent separation or loss of the material.
- B. Runway supports shall not bear upon reinforcing steel or fresh concrete.
- C. All conveying equipment shall be thoroughly cleaned before each run of concrete is begun.

3.06 Delivery and Protection of Materials

Deliver ready-mixed concrete in compliance with requirements set forth in ASTM C-94.

3.07 Severe-Weather Provisions

A. Hot-Weather Concreting

- (1) Provide adequate methods of lowering temperature of concrete ingredients so that the temperature of concrete when placed does not exceed 90 degrees F.

- (2) When the weather is such as to raise concrete temperature, as placed, consistently above 90 degrees F, Pozzoloth retarder shall be used.
- (3) Subgrade and forms shall be wetted with water before placing of concrete. All excess water shall be removed before concrete is placed.
- (4) Curing shall start as soon as practicable to prevent evaporation of water. Flat work shall be protected from dry winds, direct sun and high temperatures.

B. Cold-Weather Concreting

- (1) Provide adequate equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather. No frozen materials, or materials containing ice, shall be used.
- (2) All concrete materials and all reinforcement, forms, fillers and ground with which concrete is to come into contact shall be free from frost.
- (3) Whenever the temperature of the surrounding air is below 40 degrees F and falling, all concrete placed in the forms shall have a temperature of between 70 and 80 degrees F, and adequate means shall be provided for maintaining a temperature of not less than 70 degrees F for three days, or 50 degrees F for five days, or for as much more time as is necessary to insure proper curing of the concrete. If high early strength concrete is used, the requirement for maintenance of 50 degrees F can be reduced to three days.
- (4) Use only the specified non-chloride accelerator. Calcium chloride or admixtures containing more than 0.1 percent chloride ions are not permitted.
- (5) Housing, covering or other protection used in connection with curing shall remain in place and intact at least 24 hours after the artificial heat is discontinued.

3.08 Construction Joints and Expansion Joints

Construction Joints: Early in the construction program, the CONTRACTOR shall review with the OWNER any construction joints proposed for use which are not indicated on the Contract Drawings. The CONTRACTOR shall not use any construction joints which are not approved by the OWNER. In all cases, construction joints shall occur at sections of minimum shear. Where construction joint is to be made, surface of the concrete shall be roughened (construction joints detailed with key ways in slabs and walls, are not required to be roughened) and thoroughly cleaned of foreign matter and laitance. In addition to the foregoing, joints shall be dampened with water and the specified bonding compound applied, or a slush coat of neat cement grout shall be applied. Additional construction joints that are requested by the CONTRACTOR and approved by the OWNER shall be of the type shown and/or noted on the Contract Drawings for the specific element(s) being considered (i.e., wall slabs, etc.).

3.09 Waterstops

Waterstops shall be installed as indicated and noted on Contract Drawings.

3.10 Inspection of Work Before Placing

- A. The CONTRACTOR shall inspect the forms to receive concrete for any deficiencies which would prevent proper placing of concrete. Do not proceed with placing concrete until such deficiencies are corrected.
- B. Give the OWNER at least 48 hours notice before any concrete is to be cast. Concrete shall not be cast until the OWNER has observed and given approval of the work to be cast including, but not limited to, the placement of all the reinforcing, accessories, forms and the surfaces to be cast against. Such observations are in the nature of assisting the CONTRACTOR to

minimize errors and in no case will they serve to relieve the CONTRACTOR of the responsibility to provide the materials and workmanship required by the Contract Documents.

- C. Do not place concrete on earth until the fill or excavation has been prepared as set forth under applicable Sections of the Specifications for that work.
- D. The CONTRACTOR shall not place in the concrete any item that is not authorized to be placed by the Contract Drawings and Specifications. The CONTRACTOR shall insert all the items as required by the other trades and properly position and secure them in their intended location. Openings other than those which are facilitated by sleeves shall be properly formed and positioned as required by the other trades.
- E. Do not place concrete in forms until all foreign matter has been removed from forms and the reinforcing steel is in proper condition for placement of concrete.
- F. Remove hardened, or partially hardened, concrete on forms or reinforcement before placing concrete.

3.11 Placing

- A. Deposit concrete as nearly as practicable in its final position to avoid segregation due to rehandling or flowing. Do not deposit concrete on work that has partially hardened or been contaminated by foreign material, and do not use retempered concrete.
- B. Concrete shall be placed to avoid the displacement of reinforcing, and coating or spattering the reinforcing steel. The placing of concrete within form work shall be regulated so that the pressure within form work does not exceed the design pressure. In placing concrete each layer shall be placed following the preceding layer to prevent lines of separation or "cold joints" in the work. After the concrete reaches its initial set, jarring the formwork or placing strain or vibration on the ends of projecting reinforcing bars shall be carefully avoided.
- C. Concrete shall not be dropped more than four feet. For greater distances of drop, concrete shall be handled with metal chutes or tremie pipes.
- D. Once concreting is started, it shall be carried on as a continuous operation until placing of the concrete between construction joints is completed. The top surface will be finished to the required alignment.
- E. Concrete shall be placed in layers not over 12-inches deep and each layer shall be compacted with the aid of mechanical internal-vibrating equipment supplemented by hand spading. Vibrators shall in no case be used to transport concrete. Use of form vibrators will not be permitted. Internal vibrators shall maintain a speed of not less than 5,000 impulses per minute when submerged in the concrete. At least one spare vibrator shall be maintained as a relief. Provide backup power source. Duration of vibrator use shall be limited to that necessary to produce satisfactory consolidation without causing objectionable segregation. Vibrator shall not be lowered into courses that have begun to set. Apply vibrator at uniformly spaced points not further apart than the visible effectiveness of the machine.
- F. Type and use of vibrators shall be in accordance with ACI 301.

3.12 Protection

Protect freshly placed concrete from damage or injury due to water, falling objects, persons or anything that may mar or injure finish surface on concrete. Only light use of any floors shall be permitted for the first seven days after placing of concrete.

3.13 Curing

- A. All Concrete. After placement and finishing, concrete shall be maintained in a moist condition for at least seven successive days during which the temperature of the concrete is 50 degrees

F or above. For temperatures of 50 degrees F and below, curing period shall be 14 successive days.

Concrete shall be kept moist by any one, or combination, of the following methods:

- (1) Ponding or Immersion: Continually immerse the concrete in water throughout the curing period. Lowest temperature water shall not be more than 20 degrees F colder than the temperature of the concrete.
- (2) Fog Spraying or Sprinkling: Provide uniform and continuous application of water throughout the curing period.
- (3) Impervious Sheeting: Wet the entire exposed surface of the concrete thoroughly with a fine spray of water and cover with impervious sheeting throughout the curing period. Lay sheeting directly on the concrete surface and overlap edges 12-inches minimum. Provide sheeting not less than 18-inches wider than the concrete surface to be cured. Secure edges and transverse laps to form closed joints. Repair torn or damaged sheeting or provide new sheeting. Inspect surface of concrete daily for wetness. The surface shall be kept continuously wet during the curing period.

- B. Concrete in Formed Surfaces - Keep forms and exposed surfaces wet with water during the curing period. If forms are removed before the end of the curing period, apply a curing compound within one hour after form removal.

3.14 Patching

- A. Any concrete which is not formed as shown on the Contract Drawings, or for any reason is out of alignment or level or shows a defective surface, or shows defects which reduce the structural adequacy of a member or members, as determined by the QAC, shall be considered as not conforming with these Specifications and shall be removed from the project by the CONTRACTOR at CONTRACTOR's own expense, unless the QAC grants permission to patch the defective area, which shall be done in accordance with the following procedure:

Permission to patch any such area shall not be considered a waiver of the QAC right to require complete removal of the defective work if the patching does not, in the QAC's opinion, satisfactorily restore the quality and appearance of the surface or the structural adequacy of the member or members.

- B. After removing the forms, all concrete surfaces shall be inspected and any joints, voids, stone pockets or defective areas permitted by the QAC to be patched and all tie holes, shall be patched. Defective areas shall be chipped away to a depth not less than 1-inch with the edges perpendicular to the surface. Remove defective areas to sound concrete with clean, square cuts. Dampen concrete surfaces to be in contact with patching concrete and apply the specified bonding compound. Place patching concrete over the bonding compound as specified by the manufacturer. Place, compact and finish to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete. Before patching mix is applied, the prepared surface shall first be approved by the QAC.
- C. Patching concrete mix (or mortar) shall be subject to the approval of the QAC. The patching concrete shall be compacted into place and screeded off so as to leave the patch higher than the surrounding surface. It shall then be left undisturbed for a period of one to two hours to permit initial shrinkage before being finished. The patch shall be finished to match the adjoining surface. All patches shall be cured as specified for the original concrete.
- D. Tie holes left by withdrawal of rods or the holes left by removal of ends of wall ties shall be filled solid with mortar after first being wetted. For holes passing through the wall, a plunger-type grout gun shall be used to force the mortar through the wall starting at the back face. A piece of burlap or canvas shall be held over the hole on the outside and when the hole is filled, the excess mortar shall be struck off with the cloth flush with the surface. Holes not passing through the walls shall be filled with a small tool that will permit packing the hole

solid with mortar. Any excess mortar at the surface of the wall shall be struck off flush with a cloth.

3.15 Finishes on Formed Surfaces

Upon completion of patching, surfaces of concrete shall be finished as follows:

- A. Rubbed stone finish shall be produced by casting concrete against plywood forms and by rubbing the surfaces with carborundum stone and water, after patching of tie holes and depressions, to a true, even and smooth finish of uniform color and texture. No slush coat of cement grout or cement wash will be permitted at any state of the finishing.
- B. Areas to be rubbed shall be finished as soon as forms can be stripped. Strip only those forms on areas which can be finished in the same day as the forms are stripped.
- C. Common finish shall be produced by filling all tie holes, honeycomb and depressions, and knocking off and evening up burrs and form marks. All concrete surfaces not receiving a stone-rubbed or rough finish shall receive a common finish.
- D. Rough finish shall be produced by filling all tie holes and honeycomb and in other respects leaving the surface as formed. All concrete surfaces which will be covered by earth and which will not be visible in the completed structure, shall receive a rough finish.

3.16 Testing Laboratory

- A. The testing laboratory shall be paid by the OWNER. The laboratory shall have access to all places where concrete materials and concretes are manufactured, stored, proportioned, mixed, placed and tested. Duties shall include, but not necessarily be limited to the following:
 - (1) Make, store, transport, cure and test compression specimens made during placing of concrete. Compression test specimens shall be tested in accordance with ASTM C-39. Test reports shall show all pertinent data, such as class of concrete, exact location of pour, air temperature, date of pour, time of pour, truck number for ready-mixed concrete, date on which specimen was broken, age of specimen, compressive strength of specimen, slump test results, and air content of pour from which the specimen was made. One copy each of all tests shall be sent to the CONTRACTOR and two copies each to the QAC.
 - (2) For each class of concrete, take five standard test cylinders from each 100 cubic yards or fraction thereof of concrete placed, not less than five cylinders for each 5,000 square feet of surface area placed in any single day. Two of these cylinders shall be designated for the 28 day test and shall comprise a test under the definition of these Specifications. One cylinder will be broken at seven days and will be used as an aid in determining the early strength of the concrete and the 28 day strength, and two cylinders retained in reserve for later testing if required.
 - (3) Periodically inspect the batching plant and file a report with the OWNER stating whether the supplier's equipment and methods meet the requirements of these Specifications.
- B. Temperature and Placing Record: Temperature record shall be made each day during the concreting operations. Records shall also include location, quantity and starting and finishing time of placement for all concrete work. Copy distribution shall be as specified above for test reports.

3.17 Evaluation of Compression Tests

- A. Evaluation of compression test results shall be as follows:

For each class of concrete, compression-strength tests for laboratory-cured cylinders shall be considered satisfactory if the averages of the results of all sets of three consecutive

compression-strength tests equal or exceed the 28-day design compression-strength specified; and, no individual cylinder strength test falls below the required compression strength by more than 500 psi. Strength tests of specimens cured under field conditions may be required by the QAC to check the adequacy of curing and protecting of the concrete placed. Specimens shall be molded by the field quality-control laboratory at the same time and from the same samples as the laboratory-cured specimens.

- B. Faulty Concrete: Failure to meet any of the specified conditions constitutes faulty concrete. Unless otherwise directed by the QAC, faulty concrete shall be removed and replaced with concrete as specified, at no expense to the QAC.
- C. Additional Testing: If permitted by the QAC, additional testing shall be subject to the approval of the QAC and at no expense to the QAC. Load test, if permitted by the QAC, shall be conducted in accordance with the loading criteria as required by the design of the structure, as determined by the QAC.
- D. Neither the results of laboratory verification tests nor any provision in the Contract Documents shall relieve the CONTRACTOR of the obligation to furnish concrete of the class and strength specified.

3.18 Non-Shrink Grout

All applicable locations noted on the Contract Drawings or in these Specifications shall be grouted with the specified non-shrink, non-metallic grout.

END OF SECTION

SECTION 16050

BASIC ELECTRIC METHODS AND MATERIALS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. CONTRACTOR shall furnish all labor, material, equipment, tools, and appurtenances required to setup and install all electrical components presented on the Drawings, mentioned herein, or both.
- B. CONTRACTOR shall comply with all applicable codes, ordinances, rules, regulations and laws of local, municipal, State or Federal authorities having jurisdiction. CONTRACTOR shall also comply with all applicable health and safety regulations as required by OSHA and in accordance with the CONTRACTOR's Health and Safety Plan and basic electrical requirements specifically applicable to Division 16 – Electrical, in addition to Division 1 - General Requirements.

1.02 RELATED SECTIONS

- D. Section 15250 – Landfill Leachate Pumps

1.03 REGULATORY REQUIREMENTS

- A. Conform to applicable Federal, State, and local Building Codes.
- B. Electrical: Conform to NFPA 70.
- C. Obtain permit, and request inspections for authority having jurisdiction.

1.04 PROJECT/STATE CONDITIONS

- A. Install Work in locations shown on the Contract Drawings, unless prevented by project conditions.

PART 2 - PRODUCTS

- A. Install equipment type as specified on the Contract Drawings, or as provided in the attached wire and cable specification sheet.

PART 3 - EXECUTION

- A. All installations shall be in accordance with manufacturer's instructions and recommendations.

END OF SECTION

SECTION 16054

UNDERGROUND ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Direct-buried conduit, ducts, and duct accessories.
 - 2. Concrete-encased conduit, ducts, and duct accessories.
 - 3. Handholes and boxes.
 - 4. Manholes.

1.3 DEFINITIONS

- A. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 2. Include accessories for manholes, handholes, and boxes.
 - 3. Include warning tape.
- B. Shop Drawings:
 - 1. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:
 - a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
 - b. Include duct entry provisions, including locations and duct sizes.
 - c. Include cover design.
 - d. Include grounding details.
 - e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.5 INFORMATIONAL SUBMITTALS

- A. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
 - 1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
 - 2. Drawings shall be signed and sealed by a qualified professional engineer.

- B. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.
- C. Source quality-control reports.
- D. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

1.7 FIELD CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Owner's written permission.
- B. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR DUCTS AND RACEWAYS

- A. Comply with ANSI C2.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

- A. Underground Plastic Utilities Duct: NEMA TC 2, UL 651, ASTM F 512, Type EPC-80 and Type EPC-40, with matching fittings complying with NEMA TC 3 by same manufacturer as the duct.
- B. Duct Accessories:
 - 1. Warning Tape: Underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."

2.3 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. General Requirements for Handholes and Boxes: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
 - 1. Color: Gray.
 - 2. Configuration: Units shall be designed for flush burial and have integral closed bottom unless otherwise indicated.
 - 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
 - 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 5. Cover Legend: Molded lettering, "ELECTRIC."

6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
 7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 8. Handholes **12 inches wide by 24 inches long** and larger shall have factory-installed inserts for cable racks and pulling-in irons.
- B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

2.4 PRECAST MANHOLES

- A. Comply with ASTM C 858.
- B. Structural Design Loading: Comply with requirements in "Underground Enclosure Application" Article.
- C. Precast Manholes: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.
- D. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks, plus an additional **12 inches** vertically and horizontally to accommodate alignment variations.
1. Windows shall be located no less than **6 inches** from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
 2. Window opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 3. Window openings shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
- E. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
1. Type and size shall match fittings to duct or conduit to be terminated.
 2. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.
- F. Concrete Knockout Panels: **1-1/2 to 2 inches** thick, for future conduit entrance and sleeve for ground rod.
- G. Ground Rod Sleeve: Provide a **3-inch** PVC conduit sleeve in manhole floors **2 inches** from the wall adjacent to, but not underneath, the ducts routed from the facility.
- H. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.5 UTILITY STRUCTURE ACCESSORIES

- A. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, **29 inches**.

- a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
 - 2. Cover Legend: Cast in. Selected to suit system.
 - a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
 - b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.
 - 3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
 - a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C 387, Type M, may be used.
 - b. Seal joints watertight using preformed plastic or rubber conforming to ASTM C 990. Install sealing material according to the sealant manufacturers' printed instructions.
 - B. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.
 - C. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch-diameter eye, and 1-by-4-inch bolt.
 - 1. Working Load Embedded in 6-Inch , 4000-psi Concrete: 13,000-lbf minimum tension.
 - D. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch-diameter eye, rated 2500-lbf minimum tension.
 - E. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch-diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
 - 1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.
 - F. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.
 - 1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.
 - G. Ground Rod Sleeve: 3-inch, PVC conduit sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the ducts routed from the facility.
 - H. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.
- 2.6 SOURCE QUALITY CONTROL
- A. Test and inspect precast concrete utility structures according to ASTM C 1037.
 - B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Tests of materials shall be performed by an independent testing agency.
 - 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

3. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.
- C. Clear and grub vegetation to be removed, and protect vegetation to remain according to Section 02110 - Site Clearing and Grubbing. Remove and Ash-Laden soil according to Section 31100 - Ash-Laden Soil Stripping.

3.2 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less:
 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
 3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10] [Polymer concrete units, SCTE 77, Tier 8 structural load rating.
 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.
 5. Cover design load shall not exceed the design load of the handhole or box.
- B. Manholes: Precast concrete.
 1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
 2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.3 EARTHWORK

- A. Excavation and Backfill: Comply with Section 02200-Earthwork, but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 02936-Seeding.

3.4 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from **1/2-inch** sieve to **No. 4** sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes **1 inch** above finished grade.
- D. Install handholes and boxes with bottom below frost line, 24-inches below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
- F. Field cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- G. For enclosures installed in asphalt and concrete paving and subject to occasional, non-deliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted course aggregate.
 - 1. Concrete: **4000 psi**, 28-day strength, complying with Section 03300 "Cast-in-Place Concrete," with a troweled finish.
 - 2. Dimensions: **10 inches wide by 12 inches deep**.

3.5 GROUNDING

- A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
 - 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum **6-inch**-long mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
 - 3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections.

3.7 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION

SECTION 26052
SUBMERSIBLE EFFLUENT PUMPS

PART 1 - GENERAL

1.01 Description of Work

- A. The CONTRACTOR shall provide all labor, materials, and equipment to install the following to meet the requirements described in 1.01(B):
1. Pump complete with specified accessories.
 2. Control panel, mounting, necessary conduits and controls.
 3. All related electrical works, including wire and conduit, necessary to provide power to the pump control panel.
 4. All related mechanical components, including hose, valves, and fittings necessary to provide a connection from the pump to the leachate force main.
 5. Test and demonstrate operation of system.
 6. Submit operation and maintenance manuals, and warranties
- B. The Submersible Effluent pump system shall consist of pump, hose, controls, valves, fittings, and related electrical and mechanical works necessary to pump leachate from NORTH AND SOUTH TOE DRAINS to the leachate force main. The pumping system shall be of material and construction to be compatible with the material (leachate) to be pumped. This specification and the contract drawings detail the requirements for the construction of the leachate sump pump system. The pump shall be manufactured by **Flygt, Model BS 2660 HT with 175mm impeller**. The contained motor shall be **15 HP, 3 phase, 230 volts, 60 Hz**, pump(s) rated for **70** GPM, at **180** Ft. Total Dynamic Head. **Four (4) pumps** are required.

1.02 Related Documents

- A. Drawings and general provisions of the Contract apply to this Section.

1.03 Related Sections

Section 01564 – Project Record Documents
Section 02607 – Manholes
Section 026054 – Underground Electrical Systems
Section 055000 – Miscellaneous Metals
Section 16050 - Basic Electric Materials and Methods

1.04 Qualifications

All pump manufacturers must be pre-qualified by the engineer in order to qualify as acceptable manufacturers. Pre-qualification shall be no later than two (2) weeks prior to published bid date for this project. Failure to pre-qualify will be grounds for disqualification after the bid opening date. All decisions of qualification shall reside with the engineer of record at time of bidding.

1.05 Submittals

A. Pumps and Motors

The CONTRACTOR shall submit product data for the pump and motor to the OWNER'S REPRESENTATIVE as specified in Part 2.0 and as shown on the contract drawings. Pump data shall include, but is not limited to, characteristic curves, dimensional drawings, materials of construction for all parts, mechanical seals, packings, and shafts. Pump curves shall indicate efficiency, horsepower, NPSHR, proposed number of impeller stages, and electrical characteristics of the motor. The motor data shall include motor manufacturer, motor horsepower, rated speed, service factors, voltage, maximum amperage draw, and phase.

B. Control Panel

The CONTRACTOR shall submit detailed panel layout and electrical diagrams showing the panel enclosure, panel face, and wiring diagrams to the OWNER'S REPRESENTATIVE for approval. The CONTRACTOR shall also submit product data for transformers, relay modules, motor controllers and starters, circuit breakers, level switches and related controls, receptacles and devices, and other items as specified in Part 2.0 and as shown on the contract drawings.

C. Piping and Related Works

The CONTRACTOR shall submit diagrams to the OWNER'S REPRESENTATIVE product data for all hose, piping, fittings, valves, check valves, and other piping related materials as specified in Part 2.0 and as shown on the contract drawings. The product data shall include, but is not limited to, materials of construction, pressure ratings, flow ratings, and physical dimensions.

D. Electrical Works

The CONTRACTOR shall submit diagrams to the OWNER'S REPRESENTATIVE product data for all wire, conduit, breakers, explosion proof fittings, sealing compounds, and other materials as specified in Part 2.0 and as shown on the contract drawings

E. Operation and Maintenance Data

The CONTRACTOR shall provide three sets of operation and maintenance (O&M) manuals for the leachate sump pumping system. The O&M manuals shall include at a minimum, all drawings, equipment lists with manufacturer's name and model number, equipment manuals, recommended spare parts inventory, detailed description of controls sequence of operation, and troubleshooting guide.

1.06 Codes and Regulations

A. Comply with the latest editions of following works, including all supplements thereto and any other authority having jurisdiction within requirements of this specification.

1. Local Codes
2. National Electrical Code as amended (NFPA No. 70, 70E, 71, 72, 72C)
3. O.S.H.A.
4. International Building Code (IBC 2012).
5. ASME and ASTM Standard for Materials of Construction.

B. Whenever drawings or specification require materials, workmanship, arrangement or construction of higher standard or larger size than is required by codes and regulations, then drawings and specifications shall take precedence.

C. Should there be direct conflict between above-mentioned regulations and Drawings or Specifications, regulations shall govern.

- D. All electrical materials and equipment shall bear the label of Underwriters Laboratories' listed by them in their list of electrical fittings; and approved by them for which they are to be used, unless material and equipment is of type for which Underwriter's Laboratories do not list or provide label.

1.07 Quality Assurance

PART 2 – PRODUCTS

2.01 PUMP DESIGN

Pump(s) shall have 2 inch NPT integral vertical discharge and shall be capable of handling effluent containing non-abrasive $\frac{3}{4}$ inch maximum solids.

2.02 MECHANICAL SHAFT SEALS

The motor shall be protected by a mechanical shaft seal mounted on the pump shaft. The mechanical seal shall be constructed of silicon carbide vs. silicon carbide sealing faces. The mechanical seal shall be tensioned by a spring constructed of series 300 stainless steel metal components and BUNA-N elastomers.

2.03 IMPELLER

The impeller shall be semi-open with ejector (pump out) vanes on the top of the impeller for protection of the mechanical seal and hydraulic balance. Due to design, only single plane spin balancing shall be required for smooth operation. The impeller shall be threaded to the solid series 400 stainless steel shaft. All impellers shall be secured by a thread-locking feature which will prevent the impeller from loosening during short periods of reverse rotation as might occur when rotation direction is being verified outside the installation.

2.04 CASING

The casing shall be cast from ASTM A48 class 30 gray cast iron of sufficient thickness to withstand 1.5 times the shut off pressure generated by the largest impeller available for this model in accordance with current revision of the Hydraulic Institute Standards. The discharge connection shall be a standard 2 inch NPT suitable for direct connection to the station piping, without the use of any external fittings or adapters for vertical orientation of the discharge direction. Integral feet of cast iron shall be made a part of the casing for accurately positioning the pump suction opening at the correct elevation off the sump floor for good pump down capability.

2.05 MAJOR CASTING MATERIALS

The impeller, casing, bearing/seal housing and motor cover shall be of ASTM A48 Class 30 high quality cast iron for strength and long life. Bronze impeller shall be cast iron from ASTM B584 UNS C87600 when ordered as an option.

2.06 CORROSION PROTECTION

The pump/motor shaft wetted-end shall be series 300 stainless steel. Impeller may be made from HARD-IRON®.

2.07 MOTOR

The integral motor shall be completely sealed from the environment by use of circular cross section o-rings accurately fitted into machined grooves which shall provide designed compression of metal to metal fits. Designs which require a specific torque on the casing bolts or which require rectangular gaskets or sealing rings shall not be allowed. The motor shall be rated for continuous duty under full nameplate load while at full submergence in the station. The motor shall be provided at the voltage and phase as detailed above. Single phase motors shall be capacitor-start. All single phase motors shall be provided with thermal protection. Single phase motors shall have an on winding sensor with automatic reset. Three phase motors shall be protected by ambient compensated quick-trip heaters, or, adjustable motor circuit protectors provided in control. The stator winding shall be open type with class F insulation suitable for operation in clean dielectric oil for efficient heat transfer and lubrication of the ball bearings. The stator shall be a register fit into the bearing housing to ensure positive alignment, and bolted for ease of serviceability. The motor shall be provided with ball type anti-friction bearings which shall support the heavy duty rotor shaft and to handle all radial and axial loads imposed by the impeller while limiting shaft deflection at the mechanical seal faces. Sleeve type bearings shall not be considered equal and, therefore, shall

not be allowed. The ball bearings shall be designed for a B-10 life of 30,000 hours minimum. The motor shall be designed and tested to withstand an 18 day locked-rotor operation without damage.

2.08 POWER CABLE

The power cable shall be provided by the pump manufacturer and sealed at the motor end as it enters the motor casing by the factory. The first line of defense shall be the compression of the oil and chemical resistant grommet which shall seal the outer jacket of the power cord. In the event that the outer jacket of the power cord should become damaged, then the second line of defense shall be the epoxy poured isolated conductors within the jacketed cable itself. The insulation shall be removed from the individual conductors and the epoxy shall be allowed to form a leak-proof seal against wicking of the power cable between the outer jacket and the insulation of the individual conductors. The outer jacket of the power cord shall be oil resistant and water resistant. The power cable shall be rated for NEC severe service "S", type "SJTOW" or "STOW" or better. **The power cable shall be at least sixty feet (60') long without splices.**

2.09 CONTROLS PANELS AND CONTROLS

A. Complete automatic pump control system shall be furnished by the pump manufacturer or certified representative and installed near the top of the side slope riser by the CONTRACTOR as shown on the contract drawings and specified herein. The control system shall consist of a pump control panel for housing the controls for the side slope riser pump over a range of 0 to 12.5 feet of leachate depth. The CONTRACTOR shall provide all materials for mounting and wiring the pump control panel.

B. Level Control System

1. The level control system shall be a point measurement system using a level sensor transducer. Level sensor shall be a fully submersible pressure transmitter.
2. The level sensor shall be 316 stainless steel, compatible with leachate, mounted on the pump carriage.
3. The system shall be easy to maintain and not require recalibration or specialty equipment to maintain.
4. The cable shall be severe duty rated, oil and water resistant, jacketed for submergence in leachate
5. Chemical resistant atmospheric pressure compensating vent tube.
6. level transducer shall be equipped with 75 feet of continuous, without splices, control cable.
7. Range: 0 – 15 Feet W.C. (0-7 PSIG)
8. Accuracy: 1.25% of operating range
9. Manufacturer: EPG LevelMaster, or equal

C. Control Panel

1. The pump controls and electrical equipment shall be housed in a NEMA 4X enclosure. The enclosure shall be equipped with an inner door, stainless steel drip shield, and lock. Two milled keys shall be furnished with each lock. All indicating lights, switches, and indicators shall be mounted on the inner door. The enclosure shall be sized and assembled to provide 20% free space for future controls relays and wires. All components shall be clearly identified by suitable name plates.
2. Control panel shall designed for 3-phase; 230 volts; 60 hertz with conductors sized to accommodate the pump motor and auxiliary usage. Surge suppression shall be installed on all incoming power lines to protect the control panel equipment. The control panel shall

be equipped with a main disconnect and fuses/circuit breakers to de-energize the complete control panel, including controls. The control panel enclosure shall be designed to allow access to indicating lights, breakers, receptacles and meter without de-energizing the control panel. The control panel shall include separate auxiliary circuit breakers for pump, alarm and control circuits, 20 amp GFCI receptacle and space for one (1) future 120 volt breaker.

3. Controls

The pump shall be operated by a HOA selector switch and related controls. The controls shall include a "soft start" motor starter with overload relays with ambient compensated, quick trip characteristics with manual reset and shall be sized for the motor being used. Each starter shall have a minimum of two auxiliary contacts. Panel shall include an anticondensation heater. The panel shall include all necessary relays, low voltage power supplies, transformers and interlocks required for operation of the system as described above.

The control panel shall include an intrinsically safe level control system to start and stop the leachate pump as required and for high level alarm indication or pump seal failure. The level control system shall maintain the leachate level in the bottom of the side slope riser at below 24 inches.

4. Lights/Indicators

The control panel shall include:

- a) Pump "running" light; (Red);
- b) Pump "fault" light; (Amber);
- c) Pump "leakage" light; (Amber);
- d) Pump "OFF" light; (Green);
- e) Leachate level indicator;
- f) Resettable elapsed pump run time meter;
- g) NEMA 4 amber flashing alarm light mounted on top of the control panel (100 Watts) shall illuminate on "High Leachate Level".
- h) Audio alarm for "High Leachate Level"

2.01 Electrical Works

- A. The CONTRACTOR shall provide electric service to the pump panels from the existing service panels by means of underground conduit, cables and connections.
- B. The CONTRACTOR shall provide all conduit, cables, enclosures and terminations as shown on the contract documents or as required in this specification.
- C. Wire
 - a) All wiring with the exception of motor lead wires of the submersible pump, shall be Type THWN copper wire having 600 volt insulation. Wiring for light or power shall be not smaller than #12 AWG. The main electrical service shall be sized as appropriate. Aluminum wire is **not** allowed. All main feeders and branch circuits shall be color coded as required by Code. Wire shall be as manufactured by Phelps-Dodge, General Cable, Triangle, Crescent Insulated Wire and Cable Company or Essex Wire & Cable Co. Wire to the pumps and level controls shall be submersible as provided by the pump manufacturer.
 - b) Properly identify and tag all mains, feeders, and branch circuits in all pull boxes, gutters, troughs, junction boxes, etc., in which they connect. Similarly, identify and tag wires where two or more circuits run to or pass through the same outlet or junction box.
 - c) On all circuit wiring, allow sufficient slack at splices and outlets to permit connections without straining, generally not less than 6" of slack in junction or outlet boxes and 10" in

ducts, troughs or pull boxes. Joints and splices shall only be made in pull boxes, junction boxes and outlet boxes in a mechanically and electrically secure manner using only approved solderless connectors, lugs, etc., as approved by Code.

- d) Grounding and bonding shall be in accordance with the NEC and with the requirements of the local Utility Company. All exposed non-current carrying metallic parts of the electrical equipment, and neutral conductor of wiring systems shall be grounded. All grounding conductors shall be of copper. The CONTRACTOR shall provide test results that demonstrate that the resistance to ground for the grounding system is not more than 15 ohms.

E. Conduit

- a) Rigid nonmetallic conduit, PVC Schedule 80, may be used underground and under slabs. All PVC conduit passing under roadways shall be Schedule 80. All exposed conduit and upturn elbows and conduit passing through the ground or masonry shall be rigid galvanized steel conduit. Exposed conduit fittings shall be hot-dip galvanized malleable iron fittings, for elbows, unions, and switch boxes; type FS or FD, manufactured by Appleton or Crouse-Hinds. When entering boxes, fittings or cabinets the fittings shall be double-lock-nut-and-bush except at threaded hubs. All conduit, fittings, connections, etc. shall be water tight. Bushings larger than 1" shall be insulating type with plastic, fiber, or bakelite insulating rings molded into hot-dip galvanized malleable iron threaded bushings. All conduit and fittings from the pump control panel down to the pumping area shall conform to Class 1, Division I standards with explosion proof seal off fittings for conduit entrance into the control panels. Conduit size shall be as shown on the contract documents and at a minimum 3/4" in diameter.
- b) Where required for proper execution of work, provide all junction and/or pull boxes, each of proper size, gauge and type for location and use, complete with screw covers of size convenient and adequate for proper installation of required number of cable or wires; to conform with code requirements.

PART 3 – EXECUTION

- 3.01 All installation procedures for the specified pumping system component including but not limited to pumps, couplings, flow meters, valves, controls, and electrical equipment shall be installed per manufacturer's recommendations and instructions.
- 3.02 The CONTRACTOR shall utilize a licensed electrician to make all electrical power and control wiring connections between all new and existing electrical distribution equipment, control panels and equipment as specified in this specification and as shown on the Contract Drawings. All power and control conduit runs between control panels and the pumps and level controls located in the Side Slope Riser shall include seal fittings for hazardous locations. The seal fittings shall be properly installed and sealed in accordance with relevant electrical codes for a Class 1, Division I location. These wiring connections shall utilize explosion proof junction boxes or other equipment as required and shall be located to allow disconnection and removal of the pump and level control equipment without entering the Side Slope Riser.
- 3.03 Upon completion of the installation, the CONTRACTOR shall test all circuits, control systems and devices, including all condition signals, in the Presence of the OWNER's Representative. All apparatus shall be cleaned, adjusted and made ready for operation after testing. The CONTRACTOR shall make such changes in wiring or connections and such adjustments, repairs or replacements as are necessary to make the circuits, device or control system to function as specified and otherwise comply with the specifications or data on Contract Drawings. The CONTRACTOR shall supply all necessary material labor and equipment for these tests. The pump shall be tested in the presence of the OWNER's Representative to insure that the pumps are adjusted and in proper running order and that said pumps will meet the rated capacities specified. The field test shall include pumping at least three cycles at normal starting levels to check the operation of the pump. Pump tests shall include plotting of pump curve based on field data for each pump. Points on pump curve shall include shutoff head and three (3) other points. During pump testing, inspections shall be performed in the presence of the OWNER's Representative to insure free passage of liquid into the force main. Any problems shall be promptly repaired at the CONTRACTOR's expense.

END OF SECTION

SECTION 55000

MISCELLANEOUS METALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Steel framing and supports for applications where framing and supports are not specified in other Sections.
2. Metal ladders.
3. Ladder safety cages.
4. Alternating tread devices.
5. Metal bollards.
6. Abrasive metal treads.

B. Products furnished, but not installed, under this Section include the following:

1. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
2. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

C. Related Requirements:

1. Section 03300 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.

1.3 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Nonslip aggregates and nonslip-aggregate surface finishes.
 - 2. Metal nosings and treads.
 - 3. Paint products.
 - 4. Grout.
- B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:
 - 1. Steel framing and supports for applications where framing and supports are not specified in other Sections.
 - 2. Metal ladders.
 - 3. Ladder safety cages.
 - 4. Alternating tread devices.
 - 5. Metal bollards.
 - 6. Abrasive metal treads.
- C. Samples for Verification: For each type and finish of extruded tread.
- D. Delegated-Design Submittal: For ladders and alternating tread devices, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer.
- B. Mill Certificates: Signed by stainless-steel manufacturers, certifying that products furnished comply with requirements.
- C. Welding certificates.
- D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- E. Research/Evaluation Reports: For post-installed anchors, from ICC-ES.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer to design ladders and alternating tread devices.
- B. Structural Performance of Aluminum Ladders: Aluminum ladders shall withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.
- C. Structural Performance of Alternating Tread Devices: Alternating tread devices shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
 - 1. Uniform Load: 100 lbf/sq. ft.
 - 2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.
 - 3. Uniform and concentrated loads need not be assumed to act concurrently.
 - 4. Alternating Tread Device Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- C. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- D. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 304.
- E. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.
- F. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

- G. Rolled-Stainless-Steel Floor Plate: ASTM A 793.
- H. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.
- I. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.
- J. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
 - 1. Size of Channels: As indicated.

Metal thicknesses in "Material" subparagraphs below are 12, 14, and 16 gage, respectively.

 - 2. Material: Galvanized steel, ASTM A 653/A 653M; structural steel, Grade 33, with G90 coating; 0.108-inch nominal thickness.
 - 3. Material: Cold-rolled steel, ASTM A 1008/A 1008M; structural steel, Grade 33; 0.0966-inch minimum thickness; coated with rust-inhibitive, baked-on, acrylic enamel.
- K. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.
- L. Aluminum Plate and Sheet: ASTM B 209, Alloy 6061-T6.
- M. Aluminum Extrusions: ASTM B 221, Alloy 6063-T6.
- N. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6.
- O. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.

2.3 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners (unless stated otherwise) for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
 - 1. Provide stainless-steel fasteners for fastening aluminum.
 - 2. Provide stainless-steel fasteners for fastening stainless steel.
 - 3. Provide stainless-steel fasteners for fastening nickel silver.
 - 4. Provide bronze fasteners for fastening bronze.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.
- C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 325, Type 3; with hex nuts, ASTM A 563, Grade C3; and, where indicated, flat washers.
- D. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593; with hex nuts, ASTM F 594; and, where indicated, flat washers; Alloy Group 1.

- E. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.
 - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- F. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.
- G. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.
- H. Post-Installed Anchors:
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
 - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.
- I. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

- A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
 - 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- C. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.
- D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

- G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.
- H. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- I. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi.

2.5 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch

embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.6 METAL LADDERS

A. General:

1. Comply with ANSI A14.3.

B. Steel Ladders:

1. Space siderails **18 inches** apart unless otherwise indicated.
2. Siderails: Continuous, **1/2-by-2-1/2-inch** steel flat bars, with eased edges.
3. Rungs: **1-inch-square** steel bars.
4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
5. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
6. Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.
7. Provide platforms as indicated fabricated from welded or pressure-locked steel bar grating, supported by steel angles. Limit openings in gratings to no more than **3/4 inch** in least dimension.
8. Support each ladder **at top and bottom and not more than 60 inches o.c.** with welded or bolted steel brackets.
9. Galvanize ladders, including brackets.

2.7 LADDER SAFETY CAGES

A. General:

1. Fabricate ladder safety cages to comply with ANSI A14.3. Assemble by welding or with stainless-steel fasteners.
2. Provide primary hoops at tops and bottoms of cages and spaced not more than 20 feet o.c. Provide secondary intermediate hoops spaced not more than 48 inches o.c. between primary hoops.
3. Fasten assembled safety cage to ladder rails and adjacent construction by welding or with stainless-steel fasteners unless otherwise indicated.

B. Steel Ladder Safety Cages:

1. Primary Hoops: 1/4-by-4-inch flat bar hoops.
2. Secondary Intermediate Hoops: 1/4-by-2-inch flat bar hoops.
3. Vertical Bars: 3/16-by-1-1/2-inch flat bars secured to each hoop.
4. Galvanize ladder safety cages, including brackets and fasteners.

2.8 ALTERNATING TREAD DEVICES

- ### A. Alternating Tread Devices:
- Fabricate alternating tread devices of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.

1. Tread depth shall be not less than 8-1/2 inches exclusive of nosing or less than 10-1/2 inches including the nosing, tread width shall be not less than 7 inches, and riser height shall be not more than 8 inches.
 2. Fabricate from steel and assemble by welding or with stainless-steel fasteners.
 3. Comply with applicable railing requirements in Section 055213 "Pipe and Tube Railings."
- B. Galvanize steel alternating tread devices, including treads, railings, brackets, and fasteners.
- 2.9 METAL BOLLARDS
- A. Fabricate metal bollards from Schedule 80 steel pipe.
1. Fill bollards with 3,000 PSI concrete and crown concrete to promote water runoff.
- B. Prime bollards with zinc-rich primer.
- 2.10 ABRASIVE METAL TREADS
- A. Cast-Metal Units: Cast iron, with an integral-abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.
1. Treads: Cross-hatched units, full depth of tread with 3/4-by-3/4-inch nosing, for application over bent plate treads or existing stairs.
- B. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.
- C. Drill for mechanical anchors and countersink. Locate holes not more than 4 inches from ends and not more than 12 inches o.c., evenly spaced between ends, unless otherwise indicated. Provide closer spacing if recommended by manufacturer.
1. Provide two rows of holes for units more than 5 inches wide, with two holes aligned at ends and intermediate holes staggered.
- D. Apply bituminous paint to concealed surfaces of cast-metal units.
- E. Apply clear lacquer to concealed surfaces of extruded units.
- 2.11 FINISHES, GENERAL
- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.
- 2.12 STEEL AND IRON FINISHES
- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
- C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
 1. Shop prime with universal shop primer.
- D. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.13 ALUMINUM FINISHES

- A. As-Fabricated Finish: AA-M12.
- B. Clear Anodic Finish: AAMA 611, Class I, AA-M12C22A41.

2.14 BATTEN STRIPS

Materials for Battening geomembrane to concrete shall include

- Gaskets,
 - metal battens,
 - clamps,
 - Stainless Steel bolts,
 - embed channels,
 - welding rod,
 - adhesive, and
 - sealant.
1. Gasket material shall be neoprene, closed-cell medium, 0.25 inch thick, with adhesive on one side, or other gasket material as approved by the liner manufacturer.
 2. Metal battens shall be 0.25-inch-thick by 2-inch-wide aluminum.
 3. Clamps shall be 0.5-inch-wide stainless steel.
 4. Bolts shall be stainless steel.
 5. The embed channel and welding rod shall have the same properties as the liner.
 6. Adhesive shall be approved by the manufacturer and shall consist of material with a life expectancy similar to the liner material.
 7. Sealant shall be as recommended by the manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
 - 1. Cast Aluminum: Heavy coat of bituminous paint.
 - 2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLING METAL BOLLARDS

- A. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.
- B. Fill bollards solidly with concrete, mounding top surface to shed water.

3.3 INSTALLING NOSINGS, TREADS, AND THRESHOLDS

- A. Center nosings on tread widths unless otherwise indicated.
- B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.

3.4 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded 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. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

- END OF SECTION -

SECTION 055213

PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

- A. Section Includes:
 - 1. Steel pipe and tube railings.
 - 2. Aluminum pipe and tube railings.
- B. Related Requirements:
 - 1. Section 55000 – Miscellaneous Metals

1.4 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for railings. 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.
- C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Manufacturer's product lines of mechanically connected railings.
 - 2. Railing brackets.
 - 3. Grout, anchoring cement, and paint products.
- B. LEED Submittals:
 - 1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
 - 2. Laboratory Test Reports for Credit IEQ 4.2: For primers, documentation indicating that products comply with the testing and product requirements of the California Department of Public Health's (formerly, the California

Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- D. Samples: For each type of exposed finish required.
 - 1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
 - 2. Fittings and brackets.
- E. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Welding certificates.
- C. Mill Certificates: Signed by manufacturers of stainless-steel products certifying that products furnished comply with requirements.
- D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.
- E. Product Test Reports: For pipe and tube railings, for tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.
- F. Evaluation Reports: For post-installed anchors, from ICC-ES.

1.7 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
 - 3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

1.9 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of railing from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design railings, including attachment to building construction.
- B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 - 2. Infill of Guards:
 - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft..
 - b. Infill load and other loads need not be assumed to act concurrently.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.3 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.
 - 1. Provide type of bracket with predrilled hole for exposed bolt anchorage and that provides 1-1/2-inch clearance from inside face of handrail to finished wall surface.

2.4 STEEL AND IRON

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Tubing: ASTM A 513.
- C. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

Provide galvanized finish for exterior installations and where indicated.

- D. Plates, Shapes, and Bars: ASTM A 36/A 36M.
- E. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

2.5 ALUMINUM

- A. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.
- B. Extruded Bars and Tubing: ASTM B 221 (ASTM B 221M), Alloy 6063-T5/T52.
- C. Extruded Structural Pipe and Round Tubing: ASTM B 429/B 429M, Alloy 6063-T6.
 - 1. Provide Standard Weight (Schedule 40) pipe unless otherwise indicated.
- D. Drawn Seamless Tubing: ASTM B 210, Alloy 6063-T832.
- E. Castings: ASTM B 26/B 26M, Alloy A356.0-T6.

2.6 FASTENERS

- A. General: Provide the following:
 - 1. Ungalvanized-Steel Railings: Plated steel fasteners complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5 for zinc coating.
 - 2. Hot-Dip Galvanized Railings: Type 304 stainless-steel or hot-dip zinc-coated steel fasteners complying with ASTM A 153/A 153M or ASTM F 2329 for zinc coating.
 - 3. Aluminum Railings: Type 304 stainless-steel fasteners.
 - 4. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.
- B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.
- C. Fasteners for Interconnecting Railing Components:
 - 1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.
 - 2. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
 - 3. Provide Phillips flat-head machine screws for exposed fasteners unless otherwise indicated.
- D. Post-Installed Anchors: Torque-controlled expansion anchors capable of sustaining, without failure, a load equal to 6 times the load imposed when installed in unit masonry and 4 times the

load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.7 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
 1. For aluminum railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
- B. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
- D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- E. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- F. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- G. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- H. Epoxy Intermediate Coat: Complying with MPI #77 and compatible with primer and topcoat.
- I. Polyurethane Topcoat: Complying with MPI #72 and compatible with undercoat.
- J. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- K. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
 1. Water-Resistant Product: At exterior locations provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.8 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage.

- B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that are exposed to weather in a manner that excludes water. Provide weep holes where water may accumulate.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with welded connections unless otherwise indicated.
- H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
 - 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 flux immediately.
 - 4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
- I. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.
- J. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
 - 1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.
Form Changes in Direction by bending or by inserting prefabricated elbow fittings.
- K. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- L. Close exposed ends of railing members with prefabricated end fittings.
- M. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.
- N. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
 - 1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.
- O. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

- P. For railing posts set in concrete, provide steel sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with metal plate forming bottom closure.
- Q. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.9 STEEL AND IRON FINISHES

- R. Galvanized Railings:
 - 1. Hot-dip galvanize steel railings, including hardware, after fabrication.
 - 2. Comply with ASTM A 123/A 123M for hot-dip galvanized railings.
 - 3. Comply with ASTM A 153/A 153M for hot-dip galvanized hardware.
 - 4. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
 - 5. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- S. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
- T. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.
- U. For non-galvanized-steel railings, provide non-galvanized ferrous-metal fittings, brackets, fasteners, and sleeves; however, galvanize anchors to be embedded in exterior concrete or masonry.
- V. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with **SSPC-SP 6/NACE No. 3**, "Commercial Blast Cleaning."
- W. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
 - 1. Shop prime uncoated railings with universal shop primer.
 - 2. Do not apply primer to galvanized surfaces.
- X. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.

2.9 ALUMINUM FINISHES

- A. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- B. Mill Finish: AA-M12, nonspecular as fabricated.
- C. Clear Anodic Finish: AAMA 611.
- D. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

- E. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 50 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Fit exposed connections together to form tight, hairline joints.
- B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
 - 1. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 - 2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
 - 3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.
- C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
 - 1. Coat, with a heavy coat of bituminous paint, concealed surfaces of aluminum that are in contact with grout, concrete, masonry, wood, or dissimilar metals.
- D. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.2 RAILING CONNECTIONS

- A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.
- B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.
- C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches of post.

3.3 ANCHORING POSTS

- A. Use metal sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.

- B. Form or core-drill holes not less than 5 inches deep and 3/4 inch larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
- C. Cover anchorage joint with flange of same metal as post, attached to post with set screws.
- D. Leave anchorage joint exposed with anchoring material flush with adjacent surface.
- E. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
 - 1. For aluminum pipe railings, attach posts using fittings designed and engineered for this purpose.
 - 2. For stainless-steel pipe railings, weld flanges to post and bolt to supporting surfaces.
 - 3. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.
- F. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

3.5 ATTACHING RAILINGS

- A. Anchor railing ends at walls with round flanges anchored to wall construction and welded to railing ends.
- B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends.
- C. Attach railings to wall with wall brackets, except where end flanges are used. Locate brackets at spacing required to support structural loads.

3.6 ADJUSTING AND CLEANING

- A. Clean aluminum by washing thoroughly with clean water and soap and rinsing with clean water.
- B. 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 requirements for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A 780/A 780M.

3.7 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION