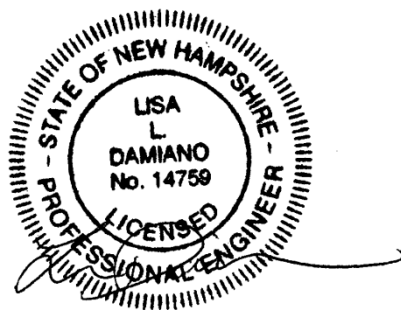


# CLOSURE AND POST-CLOSURE PLAN MERRIMACK STATION COAL ASH LANDFILL

*Bow, New Hampshire  
NHDES Permit No. DPHS-SW-85-012*

*Prepared for Public Service of New Hampshire  
File No. 2025.03  
Revised October 2016*



**CLOSURE AND POST-CLOSURE PLAN**  
**Merrimack Station Coal Ash Landfill**  
**Bow, New Hampshire**

This Closure Plan describes the procedures for closure of the Merrimack Station Coal Ash Landfill. Closure involves terminating landfilling activities, constructing and maintaining a final cover system over the landfilled material, and continued maintenance of the stormwater management and leachate collection systems. Information required by the New Hampshire Solid Waste Rules and the federal Standards for the Disposal of Coal Combustion Residuals (CCR) in Landfills and Surface Impoundments (40 CFR Part 257 Subpart D) is provided in this document.

**1.0 FACILITY IDENTIFICATION**

Facility Name: Merrimack Station Coal Ash Landfill

Mailing Address: Public Services of New Hampshire (PSNH)  
dba Eversource Energy  
PO Box 330  
Manchester, New Hampshire 03105

Location: 716 River Road  
Bow, New Hampshire

Permit No.: DPHS-SW-85-012

Facility Capacity: Approximately 300,000 yd<sup>3</sup>

Contact Information: Allan Palmer  
Generation Field Office  
431 River Road  
Bow, New Hampshire 03304  
(603) 634-2439  
allan.palmer@eversource.com

**2.0 CLOSURE SCHEDULE**

Closure construction will involve final grading and construction of the final cover system over those areas that have not yet received final cover. The final cover system will be constructed incrementally as the landfill is filled. However, following termination of ash placement, the final portion of the cover will be constructed.

As of 2016, final cover was constructed over approximately 1.6 acres of the landfill footprint, leaving approximately 3.8 acres of final cover system to be constructed as active portions of the landfill reach final grade. Disposal of ash at the facility will cease when final grades have been achieved throughout the entire permitted area. Installation of final cover system will occur incrementally, and the timing of construction events is greatly influenced by incoming waste quantities.

Based on the anticipated incoming waste quantities, PSNH expects that the facility will be filled to capacity near year 2023.

It is anticipated that construction of the landfill cover system will take place during the spring through fall construction seasons. Closure construction will involve fine grading in-place ash followed by the construction of final cover system over areas filled to final grade. A general summary of work items and associated times frames to complete each phase of closure construction is provided in the following table. It is noted that the construction-related work items and their associated time frames will typically overlap during actual construction.

<b>WORK ITEM</b>	<b>TIME FRAME TO COMPLETE (weeks)</b>
Prepare Construction Plans and associated Application for a Type II Permit Modification for New Hampshire Department of Environmental Services (NHDES) Review (to be completed by March 1 each year final cover construction is proposed)	6
NHDES Review and Approval	8
Fine Grade Intermediate Cover	1
Place 12- inch thick of Sand Bedding layer	1
Install 40-mil thick textured geomembrane, drainage geocomposite, and 12-inch thick Sand Cover layer	2 to 3
Place the 6-inch thick Moisture Retention Layer and 4-inch thick topsoil layer; hydroseed	1 to 2

### **3.0 WASTE IDENTIFICATION**

Waste materials accepted for disposal at the facility primarily include fly ash and slag generated at Merrimack Station in Bow. Other limited quantities of material disposed intermittently at the facility include, but are not limited to, waste materials from Merrimack Station such as coal, dirt, slag, pond dredgings and sand blast grit. Under emergency conditions, limited volumes of coal ash from PSNH's Schiller Station in Portsmouth have been disposed at the landfill.

### **4.0 NOTIFICATIONS**

The landfill serves for disposal of ash generated by PSNH. There are no other users of the facility that need to be notified prior to terminating receipt of waste.

### **5.0 CLOSURE REQUIREMENTS**

The facility is to be closed in a manner consistent with the requirements of the New Hampshire Solid Waste Rules and the federal CCR rules. The objectives of the closure are to isolate the landfill from the environment, manage stormwater, and continue to remove leachate from the landfill, while monitoring leachate flow rates and composition.

The facility will be closed as final grades are attained and the final cover is placed. Proposed final grades are shown on Sheet MK-S-7.2 of the Design Plans. At least eight

weeks prior to the anticipated start of closure construction, construction drawings and specifications will be prepared and submitted to NHDES for review and approval via a Type II Permit Modification.

An Existing Conditions Plan is provided on Sheet 1 in Appendix A, indicates the limits of the final cover system constructed as of 1995, which consists of the following components, listed from top to bottom:

- 4-inch thick topsoil layer, that was vegetated;
- 18-inch thick Sand Cover layer;
- 36-mil thick Hypalon geomembrane; and
- 12-inch thick Sand Bedding layer.

The cover system to be used over the remainder of the landfill is proposed to include the following layers listed from top to bottom:

- 4-inch topsoil layer that will be fertilized and seeded.
- 6-inch thick Moisture Retention Soil layer;
- 12-inch thick Sand Cover layer;
- A drainage geocomposite;
- 40-mil thick textured, high-density polyethylene (HDPE) geomembrane; and
- 12-inch thick Sand Bedding layer.

The cover system meets the requirements of the New Hampshire Solid Waste Rules Env-Sw 805.10 and 40 CFR Part 257.102(d)(3).

The Sand Bedding is a granular soil with 100 percent of the material passing a 1-inch sieve. The geomembrane component of the cover system is proposed to consist of 40-mil thick textured HDPE. HDPE geomembrane is more commonly used in landfill applications, and the 40-mil thick material satisfies the requirements of Env-Sw 805.10 (e)(3)(b) and 40 CFR Part 257.102(d)(3)(i)(A). Textured geomembrane is proposed to enhance stability.

The drainage geocomposite was incorporated in the cover system to promote drainage of water infiltrating through the cover system soils and to limit the potential for head to build up on the geomembrane. Water flowing in the cover section above the geomembrane will discharge at the toe of slope. To stabilize the toe, a crushed stone drain constructed over 10-ounce per square yard nonwoven geotextile will be provided. The drain provides a high permeable zone allowing water within the cover section to discharge freely at the toe of slope.

Twelve inches of Sand Cover will be placed above the geocomposite followed by 6 inches of Moisture Retention Soil and 4 inches of topsoil. Sand Cover is a granular soil with 100 percent of the material passing a 1-inch sieve and not more than 12 percent silt. The above described drainage geocomposite and the 12 inches of Sand Cover meet the requirements of 40 CFR Part 257.102(d)(3)(i)(B) and is an approved infiltration layer alternative to 18 inches of Sand Cover in New Hampshire, as specified in Env-Sw 805.10(e)(4)(c)(2). The Moisture Retention Soil has a specified permeability less than  $1 \times 10^{-4}$  centimeters per second, which is expected to be 1 to 2 orders of magnitude lower than that of the Sand Cover. This layer was incorporated to promote moisture retention in the root zone to better support vegetative growth. The combination of the 4-inch topsoil layer and 6-inch thick Moisture Retention Soil layer exceeds the 6-inch thick earthen material erosion layer requirement specified in 40 CFR Part 257.102(d)(3)(i)(C).

Cover section details are provided on Sheets 1 and 2 prepared by Sanborn Head. These sheets are provided in Appendix A for ease of reference. Relevant technical specifications for the closure construction work are included in Appendix B.

Prior to placing final cover materials, existing grades are to be surveyed to verify surface elevations. In areas that are below final design grade, additional ash fill will be placed prior to closure construction. The surface should be fine graded in preparation for cover system construction. After grading, the Sand Bedding soil will be placed in the area to receive final cover. The 40-mil thick textured geomembrane will be installed over the subgrade and overlain by the drainage geocomposite followed by the placement of the Sand Cover. A drainage swale will be constructed on the landfill in the location indicated on Sheet MK-S-7.2. The swale will be shaped using Sand Cover soil. Following placement of the Sand Cover, the Moisture Retention layer soil will be placed followed by topsoil, which will be fertilized and seeded. The crushed stone drain is to be provided at the toe of the north slope and in other areas where swales are to be constructed at the landfill perimeter to allow water above the cap to drain freely to the perimeter swale.

The design of the final cover system is consistent with modern landfill engineering practices to reduce post-closure infiltration of liquid, contain leachate, manage stormwater, and reduce post-closure maintenance.

## **6.0 POST-CLOSURE MONITORING PLAN**

Following closure of the facility, Post-Closure Monitoring will be implemented to observe that the physical integrity of the site is maintained and to monitor groundwater quality. There are no anticipated planned uses of the property during the post-closure period. Post-closure inspections are to take place no less than twice each year. Inspection reports are to be provided to NHDES. Post-closure inspections are to be performed for a 30-year period or as approved by the NHDES. Access to the property is to be maintained so that post-closure monitoring can be performed.

Post-closure monitoring will involve the following.

- Inspection of site security and access including fencing, gates, and access roads.

- Groundwater quality monitoring in accordance with the requirements of the Groundwater Permit for the facility, which is to be renewed as required.
- Inspection of the leachate collection system appurtenances to see that they are operating properly. This inspection is to include, but not be limited to, collection piping, cleanouts, storage tanks, and pumps. In addition, data is to be collected and reviewed regarding the quantity of leachate collected from the facility. An increase in the rate of leachate removed from the facility is to be evaluated to assess the cause. Leachate samples are to be collected for analysis in accordance with NHDES requirements.
- Inspection of landfill area for evidence of erosion, settlement, and to observe the quality of the vegetation. Mowing is to be performed at least once per year to prevent growth of woody plants. Settlement monitoring will consist of visual observations focusing on evidence of differential settlement that results in damage to the final cover system or ponding water. Areas where damage or ponded water are noted are to be repaired.
- Inspection of the stormwater drainage system including the perimeter swales.

A post-closure facility inspection checklist similar to the one included as Appendix C will be used during post-closure inspections. The inspection will include the landfill itself and adjacent areas to observe that the final cover system, landfill drainage swales, perimeter drainage swales, leachate holding tank, and monitoring appurtenances are functioning properly. Items that are malfunctioning or damaged will be noted and repaired in a timely manner, to maintain the integrity of the closed landfill.

The following timing is anticipated for post-closure monitoring activities:

<b>Task</b>	<b>Monitoring Frequency</b>
Gas Monitoring	Not required due to nature of waste accepted
Settlement Monitoring	Not required due to nature of waste accepted
Facility Inspections	2x/year
Annual Facility Report	Annual

## **7.0 RECORDKEEPING AND REPORTING**

Following closure construction, record drawings will be prepared and submitted to NHDES. Post-closure facility inspection reports will be prepared and submitted to NHDES in duplicate following each site inspection. Annually, a report will summarize the facility performance for the prior year, including a summary of environmental monitoring data, will be prepared and submitted to NHDES. The report will include a statement by a Professional Engineer regarding the performance of the closed facility relative to expected performance and whether adjustments to the post-closure monitoring and maintenance provisions are recommended.

Following closure, facility records are to be maintained at PSNH's offices. Records are not to be moved or destroyed unless such action is approved by NHDES pursuant to a Type V Permit modification.

## **8.0 OTHER PERMITS**

A Type II Permit Modification is required prior to closure construction. At this time, it is not anticipated that any other post-closure permits will be required. The facility has a Groundwater Permit that is to be renewed as required.

## **9.0 CLOSURE COST ESTIMATE**

A cost estimate developed for closure and post-closure activities in accordance with this Closure Plan was prepared and submitted to the NHDES in 2014. The estimate was based on the current operating area of the facility. The costs used in the estimate are based on a third party performing the work. Post-closure costs for the existing facility were also prepared and submitted to the NHDES in 2014 and were calculated for a 30-year post-closure period. The cost estimate is required to be updated periodically by the NHDES.

P:\2000s\2025.03\Source Files\Closure Plan\20161031 Closure & Post Closure Plan.docx

**APPENDIX A**  
**RELEVANT DESIGN PLAN SHEETS**





TBM MW #14  
RIM=242.56'

GATE  
(TO BE RELOCATED)

FENCE POST  
BASELINE  
N 232,007.13  
E 1,034,900.75  
ELEV. 251.59'

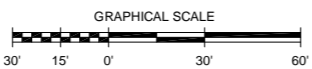
FENCE POST  
BASELINE  
N 231,242.02  
E 1,035,069.22  
ELEV. 218.05'

**NOTES:**

1. THE BASE MAP WAS PROVIDED IN ELECTRONIC FORMAT BY WSP-SELLS TRANSPORTATION & INFRASTRUCTURE OF NASHUA, NEW HAMPSHIRE IN A FILE TITLED "123012-1.dwg" ON FEBRUARY 14, 2012.
2. THE HORIZONTAL DATUM IS BASED ON THE NEW HAMPSHIRE STATE PLANE COORDINATE SYSTEM NAD83 AND THE VERTICAL DATUM IS BASED ON NAVD88.
3. SITE BASELINE TRANSFORMED TO NH STATE PLANE COORDINATE SYSTEM FROM PLAN PROVIDED IN ELECTRONIC FORMAT BY DUBOIS AND KING INC. IN A FILE TITLED "98 Base Plan.dwg"

**LEGEND:**

- 230' EXISTING 10-FOOT CONTOUR LINES
- EXISTING 2-FOOT CONTOUR LINES
- 1995 LIMIT OF CAP
- EXISTING CAPPED AREA
- LIMIT OF LINER
- FENCE LINE
- CONTROL POINT



DRAWN BY: C. RIVET / R. CLAY  
 DESIGNED BY: C. RIVET  
 REVIEWED BY: R. S. SHILLABER  
 PROJECT MGR: K. ANDERSON  
 PIC: R. S. SHILLABER  
 DATE: SEPTEMBER 2012

PUBLIC SERVICE OF NEW HAMPSHIRE  
 MERRIMACK STATION  
 BOW, NEW HAMPSHIRE

PROJECT NUMBER:  
2025.02

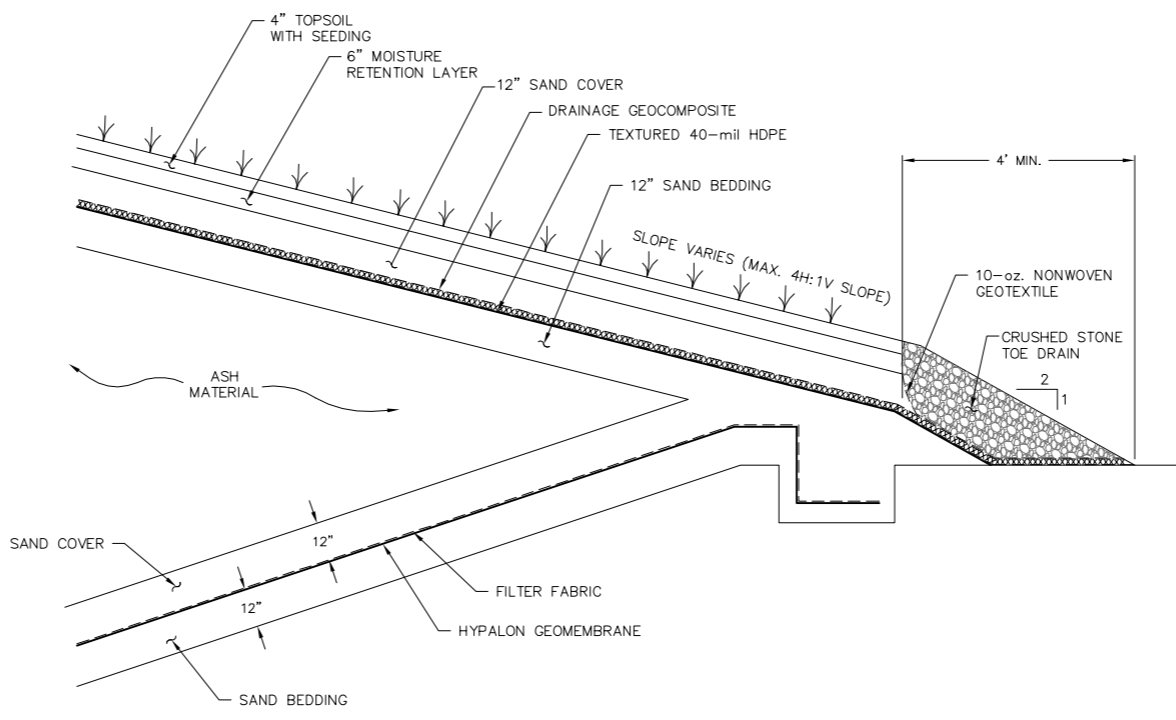
EXISTING CONDITIONS PLAN

SHEET NUMBER:  
1 OF 3

SANBORN HEAD

FILE: S:\0000\FURNISHING\2012\09\09\20120909.DWG, DESIGNED: RSCOTT SHILLABER, PROJECT MGR: KANDERSON, DATE: 09/14/12, 11:44 AM, PLOT DATE: 09/14/12, 11:44 AM, PLOT BY: RSCOTT SHILLABER, PLOT SCALE: 1.0000, PLOT SHEET: 1 OF 3, PLOT TITLE: MERRIMACK STATION EXISTING CONDITIONS PLAN

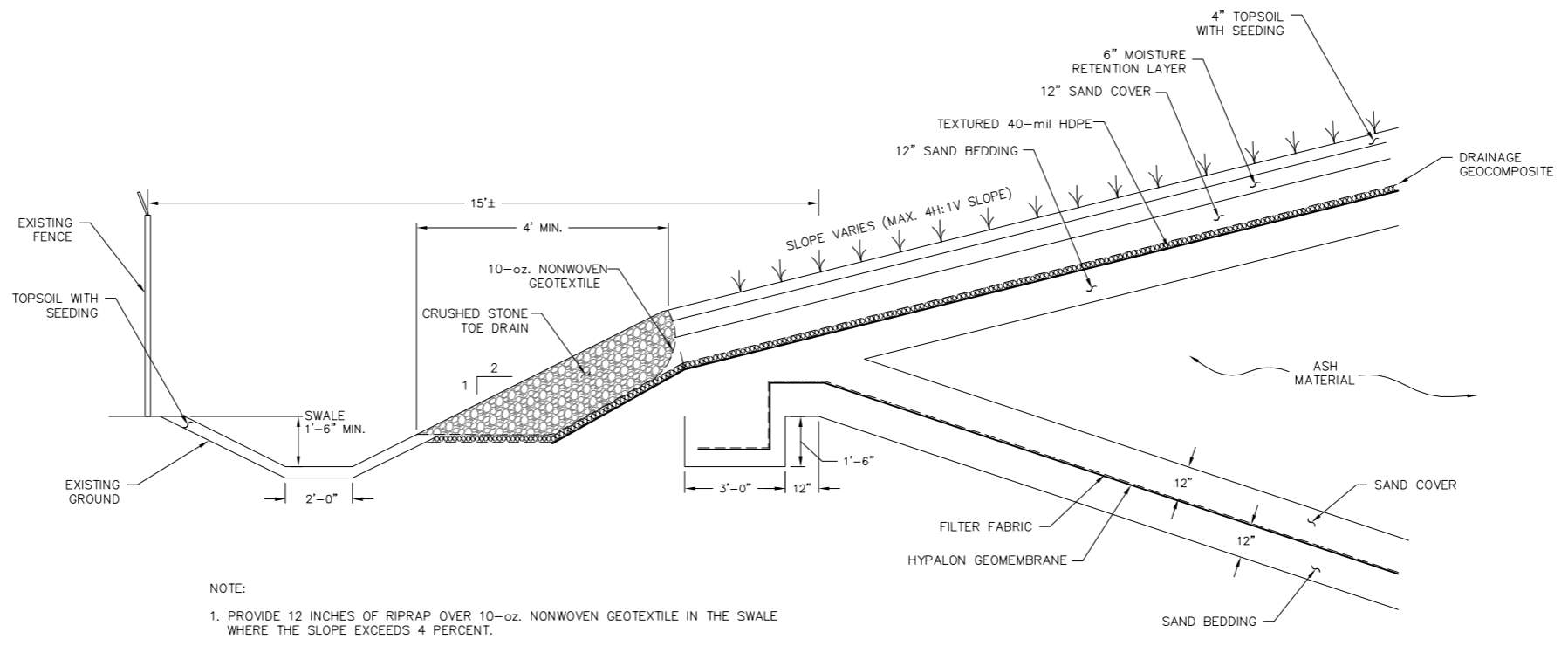
© 2012 SANBORN, HEAD & ASSOCIATES, INC.



- NOTES:
1. MOISTURE RETENTION LAYER SOIL SHALL BE AN INORGANIC SOIL WITH A MAXIMUM STONE SIZE OF 3-INCHES, A SILT CONTENT BETWEEN 15 AND 35 PERCENT AND A PERMEABILITY LESS THAN  $1 \times 10^{-4}$  CM/SEC WHEN TESTED IN ACCORDANCE WITH ASTM D-5084. THE PERMEABILITY TEST SHOULD BE PERFORMED AT A WATER CONTENT WITHIN 2 PERCENT OF THE OPTIMUM WATER CONTENT AT A DENSITY WHICH IS 90 TO 92 PERCENT OF THE MAXIMUM DRY DENSITY PER ASTM D-698.
  2. CRUSHED STONE FOR THE TOE DRAIN SHALL BE HARD DURABLE, RESISTANT TO WEATHERING AND FREE FROM OVERBURDEN SPOIL. THE MATERIAL SHALL MEET THE GRADATION REQUIREMENTS FOR NHDOT SECTION 703 #4 AGGREGATE (1-1/2-INCH CRUSHED STONE.)

### 1 REVISED MEMBRANE LINER SYSTEM & ANCHORAGE AT HIGH SIDE

1  
N.T.S.



- NOTE:
1. PROVIDE 12 INCHES OF RIPRAP OVER 10-oz. NONWOVEN GEOTEXTILE IN THE SWALE WHERE THE SLOPE EXCEEDS 4 PERCENT.

### 2 REVISED MEMBRANE LINER SYSTEM & ANCHORAGE AT LOW SIDE

2  
N.T.S.

FILE: S:\2006\2006\_0909\2006\_0909.dwg P:\01\Projects\Merrimack Station\2011\Plan\2011\Plan.dwg DATE: 9-27-12  
LAYOUT: Sheet - Details.ctb  
PLOT DATE: 9-27-12



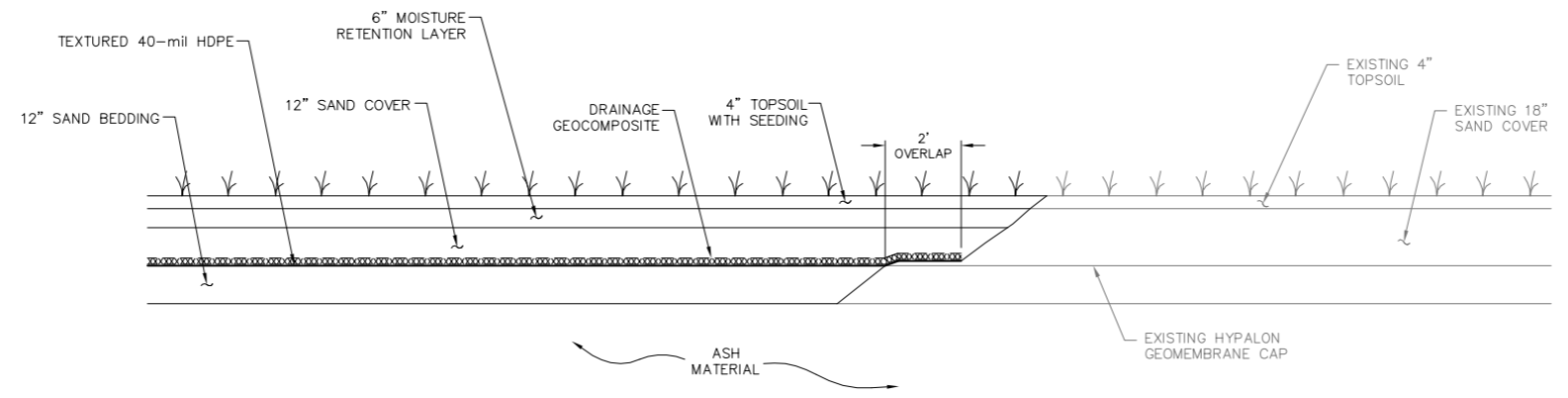
SCALE: AS NOTED



NO.	DATE	DESCRIPTION	BY

DRAWN BY: C. RIVET / R. CLAY  
 DESIGNED BY: C. RIVET  
 REVIEWED BY: R. S. SHILLABER  
 PROJECT MGR: K. ANDERSON  
 PIC: R. S. SHILLABER  
 DATE: SEPTEMBER 2012

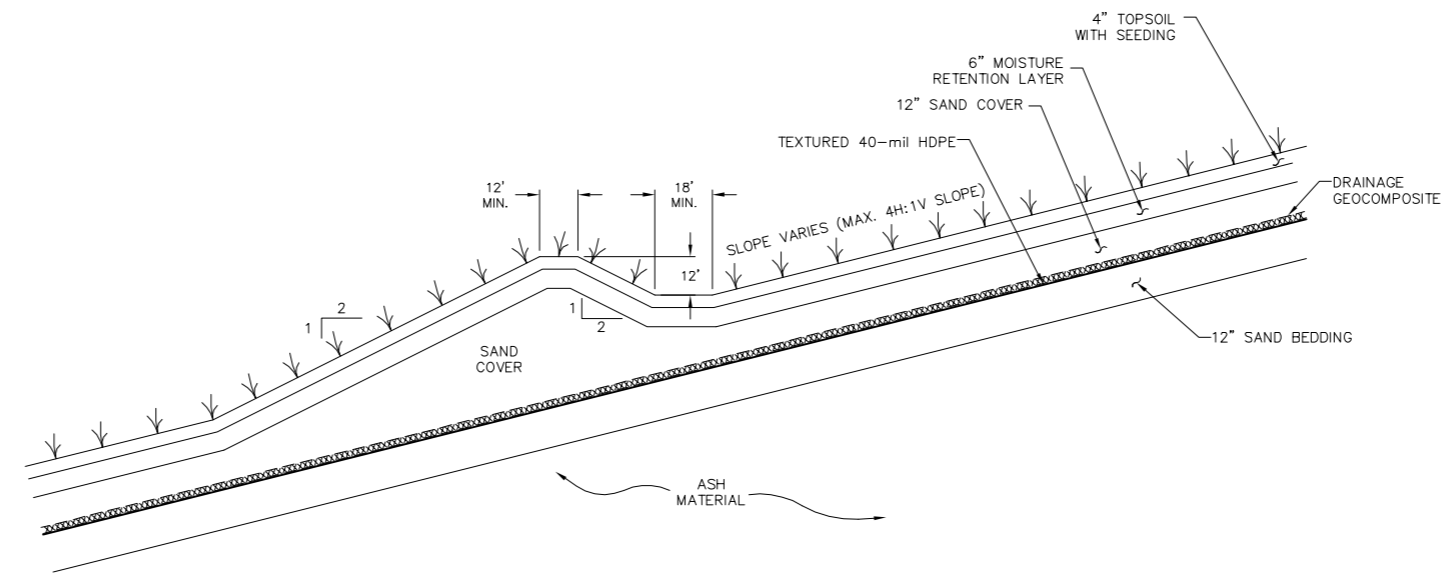
<b>PUBLIC SERVICE OF NEW HAMPSHIRE MERRIMACK STATION BOW, NEW HAMPSHIRE</b>	PROJECT NUMBER: 2025.02
	SHEET NUMBER: 2 OF 3



NOTES:

1. CAREFULLY EXPOSE EDGE OF EXISTING HYPALON GEOMEMBRANE CAP.
2. SWEEP SURFACE IN AREA OF OVERLAP TO REMOVE ALL SOIL.
3. INSTALL TEXTURED 40-mil HDPE GEOMEMBRANE. OVERLAP A MINIMUM OF 2 FEET ON THE EXISTING HYPALON GEOMEMBRANE.
4. INSTALL REMAINDER OF COVER SYSTEM SOILS.

**3** COVER SYSTEM TRANSITION DETAIL  
N.T.S.



**4** TYPICAL COVER MEMBRANE/SWALE DETAIL  
N.T.S.

MADE: C:\Program Files\Autodesk Land Desktop 2011\Temp\04\SHA\_top.dwg  
D:\SHILLABER\NCTF

8/8/12

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PLOT DATE: 9-27-12



SCALE: AS NOTED



NO.	DATE	DESCRIPTION	BY

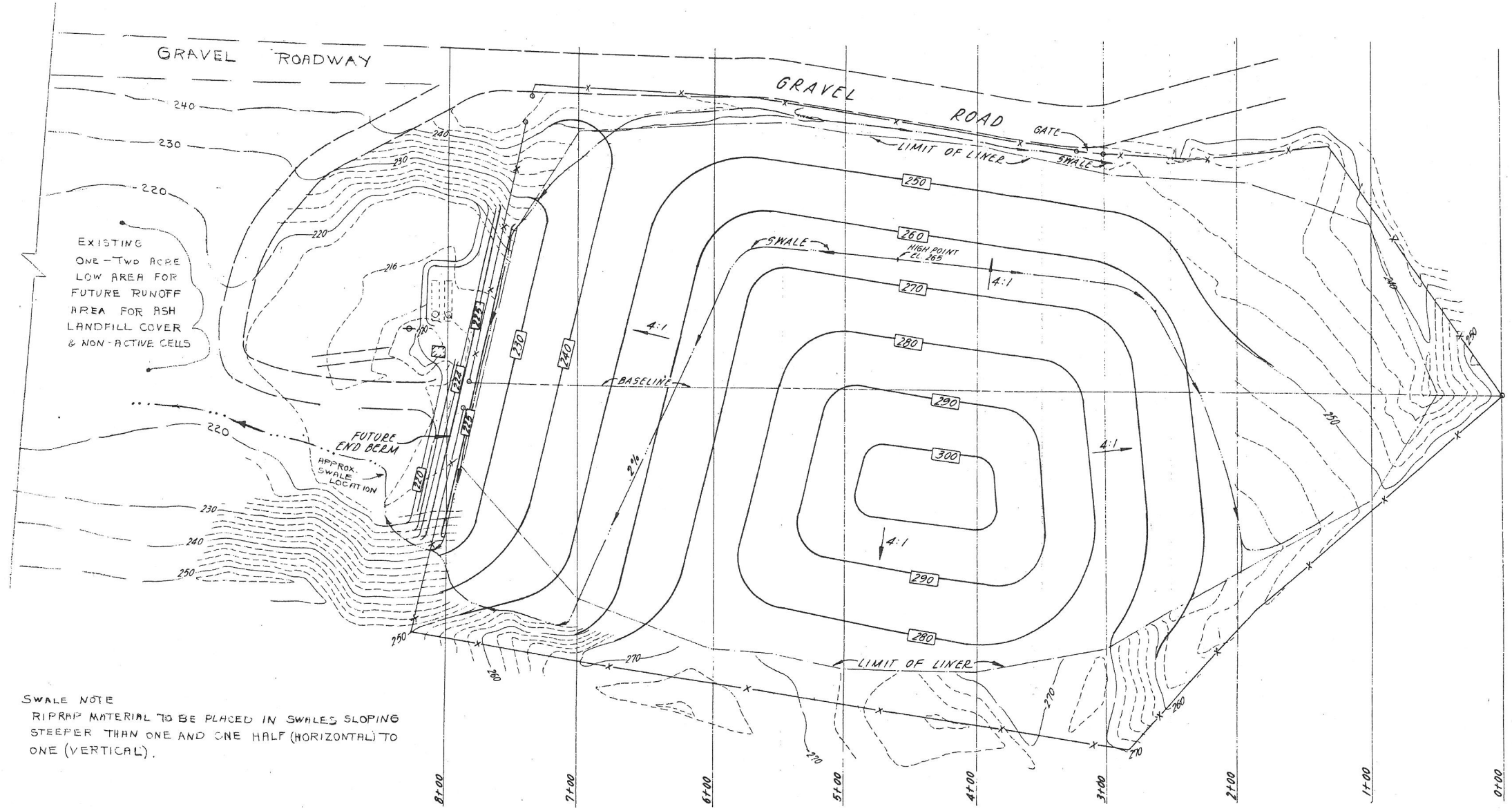
DRAWN BY: C. RIVET / R. CLAY  
 DESIGNED BY: C. RIVET  
 REVIEWED BY: R. S. SHILLABER  
 PROJECT MGR: K. ANDERSON  
 PIC: R. S. SHILLABER  
 DATE: SEPTEMBER 2012

PUBLIC SERVICE OF NEW HAMPSHIRE  
 MERRIMACK STATION  
 BOW, NEW HAMPSHIRE

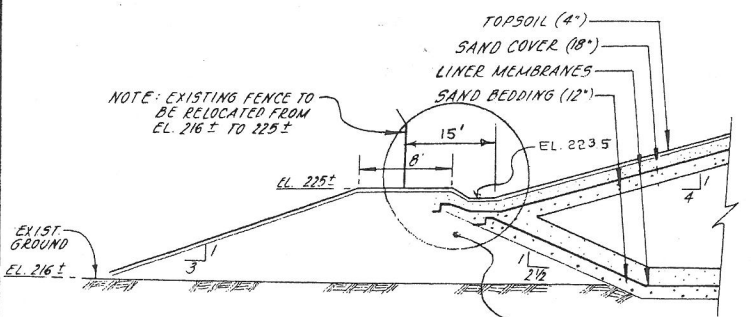
**REVISED COVER SYSTEM  
 DETAILS**

PROJECT NUMBER:  
2025.02

SHEET NUMBER:  
3 OF 3

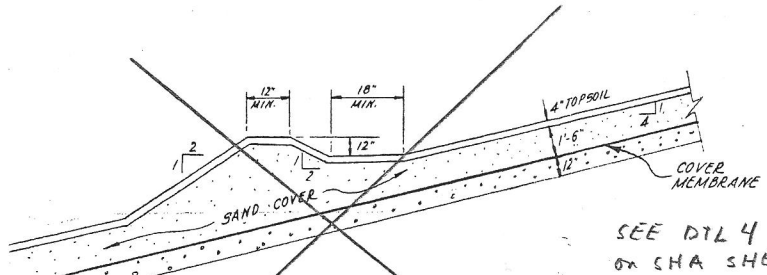


**SWALE NOTE**  
RIPRAP MATERIAL TO BE PLACED IN SWALES SLOPING STEEPER THAN ONE AND ONE HALF (HORIZONTAL) TO ONE (VERTICAL).



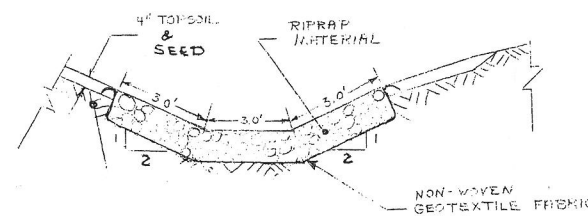
**FUTURE END BERM DETAIL**  
(N.T.S.)

SEE "TYPICAL MEMBRANE LINER SYSTEM & ANCHORAGE AT LOW SIDE" FOR DETAILS (MK-S-10)



**TYPICAL COVER MEMBRANE/SWALE DETAIL**  
(N.T.S.)

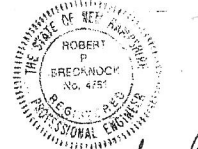
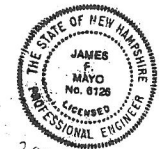
SEE DTL 4 ON SHA SHEET #2



**LINED RIPRAP SWALE**  
NTS

**NOTES:**

- 1) BOTTOM MEMBRANE NOTE: FROM STATION 5+68.41 TO THE END BERM, 60 MIL HYPALON MEMBRANE WILL BE INSTALLED IN PLACE OF THE 36 MIL HYPALON MEMBRANE NOTED ON PLANS. 40 MIL TEXTURED HDPE
- 2) CAP (COVER) MEMBRANE NOTE: FROM STATION 2+82.41 TO THE END BERM, 45 MIL HYPALON MEMBRANE WILL BE INSTALLED IN PLACE OF THE 36 MIL HYPALON MEMBRANE NOTED ON PLANS.



2001 REVISIONS  
9/7/01  
James Mayo  
Robert Brecknock

NO.	REVISION	DATE	DRWN	CHKD	APPR
1	ADDED "LINED RIPRAP SWALE" DETAIL NOTE 5/2/01 PSL				
2	REVISED RUNOFF BASIN NOTE 2 ADDED 1/10/00 PSL				
3	REV. TYP. MEMBRANE DETAIL	10/02 NT			
4	ADDED NOTE TO FUTURE END BERM	5/01 PSL JFM JFM			
5	ADDED 60 MIL AND 45 MIL NOTE	9/01 PSL JFM JFM			

DRAWN	W. N. T.
DESIGNED	P. S. L.
CHECKED	
APPROVED	

**PSNH PUBLIC SERVICE ENGINEERING DIVISION**  
Company of New Hampshire

**CLOSURE PLAN**  
**ASH DISPOSAL LANDFILL**  
**MERRIMACK STATION**  
**BOW, N. H.**

SCALE: 1" = 50'  
DATE: 7/6/90  
SHEET: OF  
DRAWING NO.: MK-S-7.2

**APPENDIX B**

**RELEVANT TECHNICAL SPECIFICATIONS  
FOR CLOSURE CONSTRUCTION**

# **CONTENTS**

## **DIVISION 2 – SITE WORK**

Section 02070 - Cap Geomembrane

Section 02074 - Geotextiles

Section 02075 - Drainage Geocomposite

Section 02200 - Earthwork

Section 02920 - Topsoil, Hydroseeding and Turf Establishment

**SECTION 02070**  
**CAP GEOMEMBRANE**

**PART 1 - GENERAL**

1.1 SCOPE OF WORK

- A. The Contractor shall furnish all labor, materials, tools, equipment, and incidentals, and perform all operations necessary to furnish, deploy, seam and test the double-sided textured high density polyethylene (HDPE) geomembrane.
- B. The Contractor shall be responsible for implementing a quality control (QC) testing program meeting, as a minimum, the requirements specified herein, and coordinating QC procedures with the Quality Assurance (QA) Consultant to assure that materials and installation methods employed are of a quality suitable for use in a secure landfill application.

1.2 DEFINITIONS

- A. Contractor: The Owner will engage a qualified Contractor who is trained and experienced in field handling, storing, deploying, seaming, and QC testing of HDPE liner for secure landfill applications.
- B. Quality Assurance (QA) Consultant: The Owner will engage a qualified QA Consultant to verify the quality of raw materials, the integrity and quality of seams and seaming processes performed on site, and the locations and results of all testing and repair work performed. The QA Consultant shall observe and document the work, and in particular, the QC testing, performed by the Contractor.
- C. Quality Control (QC): The Contractor shall implement QC measures to ensure liner installation is completed in a good workman-like manner and is in compliance with the specifications contained herein. QC procedures include, but are not limited to, providing manufacturer's material QC certifications; providing experienced and competent field staff; performing adequate personnel training; performing QC testing during liner installation; and maintaining records documenting QC items, such as as-built panel layout, locations and identifications of all repairs, locations and test results of all destructive and non-destructive field tests, as specified herein.

1.3 SUBMITTALS

- A. The Contractor shall submit with the Bid Package the following information.
  - 1. Contractor qualifications, including project descriptions.

2. Brand of textured HDPE to be used, and a statement from the supplier detailing its properties and composition.
  3. Warranties regarding quality of workmanship, materials, and long-term performance of the completed landfill liner.
- B. Shop Drawings, showing extent, sizes, panel identification numbers, and details of the textured HDPE geomembrane installation, including recommendations for terminating the liner and proposed methods of sealing around penetrations, if different than shown on the Drawings, shall be submitted prior to the start of geomembrane installation. Except for special requirements due to configuration and/or termination of the geomembrane, maximum use of large size panels shall be made.
  - C. QC plans detailing proposed QC procedures shall be submitted prior to the start of geomembrane installation.
  - D. Prior to shipment of the geomembrane material from the manufacturer, the installation Contractor shall provide roll certifications to the QA Consultant for review.
  - E. Prior to installation of the geomembrane, the Contractor and QA Consultant will issue a Letter of Surface Conformation to the Owner.
  - F. The manufacturer shall furnish certification that the resin used meets specifications.
  - G. Samples of all materials and certificates of specifications shall be submitted for inspection and acceptance upon the QA Consultant's request.
  - H. During the course of the work, the Contractor, along with the QA Consultant, shall each maintain As-Built Drawings showing, but not limited to, panel layout and identification, seam type and identification, repair locations and identifications, and destructive test sample locations and identification. The Contractor shall submit working copies of the As-Built Drawings to the QA Consultant upon request, and shall submit a final copy to the QA Consultant prior to demobilizing from the site.
  - I. The Contractor, with the QA Consultant, shall submit a Certificate of Acceptance as part of the QA Consultant's final report stating that all installation procedures and required testing have been accomplished in accordance with accepted procedures.

#### 1.4 CONTRACTOR AND MANUFACTURER REQUIREMENTS

- A. The Contractor to perform the work of this specification shall have demonstrated, by previous experience, the ability to do the work. The required previous experience shall consist of the following:



1. The Contractor shall have successfully installed not less than ten synthetic liners or covers totaling a minimum of 2,000,000 square feet similar in type to that specified herein, now giving satisfactory service in the United States.
  2. The Contractor shall be approved and/or licensed by the geomembrane material supplier.
- B. The manufacturer of the geomembrane shall have manufactured and fabricated not less than 10,000,000 square feet of HDPE for use in liner or cap installations.
  - C. The Contractor shall provide the services of a competent English-speaking field superintendent and QA technical representative throughout the installation of the liner and all appurtenant structures. The superintendent and QA technical representative shall each have personally supervised and directed the installation of a minimum of 2,000,000 square feet of HDPE lining or capping material.
  - D. All personnel performing seaming operations shall be qualified by experience. At least one seamer shall have experience seaming a minimum of 1,000,000 square feet of geomembrane with a similar method. This "Master Seamer" shall provide direct supervision over less experienced seamers. No seaming shall be performed without a Master Seamer present.
  - E. All field seams shall be inspected over their full length per these specifications by the Contractor in the presence of the QA Consultant.
  - F. The manufacturer shall furnish complete written instructions for the storage, handling, installation, seaming, repair, and inspection of the HDPE liner material in compliance with this specification and conforming to the conditions of his warranty. A copy of all manufacturer literature shall be submitted to the QA Consultant upon request.
  - G. The manufacturer or his designated representative shall furnish panel layouts as required for the HDPE liner installation.

#### 1.5 PRE-CONSTRUCTION MEETING

- A. A pre-construction meeting is required between the Owner, Engineer, Contractor, and QA Consultant prior to the start of any work on-site. The intent of the meeting is to discuss the requirements of these Contract Documents to ensure that all parties involved are familiar with their respective responsibilities.

#### 1.6 QUALITY ASSURANCE

- A. The Owner shall retain the QA Consultant to perform liner installation QA procedures. The QA Consultant will be on-site for observation of geomembrane handling, deploying, seaming, testing, and repair work.

- B. The Contractor shall cooperate with the QA Consultant, and furnish tools, samples of materials, and assistance as requested.
- C. The Contractor shall apprise the QA Consultant of the proposed work schedule on a daily basis, and shall inform the QA Consultant of schedule changes in a timely manner.
- D. The Contractor shall at all times furnish the QA Consultant and his representatives, facilities including labor, and allow proper time for inspecting and testing materials and workmanship. The Contractor must anticipate that possible delays may be caused to him in the execution of this work due to the necessity of materials and workmanship being inspected and accepted for use. The Contractor shall furnish, at his own expense, all samples of materials required by the QA Consultant for testing.

**PART 2 - PRODUCTS**

**2.1 HDPE LINER (SYNTHETIC MEMBRANE)**

**A. Membrane Resin Specifications**

- 1. The synthetic liner double-sided textured HDPE geomembrane shall be made from first quality resin containing no recycled polymer (product run may be recycled). The HDPE resin shall be the same for the membrane and the extrudite rod or bead and shall meet the following minimum requirements:

Melt Index	(ASTM D 1238 Condition 190/2.16)	<1.0 grams/10 min.
Specific Gravity	(ASTM D 1505)	0.940 g/cm <sup>3</sup>

**B. Membrane Specifications**

- 1. The manufacturer shall deliver textured HDPE geomembrane which is in conformance with the specifications below.

Minimum Average Sheet Thickness	ASTM D 5994	40 mils - 5%
Lowest Individual Thickness Reading	ASTM D 5994	34 mils

Tensile strength at break	ASTM D 6693 Type IV, 2 ipm	≥60 lb/in of width
Elongation at break	ASTM D 6693 Type IV, 2 ipm 2.0-inch Gauge Length	≥100%
Tear resistance	ASTM D-1004 Die C	≥28 lbs.
Puncture Resistance	ASTM D 4833	≥60 lbs.

In addition, the membrane shall:

2. Contain a minimum of 2 percent, but not more than 3 percent, carbon black according to ASTM D 4218, and have a carbon black dispersion rating of Category 1 or 2 with no more than 1 view in 10 of Category 3 according to ASTM D 5596.
  3. Consist of unreinforced high density polyethylene (HDPE) containing 3% by weight maximum additives, fillers or extenders including carbon black;
  4. Have no striations, pinholes or bubbles on the surface;
  5. Be produced so as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter.
  6. Geomembrane shall have 6 inches of smooth, non-textured material along both edges of the rolls. The texturing of the geomembrane shall be regular and uniform. Rolls of geomembrane containing irregular texturing (bald areas or clumps of texturing material) will be rejected by the QA Consultant and removed from the Site by the Contractor.
  7. Synthetic liner material delivered to the site shall be accompanied by a QC Certificate for each roll and shall be identified with a distinctive code which will serve as the identification number on the As-Built Drawing.
  8. Samples shall be taken and tested by the manufacturer at a frequency of 1 sample per 50,000 square feet, to assure conformance with the specifications.
  9. Samples shall be taken from the delivered material by the QA Consultant, at a frequency of 1 sample per 250,000 square feet, and shall be sent to an Independent Testing Laboratory to assure conformance with the specifications listed.
- C. The interface strength for the Geomembrane to Drainage Geocomposite and the Geomembrane to Sand Bedding soil interfaces shall equal or exceed strength represented by a friction angle of 21° when measured in general accordance with ASTM D 5321. The testing should include the following:

1. A minimum of three tests at varying normal stresses of 150 psf, 300 psf, and 500 psf shall be run to develop a failure envelope using samples of materials proposed to be used in the cover system.
2. The tests should be run in a soaked condition. The shear displacement rate for these tests should not exceed 0.04 inches per minute.

### **PART 3 - EXECUTION**

#### **3.1 DELIVERY, STORAGE, AND HANDLING**

- A. Damaged material or material not meeting specifications shall be immediately removed from the site and replaced at no cost to the Owner. Once delivered and accepted by the QA Consultant, the membrane rolls shall be stored on a surface approved by the QA Consultant, no more than 3 rolls high, and protected from dirt, grease, water, abrasions, excessive heat or cold, or other damage.
- B. Membrane rolls shall be handled with appropriate equipment to prevent damaging or stressing the membrane material. Loading and unloading shall be performed using equipment such as spreader bars and cloth chokers. Deployment shall be performed using equipment such as roll bars and vise-grip pliers designed to handle sheet materials. Any damaged membrane shall be repaired or replaced immediately, at the discretion of the QA Consultant, and at no cost to the Owner.

#### **3.2 WEATHER CONDITIONS**

- A. Membrane panels shall not be installed, seamed, or repaired during precipitation, excessively high winds, or in areas of ponded water or excessive moisture. Membrane panels may be installed and seamed only if the ambient air temperature, measured 6 inches above liner elevation, is less than 104 degrees F. Installation and seaming of membrane panels in ambient temperatures below 32 degrees F shall only be performed with written approval of the QA Consultant, and only if trial seams demonstrate the ability to meet seaming specifications.

#### **3.3 GENERAL INSTALLATION**

- A. The Contractor shall be responsible for field handling, storing, placing, seaming, plus any other processes required to assemble a continuous secure liner. All personnel performing seaming operations shall be qualified by experience. At least one seamer shall have experience seaming a minimum of 1,000,000 square feet of HDPE with a similar method. This "Master Seamer" will provide direct supervision over less experienced seamers; no seaming will take place without a "Master Seamer" present. The Owner shall decide which proposed personnel will be required to pass a seaming test prior to admission to the project.

- B. Installation shall be performed under the direction of a competent field technical representative. The technical representative shall be in charge of the installation and shall be responsible for the work performed.
- C. Subgrade preparation shall be performed by the Contractor according to Section 02200. Surfaces to be lined shall be smooth and free of all rocks, stones, sticks, roots, sharp objects, or debris of any kind. The surface should provide a firm, unyielding foundation for the membrane with no sudden, sharp or abrupt changes or break in grade. No standing water or excessive moisture shall be allowed. Prior to the installation of any synthetic liner material, the Contractor, Contractor, and QA Consultant shall inspect the surface on which the liner will be installed. The Contractor will advise of any remedial work required to bring the surface to the specifications required for liner installation. Upon satisfactory surface preparation the Contractor, Contractor and QA Consultant will issue a Letter of Surface Conformation to the Owner.
- D. The HDPE membrane shall be placed over the prepared surfaces in such a manner as to assure minimum handling. Any portion of HDPE membrane damaged during installation by any cause shall be removed or repaired by using an additional piece of HDPE at no additional cost to the Owner.
- E. Each HDPE membrane panel shall be assigned a simple and logical identification number or letter. In addition, the Contractor and the QA Consultant shall record the roll number, location, and date of installation of each panel placed. The panels shall be marked by their identification number or letters, and shall be recorded on the sets of As-Built Drawings by the Contractor and the QA Consultant. Upon completion of the work, the Contractor shall submit As-Built Drawings with panel identifications to the QA Consultant.
- F. The layout of panels will be decided upon prior to their placement in accordance with the panel layout drawings, in a meeting between the Owner and the Contractor. All efforts will be made to install the liner from the highest area in the landfill to the lower areas to facilitate the protection of the subgrade. No more panels shall be deployed during a single day than can be seamed together that same day.
- G. All deployed HDPE membrane panels shall be protected from uplift by wind by placing suitable ballast that will not damage the membrane during its placement or removal.
- H. All damaged subgrade or other underlying material shall be repaired prior to deploying HDPE membrane panels. The Contractor is expected to manage stormwater runoff from installed liner in a manner to limit damage of subgrade or other underlying materials previously prepared by the Earthwork Contractor.
- I. Vehicle traffic shall not be allowed directly on HDPE membrane panels. Equipment shall not damage panels by handling, leakage, transporting across panels, or any other means. Personnel working on or with HDPE membrane

panels shall not wear shoes that will damage the panels. Approved deployment vehicles (ATVs) shall only be allowed to travel on the Drainage Geocomposite and cover soils. Traffic on the geosynthetics shall be limited to the degree practical and spinning wheels, sharp turns, and quick stops on the geosynthetics shall not be allowed.

- J. HDPE membrane panels shall be unrolled using methods that will not stretch, crimp, abrade, or otherwise damage panels. Placement of panels shall employ methods that minimize wrinkles and differential wrinkles between adjacent panels.
- K. Placement of sand cover material shall not occur above a membrane that is under stress due to thermal contraction or other causes, or that has large wrinkles that may fold over and crimp, or when the ambient air temperature 12 inches above the membrane is greater than 104 degrees F or lower than 32 degrees F without prior approval of the QA Consultant. Panels under tensile stress due to thermal contraction or any other cause shall be cut and a patch shall be placed to provide compensation for membrane contraction. No equipment shall be driven directly on the membrane during placement of a sand cover.
- L. Installed HDPE membrane panels shall be anchored in a trench around the perimeter of the landfill as indicated on the Drawings.

#### 3.4 HDPE MEMBRANE SEAMING

- A. HDPE membrane seams shall be laid out so that the seams are oriented parallel to the line of maximum slope. Cross or butt seams on slopes, seams located in corners, and unusual geometric panel shapes shall be minimized.
- B. The seam identification system shall be related to and compatible with the panel identification system.
- C. Seaming apparatus shall be equipped with temperature gauges and readout devices that enable continuous monitoring of apparatus temperatures during seaming. Electric generators shall be capable of providing constant voltage under load and shall be underlain with a splash pad to collect spilled fuel or oil when located on the membrane.
- D. Trial seams shall be performed for each seaming apparatus used at the beginning (start of shift), of each day, and at the beginning of each period after which the seaming apparatus has been turned off or disconnected from its power supply or has been idle for 5 hours, and after any change in operator personnel on a welding unit, or at any other time deemed necessary by the QA Consultant.
- E. Trial seams shall be performed under the same physical conditions as production seaming. Trial seams shall be a minimum of 5 feet long and 12 inches wide (perpendicular to the seam.) One inch wide samples shall be cut perpendicular to the seam and tested according to ASTM D 6392 in a

tensiometer for bonded seam strength (shear) and peel adhesion. Two (2) samples will be tested for shear, and five (5) samples for peel (10 peel tests total for fusion welds since both edges of the weld must be tested.) Two (2) passing shear tests and 4 out of 5 passing peel tests (9 out of 10 for fusion welds) are required for an acceptable trial seam. Each sample failure must consist of a ductile break that is film tearing bond, and must meet the following strength requirements:

		40-mil Textured HDPE
Peel Strength	ASTM D 6392	≥60 lb/in
Shear Strength	ASTM D 6392	≥80 lb/in

The criteria for field seams passing in shear and peel is the same as that for the destructive testing described below. The Contractor is responsible for providing and operating an on-site tensiometer and corresponding sample cutting equipment to perform all trial seam testing. If either test fails, another trial seam shall be performed and tested. If any test seams fail on the second trial seam, the seam welder shall not be used until it is repaired, or faulty conditions or operator are corrected and two consecutive trial seams pass the destructive tests as outlined above.

A record of the date, time, ambient weather conditions, test results, operator, and equipment number shall be maintained by the Contractor, and submitted to the QA Consultant on a weekly basis. A properly identified unused section of the trial weld seam will be retained by the Owner.

- F. Immediately prior to seaming, surfaces to be seamed shall be overlapped a minimum of 4 inches and cleaned of moisture, grease, dust, dirt, debris and any other foreign material. No solvent or adhesive shall be used for seaming or cleaning without approval from the manufacturer, the QA Consultant, Engineer, and Owner.
- G. A sample shall be cut from the end of every seam (extrusion or fusion) greater than 75 feet in length. The sample shall be cut into two (2) coupons which will be tested for peel adhesion in each direction (4 peel tests for fusion welds.) The QA Consultant shall observe the coupon testing prior to starting a new seam with that piece of welding equipment or technician. If any test fails, new trial seams shall be created and tested.
- H. Where moisture or dirt causes seaming difficulty, a protective sheet of plastic shall be placed below the seam overlap to protect the panels being seamed. This may consist of a "scrub sheet" of plastic that is pulled along beneath the seaming apparatus.
- I. For extrusion welding, surfaces to be seamed shall be cleaned of oxidation by disc grinder not more than one hour before extruding the seam. Abrasion of the seam area with the disc grinder shall not extend beyond the extrusion bead area unless inspected and approved by the QA Consultant. Tack welding of the panels to be seamed shall not damage the membrane or adversely affect the

seaming operation. The top membrane of the seam overlap shall be beveled and the extrusion apparatus shall be purged of heat-degraded extrudate before seaming.

- J. Fish mouths shall be cut along the ridge of the wrinkle and laid flat to overlap the edges of the cut. The overlap shall be extrusion-seamed and any portion of the seam with less than 3 inches of overlap shall be patched with a circular or oval patch extending a minimum of 6 inches beyond the cut in all directions.
- K. The Contractor shall log the ambient air temperature 12 inches above the membrane elevation, extruded temperatures in extruded barrels and nozzles, and operating temperatures of hot wedge seamers at intervals specified by the QA Consultant.
- L. The Contractor shall visually inspect seams and panels for holes, crimps, abrasions, or defects, and shall mark each suspect location. All repair locations shall be assigned an appropriate identifying label which shall be clearly marked on the panel adjacent to the repair location and shall be shown on the As-Built Drawing. Each marked location shall be repaired, non-destructively tested, and recorded on the As-Built Drawings. No repairs shall be covered until passing results of non-destructive tests and destructive tests are achieved and accepted by the QA Consultant.
- M. Methods of repair shall consist of spot welding small tears, pinholes or over-abraded areas where the thickness of the geomembrane has been reduced by more than 6 mils (0.006 inches); abrading and rewelding small sections of defective extrusion welds; and removing a defective seam and replacing with a new strip of material. The surface of the HDPE in the seam/repair area shall be abraded no more than one hour before the repair is made. All HDPE surfaces shall be cleaned and dried at the time of the repair. Defective hot wedge seams may be abraded and extrusion welded providing the top membrane overlap is carefully cut off. Patches over larger holes and other defects shall extend a minimum of 6 inches beyond the edges of the defect. All corners of patches shall be rounded with a radius of at least 3 inches.
- N. Seams formed at the intersection of cross or butt seams and adjacent panels, "T seams", shall be patched with a circular or oval patch extending a minimum of 12 inches beyond the intersection in all directions.

### 3.5 INSTALLATION CONTRACTOR QC TESTING

- A. Non-destructive testing over the full length of all seams shall be performed to ensure watertight, homogeneous seams. Test methods shall consist of vacuum box testing of extrusion seams, air-pressure testing of double-fusion seams, or other methods approved in writing by the manufacturer and QA Consultant. The testing shall be performed as work progresses, not at the completion of all field seaming. All seams from prior day's production shall be required to be tested prior to additional liner deployment and seaming.



- B. Vacuum box testing shall be performed on extrusion welds using a vacuum box with a rigid housing, transparent viewing window, a soft rubber gasket on the bottom edge and a valve assembly with a vacuum gauge. The vacuum box must be approved by the QA Consultant prior to use. The QA Consultant has the right to reject any vacuum box that he feels may not provide accurate results.
- C. Vacuum box testing shall be performed in accordance with ASTM D 5641 by applying a soap and water solution to the seam, placing the box over the seam and applying a vacuum of 5 psi (min.) to the box so a leak-tight seal is obtained. The seam shall be examined through the viewing window for at least 10 seconds or as directed by the QA Consultant for the presence of soap bubbles. If soap bubbles are detected in the viewing window, the location will be marked and repaired in accordance with Section 3.4 of these specifications.
- D. Air pressure testing shall be performed on double-fusion seams having an air channel between the seams. Both ends of the seam shall be heat-sealed and a hollow needle with a pressure gauge and valve attached shall be inserted into the air channel. A pump shall be attached to the needle and an initial air pressure of between 20 to 30 psi shall be applied to the air channel. The valve shall be closed and the pressure shall be observed for a minimum of 2 minutes. If the gauge pressure drops more than 4 psi or doesn't stabilize, the defective area shall be located, marked, and repaired in accordance with Section 3.4 of these specifications. The QA Consultant will witness the entire test, including the release of pressure or vacuum, to monitor for a defective pressure or vacuum gauge. Air pressure testing shall be performed in accordance with ASTM D 5820. After completing the air pressure test, the needle shall be removed and the hole shall be sealed and tested with the vacuum box.
- E. Destructive seam strength testing shall be performed at a minimum frequency of one per 500 linear feet of seam per welding machine or technician. The QA Consultant will select the locations for destructive seam samples and, at his discretion, may take samples more frequently than one per 500 feet. The QA Consultant reserves the right to increase the frequency of destructive testing if deemed necessary. Destructive seam strength testing shall be performed as work progresses to obtain test results before seams are covered. Destructive seam strength test samples shall be cut by noon of the following workday, or no additional deployment or seaming shall occur until the sample is cut.
- F. The Contractor shall cut destructive test samples at the locations designated by the QA Consultant. The destructive test samples shall be 12 inches wide and 42 inches long with the seam centered lengthwise. Each test sample shall be assigned an identification number and the locations shall be recorded on the As-Built Drawings.
- G. All holes resulting from destructive test samples shall be repaired immediately and tested within 24 hours of patch completion with the vacuum box in accordance with these specifications.

- H. Field testing of each destructive test sample shall be coordinated by the QA Consultant and then performed by the Contractor as specified in Part 3.5E of this Section. Samples not passing destructive field testing shall be considered failed seams and shall not be sent for laboratory testing.
- I. Laboratory testing of each destructive test sample shall be coordinated by the QA Consultant and performed by an independent geosynthetic testing laboratory paid for by the Owner. Testing shall be performed in accordance with Part 3.4 E. of this Section, and also include thickness testing in accordance with ASTM D 5994.
- J. If either field destructive test seams or laboratory test seams do not pass, the seam shall be reconstructed between any two passing test seam locations, or intermediate tests may be performed on both sides of the failed test sample location to further isolate the defective seam area. If intermediate field test seams pass, laboratory test seams shall be performed on samples from the same locations. If laboratory test seams also pass, then the seam shall be reconstructed between the intermediate sample locations. If either of the test seams fail, then the process shall be repeated with intermediate samples further away from the original failing seam location to determine the defective seam area.
- K. To be considered an acceptable seam, each seam shall be bounded by two locations where samples passed the laboratory destructive tests. Whenever a reconstructed seam exceeds 150 feet, an additional sample shall be obtained for destructive testing along the reconstructed seam. At the QA Consultant's discretion, it may be necessary to take additional samples from seams welded on the same day by a seaming apparatus that welded a seam not passing seam specifications. The use of such welding machines shall be discontinued until passing results are received.
- L. After large areas of geomembrane have been seamed and before they are covered, large wrinkles shall be cut, reseamed and tested.
- M. If a seam is located where non-destructive testing cannot be performed, the seam shall, at the discretion of the QA Consultant, be liner-stripped (capped) and the liner-stripping operation shall be observed by the QA Consultant and Contractor for completeness and undergo non-destructive testing, if possible.
- N. All destructive and non-destructive field test results and locations shall be recorded by the Contractor and the QC Consultant on the As-Built Drawing. Records shall be kept on file at the site for inspection by the Owner and QC Consultant.

### 3.6 FINAL INSPECTION

- A. A final inspection shall be performed by the Contractor, QA Consultant, and Owner prior to the Installers' liner crew moving off the site. All identified problem areas shall be repaired by the Contractor and accepted by the QA Consultant prior to the crew moving off site.

**[END OF SECTION 02070]**

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## **SECTION 02074**

### **GEOTEXTILES**

#### **PART 1 - GENERAL**

##### **1.1 SCOPE OF WORK**

- A. Furnish all labor, materials, tools and equipment and perform all operations necessary to furnish, deploy, and install geotextiles in the areas indicated on the Drawings or as required by the Engineer or Owner.

##### **1.2 QUALITY ASSURANCE**

- A. Experience
  - 1. The Contractor shall be trained and experienced in field handling, storing, deploying, installing and protecting geotextiles.
- B. Submittals
  - 1. The Contractor shall submit to the Engineer samples of the proposed geotextiles, and certification that the geotextiles meet the required specifications, at least 15 days prior to delivery of materials to the site.

##### **1.3 MATERIALS STORAGE AND HANDLING**

- A. The Contractor shall be responsible for the handling, storage and care of geotextiles from the time of delivery to the site until final acceptance of the completed work by the Owner. The Contractor shall be liable for all damages to the materials during such time.

#### **PART 2 - PRODUCTS**

##### **2.1 GENERAL**

- A. The geotextiles provided shall meet or exceed the property values specified herein. Geotextiles shall be comprised of polymeric yarns of fibers or weld or drawn strands oriented into a stable network which will retain its structure during handling, placement, and long-term service. Geotextiles shall be capable of withstanding direct exposure to the sunlight for 30 days with no measurable deterioration.
- B. Synthetic fabrics shall be non-biodegradable. The Contractor shall follow the manufacturer's recommendations regarding handling and installation of such materials.
- C. Samples of the product selected for use by the Contractor shall be submitted to the Engineer for approval prior to the delivery of the materials to the site from the source.

## 2.2 GEOTEXTILES

- A. Nonwoven Geotextile shall be a nonwoven polypropylene or polyester material, which meets or exceeds the minimum average roll values tabulated below:

Fabric Property	Test Method	Minimum Fabric Requirement
Mass per Unit Area, oz/yd <sup>2</sup>	ASTM D 5261	10
Grab Tensile Strength, lbs	ASTM D 4632	230
Trapezoidal Tear Strength, lb	ASTM D 4533	95
Puncture Resistance, lbs	ASTM D 4833	120
Water Flow Rate, gpm/ft <sup>2</sup>	ASTM D 4491	30

## 2.3 THREAD

- A. Thread used to seam Nonwoven Geotextiles shall be a polymeric material with chemical resistance properties equal to or exceeding those of the Nonwoven Geotextile. The thread shall be different color than the Nonwoven Geotextile.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Geotextiles shall be installed in accordance with the manufacturer's recommendations, and as shown on the Drawings and specified herein; and,
- B. Where the use of adjacent sheets of a geotextile are required and are not to be sewn, a minimum overlap of 18 inches shall be maintained.
- C. In applications where geotextile surrounds pipe and crushed stone, the geotextile wrap shall be overlapped a minimum of 18 inches.
- D. All holes and tears in the geotextiles shall be noted and repaired as specified by the Engineer.

**[END OF SECTION 02074]**

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**SECTION 02075**

**DRAINAGE GEOCOMPOSITE**

**PART 1 – GENERAL**

**1.1 SCOPE OF WORK**

- A. The Contractor shall provide all labor, materials, tools, and equipment and perform all operations necessary to furnish, deploy, and install Drainage Geocomposite in the areas indicated on the Drawings or as required by the Engineer or Owner.

**1.2 QUALITY ASSURANCE**

- A. The Contractor shall be trained and experienced in field handling, storing, deploying, and installing Drainage Geocomposite. Alternatively, the Contractor shall engage an experienced Subcontractor who shall meet the experience requirements.
- B. The Contractor shall submit to the Engineer samples of the proposed Drainage Geocomposite, and certification that the material meets the required specifications, at least 15 days prior to delivery of materials to the site.

**1.4 MATERIAL STORAGE AND HANDLING**

- A. The Contractor shall be responsible for the handling, storage, and care of the Drainage Geocomposite from the time of delivery to the site until final acceptance of the completed work by the Owner. The Contractor shall be liable for all damages to the materials during such time.

**PART 2 – PRODUCTS**

**2.1 GEONET**

- A. Geonet shall be manufactured of HDPE which has a carbon black content of 2 to 3 percent by weight according to ASTM D 4218.
- B. In addition to the properties specified above, Geonet shall meet or exceed the specifications tabulated below.

<b>Property</b>	<b>Units</b>	<b>Value</b>	<b>Test</b>
Polymer specific gravity	g/cm <sup>3</sup>	0.94	ASTM D 1505
Polymer melt index	g/10 min	<1.1	ASTM D 1238
Thickness	mils	≥ 190	ASTM D 5199

## 2.2 DRAINAGE GEOCOMPOSITE

- A. Drainage Geocomposite shall consist of a Geonet meeting the specifications described in Section 2.1 to which a geotextile has been heat-bonded to both sides.
- B. The geotextile portion of the Drainage Geocomposite shall meet or exceed the minimum average roll values tabulated below:

<b>Geotextile Property</b>	<b>Unit</b>	<b>Test Method</b>	<b>Required Value</b>
Fabric weight	oz/y <sup>2</sup>	ASTM D 5261	5.5
Grab Strength	lbs	ASTM D 4632	≥ 150
Puncture resistance	lbs	ASTM D 4833	≥ 80
Permittivity	sec <sup>-1</sup>	ASTM D 4491	1.5 minimum average

- C. The bond strength between the geotextile, Geonet, and the geocomposite shall be greater than or equal to 1.0 pound per inch using ASTM D-7005 methods.
- D. The minimum average roll value transmissivity measured in accordance with ASTM D 4716 (modified) using a gradient of 0.25 under a compressive stress of 300 psf shall meet or exceed  $2.2 \times 10^{-4}$  meters squared per second when tested between steel plate and granular soil. ASTM D 4716 shall be modified to use 100-hour seating time.
- E. The interface strength for the Geomembrane to Drainage Geocomposite and the Sand Cover to Drainage Geocomposite interfaces shall equal or exceed strength represented by a friction angle of 21° when measured in general accordance with ASTM D 5321. The testing should include the following:
  - a. A minimum of three tests at varying normal stresses of 150 psf, 300 psf, and 500 psf shall be run to develop a failure envelope using samples of materials proposed to be used in the cover system.
  - b. The tests should be run in a soaked condition. The shear displacement rate for these tests should not exceed 0.04 inches per minute.

## 2.3 TIES

- A. Ties used to secure adjacent sheets of Geonet shall be plastic fasteners, or polymer braid. Metallic ties will not be allowed. Ties shall be yellow or white to facilitate inspection.

## **PART 3 – EXECUTION**

### **3.1 INSTALLATION**

- A. Drainage Geocomposite shall be installed in accordance with manufacturer's recommendations, and as shown on the Drawings and specified herein.
- B. Care shall be taken to keep the Drainage Geocomposite clean prior to installation.
- C. Folds or excessive wrinkling of deployed Drainage Geocomposite shall be removed to the extent practicable. The Contractor shall exercise care not to entrap stones, excessive dust, or foreign objects in the material. Drainage Geocomposite shall be adequately weighted, using sand bags or equivalent until sand cover is placed.
- D. Adjacent sheets of Drainage Geocomposite shall be overlapped a minimum of 4 inches, and shall be secured using ties placed at intervals no greater than 4 feet. Additional ties spaced at intervals not exceeding 2 feet shall be used on seams running across slopes and located in anchor trenches. Spot welding of the Drainage Geocomposite to the geomembrane shall not be allowed.
- E. The geotextile on adjacent panels of Drainage Geocomposite shall be sewn together with continuous seam in the field prior to placement of overlying soil. All seams on sideslopes shall be oriented parallel to the slope. The adjacent sheets of geotextile shall be overlapped a minimum of 6 inches prior to seaming. All overlaps shall be such that the upslope sheet is placed over the downslope sheet.
- F. Drainage Geocomposite shall not be exposed to ultraviolet rays for more than fourteen (14) days before being covered. The Contractor shall place cover material over the Drainage Geocomposite as specified in Section 02200 and in such a manner as to ensure the Drainage Geocomposite is not damaged.

**[END OF SECTION 02075]**

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## **SECTION 02200**

### **EARTHWORK**

#### **PART 1 - GENERAL**

##### **1.1 SCOPE OF WORK**

- A. Furnish all labor, materials, equipment and incidentals necessary to perform all excavation, backfill, fill and grading required to complete the work shown on the contract drawings and specified herein.

##### **1.2 PROTECTION**

###### **A. Sheeting and Bracing**

1. Protect excavations to prevent cave-in or loose soil from falling into excavation. Observe all applicable OSHA regulations and standards for trenching and excavation.
2. Protect bottom of excavations from freezing. Do not place fill over frozen soil without first obtaining approval from the Engineer or Owner.
3. Recompact fills subjected to vehicular traffic or other disturbances.

###### **B. Pumping and Drainage**

1. The Contractor shall at all times during construction provide and maintain proper equipment and facilities to remove all water entering the construction area and any excavations created as part of this Work. The Contractor shall keep excavations dry so as to obtain a satisfactory subgrade condition.
2. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation.
3. Water entering the excavation from surface runoff shall be collected and pumped from the excavation to maintain a bottom free of standing water.
4. Drainage shall be disposed of in an approved area so that flow or seepage back into the excavated area will be prevented and any fines contained within the water will not be discharged to surface waters.
5. The Contractor shall take all necessary precautions to preclude the accidental discharge of fuel, oil, etc. in order to prevent adverse effects on surface water and groundwater quality. In the event of an accidental spill, the Engineer and Owner shall be immediately notified and all free liquids shall be cleaned up and all contaminated soils shall be excavated and disposed of properly by the Contractor at the Contractor's expense.

### 1.3 SUBMITTALS

- A. The Contractor shall submit to the Engineer and Owner for review the proposed Execution Plan for construction, including filling, compaction, and moisture control for the various portions of the work. The Contractor shall submit results of testing demonstrating proposed soil material meet the specifications, prior to delivery of materials to the site. Review shall be for method only. The Contractor shall remain responsible for the adequacy and safety of the methods.

### 1.4 SOIL TESTING AND CONSTRUCTION MONITORING

- A. Prior to the general placement of the fill, and during such placement, the Engineer or Owner may select areas within the limits of the fill for testing the degree of compaction obtained. The Contractor shall cooperate fully in obtaining the information desired and shall allow the Engineer sufficient time to make necessary observations and tests. See Section 2.2 for specific information.
- B. Payment for all testing, with the exception of the off-site source testing conducted by the Contractor, will be made by the Owner. If test results are unsatisfactory, all costs involved in correcting deficiencies to the satisfaction of the Engineer and Owner will be borne by the Contractor.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

#### A. Sand Bedding

- 1. Sand Bedding to be used as the soil material on which the HDPE geomembrane cap is installed shall be a granular soil consisting of clean, inert, hard, durable grains of quartz or other hard durable rock, free from clay, organics surface coatings, or other deleterious material and shall be free of all angular materials. Sand Bedding shall conform to the following gradation:

Sieve Size	Percent Finer by Weight
1-inch	100
No. 4	85-100
No. 40	50-90
No. 200	0-50

#### B. Granular Fill

- 1. Granular fill is to be used as general fill as may be required. This material shall be soil containing no stone larger than four inches in largest dimension, be free of trash, ice, snow, tree stumps, roots, and other organic and deleterious material. Granular fill shall not contain more than 15 percent of soil material passing the No. 200 sieve. It shall be of such a

nature and character that it can be compacted to the specified densities in a reasonable length of time.

Sieve Size	Percent Finer by Weight
4-inch	100
No. 40	15 – 95
No. 200	0 – 15

C. Sand Cover

- Sand Cover soil to be used above the drainage geocomposite in the landfill cover system shall conform to the following:

Sieve Size	Percent Finer by Weight
1-inch	100
No. 40	40 – 90
No. 200	0 – 12

In addition, the material shall have a calcium carbonate content of no more than 15%.

D. Moisture Retention Soil

- Moisture Retention soil to be used as above the Sand Cover and below the topsoil in the cover system shall consist of inorganic soil with a maximum particle size of 3 inches, a silt content between 15 and 35 percent and a permeability that is less than  $1 \times 10^{-4}$  centimeters per second (cm/sec) when tested in accordance with ASTM D 5084. The permeability test should be performed at a moisture content within 2 percent of the optimum water content and at a density that is 88 to 92 percent of the maximum density per ASTM D 698.

E. Crushed Stone

- Crushed Stone for use in the toe drain shall be composed of hard, durable particles of crushed stone and mineral matter conforming to the requirements of #67 aggregate as specified in Section 703 (1½-inch crushed stone) of the 2010 New Hampshire Department of Transportation Standard Specifications (NHDOT Specifications).

## 2.2 MATERIALS TESTING

- The Contractor shall supply testing results for off-site sources showing the soils comply with the specifications. The testing shall include the following:
  - Particle Size (ASTM D 422)

2. Calcium Carbonate (ASTM D 4373)
- C. The soils will be tested by the Quality Assurance Consultant retained by the Owner as they arrive onsite and are placed for Particle Size (ASTM D 422) at an approximate frequency of 1 test per 3000 CY for unprocessed soil materials and 1 test per 10,000 CY for processed soil materials.

### **PART 3 - EQUIPMENT**

#### **3.1 LOW GROUND PRESSURE (LGP) EQUIPMENT**

- A. The Contractor's attention is brought to the need for LGP construction equipment. The LGP equipment is required during the placement of all materials over the geosynthetic cap system. All travel ways above the geomembrane for non-LGP equipment shall be a minimum of three (3) feet thick.

### **PART 4 - EXECUTION**

#### **4.1 EXCAVATION BELOW GRADE**

- A. Excavation shall be made to the grades shown on the contract drawings and to such widths as will give suitable room for construction. The bottom of the excavations shall be rendered firm and dry and in all respects acceptable to the Engineer and Owner.
- B. When excavation has reached prescribed depths, the Engineer shall be notified and will inspect conditions. If materials and conditions are not satisfactory to the Engineer and Owner, the Engineer or Owner will issue instructions as to the procedures.
- C. If, in the opinion of the Engineer or Owner, the material in its undisturbed natural condition, at or below the normal grade of the excavation as indicated on the contract drawings is unsuitable, it shall be removed to such depth and width and replaced with suitable material as directed by the Engineer or Owner. The Contractor shall be responsible for the removal, relocation and stockpiling of unsuitable material in the area designated by the Owner or Engineer. Unsuitable material is classified here as stumps, excessively wet soil, ledge rock, ice, topsoil, subsoil, organics, existing fill or other deleterious material.
- D. The Contractor shall use a flat edge backhoe bucket to excavate to expose to the existing geosynthetic materials in the area where cap membrane will overlap existing cap or liner system geosynthetics. This excavation activity shall not damage the existing geosynthetics. Damage to geosynthetics shall be repaired at the Contractor's expense. This excavation will be maintained accessible and free of excessive water, soil, or other deleterious material until the new geosynthetics can be installed.

#### 4.2 MISCELLANEOUS EXCAVATION

- A. The Contractor shall make all excavations necessary to permit the placing of topsoil, for constructing roadways, berms and any other miscellaneous earth excavation required.

#### 4.3 SUBGRADE PREPARATION - GENERAL

- A. Prior to fill placement, the subgrade should be compact, dry, and free from debris, ice, and snow. Fill shall not be placed over frozen soil unless otherwise approved by the Engineer or Owner.
- B. Subgrade preparation should be followed immediately by fill placement. Deterioration of the subgrade between excavation or fine grading and initial fill placement or geomembrane installation shall be the responsibility of the Contractor and shall be repaired at the Contractor's expense.
- C. All subgrade surfaces must be inspected and approved by the Engineer and Owner prior to fill placement. Sufficient time must be given to the Engineer and Owner to inspect the subgrade.

#### 4.4 FILL COMPACTION CRITERIA

- A. Unless otherwise waived by the Engineer, Sand Bedding soil shall be compacted with at least two passes of a smooth drum roller with a static weight of at least 8,000 pounds. Compaction shall take place when the water content of the soil is not more than 2% above the optimum moisture content per ASTM D 698.

#### 4.5 FILL PLACEMENT AND COMPACTION - GENERAL

- A. The Sand Cover fill shall be placed in one lift of 12 inches. This lift must be placed by pushing upslope only, using LGP equipment.
- B. All fill shall be placed "in the dry." The fill areas shall be graded to drain and provide a smooth surface, which will readily shed water.
- C. Fill containing ice, snow, frozen soil, large rocks, or other deleterious material shall not be placed without removal of unacceptable materials.
- D. Fill placement shall not be allowed during weather conditions, which do not allow for proper moisture and density controls.
- E. The Engineer will observe construction. During the course of construction, the Engineer will advise the Owner in writing if at any time in his opinion the work does not conform to the Contract Documents.
- F. The Engineer's presence does not include supervision or direction of the actual work by the Contractor, his employees, or agents. Neither the presence of the Engineer nor any observations and testing performed by him shall excuse the Contractor from defects discovered in his work.

- G. The Contractor shall have a “spotter” when dumping soils to construct the cover and to ensure no deleterious material is mixed in with the cover soils (i.e., rocks, sticks, etc.) and to minimize folding of wrinkles in the geosynthetics.

**[END OF SECTION 02200]**

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## **SECTION 02920**

### **TOPSOIL, HYDROSEEDING, AND TURF ESTABLISHMENT**

#### **PART 1 - GENERAL**

##### **1.1 SCOPE OF WORK**

- A. Furnish all labor, materials, equipment and incidentals required to furnish and place topsoil, finish grade, furnish and apply lime and fertilizer, furnish and hydraulically apply seed and mulch, and maintain all seeded areas as specified herein.
- B. Contractor shall seed all areas disturbed by his operations. All areas disturbed or not having sufficient vegetation to prevent erosion shall be seeded.

##### **1.2 SAMPLES AND APPROVAL OF MATERIAL**

- A. Samples of all materials shall be submitted for inspection and acceptance upon Engineer's request.
- B. The Contractor shall submit the proposed seed mix including the manufacturer's certificate of compliance to the Engineer for review prior to seeding.
- C. Seed bag tags shall be provided to the Engineer at the time of seeding.

#### **PART 2 - PRODUCTS**

##### **2.1 MATERIALS**

- A. Topsoil shall be fertile, natural soil capable of sustaining vigorous plant growth, typical of the locality, free from stones greater than 3 inches, roots, sticks, clay, peat, weeds and sod and obtained from naturally well drained areas. It shall not be excessively acidic or alkaline nor contain toxic material harmful to plant growth.
- B. Fertilizer shall be a complete commercial fertilizer, 10-10-10 grade for grass areas. It shall be delivered to the site in the original unopened containers each showing the manufacturer's guaranteed analysis. Fertilizer shall be stored so that when used it shall be dry and free flowing.
- C. Lime shall be ground limestone containing not less than eighty-five percent (85%) calcium and magnesium carbonates.
- D. Grass seed shall be from the same or previous year's crop; each variety of seed shall have a percentage of germination not less than ninety (90), a percentage of purity of not less than eighty-five (85) and shall have not more than one percent (1%) weed content. The seed mixture shall conform to the

requirements of Slope Seed Type 44 as specified in Section 644 of the 2010 New Hampshire Department of Transportation Standard Specifications (NHDOT Specifications), or other seed mix approved by the Engineer.

- E. The seed shall be furnished and delivered premixed in the proportions specified above. A manufacturer's certificate of compliance to the specified mix shall be submitted by the manufacturer for each seed type. These certificates shall include the guaranteed percentages of purity, weed content and germination of the seed, and also the net weight and date of shipment. No seed may be sown until the Contractor has submitted the certificates.
- F. Hay mulch shall be dry hay or straw mulch free of mold.
- G. Fertilizer, seed, and lime shall be furnished in new, clean, sealed, and properly labeled bags, with the following information clearly marked:
  - Manufacturer name
  - Type
  - Weight
  - Guaranteed analysis

### **PART 3 - EXECUTION**

#### **3.1 APPLICATION**

- A. Unless otherwise shown on the Drawings, topsoil shall be placed to a minimum thickness of 4 inches.
- B. For all areas to be seeded:
  1. Lime shall be applied uniformly over the area at the rate of twenty-five (25) pounds per 1,000 square feet minimum and one-hundred (100) pounds per 1,000 square feet maximum.
  2. Fertilizer (10-10-10) shall be applied uniformly over the area at the rate of twenty (20) pounds per 1,000 square feet.
  3. Seed shall be applied uniformly over the area at the minimum rate of three (3) pounds per 1,000 square feet.
  4. Fiber mulch shall be applied uniformly over the area at the rate of seventy-five (75) pounds per 1,000 square feet minimum and one-hundred fifty (150) pounds per 1,000 square feet maximum.
- C. The application of fertilizer and lime shall be performed hydraulically in one operation with hydroseeding. The Contractor will be responsible for cleaning all structures and paved areas of unwanted deposits.
- D. The application of hay mulch is to be by pneumatic blower.



## 3.2 INSTALLATION

- A. The subgrade of all areas to be covered with topsoil and seeded shall be raked and all rubbish, sticks, roots and stones larger than 3 inches shall be removed. Subgrade surfaces in all areas shall be tracked immediately after fine grading and raking has been completed. Tracking is to be performed with bulldozers operating in the direction of water flow. The tracks of the bulldozers are to have grousers of sufficient height to leave visible depressions in the subgrade. The depressions are to be perpendicular to the direction of water flow to reduce erosion potential until topsoil is placed. During the tracking, all depressions caused by settlement or tracking shall be filled with additional topsoil and the surface shall be regraded and tracked until an even finished grade is created.
- B. Subgrades shall be observed and approved by the Engineer before topsoil is placed. After topsoil has been spread and fine graded, all large stiff clods, lumps, brush, roots, stumps, litter and other foreign material shall be removed from the area covered with topsoil and disposed of by the Contractor. The entire area where topsoil has been placed shall then be tracked as indicated in paragraph 3.2.A above.
- C. Application of fertilizer, lime, seed and mulch shall only be performed during those periods within the seasons that are normal for such work as determined by the weather and locally accepted practice, and as approved by the Engineer. Seeding and fertilizing shall be conducted between April 1 and June 1 or between August 15 and October 15, or as directed or permitted by the Engineer. The Contractor shall hydroseed and hay mulch only on a calm day.
- D. Schedules for seeding and fertilizing must be submitted to the Engineer and Owner for approval prior to the work being performed.
- E. Lime and fertilizer are to be spread hydraulically in one operation with the hydroseeding.
- F. Seeding shall be done within five (5) days following soil preparation. Seed shall be applied hydraulically at the rates and percentages indicated. The spraying equipment and mixture shall be so designed that when the mixture is sprayed onto an area, the lime, fertilizer and seed shall be equal in quantity to the specified rates. Prior to the start of work, the Engineer and Owner shall be furnished with a certified statement for approval as to the number of pounds of materials to be used per 100 gallons of water. This statement shall also specify the number of square feet of seeding that can be covered with the quantity of solution in the hydroseeder.
- G. When protection of newly graded areas is necessary at a time that is outside of the normal seeding season, the Contractor shall protect those areas by whatever means necessary (such as straw or erosion control mats) or by other measures as approved by the Engineer and Owner.

### 3.3 MAINTENANCE AND PROVISIONAL ACCEPTANCE

- A. The Contractor shall keep all seeded areas watered and in good condition, shall reseed if and when necessary until a good, healthy, uniform growth is established over the entire area seeded, and shall maintain these areas in an approved condition until provisional acceptance.
- B. On slopes, the Contractor shall protect against wash outs by an approved method. Any wash out that occurs shall be regraded and reseeded at the Contractor's expense until a good sod cover is established.
- C. The Engineer or Owner will observe work for provisional acceptance at the end of the eight (8) week grass maintenance period, and upon the written request of the Contractor, which must be received at least ten (10) days before the anticipated date of observation.
- D. A satisfactory stand will be defined as a section of grass of 10,000 square feet or larger that has:
  - 1. No bare spots larger than three (3) square feet.
  - 2. No more than ten percent (10%) of total area with bare spots larger than one (1) square foot.
  - 3. No more than fifteen percent (15%) of total area with bare spots larger than 6 inches square.
  - 4. The observations by the Engineer or Owner will determine whether maintenance shall continue in any area or manner.
- F. After all necessary corrective work and cleanup has been completed, the Engineer or Owner will acknowledge the provisional acceptance of the seeded areas. The Contractor's responsibility for maintenance of seeded areas, or parts of seeded areas shall cease on receipt of provisional acceptance.

### 3.4 GUARANTEE PERIOD AND FINAL ACCEPTANCE

- A. All seeded areas shall be guaranteed by the Contractor for not less than one (1) full year from the time of provisional acceptance.
- B. At the end of the guarantee period, the Engineer or Owner will make observations upon written request submitted by the Contractor at least ten (10) days before the anticipated date. Seeded areas not demonstrating satisfactory stands as outlined above, as determined by the Engineer or Owner, shall be renovated, reseeded, and maintained meeting all requirements as specified herein.
- C. After all necessary corrective work has been completed, the Engineer or Owner shall acknowledge in writing the final acceptance of the seeded areas.

**[END OF SECTION 02920]**

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**APPENDIX C**  
**POST-CLOSURE INSPECTION CHECKLIST**

**MERRIMACK STATION COAL ASH LANDFILL  
POST-CLOSURE FACILITY INSPECTION CHECKLIST**

INSPECTORS: \_\_\_\_\_

DATE: \_\_\_\_\_

WEATHER: Today:

Yesterday:

<u>FACILITY ACCESS</u>	YES	NO	NA	<u>COMMENTS/ ACTION ITEMS</u>
1. Is access controlled with gate and perimeter fence?	___	___	___	
2. Are the following signs/information posted? - emergency telephone number - no trespassing	___	___	___	
3. Is entrance/access road properly graded and drained?	___	___	___	
<u>DISPOSAL AREA – FINAL COVER</u>				
4. Is vegetation established over areas with final cover?	___	___	___	
<u>DRAINAGE</u>				
5. Is there evidence of erosion of final cover?	___	___	___	
6. Are drainage structures properly maintained?	___	___	___	
7. Are sediment controls provided and working adequately?	___	___	___	
<u>SETTLEMENT</u>				
8. Is there ponding on the cap or other indications of excessive settlement?	___	___	___	
9. Does the cap slope to promote runoff?	___	___	___	
<u>GROUNDWATER MONITORING</u>				
10. Is the structural integrity of the monitoring wells (i.e., riser pipe and protective casing) acceptable?	___	___	___	
11. Are all monitoring wells properly secured (i.e., locked?)	___	___	___	
12. Is groundwater monitoring performed as required by permit and are results acceptable?	___	___	___	
<u>LEACHATE COLLECTION</u>				
13. Is leachate contained as indicated by the lack of leachate seeps?	___	___	___	
14. Are leachate collection systems and appurtenances functioning properly?	___	___	___	
15. Is leachate properly removed and disposed?	___	___	___	
<u>PERMIT REPORTING REQUIREMENTS</u>				
16. Periodic reporting required by Solid Waste Rules permit completed and submitted?	___	___	___	

COMMENTS

I have read and agree with the information provided above.

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date