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PERMIT TO CONSTRUCT AND DESIGN REPORT FOR LANDFILL NO. 6 AREA D NORTH CANTON, NORTH CAROLINA

Prepared for

EVERGREEN PACKAGING CANTON, NORTH CAROLINA

~~VOLUME I and~~ VOLUME II

August 2013

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NORTH CAROLINA PROFESSIONAL SEAL 037702 ENGINEER GUY H. COTE, JR.
8/15/13

DESIGN REPORT
FOR
LANDFILL NO. 6
AREA D NORTH
CANTON, NORTH CAROLINA

Prepared for

EVERGREEN PACKAGING
CANTON, NORTH CAROLINA

VOLUME II

August 2013

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1.0 INTRODUCTION

1.1 Site History

Evergreen Packaging – Canton Mill (Evergreen) owns and operates a solid waste landfill known as Landfill No. 6 under Permit #44-06[1] of the North Carolina Department of Environment and Natural Resources (NCDENR), Division of Solid Waste. The 240-acre site is used for the disposal of boiler fly ash, cinders, dewatered wastewater treatment sludge, lime mud, woodwaste, biosolids, and asbestos containing material (ACM).

Landfill No. 6 is divided into eight major landfilling areas designated as Areas A through H. The original design of the facility was based upon plans and specifications[2] prepared by Law Engineering and Testing Company (Law) of Charlotte, North Carolina. Areas A through E are designated for sludge, ash, lime mud, and wood waste disposal. Areas F, G, and H are designated for lime mud and ACM disposal. Areas A-East, A-West, B, C, F, G, and H have been constructed according to the original design specifications and landfilled to capacity. In addition, Areas A-East, A-West, B, C, F, and G have been capped according to the original design. The current operating area, Area D South, will reach capacity in early 2015. Upon reaching capacity in Area D South, the next stage of development is planned for Area D North, then Area E.

In 2013, Evergreen retained the services of SME to conduct a hydrogeologic investigation and prepare engineering drawings and specifications for Area D North. SME has prepared this document to detail the proposed site development and construction specifications for the second phase of development, Area D North.

1.2 Site Location

Evergreen's Landfill No. 6 is located approximately two (2) miles northwest of the City of Canton in Haywood County, North Carolina. The 240-acre site is situated north of the Pigeon River and south of Interstate I-40, between State Routes 1550 and 1513. A site location plan is provided as Figure 1-1.

1.3 Basis of Design

The objective of this design is to present a site development plan which will protect the environment, complement the existing operation plan, and maximize landfilling volume for the planned area of the landfill.

Protection of groundwater quality is provided by the use of a geosynthetic liner. The liner proposed for use is 60-mil textured High Density Polyethylene (HDPE) overlying a geosynthetic clay liner at the base of the landfill.

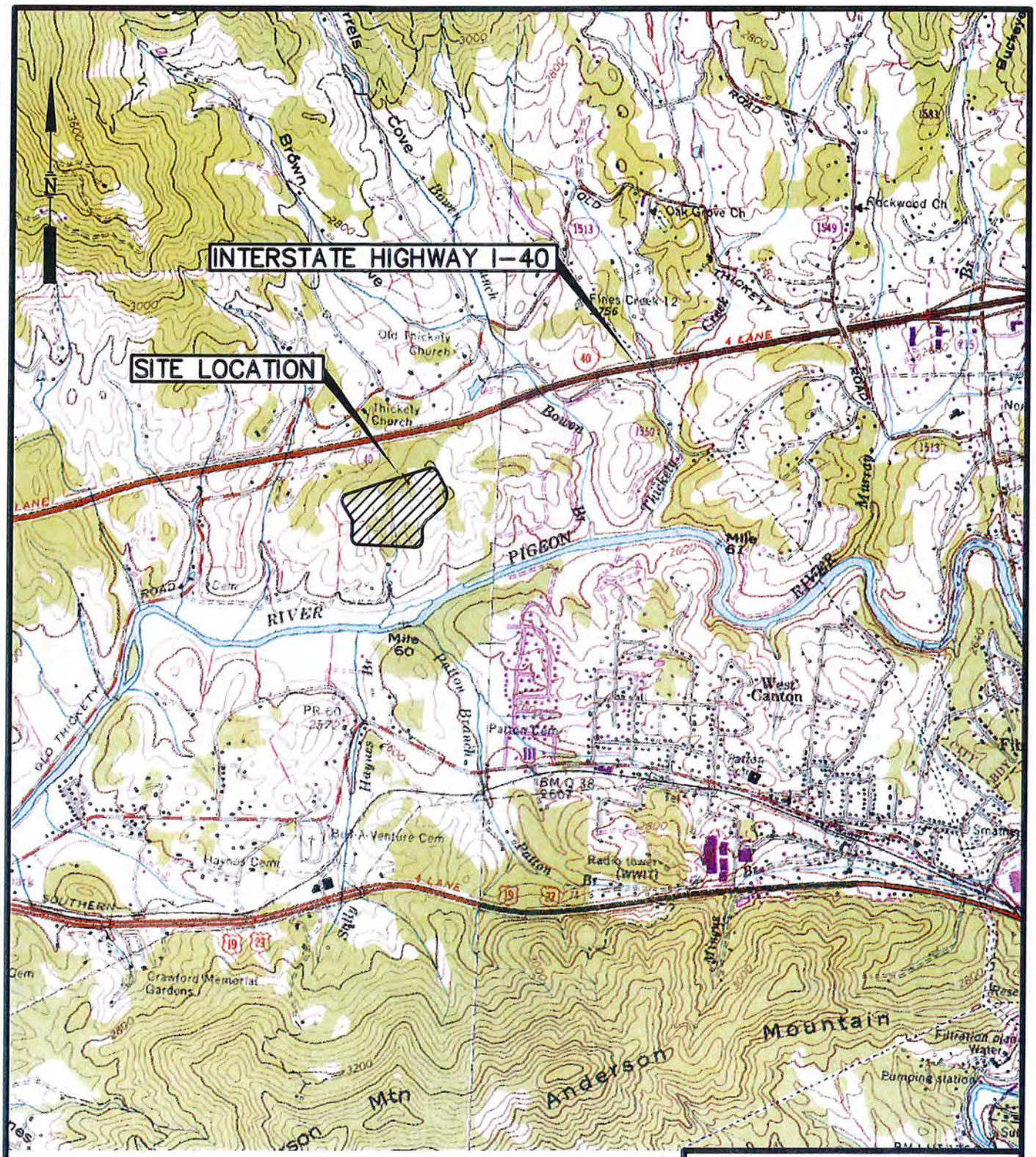
The design of Area D North proposes to include perimeter and temporary landfill access roads for efficient traffic movement.

The landfill waste volume is maximized through the base grading plan which includes 2H:1V sideslope grades and a minimum 2-percent base grade.

1.4 Design Support

The proposed design is supported by calculations presented herein for the following: stability of the geomembrane anchor trench; piping system design strength; maximum leachate head-on the liner; geotextile cushion design to protect the geomembrane from the leachate collection stone; and, erosion control measures and temporary detention of clean storm water runoff.

The design of Area D North is based on engineering evaluations consistent with those normally employed in geotechnical engineering for landfills.



BASE MAP ADAPTED FROM THE 7.5-MINUTE USGS CANTON, NC (1990) AND CLYDE (1978) TOPOGRAPHIC QUADRANGLE MAPS.

1000 0 2000 FEET

FIGURE 1-1
SITE LOCATION MAP
ANALYSIS OF LANDFILL LINER SYSTEM
LANDFILL NO. 6 AREA D NORTH
EVERGREEN PACKAGING
CANTON, NORTH CAROLINA

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2.0 LANDFILL DESIGN

2.1 Design Considerations

The proposed landfill facility is designed as a secure landfill for the acceptance of pulp and paper production residuals from Evergreen. In general, the facility will be an area-type landfill where waste will be spread and compacted to create an above-grade mound. The design of this landfill is based on the volume and characteristics of the waste and the physical characteristics of the site. The primary objective is to provide an ultimate disposal mechanism which will not cause degradation of the environment.

2.2 Base Liner System

Area D North will utilize a liner system consisting of a 60-mil HDPE textured geomembrane and geosynthetic clay liner (GCL) over 1 feet of screened, compacted site soils, refer to drawing C-300 in Attachment A. The combination of the HDPE liner and GCL reduces leachate leakage rates by providing a barrier with a very low hydraulic conductivity, i.e. $1x10^{-13}$ cm/sec, between the waste and the native soils.

A textured geomembrane was selected for an increased interface friction angle between the geomembrane and the soil subgrade and the overlying non-woven geotextile. The textured geomembrane will provide stable liner sideslopes and allow for safer installation and oversight of the geomembrane installation on the 2H:1V sideslopes. Installation of the geomembrane will follow a quality assurance/quality control plan as presented in the Engineering Specifications, provided in Attachment D.

2.3 Base Grading

Base grading of Area D North will require filling (fill) and excavation (cut) of soil and weathered bedrock to meet the proposed base grades, refer to drawings C-103 and C-104 in Attachment A. The maximum expected excavation depth is approximately 64 feet and maximum expected filling depth is approximately 70 feet. The estimated volume of material filling and excavation is listed in Table 2-1 below.

TABLE 2-1

ESTIMATED CUT/FILL VOLUMES

Material Cut/Fill	Volume (cu yd)
Stripping	17,500
Soil Fill	560,000
Soil Cut	674,000

The overburden soils consist primarily of saprolite (residuum) that transitions to partially weathered rock (PWR), which may be soil-like between blocks of rock. The PWR eventually becomes competent bedrock with depth. Experience at the site has shown that the shallow saprolite can be excavated with standard earthmoving equipment. As the excavation becomes deeper into the saprolite, the excavation becomes more difficult requiring machinery with ripping attachments. Finally as the soil transitions to PWR, the saprolite and PWR cannot be excavated with heavy equipment, but would require blasting. In order to better estimate the layer of soil and PWR requiring blasting a geophysics program was conducted over Area D North. The geophysical investigation, using seismic refraction techniques, was completed by Geo Solutions, Inc. (Geo Solutions) for Area D North. The geophysical investigation included a field investigation, which occurred between February 18 and February 24, 2013. The geophysics program consisted of 12 seismic lines.

In conjunction with the geophysicist, a velocity of 4,000 ft/s or greater was chosen as the criteria for requiring blasting to excavate the saprolite or PWR. That surface when compared to the base grades will require about 74,000 cubic yards of material to be blasted by the contractor. A blasting specification is provided in Attachment D.

The proposed base grades were designed to provide a minimum of 4 feet of separation between seasonal high water elevation and waste.

2.4 Leachate Collection and Transport System

Leachate collection above the geomembrane is provided through the placement of 15 inches of granular drainage material and HDPE perforated collection piping (minimum diameter 6 inches); refer to Drawings C-105 and C-300 in Attachment A. The leachate collection system is a gravity drain system that has been designed to meet the Department's design criteria for maximum

head-on a liner using estimated leachate generation rates predicted by the U.S.EPA Hydrologic Evaluation of Landfill Performance (HELP) model Version 3.07.

The leachate pipe spacing, based upon the landfill base slopes and HELP model impingement rates, will not exceed 200 feet (slope length). The main leachate collection headers will run in a north/south direction and tie into leachate collection piping and a leachate collection sump located in Area D South. An existing pump station then transports the leachate to the existing leachate storage ponds via a 6-inch force main connected to the existing 12-inch pipeline servicing Area C. The leachate collection system is designed to drain leachate from the landfill without any penetrations through the liner system.

The leachate collection pipes at the base of the landfill will be extended to the rim elevation of the landfill. The purpose of the pipe extensions is to provide access to the header for cleaning and maintenance and to provide collection of leachate for above-rim landfilling. The location of the leachate collection piping system is presented in Drawing C-105 located in Attachment A.

2.5 Erosion Control

The site soils consist of micaceous silty-sands and/or sandy-silts which are susceptible to erosion. The construction of Area D North will require a staged schedule or the use of a protective material (jute-mat, temporary geotextile, etc.) to minimize exposure of site soils prior to geomembrane installation. An erosion control plan for construction of Area D North is provided in Attachment 3 of the Permit to Construct application. The primary erosion control features necessary for completing Area D North are detention basins outfitted with perforated manholes to attenuate runoff from large, infrequent storm events while providing stormwater detention time for settlement of soil particles. The detention basins are located at the northern boundary of Area D North and Area E. Additional erosion control during construction will follow NCDENR Best Management Practices (BMP).[3]

Above rim (landfill perimeter road elevation) erosion control is provided through proper grading of the perimeter access road. The road is graded to drain away from the landfill and will drain to drainage channels located adjacent to the landfill area. In addition, a silt fence will be installed around the perimeter of the containment dike and will be inspected and maintained to assure proper function.

2.6 Access Roadways

Access for Area D North will utilize existing roadways around the perimeter of the Work Area along with the construction of a 16-foot-wide gravel access road associated with the Area E containment berm.

The location of the roadways is presented on Drawings C-103 and C-104, along with detailed cross-sections on Drawing C-301 in Attachment A.

2.7 Containment Berm

Area D North is situated upgradient of Area D South and down-gradient of the future landfill Area E. In order to minimize leachate generated by Area D North, upgradient runoff is prevented from entering the landfilling area by the construction of an earthen containment berm along the southerly boundary of Area E. The containment berm diverts upgradient runoff into a detention basin which discharges through piping located underneath the base liner system of the Area D North and Area D South landfills. Refer to Section 2.8 for a description of the stormwater piping system associated with the detention basin.

The containment berm will be constructed ahead of the geomembrane liner system and will consist of suitable site soils (silty sand or sandy silt). The top of the berm will consist of a geotextile overlain with 12 inches of ABC road gravel. The berm sideslopes will also be covered with a geotextile and overlain with granular drainage material, #78M stone. A cross-section of the containment berm is shown on Drawing C-300 in Attachment A.

2.8 Stormwater Piping System

The proposed stormwater piping system associated with the Area D North detention basin will be located beneath the base liner system and tie into the outlet pipe of an existing detention pond. The existing detention basin will be filled to the base grade elevations; however, the existing outlet pipe will continue to transport flow beneath the 6D-South landfill and discharge into Detention Pond No. 1. The location and construction details of the proposed storm drain pipe is shown on Drawings C-103 and C-302 in Attachment A.

3.0 DESIGN CONSIDERATIONS

3.1 Stability

3.1.1 Landfill Containment Berm and Waste Stability. SME completed a stability evaluation in 2007 and 2008 as part of the landfill expansion into Areas D and E. Components of the evaluation included a stability analysis addressing the geotechnical performance of the subsurface (foundation) soils, the proposed wastes, perimeter containment dikes, and the landfill liner system. The evaluation considered both static and seismic loading criteria. The analyses were completed using site-specific data collected during the Fall 2007 site investigation (See Volume 1 of this application), laboratory testing of representative materials, along with data from previous SME investigations and those conducted by others.

Based on interpretations of field and laboratory testing, review of available data, and results of the slope stability evaluation, the final grading plan for Areas D and E meet or exceed generally accepted safety factor requirements for both static and seismic loading for each condition evaluated. The Stability Evaluation Report with associated data and calculations is presented in Attachment B.

3.1.2 Geomembrane Anchor Trench. The geomembrane liner will be anchored along the inside edge of the perimeter access road. The anchor trench is designed to provide enough pull-out resistance to hold the geomembrane in place under normal operating conditions. The anchor trench is also designed to allow the geomembrane to pull out of the trench under extreme loading conditions before the limits of the geomembrane are exceeded.

Based on these criteria, the anchor trench will be buried two feet deep and will have a run-out length of three feet. The design calculations and a list of design parameters are provided within Attachment C-1.

3.2 Leachate Collection System

3.2.1 Maximum Leachate Head-on Liner. An important design constraint of the leachate collection system is the depth at which the leachate will mound on top of the liner system. The depth of the leachate over the liner or head-on the liner is directly related to the leakage rate through the liner system. Therefore, the goal in designing the leachate collection system is to minimize the head-on the liner and likewise the leakage rate. A typical design standard for the landfill leachate collection system is to maintain head levels on the liner to less than 12 inches.

The maximum head-on the base liner system is calculated by using Giroud's method[4]. The equation to solve the head-on the liner utilizes the slope of the base liner system, the leachate collection stone's hydraulic conductivity, the leachate impingement rate, the thickness of the leachate collection stone, and the drainage length between pipes. The head-on the liner for the collection system design is 0.6 feet, which is less than the typical maximum allowable head of one foot. The leachate collection/liner head calculations are shown in Attachment C-2.

3.2.2 Geotextile Cushion. The geotextile located between the geomembrane liner and the leachate collection stone is required to provide adequate cushion to protect the geomembrane from puncture. The method to determine the cushion requirements of the geotextile utilized the geotextile weight, the maximum stone diameter, and the confining stresses to calculate a cushion pressure capacity (Boschuk[5]). The proposed geotextile will provide adequate cushion for protection of the liner. Design calculations presented in Attachment C-3 provide a factor of safety of 20.8, which exceeds the recommended minimum of 2.0. The proposed 16 oz/sy cushion geotextile is considered industry standard.

3.2.3 Leachate Collection and Storm Drain Pipe Strength. The leachate collection piping must be able to withstand the anticipated loads produced by the depth of waste placed over the pipes. The pipe material selected for the landfill is HDPE pipe which is manufactured in a variety of thicknesses, or Standard Diameter Ratios (SDR). The design strength to resist buckling and critical pressure (crushing) was calculated using pipe thickness, perforations, and confining stresses under a positive projecting condition, i.e. no trench. The proposed pipe and thickness, SDR 11, for the perforated leachate collection piping and storm drain piping located beneath the landfill meet the minimum factor of safety of 2.3 recommended by the manufacturer. Calculations are provided in Attachment C-4.

3.2.4 Leachate Pump Station. An existing leachate pump station is proposed to transport Area D North leachate to the existing 12-inch gravity leachate transport lines located east of Area D South. The leachate pump station consists of two separate 275-gpm pumps housed in individual 24" HDPE conduits. The conduits run from the leachate sump area in Area D South, up the perimeter road dike side slope, and to the pump station building which is located along the perimeter road on the southern boundary of Area D South. The pumps were designed to remove leachate generated by the 24-hour/25-year storm event over a period of four to five days. Calculations are provided in Attachment C-5.

3.3 Stormwater and Erosion Control

3.3.1 Perimeter Access Roadway Runoff. The access roadway surrounding Area D North and Area E will be graded to drain away from the landfill, refer to Drawings C-103 and C-104 in Attachment A. Calculations of peak surface water flow generated from a 25-year/24-hour duration storm were made using the Soil Conservation Service Technical Release Manual TR-20 methodology. The calculations indicate that the capacity of the storm water detention ponds will not be exceeded (refer to Attachment 4 in Volume 1 of the Permit to Construct application).

3.3.2 Sediment Control During Base Grading. Sediment control will be provided with the installation of silt fence along the entire perimeter of excavations during construction of the perimeter road. Detention basins located in the northwest corners of Area D North and Area E will provide sediment control for all upgradient areas which includes the construction of the containment berm and landfill access roads. Rock Filters will be located within ditches for additional sediment control.

Sediment control within the contained lined landfill area will not be required as all runoff is collected in the leachate collection system and conveyed to the leachate collection ponds.

3.3.3 Stormwater Detention Prior to Landfilling. The available capacity for stormwater detention within the lined Area D North is greater than the required volume of the 25-year/24-hour duration storm.

3.3.4 Erosion Control During Base Grading. Base grading of the landfill area consists of excavating soil and bedrock. The on-site soils are micaceous and are susceptible to erosion. To minimize erosion, the general contractor will be required to perform the work in conformance with the BMP Manual[3] prepared by the NCDENR, and to take any additional measures required to protect the base soil prior to installation of the geomembrane. An Erosion and Sediment Control Plan describing the measures specified for the landfill development associated with Area 6D-North is included as Attachment 4 of the Permit to Construct application.

4.0 LANDFILL CONSTRUCTION

Evergreen plans to initiate construction of Area D North in the fall of 2013 and anticipates that the facility will be operational by the fall of 2014. A proposed construction schedule is presented on Figure 4-1. The landfill will be constructed by a general contractor who will be responsible for supplying the materials, labor, and equipment necessary to complete the landfill construction. Services of a general contractor will be procured through a competitive bid process. Bid packages for the solicitation of construction services will require the contractor to identify and demonstrate familiarity and experience with the various aspects of landfill construction. These will include:

- Earthmoving;
- Pipe installation; and,
- HDPE and GCL liner installation.

The specific levels of experience required for the various components of the landfill are included in the engineering specifications prepared for the project. The specifications are provided in Attachment D.

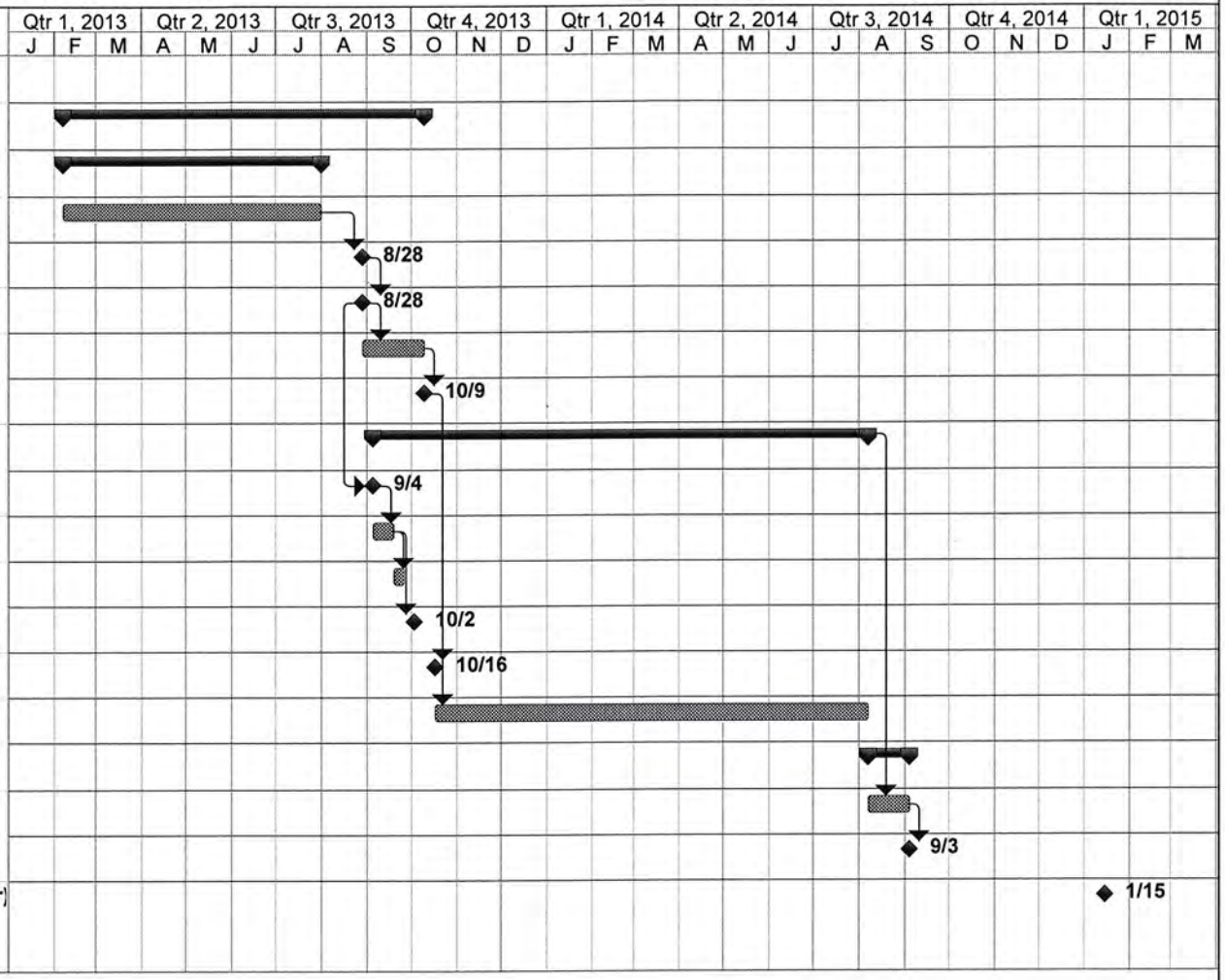
4.1 Quality Assurance/Quality Control

To control the quality of the soil materials used in the landfill construction, a quality assurance/quality control (QA/QC) program will be implemented. The program will include source testing to demonstrate compliance with material specifications and construction testing to demonstrate that the materials have been properly installed. In addition to source testing of soil materials, the contractor will be responsible for submitting to the engineer for review the manufacturer's specifications and warranties for the following items:

- Leachate collection pipes and fittings;
- Liner geomembrane material; and,
- Geotextile.

FIGURE 4-1
EVERGREEN PACKAGING
AMENDMENT TO PERMIT LANDFILL No. 6 AREA D NORTH
PROPOSED CONSTUCTION SCHEDULE

ID	Task Name
1	
2	**PERMIT TO CONSTRUCT**
3	**Hydrogeological Investigation**
4	Water Levels
5	Meeting with NCDENR
6	File Application
7	NCDENR Review
8	NCDENR Approval
9	**CONSTRUCTION**
10	Solicit Bids from Contractors
11	Bids Due
12	Review Bids
13	Issue Notice of Award
14	Issue Notice to Proceed
15	Construction
16	**PERMIT TO OPERATE APPLICATION**
17	Construction Documentation Report
18	File Permit to Operate
19	**LANDFILL CAPACITY - AREA 6D SOUTH (250,000 cy/yr)**



The specific items which must be submitted for each of these items is discussed in the specifications included in Attachment D.

4.1.1 Source Testing. An excess of excavation material (cut) will result from the proposed Area D North project. The material may be used for a source of borrow material; however, testing will be required prior to use to demonstrate compliance with the materials specifications. Additional materials to be used at the landfill construction will be required to be tested at their source prior to being delivered on-site. The soil materials that will require source testing include: granular drainage material and graded drainage stone for leachate collection, and gravel material for the access road. Samples will be collected at each borrow source in accordance with the methods specified by ASTM D 420 and C 702, and tested by the contractor prior to the Owner's acceptance of the materials. The contractor will be required to have the test performed by a State of North Carolina qualified testing laboratory.

4.1.2 Construction Testing. As the soil materials are used in the landfill construction, in-place testing will be performed by Evergreen to monitor material placement and conformance with the criteria specified in the construction specifications. In-place material testing will be performed by a qualified materials testing laboratory and will be observed by the owner's representative.

4.1.3 Liner QA/QC. The quality assurance and quality control of the facility's synthetic liner is described in the construction specifications contained in Attachment D of this report.

4.2 Weekly Inspection Reports

Weekly inspection reports will be prepared by the owner's representative during the landfill construction period. The report will include material test results, summary of contractor submittals, actions taken, summary of progress made to date, and anticipated work items.

4.3 Photographic Documentation

Photographic documentation of the landfill construction will be taken periodically. Copies of the photographs will be provided in the construction certification report.

4.4 Record Drawings

Upon completion of the landfill construction, record drawings will be prepared for the facility. The drawings will be sealed by a State of North Carolina Professional Engineer and will be submitted to the NCDENR.

4.5 Final Construction Certification and Report

A final construction report will be submitted by Evergreen to the NCDENR following the completion of construction at Area D North. The report will include written certification signed and stamped by the engineer supervising the project inspections that the site has been constructed in accordance with the approved plans and specifications.

5.0 CONCLUSIONS

The Landfill No. 6 Area D North proposed design is a state-of-the-art design which provides Evergreen with an optimal operational area which maximizes the waste volume for the project area. Area D North is estimated to require approximately 9-12 months to complete construction.

Based on the proposed landfill base grades and final grades, Area D North will have an approximate volume of one million cubic yards, and according to current waste disposal rates, a service life of approximately four to five years.

Proposed specifications are attached to this report in Attachment D for use in procuring bids and detailing construction activities.

REFERENCES

1. Champion International Corporation, 1983. Solid Waste Permit Application – Sanitary Landfill Site Six. March 1983.

2. Law Engineering and Testing Company, 1982. Revised Report of Geotechnical Exploration and Evaluation and Conceptual Site Development Recommendations, Landfill No. 6. February 1982.

3. North Carolina Department of Natural Resources and Community Development, Division of Land Resources Land Quality Section, 2013. Best Management Practices for Erosion Control.

4. Giroud, J.P., et al, 1993. Flow in Leachate Collection Layers.

5. Boschuk, J., 1994. Designing with Geosynthetic Cushions, October 1994.

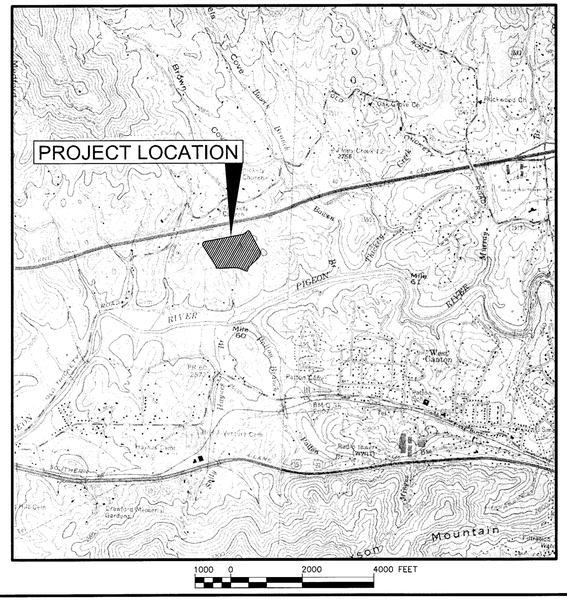
ATTACHMENT A

ENGINEERING DRAWINGS

EVERGREEN PACKAGING
CANTON, NORTH CAROLINA
LANDFILL NO. 6
AREA 6D NORTH DEVELOPMENT

TITLE	DWG. NO.
COVER SHEET	
SYMBOLS & ABBREVIATIONS	C-100
EXISTING CONDITIONS PLAN	C-101
OVERALL SITE LOCATION PLAN	C-102
BASE GRADING PLAN (1 OF 2)	C-103
BASE GRADING PLAN (2 OF 2)	C-104
LEACHATE COLLECTION PIPING PLAN	C-105
FINAL GRADING PLAN	C-106 (NITC)
LANDFILL CROSS SECTIONS	C-200
STORMDRAIN PROFILES	C-201
SECTIONS & DETAILS	C-300
SECTIONS & DETAILS	C-301
SECTIONS & DETAILS	C-302
EROSION CONTROL DETAILS	C-303

LOCATION MAP



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SYMBOLS

EXISTING	PROPOSED		EXISTING	PROPOSED		EXISTING	PROPOSED	
		NORTH ARROW (MAGNETIC)			STONE WALL			MANHOLE
N		NORTH ARROW (PLAN NORTH)			DRAINAGE COURSE (WITH DIRECTION)			CATCH BASIN
25	25	CONTOUR LINES	SHORE SIDE		EDGE OF WATER			WATER VALVE
25 x 63	25.56	SPOT ELEVATION (GRADE)			WATER ELEVATION (GROUND OR SURFACE)			HYDRANT
		EXISTING GROUND			FENCE LINE (WOOD)			UTILITY POLE
S B		SURVEY BASELINE WITH TRIANGULATION OR INTERSECTION PT.			FENCE LINE (WIRE)			CLEAN OUT STRUCTURE
		PROPERTY LINE OR R.O.W.			RETAINING WALL	G	G	UNDERGROUND GAS MAIN
N35°-10'-10"W 251.17'	N35°-10'-10"W 251.17'	PROPERTY LINE W/ BEARING AND DISTANCE			GUARD RAIL	T	T	UNDERGROUND TELEPHONE LINE
	0+00 1+00	CONSTRUCTION BASELINE			BUILDING AND STRUCTURES	E	E	UNDERGROUND ELECTRICAL LINE
		BOUNDARY LINE (State, County, Municipality)		2 1 OR 2:1	SLOPE RATIO (HORIZONTAL TO VERTICAL)	OE	OE	OVERHEAD ELECTRICAL LINE
		SURVEY MONUMENT		TOP OF SLOPE 2:1	SLOPES (WITH SLOPE RATIO)		12" ACP	SANITARY SEWER, SIZE & TYPE
IF	IF	SURVEY IRON			EDGE OF TRAVELED WAY	FM	8" PVC	FORCE MAIN, SIZE & TYPE
		DRILL HOLE, PK, OR STAKE		C F	CUT OR FILL LINE	W	8" D.I.	WATER MAIN, SIZE & TYPE
		WOODS OR BRUSH LINE		CLL	CLEARING LIMIT LINE		12" RCP	STORM DRAIN, SIZE & TYPE
		INDIVIDUAL TREE (Deciduous)			BITUMINOUS PAVEMENT	UD	8" UD	UNDERDRAIN, SIZE & TYPE
		INDIVIDUAL TREE (Coniferous)			CONCRETE			CULVERT
		TREE, TO BE REMOVED	B-12 MW-12 P-12	B-12 MW-12 P-12	TEST BORING, MONITORING WELL, OR PIEZOMETER AND NUMBER		LT	LEACHATE TRANSPORT LINE
		MARSH AREA	TP-12	TP-12	TEST PIT AND NUMBER		LC	LEACHATE COLLECTION LINE
		BENCHMARK						RAILROAD
							S	SILTATION FENCE
							D	DIVERSION BERM
								STONE CHECK DAM

A.C.C.M.P	ASPHALT COATED C.M.P.	D	DEGREE OF CURVE (ARC DEF.)	HDPE	HIGH DENSITY POLYETHYLENE	QTY	QUANTITY
A.C.P.	ASBESTOS CEMENT PIPE	DBL	DOUBLE	HP	HORSEPOWER		
AC	ACRE	DEG OR °	DEGREE	HYD	HYDRANT	R.O.W.	RIGHT OF WAY
AGG	AGGREGATE	DEPT	DEPARTMENT			RAD	RADIUS
ALUM	ALUMINUM	DI	DUCTLE IRON	I.D.	INSIDE DIAMETER	REQD	REQUIRED
APPD	APPROVED	DIA OR ø	DIAMETER	IN OR "	INCHES	RT	RIGHT
APPROX	APPROXIMATE	DIM	DIMENSION	INV	INVERT	RTE	ROUTE
ASB	ASBESTOS	DIST	DISTANCE	INV. EL	INVERT ELEVATION		
ASPH	ASPHALT	DN	DOWN			S	SLOPE
AUTO	AUTOMATIC	DR	DRAIN	LB	POUND	SCH	SCHEDULE
AUX	AUXILIARY	DWG	DRAWING	LC	LEACHATE COLLECTION	SF	SQUARE FEET
AVE	AVENUE			LD	LEAK DETECTION	SD	STORM DRAIN
AZ	AZIMUTH	EA	EACH	LIN FT.	LINEAR FEET	SDR	STANDARD DIMENSION RATIO
		EG	EXISTING GROUND OR GRADE	LOC	LOCATION	SHT	SHEET
B.C.C.M.P.	BITUMINOUS COATED C.M.P.	ELEC	ELECTRIC	LT	LEFT	STA	STATION
B.M.	BENCH MARK	EL	ELEVATION			SY	SQUARE YARD
BIT	BITUMINOUS	ELB	ELBOW	M.H.	MANHOLE		
BLDG	BUILDING	EQUIP	EQUIPMENT	M.J.	MECHANICAL JOINT	TAN	TANGENT
BOT	BOTTOM	EST	ESTIMATED	MATL	MATERIAL	TDH	TOTAL DYNAMIC HEAD
BRG	BEARING	EXC	EXCAVATE	MAX	MAXIMUM	TEMP	TEMPORARY
		EXIST	EXISTING	MFR	MANUFACTURE	TYP	TYPICAL
C.B.	CATCH BASIN			MIN	MINIMUM		
CEN	CENTER	F.G.	FINISH GRADE	MISC	MISCELLANEOUS	V	VOLTS
CEM. LIN.	CEMENT LINED	FBRGL	FIBERGLASS	MON	MONUMENT		
C.M.P.	CORRUGATED METAL PIPE	FDN	FOUNDATION			W/	WITH
C.O.	CLEAN OUT	FLEX	FLEXIBLE	N.I.T.C.	NOT IN THIS CONTRACT	W/O	WITHOUT
CF	CUBIC FEET	FLG	FLANGE	N.T.S.	NOT TO SCALE		
CFS	CUBIC FEET PER SECOND	FLR	FLOOR	N/F	NOW OR FORMERLY	YD	YARD
CI	CAST IRON	FPS	FEET PER SECOND	NO. OR #	NUMBER		
CL	CLASS	FT OR '	FEET				
CONC	CONCRETE	FTG	FOOTING	O.C.	ON CENTER		
CONST	CONSTRUCTION			O.D.	OUTSIDE DIAMETER		
CONTR	CONTRACTOR	GA	GAUGE				
CTR	CENTER	GAL	GALLON	P.C.	POINT ON CURVE		
CY	CUBIC YARD	GALV	GALVANIZED	P.I.	POINT OF INTERSECTION		
		GPD	GALLONS PER DAY	P.T.	POINT OF TANGENT		
		GPM	GALLONS PER MINUTE	PERF	PERFORATED		
				PSI	POUNDS PER SQUARE INCH		
				PVC	POLYVINYL CHLORIDE		
				PVMT	PAVEMENT		

GENERAL NOTES:

THE CONTRACTOR MUST COMPLY WITH ALL APPLICABLE SAFETY PROCEDURES WITH RESPECT TO THE EMPLOYEES OF THE CONTRACTOR AND HIS SUBCONTRACTOR UNDER THE OCCUPATIONAL SAFETY AND HEALTH ACT (OSHA) AND REGULATIONS ISSUED THEREUNDER AND STATE LABOR (SAFETY) DEPARTMENT AND MILL RULES, PROCEDURES, AND REGULATIONS REGARDING SAFETY.

CONTOURS SHOWN ON PLANS MAY NOT REPRESENT EXISTING CONDITIONS OF THE SITE.

PRIOR TO THE START OF CONSTRUCTION, THE CONTRACTOR SHALL PRESENT AND ACQUIRE APPROVAL OF A TEMPORARY EROSION AND SEDIMENT CONTROL PLAN AND DEWATERING PLAN BASED ON THE CONTRACTORS PROPOSED PHASING SEQUENCING.

MATERIAL SPECIFICATIONS:

COMMON BORROW – SECTION 02200 SPECIFICATION
ROADWAY SUBBASE – NCDOT SA AGGREGATE
ROADWAY SURFACE – NCDOT ABC AGGREGATE

#57 STONE – NCDOT #57 AGGREGATE
#78M STONE – NCDOT #78M AGGREGATE
#5 STONE – NCDOT #5 AGGREGATE

COMPACTION – ALL FILL SOIL SHALL BE COMPACTED TO A DENSITY OF 90 PERCENT OF ITS MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D 1557 (MODIFIED PROCTOR)

6" HDPE PIPE – SDR 11.0 SOLID
6" HDPE PIPE – SDR 11.0 PERFORATED
12" HDPE PIPE – SDR 11.0 SOLID
12" HDPE PIPE – SDR 11.0 PERFORATED
24" HDPE PIPE – SDR 11.0 SOLID
36" HDPE PIPE – SDR 11.0 PERFORATED

CUSHION GEOTEXTILE – 16 OZ/SY NON-WOVEN GEOTEXTILE, NOCOLON S1600, OR EQUAL
FILTER GEOTEXTILE – MIRAFI 600X, OR EQUAL

GRUBBING:

ALL VEGETATION AND TOPSOIL SHALL BE STRIPPED FROM THE AREA D SOUTH AREA PRIOR TO PLACING ADDITIONAL MATERIAL. ANY TOPSOIL CLAIMED DURING THE GRUBBING OPERATION WILL BE STOCKPILED FOR THE OWNER'S USE. ALL OTHER GRUBBINGS WILL BE DISPOSED OF IN THE EXISTING SPOIL PILE OR AS OUTLINED ON THE PLANS. ALL WORK WILL ABIDE BY NCDOT SPECIFICATION SECTION 200.

SEED AND FERTILIZER:

AREAS DISTURBED BY CONSTRUCTION AND THE OUTBOARD SLOPES OF THE DIKE SHALL BE FERTILIZED AND SEEDED.

MATERIAL:

AGRICULTURAL GROUND LIMESTONE: 100 LBS PER 1,000 SF OR AS NEEDED BASED ON TESTING

FERTILIZER: GRANULAR FERTILIZER 10,10,10 (N,P,K) 25 LB/1000 SF OR AS NEEDED BASED ON TESTING

SEED:	TALL FESCUE (KY 31)	80 lb/acre
	SERICEA LESPEDEZA	20 lb/acre
	KOBE LESPEDEZA	10 lb/acre
		110 lb/acre

SEEDING WILL OCCUR BETWEEN MAY 1 AND AUG 15; IF NOT, ADD 40 LB/ACRE RYE GRAIN

MULCH – THE MULCH APPLICATION RATE SHALL BE 2 TONS PER ACRE

VIEW MARKERS & IDENTIFICATION

SECTION TITLE & NO.
ACCESS ROAD 3
C-100
DRAWING WHERE SECTION APPEARS

DETAIL TITLE & LETTER
MANHOLE A
C-100
DRAWING WHERE DETAIL APPEARS

REV.	BY	DATE	STATUS
	ASB	8/13	SUBMITTED TO NCDENR

NORTH CAROLINA PROFESSIONAL SEAL 037700 ENGINEER GUY H. COTE, JR.

EVERGREEN PACKAGING
CANTON, NORTH CAROLINA
LANDFILL NO. 6
AREA 6D NORTH DEVELOPMENT

SYMBOLS AND ABBREVIATIONS

SME
Sevee & Maher Engineers, Inc.
ENVIRONMENTAL • CIVIL • GEOTECHNICAL • WATER • COMPLIANCE
4 Blanchard Road, PO Box 85A, Cumberland Center, Maine 04021
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DESIGN BY: ASB
DRAWN BY: SJM
DATE: 6/12/2013
CHECKED BY:
LMN: NONE
CTB: SME-STD

JOB NO. 12121.03 DWG FILE 6DN-SYMSHT

C-100

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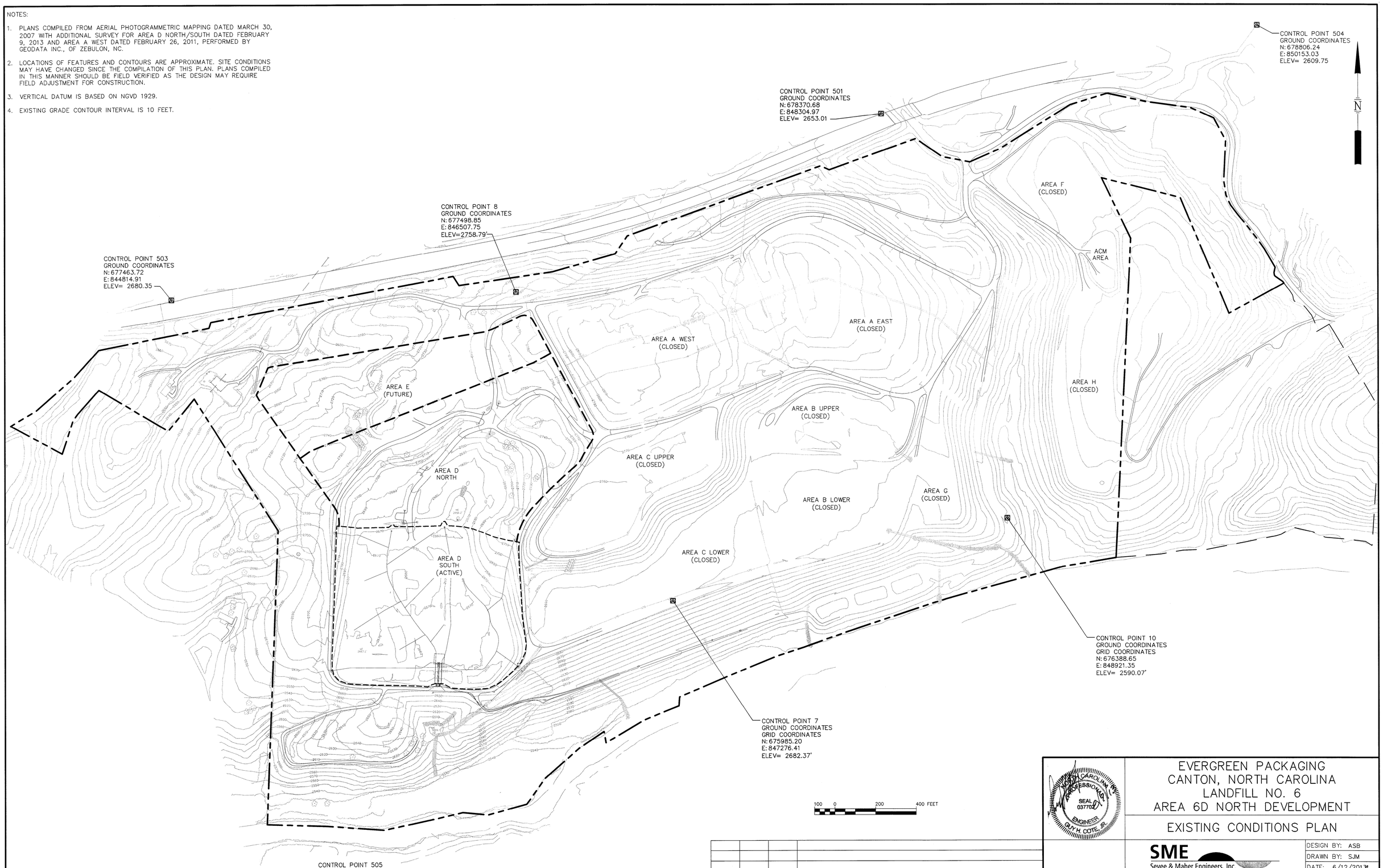
NOTES:

1. PLANS COMPILED FROM AERIAL PHOTOGRAMMETRIC MAPPING DATED MARCH 30, 2007 WITH ADDITIONAL SURVEY FOR AREA D NORTH/SOUTH DATED FEBRUARY 9, 2013 AND AREA A WEST DATED FEBRUARY 26, 2011, PERFORMED BY GEODATA INC., OF ZEBULON, NC.
2. LOCATIONS OF FEATURES AND CONTOURS ARE APPROXIMATE. SITE CONDITIONS MAY HAVE CHANGED SINCE THE COMPILATION OF THIS PLAN. PLANS COMPILED IN THIS MANNER SHOULD BE FIELD VERIFIED AS THE DESIGN MAY REQUIRE FIELD ADJUSTMENT FOR CONSTRUCTION.
3. VERTICAL DATUM IS BASED ON NGVD 1929.
4. EXISTING GRADE CONTOUR INTERVAL IS 10 FEET.



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	ASB	8/13	SUBMITTED TO NCDENR

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EVERGREEN PACKAGING
CANTON, NORTH CAROLINA
LANDFILL NO. 6
AREA 6D NORTH DEVELOPMENT

EXISTING CONDITIONS PLAN

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LMN: EXCON
CTB: SME-STD

JOB NO. 12121.03 DWG FILE 6DN-BASE

C-101

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NOTES:

1. PLANS COMPILED FROM AERIAL PHOTOGRAMMETRIC MAPPING DATED MARCH 30, 2007 WITH ADDITIONAL SURVEY FOR AREA D NORTH/SOUTH DATED FEBRUARY 9, 2013 AND AREA A WEST DATED FEBRUARY 26, 2011, PERFORMED BY GEODATA INC., OF ZEBULON, NC.
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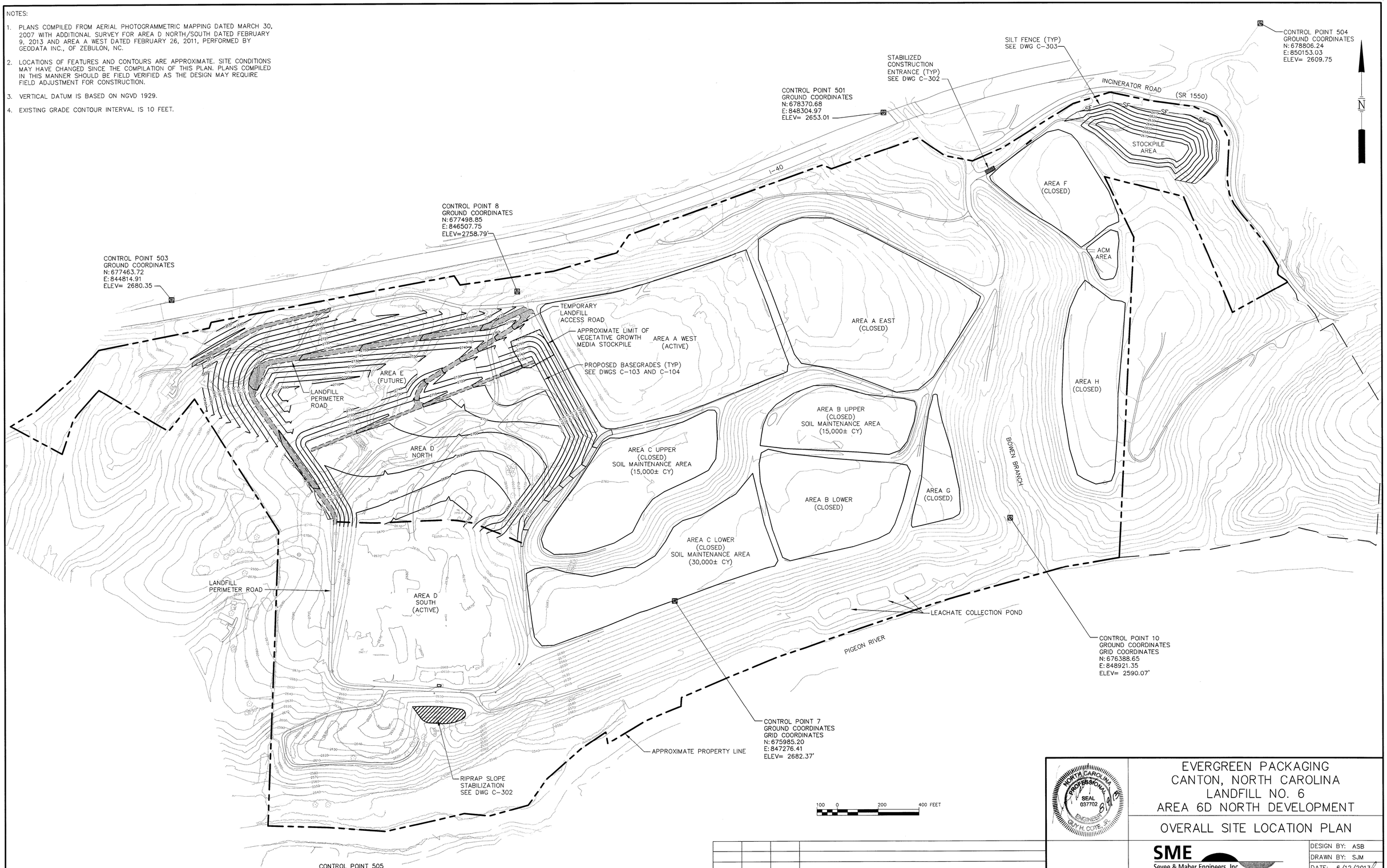

REV.	BY	DATE	STATUS
	ASB	8/13	SUBMITTED TO NCDENR

NORTH CAROLINA PROFESSIONAL SEAL 037702 ENGINEER GUY H. COTE, JR.

EVERGREEN PACKAGING
CANTON, NORTH CAROLINA
LANDFILL NO. 6
AREA 6D NORTH DEVELOPMENT

OVERALL SITE LOCATION PLAN

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DATE: 6/12/2013
CHECKED BY:
LMN: OVERALL SITE
CTB: SME-STD

JOB NO. 12121.03 DWG FILE 6DN-BASE

C-102

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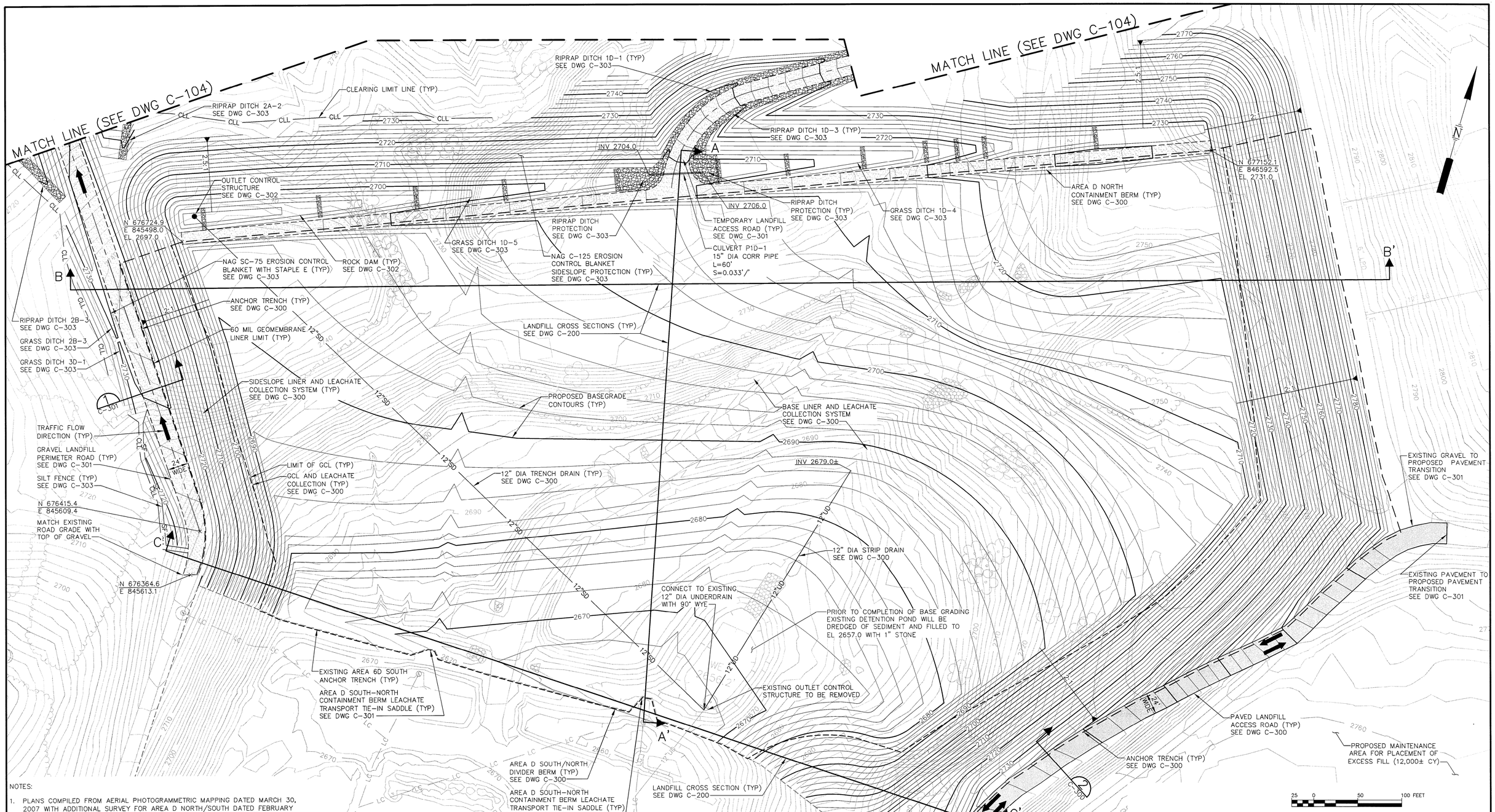

NOTES:

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3. VERTICAL DATUM IS BASED ON NGVD 1929.
4. BASE GRADE CONTOUR INTERVAL IS 2 FEET.

REV.	BY	DATE	STATUS
	ASB	8/13	SUBMITTED TO NCDENR

NORTH CAROLINA PROFESSIONAL SEAL 037702 ENGINEER GLY H. COTE, JR.

EVERGREEN PACKAGING CANTON, NORTH CAROLINA LANDFILL NO. 6 AREA 6D NORTH DEVELOPMENT

BASE GRADING PLAN – 1 OF 2

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DATE: 6/12/2013
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LMN: BASEGRADE-S
CTB: SME-STD

JOB NO. 12121.03 DWG FILE 6DN-BASE

C-103

NOTES:

1. PLANS COMPILED FROM AERIAL PHOTOGRAMMETRIC MAPPING DATED MARCH 30, 2007 WITH ADDITIONAL SURVEY FOR AREA D NORTH/SOUTH DATED FEBRUARY 9, 2013 AND AREA A WEST DATED FEBRUARY 26, 2011, PERFORMED BY GEODATA INC., OF ZEBULON, NC.
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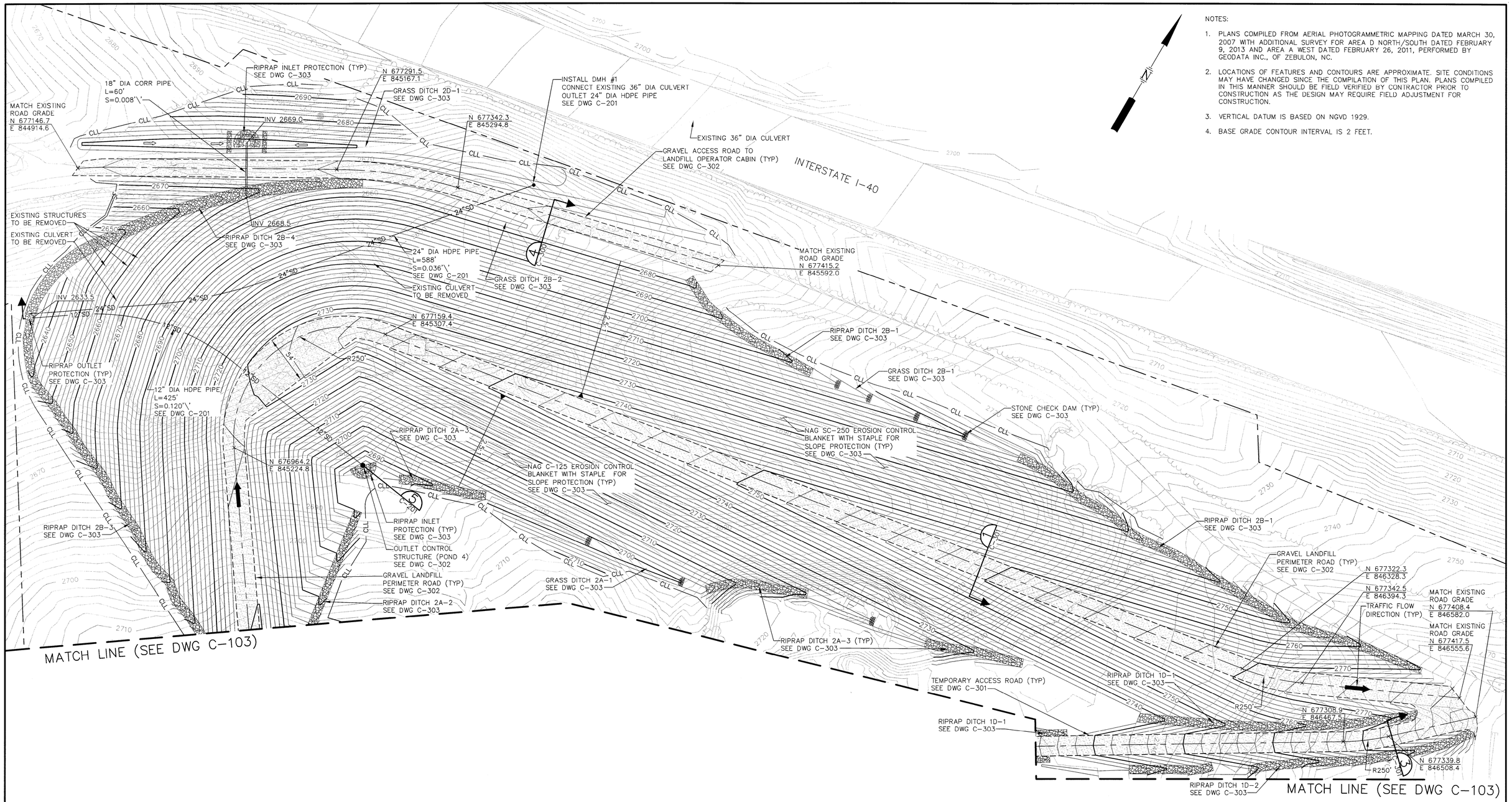
3. VERTICAL DATUM IS BASED ON NGVD 1929.
4. BASE GRADE CONTOUR INTERVAL IS 2 FEET.



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	ASB	8/13	SUBMITTED TO NCDENR

NORTH CAROLINA PROFESSIONAL SEAL 037702 ENGINEER GLYN H. COTE, JR.

EVERGREEN PACKAGING
CANTON, NORTH CAROLINA
LANDFILL NO. 6
AREA 6D NORTH DEVELOPMENT

BASE GRADING PLAN – 2 OF 2

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DATE: 6/12/2013
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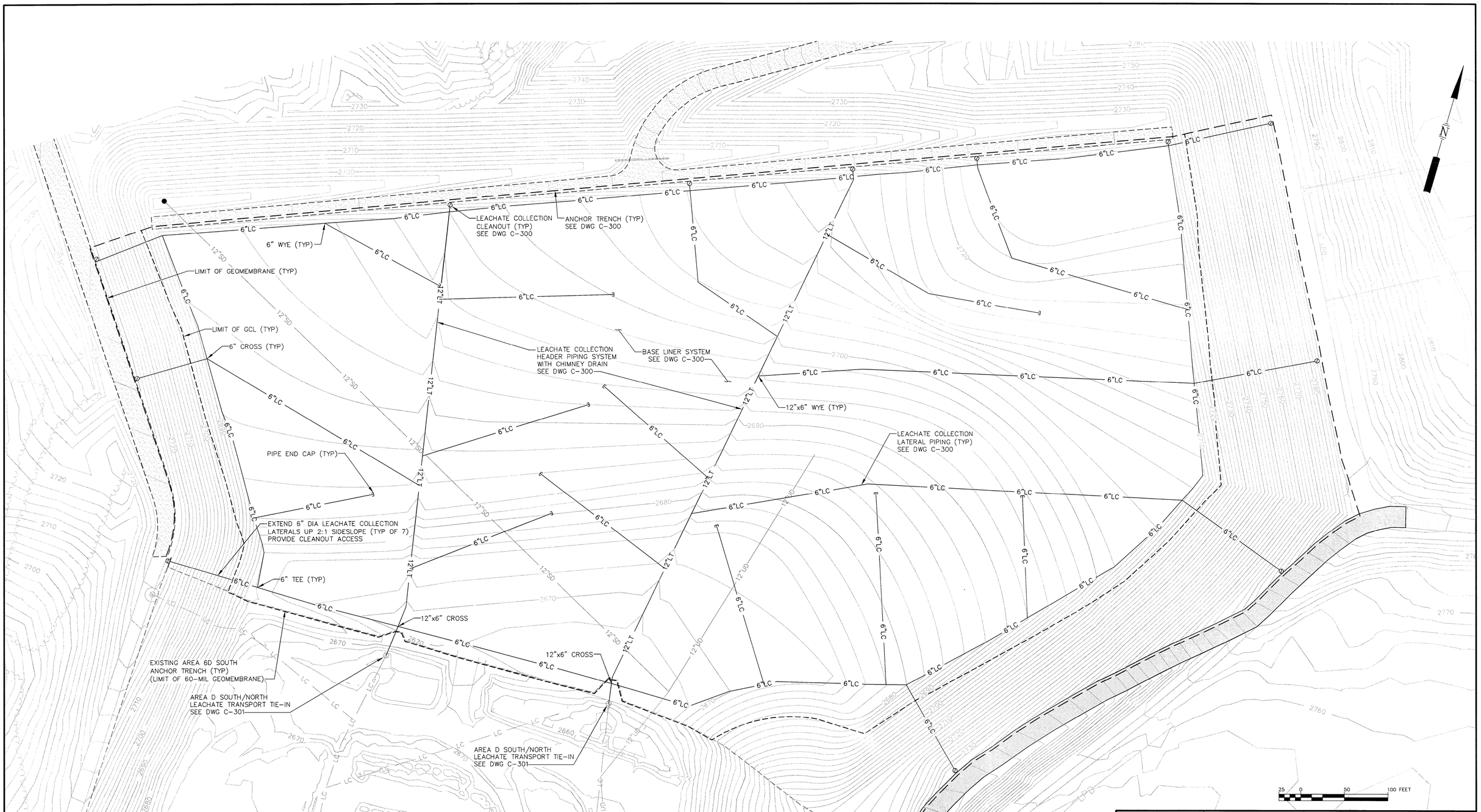
LMN: BASEGRADE-N
CTB: SME-STD

JOB NO. 12121.03 DWG FILE 6DN-BASE

C-104



NOTES:

1. PLANS COMPILED FROM AERIAL PHOTOGRAMMETRIC MAPPING DATED MARCH 30, 2007 WITH ADDITIONAL SURVEY FOR AREA D NORTH/SOUTH DATED FEBRUARY 9, 2013 AND AREA A WEST DATED FEBRUARY 26, 2011, PERFORMED BY GEODATA INC., OF ZEBULON, NC.
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3. VERTICAL DATUM IS BASED ON NGVD 1929.
4. BASE GRADE CONTOUR INTERVAL IS 2 FEET.

REV.	BY	DATE	STATUS
	ASB	8/13	SUBMITTED TO NCDENR

NORTH CAROLINA PROFESSIONAL SEAL 037702 ENGINEER GWYN. COTE, JR.

EVERGREEN PACKAGING CANTON, NORTH CAROLINA LANDFILL NO. 6 AREA 6D NORTH DEVELOPMENT

LEACHATE COLLECTION PIPING PLAN

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DATE:	6/12/2013
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LMN:	LCPIPE
CTB:	SME-STD

JOB NO. 12121.03 DWG FILE 6DN-BASE

C-105

NOTES:

1. PLANS COMPILED FROM AERIAL PHOTOGRAMMETRIC MAPPING DATED MARCH 30, 2007 WITH ADDITIONAL SURVEY FOR AREA D NORTH/SOUTH DATED FEBRUARY 9, 2013 AND AREA A WEST DATED FEBRUARY 26, 2011, PERFORMED BY GEODATA INC., OF ZEBULON, NC.
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4. EXISTING GRADE CONTOUR INTERVAL IS 10 FEET.

REV.	BY	DATE	STATUS
	ASB	8/13	SUBMITTED TO NCDENR

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 037702 GUY H. COTE, JR.

EVERGREEN PACKAGING
CANTON, NORTH CAROLINA
LANDFILL NO. 6
AREA 6D NORTH DEVELOPMENT

FINAL GRADING PLAN

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DATE: 6/12/2013
CHECKED BY: GHC
LMN: FGRADE
CTB: SME-STD

JOB NO. 12121.03 DWG FILE 6DN-BASE

C-106

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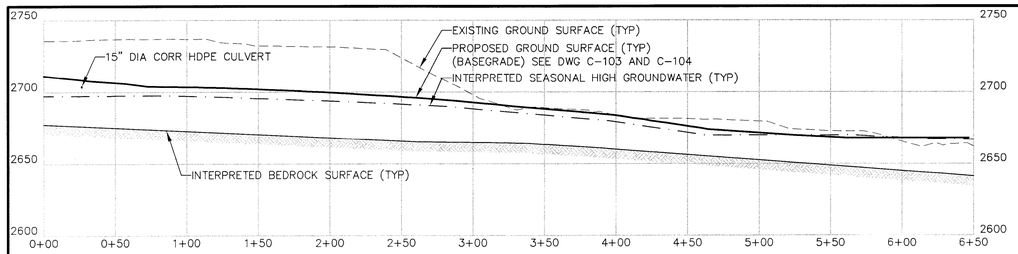
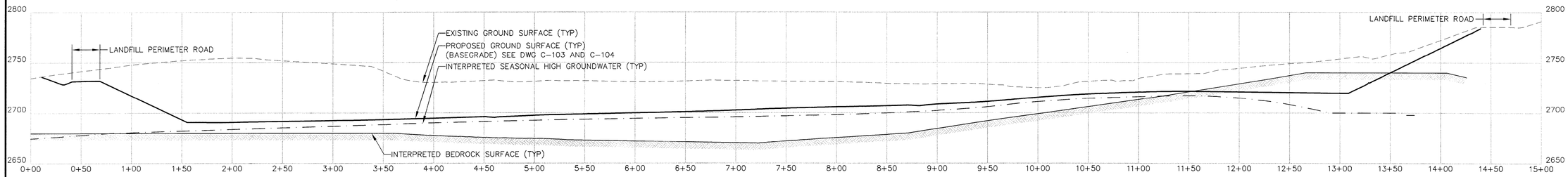
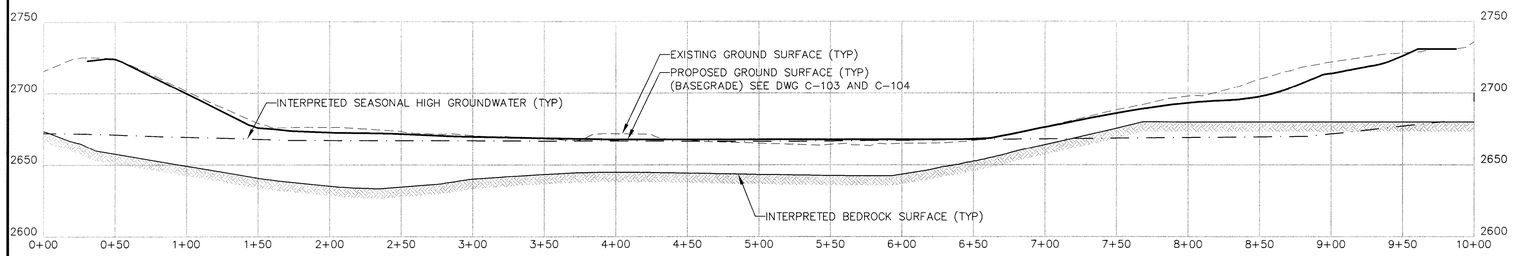


SECTION A–A'



SECTION B–B'



SECTION C–C'

NOTES:

1. FOR CROSS SECTION AND PROFILE LOCATIONS, SEE DRAWING C–103 AND C–104.
2. EXISTING GROUND ELEVATIONS COMPILED FROM AERIAL PHOTOGRAMMETRIC MAPPING DATED MARCH 30, 2007 WITH ADDITIONAL SURVEY FOR AREA D NORTH/SOUTH DATED FEBRUARY 9, 2013 AND AREA A WEST DATED FEBRUARY 26, 2011, PERFORMED BY GEODATA INC., OF ZEBULON, NC.
3. VERTICAL DATUM IS BASED ON NGVD 1929.

25 0 50 100 FEET (HORZ)
25 0 50 100 FEET (VERT)

REV.	BY	DATE	STATUS
	ASB	8/13	SUBMITTED TO NCDENR

NORTH CAROLINA PROFESSIONAL SEAL 037702 ENGINEER GUY H. COTE, JR.

EVERGREEN PACKAGING
CANTON, NORTH CAROLINA
LANDFILL NO. 6
AREA 6D NORTH DEVELOPMENT

LANDFILL CROSS SECTIONS

SME
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DATE: 7/23/2013
CHECKED BY:
LMN: NONE
CTB: SME–STD

JOB NO. 12121.03 DWG FILE 6DN–XSEC–PROF

C–200

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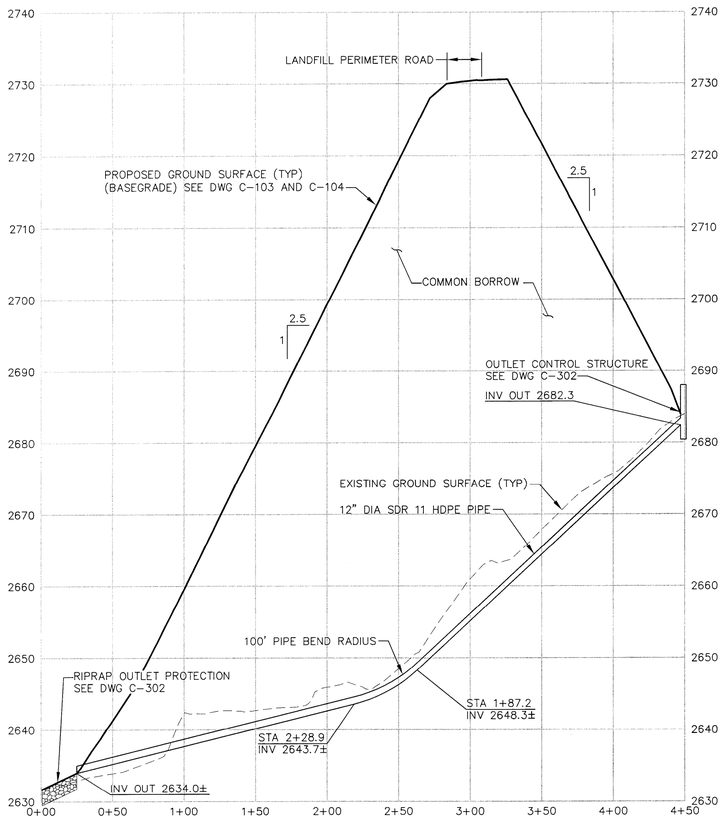
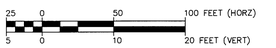
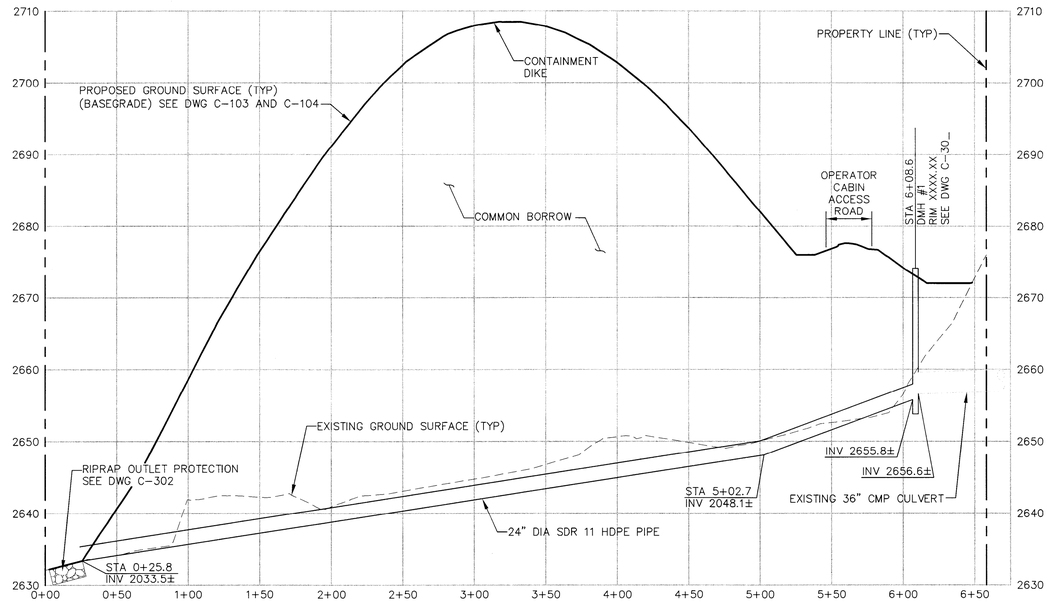
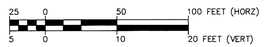


12" DIA SDR 11 HDPE PIPE PROFILE (5) C-104





24" DIA SDR 11 HDPE PIPE PROFILE (6) C-104



NOTES:

1. FOR CROSS SECTION AND PROFILE LOCATIONS, SEE DRAWING C-103 AND C-104.
2. EXISTING GROUND ELEVATIONS COMPILED FROM AERIAL PHOTOGRAMMETRIC MAPPING DATED MARCH 30, 2007 WITH ADDITIONAL SURVEY FOR AREA D NORTH/SOUTH DATED FEBRUARY 9, 2013 AND AREA A WEST DATED FEBRUARY 26, 2011, PERFORMED BY GEODATA INC., OF ZEBULON, NC.
3. VERTICAL DATUM IS BASED ON NGVD 1929.

REV.	BY	DATE	STATUS
	ASB	8/13	SUBMITTED TO NCDENR

NORTH CAROLINA PROFESSIONAL SEAL 037702 ENGINEER G. H. COTE, JR.

EVERGREEN PACKAGING
CANTON, NORTH CAROLINA
LANDFILL NO. 6
AREA 6D NORTH DEVELOPMENT

STORMDRAIN PROFILES

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Sevee & Maher Engineers, Inc.
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4 Blanchard Road, PO Box 85A, Cumberland Center, Maine 04021
Phone 207.829.5016 • Fax 207.829.5692 • www.smemaine.com

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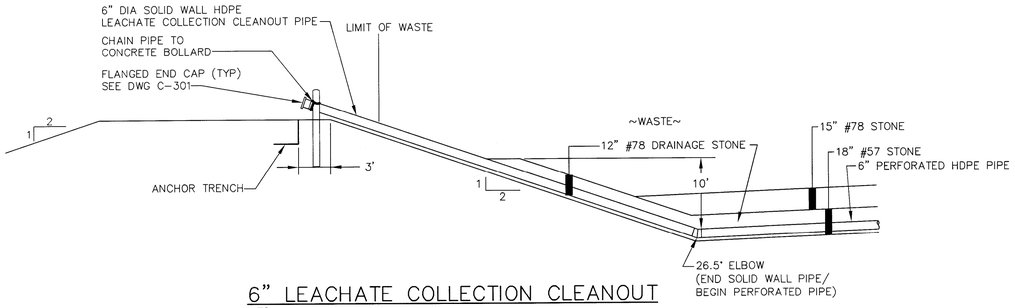
DRAWN BY: SJM
DATE: 7/23/2013
CHECKED BY:
LMN: NONE
CTB: SME-STD

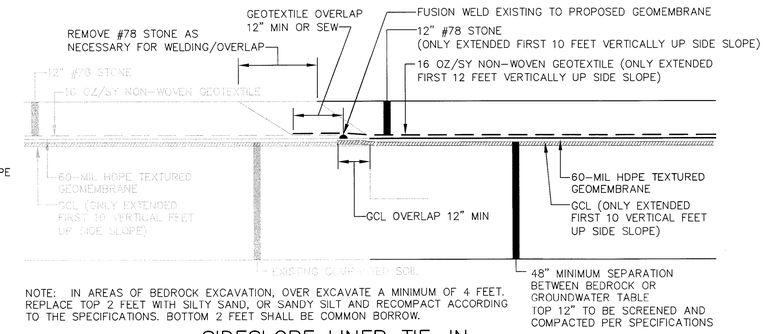
JOB NO. 12121.03 DWG FILE 6DN-XSEC-PROF

C-201

\\Maxwell\Eng\NC06-Arcadia\Plans\6DN-XSEC-PROF.dwg, 8/9/2013 5:13:15 AM, sjm

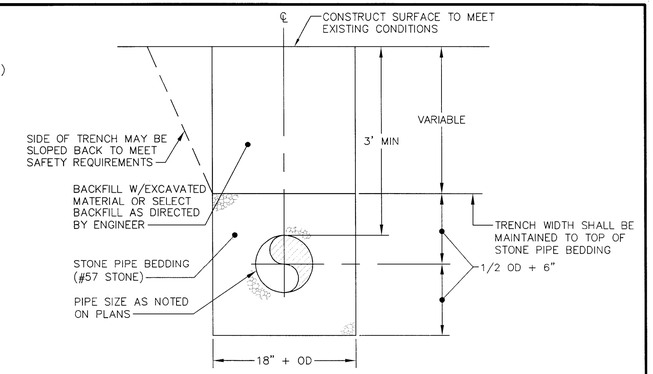


6" LEACHATE COLLECTION CLEANOUT
NTS

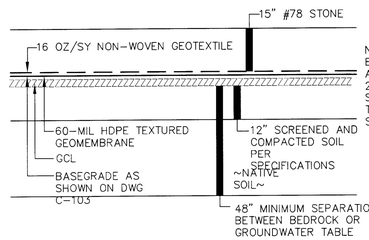


NOTE: IN AREAS OF BEDROCK EXCAVATION, OVER EXCAVATE A MINIMUM OF 4 FEET. REPLACE TOP 2 FEET WITH SILTY SAND, OR SANDY SILT AND RECOMPACT ACCORDING TO THE SPECIFICATIONS. BOTTOM 2 FEET SHALL BE COMMON BORROW.

SIDESLOPE LINER TIE-IN
NTS

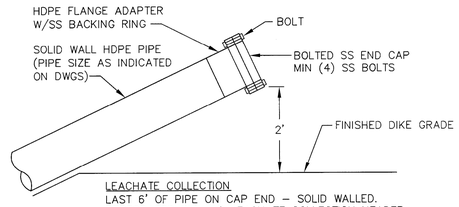


PIPE TRENCH DETAIL
NTS



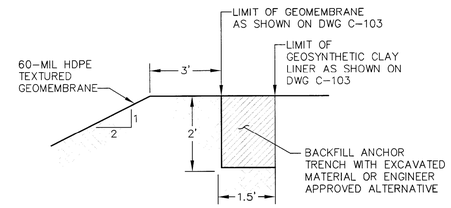
NOTE: IN AREAS OF BEDROCK EXCAVATION, OVER EXCAVATE A MINIMUM OF 4 FEET. REPLACE TOP 2 FEET WITH SILTY SAND, OR SANDY SILT AND RECOMPACT ACCORDING TO THE SPECIFICATIONS. BOTTOM 2 FEET SHALL BE COMMON BORROW.

BASE LINER AND LEACHATE COLLECTION
NTS

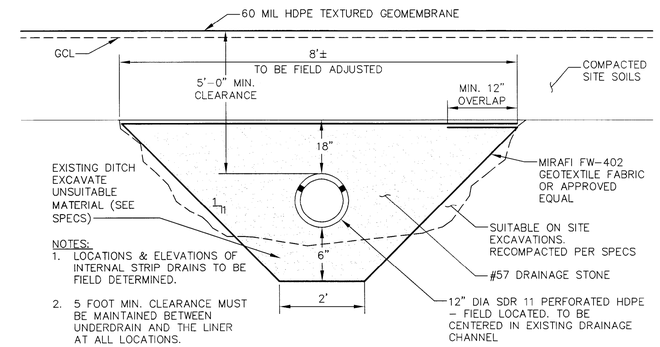


LEACHATE COLLECTION
LAST 6' OF PIPE ON CAP END – SOLID WALLED.
PERFORATED PIPE TO LEACHATE COLLECTION HEADER.

FLANGED END CAP
NTS

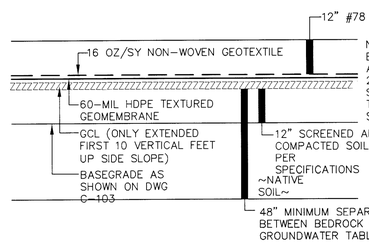


ANCHOR TRENCH
NTS



NOTES:
1. LOCATIONS & ELEVATIONS OF INTERNAL STRIP DRAINS TO BE FIELD DETERMINED.
2. 5 FOOT MIN. CLEARANCE MUST BE MAINTAINED BETWEEN UNDERDRAIN AND THE LINER AT ALL LOCATIONS.

STRIP DRAIN COLLECTION PIPE
NTS



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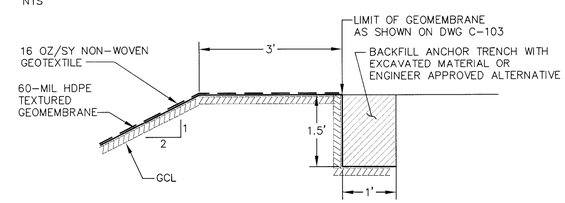
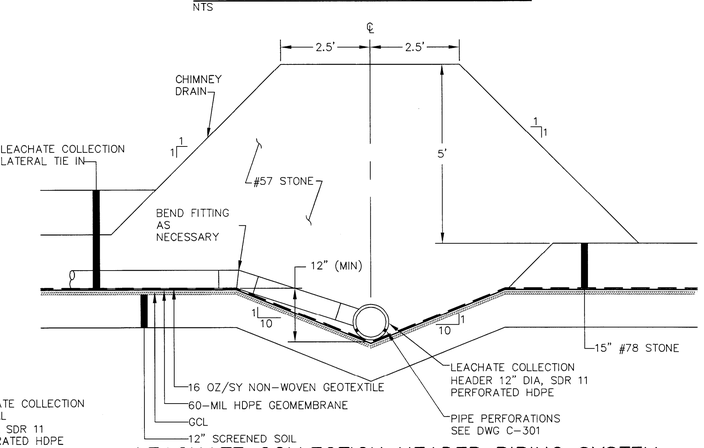
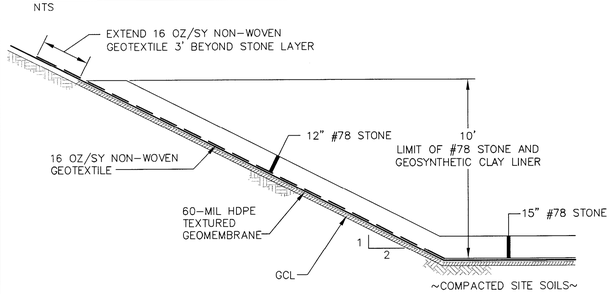
SIDESLOPE LINER AND LEACHATE COLLECTION
NTS



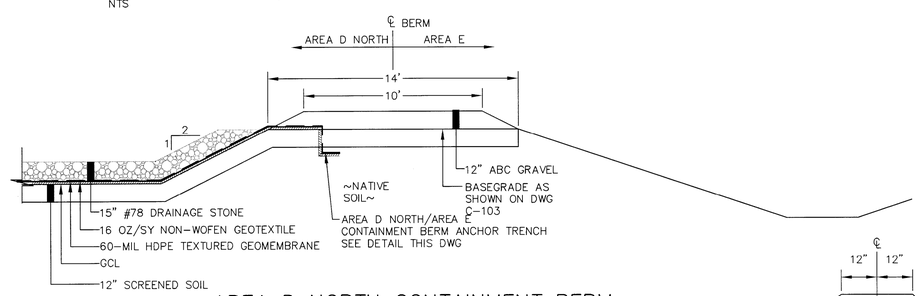
AREA D NORTH/AREA E CONTAINMENT BERM ANCHOR TRENCH
NTS



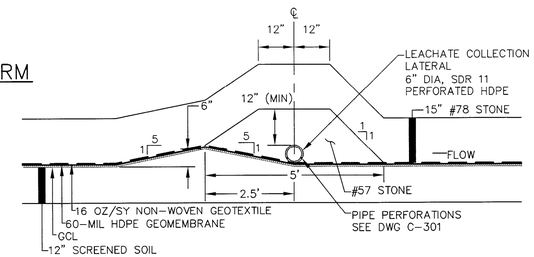
LEACHATE COLLECTION HEADER PIPING SYSTEM WITH CHIMNEY DRAIN
NTS



GCL AND LEACHATE COLLECTION
NTS



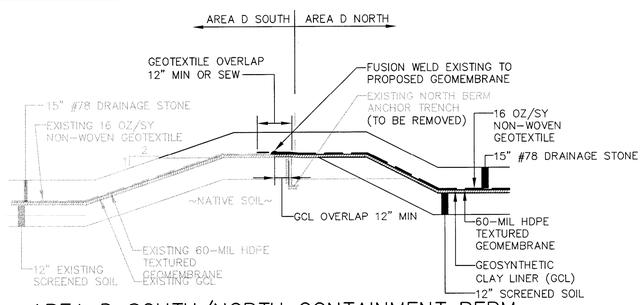
AREA D NORTH CONTAINMENT BERM
NTS



LEACHATE COLLECTION LATERAL PIPING SYSTEM
NTS

NOTE: PIPE PERFORATIONS SHALL BE 3/8" DIAMETER, 2 ROWS, 6" O.C. MAX., HOLES FACE DOWN

PIPE PERFORATIONS
NTS



AREA D SOUTH/NORTH CONTAINMENT BERM
NTS

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	ASB	8/13	SUBMITTED TO NCDENR

NORTH CAROLINA PROFESSIONAL SEAL 037702 ENGINEER GARY H. COTE

EVERGREEN PACKAGING
CANTON, NORTH CAROLINA
LANDFILL NO. 6
AREA 6D NORTH DEVELOPMENT

SECTIONS AND DETAILS

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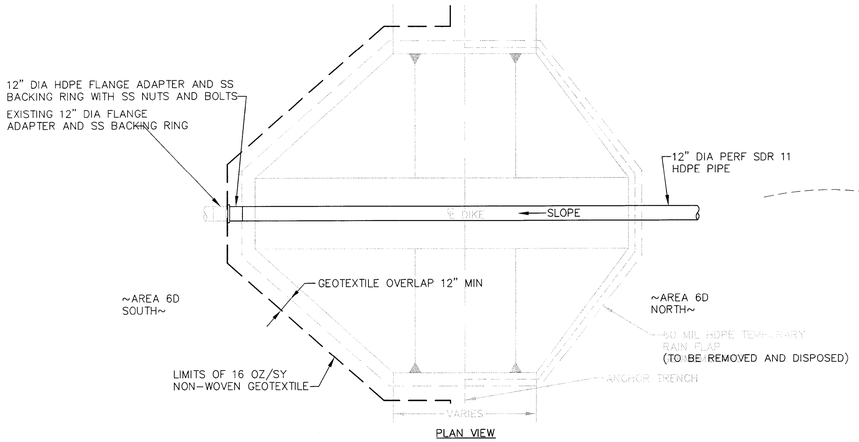
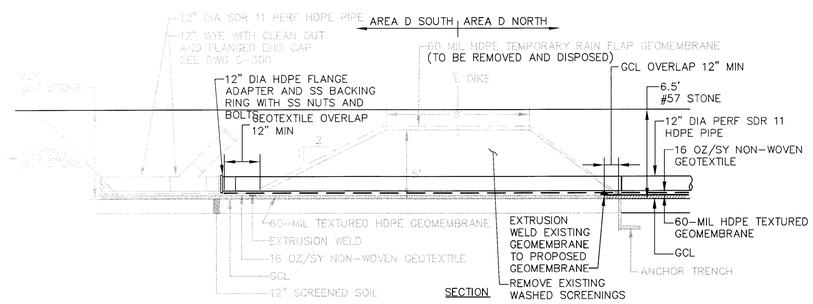
JOB NO. 12121.03 DWG FILE 6DN-DETAILS

C-300



PLAN VIEW



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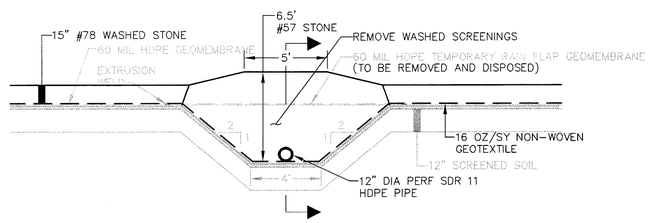
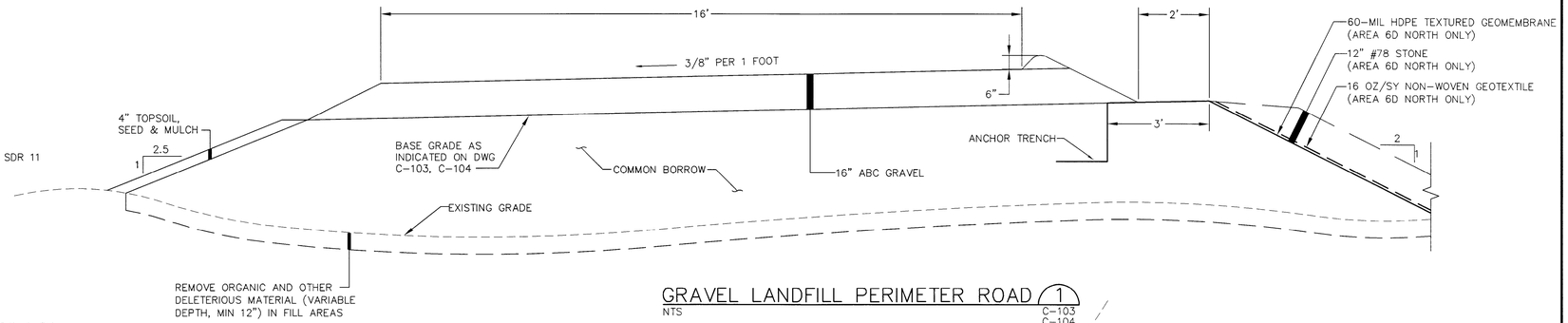


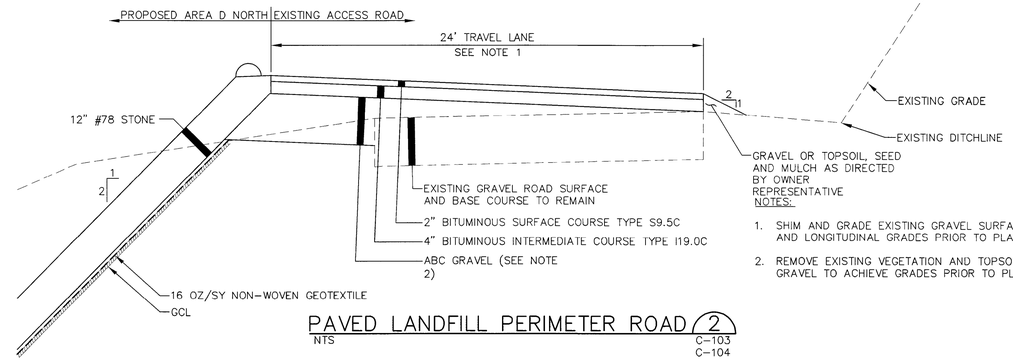
AREA D SOUTH – NORTH CONTAINMENT BERM LEACHATE TRANSPORT TIE-IN SADDLE

NTS



GRAVEL LANDFILL PERIMETER ROAD (1)

NTS C-103 C-104

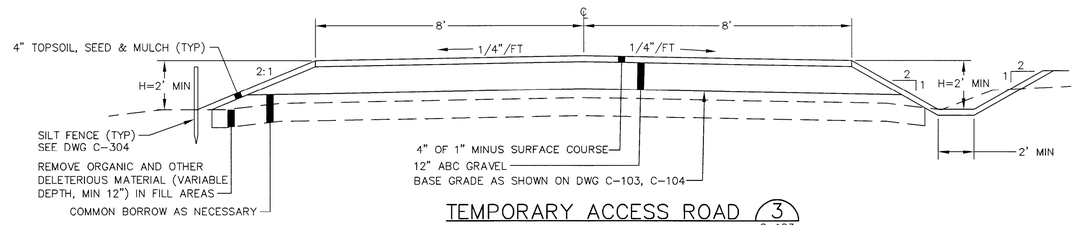


NOTES:

1. SHIM AND GRADE EXISTING GRAVEL SURFACE TO ACHIEVE CROSS SLOPE AND LONGITUDINAL GRADES PRIOR TO PLACING BITUMINOUS PAVEMENT.
2. REMOVE EXISTING VEGETATION AND TOPSOIL AND REPLACE WITH ABC GRAVEL TO ACHIEVE GRADES PRIOR TO PLACEMENT OF PAVEMENT.

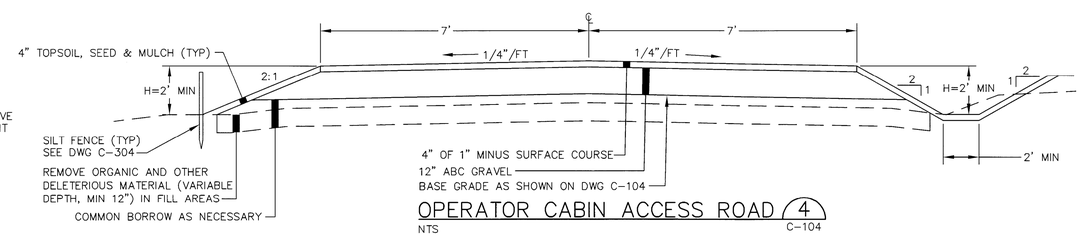
PAVED LANDFILL PERIMETER ROAD (2)

NTS C-103 C-104



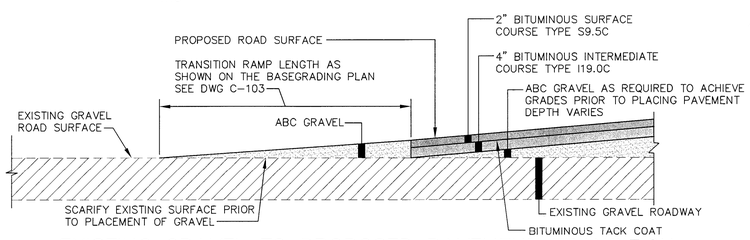
TEMPORARY ACCESS ROAD (3)

NTS C-103 C-104



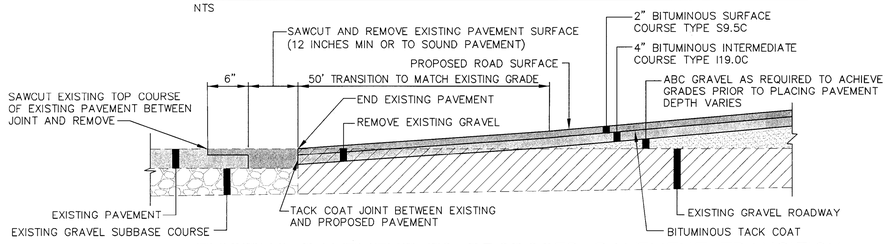
OPERATOR CABIN ACCESS ROAD (4)

NTS C-104



EXISTING GRAVEL TO PROPOSED PAVEMENT TRANSITION

NTS



EXISTING PAVEMENT TO PROPOSED PAVEMENT TRANSITION

NTS

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NORTH CAROLINA PROFESSIONAL SEAL 037702 ENGINEER SUYH COTE, JR.

EVERGREEN PACKAGING
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JOB NO. 12121.03 DWG FILE 6DN-DETAILS

C-301

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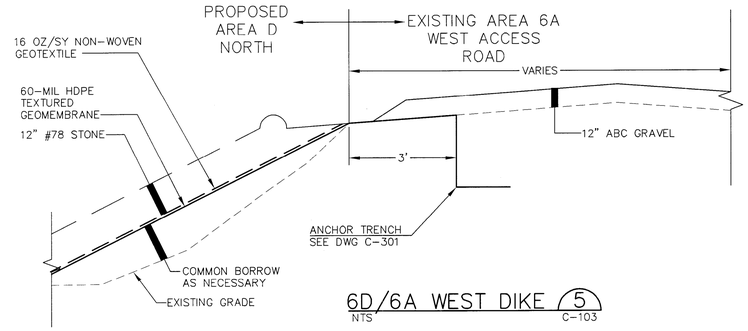
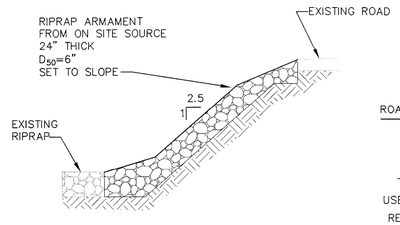
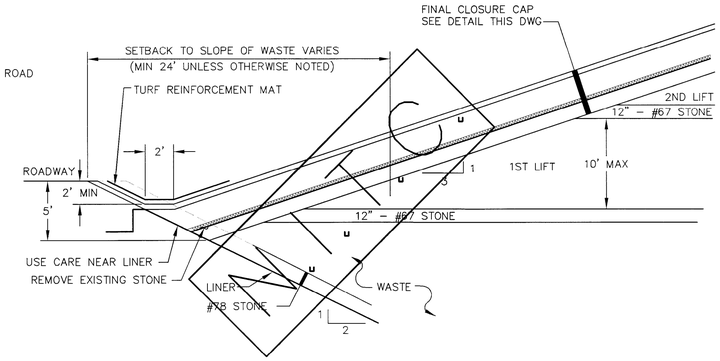


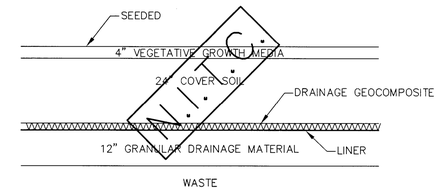
6D/6A WEST DIKE (5)
NTS C-103



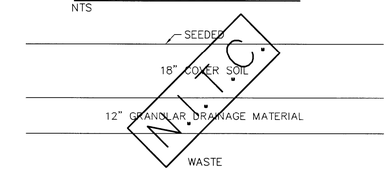
RIPRAP SLOPE STABILIZATION
NTS



FINAL COVER SYSTEM
NTS

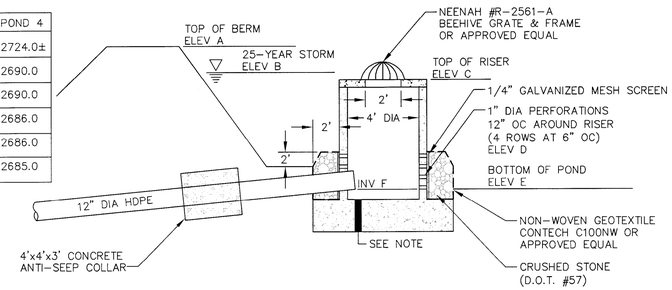


FINAL CLOSURE CAP
NTS



INTERMEDIATE CLOSURE
NTS

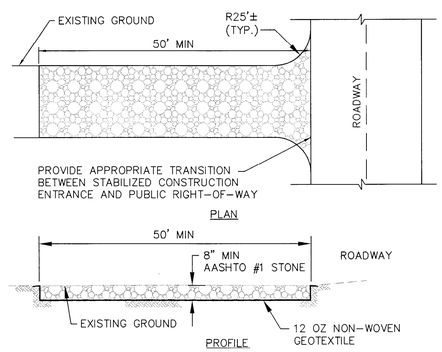
ELEV	POND 3	POND 4
A	2697.0	2724.0±
B	2693.4	2690.0
C	2693.0	2690.0
D	2690.0	2686.0
E	2690.0	2686.0
F	2689.0	2685.0



NOTE:

SHOP DRAWINGS: SUBMIT FOR REVIEW SHOP DRAWINGS OF ALL PRECAST UNITS. MANUFACTURER'S INFORMATION SHALL BE SUBMITTED FOR JOINT SEALANTS AND WATERPROOFING. MANUFACTURESS SHALL PROVIDE ANTI-FLOATATION DESIGN SHOP DRAWINGS AND CALCULATIONS, INCLUDING ANY EXTENDED BASE SLABS AS NECESSARY, FOR PROPOSED MANHOLES. MANUFACTURER SHALL ASSUME GROUNDWATER LEVELS EQUAL TOP OF GROUND ELEVATIONS AND PROVIDE FOR A 1.2 FACTOR OF SAFETY AGAINST FLOATATION.

OUTLET CONTROL STRUCTURE
NTS



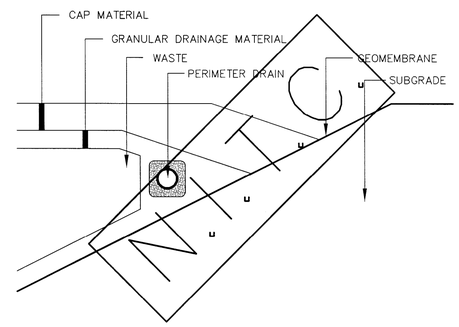
NOTES:

1. AASHTO #1 STONE SHALL HAVE THE FOLLOWING GRADATION STONE REQUIREMENTS:

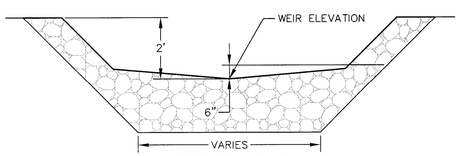
SIEVE DESIGNATION (INCHES)	% PASSING BY WEIGHT
4"	100
3 1/2"	90-100
2 1/2"	25-60
1 1/2"	0-15
3/4"	0-5

2. LENGTH - AS EFFECTIVE, BUT NOT LESS THAN 50 FEET.
3. THICKNESS - NOT LESS THAN 8 INCHES.
4. WIDTH - 20 FEET MINIMUM, OR NOT LESS THAN FULL WIDTH OF ALL POINTS OF INGRESS OR EGRESS.
5. MAINTENANCE - CONSTRUCTION ENTRANCE THICKNESS SHALL BE CONSTANTLY MAINTAINED TO THE SPECIFIED DIMENSION BY ADDING ROCK. A STOCKPILE SHALL BE MAINTAINED ON SITE FOR THIS PURPOSE. AT THE END OF EACH CONSTRUCTION DAY, ALL SEDIMENT DEPOSITED ON PAVED ROADWAYS SHALL BE REMOVED AND PLACED IN AREA D.

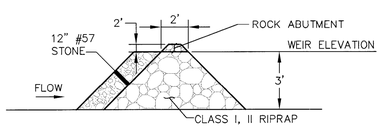
STABILIZED CONSTRUCTION ENTRANCE/EXIT
NTS



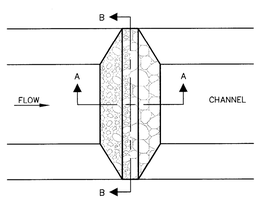
PERIMETER DRAIN
NTS



SECTION B-B



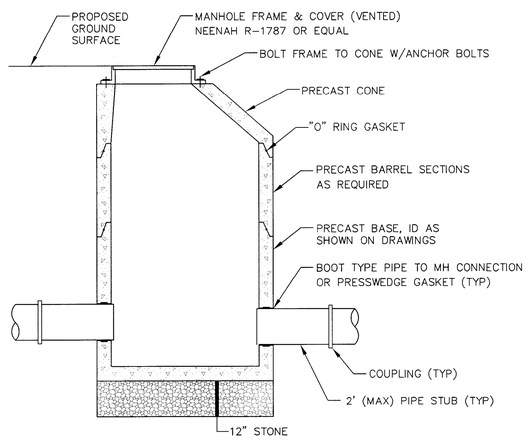
SECTION A-A



PLAN VIEW

NOTE: SEDIMENT MUST BE REMOVED WHEN ACCUMULATIONS REACH 1/2 THE HEIGHT OF THE FILTERS. IMMEDIATELY UPON STABILIZATION OF EACH CHANNEL, REMOVE ACCUMULATED SEDIMENT, REMOVE ROCK FILTER AND STABILIZE DISTURBED AREAS.

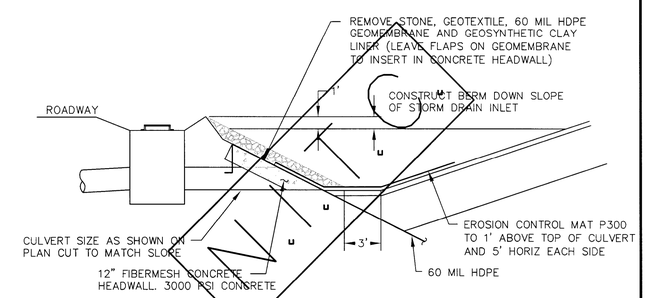
ROCK DAM
NTS



TYPICAL MANHOLE
NTS

MANHOLE NOTES:

1. ALL CONCRETE SHALL HAVE A MINIMUM 4000 PSI COMPRESSIVE STRENGTH AFTER 28 DAYS.
2. DESIGN FOR H-20 WHEEL LOADING.
3. CONFORM TO ASTM-C478 SPECIFICATIONS.
4. FIELD VERIFY EXISTING PIPE INVERTS PRIOR TO CONSTRUCTION.
5. PENETRATIONS INTO EXISTING MANHOLES FOR NEW PIPES SHALL USE EITHER A PRESS BOOT CONNECTION OR COMPRESSION TYPE GASKET.



STORMDRAIN INLET/PENETRATION
NTS

REV.	BY	DATE	STATUS
	ASB	8/13	SUBMITTED TO NCDENR

NORTH CAROLINA PROFESSIONAL SEAL 037702 ENGINEER GUY H. COTE, JR.

EVERGREEN PACKAGING
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C-302

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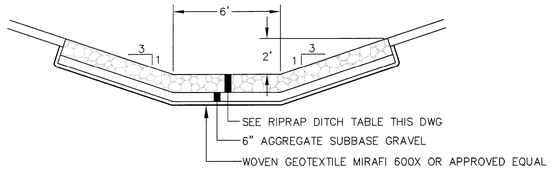
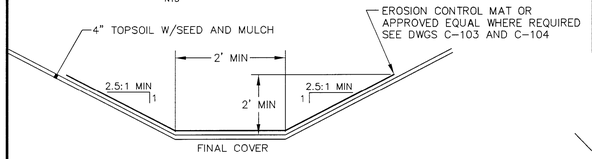


NOTE: SEE RIPRAP DITCH TABLE THIS DWG

RIPRAP DITCH
NTS



NOTE: SEE GRASS DITCH TABLE THIS DWG

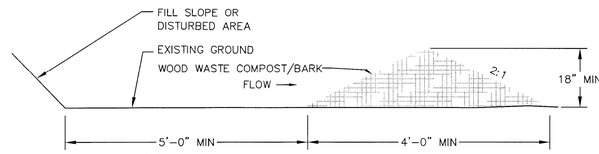
GRASS DITCH
NTS

RIPRAP DITCH TABLE

CHANNEL ID	B (FT)	D (FT)	Z1	Z2	d_{50} (in)	thickness (in)
1D-1	0	2	2	2	8	18
1D-2	0	2	2	2	6	14
1D-3	0	2	2	2	6	14
2A-2	20	2	2.5	2.5	6	14
2A-3	2	2	2.5	2.5	6	14
2B-1	2	2	2.5	2.5	12	27
2B-3	2	2	2.5	2.5	8	18
2B-4	4	2	2.5	2.5	12	27

GRASS DITCH TABLE

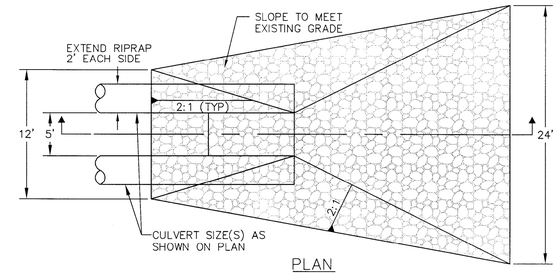
CHANNEL ID	B (FT)	D (FT)	Z1	Z2	LINING	STAPLE PATTERN
1D-4	8	5	2.5	2.5	S75	D
1D-5	8	5	2.5	2.5	S75	D
2A-1	2	2	2.5	2.5	C125	D
2B-1	2	2	2.5	2.5	C125	D
2B-2	4	2	2.5	2.5	C125	D
2D-1	4	2	2.5	2.5	C125	D
3D-1	2	2	2.5	2.5	C125	D



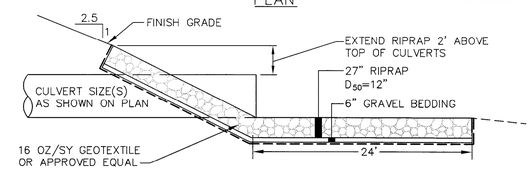
NOTE:

BARK MULCH SEDIMENT BARRIERS MAY BE USED AS AN ALTERNATE TO SILT FENCE WHEN APPROVED BY THE ENGINEER.

BARK MULCH SEDIMENT BARRIER
NTS

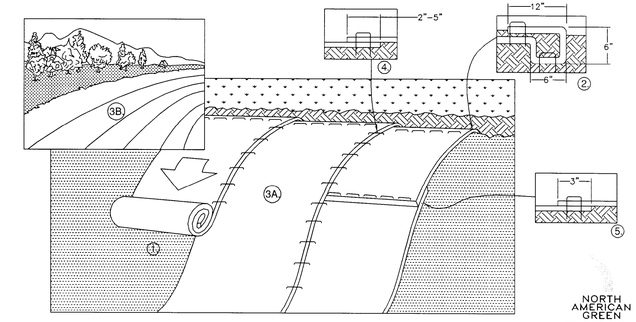


PLAN



SECTION

RIPRAP OUTLET PROTECTION
NTS



1. PREPARE SOIL BEFORE INSTALLING ROLLED EROSION CONTROL PRODUCTS (RECP's), INCLUDING ANY NECESSARY APPLICATION OF LIME, FERTILIZER, AND SEED.
2. BEGIN AT THE TOP OF THE SLOPE BY ANCHORING THE RECP's IN A 6" DEEP X 6" WIDE TRENCH WITH APPROXIMATELY 12" OF RECP's EXTENDED BEYOND THE UP-SLOPE PORTION OF THE TRENCH. ANCHOR THE RECP's WITH A ROW OF STAPLES/STAKES APPROXIMATELY 12" APART IN THE BOTTOM OF THE TRENCH. BACKFILL AND COMPACT THE TRENCH AFTER STAPLING. APPLY SEED TO COMPACTED SOIL AND FOLD REMAINING 12" PORTION OF RECP's BACK OVER SEED AND COMPACTED SOIL. SECURE RECP's OVER COMPACTED SOIL WITH A ROW OF STAPLES/STAKES SPACED APPROXIMATELY 12" APART ACROSS THE WIDTH OF THE RECP's.
3. ROLL THE RECP's (A) DOWN OR (B) HORIZONTALLY ACROSS THE SLOPE. RECP's WILL UNROLL WITH APPROPRIATE SIDE AGAINST THE SOIL SURFACE. ALL RECP's MUST BE SECURELY FASTENED TO SOIL SURFACE BY PLACING STAPLES IN APPROPRIATE LOCATIONS AS SHOWN IN THE STAPLE PATTERN GUIDE. WHEN USING THE DOT SYSTEM™ STAPLES SHOULD BE PLACED THROUGH EACH OF THE COLORED DOTS CORRESPONDING TO THE APPROPRIATE STAPLE PATTERN.
4. THE EDGES OF PARALLEL RECP's MUST BE STAPLED WITH APPROXIMATELY 2" – 5" OVERLAP DEPENDING ON RECP's TYPE.
5. CONSECUTIVE RECP's SPLICED DOWN THE SLOPE MUST BE PLACED END OVER END (SHINGLE STYLE) WITH AN APPROXIMATE 3" OVERLAP. STAPLE THROUGH OVERLAPPED AREA, APPROXIMATELY 12" APART ACROSS ENTIRE RECP's WIDTH.

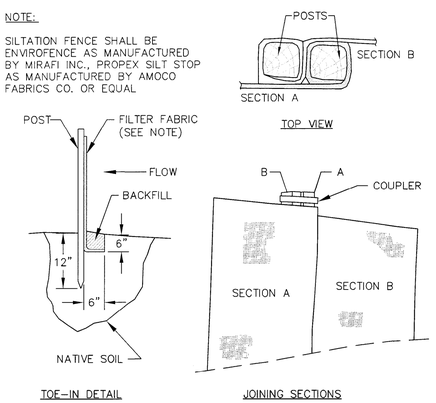
NOTE:
*IN LOOSE SOIL CONDITIONS, THE USE OF STAPLE OR STAKE LENGTHS GREATER THAN 6" MAY BE NECESSARY TO PROPERLY SECURE THE RECP's.

NORTH AMERICAN GREEN
EROSION CONTROL Products Guaranteed SOLUTIONS
14649 HIGHWAY 41 NORTH
EVANSVILLE, IN 47725
800-772-2040
www.nagreen.com

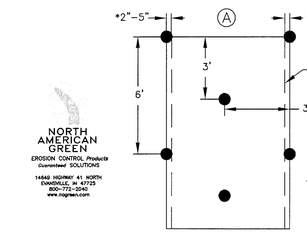
SLOPE INSTALLATION
NTS

NOTE:

SILTATION FENCE SHALL BE ENVIROFENCE AS MANUFACTURED BY MIRAFI INC., PROPEX SILT STOP AS MANUFACTURED BY AMOCO FABRICS CO. OR EQUAL

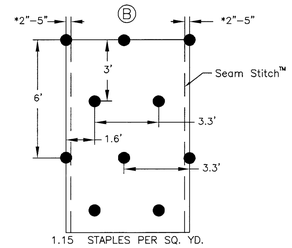


SILT FENCE
NTS



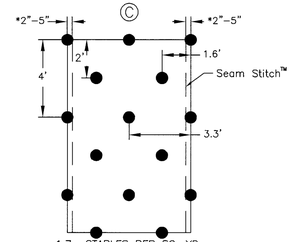
0.7 STAPLES PER SQ. YD.

For blankets with the North American Green DOT System™ place staples through each of the dots.



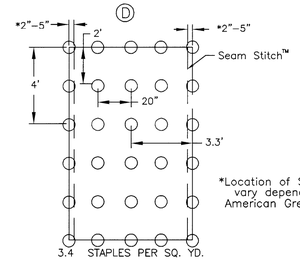
1.15 STAPLES PER SQ. YD.

For blankets with the North American Green DOT System™ place staples through each of the dots.



1.7 STAPLES PER SQ. YD.

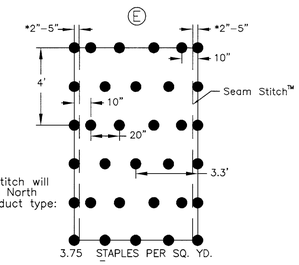
For blankets with the North American Green DOT System™ place staples through each of the dots.



3.4 STAPLES PER SQ. YD.

For blankets with the North American Green DOT System™ place staples through each of the dots.

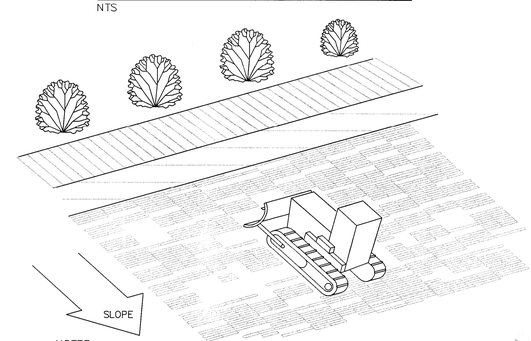
*Location of Seam Stitch will vary depending on North American Green product type:



3.75 STAPLES PER SQ. YD.

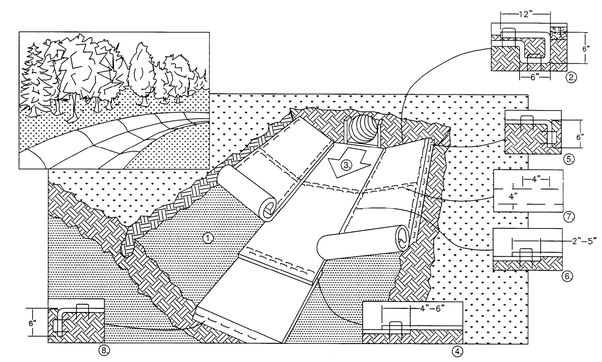
For blankets with the North American Green DOT System™ place staples through each of the dots.

DOT SYSTEM™ STAPLE PATTERN GUIDE
NTS



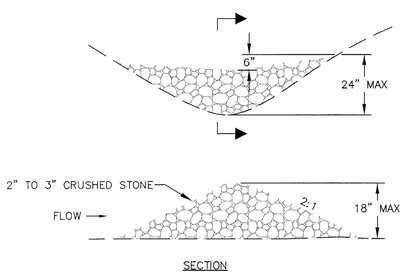
NOTES:
1. SLOPE TRACKING SHALL BE PERFORMED BY CONTRACTOR ON ALL FINISHED AREAS TO BE SEEDED.
2. TRACKING SHALL BE PERFORMED BY RUNNING TRACKED MACHINERY UP AND DOWN SLOPES LEAVING TREAD MARKS PARALLEL TO THE CONTOUR.

SLOPE TRACKING
NTS



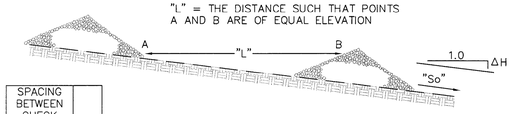
1. PREPARE SOIL BEFORE INSTALLING ROLLED EROSION CONTROL PRODUCTS (RECP's), INCLUDING ANY NECESSARY APPLICATION OF LIME, FERTILIZER, AND SEED.
2. BEGIN AT THE TOP OF THE CHANNEL BY ANCHORING THE RECP's IN A 6" DEEP X 6" WIDE TRENCH WITH APPROXIMATELY 12" OF RECP's EXTENDED BEYOND THE UP-SLOPE PORTION OF THE TRENCH. ANCHOR THE RECP's WITH A ROW OF STAPLES/STAKES APPROXIMATELY 12" APART IN THE BOTTOM OF THE TRENCH. BACKFILL AND COMAPCT THE TRENCH AFTER STAPLING. APPLY SEED TO COMPACTED SOIL AND FOLD REMAINING 12" PORTION OF RECP's BACK OVER SEED AND COMPACTED SOIL. SECURE RECP's OVER COMPACTED SOIL WITH A ROW OF STAPLES SPACED APPROXIMATELY 12" ACROSS THE WIDTH OF THE RECP's.
3. ROLL CENTER RECP's IN DIRECTION OF WATER FLOW IN BOTTOM OF CHANNEL. RECP's WILL UNROLL WITH APPROPRIATE SIDE AGAINST THE SOIL SURFACE. ALL RECP's MUST BE SECURELY FASTENED TO SOIL SURFACE BY PLACING STAPLES IN APPROPRIATE LOCATIONS AS SHOWN IN THE STAPLE PATTERN GUIDE. WHEN USING THE DOT SYSTEM™, STAPLES SHOULD BE PLACED THROUGH EACH OF THE COLORED DOTS CORRESPONDING TO THE APPROPRIATE STAPLE PATTERN.
4. PLACE CONSECUTIVE RECP's END OVER END (SHINGLE STYLE) WITH A 4" – 6" OVERLAP. USE A DOUBLE ROW OF STAPLES STAGGERED 4" APART AND 4" ON CENTER TO SECURE RECP's.
5. FULL LENGTH EDGE OF RECP's AT TOP OF SIDE SLOPES MUST BE ANCHORED WITH A ROW OF STAPLES APPROXIMATELY 12" APART IN A 6" DEEP X 6" WIDE TRENCH. BACKFILL AND COMPACT THE TRENCH AFTER STAPLING.
6. ADJACENT RECP's MUST BE OVERLAPPED APPROXIMATELY 2" – 5" (DEPENDING ON RECP's TYPE) AND STAPLED.
7. IN HIGH FLOW CHANNEL APPLICATIONS, A STAPLE CHECK SLOT IS RECOMMENDED AT 30 TO 40 FOOT INTERVALS. USE A DOUBLE ROW OF STAPLES STAGGERED 4" APART AND 4" ON CENTER OVER ENTIRE WIDTH OF THE CHANNEL.
8. THE TERMINAL END OF THE RECP's MUST BE ANCHORED WITH A ROW OF STAPLES APPROXIMATELY 12" APART IN A 6" DEEP X 6" WIDE TRENCH. BACKFILL AND COMPACT THE TRENCH AFTER STAPLING.

NOTE:
* IN LOOSE SOIL CONDITIONS, THE USE OF STAPLE OR STAKE LENGTHS GREATER THAN 6" MAY BE NECESSARY TO PROPERLY ANCHOR THE RECP's.



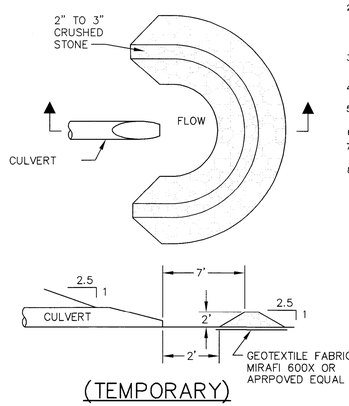
SECTION

"L" = THE DISTANCE SUCH THAT POINTS A AND B ARE OF EQUAL ELEVATION

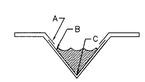


SPACING BETWEEN CHECK DAMS	
"So" FT/FT	"L" FT
0.020	75
0.030	50
0.040	40
0.050	30
0.080	20
0.100	10

STONE CHECK DAM
NTS



(TEMPORARY) RIPRAP CULVERT INLET PROTECTION
NTS



CRITICAL POINTS
A. OVERLAPS AND SEAMS
B. PROJECTED WATER LINE
C. CHANNEL BOTTOM/SIDE SLOPE VERTICES

NOTE:
* HORIZONTAL STAPLE SPACING SHOULD BE ALTERED IF NECESSARY TO ALLOW STAPLES TO SECURE THE CRITICAL POINTS ALONG THE CHANNEL SURFACE.

CHANNEL INSTALLATION
NTS

REV.	BY	DATE	STATUS
	ASB	8/13	SUBMITTED TO NCDENR

NORTH CAROLINA PROFESSIONAL SEAL 037702 ENGINEER GARY H. COTE, JR.

EVERGREEN PACKAGING
CANTON, NORTH CAROLINA
LANDFILL NO. 6
AREA 6D NORTH DEVELOPMENT

SECTIONS AND DETAILS

SME
Sevee & Maher Engineers, Inc.
ENVIRONMENTAL • CIVIL • GEOTECHNICAL • WATER • COMPLIANCE
4 Blanchard Road, PO Box 85A, Cumberland Center, Maine 04021
Phone 207.829.5016 • Fax 207.829.5692 • www.smemaine.com

JOB NO. 12121.03 DWG FILE 6DN–DETAILS

DESIGN BY:	ASB
DRAWN BY:	SJM
DATE:	6/12/2013
CHECKED BY:	
LMN:	NONE
CTB:	SME–STD

C–303

NOTES:

1. MAPPING FOR LANDFILL AREA COMPILED USING PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED MARCH 5, 2008
2. LOCATIONS OF OBJECTS SHOWN AND CONTOURS ARE APPROXIMATE. SITE CONDITIONS HAVE CHANGED SINCE THE COMPILATION OF THIS MAP AND STANDARD PRACTICE DICTATES THAT PLANS COMPILED IN THIS MANNER SHOULD BE FIELD VERIFIED, AS THE DESIGN MAY REQUIRE FIELD ADJUSTMENT FOR CONSTRUCTION.
3. GRID IS BASED ON NORTH CAROLINA STATE PLANE COORDINATE SYSTEM BASED ON NAGS (1983).
4. VERTICAL DATUM BASED ON NGVD (1929).
5. PROPERTY LINE DIGITIZED FROM LAW ENGINEERING DRAWING DATED JANUARY 14, 1984.
6. EXISTING GRADE CONTOUR INTERVAL IS 2 FT.

STANDARD STORMWATER MANAGEMENT SYMBOLS

1	SUBCATCHMENT DESIGNATION
	SUBCATCHMENT BOUNDARY
A B C	TIME OF CONCENTRATION SEGMENT DESIGNATION TIME OF CONCENTRATION PATH
Sht L=50' S=0.005	TIME OF CONCENTRATION TYPE, LENGTH AND SLOPE. (75% TEXT HT)
Sht	SHEET FLOW
Shc	SHALLOW CONCENTRATED FLOW
Cf	CHANNEL FLOW
	DRAINAGE REACH
R4	REACH DESIGNATION
P9	POND/STRUCTURE DESIGNATION
tc 1	TIME OF CONCENTRATION WITH SUBCATCHMENT DESIGNATION

75 0 150 300 FEET

REV.	BY	DATE	STATUS
	ASB	8/13	SUBMITTED TO NCDENR

NORTH CAROLINA PROFESSIONAL SEAL 037702 ENGINEER JOHN H. COTE, JR.

EVERGREEN PACKAGING
CANTON, NORTH CAROLINA
LANDFILL NO. 6
AREA 6D NORTH DEVELOPMENT
PRE-DEVELOPMENT STORMWATER MANAGEMENT PLAN

SME
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Phone 207.829.5016 • Fax 207.829.5692 • www.smemaine.com

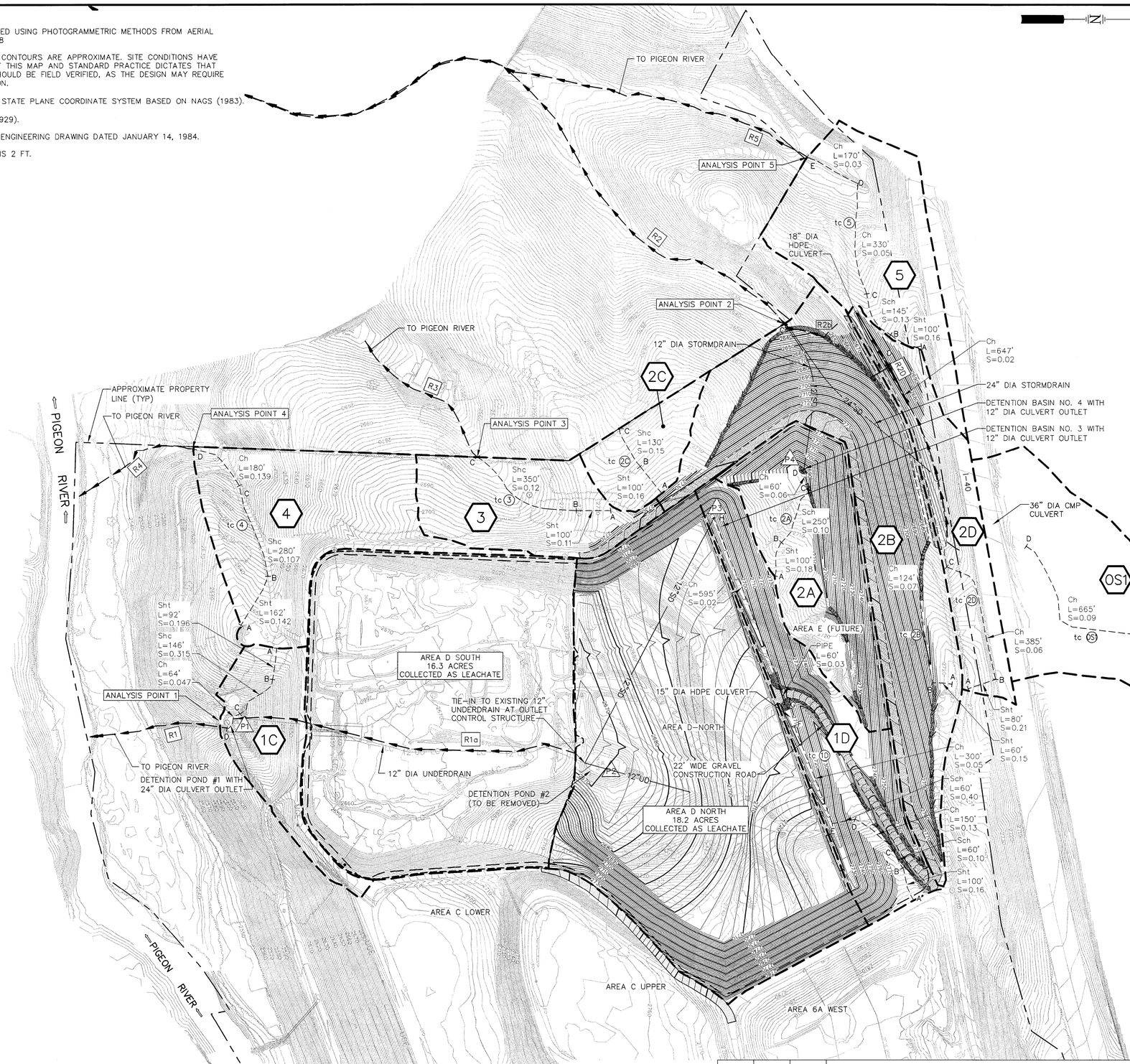
DESIGN BY:	ASB
DRAWN BY:	SJM
DATE:	7/17/2013
CHECKED BY:	
LMN:	SMP-E
CTB:	SME-STD

JOB NO. 12121.03 DWG FILE 6DN-E-SMP

D-100

NOTES:

1. MAPPING FOR LANDFILL AREA COMPILED USING PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHY DATED MARCH 5, 2008
2. LOCATIONS OF OBJECTS SHOWN AND CONTOURS ARE APPROXIMATE. SITE CONDITIONS HAVE CHANGED SINCE THE COMPILATION OF THIS MAP AND STANDARD PRACTICE DICTATES THAT PLANS COMPILED IN THIS MANNER SHOULD BE FIELD VERIFIED, AS THE DESIGN MAY REQUIRE FIELD ADJUSTMENT FOR CONSTRUCTION.
3. GRID IS BASED ON NORTH CAROLINA STATE PLANE COORDINATE SYSTEM BASED ON NAGS (1983).
4. VERTICAL DATUM BASED ON NGVD (1929).
5. PROPERTY LINE DIGITIZED FROM LAW ENGINEERING DRAWING DATED JANUARY 14, 1984.
6. EXISTING GRADE CONTOUR INTERVAL IS 2 FT.



STANDARD STORMWATER MANAGEMENT SYMBOLS

1	SUBCATCHMENT DESIGNATION
	SUBCATCHMENT BOUNDARY
A B C	TIME OF CONCENTRATION SEGMENT DESIGNATION TIME OF CONCENTRATION PATH
Sht L=50' S=0.005	TIME OF CONCENTRATION TYPE, LENGTH AND SLOPE. (75% TEXT HT)
Sht	SHEET FLOW
Shc	SHALLOW CONCENTRATED FLOW
Cf	CHANNEL FLOW
	DRAINAGE REACH
R4	REACH DESIGNATION
P3	POND/STRUCTURE DESIGNATION
tc 1	TIME OF CONCENTRATION WITH SUBCATCHMENT DESIGNATION

75 0 150 300 FEET

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 037702 GUY H. COTE, JR.

EVERGREEN PACKAGING
CANTON, NORTH CAROLINA
LANDFILL NO. 6
AREA 6D NORTH DEVELOPMENT
POST DEVELOPMENT STORMWATER MANAGEMENT PLAN

REV.	BY	DATE	STATUS
	ASB	8/13	SUBMITTED TO NCDENR

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DESIGN BY: ASB
DRAWN BY: SJM
DATE: 7/17/2013
CHECKED BY:
LMN: SMP-P
CTB: SME-STD

JOB NO. 12121.03 DWG FILE 6DN-BASE

D-101

ATTACHMENT B

STABILITY EVALUATION

STABILITY EVALUATION

LANDFILL NO. 6
SITE INVESTIGATION – AREAS D AND E

BLUE RIDGE PAPER PRODUCTS INC. – CANTON MILL
DIVISION OF EVERGREEN PACKAGING
CANTON, NORTH CAROLINA

NOVEMBER 2008

SME

Sevee & Maher Engineers, Inc.

Waste Management and Hydrogeologic Consultants
Cumberland Center, Maine

NORTH CAROLINA PROFESSIONAL SEAL 20589 ENGINEER JOHN E. SEVEE

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1.0 STABILITY EVALUATION

SME has completed a stability evaluation as part of the landfill expansion into Areas D and E. Components of the evaluation included a stability analysis addressing the geotechnical performance of the subsurface (foundation) soils, the proposed wastes, perimeter containment dikes and the landfill liner system. The evaluation considered both static and seismic loading conditions. The stability evaluation for Areas D and E of Blue Ridge Paper Products Inc. – Canton Mill (Blue Ridge) Landfill No. 6 used site data collected in the Fall of 2007 as part of the site investigation (as described in Volume I of the Application). In addition, SME's evaluation made use of several previous geotechnical investigations that have been conducted at the Blue Ridge landfill facility. Testing has been performed by SME and others on the site wastes, foundation and dike soils. Data from previous investigations were used to augment the 2007 investigation and testing, namely:

- Landfill Stability Evaluation for Vertical Expansions, Area 6A-West (SME, 2006)
- Landfill Stability Evaluation for Vertical Expansions, Area 6A-East (SME, 1999)
- Operations Manual, Champion International Corporation Landfill No. 6 East, Canton, North Carolina, (SME, 1995a)
- Landfill No. 6 Closure Report, Field and Laboratory Investigation Report (SME, 1995b)
- Geotechnical Report for Landfill No. 6 Expansion Area A (Sirrine, 1989)
- Revised Report of Geotechnical Exploration and Evaluation and Conceptual Site Development Recommendations, Landfill No. 6 (Law, 1982)

1.1 Selection of Input Parameters

1.1.1 Landfill Wastes. The relevant geotechnical properties for the proposed Areas D and E waste were selected based primarily on the laboratory testing performed as part of SME's, May 2006 Landfill Stability Evaluation for Vertical Expansion, Area 6A-West (SME, 2006). The total unit weight and effective strength data are tabularized on Table A-1 in Appendix A. The

selected effective shear strength of the waste is graphically presented relative to the rest of the available test data in Figure A-1 in Appendix A. The properties selected for the waste were: an average total unit weight of 90 pcf and an average effective friction angle of 36 degrees with no cohesion. Both of these values are conservative estimates based on SME's laboratory testing and on the historical values presented by others. Selective laboratory test results are presented in Appendix A.

1.1.2 Perimeter Dikes. The geotechnical properties for the proposed Areas D and E dikes were selected based on data and testing performed and collected from dike soils as part of the Area 6A-East Vertical Expansion. This data along with data from previous investigations is tabularized on Table A-2 in Appendix A. The direct shear data is plotted in Figure A-2 of Appendix A, along with available data from previous investigations of borrow source material for the perimeter dike. The geotechnical properties selected for the perimeter dikes were a total unit weight of 120 pcf and an effective friction angle of 32 degrees with an effective cohesion of zero psf.

1.1.3 Foundation Materials. The geotechnical properties of the foundation soils were also based on testing performed as part of the Area 6A-West Vertical Expansion and confirmed with field testing performed as part of the Areas D and E site investigation. The foundation soils were assumed to have a slightly lower friction angle than the dike soils since they were not manually compacted. The total unit weight and effective friction angles were selected based on undisturbed tube samples of foundation soils tested by Sirrine, 1989. A total unit weight of 115 pcf and an effective friction angle of 28.5 degrees with no cohesion was selected for use in the stability analysis. The data is graphically presented in Figure A-3, and is tabularized on Table A-3, both in Appendix A.

1.1.4 Soil Cover. The soil cover was estimated to have an effective friction angle of 30 degrees with no cohesion and was assumed to have a unit weight of 125 pcf. The shear strength is based on a slight reduction of the dike soil strength, since a similar soil is assumed for the cover.

1.1.5 Liner. The proposed Areas D and E liner system will consist of 15-inches of #78 stone, underlain by a 16-ounce geotextile, underlain by a 60 mil HDPE textured geomembrane and, on all but the interior sideslopes, the 60-mil HDPE textured geomembrane is underlain by a geosynthetic clay liner. The liner system was assigned a strength envelop based on interface strength testing that SME has obtained on similar materials. That data is presented in Appendix A-1.

1.1.6 Piezometric Conditions. Based on water level data collected from piezometers placed within and around Areas D and E during the fall of 2007, a groundwater phreatic surface (i.e., water table) in the foundation soils was developed. Based on water level measurements of the Area 6A-West piezometers (SME, 2006), which showed that no phreatic surface existed within the dikes, it was assumed for the stability analysis that the Areas D and E dikes will be unsaturated. For the stability analysis it was assumed that the phreatic surface in the foundation soils was below the base of Areas D and E, sloping from Elevation 2702 feet NGVD in the north to Elevation 2590 feet NGVD at the landfill's southern toe.

The piezometric conditions assumed within the proposed Areas D and E waste mass were based on measurements from piezometers placed within the Area 6A-West waste (SME, 2006). In that evaluation, a relationship between excess pore pressure and waste depth was established, based on the measured liquid levels in the piezometers. As a result, for every foot of waste depth in the landfill, 0.18 feet of pore pressure was applied within the waste. A plot of this relationship is presented in Appendix B.

It should be noted that although the piezometric conditions modeled in Areas D and E were observed in Area 6A-West wastes, the SME evaluation also analyzed the worst-case condition of a fully-saturated waste mass with a phreatic surface at the top of the waste. This conservative condition assumes that the wastes are undrained and the leachate collection system is inoperable.

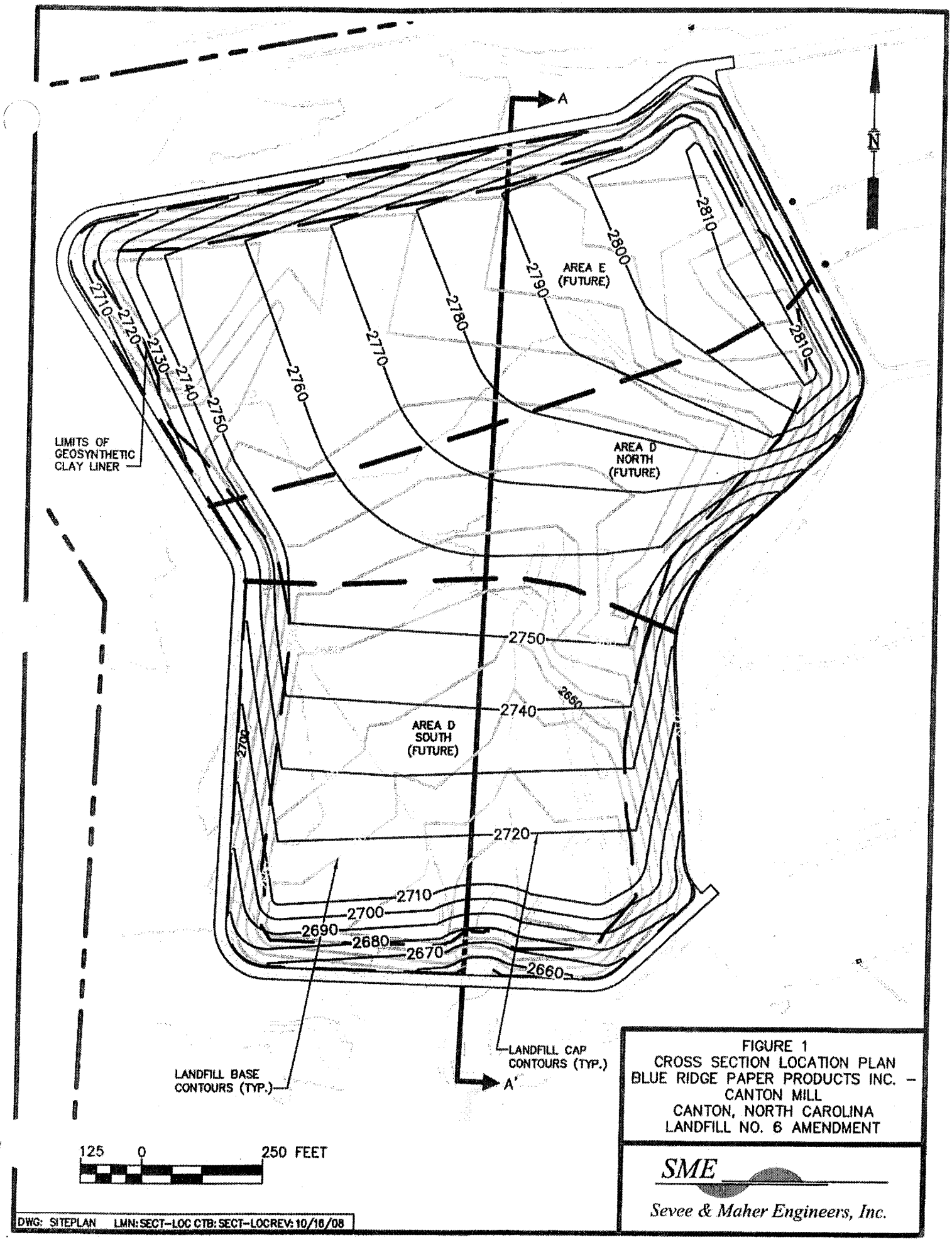
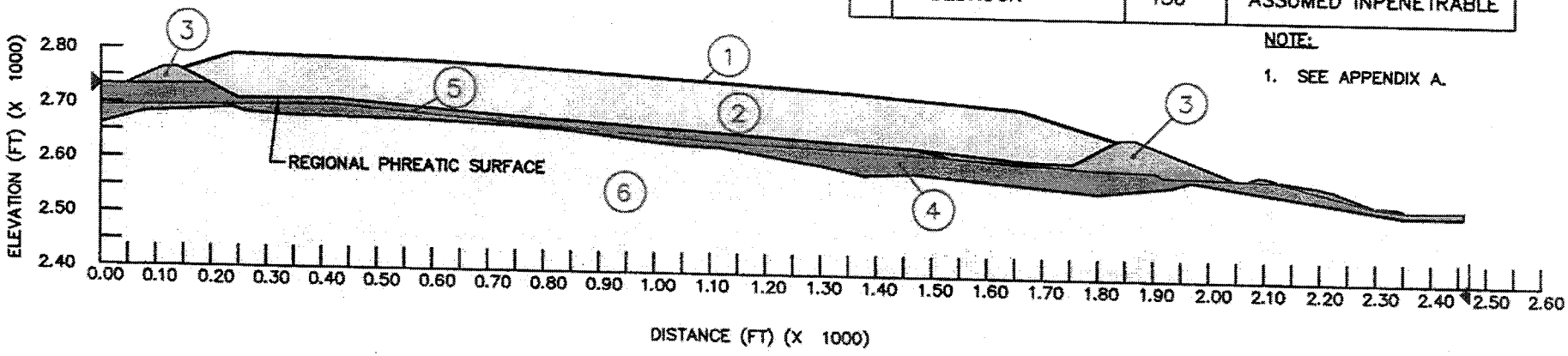


FIGURE 1
CROSS SECTION LOCATION PLAN
BLUE RIDGE PAPER PRODUCTS INC. –
CANTON MILL
CANTON, NORTH CAROLINA
LANDFILL NO. 6 AMENDMENT

MATERIAL		UNIT	SHEAR STRENGTH	
NO	TYPE	WEIGHT (PCF)	ø (DEGREES)	c (PSF)
1	SOIL COVER	125	30	--
2	WASTE	90	36	--
3	PERIMETER DIKE	120	32	115
4	FOUNDATION SOIL	115	28.5	--
5	LINER	120	STRENGTH ENVELOPE [1]	
6	BEDROCK	150	ASSUMED INPENETRABLE	

NOTE:

1. SEE APPENDIX A.



NOTE:

PIEZOMETRIC CONDITION IN WASTE MODELED AS A GRID OF PRESSURE HEADS. BASED ON THE RELATIONSHIP OF 0.18 FEET OF PORE PRESSURE PER FOOT OF WASTE.

FIGURE 2
CROSS SECTION A–A'
BLUE RIDGE PAPER PRODUCTS INC. – CANTON MILL
CANTON, NORTH CAROLINA
LANDFILL NO. 6 AMENDMENT

SME
Sevee & Maher Engineers, Inc.

DWG:SECTION A–A LMN: CTB:HPSTD REV:10/20/08

1.2 Selection of Critical Stability Cross-Section

One cross-section (Cross-Section A-A') was selected as representative of the geometry for Areas D and E, relative to slope stability. This cross-section is presented in Figure 2, and its locations in Figure 1. Cross-Sections A-A' was selected as because it passes through the area with the greatest proposed waste thickness and steepest sloping base grades. The maximum designed waste grade for Cross-Section A-A' is about Elevation 2790 feet NGVD, and the elevation of the toe of the southern dike is about Elevation 2590 feet NGVD.

1.3 Stability Analyses

Effective stress conditions were used in the stability analysis for the post-closure period. This approach is appropriate for free-draining materials such as the wastes expected to be landfilled in Areas D and E. The assumed piezometric conditions in the waste, foundation soils and perimeter dike allowed application of piezometric conditions necessary for the effective stress analysis. SME performed both static (i.e., non-earthquake) and pseudo-static (i.e., earthquake) stability analysis for the proposed final grading after closure of Areas D and E. The pseudo-static analysis consisted of applying a horizontal force to the static model to simulate an earthquake acceleration. The seismic stability analyses followed the approach outlined in U.S.EPA Subtitle D – Seismic Design Guidance. Based on the work of Hynes and Franklin, 1984, for a factor of safety greater than or equal to 1.0, a maximum value of the seismic coefficient used in the pseudo-static analysis was one-half the maximum acceleration estimated at the base of the landfill in order to keep permanent cover and embankment deformations less than 12 inches after an earthquake. Six to 12 inches of seismically induced downslope displacement is generally considered tolerable in the current design of landfill liners (Seed and Bonaparte, 1992). The maximum horizontal seismic acceleration at Areas D and E were obtained from Algermissen, et al, 1990. This map provides a maximum acceleration at the bedrock surface of 0.26g (acceleration, as a percent of gravity) in the western North Carolina region, with a 90 percent probability of not being exceeded in 250 years. Based on Hynes and Franklin, 1984, the seismic coefficient to be used in the pseudo-static stability analysis is one-half of 0.26g or 0.13g.

The results of static and pseudo-static analyses are included in Appendix C and indicate factors of safety greater than 1.5 for the proposed final grading configuration under drained conditions. Factors of safety were calculated for three types of slip surfaces: (1) a slip surface passing through the waste alone; (2) a slip surface passing through the waste, perimeter dike and foundation soil; and (3) a slip surface passing through the dike and foundation soil. Minimum factors of safety for the three types of slip surfaces described above were 2.3, 1.8 and 1.7, respectively. For the seismic case, minimum factors of safety were 1.6, 1.1 and 1.1 for the three failure scenarios, respectively. Factors of safety greater than 1.5 for static loading and 1.0 for seismic loading are considered acceptable for this type of facility, based on SME experience in other states and other projects in North Carolina where no regulatory limits exist.

Moreover, analysis of waste stability for a worst-case condition of a fully-saturated waste mass with a phreatic surface at the top of the waste yielded factors of safety of 1.5 or better for each of the slip surface types described above.

It is expected that the interior of the containment dike will remain unsaturated. However, sensitivity analysis was performed with respect to the phreatic surface within the dike. The results demonstrated that the water surface within the dike could be as high as forty feet above the existing regional groundwater surface before dike stability is potentially compromised, as shown on the output plots in Appendix C.

Stability analysis was performed to evaluate the operational stability of the liner system, relative to the waste placement lift height and the slope of the operating face. The analyses demonstrate that the slope of the waste operating face should not be placed at an angle greater than 2 horizontal (H) to 1 vertical (V). At angles greater than this, stress imbalances on the liner system result in factors of safety less than 1.3, which is considered adequate to maintain operational stability.

The infinite-slope case (Lambe and Whitman, 1969) was used to check the stability of the face of the closed landfill and cover. At this point, it is expected that a compacted soil cover will be

used for Area 6A-West. No specific final cover system stability analysis was performed for this report other than this infinite slope analysis. Based on the selected shear strengths, and assuming no seepage parallel to the landfill slope faces, a minimum factor of safety of 1.7 was calculated. This calculation is provided in Appendix C.

2.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the interpretation of the available site specific field and laboratory test data, and the results of the slope stability evaluation completed for this report, the following conclusions have been reached.

- The results of the static and seismic stability analyses conducted for the proposed final grading plan for the Areas 6D and 6E Landfill exceed generally accepted safety factors for the stability cross-section analyzed. Accordingly, it is concluded that stable slope, foundation, and waste conditions will be maintained with the proposed final grades and waste streams described in this report.

- Future wastes delivered to the landfill are assumed to consist mainly of the same sludge, ash, and lime mud as has historically been placed in Area 6A-East and Area 6A-West. It is recommended that if the future waste stream changes in strength or character, or if the percentage of low-strength material increases from that described within this report, that a reevaluation of the landfill stability be conducted by a qualified geotechnical engineer.

- It is recommended that layering of ash and sludge continue during landfilling operations to maintain landfill stability and otherwise follow the recommendations set forth in the Operations Manual (SME, 2006), including the placement of any lower strength waste within the interior portion of the landfill, not less than 100 feet from the exterior slope faces. Moreover, to avoid stress imbalances and potential compromise of the integrity of the liner system, it is recommended that the slope of the landfill operating face not exceed 2H to 1V.

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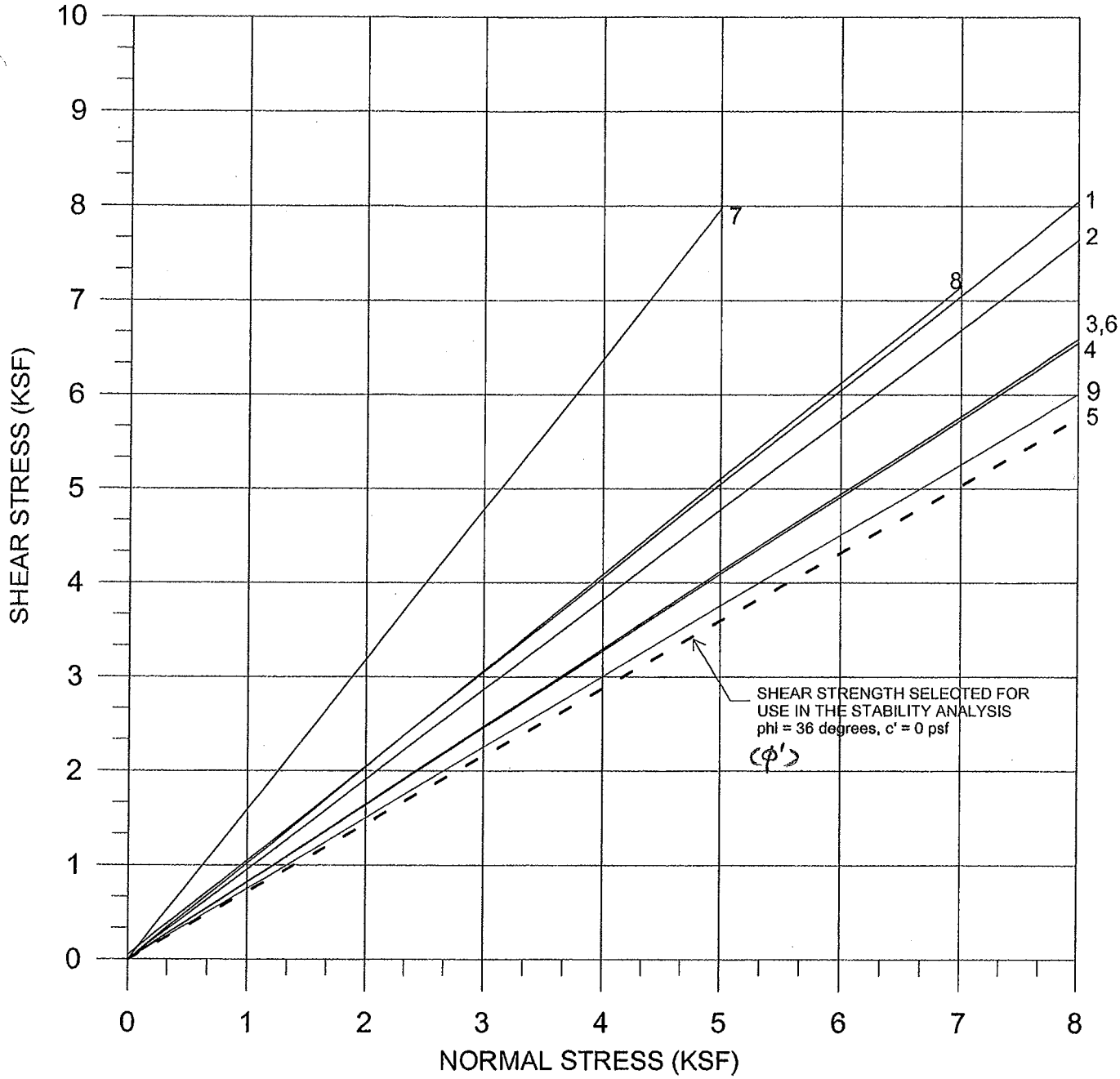
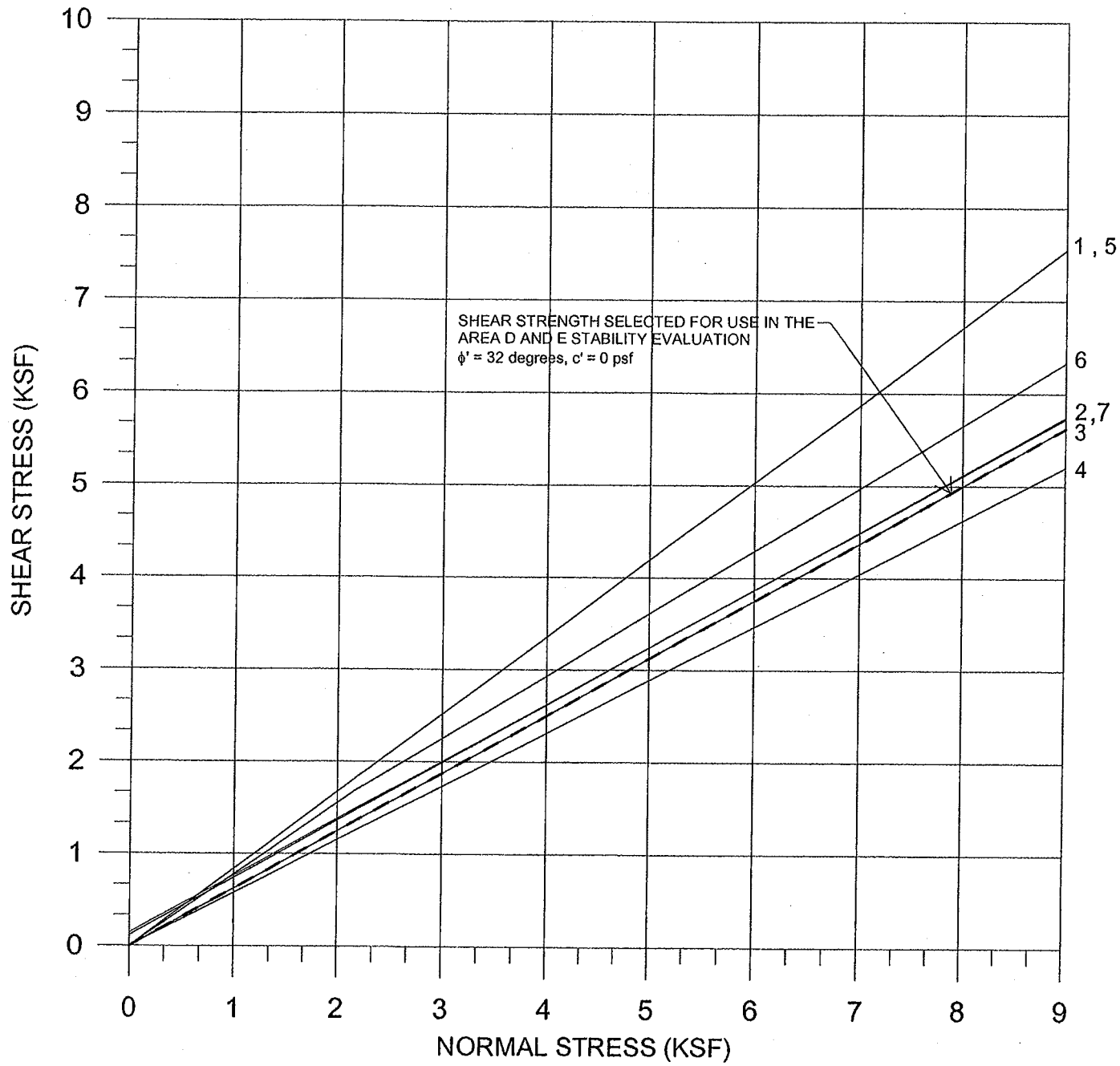
APPENDIX A

SHEAR STRENGTH SELECTED FOR USE IN THE STABILITY ANALYSIS



1) 45°, 0.05 KSF; LAW 1982, ASSUMED WASTE VALUE
2) 43.7°, 0 KSF; SME 1995, SLUDGE/ASH, CIUC TEST
3) 39.5°, 0 KSF; SME 1995, SLUDGE/ASH, CIUC TEST
4) 39.3°, 0 KSF; SME 1995, SLUDGE/ASH, CIUC TEST
5) 35.7°, 0 KSF; SME 1995, SLUDGE/ASH, CIUC TEST
6) 39.5°, 0 KSF; SME 1999, LIME MUD, CIUC TEST
7) 57.9°, 0 KSF; SME 1999, SLUDGE/ASH, CIUC TEST
8) 45.6°, 0 KSF; SME 1999, SLUDGE/ASH, CIUC TEST
9) 36.9°, 0 KSF; SME 2006, SLUDGE/LIME/ASH, CIUC TEST

FIGURE A-1
PLOT OF AVAILABLE EFFECTIVE SHEAR STRENGTHS FOR WASTES
LANDFILL NO. 6, AREA D AND E
BLUE RIDGE PAPER PRODUCTS INC.



1) 40°, 0 KSF; SIRRINE 1989, CIUC TEST

2) 32°, 0.115 KSF; SIRRINE 1989, CIUC TEST

3) 32°, 0 KSF; LAW 1982, CIUC TEST

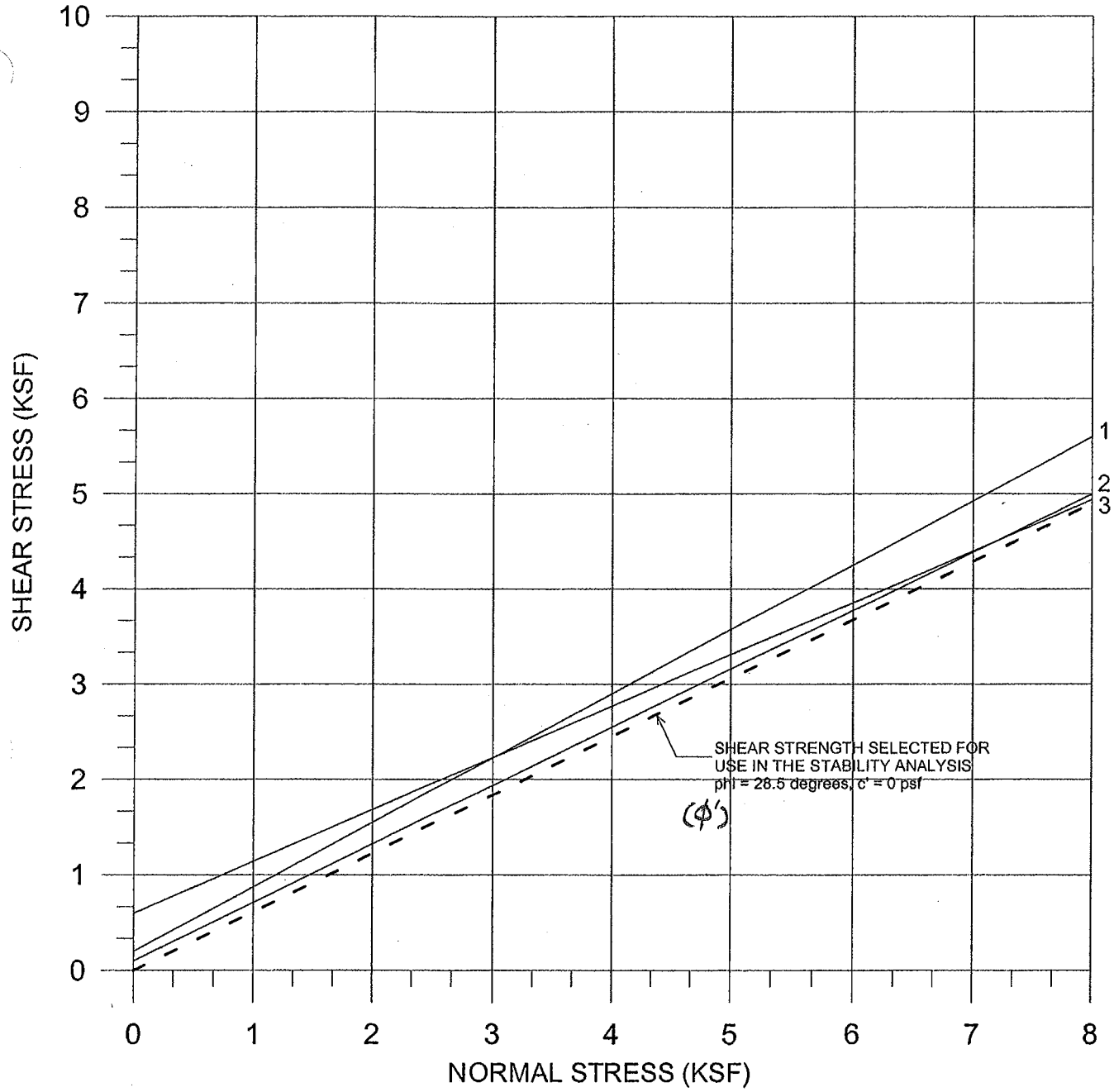
4) 30°, 0 KSF; LAW 1982, CIUC TEST

5) 40°, 0 KSF; SME 1999, DIRECT SHEAR TEST (WET)

6) 38°, 0 KSF FOR NORMAL STRESSES LESS THAN 2.2 KSF
34°, 0.26 KSF FOR NORMAL STRESSES GREATER THAN 2.2 KSF;
SME 1999, DIRECT SHEAR TEST (DRY)

7) 32°, 0.144 KSF; SME 2006

FIGURE A-2
PLOT OF AVAILABLE EFFECTIVE SHEAR STRENGTHS FOR PERIMETER DIKE SOILS
LANDFILL NO. 6, AREA D AND E
BLUE RIDGE PAPER PRODUCTS INC.



1) 34°, 0.2 KSF; LAW 1982, CIUC TEST

2) 31.5°, 0.1 KSF; LAW 1982, CIUC TEST

3) 28.5°, 0.6 KSF; LAW 1982, CIUC TEST

FIGURE A-3
PLOT OF AVAILABLE EFFECTIVE SHEAR STRENGTHS FOR FOUNDATION SOILS
LANDFILL NO. 6, AREA D AND E
BLUE RIDGE PAPER PRODUCTS INC.

Table A-1
Summary of Waste Geotechnical Properties Used in the Stability Analysis
Landfill 6 Area D and E
Blue Ridge Paper Products Inc.

Data Source	Boring ID	Sample ID	Depth (ft.below ground)	Total Unit Weight (pcf)	Water Content (%)	Effective Friction Angle (degrees)	Effective Cohesion (psf)	Total Friction Angle (degrees)	Total Stress Cohesion (psf)	Description
(1)		Bulk #1		64	160				570	Sludge UU Test
(1)		Bulk #2		82	160				550	Sludge/Ash, UU Test
(1)		Bulk #3		68	90				1100	Sludge/Ash, UU Test
(1)		Sample #1		#N\A				40	200	Sludge, Compaction Test
(1)		Sample #2		#N\A						Sludge/Ash, Compaction Test
(2)				55		45	50			Assumed
(3)				76						Used in Report
(3)	B101	3S	32.5	78	79	39.3	0			Sludge/Ash,CIUC
(3)	B101	4S	40.5	80	75	43.7	0			Sludge/Ash,CIUC
(3)	B101	1S	13.5	#N\A	79	35.7	0			Ash
(3)	B102	1S	12.5	#N\A	79	39.5	0			Ash, some Sludge
(3)				96	54					Lime mud Density test
(4)	B99-102	U3	30.6	78	77.6	57.9	0			Sludge/Ash,CIUC
(4)	B99-102	U2	20.5	85	71.1	45.6	0			Sludge/Ash,CIUC
(4)	B99-103	U4	40.5	96		39.5	0			Lime mud, CIUC
(5)	B-06-01	2S	16-18	84	94					Sludge/Ash/Lime, CIUC
(5)	B-06-01	1S	6.5-8.5	81	50	36.9	0			Lime mud, CIUC
(5)	B-06-02	2S	35.5-37.5	94	52					Lime/Sludge/Ash, CIUC

(1) Sirrine, 1989
(2) Law, 1982
(3) SME, 1995
(4) SME, 1999
(5) SME, 2006

Table A-2
Summary of Perimeter Dike Geotechnical Properties Used in the Stability Analysis
Landfill 6 Area D and E
Blue Ridge Paper Products Inc.

Data Source	Boring ID	Depth (ft.below ground)	Total Unit Weight[5] (pcf)	Maximum Dry Density (pcf)	Optimum Water Content (%)	Effective Friction Angle (degrees)	Effective Cohesion (psf)	Total Friction Angle (degrees)	Total Stress Cohesion (psf)	Description
(1)	AP-18	18.5-23.5	126	109	15.9					Compaction Test
(1)	AP-14	28.5-38.5	133	117	14.1					Compaction Test
(1)	AP-5	18.5-23.5	127	112	13.9	40	0	20	216	CIUC/Compaction Test
(1)	AP-3	14-20	128	109	18.6					Compaction Test
(1)	AP-1	20-35	127	110	15.5	32	115	18.5	202	CIUC/Compaction Test
(2)	B-8	3-12	127	107	17.9					Compaction Test
(2)	B-10	1-8	131	113	16.3	32	0	19	600	CIUC/Compaction Test
(2)	B-18	1-8	129	111	16.3	30	0	19	900	CIUC/Compaction Test
(2)	B-18	18-23	127	108	17.3					Compaction Test
(3)	B99-101	10-60	117		14.6[6]	34	260			Direct Shear test, run dry,normal stress>15psi
(3)	B99-101	10-60	117		14.6[6]	38	0			Direct Shear test, run dry,normal stress<15psi
(3)	B99-101	10-60	117		16.4[6]	40	0			Direct Shear test, run wet
(4)	B-06-04	4-14	119-124		17.8[6]	32	144			Direct Shear test, run dry

(1) Sirrine, 1989
(2) Law, 1982
(3) SME, 1999
(4) SME, 2006
(5) With the exception of the direct shear tests, total unit weight is based on max. dry density and optimum water content.
(6) Natural water content.

Table A-3
Summary of Foundation Soil Geotechnical Properties Used in the Stability Analysis
Landfill 6 Area D and E
Blue Ridge Paper Products Inc.

Data Source	Boring ID	Depth (ft.below ground)	Total Unit Weight (pcf)	Saturated Total Unit Weight (pcf)	Water Content (%)	Effective Friction Angle (degrees)	Effective Cohesion (psf)	Total Friction Angle (degrees)	Total Stress Cohesion (psf)	Description
(1)	B-8	9-11	117	130	13.2	34	200	27.5	300	Undisturbed Sample
(1)	B-10	13-15	104	118	19.7	31.5	100	16.5	400	Undisturbed Sample
(1)	B-11	8-11	124	125	28.3	28.5	600	17.5	800	Undisturbed Sample

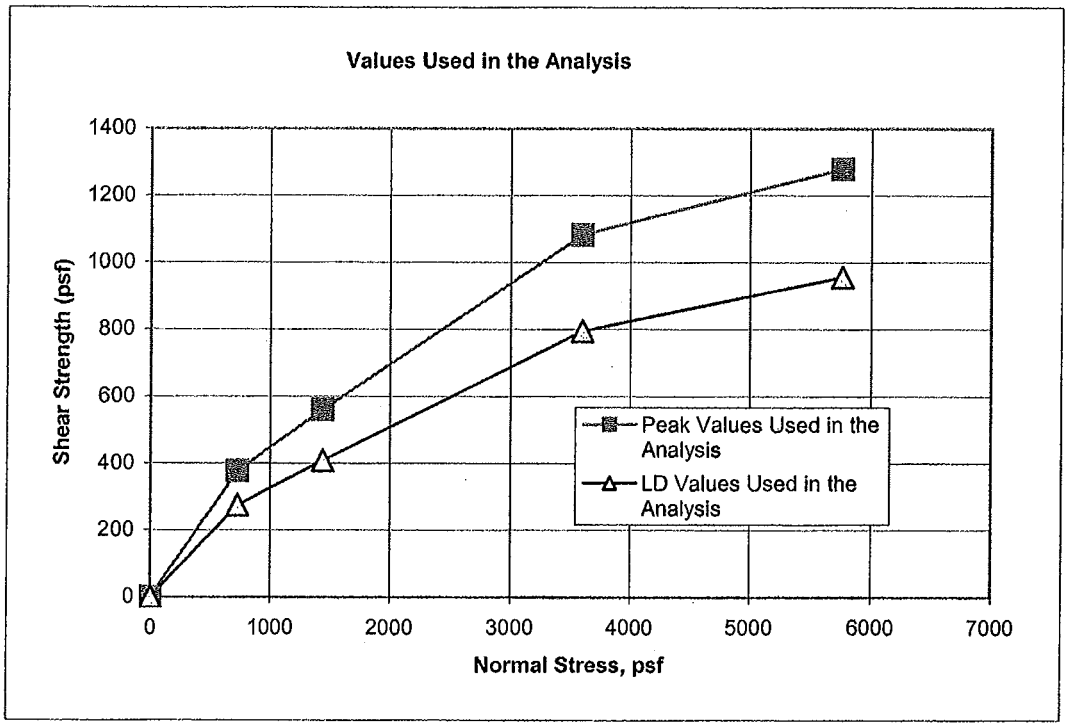
(1) Law, 1982

Summary of Interface Shear Strength Testing on GCL vs. Textured HDPE Interface.
SME Database

	TEST RESULTS (By Interface)					
	GCL vs 60-milHDPE					
		PGL Table	3-1	3-2	3-2RT	3-3
		GCL	820CV ST	820CV-ST	820CV-ST	820CV-ST
		HDPE	60-1-70981	40-1-70967	40-1-70967	40-1-70972
Normal Stress psf	Average Peak, psf	Minimum Peak, psf	Peak Shear Strength (psf)			
720	393	378	398	404		378
1440	651	561	561	724		667
3600	1215	1083	1295	1268		1083
5760	1494	1279	1888	1319	1279	1490
Normal Stress psf	Average LD psf	Minimum LD psf	LD Shear Strength (psf)			
720	302	275	329	275		302
1440	502	408	408	553		546
3600	811	795	795	803		834
5760	1079	956	1320	966	956	1074

LD = Large Displacement, as Reported by Precision Geosynthetic Laboratories

VALUES USED IN ANALYSIS	
Normal psf	Peak psf
0	0
720	378
1440	561
3600	1083
5760	1279
Normal psf	LD psf
0	0
720	275
1440	408
3600	795
5760	956



SELECTIVE LABORATORY TEST RESULTS (SME, 2006)

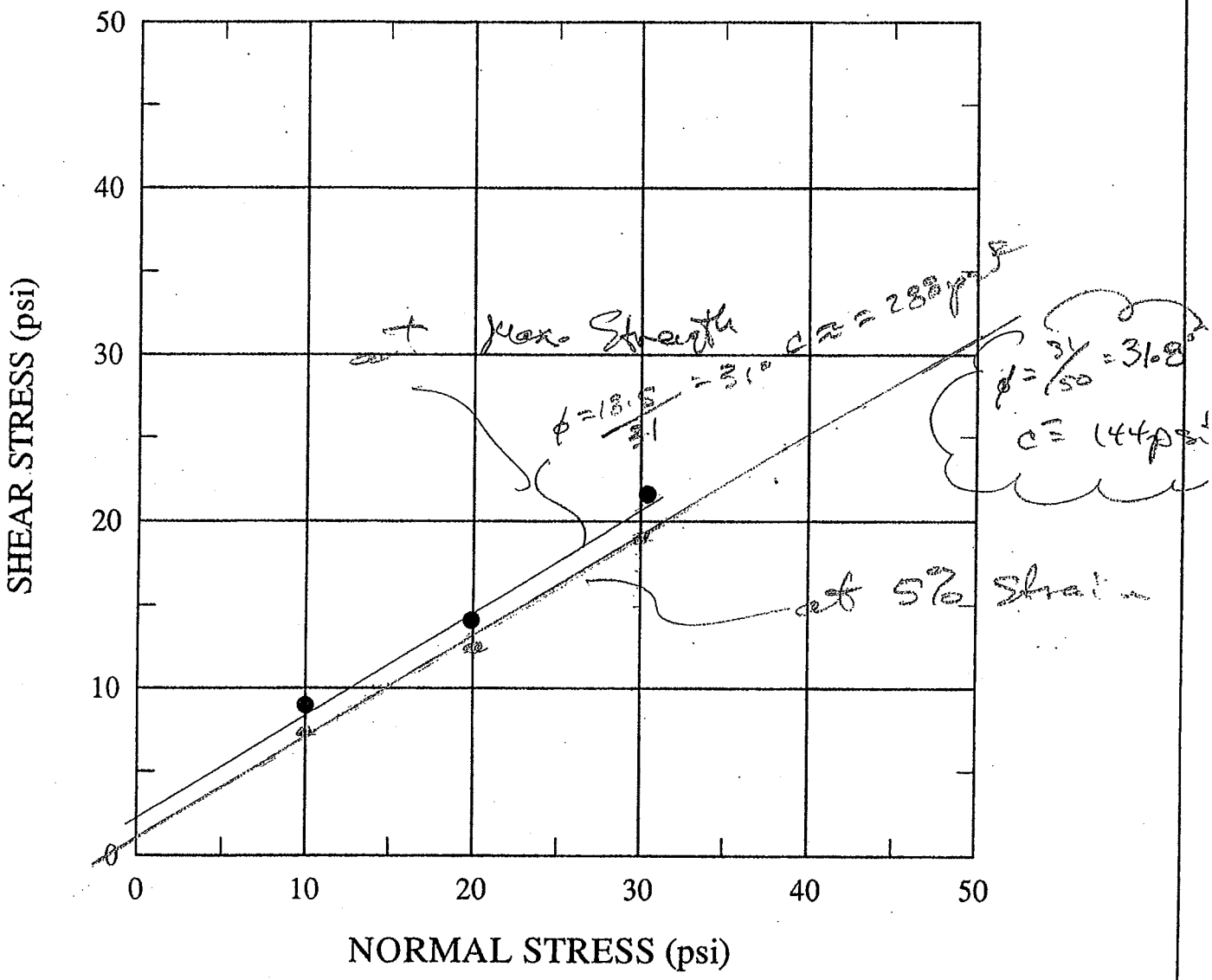
DIRECT SHEAR TEST

PROJECT: BLUE RIDGE PAPER
CANTON, N. CAROLINA

JOB No: 05127
DATE: FEB 06
TEST No: DS 1-3

BORING No: B06-4
SAMPLE No: Composite
DEPTH (ft.): 4-14

DESCRIPTION: Red/ brown sandy SILT
(DIKE FILL)



DIAMETER= 2.5 in..
AREA= 4.909 sq. in.
NORMAL STRESS= See Graph psi

LOADING RATE= 0.008 in/min
INIT. W.C.= 17.8 %
PRE-SHEAR DENSITY= 119-124 pcf

DIRECT SHEAR TEST

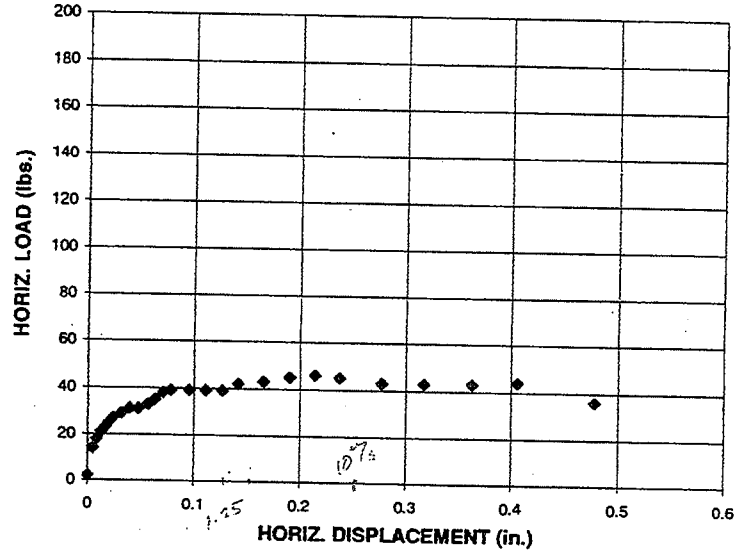
CLIENT: Blue Ridge Paper
PROJECT: Canton, N. Carolina

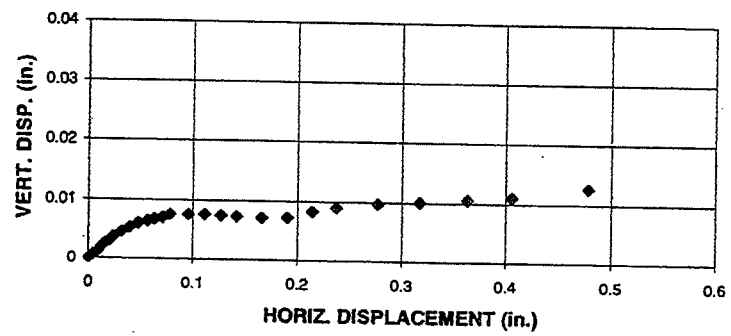
SAMPLE DESCRIPTION: Rd-br sandy SILT to silty SAND

BORING:	B06-4		TEST No.:	DS-1	
SAMPLE:	Composite		WEIGHT:	221.3	(gms)
DEPTH:	4-16	(ft.)	AVE. INITIAL W.C.:	17.8	(%)
INIT. HEIGHT:	1.47	(in.)	FINAL W.C.:	17.8	(%)
DELTA H.:	0.0296	(in.)	INITIAL DENSITY:	116.8	(pcf)
AREA:	4.909	(sq.in.)	BEFORE SHEAR DENSITY;	119.2	(pcf)
STRAIN RATE:	0.008	(in./min.)	NORMAL STRESS:	10	(psi)

ELASPED TIME (min.)	VERICAL DIAL READING (in.)	VERTICAL DISP. (in.)	HORIZ. DIAL READING (in.)	HORIZ. DISP. (in.)	LOAD CELL READING (lbs.)	SHEAR STRESS (psi)
0	0.361	0	0.878	0	2	0.00
0.5	0.3603	0.0007	0.8735	0.0045	14	2.44
1	0.3598	0.0012	0.8695	0.0085	18	3.26
1.5	0.359	0.002	0.8657	0.0123	21	3.87
2	0.3584	0.0026	0.862	0.016	23	4.28
2.5	0.358	0.003	0.858	0.02	25	4.69
3	0.3573	0.0037	0.854	0.024	27	5.09
4	0.3564	0.0046	0.846	0.032	29	5.50
5	0.3557	0.0053	0.8383	0.0397	31	5.91
6	0.355	0.006	0.83	0.048	31	5.91
7	0.3546	0.0064	0.821	0.057	33	6.31
8	0.3543	0.0067	0.8145	0.0635	35	6.72
9	0.354	0.007	0.807	0.071	38	7.33
10	0.3535	0.0075	0.7997	0.0783	39	7.54
12	0.3535	0.0075	0.7823	0.0957	39	7.54
14	0.3534	0.0076	0.767	0.111	39	7.54
16	0.3536	0.0074	0.7515	0.1265	39	7.54 5%
18	0.3537	0.0073	0.7365	0.1415	42	8.15
21	0.3539	0.0071	0.7125	0.1655	43	8.35
24	0.3538	0.0072	0.6882	0.1898	45	8.76
27	0.3527	0.0083	0.664	0.214	46	8.96
30	0.352	0.009	0.641	0.237	45	8.76
35	0.3513	0.0097	0.601	0.277	43	8.35
40	0.351	0.01	0.5608	0.3172	43	8.35
45	0.3505	0.0105	0.515	0.363	43	8.35
51	0.35	0.011	0.4723	0.4057	44	8.56
60	0.3484	0.0126	0.4	0.478	36	6.93

Note: Shear Box Not Flooded





2/14/2006

SEVEE MAI NGINEERS

DIRECT SHEAR TEST

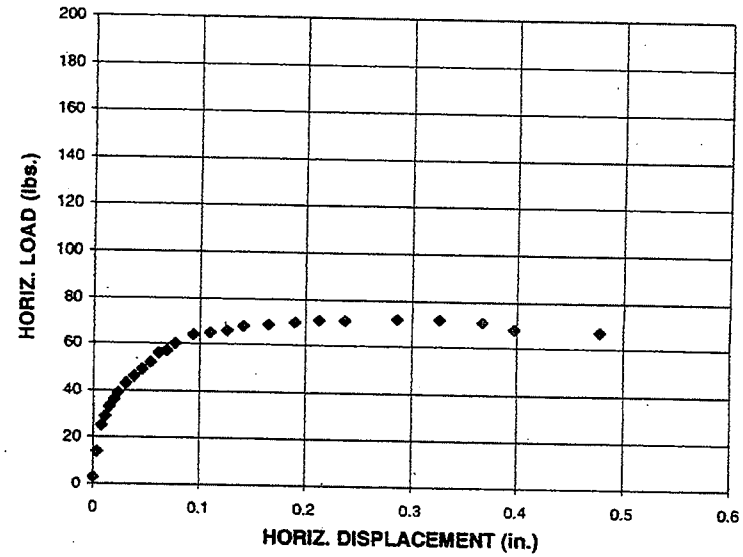
CLIENT: Blue Ridge Paper
PROJECT: Canton, N. Carolina

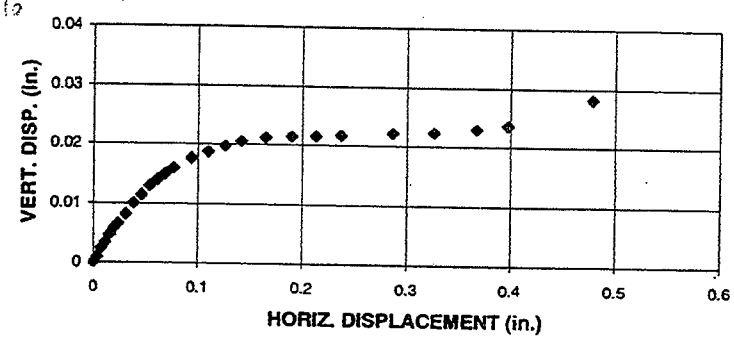
SAMPLE DESCRIPTION: Rd-br sandy SILT to silty SAND

BORING:	B06-4		TEST No.:	DS-2	
SAMPLE:	Composite		WEIGHT:	221.7	(gms)
DEPTH:	4-16	(ft.)	AVE. INITIAL W.C.:	17.8	(%)
INIT. HEIGHT:	1.47	(in.)	FINAL W.C.:	17.8	(%)
DELTA H.:	0.0362	(in.)	INITIAL DENSITY:	117.0	(pcf)
AREA:	4.909	(sq.in.)	BEFORE SHEAR DENSITY:	120.0	(pcf)
STRAIN RATE:	0.008	(in./min.)	NORMAL STRESS:	19.9	(psi)

ELASPED TIME (min.)	VERICAL DIAL READING (in.)	VERTICAL DISP. (in.)	HORIZ. DIAL READING (in.)	HORIZ. DISP. (in.)	LOAD CELL READING (lbs.)	SHEAR STRESS (psi)
0	0.3482	0	0.867	0	3	0.00
0.5	0.3473	0.0009	0.8635	0.0035	14	2.24
1	0.3458	0.0024	0.8595	0.0075	25	4.48
1.5	0.3448	0.0034	0.8558	0.0112	29	5.30
2	0.3435	0.0047	0.852	0.015	33	6.11
2.5	0.3424	0.0058	0.8475	0.0195	36	6.72
3	0.3416	0.0066	0.844	0.023	39	7.33
4	0.34	0.0082	0.8362	0.0308	43	8.15
5	0.3382	0.01	0.8285	0.0385	46	8.76
6	0.3368	0.0114	0.821	0.046	49	9.37
7	0.3353	0.0129	0.813	0.054	52	9.98
8	0.3342	0.014	0.8053	0.0617	56	10.80
9	0.3332	0.015	0.7978	0.0692	57	11.00
10	0.3323	0.0159	0.79	0.077	60	11.61
12	0.3306	0.0176	0.773	0.094	64	12.43
14	0.3295	0.0187	0.757	0.11	65	12.63
16	0.3285	0.0197	0.741	0.126	66	12.83
18	0.3277	0.0205	0.7255	0.1415	68	13.24
21	0.327	0.0212	0.702	0.165	69	13.44
24	0.3268	0.0214	0.677	0.19	70	13.65
27	0.3267	0.0215	0.6542	0.2128	71	13.85
30	0.3265	0.0217	0.63	0.237	71	13.85
36	0.326	0.0222	0.581	0.286	72	14.06
41	0.3258	0.0224	0.541	0.326	72	14.06
46	0.3252	0.023	0.5	0.367	71	13.85
50	0.3246	0.0236	0.4695	0.3975	68	13.24
60	0.32	0.0282	0.389	0.478	67	13.04

Note: Shear Box Not Flooded





2/14/2006

SEVEE MAHER ENGINEERS

DIRECT SHEAR TEST

CLIENT: Blue Ridge Paper
PROJECT: Canton, N. Carolina

SAMPLE DESCRIPTION: Rd-br sandy SILT to silty SAND

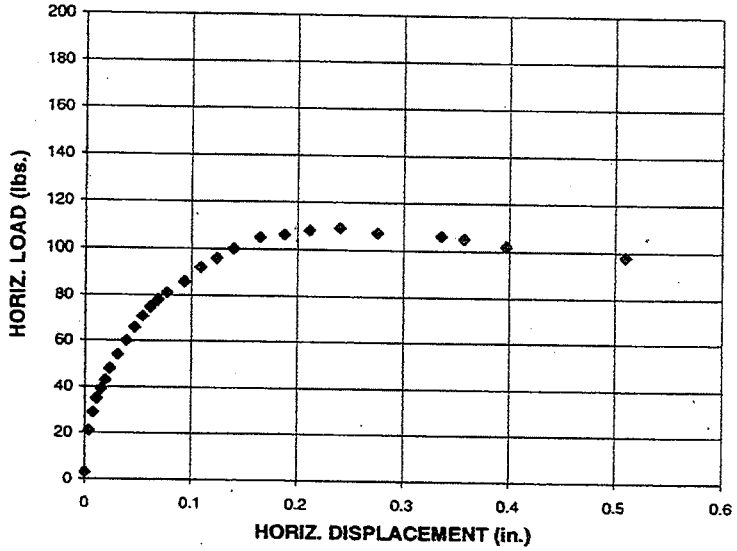
BORING:	B06-4		TEST No.:	DS-3	
SAMPLE:	Composite		WEIGHT:	221.4	(gms)
DEPTH:	4-16	(ft.)	AVE. INITIAL W.C.:	17.8	(%)
INIT. HEIGHT:	1.47	(in.)	FINAL W.C.:	17.8	(%)
DELTA H.:	0.0852	(in.)	INITIAL DENSITY:	116.9	(pcf)
AREA:	4.909	(sq.in.)	BEFORE SHEAR DENSITY;	124.1	(pcf)
STRAIN RATE:	0.008	(in./min.)	NORMAL STRESS:	30.4	(psi)

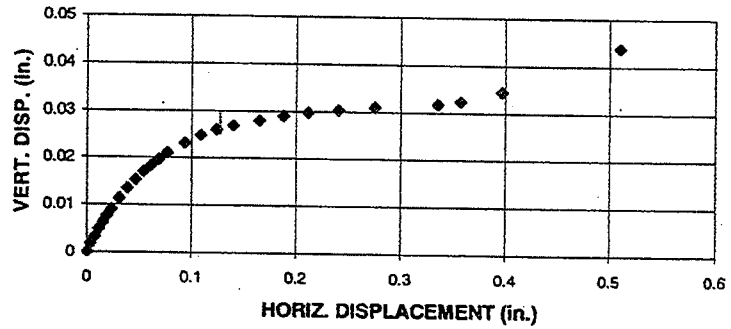
ELASPED TIME (min.)	VERICAL DIAL READING (in.)	VERTICAL DISP. (in.)	HORIZ. DIAL READING (in.)	HORIZ. DISP. (in.)	LOAD CELL READING (lbs.)	SHEAR STRESS (psi)
0	0.3003	0	0.87	0	3	0.00
0.5	0.2985	0.0018	0.8665	0.0035	21	3.67
1	0.297	0.0033	0.8625	0.0075	29	5.30
1.5	0.2954	0.0049	0.859	0.011	35	6.52
2	0.294	0.0063	0.855	0.015	39	7.33
2.5	0.2926	0.0077	0.851	0.019	43	8.15
3	0.2913	0.009	0.847	0.023	48	9.17
4	0.289	0.0113	0.8395	0.0305	54	10.39
5	0.2868	0.0135	0.8315	0.0385	60	11.61
6	0.285	0.0153	0.8235	0.0465	66	12.83
7	0.2833	0.017	0.816	0.054	71	13.85
8	0.282	0.0183	0.8085	0.0615	75	14.67
9	0.2807	0.0196	0.801	0.069	78	15.28
10	0.2793	0.021	0.793	0.077	81	15.89
12	0.2772	0.0231	0.7765	0.0935	86	16.91
14	0.2755	0.0248	0.761	0.109	92	18.13
16	0.2743	0.026	0.746	0.124	96	18.94 5%
18	0.2734	0.0269	0.73	0.14	100	19.76
21	0.2723	0.028	0.705	0.165	105	20.78
24	0.2713	0.029	0.682	0.188	106	20.98
27	0.2705	0.0298	0.6585	0.2115	108	21.39
30	0.27	0.0303	0.6295	0.2405	109	21.59
35	0.2693	0.031	0.5945	0.2755	107	21.19
40	0.2686	0.0317	0.535	0.335	106	20.98
45	0.268	0.0323	0.513	0.357	105	20.78
50	0.266	0.0343	0.473	0.397	102	20.17
64	0.2565	0.0438	0.36	0.51	98	19.35

$\frac{.212}{1.5}$

$\varepsilon = 8.5\%$

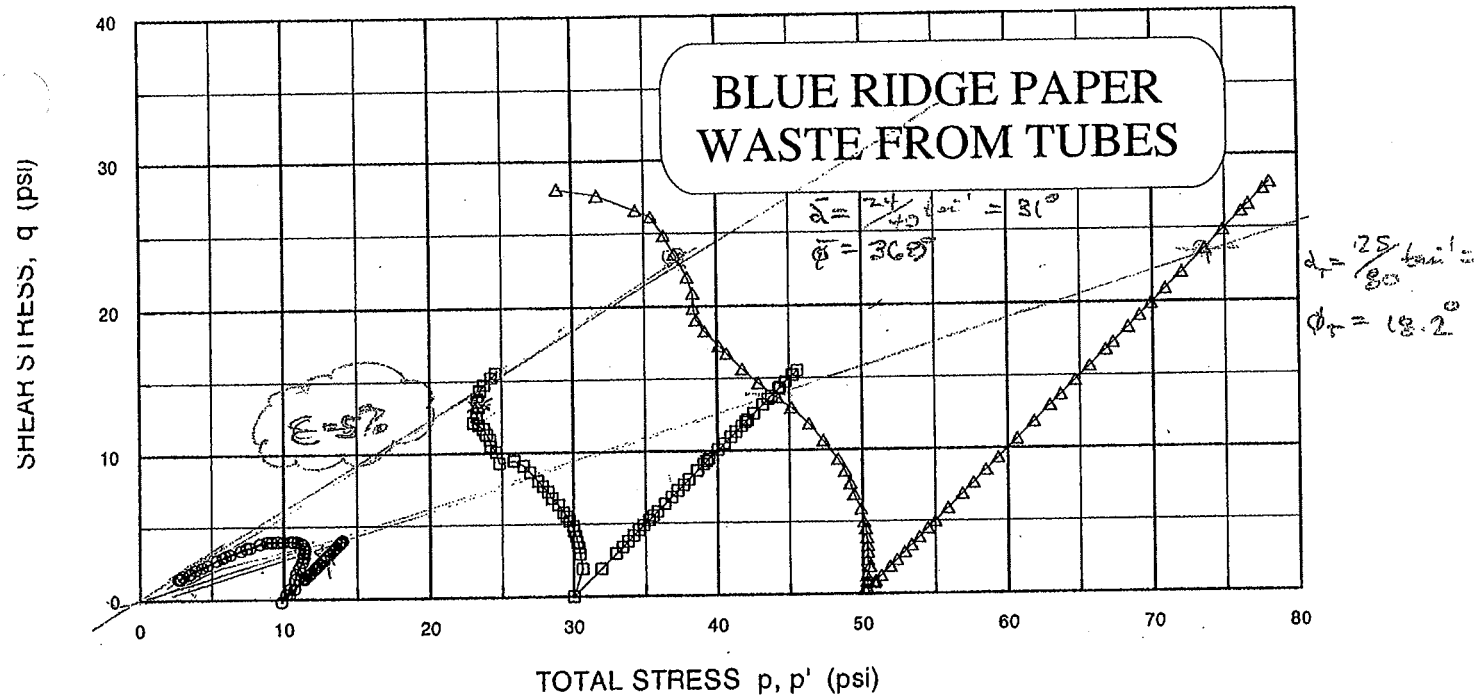
Note: Shear Box Not Flooded



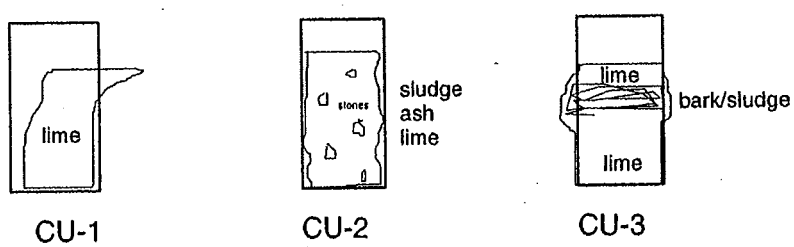


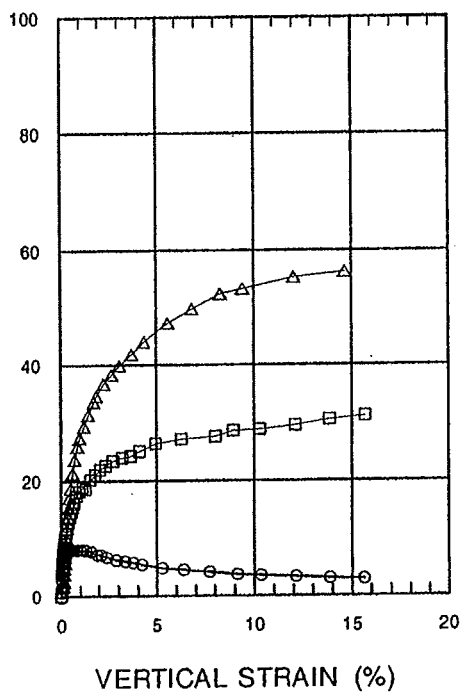
.25 = 10%
.125 = 5%

Consolidated Undrained Triaxial Test ASTM D4767



ilure Sketch





TEST CONDITIONS

	SYMBOL:	O	□	△
	TEST No.:	CU-1	CU-2	CU-3
INITIAL	WATER CONTENT (%):	50	89.6	59
	AREA (in^2):	6.350	6.417	6.474
	HEIGHT (in.):	6.000	6.000	6.000
	DRY DENSITY (pcf):	53.9	46.1	55.3
	SATURATION (%):	64.9	92.7	82.5
	VOID RATIO:	1.988	2.495	1.730
	B-VALUE:	1	1	1
PRE-SHEAR	WATER CONTENT (%):	63.7	64.3	57.4
	DRY DENSITY (pcf):	58.7	54.1	66.1
	SATURATION (%):	94.2	84	103
	VOID RATIO:	1.744	1.975	1.437
	MINOR PRIN. STRESS (psi):	10	30	50
	MAX DEVIATOR STRESS (psi):	8	31.1	56.1
	RATE OF STRAIN (in./min.):	0.005	0.005	0.005
	FINAL WATER CONTENT (%):	63.7	64.3	57.4

PROJECT:	Blue Ridge Paper	TEST CONDITIONS				INITIAL	PRE-SHEAR	FINAL			
DESCRIPTION:	Lime Mud with sludge	INITIAL DIAL READING (in.):	0.43		HEIGHT (in.):	6.000	5.663		15.2400	14.384	(cm)
BORING:	B06-2	SPECIFIC GRAVITY:	2.58	est.	AREA (in²):	6.474	6.124		41.7664	39.5077	(cm²)
SAMPLE:	2S	INITIAL WET WT. (gms):	934.2		TOTAL DENSITY (pcf):	91.6	104.0				
DEPTH (ft.):	35.9	INITIAL DRY WT. (gms):	601.5		DRY DENSITY (pcf):	59.0	66.1				
FILE No.:	05127	CELL PRESSURE (psi):	105		WATER CONTENT (%):	55.3		57.4			
TEST No.:	CIUC-3	BACK PRESSURE (psi):	55		VOLUME TOTAL (cc):	636.52	568.28				
DATE:	2/15/2005	EFFECTIVE CONFINING PRESSURE (psi):	50		VOLUME SOLIDS (cc):	233.16					
TESTED BY:	EJL	PORE PRESSURE @ PRESHEAR (psi):	55.1		VOLUME VOIDS (cc):	403.36	335.12				
PRC (lb/div):	0.463	AXIAL STRAIN RATE (in./min.):	0.005		VOID RATIO:	1.7300	1.4373				
		MEMBRANE THICKNESS (in.):	0.012		SATURATION (%):	82.5	103.0				

TIME (min)	DIAL (in.)	LOAD (lb)	PWP (psi)	DELTA L (in.)	AREA CF	CORR. AREA (sq. in.)	IND LOAD (lbs.)	IND PWP (psi)	DEV STRESS (psi)	SIGMA 3 (psi)	SIGMA 1 (psi)	SIGMA 3' (psi)	SIGMA 1' (psi)	P (psi)	P' (psi)	Q (psi)	STRAIN (%)	A
0	0.43	53	55.3	0.0000	1.0000	6.12	3.9	0	0.6	50.0	50.6	49.8	50.4	50.3	50.1	0.3	0.00	0.32
0.5	0.4335	65	55.5	0.0035	0.9994	6.13	9.4	0.4	1.5	50.0	51.5	49.6	51.1	50.8	50.4	0.8	0.06	0.26
1	0.436	68	55.7	0.0060	0.9989	6.13	10.8	0.6	1.8	50.0	51.8	49.4	51.2	50.9	50.3	0.9	0.11	0.34
1.5	0.4375	78	56.1	0.0075	0.9987	6.13	15.4	1.0	2.5	50.0	52.5	49.0	51.5	51.3	50.3	1.3	0.13	0.40
2	0.4383	94	56.5	0.0083	0.9985	6.13	22.8	1.4	3.7	50.0	53.7	48.6	52.3	51.9	50.5	1.9	0.15	0.38
2.5	0.4392	107	57.1	0.0092	0.9984	6.13	28.9	2.0	4.7	50.0	54.7	48.0	52.7	52.4	50.4	2.4	0.16	0.43
3	0.44	120.5	57.6	0.0100	0.9982	6.13	35.1	2.5	5.7	50.0	55.7	47.5	53.2	52.9	50.4	2.9	0.18	0.44
3.5	0.441	133.5	58.1	0.0110	0.9981	6.14	41.1	3.0	6.7	50.0	56.7	47.0	53.7	53.4	50.4	3.4	0.19	0.45
4	0.442	148	58.7	0.0120	0.9979	6.14	47.8	3.6	7.8	50.0	57.8	46.4	54.2	53.9	50.3	3.9	0.21	0.46
4.5	0.4433	164	59.4	0.0133	0.9977	6.14	55.2	4.3	9.0	50.0	59.0	45.7	54.7	54.5	50.2	4.5	0.23	0.48
5	0.4444	177	60	0.0144	0.9975	6.14	61.3	4.9	10.0	50.0	60.0	45.1	55.1	55.0	50.1	5.0	0.25	0.49
6	0.4465	201	61.1	0.0165	0.9971	6.14	72.4	6.0	11.8	50.0	61.8	44.0	55.8	55.9	49.9	5.9	0.29	0.51
7	0.4493	228	62.6	0.0193	0.9966	6.14	84.9	7.5	13.8	50.0	63.8	42.5	56.3	56.9	49.4	6.9	0.34	0.54
8	0.4513	248	63.6	0.0213	0.9962	6.15	94.1	8.5	15.3	50.0	65.3	41.5	56.8	57.7	49.2	7.7	0.38	0.56
9	0.454	271	64.8	0.0240	0.9958	6.15	104.8	9.7	17.0	50.0	67.0	40.3	57.3	58.5	48.8	8.5	0.42	0.57
10	0.457	293	66.1	0.0270	0.9952	6.15	115.0	11.0	18.7	50.0	68.7	39.0	57.7	59.3	48.3	9.3	0.48	0.59
12	0.463	328	68.4	0.0330	0.9942	6.16	131.2	13.3	21.3	50.0	71.3	36.7	58.0	60.6	47.3	10.6	0.58	0.62
14	0.47	360	70.6	0.0400	0.9929	6.17	146.0	15.5	23.7	50.0	73.7	34.5	58.2	61.8	46.3	11.8	0.71	0.65
16	0.478	390	72.9	0.0480	0.9915	6.18	159.9	17.8	25.9	50.0	75.9	32.2	58.1	62.9	45.1	12.9	0.85	0.69
18	0.485	409.7	74.6	0.0550	0.9903	6.18	169.0	19.5	27.3	50.0	77.3	30.5	57.8	63.7	44.2	13.7	0.97	0.71
21	0.498	437.5	76.9	0.0680	0.9880	6.20	181.9	21.8	29.3	50.0	79.3	28.2	57.5	64.7	42.9	14.7	1.20	0.74
24	0.5115	465.5	79	0.0815	0.9856	6.21	194.8	23.9	31.4	50.0	81.4	26.1	57.5	65.7	41.8	15.7	1.44	0.76
28	0.5285	496	81.2	0.0985	0.9826	6.23	209.0	26.1	33.5	50.0	83.5	23.9	57.4	66.8	40.7	16.8	1.74	0.78
30	0.5365	510	82.2	0.1065	0.9812	6.24	215.4	27.1	34.5	50.0	84.5	22.9	57.4	67.3	40.2	17.3	1.88	0.79
35	0.559	540.5	84.2	0.1290	0.9772	6.27	229.6	29.1	36.6	50.0	86.6	20.9	57.5	68.3	39.2	18.3	2.28	0.79
40	0.5815	564	85.6	0.1515	0.9732	6.29	240.4	30.5	38.2	50.0	88.2	19.5	57.7	69.1	38.6	19.1	2.68	0.80
45	0.604	588	86.6	0.1740	0.9693	6.32	251.6	31.5	39.8	50.0	89.8	18.5	58.3	69.9	38.4	19.9	3.07	0.79
52	0.6385	618.5	87.6	0.2085	0.9632	6.36	265.7	32.5	41.8	50.0	91.8	17.5	59.3	70.9	38.4	20.9	3.68	0.78
60	0.675	653	89.1	0.2450	0.9567	6.40	281.7	34.0	44.0	50.0	94.0	16.0	60.0	72.0	38.0	22.0	4.33	0.77
75	0.747	706	91.6	0.3170	0.9440	6.49	306.2	36.5	47.2	50.0	97.2	13.5	60.7	73.6	37.1	23.6	5.60	0.77
90	0.8175	751	93.6	0.3875	0.9316	6.57	327.0	38.5	49.7	50.0	99.7	11.5	61.2	74.9	36.4	24.9	6.84	0.77
107	0.9	799	95.8	0.4700	0.9170	6.68	349.3	40.7	52.3	50.0	102.3	9.3	61.6	76.1	35.4	26.1	8.30	0.78
120	0.964	822	97.3	0.5340	0.9057	6.76	359.9	42.2	53.2	50.0	103.2	7.8	61.0	76.6	34.4	26.6	9.43	0.79
150	1.1125	875.5	101	0.6825	0.8795	6.96	384.7	45.9	55.2	50.0	105.2	4.1	59.3	77.6	31.7	27.6	12.05	0.83
180	1.261	915	104.2	0.8310	0.8533	7.18	403.0	49.1	56.1	50.0	106.1	0.9	57.0	78.1	29.0	28.1	14.67	0.87

PROJ.:	Blue Ridge Paper	TEST CONDITIONS				INITIAL	PRE-SHEAR	FINAL			
DESCRIPTION:	Green LIME MUD, trace ash pockets	INITIAL DIAL READING (in.):	0.3343		HEIGHT (in.):	6.000	5.861		15.2400	14.887	(cm)
BORING:	B06-1	SPECIFIC GRAVITY:	2.58	est.	AREA (in²):	6.350	5.971		40.9651	38.5219	(cm²)
SAMPLE:	1S	INITIAL WET WT. (gms):	808.7		TOTAL DENSITY (pcf):	80.9	96.1				
DEPTH (ft.):	-	INITIAL DRY WT. (gms):	539.1		DRY DENSITY (pcf):	53.9	58.7				
FILE No.:	05127	CELL PRESSURE (psi):	100		WATER CONTENT (%):	50		63.7			
TEST No.:	CIUC-1	BACK PRESSURE (psi):	90		VOLUME TOTAL (cc):	624.31	573.47				
DATE:	2/6/2006	EFFECTIVE CONFINING PRESSURE (psi):	10		VOLUME SOLIDS (cc):	208.97					
TESTED BY:	EJL	PORE PRESSURE @ PRESHEAR (psi):	90.8		VOLUME VOIDS (cc):	415.34	364.51				
PRC (lb/div):	0.463	AXIAL STRAIN RATE (in./min.):	0.005		VOID RATIO:	1.9876	1.7443				
		MEMBRANE THICKNESS (in.):	0.012		SATURATION (%):	64.9	94.2				

TIME (min)	DIAL (in.)	LOAD (lb)	PWP (psi)	DELTA L (in.)	AREA CF	CORR. AREA (sq. in.)	IND LOAD (lbs.)	IND PWP (psi)	DEV STRESS (psi)	SIGMA 3 (psi)	SIGMA 1 (psi)	SIGMA 3' (psi)	SIGMA 1' (psi)	P (psi)	P' (psi)	Q (psi)	STRAIN (%)	A
0	0.3343	38.5	90.8	0.0000	1.0000	5.97	-1.9	0	-0.3	10.0	9.7	10.0	9.7	9.8	9.8	-0.2	0.00	0.00
0.5	0.335	52	91.0	0.0007	0.9999	5.97	4.4	0.2	0.7	10.0	10.7	9.8	10.5	10.4	10.2	0.4	0.01	0.27
1	0.3358	61	91.1	0.0015	0.9997	5.97	8.5	0.3	1.4	10.0	11.4	9.7	11.1	10.7	10.4	0.7	0.03	0.21
1.5	0.337	77.5	91.4	0.0027	0.9995	5.97	16.2	0.6	2.7	10.0	12.7	9.4	12.1	11.4	10.8	1.4	0.05	0.22
2	0.3382	87.5	91.7	0.0039	0.9993	5.97	20.8	0.9	3.5	10.0	13.5	9.1	12.6	11.7	10.8	1.7	0.07	0.26
2.5	0.3395	98.5	91.9	0.0052	0.9991	5.98	25.9	1.1	4.3	10.0	14.3	8.9	13.2	12.2	11.1	2.2	0.09	0.25
3	0.341	108	92.1	0.0067	0.9989	5.98	30.3	1.3	5.1	10.0	15.1	8.7	13.8	12.5	11.2	2.5	0.11	0.26
3.5	0.3425	116.5	92.3	0.0082	0.9986	5.98	34.2	1.5	5.7	10.0	15.7	8.5	14.2	12.9	11.4	2.9	0.14	0.26
4	0.3443	124	92.6	0.0100	0.9983	5.98	37.7	1.8	6.3	10.0	16.3	8.2	14.5	13.2	11.4	3.2	0.17	0.29
4.5	0.3465	129	92.7	0.0122	0.9979	5.98	40.0	1.9	6.7	10.0	16.7	8.1	14.8	13.3	11.4	3.3	0.21	0.28
5	0.3487	133.5	92.9	0.0144	0.9975	5.99	42.1	2.1	7.0	10.0	17.0	7.9	14.9	13.5	11.4	3.5	0.25	0.30
6	0.353	139	93.2	0.0187	0.9968	5.99	44.7	2.4	7.5	10.0	17.5	7.6	15.1	13.7	11.3	3.7	0.32	0.32
7	0.3577	142.5	93.5	0.0234	0.9960	5.99	46.3	2.7	7.7	10.0	17.7	7.3	15.0	13.9	11.2	3.9	0.40	0.35
8	0.3625	144.5	93.8	0.0282	0.9952	6.00	47.2	3.0	7.9	10.0	17.9	7.0	14.9	13.9	10.9	3.9	0.48	0.38
9	0.368	145.5	94.1	0.0337	0.9943	6.01	47.7	3.3	7.9	10.0	17.9	6.7	14.6	14.0	10.7	4.0	0.57	0.42
10	0.3733	146	94.3	0.0390	0.9933	6.01	47.9	3.5	8.0	10.0	18.0	6.5	14.5	14.0	10.5	4.0	0.67	0.44
12	0.3838	146	94.8	0.0495	0.9916	6.02	47.9	4.0	8.0	10.0	18.0	6.0	14.0	14.0	10.0	4.0	0.84	0.50
14	0.3935	146.2	95.2	0.0592	0.9899	6.03	48.0	4.4	8.0	10.0	18.0	5.6	13.6	14.0	9.6	4.0	1.01	0.55
16	0.404	146.2	95.6	0.0697	0.9881	6.04	48.0	4.8	7.9	10.0	17.9	5.2	13.1	14.0	9.2	4.0	1.19	0.60
18	0.413	145.5	95.9	0.0787	0.9866	6.05	47.7	5.1	7.9	10.0	17.9	4.9	12.8	13.9	8.8	3.9	1.34	0.65
21	0.4283	143.3	96.3	0.0940	0.9840	6.07	46.6	5.5	7.7	10.0	17.7	4.5	12.2	13.8	8.3	3.8	1.60	0.72
24	0.447	136.5	96.7	0.1127	0.9808	6.09	43.5	5.9	7.1	10.0	17.1	4.1	11.2	13.6	7.7	3.6	1.92	0.83
27	0.46	136	96.9	0.1257	0.9786	6.10	43.3	6.1	7.1	10.0	17.1	3.9	11.0	13.5	7.4	3.5	2.14	0.86
30	0.4762	131.7	97.1	0.1419	0.9758	6.12	41.3	6.3	6.7	10.0	16.7	3.7	10.4	13.4	7.1	3.4	2.42	0.93
35	0.5045	124.8	97.6	0.1702	0.9710	6.15	38.1	6.8	6.2	10.0	16.2	3.2	9.4	13.1	6.3	3.1	2.90	1.10
40	0.5295	122.5	97.8	0.1952	0.9667	6.18	37.0	7.0	6.0	10.0	16.0	3.0	9.0	13.0	6.0	3.0	3.33	1.17
45	0.554	120	97.9	0.2197	0.9625	6.20	35.9	7.1	5.8	10.0	15.8	2.9	8.7	12.9	5.8	2.9	3.75	1.23
50	0.581	115.8	98.2	0.2467	0.9579	6.23	33.9	7.4	5.4	10.0	15.4	2.6	8.0	12.7	5.3	2.7	4.21	1.36
62	0.644	107.5	98.5	0.3097	0.9472	6.30	30.1	7.7	4.8	10.0	14.8	2.3	7.1	12.4	4.7	2.4	5.28	1.61
75	0.709	104	98.7	0.3747	0.9361	6.38	28.5	7.9	4.5	10.0	14.5	2.1	6.6	12.2	4.3	2.2	6.39	1.77
90	0.788	99.8	99	0.4537	0.9226	6.47	26.5	8.2	4.1	10.0	14.1	1.8	5.9	12.0	3.8	2.0	7.74	2.00
106	0.8705	94.7	99.1	0.5362	0.9085	6.57	24.1	8.3	3.7	10.0	13.7	1.7	5.4	11.8	3.5	1.8	9.15	2.26
120	0.941	93	99.1	0.6067	0.8965	6.66	23.4	8.3	3.5	10.0	13.5	1.7	5.2	11.8	3.5	1.8	10.35	2.37
140	1.046	90.3	99.4	0.7117	0.8786	6.80	22.1	8.6	3.3	10.0	13.3	1.4	4.7	11.6	3.0	1.6	12.14	2.64
160	1.1485	87	99.4	0.8142	0.8611	6.93	20.6	8.6	3.0	10.0	13.0	1.4	4.4	11.5	2.9	1.5	13.89	2.90
194	1.251	86.5	99.5	0.9167	0.8436	7.08	20.3	8.7	2.9	10.0	12.9	1.3	4.2	11.4	2.7	1.4	15.64	3.03

PROJECT:	Blue Ridge Paper	TEST CONDITIONS				INITIAL	PRE-SHEAR	FINAL			
DESCRIPTION:	SLUDGE,ASH,LIME,GRAVEL	INITIAL DIAL READING (in.):	0.59		HEIGHT (in.):	6.000	5.600		15.2400	14.224	(cm)
BORING:	B06-1	SPECIFIC GRAVITY:	2.58	est.	AREA (in^2):	6.417	5.852		41.3986	37.7548	(cm^2)
SAMPLE:	2S	INITIAL WET WT. (gms):	883.1		TOTAL DENSITY (pcf):	87.4	89.0				
DEPTH (ft.):	16.9	INITIAL DRY WT. (gms):	465.8		DRY DENSITY (pcf):	46.1	54.1				
FILE No.:	05127	CELL PRESSURE (psi):	105		WATER CONTENT (%):	89.6		64.3			
TEST No.:	CIUC-2	BACK PRESSURE (psi):	75		VOLUME TOTAL (cc):	630.92	537.02				
DATE:	2/9/2006	EFFECTIVE CONFINING PRESSURE (psi):	30		VOLUME SOLIDS (cc):	180.53					
TESTED BY:	EJL	PORE PRESSURE @ PRESHEAR (psi):	75.4		VOLUME VOIDS (cc):	450.38	356.49				
PRC (lb/div):	0.463	AXIAL STRAIN RATE (in./min.):	0.005		VOID RATIO:	2.4948	1.9747				
		MEMBRANE THICKNESS (in.):	0.012		SATURATION (%):	92.7	84.0				

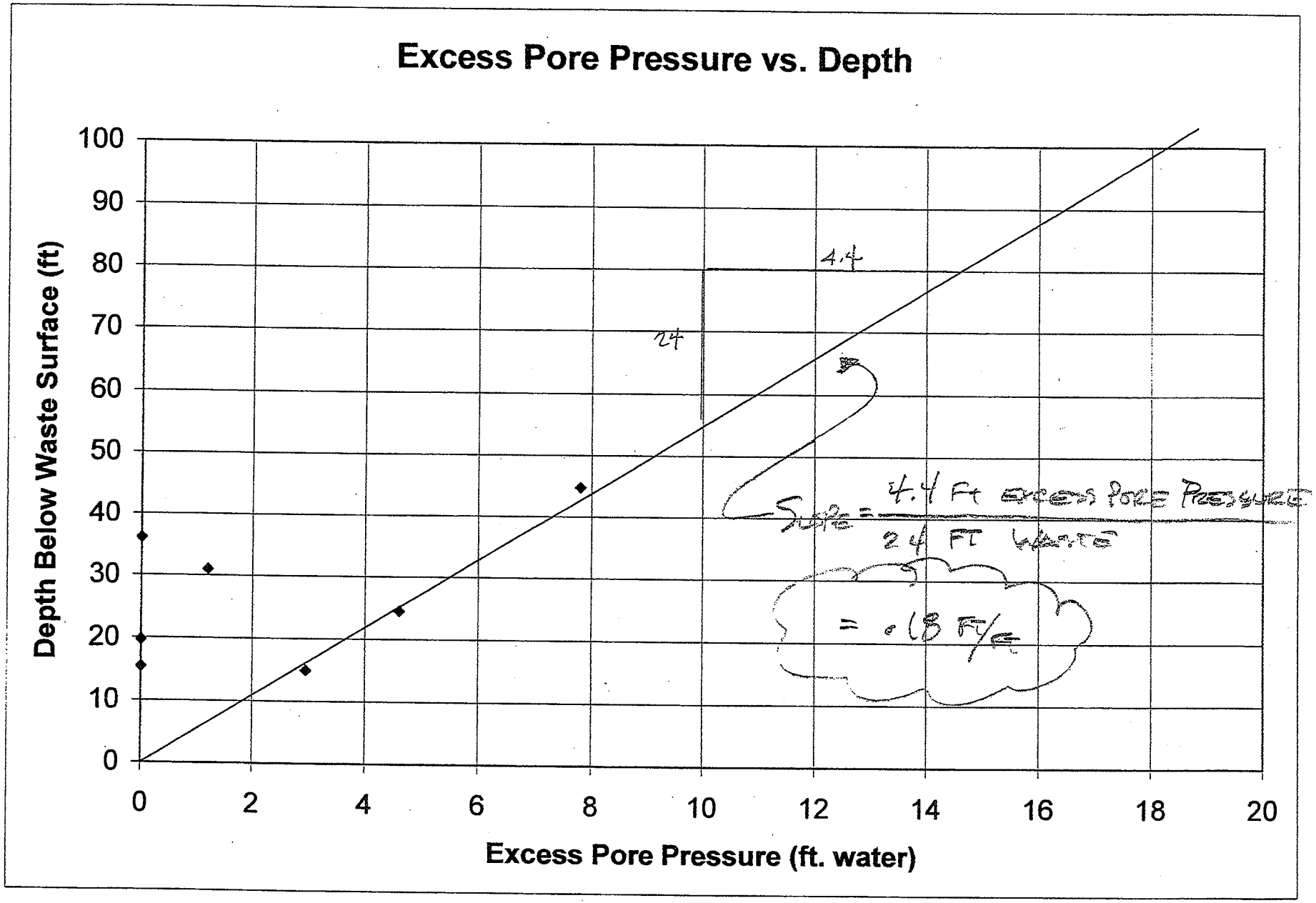
TIME (min)	DIAL (in.)	LOAD (lb)	PWP (psi)	DELTA L (in.)	AREA CF	CORR. AREA (sq. in.)	IND LOAD (lbs.)	IND PWP (psi)	DEV STRESS (psi)	SIGMA 3 (psi)	SIGMA 1 (psi)	SIGMA 3' (psi)	SIGMA 1' (psi)	P (psi)	P' (psi)	Q (psi)	STRAIN (%)	A
0	0.59	45	75.4	0.0000	1.0000	5.85	0.1	0	0.0	30.0	30.0	30.0	30.0	30.0	30.0	0.0	0.00	0.00
0.5	0.5915	93	76.7	0.0015	0.9997	5.85	22.4	1.3	3.8	30.0	33.8	28.7	32.5	31.9	30.6	1.9	0.03	0.34
1	0.594	119	77.9	0.0040	0.9993	5.86	34.4	2.5	5.9	30.0	35.9	27.5	33.4	32.9	30.4	2.9	0.07	0.43
1.5	0.5955	130.3	78.4	0.0055	0.9990	5.86	39.6	3.0	6.8	30.0	36.8	27.0	33.8	33.4	30.4	3.4	0.10	0.44
2	0.597	140	78.9	0.0070	0.9988	5.86	44.1	3.5	7.5	30.0	37.5	26.5	34.0	33.8	30.3	3.8	0.13	0.46
2.5	0.5985	150	79.4	0.0085	0.9985	5.86	48.8	4.0	8.3	30.0	38.3	26.0	34.3	34.2	30.2	4.2	0.15	0.48
3	0.6	159.5	79.9	0.0100	0.9982	5.86	53.2	4.5	9.1	30.0	39.1	25.5	34.6	34.5	30.0	4.5	0.18	0.50
3.5	0.6018	168	80.3	0.0118	0.9979	5.86	57.1	4.9	9.7	30.0	39.7	25.1	34.8	34.9	30.0	4.9	0.21	0.50
4	0.6034	177	80.9	0.0134	0.9976	5.87	61.3	5.5	10.4	30.0	40.4	24.5	34.9	35.2	29.7	5.2	0.24	0.53
4.5	0.605	185	81.4	0.0150	0.9973	5.87	65.0	6.0	11.1	30.0	41.1	24.0	35.1	35.5	29.5	5.5	0.27	0.54
5	0.6068	192.5	81.9	0.0168	0.9970	5.87	68.4	6.5	11.7	30.0	41.7	23.5	35.2	35.8	29.3	5.8	0.30	0.56
6	0.61	206	82.8	0.0200	0.9964	5.87	74.7	7.4	12.7	30.0	42.7	22.6	35.3	36.4	29.0	6.4	0.36	0.58
7	0.616	218	83.7	0.0260	0.9954	5.88	80.2	8.3	13.6	30.0	43.6	21.7	35.3	36.8	28.5	6.8	0.46	0.61
8	0.62	229.5	84.4	0.0300	0.9946	5.88	85.6	9.0	14.5	30.0	44.5	21.0	35.5	37.3	28.3	7.3	0.54	0.62
9	0.6235	240	85.2	0.0335	0.9940	5.89	90.4	9.8	15.4	30.0	45.4	20.2	35.6	37.7	27.9	7.7	0.60	0.64
10	0.6275	249	85.9	0.0375	0.9933	5.89	94.6	10.5	16.1	30.0	46.1	19.5	35.6	38.0	27.5	8.0	0.67	0.65
12	0.6355	265	87.1	0.0455	0.9919	5.90	102.0	11.7	17.3	30.0	47.3	18.3	35.6	38.6	26.9	8.6	0.81	0.68
14	0.644	276.5	88	0.0540	0.9904	5.91	107.3	12.6	18.2	30.0	48.2	17.4	35.6	39.1	26.5	9.1	0.96	0.69
16	0.6535	286	89	0.0635	0.9887	5.92	111.7	13.6	18.9	30.0	48.9	16.4	35.3	39.4	25.8	9.4	1.13	0.72
18	0.6625	282.5	89.9	0.0725	0.9871	5.93	110.1	14.5	18.6	30.0	48.6	15.5	34.1	39.3	24.8	9.3	1.29	0.78
21	0.6773	303.5	90.9	0.0873	0.9844	5.94	119.8	15.5	20.2	30.0	50.2	14.5	34.7	40.1	24.6	10.1	1.56	0.77
24	0.692	315	91.7	0.1020	0.9818	5.96	125.2	16.3	21.0	30.0	51.0	13.7	34.7	40.5	24.2	10.5	1.82	0.78
27	0.707	327	92.2	0.1170	0.9791	5.98	130.7	16.8	21.9	30.0	51.9	13.2	35.1	40.9	24.1	10.9	2.09	0.77
30	0.723	337	92.8	0.1330	0.9763	5.99	135.3	17.4	22.6	30.0	52.6	12.6	35.2	41.3	23.9	11.3	2.38	0.77
35	0.744	349	93.4	0.1540	0.9725	6.02	140.9	18.0	23.4	30.0	53.4	12.0	35.4	41.7	23.7	11.7	2.75	0.77
40	0.769	357	94	0.1790	0.9680	6.05	144.6	18.6	23.9	30.0	53.9	11.4	35.3	42.0	23.4	12.0	3.20	0.78
45	0.7935	362.5	94.5	0.2035	0.9637	6.07	147.2	19.1	24.2	30.0	54.2	10.9	35.1	42.1	23.0	12.1	3.63	0.79
50	0.819	375	94.7	0.2290	0.9591	6.10	152.9	19.3	25.1	30.0	55.1	10.7	35.8	42.5	23.2	12.5	4.09	0.77
60	0.867	394.5	95.2	0.2770	0.9505	6.16	162.0	19.8	26.3	30.0	56.3	10.2	36.5	43.2	23.4	13.2	4.95	0.75
75	0.9423	410	95.6	0.3523	0.9371	6.24	169.1	20.2	27.1	30.0	57.1	9.8	36.9	43.5	23.3	13.5	6.29	0.75
90	1.0416	423.5	95.9	0.4516	0.9194	6.37	175.4	20.5	27.6	30.0	57.6	9.5	37.1	43.8	23.3	13.8	8.06	0.74
105	1.092	441	96.2	0.5020	0.9104	6.43	183.5	20.8	28.5	30.0	58.5	9.2	37.7	44.3	23.5	14.3	8.96	0.73
120	1.168	450	96.3	0.5780	0.8968	6.53	187.7	20.9	28.8	30.0	58.8	9.1	37.9	44.4	23.5	14.4	10.32	0.73
140	1.2685	469	96.4	0.6785	0.8788	6.66	196.5	21.0	29.5	30.0	59.5	9.0	38.5	44.8	23.8	14.8	12.12	0.71
160	1.368	492	96.4	0.7780	0.8611	6.80	207.1	21.0	30.5	30.0	60.5	9.0	39.5	45.2	24.2	15.2	13.89	0.69
180	1.469	511	96.4	0.8790	0.8430	6.94	215.9	21.0	31.1	30.0	61.1	9.0	40.1	45.6	24.6	15.6	15.70	0.68

APPENDIX B

DETERMINATION OF PORE PRESSURE WITHIN THE WASTE

Water Levels From Piezometers in the Area 6A-West Landfill
Used in the Determination of Pore Pressures Within the Area Dand E Wastes

Piezometer	Elevation (approx)	Depth (tpvc)	Casing stick-up	Water Level (tpvc)							
				1/16/2006	1/17/2006	1/18/2006	1/18/2006	1/19/2006	1/19/2006	1/27/2006	2/2/2006
P-06-04A	2764	39.3	3.2	33.27	38.17	39.00	dry		dry	dry	dry
P-06-04B	2764	23.0	3.3	20.50	19.80	20.52	21.05		21.98	dry	dry
P-06-01A	2733	27.7	3.2			23.00	23.20	23.30	23.20	23.3	23.10
P-06-01B	2733	17.3	1.9			dry	dry	dry	dry	dry	dry
P-06-02A	2730	49.0	4.2			39.90	40.25	41.00	41.00	41.2	41.20
P-06-02B	2730	35.1	4.1			27.30	28.20	32.80	33.30	33.6	33.90
P-06-02C	2730	18.1	3.2				dry	16.30	16.25	15.5	15.15


Excess Pore Pressure vs. Depth
Depth Below Waste Surface (ft)
100
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
16
18
20
Excess Pore Pressure (ft. water)
4.4
24
Slope = 4.4 Ft excess Pore Pressure / 24 Ft Waste
= .18 Ft/Ft

Title: Blue Ridge Paper
Comments: A-A'
Name: C:\Documents and Settings\Bill\Copy\NC\6e\Geotech\SlopeW\waste bishop.gsz

Unit Weight: 125
Value: 0
Value: 30

Material #: 2
Name: Waste
Unit Weight: 90
Value: 0
Value: 36

Name: Perimeter Dike
Unit Weight: 120
Cohesion: 115
Phi: 32
Phi-B: 0
C-Phi Correlation Coef.: 0
Anisotropic Strength Fn: (none)

Material #: 4
Name: Foundation Soil
Unit Weight: 115
Value: 0
Value: 28.5

Material #: 5
Name: Liner
Unit Weight: 120
Value: 0
Value: 30

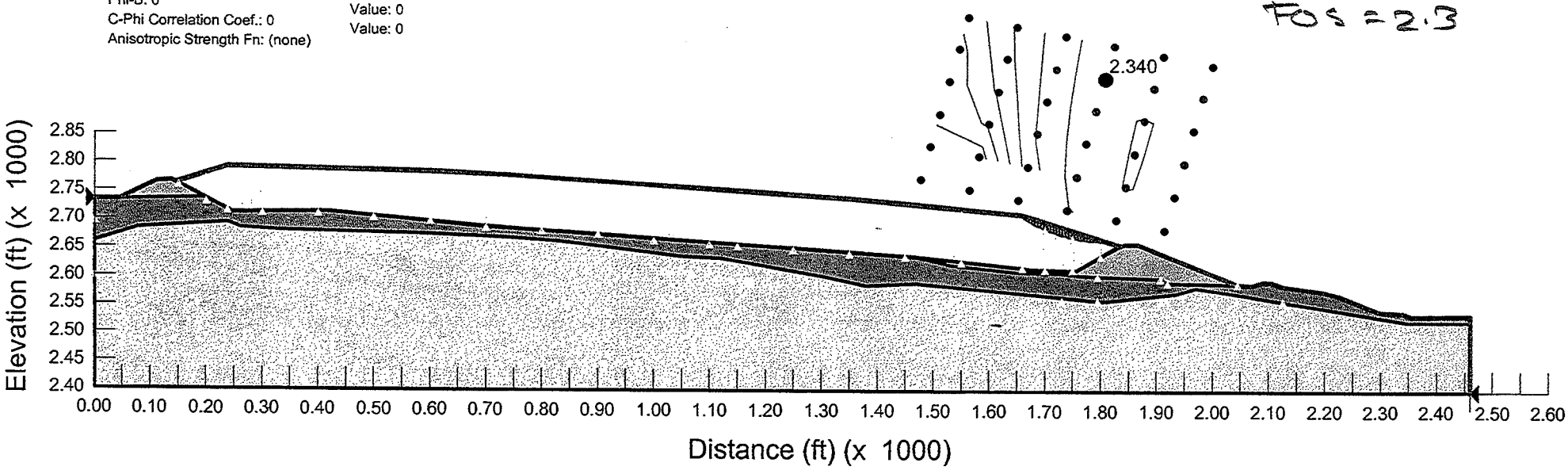
Material #: 6
Name: Bedrock
Unit Weight: 0
Value: 0
Value: 0

Method: Bishop, Ordinary and Janbu
Factor of Safety: ~~1.934~~
Horz Seismic Load: 0

Region 1 = Material Number: 2
Region 2 = Material Number: 3
Region 3 = Material Number: 3
Region 4 = Material Number: 4
Region 5 = Material Number: 6
Region 6 = Material Number: 1

Piezometric condition in waste modeled as a grid of pressure heads.
Based on the relationship of 0.18 feet of pore pressure per foot of waste.

STATIC
WASTE ALONE
15' FAILURE CIRCLE
FOS = 2.3



Title: Blue Ridge Paper
Comments: A-A'
Name: C:\Copy\NC\6e\Geotech\SlopeW\waste bishop q.gsz

Unit Weight: 125
Value: 0
Value: 30

Material #: 2
Name: Waste
Unit Weight: 90
Value: 0
Value: 36

Name: Perimeter Dike
Unit Weight: 120
Cohesion: 115
Phi: 32
Phi-B: 0
C-Phi Correlation Coef.: 0
Anisotropic Strength Fn: (none)

Material #: 4
Name: Foundation Soil
Unit Weight: 115
Value: 0
Value: 28.5

Material #: 5
Name: Liner
Unit Weight: 120
Value: 0
Value: 30

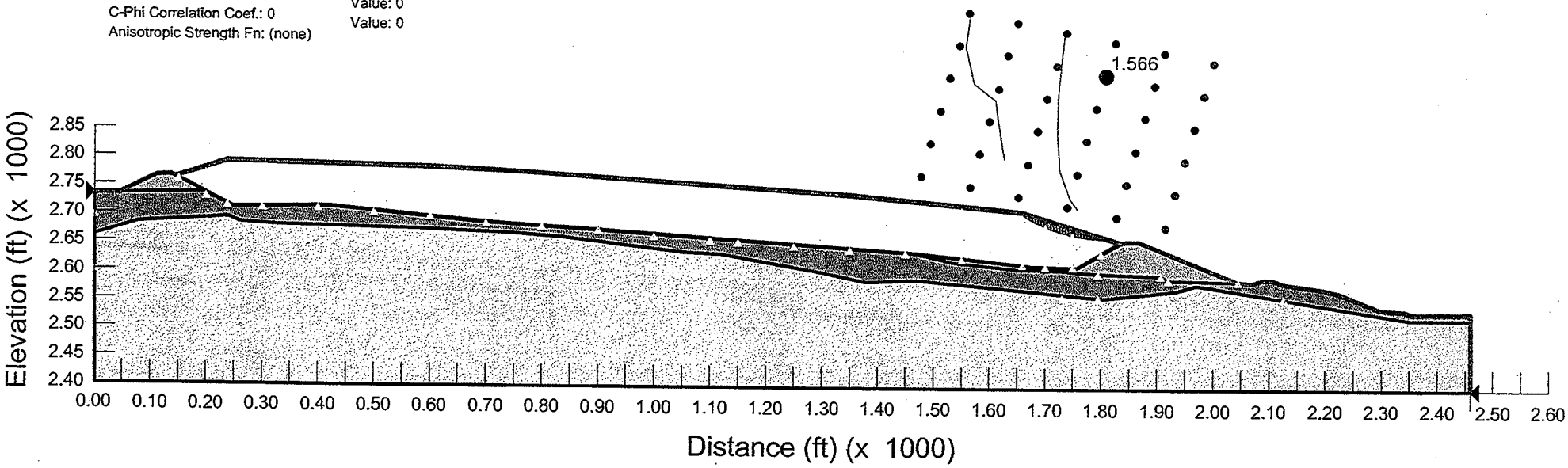
Material #: 6
Name: Bedrock
Unit Weight: 0
Value: 0
Value: 0

Method: Bishop, Ordinary and Janbu
Factor of Safety: ~~4.296~~
Horz Seismic Load: 0.13

Region 1 = Material Number: 2
Region 2 = Material Number: 3
Region 3 = Material Number: 3
Region 4 = Material Number: 4
Region 5 = Material Number: 6
Region 6 = Material Number: 1

Piezometric condition in waste modeled as a grid of pressure heads.
Based on the relationship of 0.18 feet of pore pressure per foot of waste.

PSEUDO-STATIC
WASTE ALONE
15' FAILURE CIRCLE
FOS = 1.6



Title: Blue Ridge Paper
Comments: A-A'
Name: H:\Brpp\NC\6e\Geotech\SlopeW\waste dike foundation.gsz

Material #: 1
Name: Soil Cover
Unit Weight: 125
Value: 0
Value: 30

Material #: 2
Name: Waste
Unit Weight: 90
Value: 0
Value: 36

Name: Perimeter Dike
Unit Weight: 120
Cohesion: 0
Phi: 32
Phi-B: 0
C-Phi Correlation Coef.: 0
Anisotropic Strength Fn: (none)

Material #: 4
Name: Foundation Soil
Unit Weight: 115
Value: 0
Value: 28.5

Material #: 5
Name: Liner
Unit Weight: 120
Value: 0
Value: 30

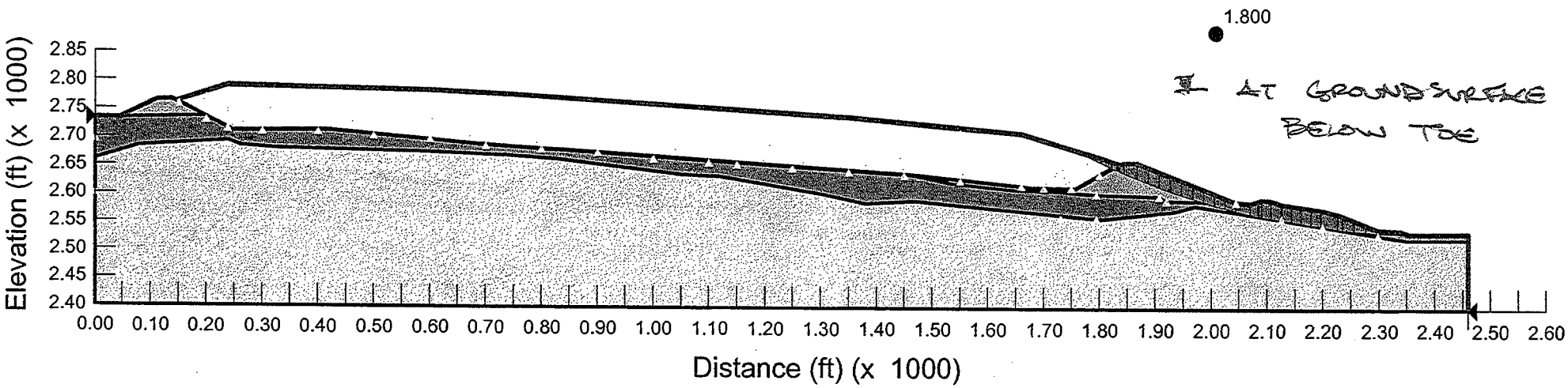
Material #: 6
Name: Bedrock
Unit Weight: 0
Value: 0
Value: 0

Method: Bishop, Ordinary and Janbu
Factor of Safety: ~~1.575~~
Horz Seismic Load: 0

Region 1 = Material Number: 2
Region 2 = Material Number: 3
Region 3 = Material Number: 3
Region 4 = Material Number: 4
Region 5 = Material Number: 6
Region 6 = Material Number: 1

Piezometric condition in waste modeled as a grid of pressure heads.
Based on the relationship of 0.18 feet of pore pressure per foot of waste.

STATIC
WASTE/DIKE / FOUNDATION



Title: Blue Ridge Paper
Comments: A-A'
Name: H:\Brpp\NC\6e\Geotech\SlopeW\dike foundation q.gsz

Material #: 1
Name: Soil Cover
Unit Weight: 125
Value: 0
Value: 30

Material #: 2
Name: Waste
Unit Weight: 90
Value: 0
Value: 36

Name: Perimeter Dike
Unit Weight: 120
Cohesion: 0
Phi: 32
Phi-B: 0
C-Phi Correlation Coef.: 0
Anisotropic Strength Fn: (none)

Material #: 4
Name: Foundation Soil
Unit Weight: 115
Value: 0
Value: 28.5

Material #: 5
Name: Liner
Unit Weight: 120
Value: 0
Value: 30

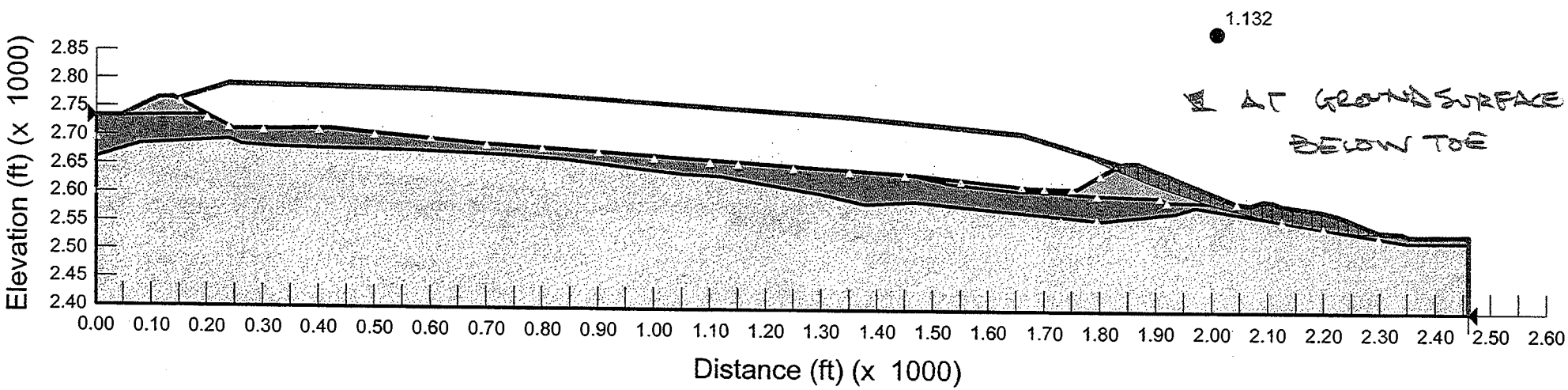
Material #: 6
Name: Bedrock
Unit Weight: 0
Value: 0
Value: 0

Method: Bishop, Ordinary and Janbu
Factor of Safety: ~~0.985~~
Horz Seismic Load: 0.13

Region 1 = Material Number: 2
Region 2 = Material Number: 3
Region 3 = Material Number: 3
Region 4 = Material Number: 4
Region 5 = Material Number: 6
Region 6 = Material Number: 1

Piezometric condition in waste modeled as a grid of pressure heads.
Based on the relationship of 0.18 feet of pore pressure per foot of waste.

PSEUDO STATIC
WASTE/DIKE/FOUNDATION



Title: Blue Ridge Paper
Comments: A-A'
Name: H:\Brpp\NC\6e\Geotech\SlopeW\dike foundation.gsz

Material #: 1
Name: Soil Cover
Unit Weight: 125
Value: 0
Value: 30

Material #: 2
Name: Waste
Unit Weight: 90
Value: 0
Value: 36

Name: Perimeter Dike
Unit Weight: 120
Cohesion: 0
Phi: 32
Phi-B: 0
C-Phi Correlation Coef.: 0
Anisotropic Strength Fn: (none)

Material #: 4
Name: Foundation Soil
Unit Weight: 115
Value: 0
Value: 28.5

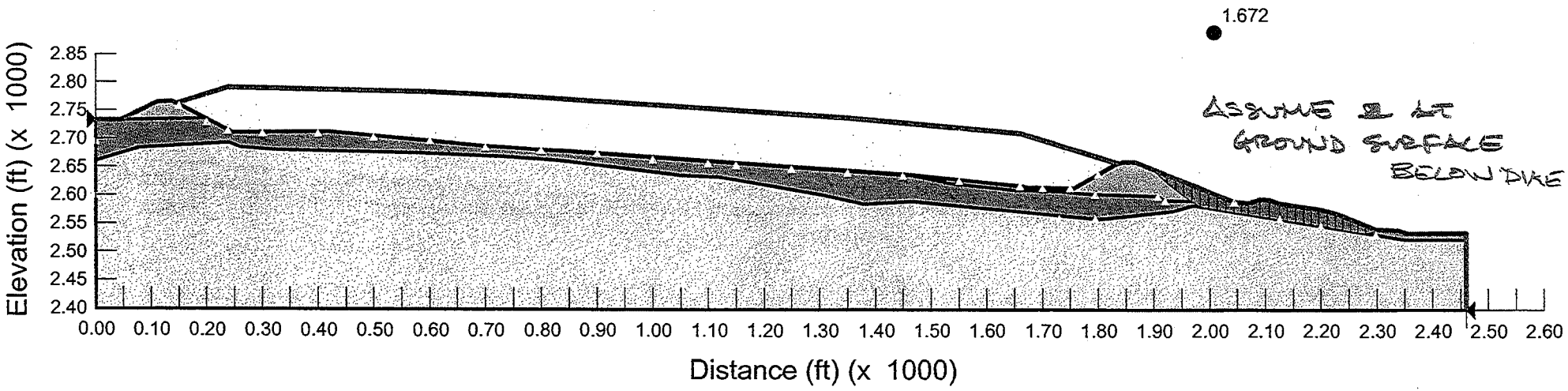
Material #: 5
Name: Liner
Unit Weight: 120
Value: 0
Value: 30

Method: Bishop, Ordinary and Janbu
Factor of Safety: ~~1.575~~
Horz Seismic Load: 0

Region 1 = Material Number: 2
Region 2 = Material Number: 3
Region 3 = Material Number: 3
Region 4 = Material Number: 4

Piezometric condition in waste modeled as a grid of pressure heads.
Based on the relationship of 0.18 feet of pore pressure per foot of waste.

STATIC
DIKE AND FOUNDATION SOIL
FOS = 1.7



Title: Blue Ridge Paper
Comments: A-A'
Name: H:\Brpp\NC\6e\Geotech\SlopeW\dike foundation seismic.gsz

Material #: 1
Name: Soil Cover
Unit Weight: 125
Value: 0
Value: 30

Material #: 2
Name: Waste
Unit Weight: 90
Value: 0
Value: 36

Name: Perimeter Dike
Unit Weight: 120
Cohesion: 0
Phi: 32
Phi-B: 0
C-Phi Correlation Coef.: 0
Anisotropic Strength Fn: (none)

Material #: 4
Name: Foundation Soil
Unit Weight: 115
Value: 0
Value: 28.5

Material #: 5
Name: Liner
Unit Weight: 120
Value: 0
Value: 30

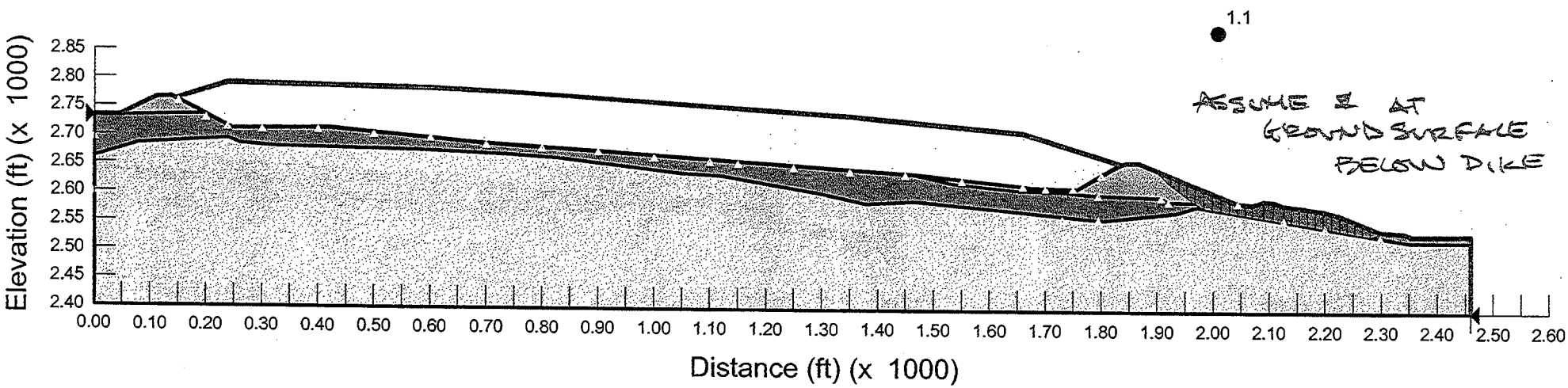
Method: Bishop, Ordinary and Janbu
Factor of Safety: ~~1.0~~
Horz Seismic Load: 0.13

Region 1 = Material Number: 2
Region 2 = Material Number: 3
Region 3 = Material Number: 3
Region 4 = Material Number: 4

Piezometric condition in waste modeled as a grid of pressure heads.
Based on the relationship of 0.18 feet of pore pressure per foot of waste.

PSEUDO-STATIC
DIKE AND FOUNDATION SOIL

FOS = 1.1



Title: Blue Ridge Paper
Comments: A-A'
Name: H:\Brpp\NC\6e\Geotech\SlopeW\fully saturated.gsz

Material #: 1
Name: Soil Cover
Unit Weight: 125
Value: 0
Value: 30

Material #: 2
Name: Waste
Unit Weight: 90
Value: 0
Value: 36

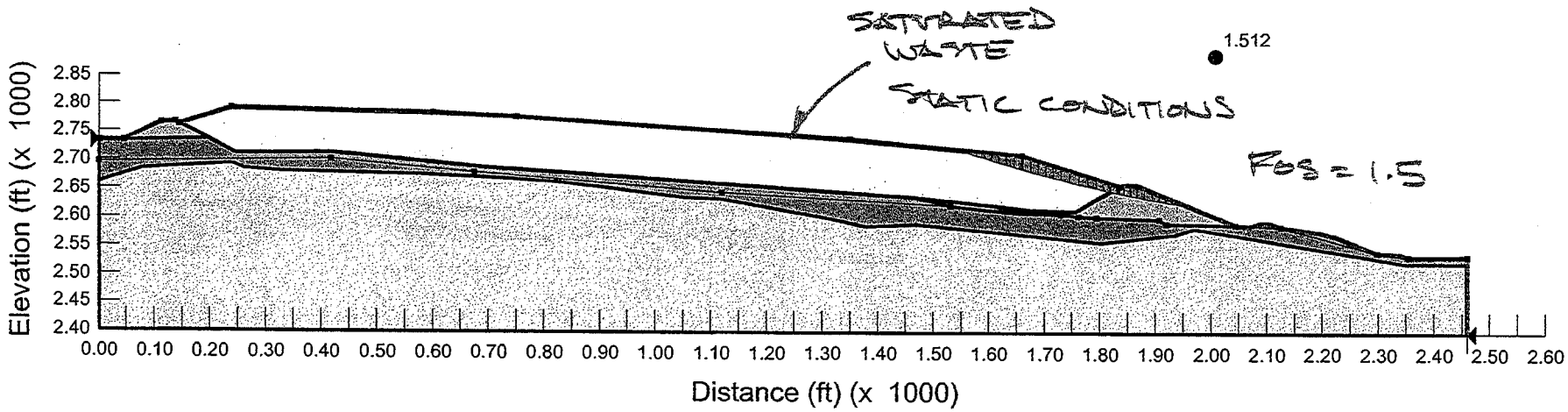
Name: Perimeter Dike
Unit Weight: 120
Cohesion: 0
Phi: 32
Phi-B: 0
C-Phi Correlation Coef.: 0
Anisotropic Strength Fn: (none)

Material #: 4
Name: Foundation Soil
Unit Weight: 115
Value: 0
Value: 28.5

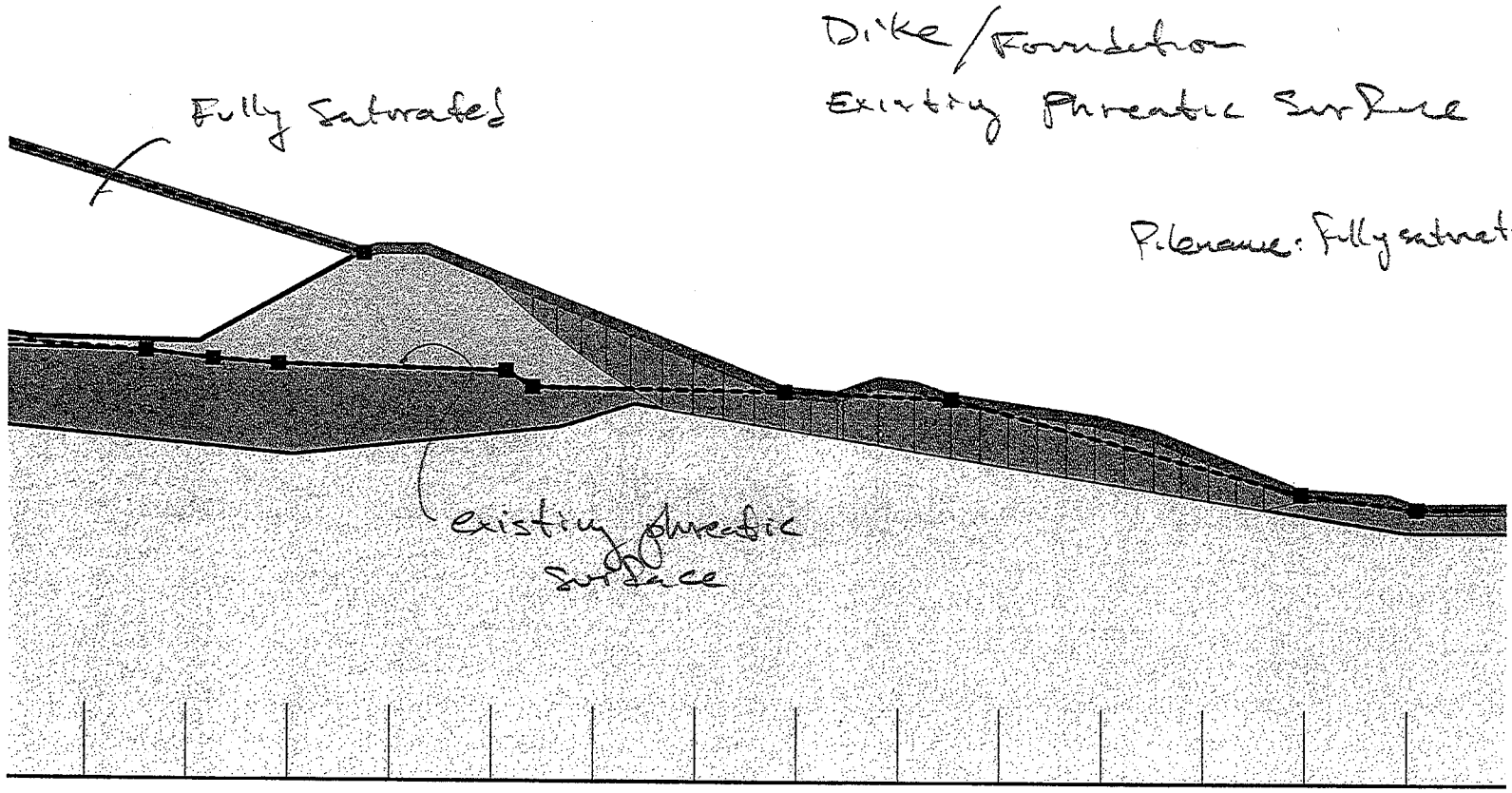
Material #: 5
Name: Liner
Unit Weight: 120
Value: 0
Value: 30

Method: Bishop, Ordinary and Janbu
Factor of Safety: 1.361
Horz Seismic Load: 0

Region 1 = Material Number: 2
Region 2 = Material Number: 3
Region 3 = Material Number: 3
Region 4 = Material Number: 4

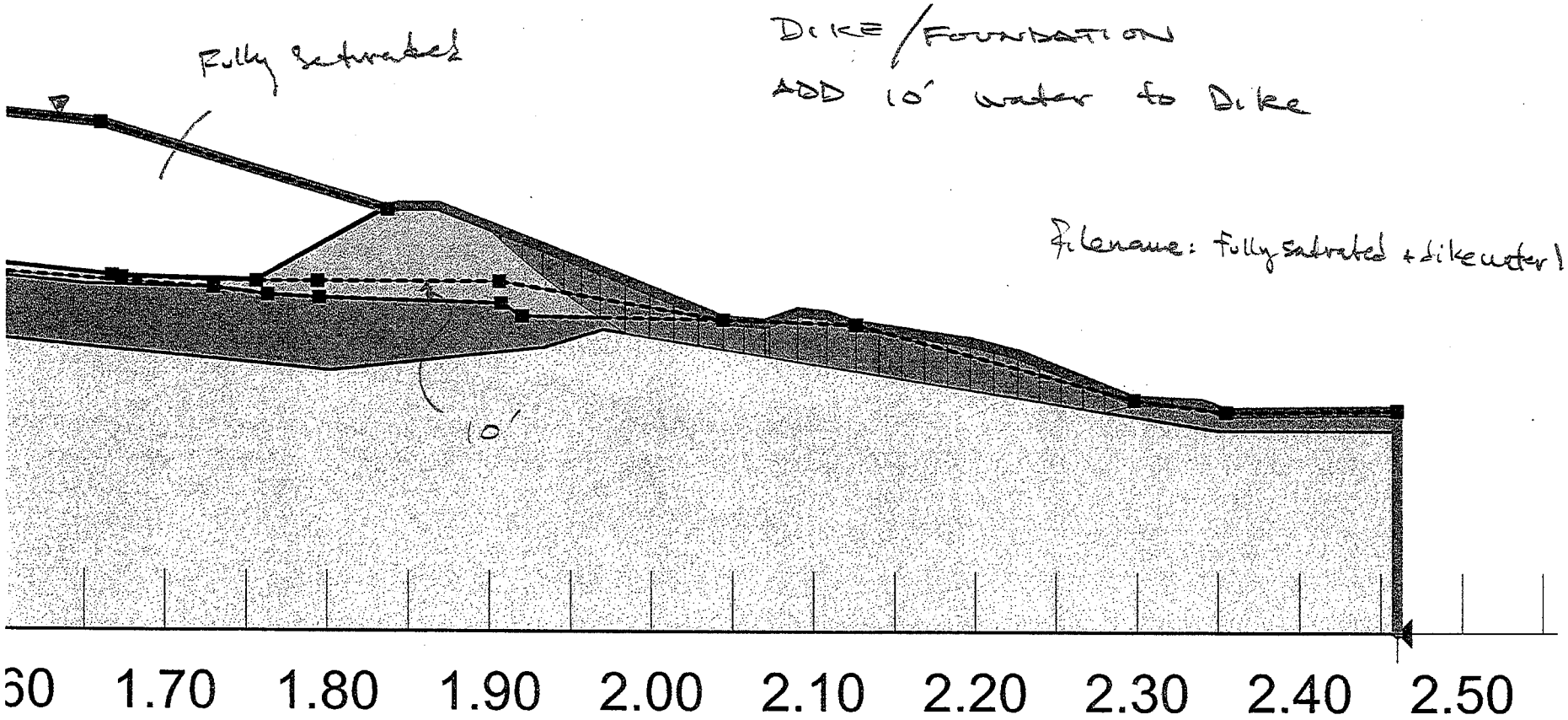


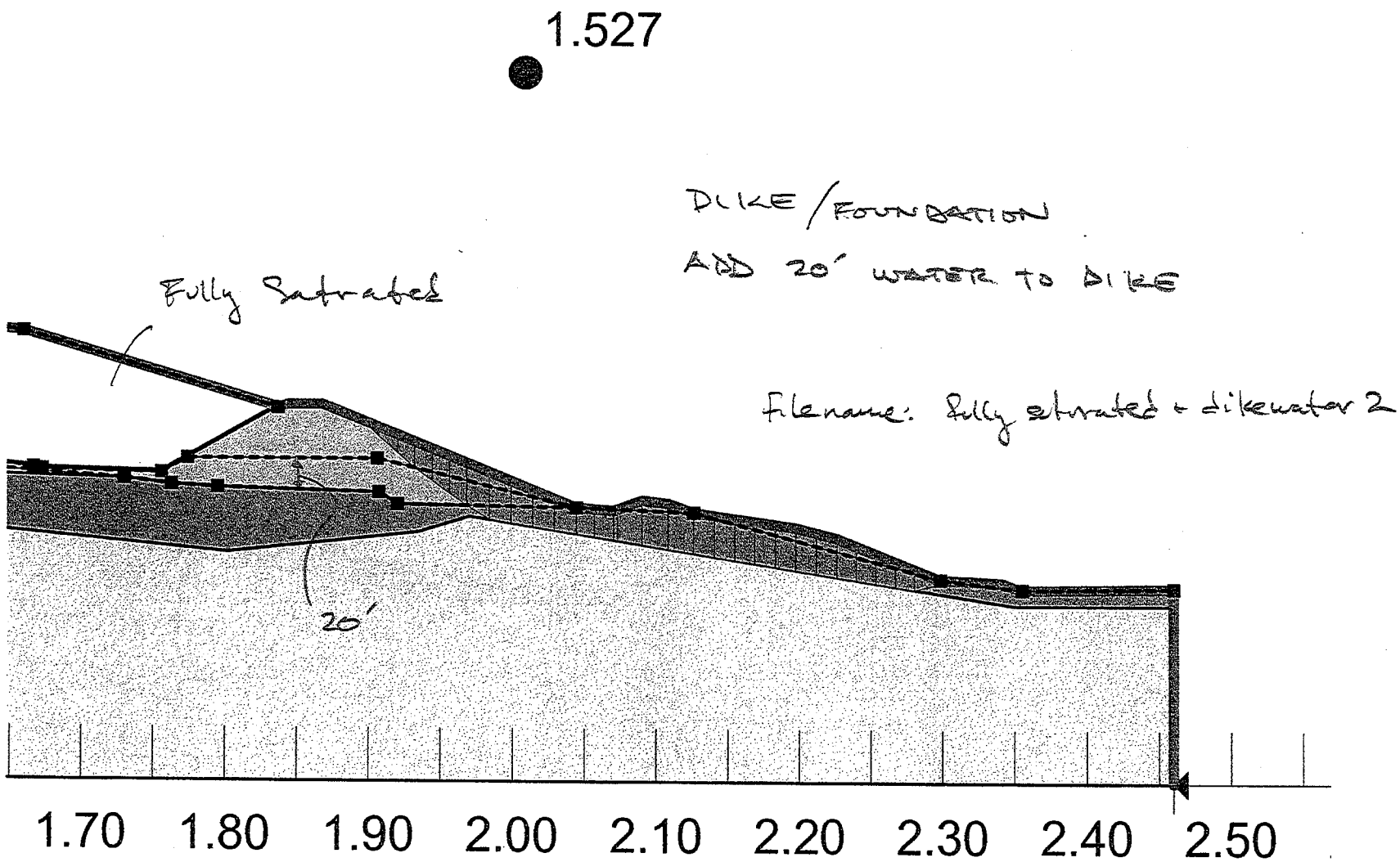
1.584



1.70 1.80 1.90 2.00 2.10 2.20 2.30 2.

1.561

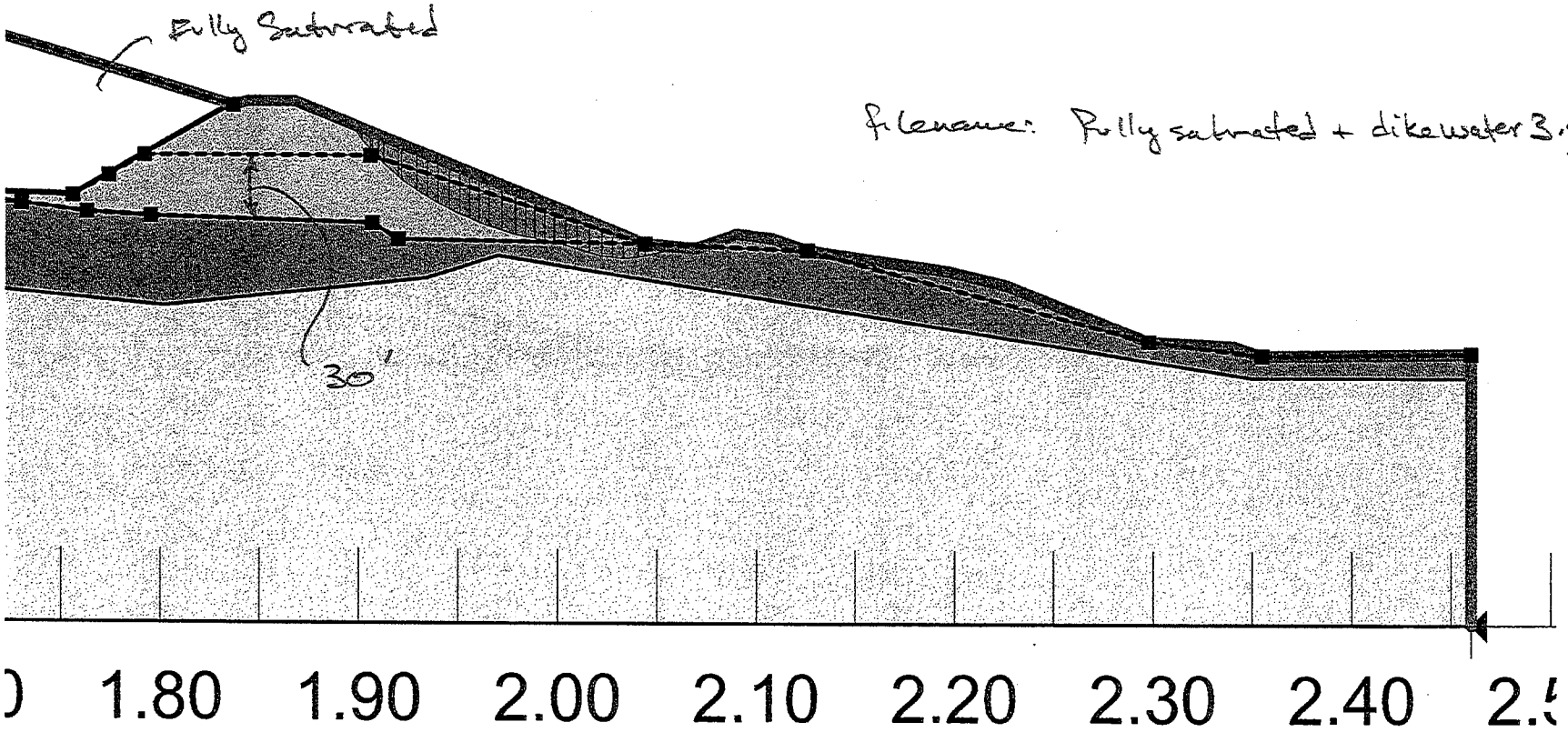

Fully Saturated
DIKE / FOUNDATION
ADD 10' water to Dike
filename: fully saturated + dike water 1
10'
60
1.70
1.80
1.90
2.00
2.10
2.20
2.30
2.40
2.50


1.527
DIKE / FOUNDATION
ADD 20' WATER TO DIKE
Fully Saturated
filename: fully saturated + dikewater 2
20'
1.70
1.80
1.90
2.00
2.10
2.20
2.30
2.40
2.50

1.299

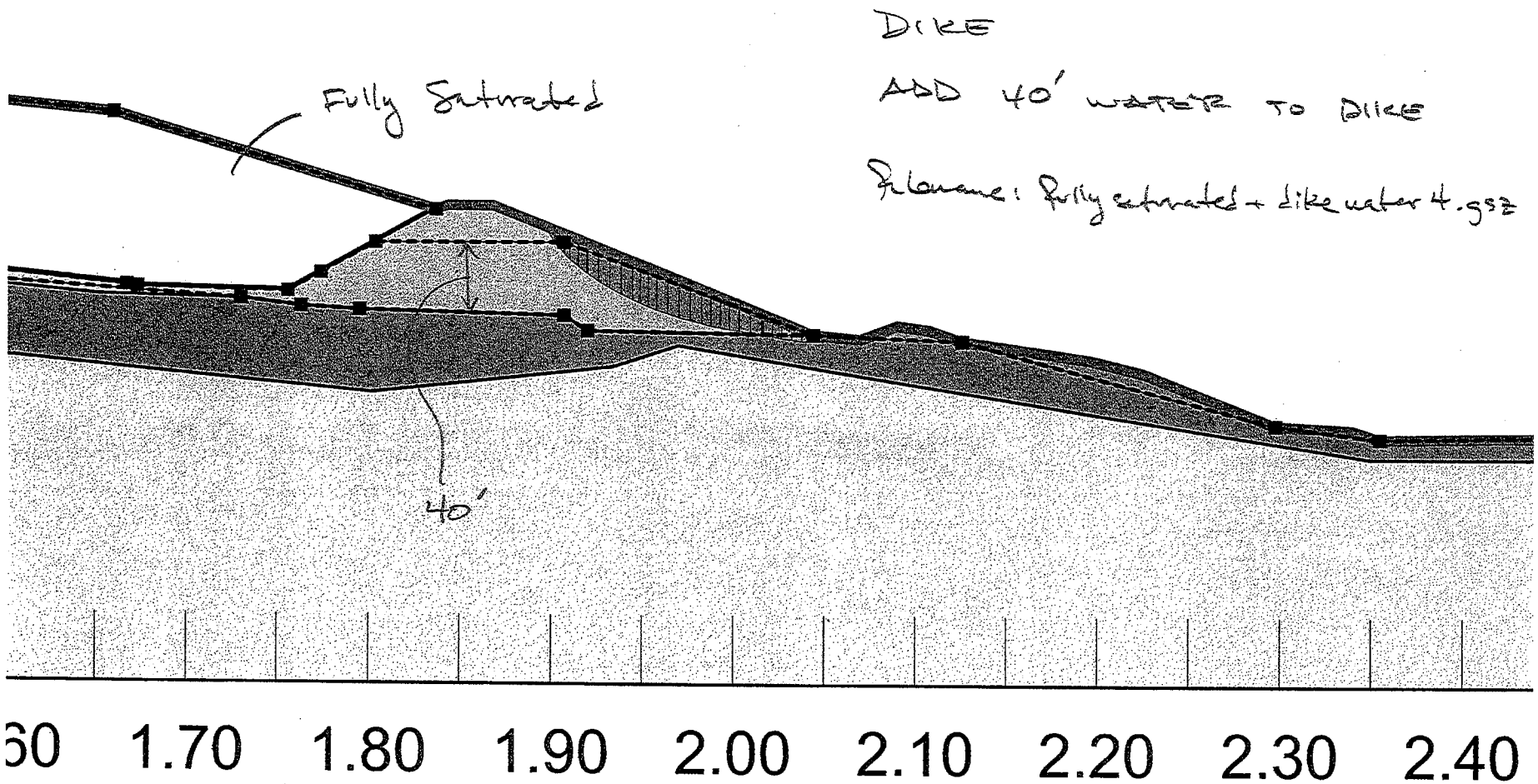
DIKE / FOUNDATION

ADD 30' WATER TO DIKE



filename: fully saturated + dikewater 3.gsz

1.096


DIKE
ADD 40' WATER TO DIKE
Filename: fully saturated + dike water 4.gsz
Fully Saturated
40'
60
1.70
1.80
1.90
2.00
2.10
2.20
2.30
2.40

INFINITE SLOPE CALCULATION

PROJECT	COMP. BY	JOB NO.
INFINITE SLOPE CALCULATION	MSR	99063
	CHK. BY	DATE 7/20/99

CALCULATE STABILITY OF SOIL COVER AND WASTE OPERATING FACE USING INFINITE SLOPE CALCULATION (LAMB & WHITMAN)

COVER SOIL

ASSUME $\phi = 30°$

FINAL GRADE = 3:1 = 18.4° = i

$$FOS = \frac{\tan \phi}{\tan i} = \frac{\tan 30}{\tan 18.4} = 1.7$$

WASTE

ASSUME $\phi = 36°$

OPERATING FACE GRADE = 3:1 = 18.4° = i

$$FOS = \frac{\tan \phi}{\tan i} = \frac{\tan 36}{\tan 18.4} = 2.2$$

THIS ASSUMES NO SEEPAGE ON COVER OR WASTE SIDESLOPES FOS > 1.5 OK

Title: Blue Ridge Paper
Comments: A-A'
Name: H:\Brpp\NC\6e\Geotech\liner lift peak4.gsz

2:1 operating Face Slope on unbuttressed liner with peak strengths
FOS = 1.4 ok

Material #: 1
Name: Soil Cover
Unit Weight: 125
Value: 0
Value: 30

Material #: 2
Name: Waste
Unit Weight: 90
Value: 0
Value: 36

Name: Perimeter Dike
Unit Weight: 120
Cohesion: 115
Phi: 32
Phi-B: 0
C-Phi Correlation Coef.: 0
Anisotropic Strength Fn: (none)

Material #: 4
Name: Foundation Soil
Unit Weight: 115
Value: 0
Value: 28.5

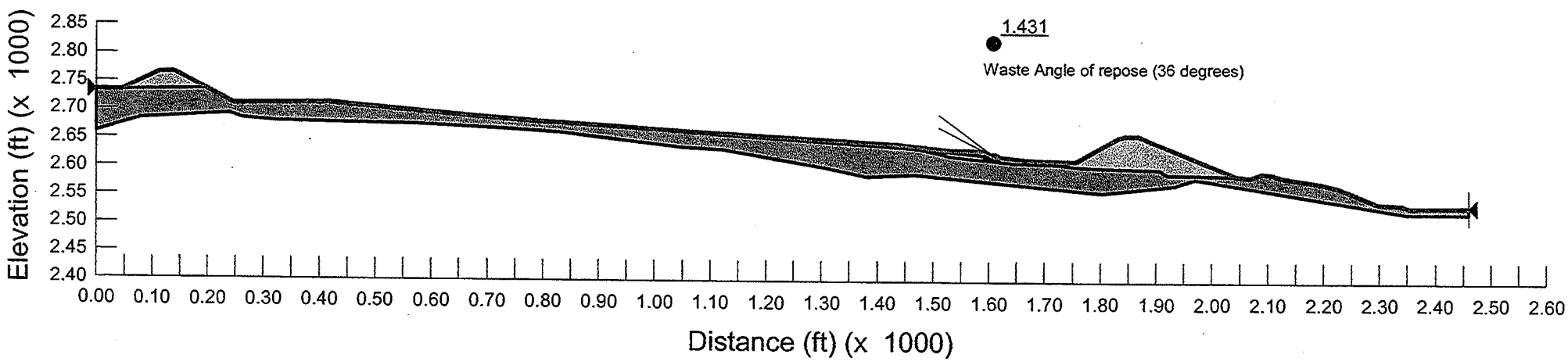
Material #: 5
Name: Liner
Unit Weight: 120
Value: 0
Value: 30

Material #: 6
Name: Bedrock
Unit Weight: 0
Value: 0
Value: 0

Method: Spencer
Factor of Safety: 1.431
Horz Seismic Load: 0

Region 1 = Material Number: 3
Region 2 = Material Number: 3
Region 3 = Material Number: 3
Region 4 = Material Number: 4
Region 5 = Material Number: 2
Region 6 = Material Number: {GeometryItems.Regions[6].MaterialID}

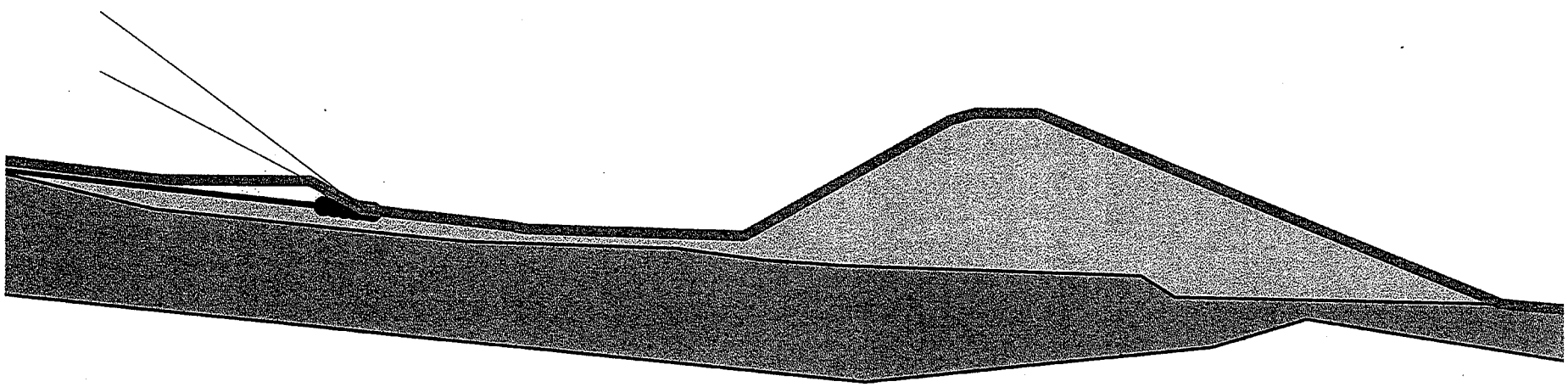
Piezometric condition in waste modeled as a grid of pressure heads.
Based on the relationship of 0.18 feet of pore pressure per foot of waste.



2:1 operating Face Slope
on unbottressed liner
with Peak strength
FOS = 1.4

1.431

Waste Angle of repose (36 degrees)



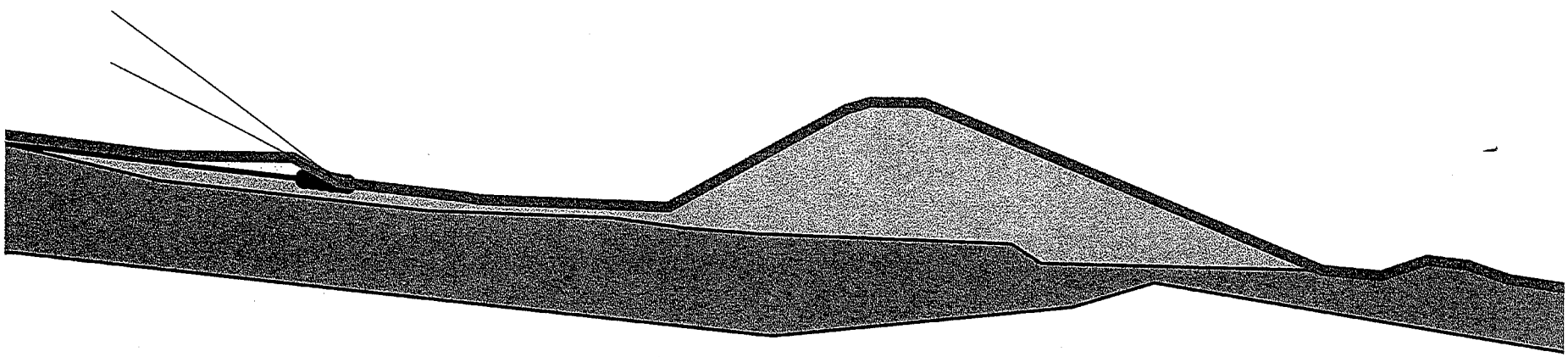
2:1 operating Face Slope on unbuttressed liner with L.D. strengths

FOS = 1.2

ok

1.228

Waste Angle of repose (36 degrees)



ATTACHMENT C

ENGINEERING CALCULATIONS

ATTACHMENT C-1

ANCHOR TRENCH DESIGN AND GEOMEMBRANE STRESS CALCULATIONS

ANCHOR TRENCH CALCULATIONS

Project Name: Evergreen Packaging Area 6D-North
Project Location: Canton, NC
Project No: 12121
Comp By: ASB
Date: 7/26/2013
Chk. By: _____

OBJECTIVE: To determine that the anchor trench dimensions fulfill the safety requirements

REFERENCES: EPA/600/2-87/097 and Basic Soils Engineering

DESIGN PROCEDURE:

1. Calculate Max Stress From Liner Weight
2. Calculate Max Stress From L.C. Stone
3. Calculate Anchor Trench At Rest
4. Calculate Anchor Trench Passive

KNOWNS:

Geomembrane Stress Spec. Yield Strength = 132 lb/in = 1584 lb/ft

SUMMARY OF RESULTS:

1. Max Stress From Liner Weight: T = .155 lb/ft — FS = 10219
2. Max Stress From L.C. Stone: T = 5.7 lb/ft — FS = 278
3. Anchor Trench At Rest:
   Must be > .155 + 5.7 = 5.855 lb/ft
   T_{KO} = 280.1 — FS = 48
4. Anchor Trench Passive:
   Must be > T_{KO} < Yield Strength
   T_{KP} = 691.4 lb/ft — FS = 2.5, 2.3

Therefore an anchor trench sized 3' runout x 2' deep x 1' cover soil is acceptable

BLUE RIDGE PAPER PRODUCTS
CANTON, NORTH CAROLINA
LANDFILL No. 6
AREA 6D-NORTH

ANCHOR TRENCH CALCULATION
REF. REQUIREMENTS FOR HAZARDOUS WASTE LANDFILL DESIGN, CONSTRUCTION AND CLOSURE, EPA CERI-88-33
DATE: 7/19/2013
FILE: ANCHOR.MCD

DESIGN PARAMETERS

$\beta := 26.6 \cdot deg$	Maximum Slope Angle
$\phi := 29 \cdot deg$	Soil Internal Friction Angle
$\delta := 26 \cdot deg$	Minimum Interface Friction Angle
$L := 3 \cdot ft$	Anchor Runout Length
$d_{at} := 2 \cdot ft$	Anchor Trench Depth
$d_{cs} := 1 \cdot ft$	Cover Soil Depth
$\gamma_{cs} := 100 \cdot \frac{lb}{ft^3}$	Cover Soil Density
$DR := 1.5$	Design Ratio

CALCULATED PULLOUT CAPACITIES

$$q := d_{cs} \cdot \gamma_{cs}$$

$$K_o := 1 - \sin(\phi)$$

$$K_a := \frac{1 - \sin(\phi)}{1 + \sin(\phi)}$$

$$K_p := \frac{1 + \sin(\phi)}{1 - \sin(\phi)}$$

$$T_{kp} := \frac{(q \cdot L \cdot \tan(\delta)) + (K_p + K_a) \cdot \tan(\delta) \cdot \left[\left(.5 \cdot \gamma_{cs} \cdot d_{at}^2\right) + \left(q \cdot d_{at}\right)\right]}{DR \cdot \cos(\beta) - (\sin(\beta) \cdot \tan(\delta))}$$

Passive Stress

$$T_{kp} = 691.4 \cdot \frac{lb}{ft}$$

$$T_{ko} := \frac{(q \cdot L \cdot \tan(\delta)) + \left[(K_o + K_a) \cdot \tan(\delta) \cdot \left[\left(.5 \cdot \gamma_{cs} \cdot d_{at}^2\right) + \left(q \cdot d_{at}\right)\right]\right]}{DR \cdot \cos(\beta) - (\sin(\beta) \cdot \tan(\delta))}$$

At-rest Stress

$$T_{ko} = 280.1 \cdot \frac{lb}{ft}$$

BLUE RIDGE PAPER PRODUCTS
CANTON, NORTH CAROLINA
LANDFILL No. 6
AREA 6D-NORTH

GEOMEMBRANE STRESS CALCULATION
REF. REQUIREMENTS FOR HAZARDOUS WASTE LANDFILL DESIGN, CONSTRUCTION AND CLOSURE, EPA CERI-88-33
DATE: 7/19/2013
FILE: GEOSTRES.MCD

DESIGN PARAMETERS

$\beta := 26.6 \cdot deg$	Maximum Slope Angle
$G := 0.941$	Geomembrane Specific Gravity
$\delta := 26 \cdot deg$	Minimum Interface Friction Angle
$D := 60 \cdot ft$	Vertical Height of Landfill
$\gamma_w := 62.4 \cdot \frac{lb}{ft^3}$	Density of Water
$t := 0.060 \cdot in$	Geomembrane Thickness

CALCULATED GEOMEMBRANE TENSILE FORCE, T

$W := (G \cdot \gamma_w \cdot t) \cdot (D \cdot \sin(\beta))$ $\quad W = 7.888 \cdot \frac{lb}{ft}$

$F := W \cdot \cos(\beta) \cdot \tan(\delta)$ $\quad F = 3.44 \cdot \frac{lb}{ft}$

$T := W \cdot \sin(\beta) - F$ $\quad T = 0.092 \cdot \frac{lb}{ft}$

GEOMEMBRANE DESIGN STRESS

Geomembrane - 60-mil, HDPE, Textured

Specification - Min. 132 lbs/in Yield Strength
Min. 13 percent Yield Elongation

Allowable Stress, FS=5, 316.8 lb/ft Yield Strength
FS=2, 6.5 percent Yield Elongation

Sevee & Maher Engineers, Inc.

BLUE RIDGE PAPER PRODUCTS
CANTON, NORTH CAROLINA
LANDFILL No. 6
AREA 6D-NORTH

LEACHATE COLLECTION STONE STRESS CALCULATION
REF. REQUIREMENTS FOR HAZARDOUS WASTE LANDFILL DESIGN, CONSTRUCTION AND CLOSURE, EPA CERI-88-33
DATE: 7/19/2013
FILE: SOILSTRS.MCD

DESIGN PARAMETERS

$\beta := 26.6 \cdot deg$	Maximum Slope Angle
$\gamma_s := 110 \cdot \frac{lb}{ft^3}$	Stone Density
$\delta := 26 \cdot deg$	Minimum Interface Friction Angle
$D := 10 \cdot ft$	Vertical Height of Stone Layer
$t_s := 1 \cdot ft$	Thickness of the Stone Layer Base or Side Slope

CALCULATED GEOMEMBRANE TENSILE FORCE, T

$W := (\gamma_s \cdot t_s) \cdot (D \cdot \sin(\beta))$ $\quad W = 492.5 \cdot \frac{lb}{ft}$

$F := W \cdot \cos(\beta) \cdot \tan(\delta)$ $\quad F = 214.8 \cdot \frac{lb}{ft}$

$T := W \cdot \sin(\beta) - F$ $\quad T = 5.7 \cdot \frac{lb}{ft}$

GEOMEMBRANE DESIGN STRESS

Geomembrane - 60-mil, HDPE, Textured

Specification - Min. 132 lbs/in Yield Strength
Min. 13 percent Yield Elongation

Allowable Stress, FS=5, 316.8 lb/ft Yield Strength
FS=2, 6.5 percent Yield Elongation

Sevee & Maher Engineers, Inc.

ATTACHMENT C-2

HEAD-ON LINER CALCULATION

BLUE RIDGE PAPER PRODUCTS
CANTON, NORTH CAROLINA
LANDFILL No. 6
AREA 6D-NORTH

MAXIMUM HEAD ON LINER CALCULATION
REF. GIROUD, ET AL., 1993
DATE: 7/15/2013
FILE: LINEHEAD-MIN-SLOPE.MCD

DESIGN PARAMETERS

$K := 1 \cdot \frac{cm}{sec}$ Leachate Collection Stone Permeability

$L := 200 \cdot ft$ Length from Peak of "Saw-Tooth" to LC Header

$t := 15 \cdot in$ Leachate Collection Stone Thickness

$e := 0.10167 \cdot \frac{in}{hr}$ Impingement Rate, 25-yr/24-hr Storm (6.1 inches)
Assume 40 percent will infiltrate as leachate

$\beta := 1.146 \cdot deg$ Base Slope of the Landfill (MIN. = 2.0 %)

$$T_{max} := L \cdot \frac{\sqrt{\left(4 \cdot \frac{e}{K}\right) + \tan(\beta)^2} - \tan(\beta)}{2 \cdot \cos(\beta)}$$

$T_{max} = 0.621\ ft$ Maximum Head on the Liner, recommended maximum 1 ft.

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\HELP\BRPP\PRECIP.D4
TEMPERATURE DATA FILE:       C:\HELP\BRPP\TEMP.D7
SOLAR RADIATION DATA FILE:   C:\HELP\BRPP\SOLARRAD.D13
EVAPOTRANSPIRATION DATA:     C:\HELP\BRPP\EVAPO18.D11
SOIL AND DESIGN DATA FILE:   C:\HELP\BRPP\NC60BASE.D10
OUTPUT DATA FILE:            C:\HELP\BRPP\NC60BASE.OUT


TIME:   8:20     DATE:   7/24/2013


******************************************************************************

     TITLE:  EVERGREEN - LANDFILL 6D NORTH - NO CAP 60-FT WASTE ON BASE

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                 TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER   0
          THICKNESS                    =    720.00   INCHES
          POROSITY                     =      0.4000 VOL/VOL
          FIELD CAPACITY               =      0.3600 VOL/VOL
          WILTING POINT                =      0.2800 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.3670 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.139999997000E-05 CM/SEC


                                  LAYER  2
                                  --------

                 TYPE 2 - LATERAL DRAINAGE LAYER
```

```
                MATERIAL TEXTURE NUMBER  21
THICKNESS                    =     15.00   INCHES
POROSITY                     =      0.3970 VOL/VOL
FIELD CAPACITY               =      0.0320 VOL/VOL
WILTING POINT                =      0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0320 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.300000012000      CM/SEC
SLOPE                        =      8.00   PERCENT
DRAINAGE LENGTH              =    200.0    FEET


                         LAYER  3
                         --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER  35
THICKNESS                    =      0.06   INCHES
POROSITY                     =      0.0000 VOL/VOL
FIELD CAPACITY               =      0.0000 VOL/VOL
WILTING POINT                =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY          =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS     =      1.00   HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD


                         LAYER  4
                         --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER   0
THICKNESS                    =      0.24   INCHES
POROSITY                     =      0.7500 VOL/VOL
FIELD CAPACITY               =      0.7470 VOL/VOL
WILTING POINT                =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.7470 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.499999997000E-08 CM/SEC


                         LAYER  5
                         --------

               TYPE 3 - BARRIER SOIL LINER
               MATERIAL TEXTURE NUMBER   0
THICKNESS                    =     48.00   INCHES
POROSITY                     =      0.4710 VOL/VOL
FIELD CAPACITY               =      0.3420 VOL/VOL
WILTING POINT                =      0.2100 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.4710 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.499999987000E-04 CM/SEC
```

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	90.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	18.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	7.149	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	7.200	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	5.040	INCHES
INITIAL SNOW WATER	=	4.684	INCHES
INITIAL WATER IN LAYER MATERIALS	=	287.503	INCHES
TOTAL INITIAL WATER	=	292.188	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
ASHEVILLE NORTH CAROLINA

STATION LATITUDE	=	35.26	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	96	
END OF GROWING SEASON (JULIAN DATE)	=	298	
EVAPORATIVE ZONE DEPTH	=	18.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.60	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	71.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	75.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	84.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	77.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ASHEVILLE NORTH CAROLINA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.48	3.60	5.13	3.84	4.19	4.20
4.43	4.79	3.96	3.29	3.29	3.51

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ASHEVILLE NORTH CAROLINA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
36.80	39.10	46.40	55.70	63.30	69.80
73.20	72.60	66.90	56.00	46.40	39.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING

COEFFICIENTS FOR ASHEVILLE NORTH CAROLINA
AND STATION LATITUDE = 35.26 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 15

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.27	3.51	4.57	3.60	4.81	4.49
	4.01	4.46	3.28	2.79	3.50	3.61
STD. DEVIATIONS	1.41	1.89	2.79	1.91	1.62	1.87
	1.50	2.02	1.89	1.57	2.44	2.00
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.769	1.005	1.649	2.203	2.923	3.280
	3.173	2.719	2.033	1.291	1.211	0.548
STD. DEVIATIONS	0.405	0.548	1.300	2.129	2.854	3.185
	3.104	2.664	1.972	1.225	0.782	0.331
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	0.8296	0.7160	0.7296	0.7541	0.8250	0.7983
	0.8145	0.8581	0.9299	1.0131	1.0072	0.9201
STD. DEVIATIONS	0.5210	0.4920	0.5522	0.5128	0.5466	0.4956
	0.4845	0.4404	0.4169	0.3269	0.3357	0.5010
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	0.0396	0.0376	0.0348	0.0372	0.0394	0.0394
	0.0389	0.0409	0.0459	0.0483	0.0497	0.0439
STD. DEVIATIONS	0.0249	0.0260	0.0264	0.0253	0.0261	0.0244
	0.0231	0.0210	0.0206	0.0156	0.0166	0.0239

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 15

	INCHES		CU. FEET	PERCENT
PRECIPITATION	45.89	(5.294)	166597.6	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	22.805	(18.9744)	82781.48	49.689
LATERAL DRAINAGE COLLECTED FROM LAYER 2	10.19553	(4.89541)	37009.766	22.21506
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.00000	(0.00000)	0.016	0.00001
AVERAGE HEAD ON TOP OF LAYER 3	0.041	(0.020)		
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000	(0.00000)	0.016	0.00001
AVERAGE HEAD ON TOP OF LAYER 5	0.000	(0.000)		
CHANGE IN WATER STORAGE	12.582	(19.2996)	45672.26	27.415

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 15

	(INCHES)	(CU. FT.)
PRECIPITATION	3.66	13285.801
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 2	0.04762	172.86519
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.000000	0.00006
AVERAGE HEAD ON TOP OF LAYER 3	0.070	
MAXIMUM HEAD ON TOP OF LAYER 3	0.139	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	2.1 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00006
AVERAGE HEAD ON TOP OF LAYER 5	0.000	
SNOW WATER	176.91	642192.8120

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3971
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2800

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 15

LAYER	(INCHES)	(VOL/VOL)
1	280.1273	0.3891
2	0.4893	0.0326
3	0.0000	0.0000
4	0.1793	0.7470
5	22.6080	0.4710
SNOW WATER	177.512	

****

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******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                 DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                   USAE WATERWAYS EXPERIMENT STATION                      **
**              FOR USEPA RISK REDUCTION ENGINEERING LABORATORY             **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:     C:\HELP\BRPP\PRECIP.D4
TEMPERATURE DATA FILE:       C:\HELP\BRPP\TEMP.D7
SOLAR RADIATION DATA FILE:   C:\HELP\BRPP\SOLARRAD.D13
EVAPOTRANSPIRATION DATA:     C:\HELP\BRPP\EVAPO18.D11
SOIL AND DESIGN DATA FILE:   C:\HELP\BRPP\NC60SIDE.D10
OUTPUT DATA FILE:            C:\HELP\BRPP\NC60SIDE.OUT


TIME:   8:18     DATE:   7/24/2013


******************************************************************************

     TITLE:  CHAMPION - LANDFILL 6D SOUTH - NO CAP 60-FT WASTE ON SIDE

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   0
          THICKNESS                  =    720.00   INCHES
          POROSITY                   =      0.4000 VOL/VOL
          FIELD CAPACITY             =      0.3600 VOL/VOL
          WILTING POINT              =      0.2800 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.3670 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.139999997000E-05 CM/SEC


                                  LAYER  2
                                  --------

                     TYPE 2 - LATERAL DRAINAGE LAYER
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                MATERIAL TEXTURE NUMBER  21
THICKNESS                    =     12.00   INCHES
POROSITY                     =      0.3970 VOL/VOL
FIELD CAPACITY               =      0.0320 VOL/VOL
WILTING POINT                =      0.0130 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0320 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.300000012000     CM/SEC
SLOPE                        =     50.00   PERCENT
DRAINAGE LENGTH              =    300.0    FEET


                       LAYER  3
                       --------

             TYPE 4 - FLEXIBLE MEMBRANE LINER
               MATERIAL TEXTURE NUMBER  35
THICKNESS                    =      0.06   INCHES
POROSITY                     =      0.0000 VOL/VOL
FIELD CAPACITY               =      0.0000 VOL/VOL
WILTING POINT                =      0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.199999996000E-12 CM/SEC
FML PINHOLE DENSITY          =      1.00   HOLES/ACRE
FML INSTALLATION DEFECTS     =      1.00   HOLES/ACRE
FML PLACEMENT QUALITY        =  3 - GOOD


                       LAYER  4
                       --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                    =     48.00   INCHES
POROSITY                     =      0.4710 VOL/VOL
FIELD CAPACITY               =      0.3420 VOL/VOL
WILTING POINT                =      0.2100 VOL/VOL
INITIAL SOIL WATER CONTENT   =      0.4710 VOL/VOL
EFFECTIVE SAT. HYD. COND.    =  0.499999987000E-04 CM/SEC


          GENERAL DESIGN AND EVAPORATIVE ZONE DATA
          ----------------------------------------

 NOTE:  SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER              =     90.00
FRACTION OF AREA ALLOWING RUNOFF     =      0.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
EVAPORATIVE ZONE DEPTH               =     18.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE    =      7.149  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE   =      7.200  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE   =      5.040  INCHES
INITIAL SNOW WATER                   =      4.684  INCHES
INITIAL WATER IN LAYER MATERIALS     =    287.228  INCHES
TOTAL INITIAL WATER                  =    291.912  INCHES
TOTAL SUBSURFACE INFLOW              =      0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
ASHEVILLE NORTH CAROLINA

STATION LATITUDE	=	35.26	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	96	
END OF GROWING SEASON (JULIAN DATE)	=	298	
EVAPORATIVE ZONE DEPTH	=	18.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.60	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	71.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	75.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	84.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	77.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ASHEVILLE NORTH CAROLINA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.48	3.60	5.13	3.84	4.19	4.20
4.43	4.79	3.96	3.29	3.29	3.51

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ASHEVILLE NORTH CAROLINA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
36.80	39.10	46.40	55.70	63.30	69.80
73.20	72.60	66.90	56.00	46.40	39.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ASHEVILLE NORTH CAROLINA
AND STATION LATITUDE = 35.26 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 15

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC

PRECIPITATION

TOTALS	3.27	3.51	4.57	3.60	4.81	4.49
	4.01	4.46	3.28	2.79	3.50	3.61
STD. DEVIATIONS	1.41	1.89	2.79	1.91	1.62	1.87
	1.50	2.02	1.89	1.57	2.44	2.00

RUNOFF

TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000

EVAPOTRANSPIRATION

TOTALS	0.769	1.005	1.649	2.203	2.923	3.280
	3.173	2.719	2.033	1.291	1.211	0.548
STD. DEVIATIONS	0.405	0.548	1.300	2.129	2.854	3.185
	3.104	2.664	1.972	1.225	0.782	0.331

LATERAL DRAINAGE COLLECTED FROM LAYER 2

TOTALS	0.8289	0.7153	0.7294	0.7550	0.8240	0.7990
	0.8134	0.8601	0.9309	1.0129	1.0071	0.9192
STD. DEVIATIONS	0.5217	0.4930	0.5509	0.5127	0.5457	0.4955
	0.4828	0.4403	0.4165	0.3267	0.3362	0.5014

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	0.0001	0.0000	0.0000	0.0000	0.0001	0.0000
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	0.0118	0.0112	0.0104	0.0111	0.0117	0.0117
	0.0116	0.0122	0.0137	0.0144	0.0148	0.0131
STD. DEVIATIONS	0.0074	0.0078	0.0078	0.0075	0.0078	0.0073
	0.0069	0.0063	0.0061	0.0046	0.0049	0.0071

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 15

INCHES CU. FEET PERCENT

PRECIPITATION	45.89	(5.294)	166597.6	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	22.805	(18.9744)	82781.48	49.689
LATERAL DRAINAGE COLLECTED FROM LAYER 2	10.19530	(4.89318)	37008.949	22.21457
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00063	(0.00029)	2.276	0.00137
AVERAGE HEAD ON TOP OF LAYER 3	0.012	(0.006)		
CHANGE IN WATER STORAGE	12.581	(19.3046)	45670.82	27.414

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 15

	(INCHES)	(CU. FT.)
PRECIPITATION	3.66	13285.801
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 2	0.04823	175.06445
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000003	0.01042
AVERAGE HEAD ON TOP OF LAYER 3	0.021	
MAXIMUM HEAD ON TOP OF LAYER 3	0.100	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	176.91	642192.8120

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3971

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.2800

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 15

LAYER	(INCHES)	(VOL/VOL)
1	280.1273	0.3891
2	0.3873	0.0323
3	0.0000	0.0000
4	22.6080	0.4710
SNOW WATER	177.512	

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ATTACHMENT C-3

GEOTEXTILE CUSHION CALCULATION

BLUE RIDGE PAPER PRODUCTS
CANTON, NORTH CAROLINA
LANDFILL No. 6
AREA 6D-NORTH

GEOTEXTILE CUSHION CALCULATION
REF. DESIGNING WITH GEOSYNTHETIC CUSHIONS, BOSCHUK
CIVIL ENGINEERING NEWS, OCTOBER 1994
DATE: 6/19/2013
FILE: CUSHION.MCD

DESIGN PARAMETERS

$M := 16 \frac{oz}{sy}$ $M := 542.5 \frac{g}{m^2}$ Geotextile Weight

$H := 1.0\ in$ $H := .0254\ m$ Stone maximum diameter

$MF_s := 1.0$ Modification Factor for Stone Shape

$MF_{pd} := .2$ Modification Factor for Stone Packing

$MF_a := 0.17$ Modification Factor for Overburden Pressure

$FS_{cr} := 1.5$ Modification Factor for Creep Puncture

$$P_{allow} := \left[(50) + 0.00045 \cdot \frac{M}{H^2}\right] \cdot \left(\frac{1}{MF_s \cdot MF_{pd} \cdot MF_a \cdot FS_{cr}}\right)$$

$P_{allow} = 8.4 \cdot 10^3\ kPa$ Allowable Pressure

$\gamma_{waste} := 80 \frac{lb}{ft^3}$ Density of Waste, 80 percent

$\gamma_{soil} := 125 \frac{lb}{ft^3}$ Density of Gravel, 20 percent

$d := 101\ ft$ Depth of Landfill

$P_{reqd} := (80 \cdot .80 + 125 \cdot .20) \cdot d$

$P_{reqd} = 8.989 \cdot 10^3 \frac{lb}{ft^2}$ $P_{reqd} := 404.kPa$ Required Pressure

$FS := \frac{P_{allow}}{P_{reqd}}$ $FS = 20.8$ Factor of Safety, recommended minimum 2.0

Sevee & Maher Engineers, Inc.

ATTACHMENT C-4

HDPE STRENGTH CALCULATION

EVERGREEN PACKAGING
CANTON, NORTH CAROLINA
LANDFILL No. 6
AREA 6D-NORTH

Pipe Calculations
Pipe Strength in Deep Fill

Pipe Location: 12" Leachate Transport Pipe
Pipe Size & Type: 12" dia. SDR 11 HDPE Perforated Pipe

DATE: 8/14/2013
FILE: 12LT-Perf_Deepfill.MCD

Project Parameters

Depth of Overburden $H := 104.33 \cdot ft$

Depth of Waste Over Pipe $D_{waste} := 101 \cdot ft$

Depth of Soil over Pipe $D_{soil} := 3.33 \cdot ft$

Depth of groundwater $Hgw := 0 \cdot ft$

Unit weight of waste $\gamma w := 80 \cdot \frac{lbf}{ft^3}$

Unit weight of soil $\gamma s := 125 \cdot \frac{lbf}{ft^3}$

Hyperbolic Parameter:

Modulus Number $k := 100$

Modulus Exponent $n := 0.4$
(for 90% Compaction)

Pipe Parameters:

Effective DR: $DR := 12.571$

Long term compressive yield streght $Sc := 1600 \cdot psi$

Outside Diameter $OD := 13.2 \cdot in$

Short Term Modulus: $Estm := 100000 \cdot psi$

Long Term Modulus: $El := 23000 \cdot psi$

Poisson Ratio of Soil: $\mu := .35$

Temperature Design Factor $f := 0.78$
(for 100 deg. F)

Overbuden weight

Weighted soil/waste unit weight $\gamma wt := \gamma w \cdot \frac{D_{waste}}{H} + \gamma s \cdot \frac{D_{soil}}{H}$

$$\gamma wt = 81.436 \cdot \frac{lbf}{ft^3}$$

Pipe Dimensional Parameters

Pipe Wall Thickness $t := \frac{OD}{DR}$ $t = 1.05 \cdot in$

Mean Radius $r := \frac{OD - t}{2}$ $r = 6.075 \cdot in$

Long Term Compressive Yeild Strength due to Temperture

$Sct := Sc \cdot f$ $Sct = 1.248 \cdot 10^3 \cdot psi$

Constrained Modulus

$$Ms := k \cdot 14.7 \cdot psi \cdot \left(\gamma wt \cdot \frac{H}{14.7 \cdot psi} \right)^n \quad Ms = 2.563 \cdot 10^3 \cdot psi$$

Hoop Thrust Stiffness

$$Sa := \frac{1.43}{El \cdot t} \cdot Ms \cdot r \qquad Sa = 0.922$$

Vertical Arching Factor, (Eq. 1 of "Guidelines for HDPE Pipes in Deep Fills")

$$VAF := .88 - .71 \cdot \left(\frac{Sa - 1}{Sa + 2.5} \right) \qquad VAF = 0.896$$

Radial Direct Earth Pressure, Eq. 3a for Deep Fills

$$Prd := VAF \cdot \gamma wt \cdot H \qquad Prd = 7.614 \cdot 10^3 \cdot \frac{lbf}{ft^2}$$

Ring Compressive Stress, Eq. 4 for Deep Fills

$$S := \frac{Prd \cdot DR}{\left[\frac{288 \cdot (in)^2}{ft^2} \right]} \qquad S = 332.362 \cdot psi \qquad N := \frac{Sct}{S} \qquad N = 3.755$$ Safety Factor

Watkins - Gaube Deflection

Secant Modulus, Eq. 6 $$Es := \frac{Ms \cdot (1 + \mu) \cdot (1 - 2 \cdot \mu)}{1 - \mu} \qquad Es = 1.597 \cdot 10^3 \cdot psi$$

Rigity, Eq. 5 $$Rf := \frac{12 \cdot Es \cdot (DR - 1)^3}{El} \qquad Rf = 1.291 \cdot 10^3$$

****Input Df factor from Figure 1 Guidlines for HDPE Pipe in Deep Fills****

Plexco

$$Df := 1.3$$

Soil Strain (Settlement of Fill Layer at pipe), Eq. 7

$$\varepsilon s := \frac{\gamma wt \cdot H}{\left(\frac{144 \cdot in^2}{ft^2} \right) \cdot Es} \qquad \varepsilon s = 3.695 \cdot \%$$

Pipe Deflection

$$DEFL := Df \cdot \varepsilon s \qquad DEFL = 4.803 \cdot \%$$ Not to exceed 7.5% for design.

Allowable Deflection, Eq. 9

$e := .05$

$fD := 4.28$ Deformaton factor for shape

Allowable Deflection=$\Delta Y / Dm$

$Dallow := \frac{e}{fD} \cdot (DR - 1)$ $Dallow = 13.518 \cdot \%$

Constrained Buckling (Use Prism Load with VAF=1),Eq. 11

$Rh := 1$ Geometry Factor

$Cf := .8$ Construction Factor

$\phi := .55$ Calibration Factor

Pcr Pressure Critical - psi

$$Pcr := \frac{Cf \cdot \phi \cdot Rh \cdot El^{\frac{1}{3}} \cdot \left(\frac{Es}{1 - \mu}\right)^{\frac{2}{3}}}{DR - 1}$$ $Pcr = 196.895 \cdot psi$

$$SF := \frac{Pcr}{\left[\frac{\gamma wt \cdot H}{\left(\frac{144 \cdot in^2}{ft^2}\right)}\right]}$$ $SF = 3.337$ **Safety Factor against Buckling**

Rule of Thumb for Design $2 \le SF \le 4$

EVERGREEN PACKAGING
CANTON, NORTH CAROLINA
LANDFILL No. 6
AREA 6D-NORTH

Pipe Calculations
Pipe Strength in Deep Fill

Pipe Location: 6" Leachate Collection Pipe
Pipe Size & Type: 6" dia. SDR 11 HDPE Perforated Pipe

DATE: 8/14/2013
FILE: 6LC-Perf_Deepfill.MCD

Project Parameters

Depth of Overburden $H := 104.33 \cdot ft$

Depth of Waste Over Pipe $D_{waste} := 101 \cdot ft$

Depth of Soil over Pipe $D_{soil} := 3.33 \cdot ft$

Depth of groundwater $Hgw := 0 \cdot ft$

Unit weight of waste $\gamma w := 80 \cdot \frac{lbf}{ft^3}$

Unit weight of soil $\gamma s := 125 \cdot \frac{lbf}{ft^3}$

Hyperbolic Parameter:

Modulus Number $k := 100$

Modulus Exponent $n := 0.4$
(for 90% Compaction)

Pipe Parameters:

Effective DR: $DR := 12.571$

Long term compressive yield streght $Sc := 1600 \cdot psi$

Outside Diameter $OD := 6.9 \cdot in$

Short Term Modulus: $Estm := 100000 \cdot psi$

Long Term Modulus: $El := 23000 \cdot psi$

Poisson Ratio of Soil: $\mu := .35$

Temperature Design Factor $f := 0.78$
(for 100 deg. F)

Overbuden weight

Weighted soil/waste unit weight $\gamma wt := \gamma w \cdot \frac{D_{waste}}{H} + \gamma s \cdot \frac{D_{soil}}{H}$

$$\gamma wt = 81.436 \cdot \frac{lbf}{ft^3}$$

Pipe Dimensional Parameters

Pipe Wall Thickness $t := \frac{OD}{DR}$ $t = 0.549 \cdot in$

Mean Radius $r := \frac{OD - t}{2}$ $r = 3.176 \cdot in$

Long Term Compressive Yeild Strength due to Temperture

$Sct := Sc \cdot f$ $Sct = 1.248 \cdot 10^3 \cdot psi$

Constrained Modulus

$$Ms := k \cdot 14.7 \cdot psi \cdot \left(\gamma wt \cdot \frac{H}{14.7 \cdot psi} \right)^n \quad Ms = 2.563 \cdot 10^3 \cdot psi$$

Hoop Thrust Stiffness

$$Sa := \frac{1.43}{EI \cdot t} \cdot Ms \cdot r \qquad Sa = 0.922$$

Vertical Arching Factor, (Eq. 1 of "Guidelines for HDPE Pipes in Deep Fills")

$$VAF := .88 - .71 \cdot \left(\frac{Sa - 1}{Sa + 2.5} \right) \qquad VAF = 0.896$$

Radial Direct Earth Pressure, Eq. 3a for Deep Fills

$$Prd := VAF \cdot \gamma wt \cdot H \qquad Prd = 7.614 \cdot 10^3 \cdot \frac{lbf}{ft^2}$$

Ring Compressive Stress, Eq. 4 for Deep Fills

$$S := \frac{Prd \cdot DR}{\left[\frac{288 \cdot (in)^2}{ft^2} \right]} \qquad S = 332.362 \cdot psi \qquad N := \frac{Sct}{S} \qquad N = 3.755$$ Safety Factor

Watkins - Gaube Deflection

Secant Modulus, Eq. 6 $$Es := \frac{Ms \cdot (1 + \mu) \cdot (1 - 2 \cdot \mu)}{1 - \mu} \qquad Es = 1.597 \cdot 10^3 \cdot psi$$

Rigity, Eq. 5 $$Rf := \frac{12 \cdot Es \cdot (DR - 1)^3}{EI} \qquad Rf = 1.291 \cdot 10^3$$

****Input Df factor from Figure 1 Guidlines for HDPE Pipe in Deep Fills****

Plexco

$$Df := 1.3$$

Soil Strain (Settlement of Fill Layer at pipe), Eq. 7

$$\varepsilon s := \frac{\gamma wt \cdot H}{\left(\frac{144 \cdot in^2}{ft^2} \right) \cdot Es} \qquad \varepsilon s = 3.695 \cdot \%$$

Pipe Deflection

$$DEFL := Df \cdot \varepsilon s \qquad DEFL = 4.803 \cdot \%$$ Not to exceed 7.5% for design.

Allowable Deflection, Eq. 9

$e := .05$

$fD := 4.28$ Deformaton factor for shape

Allowable Deflection=$\Delta Y / Dm$

$Dallow := \frac{e}{fD} \cdot (DR - 1)$ $Dallow = 13.518 \circ \%$

Constrained Buckling (Use Prism Load with VAF=1),Eq. 11

$Rh := 1$ Geometry Factor

$Cf := .8$ Construction Factor

$\phi := .55$ Calibration Factor

Pcr Pressure Critical - psi

$$Pcr := \frac{Cf \cdot \phi \cdot Rh \cdot El^{\frac{1}{3}} \cdot \left(\frac{Es}{1 - \mu}\right)^{\frac{2}{3}}}{DR - 1}$$ $Pcr = 196.895 \circ psi$

$$SF := \frac{Pcr}{\left[\frac{\gamma wt \cdot H}{\left(\frac{144 \cdot in^2}{ft^2}\right)}\right]}$$ $SF = 3.337$ **Safety Factor against Buckling**

Rule of Thumb for Design $2 \le SF \le 4$

EVERGREEN PACKAGING
CANTON, NORTH CAROLINA
LANDFILL No. 6
AREA 6D-NORTH

Pipe Calculations
Pipe Strength in Deep Fill

Pipe Location: Detention Basin 3 Outlet Pipe
Pipe Size & Type: 12" dia. SDR 11 HDPE Corr Solid Pipe

DATE: 8/14/2013
FILE: 12SD_Deepfill.MCD

Project Parameters

Depth of Overburden $H := 104.33 \cdot ft$

Depth of Waste Over Pipe $D_{waste} := 101 \cdot ft$

Depth of Soil over Pipe $D_{soil} := 3.33 \cdot ft$

Depth of groundwater $Hgw := 0 \cdot ft$

Unit weight of waste $\gamma w := 80 \cdot \frac{lbf}{ft^3}$

Unit weight of soil $\gamma s := 125 \cdot \frac{lbf}{ft^3}$

Hyperbolic Parameter:

Modulus Number $k := 100$

Modulus Exponent $n := 0.4$
(for 90% Compaction)

Pipe Parameters:

Effective DR: $DR := 11$

Long term compressive yield streght $Sc := 1600 \cdot psi$

Outside Diameter $OD := 13.2 \cdot in$

Short Term Modulus: $Estm := 130000 \cdot psi$

Long Term Modulus: $El := 22000 \cdot psi$

Poisson Ratio of Soil: $\mu := .35$

Temperature Design Factor $f := 0.78$
(for 100 deg. F)

Overburden weight

Weighted soil/waste unit weight $\gamma wt := \gamma w \cdot \frac{D_{waste}}{H} + \gamma s \cdot \frac{D_{soil}}{H}$

$$\gamma wt = 81.436 \cdot \frac{lbf}{ft^3}$$

Pipe Dimensional Parameters

Pipe Wall Thickness $t := \frac{OD}{DR}$ $t = 1.2 \cdot in$

Mean Radius $r := \frac{OD - t}{2}$ $r = 6 \cdot in$

Long Term Compressive Yeild Strength due to Temperture

$Sct := Sc \cdot f$ $Sct = 1.248 \cdot 10^3 \cdot psi$

Constrained Modulus

$$Ms := k \cdot 14.7 \cdot psi \cdot \left(\gamma wt \cdot \frac{H}{14.7 \cdot psi} \right)^n \quad Ms = 2.563 \cdot 10^3 \cdot psi$$

Hoop Thrust Stiffness

$$Sa := \frac{1.43}{EI \cdot t} \cdot Ms \cdot r \qquad Sa = 0.833$$

Vertical Arching Factor, (Eq. 1 of "Guidelines for HDPE Pipes in Deep Fills")

$$VAF := .88 - .71 \cdot \left(\frac{Sa - 1}{Sa + 2.5} \right) \qquad VAF = 0.916$$

Radial Direct Earth Pressure, Eq. 3a for Deep Fills

$$Prd := VAF \cdot \gamma wt \cdot H \qquad Prd = 7.779 \cdot 10^3 \cdot \frac{lbf}{ft^2}$$

Ring Compressive Stress, Eq. 4 for Deep Fills

$$S := \frac{Prd \cdot DR}{\left[\frac{288 \cdot (in)^2}{ft^2} \right]} \qquad S = 297.116 \cdot psi \qquad N := \frac{Sct}{S} \qquad N = 4.2$$

Safety Factor

Watkins - Gaube Deflection

Secant Modulus, Eq. 6

$$Es := \frac{Ms \cdot (1 + \mu) \cdot (1 - 2 \cdot \mu)}{1 - \mu} \qquad Es = 1.597 \cdot 10^3 \cdot psi$$

Rigity, Eq. 5

$$Rf := \frac{12 \cdot Es \cdot (DR - 1)^3}{EI} \qquad Rf = 871.036$$

****Input Df factor from Figure 1 Guidlines for HDPE Pipe in Deep Fills****

Plexco

$$Df := 1.3$$

Soil Strain (Settlement of Fill Layer at pipe), Eq. 7

$$\varepsilon s := \frac{\gamma wt \cdot H}{\left(\frac{144 \cdot in^2}{ft^2} \right) \cdot Es} \qquad \varepsilon s = 3.695 \cdot \%$$

Pipe Deflection

$$DEFL := Df \cdot \varepsilon s \qquad DEFL = 4.803 \cdot \%$$

Not to exceed 7.5% for design.

Allowable Deflection, Eq. 9

$e := .05$

$fD := 4.28$ Deformaton factor for shape

Allowable Deflection=$\Delta Y / Dm$

$Dallow := \frac{e}{fD} \cdot (DR - 1)$ $Dallow = 11.682 \circ \%$

Constrained Buckling (Use Prism Load with VAF=1),Eq. 11

$Rh := 1$ Geometry Factor

$Cf := .8$ Construction Factor

$\phi := .55$ Calibration Factor

Pcr Pressure Critical - psi

$$Pcr := \frac{Cf \cdot \phi \cdot Rh \cdot EI^{\frac{1}{3}} \cdot \left(\frac{Es}{1 - \mu}\right)^{\frac{2}{3}}}{DR - 1}$$ $Pcr = 224.476 \circ psi$

$$SF := \frac{Pcr}{\left[\frac{\gamma wt \cdot H}{\left(\frac{144 \cdot in^2}{ft^2}\right)}\right]}$$ $SF = 3.805$ **Safety Factor against Buckling**

Rule of Thumb for Design $2 \le SF \le 4$

EVERGREEN PACKAGING
CANTON, NORTH CAROLINA
LANDFILL No. 6
AREA 6D-NORTH

Pipe Calculations
Pipe Strength in Deep Fill

Pipe Location: Detention Basin 4 Outlet Pipe
Pipe Size & Type: 12" dia. SDR 11 HDPE Corr Solid Pipe

DATE: 8/14/2013
FILE: Pond 4 Outlet_Deepfill.MCD

Project Parameters

Depth of Overburden $H := 65 \cdot ft$

Depth of Waste Over Pipe $D_{waste} := 0 \cdot ft$

Depth of Soil over Pipe $D_{soil} := 65 \cdot ft$

Depth of groundwater $Hgw := 0 \cdot ft$

Unit weight of waste $\gamma w := 80 \cdot \frac{lbf}{ft^3}$

Unit weight of soil $\gamma s := 125 \cdot \frac{lbf}{ft^3}$

Hyperbolic Parameter:

Modulus Number $k := 100$

Modulus Exponent $n := 0.4$
(for 90% Compaction)

Pipe Parameters:

Effective DR: $DR := 11$

Long term compressive yield streght $Sc := 1600 \cdot psi$

Outside Diameter $OD := 13.2 \cdot in$

Short Term Modulus: $Estm := 130000 \cdot psi$

Long Term Modulus: $El := 22000 \cdot psi$

Poisson Ratio of Soil: $\mu := .35$

Temperature Design Factor $f := 0.78$
(for 100 deg. F)

Overburden weight

Weighted soil/waste unit weight

$$\gamma wt := \gamma w \cdot \frac{D_{waste}}{H} + \gamma s \cdot \frac{D_{soil}}{H}$$

$$\gamma wt = 125 \cdot \frac{lbf}{ft^3}$$

Pipe Dimensional Parameters

Pipe Wall Thickness $t := \frac{OD}{DR}$ $\quad t = 1.2 \cdot in$

Mean Radius $r := \frac{OD - t}{2}$ $\quad r = 6 \cdot in$

Long Term Compressive Yeild Strength due to Temperture

$Sct := Sc \cdot f$ $\quad Sct = 1.248 \cdot 10^3 \cdot psi$

Constrained Modulus

$$Ms := k \cdot 14.7 \cdot psi \cdot \left(\gamma wt \cdot \frac{H}{14.7 \cdot psi}\right)^n \quad Ms = 2.518 \cdot 10^3 \cdot psi$$

Hoop Thrust Stiffness

$$Sa := \frac{1.43}{EI \cdot t} \cdot Ms \cdot r \qquad Sa = 0.818$$

Vertical Arching Factor, (Eq. 1 of "Guidelines for HDPE Pipes in Deep Fills")

$$VAF := .88 - .71 \cdot \left(\frac{Sa - 1}{Sa + 2.5} \right) \qquad VAF = 0.919$$

Radial Direct Earth Pressure, Eq. 3a for Deep Fills

$$Prd := VAF \cdot \gamma wt \cdot H \qquad Prd = 7.466 \cdot 10^3 \cdot \frac{lbf}{ft^2}$$

Ring Compressive Stress, Eq. 4 for Deep Fills

$$S := \frac{Prd \cdot DR}{\left[\frac{288 \cdot (in)^2}{ft^2} \right]} \qquad S = 285.162 \cdot psi \qquad N := \frac{Sct}{S} \qquad N = 4.376$$ Safety Factor

Watkins - Gaube Deflection

Secant Modulus, Eq. 6 $$Es := \frac{Ms \cdot (1 + \mu) \cdot (1 - 2 \cdot \mu)}{1 - \mu} \qquad Es = 1.569 \cdot 10^3 \cdot psi$$

Rigity, Eq. 5 $$Rf := \frac{12 \cdot Es \cdot (DR - 1)^3}{EI} \qquad Rf = 855.608$$

****Input Df factor from Figure 1 Guidlines for HDPE Pipe in Deep Fills****

Plexco

$$Df := 1.3$$

Soil Strain (Settlement of Fill Layer at pipe), Eq. 7

$$\varepsilon s := \frac{\gamma wt \cdot H}{\left(\frac{144 \cdot in^2}{ft^2} \right) \cdot Es} \qquad \varepsilon s = 3.597 \cdot \%$$

Pipe Deflection

$$DEFL := Df \cdot \varepsilon s \qquad DEFL = 4.676 \cdot \%$$ Not to exceed 7.5% for design.

Allowable Deflection, Eq. 9

$e := .05$

$fD := 4.28$ Deformaton factor for shape

Allowable Deflection=$\Delta Y / Dm$

$Dallow := \frac{e}{fD} \cdot (DR - 1)$ $Dallow = 11.682 \circ \%$

Constrained Buckling (Use Prism Load with VAF=1),Eq. 11

$Rh := 1$ Geometry Factor

$Cf := .8$ Construction Factor

$\phi := .55$ Calibration Factor

Pcr Pressure Critical - psi

$$Pcr := \frac{Cf \cdot \phi \cdot Rh \cdot EI^{\frac{1}{3}} \cdot \left(\frac{Es}{1 - \mu}\right)^{\frac{2}{3}}}{DR - 1}$$ $Pcr = 221.817 \circ psi$

$$SF := \frac{Pcr}{\left[\frac{\gamma wt \cdot H}{\left(\frac{144 \cdot in^2}{ft^2}\right)}\right]}$$ $SF = 3.931$ **Safety Factor against Buckling**

Rule of Thumb for Design $2 \le SF \le 4$

EVERGREEN PACKAGING
CANTON, NORTH CAROLINA
LANDFILL No. 6
AREA 6D-NORTH

Pipe Calculations
Pipe Strength in Deep Fill

Pipe Location: Detention Basin 4 Outlet Pipe
Pipe Size & Type: 24" dia. SDR 11 HDPE Corr Solid Pipe

DATE: 8/14/2013
FILE: 24SD_Deepfill.MCD

Project Parameters

Depth of Overburden $H := 64 \cdot ft$

Depth of Waste Over Pipe $D_{waste} := 0 \cdot ft$

Depth of Soil over Pipe $D_{soil} := 64 \cdot ft$

Depth of groundwater $Hgw := 0 \cdot ft$

Unit weight of waste $\gamma w := 80 \cdot \frac{lbf}{ft^3}$

Unit weight of soil $\gamma s := 125 \cdot \frac{lbf}{ft^3}$

Hyperbolic Parameter:

Modulus Number $k := 100$

Modulus Exponent $n := 0.4$
(for 90% Compaction)

Pipe Parameters:

Effective DR: $DR := 11$

Long term compressive yield streght $Sc := 1600 \cdot psi$

Outside Diameter $OD := 25.8 \cdot in$

Short Term Modulus: $Estm := 130000 \cdot psi$

Long Term Modulus: $El := 22000 \cdot psi$

Poisson Ratio of Soil: $\mu := .35$

Temperature Design Factor $f := 0.78$
(for 100 deg. F)

Overburden weight

Weighted soil/waste unit weight $\gamma wt := \gamma w \cdot \frac{D_{waste}}{H} + \gamma s \cdot \frac{D_{soil}}{H}$

$\gamma wt = 125 \cdot \frac{lbf}{ft^3}$

Pipe Dimensional Parameters

Pipe Wall Thickness $t := \frac{OD}{DR}$ $t = 2.345 \cdot in$

Mean Radius $r := \frac{OD - t}{2}$ $r = 11.727 \cdot in$

Long Term Compressive Yeild Strength due to Temperture

$Sct := Sc \cdot f$ $Sct = 1.248 \cdot 10^3 \cdot psi$

Constrained Modulus

$Ms := k \cdot 14.7 \cdot psi \cdot \left(\gamma wt \cdot \frac{H}{14.7 \cdot psi}\right)^n$ $Ms = 2.502 \cdot 10^3 \cdot psi$

Hoop Thrust Stiffness

$$Sa := \frac{1.43}{EI \cdot t} \cdot Ms \cdot r \qquad Sa = 0.813$$

Vertical Arching Factor, (Eq. 1 of "Guidelines for HDPE Pipes in Deep Fills")

$$VAF := .88 - .71 \cdot \left(\frac{Sa - 1}{Sa + 2.5} \right) \qquad VAF = 0.92$$

Radial Direct Earth Pressure, Eq. 3a for Deep Fills

$$Prd := VAF \cdot \gamma wt \cdot H \qquad Prd = 7.36 \cdot 10^3 \cdot \frac{lbf}{ft^2}$$

Ring Compressive Stress, Eq. 4 for Deep Fills

$$S := \frac{Prd \cdot DR}{\left[\frac{288 \cdot (in)^2}{ft^2} \right]} \qquad S = 281.124 \cdot psi \qquad N := \frac{Sct}{S} \qquad N = 4.439$$ Safety Factor

Watkins - Gaube Deflection

Secant Modulus, Eq. 6 $$Es := \frac{Ms \cdot (1 + \mu) \cdot (1 - 2 \cdot \mu)}{1 - \mu} \qquad Es = 1.559 \cdot 10^3 \cdot psi$$

Rigity, Eq. 5 $$Rf := \frac{12 \cdot Es \cdot (DR - 1)^3}{EI} \qquad Rf = 850.318$$

****Input Df factor from Figure 1 Guidlines for HDPE Pipe in Deep Fills****

Plexco

$$Df := 1.3$$

Soil Strain (Settlement of Fill Layer at pipe), Eq. 7

$$\varepsilon s := \frac{\gamma wt \cdot H}{\left(\frac{144 \cdot in^2}{ft^2} \right) \cdot Es} \qquad \varepsilon s = 3.564 \cdot \%$$

Pipe Deflection

$$DEFL := Df \cdot \varepsilon s \qquad DEFL = 4.633 \cdot \%$$ Not to exceed 7.5% for design.

Allowable Deflection, Eq. 9

$e := .05$

$fD := 4.28$ Deformaton factor for shape

Allowable Deflection=$\Delta Y / Dm$

$Dallow := \frac{e}{fD} \cdot (DR - 1)$ $Dallow = 11.682 \circ \%$

Constrained Buckling (Use Prism Load with VAF=1),Eq. 11

$Rh := 1$ Geometry Factor

$Cf := .8$ Construction Factor

$\phi := .55$ Calibration Factor

Pcr Pressure Critical - psi

$$Pcr := \frac{Cf \cdot \phi \cdot Rh \cdot EI^{\frac{1}{3}} \cdot \left(\frac{Es}{1 - \mu}\right)^{\frac{2}{3}}}{DR - 1}$$ $Pcr = 220.902 \circ psi$

$$SF := \frac{Pcr}{\left[\frac{\gamma wt \cdot H}{\left(\frac{144 \cdot in^2}{ft^2}\right)}\right]}$$ $SF = 3.976$ **Safety Factor against Buckling**

Rule of Thumb for Design $2 \le SF \le 4$

ATTACHMENT C-5

PUMP STATION DESIGN CALCULATION

Project No. 12121.03
Design By: BDP
Design Date: 7/13/2013
Checked By:_____
Checked Date:_____

LEACHATE PUMPING EVALUATION
AREAS 6D NORTH
EVERGREEN PACKAGING
CANTON, NORTH CAROLINA

OBJECTIVE

Evalute Leachate Level within Landfill Area 6D South during 10-year and 25-year storm events.

DESIGN ASSUMPTIONS

1. Area 6D South with 60 feet of waste with no cover.
2. Area 6D North with 10-feet of waste and no cover.
3. Area 6D South and North Sideslopes above waste is collected as leachate.
4. Baseflow is monthly average flow from HELP Model Analysis
5. See Attached Sketch for areas.

ANALYSIS

See Attached HydroCAD analysis.

CONCLUSION

Calculations indicate that landfill leachate peak elevation within 6D South is approximately elevation 440.5 and 444.5 during 10-year and 25-year 24-hour storm events and that it takes approximately 4.5 and 5.5 days of pumping respectively for leachate levels to return to the sump area.

Project No. 12121.03
Design By: BDP
Design Date: 7/13/2013
Checked By:_____
Checked Date:_____

LEACHATE PUMPING EVALUATION
AREAS 6D NORTH
EVERGREEN PACKAGING
CANTON, NORTH CAROLINA

OBJECTIVE

Evaluate performance of Area 6D South Leachate Pump Station after construction of Area 6D North.

DESIGN ASSUMPTIONS

1. Area 6D South with 60 feet of waste with no cover.
2. Area 6D North with 10-feet of waste and no cover.
3. Area 6D South and North Sideslopes above waste is collected as leachate.
4. See Attached HELP Model Results for leachate generation from each area noted above.
5. See Attached Sketch for contributing areas.

ANALYSIS

Description	Contributing Area[2]		Peak Daily Leachate Generation[1] (ft3/day/acre)
	(sf)	(acres)	
Area 6D South Sideslope with No Waste	51,988	1.19	12,449
Area 6D South with 60 feet of Waste	621,069	14.26	173
Area 6D North Sideslope with No Waste	206,796	4.75	12,449
Area 6D North with 10-feet of Waste	552,435	12.68	173

Description	Contributing Area[2]		Peak Daily Leachate Generation[1] (ft3/day)
	(sf)	(acres)	
Area 6D South Sideslope with No Waste	51,988	1.19	1,238
Area 6D South with 60 feet of Waste	621,069	14.26	2,465
Area 6D North Sideslope with No Waste	206,796	4.75	59,100
Area 6D North with 10-feet of Waste	552,435	12.68	2,192
Total (ft3/day)	NA	NA	64,995
Total (gal/day)	NA	NA	486,164
Total (CFM)	NA	NA	45
Total (gpm)	NA	NA	338

CONCLUSION

Calculations indicate that peak daily leachate generation of 338 gpm may be conveyed by the existing leacahte pumping system which was designed to convey 258 gpm with a single pump running and 345 gpm with both pumps running.

Notes:

1. Peak Daily Leachate Generation in cubic feet per day determined by HELP Model Analysis.

```
******************************************************************************
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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      C:\HELP\BRPP\PRECIP.D4
TEMPERATURE DATA FILE:        C:\HELP\BRPP\TEMP.D7
SOLAR RADIATION DATA FILE:    C:\HELP\BRPP\SOLARRAD.D13
EVAPOTRANSPIRATION DATA:      C:\HELP\BRPP\EVAPO.D11
SOIL AND DESIGN DATA FILE:    C:\HELP\BRPP\SSLOPE.D10
OUTPUT DATA FILE:             C:\HELP\BRPP\SSLOPE.OUT


TIME:   8:43     DATE:   7/11/2013


******************************************************************************

     TITLE:  EVERGREEN - LANDFILL 6D NORTH - NO CAP NO WASTE ON SIDE

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                        TYPE 2 - LATERAL DRAINAGE LAYER
                          MATERIAL TEXTURE NUMBER  21
          THICKNESS                  =     12.00   INCHES
          POROSITY                   =      0.3970 VOL/VOL
          FIELD CAPACITY             =      0.0320 VOL/VOL
          WILTING POINT              =      0.0130 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.1345 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.300000012000      CM/SEC
          SLOPE                      =     50.00   PERCENT
          DRAINAGE LENGTH            =    300.0    FEET
```

LAYER 2

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	1.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 3

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	60.00	INCHES
POROSITY	=	0.4710	VOL/VOL
FIELD CAPACITY	=	0.3420	VOL/VOL
WILTING POINT	=	0.2100	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4710	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.499999987000E-04	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	90.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	1.486	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.176	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.104	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	29.874	INCHES
TOTAL INITIAL WATER	=	29.874	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
ASHEVILLE NORTH CAROLINA

STATION LATITUDE	=	35.26	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	96	
END OF GROWING SEASON (JULIAN DATE)	=	298	
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.60	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	71.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	75.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	84.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	77.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ASHEVILLE NORTH CAROLINA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.48	3.60	5.13	3.84	4.19	4.20
4.43	4.79	3.96	3.29	3.29	3.51

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ASHEVILLE NORTH CAROLINA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
36.80	39.10	46.40	55.70	63.30	69.80
73.20	72.60	66.90	56.00	46.40	39.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ASHEVILLE NORTH CAROLINA
AND STATION LATITUDE = 35.26 DEGREES

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.68	4.02	4.98	4.24	4.31	4.45
	4.17	4.78	3.51	3.46	3.04	3.57
STD. DEVIATIONS	1.72	1.77	2.33	2.09	1.94	1.86
	1.56	2.33	1.92	1.94	1.79	1.83
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	1.003	1.113	1.748	1.812	1.902	2.038
	2.096	1.854	1.173	1.035	0.882	0.805
STD. DEVIATIONS	0.306	0.340	0.497	0.641	0.606	0.673
	0.674	0.615	0.524	0.418	0.303	0.193
LATERAL DRAINAGE COLLECTED FROM LAYER 1						
TOTALS	2.6131	3.1332	3.3377	2.4480	2.4358	2.4316
	2.0008	2.9853	2.2801	2.3931	2.2095	2.4674
STD. DEVIATIONS	1.6298	1.9856	2.0908	1.6545	1.5966	1.4513
	1.0746	1.9082	1.5843	1.6414	1.6501	1.6579
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
STD. DEVIATIONS	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 2						
AVERAGES	0.0425	0.0574	0.0552	0.0414	0.0406	0.0419
	0.0326	0.0495	0.0395	0.0392	0.0376	0.0395
STD. DEVIATIONS	0.0274	0.0384	0.0352	0.0283	0.0270	0.0251
	0.0178	0.0320	0.0277	0.0273	0.0285	0.0275

****

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	INCHES		CU. FEET	PERCENT
PRECIPITATION	48.18	(6.129)	174911.2	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	17.462	(1.8237)	63385.87	36.239
LATERAL DRAINAGE COLLECTED FROM LAYER 1	30.73569	(5.32824)	111570.555	63.78697
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.00135	(0.00022)	4.912	0.00281
AVERAGE HEAD ON TOP OF LAYER 2	0.043	(0.008)		
CHANGE IN WATER STORAGE	-0.014	(1.0450)	-50.16	-0.029

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(INCHES)	(CU. FT.)
PRECIPITATION	5.05	18331.500
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 1	3.42964	12449.57910
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.000117	0.42583
AVERAGE HEAD ON TOP OF LAYER 2	2.234	
MAXIMUM HEAD ON TOP OF LAYER 2	2.992	
LOCATION OF MAXIMUM HEAD IN LAYER 1 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	7.42	26939.1777

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3970
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0130

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(INCHES)	(VOL/VOL)
1	0.2320	0.0193
2	0.0000	0.0000
3	28.2600	0.4710
SNOW WATER	0.000	

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**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
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PRECIPITATION DATA FILE:      C:\HELP\BRPP\PRECIP.D4
TEMPERATURE DATA FILE:        C:\HELP\BRPP\TEMP.D7
SOLAR RADIATION DATA FILE:    C:\HELP\BRPP\SOLARRAD.D13
EVAPOTRANSPIRATION DATA:      C:\HELP\BRPP\EVAPO.D11
SOIL AND DESIGN DATA FILE:    C:\HELP\BRPP\60-WASTE.D10
OUTPUT DATA FILE:             C:\HELP\BRPP\60-WASTE.OUT


TIME:   8:12     DATE:   7/11/2013


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     TITLE:  EVERGREEN - LANDFILL 6D SOUTH - 60-FEET OF WASTE ON BASE

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   0
          THICKNESS                  =    720.00   INCHES
          POROSITY                   =      0.4000 VOL/VOL
          FIELD CAPACITY             =      0.3600 VOL/VOL
          WILTING POINT              =      0.2800 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.3690 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.139999997000E-05 CM/SEC


                                  LAYER  2
                                  --------

                     TYPE 2 - LATERAL DRAINAGE LAYER
                       MATERIAL TEXTURE NUMBER  21
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THICKNESS	=	15.00	INCHES
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0320	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	8.00	PERCENT
DRAINAGE LENGTH	=	200.0	FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	1.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.24	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7470	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.499999997000E-08	CM/SEC

LAYER 5

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	60.00	INCHES
POROSITY	=	0.4710	VOL/VOL
FIELD CAPACITY	=	0.3420	VOL/VOL
WILTING POINT	=	0.2100	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4710	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.499999987000E-04	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	90.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	3.165	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.200	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.240	INCHES
INITIAL SNOW WATER	=	4.719	INCHES
INITIAL WATER IN LAYER MATERIALS	=	294.589	INCHES
TOTAL INITIAL WATER	=	299.308	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
ASHEVILLE NORTH CAROLINA

STATION LATITUDE	=	35.26	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	96	
END OF GROWING SEASON (JULIAN DATE)	=	298	
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.60	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	71.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	75.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	84.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	77.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ASHEVILLE NORTH CAROLINA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.48	3.60	5.13	3.84	4.19	4.20
4.43	4.79	3.96	3.29	3.29	3.51

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ASHEVILLE NORTH CAROLINA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
36.80	39.10	46.40	55.70	63.30	69.80
73.20	72.60	66.90	56.00	46.40	39.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ASHEVILLE NORTH CAROLINA

AND STATION LATITUDE = 35.26 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.68	4.02	4.98	4.24	4.31	4.45
	4.17	4.78	3.51	3.46	3.04	3.57
STD. DEVIATIONS	1.72	1.77	2.33	2.09	1.94	1.86
	1.56	2.33	1.92	1.94	1.79	1.83
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.732	0.868	1.936	2.592	3.441	3.838
	3.681	3.293	2.412	1.724	0.981	0.600
STD. DEVIATIONS	0.405	0.565	1.270	2.013	2.726	3.030
	2.908	2.605	1.907	1.371	0.694	0.344
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	0.9692	0.9027	0.8988	0.8491	0.9470	0.9725
	1.0355	1.0543	1.0980	1.1560	1.1318	1.0825
STD. DEVIATIONS	0.4892	0.4242	0.4604	0.4768	0.4516	0.3700
	0.3245	0.2976	0.2617	0.2650	0.2912	0.4565
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	0.0462	0.0473	0.0429	0.0419	0.0452	0.0480
	0.0494	0.0503	0.0541	0.0552	0.0558	0.0517
STD. DEVIATIONS	0.0233	0.0222	0.0220	0.0235	0.0215	0.0182
	0.0155	0.0142	0.0129	0.0126	0.0144	0.0218

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	INCHES		CU. FEET	PERCENT
PRECIPITATION	48.18	(6.129)	174911.2	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	26.098	(18.1350)	94735.95	54.162
LATERAL DRAINAGE COLLECTED FROM LAYER 2	12.09738	(3.39591)	43913.473	25.10615
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.00001	(0.00000)	0.018	0.00001
AVERAGE HEAD ON TOP OF LAYER 3	0.049	(0.014)		
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00001	(0.00000)	0.018	0.00001
AVERAGE HEAD ON TOP OF LAYER 5	0.000	(0.000)		
CHANGE IN WATER STORAGE	9.945	(19.1781)	36099.04	20.638

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(INCHES)	(CU. FT.)
PRECIPITATION	5.05	18331.500
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 2	0.04762	172.86519
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.000000	0.00006
AVERAGE HEAD ON TOP OF LAYER 3	0.070	
MAXIMUM HEAD ON TOP OF LAYER 3	0.139	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	2.1 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00006
AVERAGE HEAD ON TOP OF LAYER 5	0.000	
SNOW WATER	990.23	3594550.7500

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4000
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2800

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(INCHES)	(VOL/VOL)
1	286.5479	0.3980
2	0.5057	0.0337
3	0.0000	0.0000
4	0.1793	0.7470
5	28.2600	0.4710
SNOW WATER	978.279	

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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PRECIPITATION DATA FILE:      C:\HELP\BRPP\PRECIP.D4
TEMPERATURE DATA FILE:        C:\HELP\BRPP\TEMP.D7
SOLAR RADIATION DATA FILE:    C:\HELP\BRPP\SOLARRAD.D13
EVAPOTRANSPIRATION DATA:      C:\HELP\BRPP\EVAPO.D11
SOIL AND DESIGN DATA FILE:    C:\HELP\BRPP\10-WASTE.D10
OUTPUT DATA FILE:             C:\HELP\BRPP\10-WASTE.OUT


TIME:   8:22      DATE:   7/11/2013


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     TITLE:  EVERGREEN - LANDFILL 6D SOUTH - 10-FEET OF WASTE ON BASE

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     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                  LAYER  1
                                  --------

                       TYPE 1 - VERTICAL PERCOLATION LAYER
                           MATERIAL TEXTURE NUMBER   0
          THICKNESS                    =    120.00   INCHES
          POROSITY                     =      0.4000 VOL/VOL
          FIELD CAPACITY               =      0.3600 VOL/VOL
          WILTING POINT                =      0.2800 VOL/VOL
          INITIAL SOIL WATER CONTENT   =      0.3931 VOL/VOL
          EFFECTIVE SAT. HYD. COND.    =  0.139999997000E-05 CM/SEC


                                  LAYER  2
                                  --------

                       TYPE 2 - LATERAL DRAINAGE LAYER
                           MATERIAL TEXTURE NUMBER  21
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THICKNESS	=	15.00	INCHES
POROSITY	=	0.3970	VOL/VOL
FIELD CAPACITY	=	0.0320	VOL/VOL
WILTING POINT	=	0.0130	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0326	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.300000012000	CM/SEC
SLOPE	=	8.00	PERCENT
DRAINAGE LENGTH	=	200.0	FEET

LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
POROSITY	=	0.0000	VOL/VOL
FIELD CAPACITY	=	0.0000	VOL/VOL
WILTING POINT	=	0.0000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0000	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.199999996000E-12	CM/SEC
FML PINHOLE DENSITY	=	1.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3 - GOOD	

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.24	INCHES
POROSITY	=	0.7500	VOL/VOL
FIELD CAPACITY	=	0.7470	VOL/VOL
WILTING POINT	=	0.4000	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.7470	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.499999997000E-08	CM/SEC

LAYER 5

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	60.00	INCHES
POROSITY	=	0.4710	VOL/VOL
FIELD CAPACITY	=	0.3420	VOL/VOL
WILTING POINT	=	0.2100	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4710	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.499999987000E-04	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS USER-SPECIFIED.

SCS RUNOFF CURVE NUMBER	=	90.00	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	3.165	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	3.200	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.240	INCHES
INITIAL SNOW WATER	=	4.719	INCHES
INITIAL WATER IN LAYER MATERIALS	=	76.103	INCHES
TOTAL INITIAL WATER	=	80.822	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
ASHEVILLE NORTH CAROLINA

STATION LATITUDE	=	35.26	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	96	
END OF GROWING SEASON (JULIAN DATE)	=	298	
EVAPORATIVE ZONE DEPTH	=	8.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.60	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	71.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	75.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	84.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	77.00	%

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ASHEVILLE NORTH CAROLINA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
3.48	3.60	5.13	3.84	4.19	4.20
4.43	4.79	3.96	3.29	3.29	3.51

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ASHEVILLE NORTH CAROLINA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
36.80	39.10	46.40	55.70	63.30	69.80
73.20	72.60	66.90	56.00	46.40	39.30

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ASHEVILLE NORTH CAROLINA

AND STATION LATITUDE = 35.26 DEGREES

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 100

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.68	4.02	4.98	4.24	4.31	4.45
	4.17	4.78	3.51	3.46	3.04	3.57
STD. DEVIATIONS	1.72	1.77	2.33	2.09	1.94	1.86
	1.56	2.33	1.92	1.94	1.79	1.83
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION						
TOTALS	0.732	0.868	1.936	2.592	3.441	3.838
	3.681	3.293	2.412	1.724	0.981	0.600
STD. DEVIATIONS	0.405	0.565	1.270	2.013	2.726	3.030
	2.908	2.605	1.907	1.371	0.694	0.344
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	0.8626	0.8264	0.9242	1.0320	1.1709	1.0981
	1.1049	1.1007	1.1067	1.0932	1.0372	0.9524
STD. DEVIATIONS	0.3833	0.2972	0.3618	0.3379	0.3781	0.4274
	0.4739	0.4835	0.4190	0.4859	0.4815	0.4788
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	0.0412	0.0433	0.0441	0.0509	0.0559	0.0541
	0.0527	0.0525	0.0546	0.0522	0.0511	0.0455
STD. DEVIATIONS	0.0183	0.0156	0.0173	0.0167	0.0180	0.0211
	0.0226	0.0231	0.0207	0.0232	0.0237	0.0228

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 100

	INCHES		CU. FEET	PERCENT
PRECIPITATION	48.18	(6.129)	174911.2	100.00
RUNOFF	0.000	(0.0000)	0.00	0.000
EVAPOTRANSPIRATION	26.098	(18.1350)	94735.95	54.162
LATERAL DRAINAGE COLLECTED FROM LAYER 2	12.30939	(3.77863)	44683.090	25.54616
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.00001	(0.00000)	0.019	0.00001
AVERAGE HEAD ON TOP OF LAYER 3	0.050	(0.015)		
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00001	(0.00000)	0.019	0.00001
AVERAGE HEAD ON TOP OF LAYER 5	0.000	(0.000)		
CHANGE IN WATER STORAGE	9.733	(21.9648)	35329.56	20.199

****

****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 100

	(INCHES)	(CU. FT.)
PRECIPITATION	5.05	18331.500
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 2	0.04762	172.86519
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.000000	0.00006
AVERAGE HEAD ON TOP OF LAYER 3	0.070	
MAXIMUM HEAD ON TOP OF LAYER 3	0.139	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	2.1 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00006
AVERAGE HEAD ON TOP OF LAYER 5	0.000	
SNOW WATER	990.23	3594550.7500

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4000
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2800

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

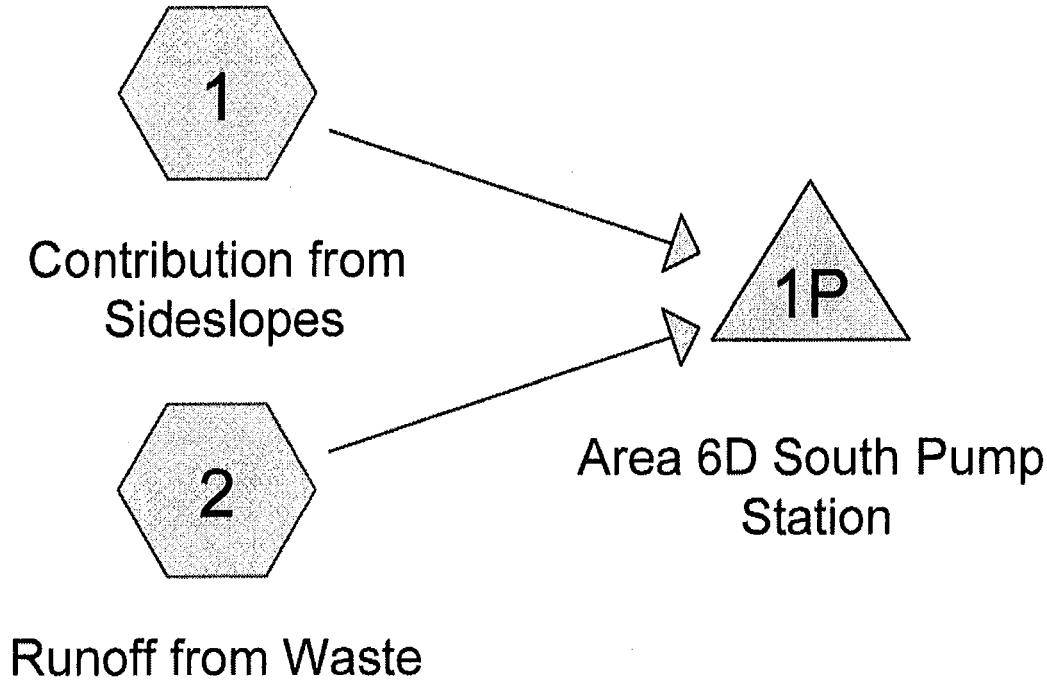
****

****

FINAL WATER STORAGE AT END OF YEAR 100

LAYER	(INCHES)	(VOL/VOL)
1	46.8727	0.3906
2	0.4975	0.0332
3	0.0000	0.0000
4	0.1793	0.7470
5	28.2600	0.4710
SNOW WATER	978.279	

****
****



Routing Diagram for pump station
Prepared by Sevee & Maher Engineers, Inc., Printed 7/26/2013
HydroCAD® 10.00 s/n 01260 © 2012 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
5.940	98	geomembrane (1)
26.940	65	waste (2)
32.880	**71**	**TOTAL AREA**

Time span=0.00-150.00 hrs, dt=0.02 hrs, 7501 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1: Contribution from Runoff Area=5.940 ac 100.00% Impervious Runoff Depth=4.96"
Flow Length=180' Slope=0.5000 '/' Tc=10.6 min CN=98 Runoff=37.99 cfs 2.457 af

Subcatchment2: Runoff from Waste Runoff Area=26.940 ac 0.00% Impervious Runoff Depth=1.79"
Flow Length=420' Slope=0.0500 '/' Tc=17.2 min CN=65 Runoff=56.15 cfs 4.014 af

Pond 1P: Area 6D South Pump Station Peak Elev=2,640.32' Storage=235,247 cf Inflow=86.67 cfs 7.215 af
Outflow=0.77 cfs 7.183 af

Total Runoff Area = 32.880 ac Runoff Volume = 6.471 af Average Runoff Depth = 2.36"
81.93% Pervious = 26.940 ac 18.07% Impervious = 5.940 ac

Summary for Subcatchment 1: Contribution from Sideslopes

Runoff = 37.99 cfs @ 12.02 hrs, Volume= 2.457 af, Depth= 4.96"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-150.00 hrs, dt= 0.02 hrs
Type II 24-hr 10-year Rainfall=5.20"

	Area (ac)	CN	Description
*	5.940	98	geomembrane
	5.940		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	180	0.5000	4.96		**Sheet Flow, sheet** Smooth surfaces n= 0.011 P2= 2.50"
10.0					**Direct Entry, flow in stone**
10.6	180	Total			

Summary for Subcatchment 2: Runoff from Waste

Runoff = 56.15 cfs @ 12.11 hrs, Volume= 4.014 af, Depth= 1.79"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-150.00 hrs, dt= 0.02 hrs
Type II 24-hr 10-year Rainfall=5.20"

	Area (ac)	CN	Description
*	26.940	65	waste
	26.940		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.6	200	0.0500	0.60		**Sheet Flow, sheet flow** Fallow n= 0.050 P2= 2.50"
1.6	220	0.0500	2.24		**Shallow Concentrated Flow, shallow conc** Nearly Bare & Untilled Kv= 10.0 fps
10.0					**Direct Entry, flow in stone**
17.2	420	Total			

Summary for Pond 1P: Area 6D South Pump Station

Inflow Area = 32.880 ac, 18.07% Impervious, Inflow Depth > 2.63" for 10-year event
Inflow = 86.67 cfs @ 12.06 hrs, Volume= 7.215 af, Incl. 0.06 cfs Base Flow
Outflow = 0.77 cfs @ 11.36 hrs, Volume= 7.183 af, Atten= 99%, Lag= 0.0 min
Primary = 0.77 cfs @ 11.36 hrs, Volume= 7.183 af

Routing by Stor-Ind method, Time Span= 0.00-150.00 hrs, dt= 0.02 hrs
Peak Elev= 2,640.32' @ 24.22 hrs Surf.Area= 227,020 sf Storage= 235,247 cf

Plug-Flow detention time= 2,580.0 min calculated for 7.182 af (100% of inflow)
Center-of-Mass det. time= 2,546.6 min (3,746.7 - 1,200.1)

Volume	Invert	Avail.Storage	Storage Description
#1	2,613.00'	257,082 cf	**Stone Sump (Prismatic)** Listed below (Recalc) 4,170,739 cf Overall - 3,528,033 cf Embedded = 642,706 cf x 40.0% Voids
#2	2,620.00'	176,402 cf	**Waste (Prismatic)** Listed below (Recalc) Inside #1 3,528,033 cf Overall x 5.0% Voids
		433,484 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
2,613.00	2,568	0	0
2,614.17	3,225	3,389	3,389
2,617.00	5,250	11,992	15,381
2,618.25	12,215	10,916	26,297
2,620.00	25,700	33,176	59,472
2,622.00	42,160	67,860	127,332
2,622.75	45,817	32,991	160,324
2,624.75	64,025	109,842	270,166
2,626.75	81,063	145,088	415,254
2,628.75	99,000	180,063	595,317
2,630.75	117,813	216,813	812,130
2,632.75	138,379	256,192	1,068,322
2,634.75	161,213	299,592	1,367,914
2,636.75	183,378	344,591	1,712,505
2,640.75	232,310	831,376	2,543,881
2,642.75	258,320	490,630	3,034,511
2,644.75	283,894	542,214	3,576,725
2,646.75	310,120	594,014	4,170,739

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
2,620.00	10,000	0	0
2,624.00	45,817	111,634	111,634
2,626.00	64,025	109,842	221,476
2,628.00	81,063	145,088	366,564
2,630.00	99,000	180,063	546,627
2,632.00	117,813	216,813	763,440
2,634.00	138,378	256,191	1,019,631
2,636.00	161,213	299,591	1,319,222
2,638.00	183,378	344,591	1,663,813
2,642.00	232,310	831,376	2,495,189
2,644.00	258,320	490,630	2,985,819
2,646.00	283,894	542,214	3,528,033

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**Sump Pump** Elev. (feet) 0.00 2,614.17 2,614.18 2,617.00 2,618.24 2,618.25 2,650.00 Disch. (cfs) 0.000 0.000 0.575 0.575 0.575 0.769 0.769

Primary OutFlow Max=0.77 cfs @ 11.36 hrs HW=2,618.28' (Free Discharge)
└─**1=Sump Pump** (Custom Controls 0.77 cfs)

Time span=0.00-150.00 hrs, dt=0.02 hrs, 7501 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1: Contribution from Runoff Area=5.940 ac 100.00% Impervious Runoff Depth=5.86"
Flow Length=180' Slope=0.5000 '/' Tc=10.6 min CN=98 Runoff=44.62 cfs 2.902 af

Subcatchment2: Runoff from Waste Runoff Area=26.940 ac 0.00% Impervious Runoff Depth=2.42"
Flow Length=420' Slope=0.0500 '/' Tc=17.2 min CN=65 Runoff=77.61 cfs 5.443 af

Pond 1P: Area 6D South Pump Station Peak Elev=2,644.68' Storage=315,169 cf Inflow=113.51 cfs 9.088 af
Outflow=0.77 cfs 9.057 af

Total Runoff Area = 32.880 ac Runoff Volume = 8.344 af Average Runoff Depth = 3.05"
81.93% Pervious = 26.940 ac 18.07% Impervious = 5.940 ac

Summary for Subcatchment 1: Contribution from Sideslopes

Runoff = 44.62 cfs @ 12.02 hrs, Volume= 2.902 af, Depth= 5.86"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-150.00 hrs, dt= 0.02 hrs
Type II 24-hr 25-year Rainfall=6.10"

	Area (ac)	CN	Description
*	5.940	98	geomembrane
	5.940		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	180	0.5000	4.96		**Sheet Flow, sheet** Smooth surfaces n= 0.011 P2= 2.50"
10.0					**Direct Entry, flow in stone**
10.6	180	Total			

Summary for Subcatchment 2: Runoff from Waste

Runoff = 77.61 cfs @ 12.10 hrs, Volume= 5.443 af, Depth= 2.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-150.00 hrs, dt= 0.02 hrs
Type II 24-hr 25-year Rainfall=6.10"

	Area (ac)	CN	Description
*	26.940	65	waste
	26.940		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.6	200	0.0500	0.60		**Sheet Flow, sheet flow** Fallow n= 0.050 P2= 2.50"
1.6	220	0.0500	2.24		**Shallow Concentrated Flow, shallow conc** Nearly Bare & Untilled Kv= 10.0 fps
10.0					**Direct Entry, flow in stone**
17.2	420	Total			

Summary for Pond 1P: Area 6D South Pump Station

Inflow Area = 32.880 ac, 18.07% Impervious, Inflow Depth > 3.32" for 25-year event
Inflow = 113.51 cfs @ 12.06 hrs, Volume= 9.088 af, Incl. 0.06 cfs Base Flow
Outflow = 0.77 cfs @ 10.88 hrs, Volume= 9.057 af, Atten= 99%, Lag= 0.0 min
Primary = 0.77 cfs @ 10.88 hrs, Volume= 9.057 af

Routing by Stor-Ind method, Time Span= 0.00-150.00 hrs, dt= 0.02 hrs
Peak Elev= 2,644.68' @ 24.25 hrs Surf.Area= 282,977 sf Storage= 315,169 cf

Plug-Flow detention time= 3,482.0 min calculated for 9.057 af (100% of inflow)
Center-of-Mass det. time= 3,455.4 min (4,574.4 - 1,119.0)

Volume	Invert	Avail.Storage	Storage Description
#1	2,613.00'	257,082 cf	**Stone Sump (Prismatic)** Listed below (Recalc) 4,170,739 cf Overall - 3,528,033 cf Embedded = 642,706 cf x 40.0% Voids
#2	2,620.00'	176,402 cf	**Waste (Prismatic)** Listed below (Recalc) Inside #1 3,528,033 cf Overall x 5.0% Voids
		433,484 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
2,613.00	2,568	0	0
2,614.17	3,225	3,389	3,389
2,617.00	5,250	11,992	15,381
2,618.25	12,215	10,916	26,297
2,620.00	25,700	33,176	59,472
2,622.00	42,160	67,860	127,332
2,622.75	45,817	32,991	160,324
2,624.75	64,025	109,842	270,166
2,626.75	81,063	145,088	415,254
2,628.75	99,000	180,063	595,317
2,630.75	117,813	216,813	812,130
2,632.75	138,379	256,192	1,068,322
2,634.75	161,213	299,592	1,367,914
2,636.75	183,378	344,591	1,712,505
2,640.75	232,310	831,376	2,543,881
2,642.75	258,320	490,630	3,034,511
2,644.75	283,894	542,214	3,576,725
2,646.75	310,120	594,014	4,170,739

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
2,620.00	10,000	0	0
2,624.00	45,817	111,634	111,634
2,626.00	64,025	109,842	221,476
2,628.00	81,063	145,088	366,564
2,630.00	99,000	180,063	546,627
2,632.00	117,813	216,813	763,440
2,634.00	138,378	256,191	1,019,631
2,636.00	161,213	299,591	1,319,222
2,638.00	183,378	344,591	1,663,813
2,642.00	232,310	831,376	2,495,189
2,644.00	258,320	490,630	2,985,819
2,646.00	283,894	542,214	3,528,033

Device	Routing	Invert	Outlet Devices
#1	Primary	0.00'	**Sump Pump** Elev. (feet) 0.00 2,614.17 2,614.18 2,617.00 2,618.24 2,618.25 2,650.00 Disch. (cfs) 0.000 0.000 0.575 0.575 0.575 0.769 0.769

Primary OutFlow Max=0.77 cfs @ 10.88 hrs HW=2,618.28' (Free Discharge)
└─**1=Sump Pump** (Custom Controls 0.77 cfs)

ATTACHMENT D

TECHNICAL SPECIFICATIONS AND QUALITY ASSURANCE/ QUALITY CONTROL PLAN

TECHNICAL SPECIFICATIONS AND QUALITY ASSURANCE/QUALITY CONTROL PLAN FOR LANDFILL NO. 6 AREA D NORTH CANTON, NORTH CAROLINA

Prepared for

EVERGREEN PACKAGING
CANTON, NORTH CAROLINA

August 2013

SME
Sevee & Maher Engineers, Inc.

ENVIRONMENTAL • CIVIL • GEOTECHNICAL • WATER • COMPLIANCE

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NORTH CAROLINA PROFESSIONAL SEAL 037702 ENGINEER GUY H. COTE, JR.

8/15/13

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SECTION 00 73 19 - HEALTH AND SAFETY REQUIREMENTS

PART 1 GENERAL INFORMATION

1.1 SUMMARY

A. Section Includes: This work shall consist of preparation of a Health and Safety Plan, submittal of the Health and Safety Plan to the Owner prior to the commencement of construction, and statement of safe working procedures.

B. Related Sections: All work specified in this Contract applies to the work specified under this section.

PART 2 EXECUTION

2.1 HEALTH AND SAFETY PLAN (HASP) REQUIREMENTS

A. While Landfill No. 6 is not a hazardous waste facility, the HASP shall conform to guidance contained in "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities" NIOSH/OSHA/USCG/EPA, October 1985 and 29 CFR 1910 (FR March 6, 1989).

B. The HASP will include, but not be limited to, the following:
   1. Identification of potential hazards.
   2. Identification of a Health and Safety Officer.
   3. Identification of the support zone, decontamination zone, and exclusion zone at the site.
   4. Air monitoring activities.
   5. Medical surveillance records.
   6. Personnel protective equipment requirements.
   7. Emergency and contingency planning.

2.2 SUBMITTALS

A. Contractor shall submit a Health and Safety Plan to the Owner.

B. WORK PROCEDURES

C. All work involving excavation below grade or otherwise involving a risk of worker exposure to gases, supernatant, or solid waste shall be performed with applicable Occupational Safety and Health Administration (OSHA) regulations, U.S.EPA Health and Safety Regulations, Operations and Maintenance Manual, and the Contractor's site Health and Safety Plan.

D. The Contractor shall follow Mill rules, including the completion of all necessary Evergreen Packaging training by all employees and subcontractors prior to admittance to the site.

PART 3 PRODUCTS – Not Used

END OF SECTION

SECTION 01 11 00 – SUMMARY OF WORK

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Project/Work Identification.
2. Contract description.
3. Definitions.
4. Project Conditions.
5. Submittals Required with Proposal.
6. Project Schedule.
7. Contractor's Submittal.
8. Weekly Review, Updating and Projections.
9. Safety.
10. Weekly Meeting.
11. Accident Reports.
12. Job Site Communications.
13. Notification of Potential Extras.
14. Record Drawings.
15. Definition of Payment Items.
16. Undefined and Contractual Costs.
17. Measurements.
18. Method of Measurement.
19. Owner-furnished products.
20. Contractor's use of Site.
21. Work sequence.
22. Owner occupancy.
23. Specification conventions.

1.2 PROJECT/WORK IDENTIFICATION

Project Title:	Landfill No. 6 Amendment Area D North
Owner:	Evergreen Packaging Co.
Design Engineer:	Sevee & Maher Engineers, Inc. Cumberland Center, Maine

1.3 PROJECT DESCRIPTION

The intent of this project is to construct the Landfill No. 6 Amendment Area 6D-North as described in the Contract drawings and Specifications attached herein.

Work shall include furnishing all materials, labor and supervision, and performing all operations required to complete the work as shown on the Drawings and as described in the specifications contained herein, and as

evidently necessary to complete the work. Work shall also include, but not be limited to, the following items:

- Construction and maintenance of necessary erosion control mechanisms shown on the Contract Drawings and installation of erosion control measures in accordance with the "North Carolina Erosion and Sediment Control Planning and Design Manual" and the "North Carolina Erosion (2007) and Sediment control Field Manual (1991)". The erosion control measures will primarily include, but not be limited to, siltation fencing, stone check dams, sediment traps, hay bales, temporary seeding, erosion control matting, and the use of hay mulch.

- Clearing, stumping, and grubbing, as required. Grubbings shall be stockpiled at a location designated by the Owner.

- Construction layout using coordinates and elevations provided on the Contract Drawings.

- Base grading of Landfill No. 6 Amendment Area 6D-North to one foot below the grades shown on the Contract Drawings. The excavation material will be used for fill and the screened soil bedding layer beneath geomembrane liner. Base grading will include the construction of perimeter ditches, access road subgrade, and detention ponds. The Contractor shall be responsible for the maintenance and construction of a soil stockpile for the excess excavation and tailing from screening, including traffic control, construction entrance, and erosion and sediment control. At the completion of the project the stockpile area shall be seeded and mulch.

- Installation of Landfill No. 6 Amendment Area 6D-North screened bedding layer as shown in the Contract Drawings. The Contractor shall screen the excavated soils to construct this layer. The Contractor shall be responsible for screening soils that will meet the required 20 percent passing the No. 200 U.S. Standard sieve.

- Installation of common borrow fill soils as shown on the Construction Drawings. Fill shall be placed according to contract specifications with regards to density and moisture content.

- Installation of the leachate collection system in accordance with the Contact Drawings and specifications, including geosynthetic clay liner, 60-mil textured HDPE primary geomembrane, 16-oz/sy non-woven geotextile, piping, pipe fittings, and stone. The Owner will be responsible for supplying and delivering the stone to the site. The Contractor shall be responsible for placing the stone. The owner will be responsible for supplying the geomembrane, geosynthetic clay liner, and 16 oz/sy non-woven geotextile. The contractor shall be responsible for unloading, storing, and installation of the geosynthetics.

- Construction of storm drains, culverts, inlet structures, inlet structure, or sediment trap, and culvert inlet and outlet protection, as shown on Drawings.

- Soils and aggregate QA/QC laboratory testing. The Contractor shall be responsible for contracting with a North Carolina State approved construction materials testing laboratory to test the common borrow, 1-inch minus bedding soil, #78 stone, #5 stone, #57 stone, and ABC gravel. The Engineer shall be responsible for field density testing.

- Maintenance of erosion control and BMP devices.

- Traffic control and signage.
- Maintenance of haul roads.
- Construction of roads, including excavation, subgrade, and gravel as shown on the Contract Drawings.
- Maintain on-site soil stockpiles, including grading, erosion control, seeding, and mulching of on-site soil stockpiles. Maintain access to on-site stockpiles including gravel and culvert installation as required.
- Construction of riprap stabilization areas to include the south dike of Area 6D-North, as shown on the Contract Drawings.
- Dust control as specified in the Contract Documents.
- Seeding, fertilizing, and mulching all disturbed areas in accordance with the Contract Drawings and seeding specifications contained herein.
- Contractor shall be responsible for maintaining on-site haul roads. Maintenance shall include grading and dust control.
- Rock removal as required to meet the base grades shown on the Contract Documents. Rock shall be used as embankment material where possible. Rock shall be used in the riprap stabilization area at the south end of Area 6D-North.
- Construction of underdrain system.
- Complete as-built survey.

1.4 DEFINITIONS:

A. Contract: The written agreement between the Owner and the Contractor setting forth the obligations of the parties thereunder, including, but not limited to, the performance of the work, the furnishing of labor and materials, and the basis of payment.

The contract includes the proposal, contract form and contract bonds, specifications, supplemental specifications, special provisions, general and detailed plans and notice to proceed, also any change orders and agreements that are required to complete the construction of the work in an acceptable manner, including authorized extensions thereof, all of which constitute one instrument.

A contract may include any part of a project or one or more projects.

B. Contract Documents: The contract includes the technical specification documents contained herein, the contract form, the Safety and Conduct Requirements, the General and Special Conditions, bid schedule, the drawings, and the addenda issued in the execution of the described work.

C. Information Precedence: In the event that any technical information presented herein conflicts with other such information, the information on the drawings will take precedence. Once such an

item is found, it is the Contractor's responsibility to report said conflict to the Construction Manager.

D. Bidder: An individual, firm, or corporation submitting a bid for the advertised work.

E. Contractor: The individual, firm, or corporation contracting with the Owner for performance of prescribed work.

F. Indicated: The term "Indicated" is a cross-reference to graphic representation, notes, or schedules on drawings, to other paragraphs or schedules in the specifications, and to similar means of recording requirements in the contract documents. Where terms such as "shown," "noted", "scheduled", and "specified" are used in lieu of "indicated", it is for purposes of helping reader locate cross-reference, and no limitation of location is intended except as specifically noted.

G. Furnish: Except as otherwise defined in greater detail, term "furnish" is used to mean supply and deliver to project site, ready for unloading, unpacking, assembly, installation, etc., as applicable to each instance.

H. Install: Except as otherwise defined in greater detail, term "install" is used to describe operations at project site, including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations, as applicable in each instance.

I. Provide: Except as otherwise defined in greater detail, term "provide" means furnish and install, complete and ready for intended use, as applicable in each instance.

1.5 PROJECT CONDITIONS:

A. Permits: All the necessary permits for this project have been filed for from the appropriate agency. If the issuance of any permit affects the scope or specification of work, all parties will be notified as soon as possible to determine the effect of cost, schedule, or previous contractual agreement.

B. Temporary Utilities: The Contractor shall be responsible for all utilities necessary to execute his contract. There may be some low voltage power and some telephone service available on site. Any labor costs associated with the extension of these utilities will be borne by the Contractor. Any assumptions made by a bidder contrary to the intent of this paragraph must be explicitly detailed in his bid.

C. Temporary Facilities: Contractor shall provide all temporary facilities including, but not limited to, structures, secured areas for materials storage, potable water, sanitary and medical facilities, etc.

1.6 SUBMITTALS REQUIRED WITH PROPOSAL:

A. Construction Schedule: Contractor shall submit a preliminary bar-chart type schedule with the Bid Documents. On the schedule, indicate a time bar for each major category or unit of work to be performed at the site, properly sequenced and coordinated with other elements of work. Include estimated man-hours for each activity.

B. Schedule of Rates: Contractor shall submit with the Bid Documents a Standard Schedule of Rates for Labor, Equipment and Materials. Schedule of Rates will be used as a basis of time and materials payment for extra work.

C. Proposed Management Personnel: The diligent, proactive management of this project, and this construction contract in particular, is extremely important to the successful execution of the project's stated objectives. Towards this end, each bidder will submit with the proposal, the proposed supervisory structure. At a minimum, it will include one full time superintendent on site, the number and type of foremen required to supervise the various activities and any anticipated clerical assistance. The proposed should be identified by name, with a resume of his associated experience as a superintendent. This portion of the proposal will be reviewed very carefully and will be a major consideration in the Contractor selection process.

PART 2 PROJECT SCHEDULE:

2.1 GENERAL:

A. The Construction Manager is responsible for the coordination of all activities on site and will work with each Contractor to ensure a timely project completion and shall coordinate all activities with the Owner.

2.2 CONTRACTOR'S SUBMITTAL:

A. Each Contractor shall submit to the construction manager a time scaled, pert-type schedule for his/her procurement, construction and quality assurance activities. Once accepted, these schedules become the baseline construction schedules.

2.3 WEEKLY REVIEW, UPDATING AND PROJECTIONS:

A. This schedule will be updated on a weekly basis to reflect the actual progress and the current completion projection. The updated schedule will be submitted one day prior to the weekly construction meeting. The Construction Manager will review the schedules from both Contractors for coordination and project compliance purposes.

PART 3 CONSTRUCTION SITE MANAGEMENT:

3.1 SAFETY:

A. Completion of this construction project without incurring an OSHA recordable incident is the first priority of all involved.

3.2 WEEKLY MEETING:

A. The Construction Manager will conduct a weekly meeting on the job site at a mutually agreed upon time. The meeting will take place at the prescribed time each week. The agenda for this meeting will consist of, at a minimum, progress to date, updated projections for each line item completion, safety performance. At this meeting, the Construction Manager will collect from

each Contractor their updated schedule, weekly safety talk minutes, and any accident investigation reports.

3.3 ACCIDENT REPORTS:

A. In the event of an accident, the Contractor will inform the Construction Manager of said accident weekly for minor cut and bruises, that day for potential lost time accidents, and just as soon as practical on emergency care accidents.

3.4 JOB SITE COMMUNICATIONS:

A. Each Contractor on the job site will designate a project superintendent and one substitute. The Owner's representative will be the Construction Manager. All discussions involving variances in schedule, cost, or quality will be directed to the designated representative.

3.5 NOTIFICATION OF POTENTIAL EXTRAS:

A. Just as soon as a potential contractual extra is revealed, the Contractor shall notify the Construction Manager in writing (i.e. hand written speedy memo) of said potential which will be signed by the Construction Manager and the appropriate superintendent(s).

3.6 RECORD DRAWINGS:

A. The Contractor shall submit as-built drawings to the Engineer for not more than 30 days following contract completion. The release of the final payment is contingent on the receipt of said drawings.

PART 4 MEASUREMENT, EXECUTION AND PAYMENT

4.1 DEFINITION OF PAYMENT ITEMS:

A. The basis of measurement and payment is lump sum, with unit cost add/deducts for changes in Scope of Work.

B. Unit price extras under this contract shall be paid as described herein under the appropriate items. Payment of work shall be full compensation for costs incurred by the Contractor in providing the work as described in the Contract Documents.

C. The Contractor shall provide a detailed breakdown of the lump sum costs, acceptable to the Construction Manager, which will be used for estimating progress payment requests unless otherwise specified herein.

4.2 UNDEFINED AND CONTRACTUAL COSTS:

D. Costs for work not specifically mentioned, and which are incidental to the overall conduct of the work, shall be included in the Contractor's Bid, distributed into the actual Bid item as deemed appropriate. Examples of these types of costs are, but not necessarily limited to, the following:

Insurances
Construction Permits and Licenses
Surveying
Temporary Erosion Control
Taxes
Miscellaneous Administrative Costs

4.2 MEASUREMENT

A. All work acceptably completed under the contract will be measured according to United States customary units. The Engineer shall approve all measurements taken for payment on unit price items. The Contractor shall assist the Engineer in conducting measurements for payment.

B. For all items, other than those to be paid for by lump sum, after the work is completed and before final payment is made, the Owner's Representative shall determine the quantities of various items of work accepted as the basis for final payment. In case of unit price items, the Contractor will be paid the amount for the quantity of work accepted and for the materials placed. The quantities of work performed shall be computed in accordance with the following methods of measurements.
   1. Area measurement, such as square yard, square feet, and units will be made along the ground surface. A unit is equal to one thousand (1,000) square feet.
   2. Volume measurement, such as cubic yard or unit, will be an in-place measurement calculated by multiplying the area satisfactorily completed by the measured depth.
   3. Linear measurement will be along the surface of the object being measured.

Actual count (per each) will be the number of individual units installed.

4.3 EXECUTION AND PAYMENT:

Quantities listed for each item are not guaranteed. The estimated quantities are provided as a Bidder's guide only; the Bidder should verify quantities.

A. Mobilization/Demobilization:
   1. General: This item shall consist of preparatory work and operations including, but not limited to those necessary to the movement of personnel, equipment, supplies and incidentals to the project site; and for all other work and operations which must be performed or costs incurred prior to beginning work and upon completion of work on the various items on the project site.
   2. Payment: This is a fixed cost lump sum item as stated in the bid. Any changes to the contract price must be based upon a change in the described scope.

B. Clearing, Grubbing, Stripping:
   1. General: This item shall consist of all equipment, labor, and materials required to prepare the site to achieve base grades in accordance with the Contract Drawings and Specifications. During site preparation activities, any materials identified for future use will be hauled to a stockpile or a fill area. Any hazardous material or material deemed unusable by the owner will be disposed of at the contractor's expense and following all local, state and federal regulations. Measurement of work will be per acre.

2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

C. Excavation to Stockpile:
1. General: This item consists of all labor and equipment required for the excavation and hauling of excavation. The excavation will be hauled to a stockpile in accordance with the Contract Drawings and Specifications. Measure of work will be cubic yards of in-place excavation.
2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

D. Excavation to Fill:
1. General: This item shall consist of all equipment, labor, and materials required to complete the excavation of materials and placement to grade as borrow or fill in accordance with the Contract Drawings and Specifications. The fill shall be provided by the Owner. Measurement of work will be per cubic yard in-place.
2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

E. Rock Excavation:
1. General: This item shall consist of all equipment, labor, and materials required to complete the removal of rock that cannot be ripped with a Cat. D8 dozer. This item includes blasting and excavation and installing the rock at the designated stockpile or fill area.
2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

F. Compacted Soil Liner:
1. General: This item shall consist of all equipment, labor, and materials required to complete the screening and placement to grade of the compacted soil liner in accordance with the Contract Drawings and Specifications. The soil shall be obtained from the excavated soils. The contractor is responsible for choosing soils that will meet the Project Specifications. Measurement of work will be per cubic yard in-place.

   The compacted soil liner shall be a 12-inch compacted layer of 1-inch minus soil material as specified in Specification 31 22 13.00, Section 2.1.5, and placed over the prepared base grade. Six inches of compacted soil liner shall be placed over the prepared sideslopes.

2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

G. Required Aggregate(s): (owner furnished)
1. General: This item shall consist of all equipment and labor required to complete the placement of the #78M, #57, and #5 stone for the leachate collection system for drainage as well as ABC and Base Gravel for access roads and the landfill perimeter required for the

Project in accordance with the Contract Drawings and Specification. The aggregate(s) shall be provided by the Owner, delivered to the project site. Measurement of each aggregate will be based on in-place cubic yardage.

2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

H. Strip Drain:

1. General: This item consists of all labor, equipment, fittings, materials, and appurtenances required to complete the placement of a 12-inch SDR 11 HDPE strip drain in accordance with the Contract Drawings and Specifications. Work shall include fine and course drainage material and Mirafi Filter Weave 402 geotextile. Owner shall furnish stone. Measurement is per lineal foot installed.
2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

I. Anchor Trench:

1. General: This item shall consist of all equipment, labor, and materials required to complete the excavation and filling of the anchor trenches associated with liner installation of the Landfill No. 6 Amendment Area 6-South. The anchor trenches shall be excavated and filled in accordance with the Contract Drawings and Specifications. Measurement is per lineal foot installed.
2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

J. 60-mil HDPE Textured Liner: (owner furnished)

1. General: 60-mil HDPE textured liner installation shall consist of installing, deploying, placing, seaming, on-site testing, sampling, and repairing of any testing failures for the liner of the Landfill No. 6 Amendment Area 6D-North, as well as for anchoring liner. Scope of work is for providing all equipment, labor, and materials required to complete the work. The contractor shall be responsible for unloading and stockpiling deliveries of the liner. Measurement of work will be per square foot of installed liner. No additional payment will be made for seam overlap, wasted trimmings, or for liner installed within the anchor trench or for field testing. This work shall be installed in accordance with Contract Drawings and Specifications.
2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

K. Geosynthetic Clay Liner: (owner furnished)

1. General: Geosynthetic clay liner (GCL) shall consist of installing, deploying, placing, seaming, and repairing of any blemishes for the liner system of Landfill No. 6 Amendment Area 6D-North. The contractor shall be responsible for unloading and stockpiling deliveries of the GCL liner. Measurement of work will be per square foot of installed GCL. No additional payment will be made for seam overlap, wasted trimmings, or material within the anchor trench.

2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

L. 16 oz/sy Non-Woven Geotextile: (owner furnished)
1. General: This item shall consist of all equipment, labor, and materials required to complete the geotextile installation consisting of the placement and securing of a 16 oz/sy non-woven geotextile above the geomembrane, as shown on the Contract Drawings. The contractor shall be responsible for unloading and stockpiling deliveries of the Geotextile. Measurement of work will be per square foot of installed geotextile, with no allowance for seam overlap. No payment will be made for wasted trimmings. This work shall be installed in accordance with the Contract Drawings and Specifications.
2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

M. 12-inch Leachate Collection Trunkline:
1. General: This item consists of all labor, equipment, fittings, materials, and appurtenances required to complete the placement of a 12-inch SDR 11 HDPE trunkline in accordance with the Contract Drawings and Specifications. Measurement is per lineal foot installed.
2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

N. 6-inch Leachate Collection Lateral:
1. General: This item consists of all labor, equipment, fittings, materials, and appurtenances required to complete the placement of a 6-inch diameter perforated SDR 11 HDPE Leachate Collection Lateral in accordance with the Contract Drawings and Specifications. Measurement is per lineal foot installed
2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

O. 6-inch Leachate Collection Lateral Cleanout:
1. General: This item consists of all labor, equipment, fittings, materials, and appurtenances required to complete the placement of 6-inch diameter SDR 11 Leachate Collection Lateral Cleanouts in accordance with the Contract Drawings and Specifications. Measurement is per each installed.
2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

P. 12-inch Storm Drain:
1. General: This item consists of all labor, equipment, fittings, materials, and appurtenances required to complete the excavation, placement of a 12-inch diameter SDR 11 HDPE storm drain and backfilling of the trench associated with storm drain in accordance with the Contract Drawings and Specifications. Measurement is per lineal foot installed

2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

Q. 24-inch Storm Drain:
1. General: This item consists of all labor, equipment, fittings, materials, and appurtenances required to complete the installation and backfill of 24-inch diameter SDR 11 storm drain in accordance with the Contract Drawings and Specifications. Measurement is per each installed.
2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

R. 12-inch Underdrain:
1. General: This item consists of all labor, equipment, fittings, materials, and appurtenances required to complete the installation and backfill of 12-inch diameter SDR 11 underdrain in accordance with the Contract Drawings and Specifications. Measurement is per each installed.
2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

S. 15-inch Corrugated Smooth-Wall Culvert (ADS N 12):
1. General: This item consists of all labor, equipment, fittings, materials, and appurtenances required to complete the installation and backfill of 15-inch diameter Corrugated Smooth-Wall Culvert in accordance with the Contract Drawings and Specifications. Measurement is per each installed.
2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

T. Silt Fence:
1. General: This item consists of all labor, equipment, materials, and appurtenances required to complete the placement of silt fence in accordance with the Contract Drawings and Specifications. Measurement is per lineal foot installed.
2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

U. Inlet/Outlet Protection:
1. General: This item shall consist of all equipment, labor, and materials and appurtenances required to complete the placement of all culvert riprap inlet and outlet aprons in accordance with the Contract Drawings and Specifications. Work shall include geotextile. Owner shall furnish riprap. Measurement is per cubic yard installed.
2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

V. Vegetative Growth Media:
   1. General: This item consists of all labor, equipment, and material required, and the placement to grade of the vegetative growth media in accordance with the Contract Drawings and Specifications. The vegetative growth media shall be material obtained from on-site sources or stockpiles. Measurement is per cubic yard installed.
   2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

W. Seed, Fertilizer and Mulch:
   1. General: This item shall consist of all equipment, labor, and materials required for seeding and mulching of the diversion berm on Landfill No. 6 Amendment Area D North in accordance with the Contract Drawings and Specifications. Seeding includes soil preparation, seed, fertilizer, lime, and mulch.
   2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

X. Stone Check Dam:
   1. General: This item shall consist of all equipment and labor required to complete the placement of the stone check dams for the project in accordance with the Contract Drawings and Specification. The aggregate shall be provided by the Owner, delivered to the project site.
   2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

Y. Sediment Outlet Control Structure:
   1. General: This item shall consist of all equipment, labor, and materials required for the installation of the outlet control structure, frame & grate, geotextile, crushed stone and anti-flotation block as shown in the Contract Drawings and Specifications. Measurement is per lump sum installed
   2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

Z. Erosion Control Blanket:
   1. General: This item shall consist of all equipment, labor, and materials required for the installation of erosion control blanket as shown in the Contract Drawings and Specifications. Measurement is per square yard installed.
   2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

AA. Culverts:
   1. General: This item shall consist of all equipment, labor, and materials required for the installation of culverts as shown in the Contract Drawings and Specifications. Work shall include anti-seep collars. Measurement is per lineal foot installed.

2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

BB. Soil-Material Testing:

1. General: This item shall consist of all costs associated with any materials testing to be completed during the duration of the project with the exception of field density testing. The cost shall include field sampling and delivery to the laboratory. Measurement is per lump sum.
2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

CC. Riprap Stabilization:

1. General: This item shall consist of all equipment and labor required for the installation of a 2-foot layer of riprap on the outboard slopes of Area 6 D South and 6E, as shown on the Contract Drawings.
2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

DD. Riprap Ditches:

1. General: This item shall consist of all equipment and labor required for the installation of the riprap ditches shown on the contract drawings. The contractor shall furnish the geotextiles and the owner will furnish the riprap.
2. Payment: This is a fixed cost item. Any changes to the contract price must be based upon a change in the described scope. Unit pricing is requested on the proposal form in the event that a quantity adjustment is required.

END OF SECTION

SECTION 01 30 00 - ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Coordination and Project conditions.

B. Preconstruction meeting.

C. Site mobilization meeting.

D. Progress meetings.

E. Preinstallation meetings.

F. Closeout meeting.

G. Alteration procedures.

1.2 COORDINATION AND PROJECT CONDITIONS

A. Coordinate scheduling, submittals, and Work of various Sections of Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements.

B. Verify that utility requirements and characteristics of operating equipment are compatible with building utilities. Coordinate Work of various Sections having interdependent responsibilities for installing, connecting to, and placing operating equipment in service.

C. Coordinate space requirements, supports, and installation of mechanical and electrical Work indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit as closely as practical; place runs parallel with lines of building. Use spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
   1. Coordination Drawings: Prepare as required to coordinate all portions of Work. Show relationship and integration of different construction elements that require coordination during fabrication or installation to fit in space provided or to function as intended. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are important.

D. Coordination Meetings: In addition to other meetings specified in this Section, hold coordination meetings with personnel and Subcontractors to ensure coordination of Work.

E. Coordinate completion and clean-up of Work of separate Sections in preparation for Substantial Completion.

F. After Owner's occupancy of premises, coordinate access to Site for correction of defective Work and Work not complying with Contract Documents, to minimize disruption of Owner's activities.

1.3 PRECONSTRUCTION MEETING

A. Engineer will schedule and preside over meeting after Notice of Award.

B. Attendance Required: Engineer, Owner, Resident Project Representative, appropriate governmental agency representatives, Construction Manager, major Subcontractors, and Contractor.

C. Minimum Agenda:
   1. Execution of Owner-Contractor Agreement.
   2. Submission of executed bonds and insurance certificates.
   3. Distribution of Contract Documents.
   4. Submission of list of products, schedule of values, and Progress Schedule.
   5. Designation of personnel representing parties in Contract and Engineer.
   6. Communication procedures.
   7. Procedures and processing of requests for interpretations, field decisions, submittals, substitutions, Applications for Payments, proposal request, Change Orders, and Contract closeout procedures.
   8. Scheduling.
   9. Critical Work sequencing.
   10. Scheduling activities of Geotechnical Engineer.

D. Contractor: Record minutes and distribute copies to participants within two days after meeting, to Engineer, Owner, and those affected by decisions made.

1.4 SITE MOBILIZATION MEETING

A. Engineer will schedule meeting at Project Site prior to Contractor occupancy.

B. Attendance Required: Engineer, Owner, Contractor, Contractor's superintendent and major Subcontractors.

C. Minimum Agenda:
   1. Use of premises by Owner and Contractor.
   2. Owner's requirements.
   3. Construction facilities and controls.
   4. Temporary utilities.
   5. Survey and layout.
   6. Security and housekeeping procedures.
   7. Schedules.
   8. Procedures for testing.
   9. Procedures for maintaining record documents.
   10. Requirements for startup of equipment.
   11. Inspection and acceptance of equipment put into service during construction period.

D. Contractor: Record minutes and distribute copies to participants within two days after meeting, to Engineer, Owner, and those affected by decisions made.

1.5 PROGRESS MEETINGS

A. Schedule and administer meetings throughout progress of the Work at maximum weekly intervals.

B. Make arrangements for meetings, prepare agenda with copies for participants, and preside over meetings.

C. Attendance Required: Job superintendent, major Subcontractors and suppliers, and Engineer as appropriate to agenda topics for each meeting.

D. Minimum Agenda:
   1. Review minutes of previous meetings.
   2. Review of Work progress.
   3. Field observations, problems, and decisions.
   4. Identification of problems impeding planned progress.
   5. Review of submittal schedule and status of submittals.
   6. Review of off-Site fabrication and delivery schedules.
   7. Maintenance of Progress Schedule.
   8. Corrective measures to regain projected schedules.
   9. Planned progress during succeeding work period.
   10. Coordination of projected progress.
   11. Maintenance of quality and work standards.
   12. Effect of proposed changes on Progress Schedule and coordination.
   13. Other business relating to Work.

E. Contractor: Record minutes and distribute copies to participants within two days after meeting, to Engineer, Owner, and those affected by decisions made.

1.6 PREINSTALLATION MEETINGS

A. When required in individual Specification Sections, convene preinstallation meetings at Project Site before starting Work of specific Section.

B. Require attendance of parties directly affecting, or affected by, Work of specific Section.

C. Notify Engineer seven days in advance of meeting date.

D. Prepare agenda and preside over meeting:
   1. Review conditions of installation, preparation, and installation procedures.
   2. Review coordination with related Work.

E. Record minutes and distribute copies to participants within two days after meeting, to Engineer, Owner, and those affected by decisions made.

1.7 CLOSEOUT MEETING

A. Schedule Project closeout meeting with sufficient time to prepare for requesting Substantial Completion. Preside over meeting and be responsible for minutes.

B. Attendance Required: Contractor, major Subcontractors, Engineer, Owner, and others appropriate to agenda.

C. Notify Engineer seven days in advance of meeting date.

D. Minimum Agenda:
   1. Start-up of facilities and systems.
   2. Operations and maintenance manuals.
   3. Testing, adjusting, and balancing.
   4. System demonstration and observation.
   5. Operation and maintenance instructions for Owner's personnel.
   6. Contractor's inspection of Work.
   7. Contractor's preparation of an initial "punch list."
   8. Procedure to request Engineer inspection to determine date of Substantial Completion.
   9. Completion time for correcting deficiencies.
   10. Inspections by authorities having jurisdiction.
   11. Certificate of Occupancy and transfer of insurance responsibilities.
   12. Partial release of retainage.
   13. Final cleaning.
   14. Preparation for final inspection.
   15. Closeout Submittals:
      a. Project record documents.
      b. Operating and maintenance documents.
      c. Operating and maintenance materials.
      d. Affidavits.
   16. Final Application for Payment.
   17. Contractor's demobilization of Site.
   18. Maintenance.

E. Record minutes and distribute copies to participants within two days after meeting, to Engineer, Owner, and those affected by decisions made.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.1 ALTERATION PROCEDURES

A. Area 6D South and access roads will be occupied for normal operations during progress of construction. Cooperate with Owner in scheduling operations to minimize conflict and to permit continuous usage.
   1. Perform Work not to interfere with operations of occupied areas.
   2. Keep utility and service outages to a minimum and perform only after written approval of Owner.
   3. Clean Owner-occupied areas daily.

B. Materials: As specified in product Sections; match existing products with new and salvaged products for patching and extending Work.

C. Employ skilled and experienced installer to perform alteration and renovation Work.

D. Cut, move, or remove items as necessary for access to alterations and renovation Work. Replace and restore at completion. Comply with Section 01 70 00 - Execution and Closeout Requirements

E. Remove unsuitable material not marked for salvage. Replace materials as specified for finished Work.

F. Remove debris and abandoned items from area and from concealed spaces.

G. Prepare surface and remove surface finishes to permit installation of new Work and finishes.

H. Remove, cut, and patch Work to minimize damage and to permit restoring products and finishes to specified condition.

I. Where new Work abuts or aligns with existing Work, provide smooth and even transition. Patch Work to match existing adjacent Work in texture and appearance.

J. When finished surfaces are cut so that smooth transition with new Work is not possible, terminate existing surface along straight line at natural line of division and submit recommendation to Engineer for review.

K. Finish surfaces as specified in individual product Sections.

END OF SECTION

SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Definitions.

B. Submittal procedures.

C. Construction progress schedules.

D. Proposed product list.

E. Product data.

F. Use of electronic CAD files of Project Drawings.

G. Shop Drawings.

H. Samples.

I. Other submittals.

J. Test reports.

K. Certificates.

L. Manufacturer's instructions.

M. Contractor review.

N. Architect/Engineer review.

1.2 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Engineer's responsive action.

B. Informational Submittals: Written and graphic information and physical Samples that do not require Engineer's responsive action. Submittals may be rejected for not complying with requirements.

1.3 SUBMITTAL PROCEDURES

A. Transmit each submittal electronically to the Engineer on an Engineer-accepted form.

B. Sequentially number transmittal forms. Mark revised submittals with original number and sequential alphabetic suffix.

C. Identify: Project, Contractor, Subcontractor and supplier, pertinent Drawing and detail number(s), and Specification Section number appropriate to submittal.

D. Apply Contractor's stamp, signed or initialed, certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information is according to requirements of the Work and Contract Documents.

E. Schedule submittals to expedite Project, and deliver to Engineer. Coordinate submission of related items. The Contractor may be obligated to provide submittals as dictated in the Contract between the Owner and Contractor.

F. For each submittal for review, allow seven (7) days excluding delivery time to and from Contractor.

G. Identify variations in Contract Documents and product or system limitations that may be detrimental to successful performance of completed Work.

H. Allow space on submittals for Contractor and Engineer review stamps.

I. When revised for resubmission, identify changes made since previous submission.

J. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.

K. Submittals not requested will not be recognized nor processed.

L. Incomplete Submittals: Engineer will not review. Complete submittals for each item are required. Delays resulting from incomplete submittals are not the responsibility of Engineer.

1.4 CONSTRUCTION PROGRESS SCHEDULES

A. Contractor shall prepare and submit detailed progress schedules, schedule of values and shop drawing and sample submittal schedules to the Engineer for approval in accordance with the General Conditions. The schedule shall be in bar graph from showing material delivery schedules and starting and completion dates for all phases of construction.

B. If, in the opinion of the Engineer, the Contractor falls behind the progress schedule, the contractor shall take such steps as may be necessary to improve his progress, which may require him to increase the number of shifts, and/or overtime operations, days of work, and/or the amount of construction planned, and to submit for approval such supplementary schedule or schedules as necessary to demonstrate the manner in which the agreed rate to progress will be regained, all without additional cost to the Owner

1.5 PROPOSED PRODUCT LIST

A. Within 15 days after date of Owner-Contractor Agreement, submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.

B. For products specified only by reference standards, indicate manufacturer, trade name, model or catalog designation, and reference standards.

1.6 PRODUCT DATA

A. Product Data: Action Submittal: Submit to Engineer for review for assessing conformance with information given and design concept expressed in Contract Documents.

B. Submit electronic submittals via email as PDF electronic files to Brian Pierce by email at phgzone12@smemaine.com.

C. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.

1.7 ELECTRONIC CAD FILES OF PROJECT DRAWINGS

A. Electronic CAD Files of Project Drawings: May only be used to expedite production of Shop Drawings for the Project. Use for other Projects or purposes is not allowed.

B. Electronic CAD Files of Project Drawings: Distributed only under the following conditions:
   1. Use of files is solely at receiver's risk. Engineer does not warrant accuracy of files. Receiving files in electronic form does not relieve receiver of responsibilities for measurements, dimensions, and quantities set forth in Contract Documents. In the event of ambiguity, discrepancy, or conflict between information on electronic media and that in Contract Documents, notify Engineer of discrepancy and use information in hard-copy Drawings and Specifications.
   2. CAD files do not necessarily represent the latest Contract Documents, existing conditions, and as-built conditions. Receiver is responsible for determining and complying with these conditions and for incorporating addenda and modifications.
   3. User is responsible for removing information not normally provided on Shop Drawings and removing references to Contract Documents. Shop Drawings submitted with information associated with other trades or with references to Contract Documents will not be reviewed and will be immediately returned.
   4. Receiver shall not hold Engineer responsible for data or file clean-up required to make files usable, nor for error or malfunction in translation, interpretation, or use of this electronic information.
   5. Receiver shall understand that even though Engineer has computer virus scanning software to detect presence of computer viruses, there is no guarantee that computer viruses are not present in files or in electronic media.
   6. Receiver shall not hold Engineer responsible for such viruses or their consequences, and shall hold Engineer harmless against costs, losses, or damage caused by presence of computer virus in files or media.

1.8 SHOP DRAWINGS

A. Shop Drawings: Action Submittal: Submit to Engineer for assessing conformance with information given and design concept expressed in Contract Documents.

B. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

C. When required by individual Specification Sections, provide Shop Drawings signed and sealed by a professional Engineer responsible for designing components shown on Shop Drawings.
   1. Include signed and sealed calculations to support design.
   2. Submit Shop Drawings and calculations in form suitable for submission to and approval by authorities having jurisdiction.
   3. Make revisions and provide additional information when required by authorities having jurisdiction.

D. Submit electronic submittals via email as PDF electronic files to Brian Pierce by email at phgzone12@smemaine.com.

1.9 SAMPLES

A. Samples: Action Submittal: Submit to Engineer for assessing conformance with information given and design concept expressed in Contract Documents.

B. Include identification on each Sample, with full Project information.

C. Submit number of Samples specified in individual Specification Sections; Engineer will retain one sample.

D. Reviewed Samples that may be used in the Work are indicated in individual Specification Sections.

E. Samples will not be used for testing purposes unless specifically stated in individual Specification Sections.

1.10 OTHER SUBMITTALS

A. Informational Submittal: Submit data for Engineer's knowledge as Owner's Representative or for Owner.

B. Submit information for assessing conformance with information given and design concept expressed in Contract Documents.

1.11 TEST REPORTS

A. Informational Submittal: Submit reports for Engineer's knowledge as Owner's Representative or for Owner.

B. Submit test reports for information for assessing conformance with information given and design concept expressed in Contract Documents.

1.12 CERTIFICATES

A. Informational Submittal: Submit certification by manufacturer, installation/application Subcontractor, or Contractor to Engineer, in quantities specified for Product Data.

B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

1.13 MANUFACTURER'S INSTRUCTIONS

A. Informational Submittal: Submit manufacturer's installation instructions for Engineer's knowledge as Contract administrator or for Owner.

B. Submit printed instructions for delivery, storage, assembly, installation, adjusting, and finishing, to Engineer in quantities specified for Product Data.

C. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.14 CONTRACTOR REVIEW

A. Review for compliance with Contract Documents and approve submittals before transmitting to Engineer.

B. Contractor: Responsible for:
   1. Determination and verification of materials including manufacturer's catalog numbers.
   2. Determination and verification of field measurements and field construction criteria.
   3. Checking and coordinating information in submittal with requirements of Work and of Contract Documents.
   4. Determination of accuracy and completeness of dimensions and quantities.
   5. Confirmation and coordination of dimensions and field conditions at Site.
   6. Construction means, techniques, sequences, and procedures.
   7. Safety precautions.
   8. Coordination and performance of Work of all trades.

C. Stamp, sign or initial, and date each submittal to certify compliance with requirements of Contract Documents.

D. Do not fabricate products or begin Work for which submittals are required until approved submittals have been received from Engineer.

1.15 ENGINEER REVIEW

A. Do not make "mass submittals" to Engineer. "Mass submittals" are defined as six (6) or more submittals or items in one (1) day or 15 or more submittals or items in one week. If "mass submittals" are received, Engineer's review time stated above will be extended as necessary to

perform proper review. Engineer will review "mass submittals" based on priority determined by Engineer after consultation with Owner.

B. Informational submittals and other similar data are for Engineer's information, do not require Engineer's responsive action, and will not be reviewed or returned with comment.

C. Submittals made by Contractor that are not required by Contract Documents may be returned without action.

D. Submittal approval does not authorize changes to Contract requirements unless accompanied by Change Order.

E. Owner may withhold monies due to Contractor to cover additional costs beyond the second submittal review.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION - Not Used

END OF SECTION

SECTION 31 05 13 - SOILS FOR EARTHWORK

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Subsoil materials.
   2. Vegetative growth media.

B. Related Sections:
   1. Section 31 05 16 - Aggregates for Earthwork.
   2. Section 31 22 13 - Rough Grading.
   3. Section 31 23 17 - Trenching.
   4. Section 31 23 23 - Fill.
   5. Section 31 37 00 - Riprap.
   6. Section 32 05 13 - Soils for Exterior Improvements.
   7. Section 32 05 16 - Aggregates for Exterior Improvements.
   8. Section 32 91 19 - Landscape Grading.
   9. Section 32 92 19 - Seeding and Soil Supplements.
   10. Section 33 46 00 - Subdrainage: Filter aggregate.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:
   1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 10-lb Rammer and a 18-in. Drop.

B. ASTM International:
   1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400 ft-lbf/ft3.
   2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft-lbf/ft3.
   3. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Samples: Submit sample of each type of fill to testing laboratory.

C. Materials Source: Submit name of imported materials source.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Furnish vegetative growth media from single source throughout the Work.

PART 2 PRODUCTS

2.1 VEGETATIVE GROWTH MEDIA MATERIALS

A. Vegetative Growth Media
   1. Imported borrow or acceptable material from on-site excavation.
   2. Friable loam.
   3. Reasonably free of roots, rocks larger than 3 inch, subsoil, debris, large weeds, and foreign matter.
      a. Screening: Single screened.
   4. Acidity range (pH) above 3.6 before liming and less than 500 parts per million of soluble salts.
   5. Containing minimum of 1.5 percent organic matter.

2.2 SOIL AMENDMENTS

A. Lime: Natural limestone containing not less than 90 percent of total carbonates, ground so that not less than 100 percent passes a #10 sieve, not less than 90 percent passes a #20 sieve and not less than 50 percent passes a #100 sieve.

B. Fertilizer: Fertilizer shall be a commercial type 50 percent of the elements derived from organic sources and shall conform to the recommendations of the agronomic testing.

2.3 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Testing and Inspection Services Testing and analysis of soil material.

B. Testing and Analysis of Vegetative Growth Media: An agronomic study shall be performed on all vegetative soil sources planned for use on this site. Agronomic testing shall be performed by the North Carolina Department of Agriculture soil testing laboratory or by commercial laboratories qualified to perform agronomic testing.

C. When tests indicate materials do not meet specified requirements, change material and retest.

D. Furnish materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.1 EXCAVATION

A. Excavate subsoil and vegetative growth media from areas designated. Strip vegetative growth media to full depth of vegetative growth media in designated areas.

B. Stockpile excavated material meeting requirements for vegetative growth media.

C. Remove excess excavated materials not intended for reuse, from site.

D. Remove excavated materials not meeting requirements for vegetative growth media from site.

3.2 STOCKPILING

A. Stockpile materials on site at locations designated by Engineer.

B. Stockpile in sufficient quantities to meet Project schedule and requirements.

C. Separate differing materials with dividers or stockpile apart to prevent mixing.

D. Prevent intermixing of soil types or contamination.

E. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

F. Stockpile hazardous materials on impervious material and cover to prevent erosion and leaching, until disposed of.

3.3 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

B. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

SECTION 31 05 19.13 - GEOTEXTILES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. 16-ounce non-woven geotextile.
   2. 6-ounce non-woven geotextile.

B. Related Sections:
   1. Contract Drawings.
   2. Specification Sections.
   3. General provisions of Contract.
   4. Summary of Work: Section 01 11 00.
   5. Submittals: Section 01 33 00.

1.2 DESCRIPTION OF WORK

A. Install 16-oz non-woven geotextile, and 6 oz woven geotextile to the extent of which is shown on the Contract Drawings. Only the appropriate portions of this section pertaining to the specific contract work identified in Section 01 11 00: Summary of Work or as directed by the Engineer, will apply.

1.3 QUALIFICATIONS AND WARRANTIES

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

B. Installer's Qualifications: Firms regularly engaged in installation of products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

1.4 QUALITY CONTROL DOCUMENTATION

A. Product Data: Prior to the installation of any geotextile, the Manufacturer shall provide the Engineer with the following information:
   1. Written certification that minimum average roll values given in the specification are guaranteed by the Manufacturer.
   2. For non-woven geotextiles, written certification that the Manufacturer has continuously inspected the geotextile for the presence of needles and found the geotextile to be needle free.
   3. Quality control certificates, signed by a responsible party employed by the Manufacturer. The quality control certificates shall include roll identification numbers, sampling procedures and results of quality control testes. At a minimum, results shall be given for:
      a. Mass per unit area

b. Grab strength
c. Trapezoidal tear strength
d. Burst strength
e. Puncture strength
f. Apparent Opening Size (AOS)

4. Quality control tests shall be performed in accordance with the test methods specified in the project specifications for at least every 100,000 square feet of geotextile produced.
5. The Manufacturer shall identify all rolls of geotextiles with the following:
   a. Manufacturer's name.
   b. Product identification.
   c. Roll number.
   d. Roll dimensions.

B. Product Review: The Engineer shall verify that:
1. Property values certified by the Manufacturer meet all of its guaranteed specifications.
2. Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.
3. Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.
4. Roll packages are appropriately labeled.
5. Certified minimum average roll properties meet the project specifications.

PART 2 PRODUCTS

2.1 GEOTEXTILE

A. General: Provide geotextiles as indicated on the Contract Drawings.

B. 6 Ounce -Woven Geotextile (Mirafi FW 402)
1. Non-Woven Geotextile: 6 ounces per square yard - The geotextile which is used as part of the drainage geocomposite and which are bonded to the geonet and shall be used in the toe drain construction, shall meet the minimum requirements listed below:

PROPERTY	TEST PROCEDURE	MINIMUM VALUE(1)
Weight	ASTM D 5261	6 ounces per square yard
Grab Strength	ASTM D 4632	200 pounds
Tear Strength	ASTM D 4533	75 pounds
Puncture Resistance	ASTM D 6241	675 pounds
AOS	ASTM D 4751	No. 40 U.S. Sieve
Mullen Burst	ASTM D 3786	450 pounds

(1) Values in weaker principle direction. All minimum values represent minimum average roll values (i.e. test results from any sampled roll in a lot, tested in accordance with ASTM D 4759 shall meet or exceed the minimum values listed).

C. 16 Ounce Non-Woven Geotextile

1. Non-Woven Geotextile: 16 ounces per square yard - The geotextile which is used as part of the drainage geocomposite and which are bonded to the geonet and shall be used in the toe drain construction, shall meet the minimum requirements listed below:

PROPERTY	TEST PROCEDURE	MINIMUM VALUE(1)
Weight	ASTM D 5261	16 ounces per square yard
Grab Strength	ASTM D 4632	380 pounds
Tear Strength	ASTM D 4533	145 pounds
Puncture Resistance	ASTM D 6241	240 pounds
AOS	ASTM D 4751	No. 70 U.S. Sieve
Mullen Burst	ASTM D 3786	60 to 100

(1) Values in weaker principle direction. All minimum values represent minimum average roll values (i.e. test results from any sampled roll in a lot, tested in accordance with ASTM D 4759 shall meet or exceed the minimum values listed).

PART 3 QUALITY ASSURANCE

3.1 GEOTEXTILE STORAGE AND DELIVERY

A. During shipment and storage, the geotextile shall be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. Geotextile rolls shall be shipped and stored in relatively opaque and watertight wrappings. Wrappings shall be removed shortly before deployment.

B. The Engineer or Owner's Representative shall observe rolls upon delivery at the site and any deviation from the above requirements shall be reported to the Engineer.

C. Contractor Supplied geotextiles found to be damaged (as listed in the above paragraphs) may be rejected by the Engineer. Rejected material shall be replaced by the contractor at no additional cost to the owner.

3.2 GEOTEXTILE DEPLOYMENT

A. The Installer shall handle all geotextiles in such a manner as to assure they are not damaged in any way, and the following shall be complied with:

1. On slopes, the geotextiles shall be securely anchored and then rolled down the slope in such a manner as to continually keep the geotextile sheet in tension.
2. In the presence of wind, all geotextiles shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during deployment and shall remain until replaced with cover material.

3. Geotextiles shall be cut using a geotextile cutter (hook blade) only. If in place, special care shall be taken to protect other materials from damage which could be caused by the cutting of the geotextiles.
4. The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geotextile.
5. During placement of geotextiles, care shall be taken not to entrap, in or beneath the geotextile, stones, excessive dust, or moisture that could damage the geomembrane, cause clogging of drains or filters, or hamper subsequent seaming.
6. A visual examination of the geotextile shall be carried out over the entire surface, after installation, to assure that no potentially harmful foreign objects, such as needles, are present.

3.3 SEAMING PROCEDURES

A. On slopes steeper than 10 (horizontal):1 (vertical), all geotextiles shall be continuously sewn (i.e. spot sewing is not allowed). Geotextiles shall be overlapped a minimum of 3 inches prior to seaming. In general, no horizontal seams shall be allowed on sideslopes (i.e. seams shall be along, not across, the slope), except as part of a patch.

B. On bottoms and slopes shallower than 10 (horizontal):1 (vertical), geotextiles shall be seamed as indicated above (preferred), or thermally bonded with the written approval of the Engineer.

C. The Installer shall pay particular attention at seams to assure that no earth cover material could be inadvertently inserted beneath the geotextile.

D. All sewing shall be done using polymeric thread with chemical and ultraviolet light resistance properties equal to or exceeding those of the geotextile.

3.4 DEFECTS AND REPAIRS

A. Any holes or tears in the geotextile shall be repaired as follows:
   1. On slopes, a patch made from the same geotextile shall be sewn into place in accordance with the project specifications. Should any tear exceed 10 percent of the width of the roll, that roll shall be removed from the slope and replaced.
   2. Care shall be taken to remove any soil or other material which may have penetrated the torn geotextile.
   3. The Geosynthetic CQA shall observe any repair and report any noncompliance with the above requirements in writing to the Engineer.

3.5 GEOTEXTILE PROTECTION

A. All soil materials located on top of a geotextiles shall be deployed in such a manner as to assure:
   1. The geotextile and underlying lining materials are not damaged.
   2. Minimal slippage of the geotextile on underlying layers occurs.
   3. No excess tensile stresses occur in the geotextile.

B. Unless otherwise specified by the Engineer, all lifts of soil material shall be in conformance with the guidelines given in Section 31 20 00 and 31 05 19.16.

END OF SECTION

SECTION 31 05 19.16 - GEOMEMBRANES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. High Density Polyethylene (HDPE) Geomembrane Liner.

B. Related Sections:
1. Contract Drawings.
2. Specification Sections.
3. Submittals: Section 01 33 00.
4. GRI Standard GM13

1.2 DESCRIPTION OF WORK

A. Install, test, and document 60-mil Textured HDPE geomembrane installation with smooth edges, to the extent of which is shown on the Drawings. The 60-mil textured HDPE geomembrane with smooth edges shall be installed as part of the liner system for Cell 6 D North.

1.3 SUBMITTALS

A. Submit the number and type of project submittals as indicated herein or in Specification Section 01 33 00.

B. Prior to placement of HDPE material, the Contractor shall submit, for the Project Manager's approval, a description or drawing of the method of sheet layout, detailing the orientation of sheets and the direction of the overlap between sheets.

1.4 QUALITY CONTROL DOCUMENTATION:

1.5 Manufacturer's Experience: The manufacturer supplying the membrane shall be GRI GM 13 certified and shall satisfactorily demonstrate previous experience by letter of certification. Certification shall indicate that the manufacturer has produced, and has in service in similar applications for a period of not less than one (1) year, at least ten (10) million square feet of HDPE material meeting these Specifications.

A. Installer's Experience:
1. The Installer proposing to install the lining shall satisfactorily demonstrate previous experience by letter of certification. Certification shall indicate the Installer's successful past installation of at least ten (10) million square feet of HDPE membrane lining.
2. Installation shall be performed under the direction of a single installation supervisor who shall remain on site and be in responsible charge throughout the liner installation, including subgrade acceptance, liner layout, seaming, testing, repairs, and all other activities contracted for with the Installer. The installation supervisor shall have supervised the installation of at least ten (10) million square feet of polyethylene geomembrane. Actual seaming shall be performed under the direction of a master seamer who may be the same

person as the installation supervisor, and who has a minimum of one (1) million square feet polyethylene geomembrane seaming experience using the same type of seaming apparatus as that specified in this project. No seaming may be done by any individual with less than 500,000 square feet of polyethylene geomembrane seaming experience. The installation supervisor or master seamer must be on site whenever seaming is being performed.

B. Quality Control During Manufacture Random sampling shall be performed by the Manufacturer throughout the production run at the frequencies indicated below for each of the listed properties for the geomembrane to be delivered to the site.

Property	Test Method	Frequency
Thickness	ASTM D 5994	1 per roll
Asperity Height	ASTM D 7466	1 per 2 rolls
Carbon black content	ASTM D 1603 or ASTM D 4218	1 per 20,000 pounds
Carbon black dispersion	ASTM D 5596	1 per 45,000 pounds
Force per unit width at yield	ASTM D 6693	1 per 20,000 pounds
Force per unit width at break	ASTM D 6693	1 per 20,000 pounds
Elongation at yield	ASTM D 6693	1 per 20,000 pounds
Elongation at break	ASTM D 6693	1 per 20,000 pounds
Tear resistance	ASTM D 1004	1 per 45,000 pounds
Puncture resistance	ASTM D 4833	1 per 45,000 pounds
Density	ASTM D 792 or ASTM D 1505	1 per 200,000 pounds
Environmental Stress Crack	ASTM D 5397	1 per 200,000 pounds
UV resistance	GM 11	1 per formulation
Oxidization induction time	ASTM D 3895 or D 5885	1 per 200,000 pounds

Values must meet the requirements specified in Table 1 of Part 2.

The Resin Manufacturer shall provide certification to the Geomembrane Sheet Manufacturer that the resin meets or exceeds the specifications for density, environmental stress crack, and melt index.

Quality control certificates should be provided for the extrusion rod to ensure quality, as well as the geomembrane compatibility.

Sheet thickness shall be monitored continuously during manufacture and shall be nominal thickness ±10% across the sheet.

Rolls not satisfying the specifications shall be rejected. The Manufacturer shall provide certification of testing as described in Part 2.

1.6 CONFORMANCE TESTING

A. The geomembrane will be sampled by the Engineer or his agent(s), at the manufacturer or upon delivery to the site. The Engineer shall assure that conformance test samples are obtained for the geomembrane at a rate of 1 test per 100,000 square feet of geomembrane with a minimum of once per lot, for testing, to assure conformance to the specification. A lot consists of a group of material which is manufactured from a specific batch of raw materials (e.g., HDPE resin). The manufacturer shall identify the consecutively numbered rolls of material that are inclusive within a lot. It is not required that all rolls included in a lot be supplied to the project, as long as the specified certification test results are supplied by the manufacture to bracket the rolls delivered to the project.

B. The manufacturer shall coordinate information on manufacture and delivery of the geomembrane with the Engineer to assure that sampling and testing occur in a timely manner as to avoid construction delays.

C. Any further testing required to assure conformance shall be the responsibility of the manufacturer. The testing laboratory and the results shall be acceptable to the Engineer.

D. Geomembrane conformance testing shall include the following:

Thickness	ASTM D 5994
Asperity	ASTM D 7466
Carbon black content	ASTM D 1603 or ASTM 4218
Carbon black dispersion	ASTM D 5596
Force per unit width at yield	ASTM D 6693
Force per unit width at break	ASTM D 6693
Elongation at yield	ASTM D 6693
Elongation at break	ASTM D 6693
Tear resistance	ASTM D 1004
Puncture resistance	ASTM D 4833
Melt Index	ASTM D 1238

These conformance tests shall be performed in accordance with the test method specified. The Contractor shall supply the materials required to perform the conformance testing.

1.7 SPECIAL PRODUCT WARRANTY

A. Manufacturer's Guarantee: Prior to shipment of the material, the manufacturer of the membrane liner shall enter into agreement with the Owner guaranteeing the membrane as follows:

The manufacturer warrants the HDPE liner which is manufactured, sold as first quality, and (1) furnished free of manufacturing defects in workmanship or material for a period of one (1) year from the time of delivery with the basis for judgment of defects being the applicable product specifications in effect at the time the order was placed unless modified by mutual written agreement; (2) shall not develop cracks/holes which go completely through the membrane due to the effects of normal service for a period of twenty (20) years from the date of delivery. "Normal service" does not include physical damage caused by acts of God, casualty, or catastrophe such as, but not limited to, earthquakes, fire, explosion, floods, lightning, piercing hail, tornadoes, corrosive air pollution, mechanical abuse by machinery, equipment, people, or animals, or excessive flexures, pressures, or stress from any source other than faulty material, and (3) immune to chemical attack and degradation by chemicals, specified in the manufacturer's literature, as compatible with, and as not having an adverse effect on the membrane.

Should defects or weathering degradation within the scope of the above warranty occur, the manufacturer shall refund to the purchaser-user the pro-rata part for the unexpired term of the warranty of the purchaser-user's original cost of such product, or will supply repair or replacement materials at the then-current price. In the event the manufacturer supplies repair or replacement materials, against the then- current price, the manufacturer will credit the lesser of (1) the pro-rata part of the original sales price of the material so repaired or replaced for the unelapsed period of the warranty, or (2) the pro-rata part of the then-current price of the material so repaired or replaced to the unelapsed period of the warranty. The warranty shall continue in effect on the repaired or replaced material for the unelapsed term of the original warranty. To enable the manufacturer's technical staff to properly determine the cause of any alleged defect and to take appropriate steps to effect timely corrective measures if such defect is within the warranty, any claim for alleged breach of warranty will be made and presented in writing to manufacturer within thirty (30) days after the alleged defect was first noticed.

PART 2 PRODUCTS

2.1 TEXTURED HIGH DENSITY POLYETHYLENE (HDPE) MEMBRANE

A. General: The materials supplied under these Specifications shall be first quality products designed and manufactured specifically for the purposes of this work, and which have been satisfactorily demonstrated by prior use to be suitable and durable for such purposes. The materials supplied shall not be manufactured from more than three different lots (resin batches). Conformance testing shall be performed in accordance to Part 1.

B. Description of HDPE Material: The membrane shall be a high-density polyethylene (HDPE) of 60-mil thickness textured, containing no reground additives, fillers, or extenders. Carbon black

2- to 3-percent shall be added to the resin for ultraviolet resistance. Edges along the length of the material shall be smooth. There shall be no more than three (3) lots of geomembrane.

The lining material shall be manufactured a minimum of 20 foot seamless widths, and have the physical characteristics listed in Table 1:

TABLE 1

Property	Test Designation	60-mil Requirement
Sheet thickness, textured	ASTM D 5994	Nominal(- 5%) -10% for individual for 8 out of 10 values -15% for individual for any of the 10 values
Asperity height	ASTM D 7466	10 mil (minimum average)
Specific gravity	ASTM D 1505 ASTM D 792	0.940 (minimum average)
Melt index	ASTM D 1238[1] Condition E	0.1 to 0.3 grams per 10 minutes
Tensile strength yield	ASTM D 6693[1]	minimum 126 pounds per inch
Tensile strength at break	ASTM D 6693[1]	minimum 90 pounds per inch width
Elongation at yield	ASTM D 6693[1]	minimum 12 percent
Elongation at break	ASTM D 6693[1]	minimum 100 percent
Tear resistance	ASTM D 1004	minimum average 28 pounds
Puncture resistance	ASTM D 4833	minimum average 90 pounds
Oxidative induction time (standard) (high pressure)	ASTM D 3895 ASTM D 5885	100 minutes 400 minutes
Oven aging at 85°C (standard OIT) (high pressure OIT)	ASTM D 3895 ASTM D 5885	55 percent retained at 90 days 80percent retained at 90 days
Dimensional stability (each direction)	ASTM D 1204 212°F, 15 minutes	3 percent maximum change
Environmental stress crack	ASTM D 5397	300 hours
Low temperature brittleness	ASTM D 746 Procedure B	minus 76°F
Carbon black content	ASTM D 1603 ASTM D 4218	2 to 3 percent
Carbon black dispersion	ASTM D 5596	9 in Categories 1 or 2, 1 in Category 3

Notes:

1. Type IV Die. ASTM D 6693 test specimen shall be used. The grip separation shall be 2.5 inches. This test does not require the use of extensometers. The rate of grip separation will be 2 inches per minute. A gauge length of 1.3 inches for yield values, and 2.0 inches for break values shall be used to calculate elongation from grip movement.

In addition, the geomembrane shall be produced as to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter, and shall not have striations, pinholes, or bubbles on the surface.

C. Factory Bonded Seam: Calendered HDPE sheeting may not be fabricated into large sections at the factory.

D. Extrusion Joining Resin: Resin for extrusion joining sheets shall be HDPE produced from the same material as the sheet resin and shall be supplied by the Installer. Physical properties shall be the same as those of the resin used in the manufacture of the HDPE liner. The resin shall be supplied in black and/or natural color. Natural resin shall be colored black through addition of 2.0 to 3.0 percent master batch colorant before use.

E. Documentation: Prior to delivery of the geomembrane to the job site, the manufacturer shall be required to provide the Owner with a written certification that the product delivered meets the standards of GRI Standard GM13. The manufacturer shall provide quality control certificates for each batch of resin and each shift's production of geomembrane, and shall follow the quality control testing program and test frequencies as described GRI Standard GM13 and in Part 1 of this Specification. These quality control certificates shall be signed by responsible parties employed by the Manufacturer, and shall be supplied to the Owner. No geomembrane will be permitted to be shipped until the Engineer has accepted such certification. The manufacturer shall permit conformance test sampling by an independent party to be performed at the manufacturing plant prior to shipment if requested.

During production of the material or after delivery of the geomembrane to the job site, the Owner shall test samples of the geomembrane. The frequency of the samples shall be once per 100,000 square feet of geomembrane with a minimum of once per lot (as per QAQC) and tested in accordance with Part 1 and Part 2.

F. Roll Identification: Each roll shall have permanently affixed both inside and outside the roll the following information: name of manufacturer; date of manufacture; resin batch code; thickness of the material; roll number; roll length; and roll width. Unlabeled rolls will not be used and shall be returned to the manufacturer at the manufacturer's expense.

2.2 MISCELLANEOUS MATERIALS (Furnished by Installer)

A. Pipe Boots, Vents, and Patches: All such devices shall be of the same material as the lining or a compatible engineer approved equal.

B. Mechanical Fastenings: Mechanical fastenings shall be of the material, size, and type as detailed on the plans or approved shop drawings.

C. Extrusion Joining Resin: Resin for extrusion joining sheets shall be HDPE produced from the same material as the sheet resin. Physical properties shall be the same as those of the resin used in the manufacture of the HDPE liner. The resin shall be supplied in black and/or natural color. Natural resin shall be colored black through addition of 2.0 to 3.0 percent master batch colorant before use.

PART 3 EXECUTION

3.1 Prior to installing HDPE material, the Installer shall submit, for the Owner's approval, a description or drawing of the method of sheet layout, detailing the orientation of sheets and the direction of the overlap between sheets. The Contractor shall schedule a pre-installation conference. During installation of the geomembrane, the Installer shall label each sheet with the roll number, panel number, and shall keep records of the date it was installed.

3.2 SHIPPING AND HANDLING

A. All handling on-site is the responsibility of the Contractor.

B. The Geosynthetics CQA will verify that:
   1. Handling equipment used on the site is adequate and does not pose any risk of damage to the geomembrane, particularly to the edges of the geomembrane.

C. Prior to use on the site, the Geosynthetics CQA will conduct a visual examination of all rolls for defects and signs of damage. This examination will be conducted without unrolling rolls unless defects or damage are found or suspected. The Geosynthetics CQA will indicate to the Owner's Representative:
   1. Any rolls, or portions thereof, which should be rejected and removed from the site because they have unacceptable flaws; and
   2. Any rolls which contain minor repairable flaws.

D. The Contractor will be responsible for the storage of the geomembrane on-site. The Owner will provide storage space in a location (or several locations) such that on-site transportation and handling are minimized. Geomembrane rolls will be stored on a smooth, dry, level surface in an area where the geomembrane, particularly the roll edge, is protected from damage. Rolls, particularly textured rolls, will not be allowed to get dirty. Rolls will not be stored more than three (3) high. Access will be provided to each end of stored rolls for the examination of identification labels and roll edges. Rolls damaged by the installer will be repaired or replaced by the Installer at no additional cost to the Owner.

3.3 SURFACE PREPARATION

A. Conditions: Surfaces to be lined shall be smooth and free of all angular rocks, stones greater than 1 inch, sticks, roots, sharp objects, or debris of any kind. The surface shall provide a firm, unyielding foundation. No standing water or excessive moisture shall be allowed. Proof rolling the surface shall be performed by the contractor at the request of the Engineer or Owner's Representative.

B. Acceptance: The Installer shall certify in writing to the Owner that the surface to be lined is acceptable. Submittal of written acceptance may proceed incrementally according to installation schedule. No geomembrane shall be placed on subgrade deemed unsuitable by the Installer, Owner's Representative, or the Geosynthetic CQA.

3.4 FIELD SEAMS: The Geosynthetic Quality Assurance Resident Engineer (QARE) can, at his sole discretion, not allow any individual seamer or seaming equipment to be used for the project, based on observations made in the field. The Geosynthetic QARE will notify the Installer of the individual or seaming equipment which may not be used on the project and the reason or steps necessary to demonstrate the person or equipment acceptance on the job. The Installer shall have no recourse for this decision against the Owner, Engineer, or other parties.

A. Layout: Overlap panels in shingle style from high to low elevation. Avoid horizontal seams whenever possible.

B. Preparation: All areas which are to become seam interfaces shall be cleaned of dust and dirt. When extrusion joining is required, the slick surfaces of the HDPE sheet which are to become seam interfaces shall be prepared by sanding or grinding (perpendicular to the seam) to a depth of less than 0.005 inches before joining the sheets. Field joints shall not take place unless the sheet is dry. Cleaning methods may include, but not be limited to, high-pressure washing, scrub brushes, vacuums, etc.

C. Seaming Methods: Installer shall submit to the Owner prior to construction a list of the seaming equipment and testing equipment, including manufacturer and model number that will be used on-site. Field seams shall be made by overlapping adjacent sheets a minimum of 3 inches and a maximum of 6 inches and using one of the following seaming techniques:

1. Hot Air/Hot Wedge: Hot air/hot wedge technique shall be made by either a nozzle which directs hot air between the sheets or a hot metal surface in contact between the sheets. Each seaming unit must include a thermometer giving the temperature of the machine at the nozzle or metal surface. The seaming unit shall maintain a recordable temperature determined by on-site conditions and shall not vary more than 50°F above or below the recommended seaming temperature. The adjacent geomembrane sheet shall be overlapped 6 inches. The overlapped sheets are then pressed together by mechanical means. Seaming equipment that makes a split hot wedge seam will be the preferred method of seaming; single hot wedge seaming will be allowed only with the approval of the Engineer.
2. Extrusion Bonding: Extrusion and fusion bonding will be limited to areas where hot wedge cannot be used, such as pipe boots, and to any necessary repairs. The use of extrusion and fusion bonding as the primary seaming method will be allowed only with the approval of the Engineer. The adjacent sheets to be seamed shall be overlapped a minimum of 3 inches. The joining procedure shall consist of softening the liner material by heated air. The temperature of the air impinging on the sheet for this purpose shall range from 420°F to 680°F. The exact temperature used shall be determined by the installation supervisor. Directly following the application of heat, a one and one-half inch minimum width strip of the same high-density polyethylene resin from which the sheet is made shall be extruded between the overlapped sheets. The temperature of the resin as it emerges from the extrusion die shall range from 428°F to 536°F. The overlapped sheets shall be firmly pressed together by mechanical means to form the extrusion joint.
3. Fusion Bonding: Extrusion and fusion bonding will be limited to areas where hot wedge cannot be used, such as pipe boots, and to any necessary repairs. The major seaming of the

liner will be done with hot wedge. Fusion bonding shall be by means of a homogeneous overlap extrusion fusion process which provides continuous dynamic integration of the extrudate bead with the lining material. The composition of the extrudate shall be identical to the lining material. The seaming unit shall be capable of continuously monitoring and controlling the temperature of the extrudate and the zone of contact where the machine is actually fusing the lining material. Temperature of the extrudate shall range from 428°F to 536°F.

D. Tie-in Seams and Cross-Seams (Butt Seam): Seaming of geomembrane at new/new geomembrane that has become soiled and all geomembrane connections shall be properly prepared prior to seaming. All tie-in seams shall be pressure washed, steam-cleaned, and/or scrubbed (as required by the Geosynthetics CQA) to remove dirt or other deposits on the geomembrane. No seaming will take place on dirty or soiled geomembrane. The CQA shall inspect the tie-in preparation prior to seaming. The installer shall trial weld representative samples taken from the seaming area. Passing trial welds shall be attained in accordance with Section 4.03(B).

E. Seaming Wrinkles: Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle, back into the panel so as to affect a flat overlap. The cut fishmouths or wrinkles shall be seamed as well as possible, and shall then be patched with an oval or round patch extending a minimum of 6 inches beyond the cut in all directions.

F. Repairs: Any required repair of scratches greater than five (5) percent of the sheet thickness and small holes in the liner surface shall be made with the extrusion hand welder. Liner material shall be cleaned of all dirt, dust and other foreign material, all smooth HDPE surfaces roughened, air heated to the prescribed temperature, and a strip of HDPE resin extruded over the hole to produce an extruded welded repair.

G. Quality of Workmanship: All joints, on completion of the work, shall be tightly bonded. Any lining surface showing injury due to crimping, scuffing, penetration by foreign objects or distress from rough subgrade shall, as directed by the Owner's Representative, be replaced or covered and sealed with an additional layer of HDPE of the proper size. The Installer shall inspect the final installation and any defects shall be repaired and tested until satisfactory.

H. No seaming shall be allowed if the Geosynthetic CQA is not on-site.

3.5 PIPE BOOTS, VENTS, MECHANICAL FASTENINGS AND PATCHES

A. The geomembrane shall be installed around any pipes, concrete structures or other penetrations through the geomembrane in accordance with the detailed Specifications and as shown on the Contract Drawings. Prior to the start of construction, the Installer may provide, for the approval of the Engineer, alternate installation methods or details to successfully perform geomembrane termination.

B. All clamps, bolts, nuts, gaskets, or other materials used to secure the geomembrane shall be compatible with and have a lifespan at least equal to that of the geomembrane.

C. Care shall be taken to protect the underside of the geomembrane from damage due to settling at any underbedding to concrete transition.

D. Extreme care shall be taken while welding around any penetration or similar structure since destructive testing is not likely to be possible in such areas. All seaming in these areas shall be performed by the Installer's Master Seamer and the operations shall be observed on a full time basis by the Owner's Representative. Non-destructive electric spark test of both the skirt and sleeve of the pipe boot shall be performed as described in Section 3.8 of this specification.

3.6 SEAMING WEATHER CONDITIONS

A. The normal required weather conditions for seaming are as follows:
   1. Ambient temperature between 32°F and 104°F.
   2. Dry conditions, i.e. no precipitation or other excessive moisture, such as fog or dew.
   3. No excessive winds as determined by the Installer or Engineer.
   4. The Geosynthetic CQA shall verify that these weather conditions are fulfilled and notify the Project Manager in writing if they are not. Ambient temperature shall be measured by the Geosynthetic CQA in the area in which the panels are to be placed. The Project Manager will then decide if the installation is to be stopped or special procedures used.

B. To assure a quality installation, if seaming is conducted when the ambient temperature is below 32°F, the following conditions must be met:
   1. Geomembrane surface temperatures shall be determined by the Geosynthetic CQA at intervals of at least once per 100 feet of seam length to determine if preheating is required. For extrusion welding, preheating is required if the surface temperature of the geomembrane is below 32°F.
   2. Preheating may be waived by the Project Manager based on a recommendation from the Geosynthetic QARE, if the Installer demonstrates to the Geosynthetic QARE's satisfaction that welds of equivalent quality may be obtained without preheating at the expected temperature of installation.
   3. If preheating is required, the Geosynthetic QARE shall inspect all areas of geomembrane that have been preheated by a hot air device prior to seaming, to assure that they have not been overheated.
   4. Care shall be taken to confirm that the surface temperatures are not lowered below the minimum surface temperatures specified for welding due to winds or other adverse conditions. It may be necessary to provide wind protection for the seam area.
   5. All preheating devices shall be approved prior to use by the Engineer.
   6. Additional destructive tests shall be taken at an interval between 250 feet and 500 feet of seam length, at the direction of the Geosynthetic QARE.
   7. Sheet grinding may be performed before preheating, if applicable.
   8. Trial seaming shall be conducted under the same ambient temperature and preheating conditions as the actual seams. Under cold weather conditions, new trial seams shall be conducted if the ambient temperature drops by more than 5°F from the initial trial seam test conditions.
   9. All snow and ice shall be removed from the liner using plastic shovels. The CQA will also have authority to suspend installation activities during severe weather conditions.

C. <u>Warm Weather Conditions:</u>
   1. At ambient temperatures above 104°F, no seaming of the geomembrane shall be permitted unless the Installer can demonstrate to the satisfaction of the Engineer that geomembrane seam quality is not compromised.

2. Trial seaming shall be conducted under the same ambient temperature conditions as the actual seams.
3. At the option of the Geosynthetic QARE, additional destructive tests may be required for any suspect areas.

3.7 QUALITY CONTROL DURING INSTALLATION

A. All work shall be performed under the direction and to the satisfaction of the Geosynthetic QARE.

B. Site Test Equipment: The Installer shall maintain on site, in good working order, the following items:
   1. Field Tensiometer: The tensiometer shall be motor driven and have jaws capable of traveling at a measured rate of 2 inches per minute. The tensiometer shall be equipped with a gauge which measures the force in unit pounds exerted between the jaws. The installer shall provide a current certificate of calibration for each tensiometer used.
   2. Vacuum Box: The vacuum box shall consist of a rigid housing with a transparent viewing window on top and a soft, closed-cell neoprene gasket attached to the bottom of the housing. The housing shall be equipped with a bleed valve. A separate vacuum source shall be connected to the vacuum box such that a negative pressure can be created and maintained between 4 and 8 inches of mercury to the box. A sudsy solution consisting of soap and distilled water shall be dispensed on the seam immediately ahead of the vacuum box.
   3. Air Pressure Test Equipment: This method shall apply only when the split hot wedge seaming method is used. Equipment shall consist of an air pump capable of generating and maintaining a positive pressure of between 20 and 30 pounds per square inch. A manometer capable of reading up to 30 pounds per square inch attached to a needle or nipple shall be used to pressurize the air channel in the seam.
   4. Electric Spark Test Equipment: This method shall be utilized for both the sleeve and the skirt of all pipe boot membrane penetrations. Equipment shall consist of a portable pulse-type detector, equipped with a brush-type electrode, charged with a low amperage current of 20,000 to 30,000 volts, and a continuous length of 24-gauge copper wire placed under the geomembrane seam.
   5. Alternative testing methods shall be submitted to the Owner or Owner's Representative for approval prior to commencement of testing.

C. Non-Destructive Testing
   1. Thickness: Upon deployment of individual panels, the Owner's Representative shall randomly check the thickness at a minimum of once per roll or once per 500 linear feet (minimum), in conformance with the specification in Section 2.01.
   2. Test Seams
      a. Test seams shall be made at a minimum every 5 hours to verify that adequate conditions exist for field seaming to proceed. Each seamer shall produce a test seam at the beginning of each shift. In addition, if a seaming operation has been suspended for more than 1 hour or if a breakdown of the seaming equipment occurs, a test seam shall be produced prior to resumption of seaming operations.
      b. Test seams shall be made in the field on pieces of the approved geomembrane. Each test seam shall be at least 5 feet long by 1 foot wide and with sufficient overlap for peel testing in the field tensiometer.

c. Five samples 1 inch wide shall be taken across the seam using an approved template. The samples shall be tested in the field tensiometer, four in peel and one in shear and shall meet the requirements of Section 3.9(D).

d. If the seam fails to pass, the seaming apparatus shall not be used for field seaming until any deficiencies have been corrected. This shall be verified by the production and successful testing of two consecutive test seams.

3. Vacuum Testing

a. All extrusion welded and solid fusion welded seams shall be evaluated using vacuum box testing. Any seam overlap will be trimmed prior to testing.

b. A sudsy solution shall be applied to the test section and the vacuum box placed over the section. The bleed valve is then closed and the vacuum valve opened. Once a tight seal has been established (2.5 to 3.0 pounds per square inch), the test section shall be visually examined for a period of not less than 15 seconds to determine whether bubbling of the soapy solution is occurring. The vacuum box is then moved and the process is repeated on the next adjacent section. A minimum 3 inch overlap shall be provided between all test sections.

c. All locations where bubbling of the sudsy solution was observed shall be clearly marked for repairs with a high visibility marker and recorded by number on field test reports. Any failed portion of seam shall be repaired by cap strip in accordance with Section 3.9(E).

4. Air Pressure Testing

a. All hot air/hot wedge seams shall be evaluated using air pressure testing. The seam shall be sealed off at one end and air passed through insuring an open passage. Once the seam is proven continuous the second end of the seam shall be sealed. If a seam end will be an integral part of the geomembrane the sealing shall be done in such a way that it does not harm the geomembrane. The seam should be pressurized to 24 to 30 pounds per square inch. The feed valve shall be closed and the pressure sustained for a period of not less than 5 minutes. If a pressure loss of greater than 4 pounds per square inch is observed or if the required pressure cannot be reached then the seam shall be rejected.

b. All faulty areas along the seam shall be identified and repaired by cap strip in accordance with Section 3.8(E). Vacuum testing shall be allowed on split wedge welds only when the faulty area cannot be isolated using air pressure testing. Any overlapping material must be removed prior to vacuum testing. All holes created during air pressure testing shall be sealed on completion of the test and vacuum tested.

c. All seams shall be non-destructively tested by the Installer over their full length to verify the integrity of the seam. Non-destructive testing shall be performed concurrently with field seaming. Prefabricated field seams which will be inaccessible after installation, such as those under structures or fastened to penetrations, shall be tested prior to final installation. All non-destructive testing shall be observed and documented by the Geosynthetic CQA.

d. Approved non-destructive testing procedure is as above. Alternate procedures shall be approved by the Owner or Owner's Representative and the Geosynthetic CQA prior to the commencement of non-destructive testing.

D. Destructive Testing

1. Destructive testing of field seams shall be performed at selected locations in order to verify the criteria given in section "Test Seams." All sampling and testing shall be done

concurrently with field seaming so that verification of field seam properties is made as the work progresses and corrective action implemented.

2. Test samples shall be taken at an average frequency of one test location per 1,000 linear feet of seam for dual-wedge seams and one test per 500 linear feet of seam for extrusion seams. A minimum of one sample shall be taken from each seam that connects to the existing geomembrane liner. More frequent sampling shall be performed at the discretion of the Geosynthetic CQA based on field trial welds, destructive seam test results, weather conditions, inspection of seams, and overall seaming performance. Sample locations shall be determined by the Geosynthetics CQA. The Installer shall not be informed in advance of the locations where the seam samples will be taken.
3. The Geosynthetic CQA may increase the amount of destructive testing based on the results of previous testing. Additional samples may also be required when the Geosynthetic QARE has reason to suspect the presence of excess crystallinity, contamination, faulty seaming equipment or any other reason affecting seam quality.
4. The test sample shall measure approximately 12 inches wide by 42 inches long with seam centered lengthwise along the sample. Two 1-inch wide sample strips shall be cut using an approved template from both ends of the sample. These strips shall be tested by the Installer in the field tensiometer in both peel and shear in accordance with section "Test Seams." The remainder of the sample shall be cut into two 12-inch lengths, and one 18-inch length. The 18-inch sample shall be taken by the Geosynthetic QARE for independent laboratory testing; of the remaining two, one shall be given to the Installer for his own records or testing, and one shall be kept by the Owner for permanent record.
5. Samples shall be cut by the Installer under the direction of the Geosynthetic QARE. Each sample shall be indelibly numbered and identified. The sample number and location shall be recorded by the Installer on the panel layout drawing and on the sheet where the sample was taken.
6. The results of laboratory testing shall be made available to the Installer by the Geosynthetic QARE not more than 48 hours after the samples have been received by the testing facility. The results of laboratory testing shall determine the acceptability of a seam. Laboratory testing shall be performed in accordance with the methods given in ASTM D 6693 and ASTM D 6392 and meet the following criteria:

Test	Test Designation	Requirement
Bonded Seam Strength (Shear)	ASTM D 6392 and ASTM D 6693	4 of 5 coupons must be greater than 90% of parent material strength with none less than 70% of parent material strength* and have an acceptable mode of rupture
Peel Adhesion (both tracks)	ASTM D 6392 and ASTM D 6693	4 of 5 coupons on each side of the weld must be greater than 60% of parent material strength* or 70% of the specified value, whichever is greater, with none less than 50% of parent material strength* and have an acceptable mode of rupture

* Parent material strength shall be determined by sampling actual sheets adjacent to the destructive test location in the same direction the seam is tested (using the lower value of the two sheets) or by using conformance testing results or manufacturer's roll certification information. The Geosynthetic CQA is responsible for reviewing both the conformance and roll certification test results to determine the parent material strength value. The Project Manager and the PADEP shall approve the parent material strength value.

Tests for peel adhesion and Shear shall be in a free condition (not 90° or 180°). Acceptable Locus of break codes for the specimen rupture mode shall be the following:

For Dual Wedge Seams: BRK, SE1, SIP and AD-BRK ≤ 25% adhesion failure;

For Extrusion Welds: SE1, SE2, SE3, BRK1, BRK2, HT, SIP, AD-WLD if strength is achieved, AD-BRK ≤ 25% adhesion failure.

Any seam that fails laboratory testing shall be repaired in accordance with section 3.8(E). The costs of repairing and retesting areas which failed destructive tests shall be the responsibility of the Installer.

The area from which the destructive test sample was taken shall be repaired without delay in accordance with the procedures given in 3.8(E).

E. Inspection and Acceptance
   1. As the work progresses, the Geosynthetic QARE shall document all locations requiring repair work and shall verify and document that all repairs have been successfully made by the Installer.
   2. A field seam shall only be considered acceptable when bounded by two destructive test locations which have passed laboratory testing and applicable non-destructive testing. The following procedures shall apply in the event that a seam fails laboratory testing:
      a. The Installer may reconstruct the seam with cap strips between the previous passing test location and the next passing test location (up to a maximum 75 feet) and retest, or;
      b. The Installer may elect to trace the extent of an unacceptable seam to some intermediate location. This shall involve taking 1-inch template-cut cross-sections from the seam at a minimum distance of 10 feet in both directions from the failed test location. These samples shall be tested in the field tensiometer in both shear and peel in accordance with section "Test Seams." If one or both of these samples fail the field test, tracing along the seam shall continue at minimum 10-foot increments until a passing result is recorded in both directions from the failed test location. At these locations large samples shall be cut for laboratory testing as in section "Destructive Testing." If laboratory testing verifies the acceptability of the seam at these locations, the Installer shall reconstruct the seam (with cap strips) between the two passing test locations. If laboratory testing shows the seam to be unacceptable, the Installer shall further trace the unacceptable seam until acceptable test results are recorded in both directions.
   3. Reconstructed seams shall be capped by cutting out the unacceptable seam, at least 6 inches each side of the seam and a minimum 6 inches beyond the defect, and patching with an acceptable material.

4. Reconstructed seams less than 150 feet in length shall be non-destructively tested in accordance with "Non-Destructive Testing - 3.08(C)." Reconstructed seams greater than 150 feet in length shall be destructively tested in accordance with "Destructive Testing - 3.8(D)."

F. Overburden

1. The Geosynthetic QARE shall monitor all overburden soils over the geomembrane liner and geocomposite. The Geosynthetic QARE shall identify any large wrinkles which may have been built into the geomembrane. Any such wrinkle not built in to accommodate thermal contraction of the geomembrane prior to placement of the overburden shall be cut, repaired, and tested by the Installer. If the geomembrane has a vertical height greater than 6 inches the material placement must cease until placement can occur without potential damage due to over turning.
2. The Geosynthetic QARE shall identify any slope toe, declivity, or other surface transitions which might result in bridging of the geomembrane during placement of the overburden above the geocomposite. Any such area shall be cut, repaired, and tested by the Installer.
3. Equipment used for placing and compacting the overburden shall not be driven directly on the geocomposite overlying the geomembrane. Such equipment shall be closely monitored during placement to ensure that no damage occurs.
4. A minimum thickness of 1 foot of cover shall be maintained between the geocomposite overlying the geomembrane and light earth moving equipment. Such equipment shall have a maximum ground pressure of 5 pounds per square inch. Equipment shall have no cleats and no turning of any equipment shall be allowed on the initial 1 foot of cover. A minimum thickness of 2 feet of cover shall be maintained between the geocomposite overlying the geomembrane and all balloon tired earthmoving equipment.
5. In all cases, the placement of overburden shall be done with caution and in a manner which is least likely to cause wrinkles in, or damage to, the geomembrane.
6. For grades greater than 2 percent, all soil placement shall be done in an upslope direction. Pushing of cover materials over the geosynthetics should be minimized, as much as possible. Loaders and backhoes equipped with tracks shall be used in placing final cover.
7. The geosynthetics must be protected when laying down metal objects with rub sheets. Only plastic shovels shall be use on the geosynthetics.

3.8 COMPLETION OF WORK

A. Requirements:

1. The installation of the geomembrane shall be considered totally complete when: all required deployment, seaming, repairs, testing, and site clean-up have been completed by the Installer; the Installer has submitted all the required quality control certificates to the Owner; and the Geosynthetic QARE is satisfied that the geomembrane has been installed in accordance with the above Specification

END OF SECTION

SECTION 31 05 16 - AGGREGATES FOR EARTHWORK

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Coarse aggregate materials.
   2. On site Materials.

B. Related Sections:
   1. Section 31 22 13 - Rough Grading.
   2. Section 31 23 17 - Trenching.
   3. Section 31 23 23 - Fill.
   4. Section 31 37 00 - Riprap.
   5. Section 32 91 19 - Landscape Grading.
   6. Section 33 41 00 - Storm Utility Drainage Piping.
   7. Section 33 46 00 - Subdrainage: Filter aggregate.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:
   1. AASHTO M147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.
   2. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 10-lb Rammer and a 18-in. Drop.

B. ASTM International:
   1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3).
   3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3).
   4. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
   5. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Samples: Submit sample of each type of fill to testing laboratory.

C. Materials Source: Submit name of imported materials suppliers.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

B. Perform Work in accordance with State of North Carolina standards.

PART 2 PRODUCTS

2.1 COARSE AGGREGATE MATERIALS

A. ABC Gravel: Crushed gravel mixed with sand furnished and placed to the lines and grades shown on the Drawings. The material passing the No. 40 sieve shall not have a liquid limit (LL) in excess of 30 nor a plasticity index (PI) in excess of 6. Sieve analysis by weight:

U.S. Standard Sieve Size	Percent Passing by Weight
1 ½ inch	100
1 inch	75 to 97
½ inch	55 to 80
No. 4	35 to 55
No. 10	25 to 45
No. 40	14 to 30
No. 200	4 to 12

B. #57 Stone: Durable, clean angular rock fragments obtained by breaking and crushing rock material, furnished, and placed to the lines and grades as shown on the Drawings. Sieve analysis by weight:

U.S. Standard Sieve Size	Percent Passing by Weight
1 ½ inch	100
1 inch	95 to 100
½ inch	25 to 60
No. 4	0 to 10
No. 8	0 to 5
No. 200	0 to 0.6

C. #78M Stone: Shall be furnished and placed to the lines and dimensions as shown on the Drawings to provide a drainage blanket between the synthetic liner and the waste, as identified in the Drawings.

U.S. Standard Sieve Size	Percent Passing by Weight
¾ inch	100
½ inch	98 to 100
3/8 inch	75 to 100
No. 4	20 to 45
No. 8	0 to 15
No. 200	0 to 0.6

D. #5 Stone: Shall be furnished and placed to the lines and dimensions as shown on the Drawings to provide a drainage in the sump area.

U.S. Standard Sieve Size	Percent Passing by Weight
1 ½ inch	100
1 inch	90 to 100
3/4 inch	20 to 55
½ inch	0 to 10
3/8 inch	0 to 5
No. 200	0 to 0.6

E. Common Borrow: Shall be earth, suitable for embankment construction or use in any base filling greater than one (1) foot below the synthetic liner. It shall be free of frozen material, perishable rubbish, peat, organic matter, large rock fragments, or other unsuitable material. AASHTO M145 Classifications A-1 through A-5 may be used. Use of other materials as common borrow is at the discretion of the Owner's Representative and only in approved areas.

F. Gravel Borrow: Shall consist of uniformly graded granular material having no rocks with a maximum dimension of over 6 in. and that portion passing a 3-in. square mesh sieve shall contain not more than 70 percent passing a 1/4 - in. mesh sieve and not more than 10 percent passing a No. 200 mesh sieve.

G. Compacted Soil Liner: Screened material shall be furnished and placed to the lines and dimensions as shown on the drawings to construct the cell division berm and any base filling requirements within one (1) foot of the synthetic liner. The soil shall not contain particles of rock which will not pass the 1-inch square mesh sieve. The soil shall have greater than 20 percent passing the U.S. Standard No. 200 Sieve, based on the portion of the sample passing the U.S. Standard No. 4 sieve.

2.2 ON-SITE MATERIAL

A. Material on the site is the property of the Owner and, if suitable, shall be incorporated in the contract work. The Owner's Representative shall classify the material under Article 2 headings. Any sample testing needed for this classification will be performed by an approved laboratory at the Owner's expense.

B. Material not incorporated in the work because it is unsuitable will be hauled away and disposed of at the Contractor's expense.

1. Material designated to be wasted by the Owner's Representative will be disposed of by the Contractor.

2. Material designated to be saved by the Owner's Representative will be stockpiled at a location shown on the drawings or designated by the Owner's Representative.

3. Unsuitable material shall consist of grubbings or other materials which contain rock of size exceeding specifications, organic materials, or other materials of a deleterious nature as deemed by the Owner's Representative.

2.3 SOURCE QUALITY CONTROL

A. Aggregate Material – The Contractor shall employ a testing laboratory acceptable to the Owner's Representative to perform the following testing and analysis: Perform a minimum of 1 gradation in accordance with ASTM D422 and a minimum of 1 maximum dry density in accordance with ASTM D698 per source, or with each change of material, or per the following table:
   1. #57 Stone – 1 gradation test per 5,000 cubic yards.
   2. #78M Stone – 1 gradation test per 3000 cubic yards.
   3. Common Borrow
      a. Grain Size – 1 gradation test per 1000 cubic yards
      b. Moisture Density (D690) 1 test per 10,000 cy
   4. Compacted Soil Liner
      a. Grain Size – 1 test per 2,500 cy
      b. Moisture Density (D698) – 1 test per 2,500 cy
   5. ABC Gravel
      a. Gradation Test – 1 per 2,500 cy
      b. Moisture Density – 1 per 5,000 cy

B. Test Reports: Two copies of the borrow source reports will be submitted directly to the Owner's Representative with copy to the Contractor. The Contractor shall schedule his operation and submissions so the Owner's Representative has sufficient time to review the test results prior to delivery and/or use of the material at the site.

C. When tests indicate materials do not meet specified requirements, change material and retest.

PART 3 EXECUTION

3.1 EXCAVATION

A. Excavate aggregate materials from on-site locations indicated as specified in Section 31 22 16.

B. Stockpile excavated material meeting requirements for coarse aggregate materials.

C. Remove excess excavated materials not intended for reuse, from site.

D. Remove excavated materials not meeting requirements for coarse aggregate materials from site.

3.2 STOCKPILING

A. Stockpile materials on site at locations indicated.

B. Stockpile in sufficient quantities to meet Project schedule and requirements.

C. Separate different aggregate materials with dividers or stockpile individually to prevent mixing.

D. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

E. Stockpile hazardous materials on impervious material and cover to prevent erosion and leaching, until disposed of.

3.3 STOCKPILE CLEANUP

A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

SECTION 31 10 00 - SITE CLEARING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Removing surface debris.
   2. Removing designated paving, curbs, and other site features.
   3. Removing designated trees, shrubs, and other plant life.
   4. Removing abandoned utilities.
   5. Excavating vegetative growth media.

B. Related Sections:
   1. Section 31 22 13 - Rough Grading.
   2. Section 31 23 18 - Rock Removal.

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data for herbicide. Indicate compliance with applicable codes for environmental protection.

1.3 QUALITY ASSURANCE

A. Conform to applicable code for environmental requirements, disposal of debris, burning debris on site, and use of herbicides.

B. Perform Work in accordance with State of North Carolina Department of Environment and Natural Resources

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify existing plant life designated to remain is tagged or identified.

C. Identify waste area and salvage area for placing removed materials.

3.2 PREPARATION

A. Call Local Utility Line Information service at 811 not less than three working days before performing Work.
   1. Request underground utilities to be located and marked within and surrounding construction areas.

3.3 PROTECTION

A. Locate, identify, and protect utilities indicated to remain, from damage.

B. Protect trees, plant growth, and features designated to remain, as final landscaping.

C. Protect bench marks, survey control points, and existing structures from damage or displacement.

3.4 CLEARING AND GRUBBING

A. Clear areas required for access to site and execution of Work.

B. Remove trees and shrubs indicated. From excavated areas (cut) all stumps, roots and other obstructions shall be grubbed to a depth of not less than 12-inches below finish grade.

   In embankment areas where there is greater than 50 feet of fill, all stump roots, roots, topsoil, and other material shall be left in-place. Trees (greater than 3-inches in diameter) shall be cut and removed and no stumps shall be left higher than the stump top diameter. In no case shall the stump diameter be more than 12-inches. Brush and saplings shall be cut and laid flat on ground surface. There shall not be any piles of woody vegetation created beneath the embankment fill areas.

C. Clear undergrowth and deadwood, without disturbing subsoil.

D. Apply herbicide to remaining stumps to inhibit growth.

3.5 REMOVAL

A. Remove debris, rock, and extracted plant life from site.

B. Remove paving, curbs, and other site features as indicated on Drawings. Neatly saw cut edges at right angle to surface.

C. Remove abandoned utilities. Indicated removal termination point for underground utilities on Record Documents.

D. Continuously clean-up and remove waste materials from site. Do not allow materials to accumulate on site.

E. Do not burn or bury materials on site. Leave site in clean condition.

3.6 TOPSOIL EXCAVATION

A. Excavate vegetative growth media from areas to be further excavated, re-landscaped, or re-graded, without mixing with foreign materials for use in finish grading.

B. Do not excavate wet vegetative growth media.

C. Stockpile in area designated on site to depth not exceeding 8 feet and protect from erosion.

D. Remove excess vegetative growth media not intended for reuse, from site.

END OF SECTION

SECTION 31 22 13 - ROUGH GRADING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Excavating vegetative growth media.
   2. Excavating subsoil.
   3. Cutting, grading, filling, rough contouring, compacting site for site structures, building pads, and fill.

B. Related Sections:
   1. Section 31 05 13 - Soils for Earthwork: Soils for fill.
   2. Section 31 05 16 - Aggregates for Earthwork: Aggregates for fill.
   3. Section 31 10 00 - Site Clearing: Excavating vegetative growth media.
   4. Section 31 23 17 - Trenching: Trenching and backfilling for utilities.
   5. Section 31 23 18 - Rock Removal.
   6. Section 31 23 23 - Fill: General building area backfilling.
   7. Section 32 91 19 - Landscape Grading: Finish grading with vegetative growth media to contours.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:
   1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 10-lb Rammer and a 18-in. Drop.

B. ASTM International:
   1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400 ft-lbf/ft3.
   3. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
   4. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft-lbf/ft3.
   5. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
   6. ASTM D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
   7. ASTM D2434 - Standard Test Method for Permeability of Granular Soils (Constant Head).
   8. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
   9. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Samples: Submit sample of each type of fill to testing laboratory.

C. Materials Source: Submit name of imported materials suppliers.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

PART 2 PRODUCTS

2.1 MATERIALS

A. Vegetative Growth Media: As specified in Section 31 05 13.

B. Coarse Aggregates: Type as specified in Section 31 05 16.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify site conditions prior to starting construction.

B. Verify survey bench mark and intended elevations for the Work are as indicated on Drawings.

3.2 PREPARATION

A. Call Local Utility Line Information service at 811 not less than three working days before performing Work.
   1. Request underground utilities to be located and marked within and surrounding construction areas.

B. Identify required lines, levels, contours, and datum.

C. Notify utility company to remove and relocate utilities.

D. Protect utilities indicated to remain from damage.

E. Protect plant life, lawns and other features remaining as portion of final landscaping.

F. Protect bench marks, survey control point, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

3.3 SUBSOIL EXCAVATION

A. Excavate subsoil from areas to be further excavated, relandscaped, or regraded.

B. Do not excavate wet subsoil or excavate and process wet material to obtain optimum moisture content.

C. When excavating through roots, perform Work by hand and cut roots with sharp axe.

D. Remove excess subsoil not intended for reuse, from site.

E. Benching Slopes: Horizontally bench existing slopes greater than as shown on plans to key placed fill material to slope to provide firm bearing.
   1. Plow, strip or break-up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.

F. Stability: Replace damaged or displaced subsoil as specified for fill.
   1. When existing ground surface has a density less than that specified, break up ground surface, pulverize, moisture-condition to optimum moisture content and compact to required depth and percentage of maximum density.

3.4 FILLING

A. Fill areas to contours and elevations with unfrozen materials as promptly as work permits, but not until completion of the following:
   1. Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
   2. Inspection by Owner's Representative, testing, approval, and recording locations of underground utilities.

B. Place fill material in continuous layers and compact in accordance with schedule at end of this section.

C. Maintain optimum moisture content of fill materials to attain required compaction density.
   1. Moisture content of the liner subgrade soil shall be at 0 to 4 percent above optimum as determined by ASTM D698.
   2. Moisture content of embankment soils (common borrow) shall be less than 2 percent above optimum moisture as determined by ASTM D698.
   3. Where subgrade or layer of soil material must be moisture conditioned to meet the allowable range of water content to achieve compaction, uniformly apply water to surface of subgrade, or layer of soil material. Apply water in manner to prevent free water appearing on surface during or subsequent to compaction operations.
   4. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
      a. Soil removed may be spread and allowed to dry.

D. Make grade changes gradual. Blend slope into level areas.

E. Repair or replace items indicated to remain damaged by excavation or filling.

3.5 TOLERANCES

A. Top Surface of Subgrade: Plus or minus 1/10 foot from required elevation.

3.6 FIELD QUALITY CONTROL

A. Perform laboratory material tests in accordance with ASTM D698.

B. Perform in place compaction tests in accordance with the following:
   1. Density Tests: ASTM D1556, ASTM D2167, or ASTM D2922.
   2. Moisture Tests: ASTM D3017.

C. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

D. Frequency of Tests:
   1. Common Borrow: 4 tests/acre lift or at Engineer's discretion.
   2. Compacted Soil Liner: 10 tests/acre/lift.
   3. ABC Gravel: 1 test per 100 lf/lift.

3.7 SCHEDULES

A. Common Borrow and Compacted Soil Liner: To provide for clod break-up of the material, a minimum number of 2 passes will be made with deep footed pad roller. To eliminate desiccation cracks the surface will be moistened (as necessary) and reworked with 2 passes of a smooth drum roller. Desiccation is defined as moisture content below optimum, or cracks deeper than 1 inch. The cover soil shall be compacted and smooth drum rolled at the end of each work day to provide for moisture/density testing and prevent ponding of surface water overnight.
   1. The following equipment will be used for compaction of the cover material:
      a. Caterpillar E25H Pad Foot Roller or equivalent equipment approved by the Engineer. Equivalent equipment shall meet the following specifications:
         1) Minimum Operating Weight — 72,000 lbs
         2) Maximum Pad Tip Area — 18 square inches
         3) Minimum Pad Height — 7.5 inches
         4) Minimum Wheel Diameter — 66 inches
   2. The following equipment will be used to obtain a smooth roll surface:
      a. Caterpillar CS563 Vibratory Drum Roller or equivalent equipment approved by the Engineer. Equivalent equipment shall meet the following specifications:
         1) Minimum Operating Weight — 24,500 lbs
         2) Vibration Frequency — 1,400 to 1,800 vpm
         3) Centrifugal Force
            a) High Amplitude — 50,000 lbs
            b) Low Amplitude — 35,000 lbs
         4) Maximum Drum Width — 7.0 feet
   3. Sealing the lifts will encourage runoff from storms, thus limiting development of excessively moist or wet lenses of soil within the barrier layer. The lift surface shall be scarified or otherwise roughened by tracking with a bulldozer prior to placing the next lift of silt-clay to promote good bonding between lifts.

B. Dikes:
   1. Fill Depth: 12 inches thick (compacted).
   2. Compact uniformly to minimum 90% (D698) percent of maximum density.

SECTION 31 23 16 - EXCAVATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Excavating for building foundations.
   2. Excavating for paving, roads, and parking areas.
   3. Excavating for slabs-on-grade.
   4. Excavating for site structures.
   5. Excavating for landscaping.

B. Related Sections:
   1. Section 31 05 13 - Soils for Earthwork: Stockpiling excavated materials.
   2. Section 31 05 16 - Aggregates for Earthwork: Stockpiling excavated materials.
   3. Section 31 22 13 - Rough Grading: Vegetative growth media and subsoil removal from site surface.
   4. Section 31 23 17 - Trenching: Excavating for utility trenches.
   5. Section 31 23 18 - Rock Removal: Removal of rock during excavating.
   6. Section 31 23 23 - Fill.

1.2 REFERENCES

A. Local utility standards when working within 24 inches of utility lines.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 PREPARATION

A. Call Local Utility Line Information service at 811 not less than three working days before performing Work.
   1. Request underground utilities to be located and marked within and surrounding construction areas.

B. Identify required lines, levels, contours, and datum.

C. Notify utility company, Owner and Owner's Representative to remove and relocate utilities.

D. Protect utilities indicated to remain from damage.

E. Protect plant life, lawns, rock outcroppings and other features remaining as portion of final landscaping.

F. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

3.2 EXCAVATION

A. Underpin adjacent structures which may be damaged by excavation work.

B. Excavate subsoil to accommodate paving, site structures, and construction operations.

C. Slope banks with machine to angle of repose or less until shored.

D. Do not interfere with 45 degree bearing splay of foundations.

E. Grade top perimeter of excavation to prevent surface water from draining into excavation.

F. Trim excavation. Remove loose matter.

G. Remove lumped subsoil, boulders, and rock up to 1/3 cu yd measured by volume. Remove larger material as specified in Section 31 23 23.

H. Notify Engineer of unexpected subsurface conditions.

I. Correct areas over excavated as specified for authorized excavations of same classification, unless otherwise directed by Engineer.

J. Stockpile satisfactory excavated materials where directed, until required for backfill or fill.
   1. Place, grade and shape stockpiles for proper drainage.
   2. Cover or seed stockpiles as specified.
   3. Place silt fence around downstream edge of stockpile to prevent transportation of soil.

K. Repair or replace items indicated to remain damaged by excavation.

3.3 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

B. Request inspection of excavation and controlled fill operations by Owner's Representative.

C. Request visual inspection of bearing surfaces by Owner's Representative before installing subsequent work.

3.4 PROTECTION

A. Prevent displacement or loose soil from falling into excavation; maintain soil stability.

B. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

C. Protect structures, utilities and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth operations.

END OF SECTION

SECTION 31 23 18 - ROCK REMOVAL

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Removing identified and discovered rock during excavation.
   2. Explosives to assist rock removal.
   3. QA/QC personnel including: Blast Consultant and Blast Control Specialist
   4. Blasting Plan requirements.
   5. Blast Monitoring requirements (fly rock, vibration and Air Blast)

B. Related Sections:
   1. Section 31 22 13 - Rough Grading.
   2. Section 31 23 16 - Excavation: Building excavation.
   3. Section 31 23 17 - Trenching: Trenching and backfilling for utilities.
   4. Section 31 23 23 - Fill: Backfill materials.
   5. Section 31 37 00 - Riprap.

1.2 REFERENCES

A. National Fire Protection Association:
   1. NFPA 495 - Explosive Materials Code.

1.3 DEFINITIONS

A. Air Blast: A transient air pressure impulse generated by explosions.

B. Blast Consultant: The Blast Consultant shall be a person with extensive knowledge of noise vibration, air blast pressure, and visual impacts of blasting operations, and who is specialized in the detonation of explosives, particularly in the field of rock removal operations. The Blast Consultant shall be provided by the CONTRACTOR.
   1. The Blast Consultant must have at least 20 years of experience in construction blasting. They must be able to demonstrate involvement in at least five (5) projects with blasting within 1,000 feet of residential structures. The Blast Consultant must be able to demonstrate attendance in at least ten (10) short courses, seminars, conferences on blasting technology, or engineering class studies during the past 15 years. For the past five (5) years, the Blast Consultant must have derived their primary source of income from providing specialized blasting consulting services.

C. Blast Control Specialist: Person authorized to act on behalf of the CONTRACTOR and licensed by the state or local regulatory agency to possess, transport, and use explosives. Must have a minimum of ten (10) years experience with blast design and vibration and air-blast monitoring, and significant involvement as the Blast Control Specialist in a minimum of ten (10) previous projects of similar nature. The Blast Control Specialist shall be a licensed blaster in the State of Alaska and shall be subject to the approval of the Blast Consultant.

D. Fly Rock: Debris that is ejected or propelled through air by blast.

E. Frequency: Ground vibration oscillation at peak event, expressed in Hertz.

F. Peak Ground Particle Velocity (PGPV): Maximum of three (3) velocity components measured in three (3) mutually perpendicular directions at a point.

G. Rock: Solid mineral material with volume in excess of 3 cu yd, solid rock, rock in ledges and rock hard cementitious aggregate deposits.

H. Rock in Trenches and Pits: Solid mineral material with volume that can be excavated with a 1.0 cubic yard (heaped) capacity excavator bucket.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Quality Control Submittals:

1. Qualifications of Blast Consultant: submit at least 30 days prior to blasting WORK.
2. Qualifications of Blast Control Specialist: submit at least 30 days prior to blasting WORK.
3. Rock excavation plan describing details for CONTRACTOR's proposed rock excavation methods. Submit at least 30 days prior to start of WORK.
4. Vibration and Air Blast Monitoring Plan. Submit at least 30 days prior to blasting WORK.
5. Blasting Plan for the project shall be submitted one (1) week prior to commencement of drilling and blasting operations.
6. A Detailed Blasting Plan for each blast shall be submitted at least 48 hours prior to beginning any WORK for that blast, describing additional details not in the Blasting Plan.
7. Performance and Restoration Bond for all items of WORK.

C. Blasting Plan and Blasting Schedule.

1. One (1) week prior to commencing drilling and blasting operations, the CONTRACTOR shall submit a "Blasting Plan", reviewed and approved by the Blasting Consultant, to the ENGINEER for review. The Blasting Plan shall contain the details of the drilling and blasting patterns and controls proposed for both the controlled and production blasting. The Blasting Plan shall contain the following minimum information:
   a. Station limits of proposed shot, the number of blasts, time of each blast.
   b. Plan and section views of proposed drill pattern indicating hole size, hole depths and angles, hole pattern and spacing and expected rock types.
   c. Drill hole diameters (preshear, productions) and depth including subdrilling depths.
   d. Drill steel diameter and bit types.
   e. Stemming length and type of material used for stemming.
   f. Loading details including trade names, types, sizes of explosives and delays.
   g. Average bench height.
   h. Proposed initiation and delay sequence of blast holes.
   i. Weight of explosives per hole and per delay and powder factors, including weight of explosives per square yard of finished backslope.
   j. Anticipated vibration levels and peak particle velocities at locations specified by the Blast Consultant.

k. Anticipated blast decibel level at nearest dwelling.

2. At any time the CONTRACTOR proposes to change the drilling or blasting methods, the CONTRACTOR shall submit a revised Blasting Plan for the affected WORK not later than one (1) week prior to the proposed commencement of the change in the WORK.
3. The Blasting Plan submittal is for quality control and record-keeping purposes. Review of the Blasting Plan by the ENGINEER or Blasting Consultant shall not relieve the CONTRACTOR of their responsibility for the accuracy and adequacy of the plan when implemented in the field.

D. Project Closeout Submittals.
1. Summary Report: Submit within 30 days of completion of blasting.

1.5 QUALITY ASSURANCE

A. Explosives Firm: Company specializing in explosives for disintegration of rock, with five years documented experience.

1.6 PROJECT CONDITIONS

A. Conduct survey and document conditions of buildings near locations of rock removal, prior to blasting, and photograph existing conditions identifying existing irregularities.

B. Advise owners of adjacent highways, buildings or structures in writing, prior to executing seismographic survey. Explain planned blasting and seismic operations.

C. Obtain seismic survey prior to rock excavation to determine maximum charges that can be used at different locations in area of excavation without damaging adjacent properties or other work.

1.7 SCHEDULING

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Schedule Work to avoid disruption to occupied buildings nearby and on-going landfill operations.

C. Conduct blasting operations during hours of the day in accordance with the local standards.

D. Blast only with direct written approval for each blast by the Blast Consultant.

E. Warning signs and public notification are required to avoid all risks to the public that use the adjacent Highway. The CONTRACTOR shall provide to ENGINEER and to the State of North Carolina Department of Transportation with its proposed traffic control plan for review and approval prior to any blasting.

F. The CONTRACTOR shall provide the OWNER, Canton Police Department and the Canton Fire Department with written notice of blasting a minimum of 24 hours in advance of each blast.

1.8 CONTROLLED BLASTING

A. Material which would classify as rock and which requires drilling and blasting to remove will be accomplished by controlled blasting. Controlled blasting is defined as the establishment of a free surface or shear plane in rock along the lines of the specified backslope by the controlled usage of explosives and blasting accessories in appropriately aligned and spaced drill holes.

B. The CONTRACTOR shall perform short test lines of holes consisting of presplit or cushion blasting if changes in conditions warrant, to determine the loading, spacing and depth or lift required to obtain desired PGPV, air blast pressures and excavation geometry. These tests will be monitored by the Blast Consultant using CONTRACTOR supplied seismographs. As part of the blasting plan, the CONTRACTOR shall prepare graphs depicting the PGPV as function of the distance from the detonation point, for each explosion loading. Explosive loading for production blasting will then be selected from the graph to limit PGPV to less than two inches per second measured next to the closest structure adjacent to the blast.

1.9 ENGINEER OVERSIGHT

A. The CONTRACTOR shall submit a copy of the Blast Consultant-approved Blasting Plan and a copy of each Blast Consultant-approved Detailed Blasting Plan(s) to the ENGINEER prior to blasting. The CONTRACTOR shall also submit a copy of their NC DOT approval to the ENGINEER and OWNER prior to any blasting.

PART 2 PRODUCTS

2.1 MATERIALS

A. Explosives: Type recommended by explosive firm following seismic survey and required by authorities having jurisdiction.

B. Delay Device: Type recommended by explosives firm.

C. Blast Mat Materials: Type recommended by explosives firm.

PART 3 EXECUTION

3.1 CONSTRUCTION

A. All explosives shall be of such character and in such amount as permitted by the state and local laws and ordinances and all respective agencies having jurisdiction over them.

B. The CONTRACTOR shall implement a blast notification program, as approved by the

C. ENGINEER, and in accordance with applicable standards.

D. The CONTRACTOR shall use the utmost care so as not to endanger life or property, or disturb materials outside the limits of the excavation.

E. Explosives, including blasting caps, shall be transported and stored in a safe, secure manner in accordance with the requirements of the appropriate public body having jurisdiction in such matters. Only persons experienced in the handling of explosives are to be allowed to use them on the WORK. Where state or local laws require, explosives are to be handled only by licensed personnel.

F. The CONTRACTOR shall provide all necessary approved types of tools and devices required for handling and using explosives, blasting caps, and accessories. The CONTRACTOR shall conform to and obey all federal, state and local laws that may be imposed by any public authority having legal jurisdiction.

G. When blasting, ample warning shall be given to all persons within the vicinity prior to blasting. Warning signs shall be erected a minimum of 24 hours prior to the blast time, and workers shall be stationed to warn people before firing any blasts. The warning signs will state the time and date of each blast.

H. After a blast has been fired, the Blast Control Specialist shall make a careful inspection to determine that all charges have exploded before employees are allowed to return to the operation. Misfires shall be corrected in accordance with the requirements of the applicable portions of the federal, state, or local safety codes for blasting. The CONTRACTOR shall be responsible for any and all damage to property or injury to persons resulting from blasting or accidental or premature explosions that may occur in connection with his use of explosives.

I. All rock that is loose, hanging or creating a dangerous situation shall be removed or stabilized, to the Blast Consultant's satisfaction, during or upon completion of the excavation in each lift as an integral sequence in each cycle of excavation. Drilling of the next lift will not be permitted until this WORK, and any rock stabilization that is necessary has been completed.

J. Material outside of the planned neatline slopes which, in the opinion of the Blast

K. Consultant, is unstable and constitutes potential slides shall be excavated and removed.

L. No blast shall exceed an in-place pre-blast volume of 5,000 cubic yards.

3.2 GENERAL

A. The CONTRACTOR shall be required to submit a description of the blast plan to the Blast Consultant no less than 21 days prior to the blasting operation. The proposed method shall be subject to the approval of the Blast Consultant. The description shall include at least the following:
   1. Limits of cut or lift
   2. Average bench height
   3. Hole positions, including angle and depth
   4. Blast hole diameters
   5. Type and quantity of explosives (including manufacturer's data sheets)
   6. Method of initiation and firing sequences
   7. Powder factor
   8. Depth and type of stemming

B. Review of the blast plan by the Blast Consultant shall not relieve the CONTRACTOR of responsibility for the accuracy and adequacy of the blast plan when implemented in the field. This includes, but is not limited to, obtaining adequate fragmentation, using proper detonation procedures and following proper safety procedures prior to and after the blast.

C. The WORK shall be conducted in such a manner that rock outside the excavation limits will be undisturbed, nearby structures will not be disturbed in any way, and the shape of the excavation will conform as nearly as possible to the lines and grades shown on the Drawings.

D. It is imperative that the blasting WORK does not disturb or impair the existing landfills or landfill embankments in any way. Any damage shall be immediately repaired, as approved by the ENGINEER. To help ensure against potential damage beyond the lines of intended excavation, the CONTRACTOR shall employ the best modern practice of controlled blasting methods.

E. The CONTRACTOR shall assign a supervisor of mature experience specialized in the use of explosives to the blasting operations, who shall be maintained on a full-time basis during the time that blasting is in progress.

F. The CONTRACTOR is forewarned that existing residential, public, industrial, and commercial properties may be located in close proximity of the blast and that these properties shall be protected. The CONTRACTOR shall be responsible for all damage to these properties, including providing suitable temporary housing to residents or business occupants until repair WORK is completed.

G. Blasting shall be monitored by the Blast Consultant using CONTRACTOR-furnished monitoring devices. The Blast Consultant will be responsible for the location and placement of these monitoring devices. The CONTRACTOR will be responsible for the protection of these monitoring devices from its equipment and operations.

H. To ensure the accuracy of firing times of blasting caps, it is required that each cap period come from one lot number. Mixing lot numbers for any one cap period is prohibited.

3.3 CONTROLLED BLASTED SURFACES

A. For all rock slopes, the CONTRACTOR shall use controlled blasting along the lines of the final rock cut slope face.

B. Controlled blasting refers to the controlled use of explosives and blasting accessories in carefully spaced and aligned drill holes to produce a free surface or shear plane in the rock along the specified excavation backslope. Controlled blasting techniques covered by this Specification include pre-splitting and cushion (trim) blasting.

C. The purpose of controlled blasting is to ensure long-term rock slope stability by minimizing damage to the rock backslope. The ENGINEER may require the CONTRACTOR to use controlled blasting to form the faces of slopes, even if the main excavation can be ripped.

D. Cuts over 30 feet in height shall be drilled and blasted in more than one lift, with each lift being limited to a maximum of 30 feet. A maximum of a two foot offset between lifts shall be permitted to allow for drill equipment clearances. The CONTRACTOR shall begin the control

blast hole drilling at a point which will allow for necessary offsets and shall adjust, at the start of the lower lifts, to compensate for any drift which may have occurred in the upper lifts. The use of horizontal lifters will not be allowed.

E. The CONTRACOR will be required to drill from the top of the cut downward for rock cuts greater than ten (10) feet in height.

F. The diameter of the control blast holes shall not be smaller than two and one half inches or greater than three inches. The deviation of these drill holes either parallel or normal to the backslope shall not exceed eight inches. If greater than five percent of the controlled blast holes are misaligned in any one lift, the CONTRACTOR shall reduce the height of the lifts until the eight inch alignment tolerance is met.

G. Buffer holes shall be drilled three feet out from the controlled blast holes on four foot centers. The buffer holes shall be drilled parallel to the controlled blast holes. The load per buffer holes shall not exceed 50 percent of the average load per production hole next to the buffer line.

H. All drilling equipment used to drill the control blast shall have mechanical devices affixed to that equipment to accurately determine the precise angle at which the drill steel enters the rock. Control blast hole drilling will not be permitted if these devices are either missing or inoperative. Hand held devices, including levels, shall not be used.

I. Prior to drilling the control blast holes, all overburden and/or loose disintegrated rock shall be removed down to solid rock in the vicinity of the holes.

J. All rock backslope faces shall be scaled of loose fragments.

K. Blast holes for controlled blasting shall be drilled within three-inches of the staked collar location. If more than five percent of the holes are outside of the three inch tolerance, they shall be filled with crushed stone and re-drilled at the proper location.

3.4 LINE DRILLING, CUSHION BLASTING, PRESPLITTING

A. Methods such as line drilling, cushion blasting, or pre-splitting shall be used to control damage beyond the final cut faces shown on the Drawings. Methods such as line drilling and pre-splitting are used to ensure that a shear plane is established between the periphery holes, thus minimizing strain or cracks in the rock beyond the blasting perimeter. Except as otherwise directed by the Blast Consultant, pre-splitting and line-drilled holes shall not be larger than three inches in diameter, and spaced no more than two feet and six inches apart, center to center, respectively.

B. Cushion blasting is similar to pre-splitting, except that the detonation along the cut face shall be performed after the detonation of the production holes.

C. The CONTRACTOR shall line drill, perform cushion blasting, or pre-split all native, permanently exposed, or steeply inclined cut faces (1H to 1V, or steeper).

D. The line drilling, cushion blasting or pre-splitting blast holes shall be between two and one half and three inches in diameter.

E. Cuts with a vertical height greater than ten feet and an average horizontal thickness of greater than 25 feet as measured from the free face to the back row of blast holes shall be "Pre-split" blasted.

Pre-splitting shall be performed for all rock slopes over ten feet in height. It shall consist of drilling holes on the plane of the final backslope then loading the holes with a continuous or well disturbed explosive charge, and then firing the holes to create a crack along the line of the backslope. Ground vibration is a consideration. The CONTRACTOR shall delay the pre-split holes no more than 25 milliseconds along the pre-split line. The detonation of the pre-split line must precede the detonation of all other blasting in the cut. The pre-split line may be detonated in advance of the main production blasting or fired along with the production blasting, providing that the pre-split line is detonated a minimum of 25 milliseconds ahead of all other blasting.

The pre-split holes shall be drilled initially on 30-inch center spacing. Prior to loading these pre-split holes, each hole shall be inspected and tested for the entire length to determine that the hole is free and clear of obstructions. If the hole is obstructed, the hole shall be cleaned prior to loading. All necessary precautions shall be exercised so as to prevent debris from falling into the holes prior to loading, and that the placing of the charge shall not cause caving of materials from walls of the hole.

The maximum initial explosive charge used in these holes shall be no more the 0.14 pounds per square foot of rock surface of the final slope face. Ammonium nitrate and fuel oil (ANFO) shall not be allowed to be loaded in the pre-split hole.

Depending on the condition of the rock encountered and the smoothness of the final slope face, the explosive loads per square foot and the spacing of the pre- split holes may be altered, as required, after an inspection and evaluation by the ENGINEER.

The space in each pre-split hole not occupied by explosives may or may not be stemmed depending on the condition of the rock encountered. In all cases, the top three feet of the pre-split holes shall be stemmed.

The maximum diameter of the explosives used in pre-split holes shall not be greater than one-half the diameter of the pre-split hole.

Only standard explosives manufactured especially for pre-splitting shall be used in pre-split holes, unless otherwise approved by the ENGINEER.

If fractional portions of standard explosive cartridges are used, they shall be firmly affixed to the detonating cord in such a manner that the cartridges shall not slip down the detonating cord nor bridge across the holes. Spacing of fractional cartridges along the length of the detonating cord shall not exceed 30 inches center to center, and shall be adjusted to give the desired results.

Continuous column cartridge-type of explosives used with detonating cord shall be assembled and affixed to the detonating cord in accordance with the explosive manufacture's instructions; a copy of which shall be furnished to the ENGINEER. No detonating cord shall be used on the surface.

The bottom charge of a pre-split hole may be larger than the line charges, but shall not be large enough to cause overbreak. The top charge of the pre-splitting hole shall be placed far enough below the collar, and reduced sufficiently, to avoid overbreaking and heaving.

F. Cuts with a vertical height greater than ten feet and an average horizontal thickness less than 25 feet as measured from the free face to the back row of blast holes shall be "cushion" blasting.
   1. Where the horizontal distance from the cut face to the existing rock face is less than 25 feet, the CONTRACTOR may cushion blast in lieu of pre-splitting. Cushion blasting is similar to pre-splitting, except that the detonation along the cut face shall be performed after the detonation of all production holes.

3.5 PRODUCTION BLASTING

A. Production blasting, as covered herein, refers to the rock fragmentation blasts resulting from more widely spaced production holes drilled throughout the main excavation area, adjacent to the controlled blast line. Production holes shall be detonated in a controlled delay sequence.

B. All production blasting, including that carried out in conjunction with the blasting test section requirements, shall be performed in accordance with the following general requirements:
   1. Production blast holes shall be drilled on the patterns submitted by the CONTRACTOR and approved by the Blast Consultant. The production blast holes shall be drilled within two blast hole diameters of the staked collar location. If more than five percent of the holes are drilled outside of this tolerance, at the option of the ENGINEER, the CONTRACTOR may be required to refill these holes with crushed stone and re-rill them at the proper location.
   2. The production holes shall not exceed four inches in diameter and shall be drilled to a depth that is below the finished surface elevation, such that unbroken rock does not extend above the finish surface.
   3. The depth of individual horizontal lifts, the depth of blast holes, and the amount of explosive per hole and per delay shall vary depending on the average thickness of the lift as measured from the cut face to the existing rock face, and shall be described in the Blasting Plan.
   4. If the blast holes are plugged or unable to be fully loaded, the CONTRACTOR shall be required to deepen or clean out those holes. The blast holes should all be checked and measured before any explosives are loaded into any of the holes to eliminate any safety hazard resulting from drilling near loaded holes.
   5. All blast holes should reach their desired depth, and if more than five percent of the holes are short before loading, the CONTRACTOR may be required by the ENGINEER to re-drill the short holes to proper grade at the CONTRACTOR's expense.
   6. In order to control blasting effects, the CONTRACTOR must maintain a burden distance acceptable to the Blast Consultant.
   7. Blast holes shall be covered after drilling to keep overburden from falling into the holes.
   8. It is the CONTRACTOR's responsibility to take all necessary precautions in the production blasting so as to minimize blast damage to the rock backslope.
   9. Do not begin production blasting prior to the line drilling, pre-splitting, or as required to preserve the rock beyond the limits of the excavation.

3.6 CONTROL CRITERIA, MONITORING AND EXPLOSIVE PRODUCT REQUIREMENT

A. The CONTRACTOR shall submit for review the proposed methods and sequence of blasting for rock excavations. The CONTRACTOR shall identify the number, depth, and spacing of holes;

stemming and number and type of delays; methods of controlling overbreak at excavation limits, procedures for monitoring the shots and recording information for each shot; and other data that may be required to control the blasting.

B. The CONTRACTOR shall submit to the Blast Consultant for review a completely detailed Blasting Plan of each blast at least 48 hours prior to preparing for, drilling or loading the holes. These details shall include the location of all holes relative to the excavation plans and sections, the size of all holes, the typical loading pattern of each hole, the distribution of charge within each hole, and the number of each delay.

C. The CONTRACTOR shall develop a trial blasting technique that identifies and limits the vibrations and damage at varying distances from each shot. This trial blasting information shall be collected and recorded by beginning the WORK at points farthest from areas to remain without damage. The CONTRACTOR can vary the hold spacing, depths and orientations, explosive types and quantities, blasting sequence, and delay patterns to obtain useful information to safeguard against damage at critical areas.
   1. If at any time during the progress of the WORK, the methods of drilling and blasting do not produce the desired result of a uniform slope and shear face, within the tolerance specified, the CONTRACTOR shall be required to drill, blast, and excavate in short sections, not exceeding 50 feet in length, until a technique is developed that shall produce the desired results.

D. Drilling logs shall be kept on each blast hole to show open bedding, jointing and open or mud filled seams, zones of soft or weathered rock, mud pockets, etc. These logs shall be provided to the Blast Consultant for information before any blast holes are loaded. The logs shall be used to properly design and load blast holes and use stemming decks in weak zones to protect residents from blowout, fly rock and unusual or hazardous blasting effects.

E. The stemming decks shall be of crushed stone. The material used for stemming decks shall be well graded between one-eighth inch and three-eighth inches in diameter. Drill cuttings shall not be used.

F. Concentrated charges will not be permitted; only special, controlled blasting procedures will be permitted.

G. Bulk explosives such as ammonium nitrate and fuel oil that do not meet manufacturer's specifications, shall not be used on the Project. When in the opinion of the ENGINEER or the Blast Consultant, any blasting product is either of excessive age or in what appears to be a deteriorated condition, all WORK shall cease until the product's age or quality can be determined.

H. No blasting product shall be brought to the job site if the date codes are missing. At the option of the Blast Consultant, the product may be tested by an independent organization to determine its performance as compared to the manufacturer's data sheet. If product performance or composition deviated by more than ten percent in any manner from the manufacturer's data sheet, that lot number shall be rejected.

I. The CONTRACTOR shall submit manufacturer's certification for the blasting agents and explosives, and that the products sent to the job meet their specifications on the technical data sheet.

J. The CONTRACTOR shall videotape, take high-speed photographs or collect other print or other electronic images of each blast. The images, photographs, film and videotape shall become part of the Project records.

3.7 BLAST DESIGN

A. Design each blast to avoid damage to existing facilities, adjacent property and completed WORK. Consider effects of blast-induced vibrations and air blast, and fly rock potential in design of each blast.

B. Whenever peak particle velocity exceeds vibration limits change design of subsequent blasts, as necessary, to reduce peak particle velocity to within limits established by Blast Control Specialist.

C. Whenever air blast exceeds limits, change design of subsequent blasts or provide controls necessary to reduce air blast to within specified limits.

3.8 PRE-BLAST CONDITION SURVEY

A. The CONTRACTOR shall arrange for a pre-blast survey of any nearby buildings, structure, or utilities that may potentially be at risk from blasting damage. The survey method used shall be acceptable to the CONTRACTOR's insurance company. The CONTRACTOR shall be responsible for any damage resulting from blasting. The pre- blast survey shall be made available to the ENGINEER for review two weeks before any blasting begins. Occupants of local buildings shall be notified by the CONTRACTOR prior to the commencement of blasting, in accordance with the approved Blast Plan.

B. The pre-blast survey shall be done on all buildings and structures with 1,000 feet of the blasting area. The pre-blast survey shall produce the following as a minimum requirement:
   1. Diagrams and information as required to accurately show the building or structure existing conditions.
   2. Photographs of existing damage.
   3. Comprehensive video of the entire structure.

C. Pre-blast surveys shall be completed by a practicing civil engineer registered in the State of North Carolina, who has experience in rock excavation, foundation design, and building design and construction.

3.9 VIBRATION LIMITS

A. Establish appropriate maximum limit for peak particle velocity for each structure or facility that is adjacent to, or near blast sites. Base maximum limits on expected sensitivity of each structure or facility to blast induced vibrations and federal, state, or local regulatory requirements, but not to exceed one-inch per second when frequency is

B. 30-Hz or greater, and 0.50 inches per second when frequency is less than 30-Hz.

C. Allowable charge weights per delay shall be based on vibration levels that shall not cause damage. The allowable charge weights per delay shall be established by carrying out trial blasts and measuring vibration levels. The trial blasts shall be carried out in conformance with blasting

test section requirements, modified as required to limit ground vibrations to a level which shall not cause damage. Regression analysis shall be performed by the Blasting Consultant with the test blast data, and directional transmission characteristics shall be determined.

D. The CONTRACTOR shall monitor each blast with approved seismographs located, as approved, between the blast area and the closet structures subject to blast damage. The seismograph used shall be capable of recording particle velocity for three mutually perpendicular components of vibration in the range generally found with controlled blasting as well as air overpressure. The seismographs must be capable of storing data in digital form, which can be electronically transferred into a computer. The type of seismograph instrumentation, and the method of use, must conform to the general guidelines for proper use of seismographs as described in the approved Blast Plan.

E. Peak particle velocity of each component shall not be allowed to exceed the safe limits of the nearest structure subject to vibration damage. The CONTRACTOR shall employ an ENGINEER-approved qualified vibration specialist to establish the safe vibration limits. The vibration specialist shall also interpret the seismograph records to ensure that the seismograph data shall be effectively utilized in the control of the blasting operations with respect to the existing structures. The vibration specialist used shall be subject to the ENGINEER's approval. The vibration specialist shall supervise the placement and operation of the seismograph.

Data recorded for each shot shall be furnished to the ENGINEER prior to the next blast and shall include the following:

1. Identification of instrument used.
2. Name of qualified observer and interpreter.
3. Distance and direction of recording station from blast area.
4. Type of ground at recording station and material on which the instrument is sitting.
5. Maximum particle velocity in each component and frequency.
6. The time history of each component.
7. The time history of air overpressure.
8. A dated and signed copy of records of seismograph readings.
9. A regression analysis shall be done after every blast to determine if conditions are changing as a result of geology or blast design.
10. Blast vibration levels must conform to the alternative blasting level criteria in
11. United States Bureau of Mines (USBM) Report of Investigation (RI) 8507.

3.10 AIR BLAST LIMITS

A. Air blast-monitoring systems shall be installed between the main blasting area and the nearest structures subject to blast damage or annoyance. The equipment used to make the air blast measurements shall be the type specifically manufactured for that purpose.

B. Peak overpressure shall be held below 90 decibels (dB) linear peak method at the nearest structures or other designated location. Appropriate blast hole patterns, detonation systems, and stemming shall be used to prevent venting of blasts and to minimize air blast and noise levels produced by the blasting operations. The overpressure limit shall be lowered if it proves too high based on damage or complaints.

C. A permanent signed and dated record of the peak overpressure measurements shall be furnished to the ENGINEER immediately after each shot. Regression analysis shall be done by the Blasting Consultant after each blast, and necessary adjustments made to ensure that air overpressure shall never exceed the 90 decibels (dB) linear peak method.

3.11 FLY ROCK CONTAINMENT

A. Before the firing of any blast, the rock to be blasted shall be covered with approved blasting mats, soil, or other equally serviceable material, to prevent fly rock that may result in damage to life or property.

B. The homeowners/renters determined to be in the design fly rock zone for a particular blast shall be notified 24 hours in advance of the pending blast, and at least two hours prior to the blast so that they may temporarily relocate during the blast. Signage along roadways shall be used to supplement the notification process.

C. Suggested methods of protecting structures and utilities from the effects of the blasting, blast induced fly rock, vibration, and air blast overpressure include, but are not limited to the following:
   1. New sisal rope blasting mats
   2. Wire rope or tire blasting mats
   3. Backfilling
   4. Stemming full depth
   5. Reduced explosive loads
   6. Use of millisecond delays
   7. Relocation of any or all existing utility lines

D. The CONTRACTOR shall protect all overhead and underground utilities prior to blasting and immediately repair or replace any damaged by the blasting operations. If the CONTRACTOR wishes to temporarily relocate any utility lines that lie near a blast zone, he shall have written approval from the governing utilities and pay all relocation costs.

E. If fly rock travels beyond the design fly rock zone limits, all blasting operations shall cease. The CONTRACTOR shall review the site and determine the cause and solution to the fly rock problem. Before any further blasting proceeds, a written report, prepared by the CONTRACTOR shall be submitted to the ENGINEER. In the event that the CONTRACTOR and the ENGINEERING cannot reach an agreement on the cause and solution to the fly rock problem, progress payments shall be suspended until an agreement is achieved.

   If after review of the report, the ENGINEER determines that the design fly rock zone shall be re-established and additional residences notified, all new homeowners/renters shall be offered the same temporary relocation benefit of $250.00 for each blast event.

   Failure to pay the temporary relocation benefits due or to resolve fly rock incidents in a timely manner, as indicated in the Specifications, will result in delay of progress payments.

F. Delays caused by fly rock incidents do not constitute grounds for extension of Contract Time.

G. If more than three fly rock incidents occur, at the option of the OWNER, the CONTRACTOR may be fined $10,000 for each additional occurrence. A fly rock incident is defined as any fly rock that hits private property.

3.12 VIBRATION AND AIR BLAST MONITORING

A. Monitor on, or at, structures or other facilities that are closest to point of blasting.

B. Monitor more distant facilities that are expected to be sensitive to blast induced vibrations and air blast.

C. The Blast Control Specialist shall supervise establishment of monitoring programs and initial operation of equipment, review interpretation of records and recommended revisions of blast designs.

3.13 BLASTING RECORDS

A. For each blast, document the following:
1. Location of blast in relation to the coordinate system and elevations
2. Date and time of loading and detonation of blast
3. Number of blasts
4. Name of person in responsible charge of loading and firing
5. Plan view and section view of each blast with notes indicating free face, burden, spacing height of lift, hole diameter, stemming depth, hole angle, hole depth, subdrill depth
6. Notes regarding conditions encountered in the drill holes, including soft or fractured zones, water table alignment problems
7. Loading diagram indicating types and amounts of explosives, primers, initiators, stemming depth, powder factors, trade names, and sizes of explosives, primers and initiators
8. Sequence plan of the shot, including surface delay times and initiator's delay times
9. Comments by blaster-in-charge regarding damage to existing facilities, adjacent property, or completed WORK, misfires, fly rock occurrences, unusual results, or unusual effects
10. Provide drilling logs as described in Article 3.6, D of this Section
11. The CONTRACTOR shall videotape, take high-speed photographs or collect other print or other electronic images of each blast. The images, photographs, film and videotape shall become part of the Project records.

3.14 DAILY EXPLOSIVE MATERIAL CONSUMPTION AND LOSS

A. The CONTRACTOR shall keep a daily record of transactions to be maintained at each storage magazine. Inventory records shall be updated at the close of every business day. The records shall show the class and quantities received and issued and total remaining on hand at the end of each day. Remaining explosive inventory shall be checked each day, and any discrepancies that would indicate a theft or loss of explosive material would be immediately reported.

B. Should a loss or theft of explosives occur, all circumstances and details of the loss or theft shall be immediately reported to the nearest office of Alcohol, Tobacco & Firearms, local law enforcement authorities and the ENGINEER.

3.15 SUSPENSION OF BLASTING

A. If damage to existing facilities or adjacent property occurs due to blasting, immediately suspend blasting and report damage to the Blast Consultant, the ENGINEER, and the OWNER.

B. Before resuming blasting operations, adjust design of subsequent blasts, or take other appropriate measures to control effects of blasting and submit complete description of proposed changes for reducing potential for future damage to the Blast Consultant.

C. Do not resume blasting until authorized by the Blast Consultant.

3.16 SCALING AND STABILIZATION

A. All rock on the cut face that is loose, hanging, or creates a potentially dangerous situation, shall be removed or stabilized to the ENGINEER's satisfaction during or upon completion of the excavation in each lift. Drilling of the next lift or WORK of any sort on the remaining rock cuts shall not be allowed until this WORK has been completed.

B. The slopes shall be scaled throughout the span of the contract and at such frequency as required to remove all hazardous loose rock or overhangs. The slopes shall be hand scaled using a suitable standard steel mine scaling rod. Subject to the ENGINEER's approval, or other methods, such as machine scaling and hydraulic splitters, may be used in lieu of or to supplement hand scaling. Payment for scaling shall be incidental to the contract unit price for rock excavation.

C. If in-place stabilization is required, as determined by the ENGINEER, rock bolting or other ENGINEER approved stabilization techniques shall be used. Stabilization necessitated, in the opinion of the ENGINEER, by the CONTRACTOR's blasting operations, shall be performed at the CONTRACTOR's expense.

D. Material outside the planned neatline slope which, in the opinion of the ENGINEER, is unstable and constitutes potential slides, shall be excavated and removed at the CONTRACTOR's expense. Such material shall be used in the construction of the embankment or disposed of as directed by the ENGINEER. The removal and disposal of this material shall be paid for at the contract unit price for rock excavation if WORK does not require blasting.

3.17 SAFETY PROCEDURES - WARNINGS AND SIGNALS

A. The CONTRACTOR shall establish a method or warning all employees on the job site of an impending blast. The signal should consist of a five minute warning signal to notify all in the area that a blast shall be fired within a five minute period. A second warning signal shall be sounded one minute before the blast. After the blast is over, there shall be an "all clear" signal sounded so all in the area understand that all blasting operations are finished.

B. Five minutes prior to the blast, five long signals on an air horn or siren shall be sounded. One minute prior to the blast, five short signals on an air horn or siren shall be sounded. The "all clear" shall be one long signal of at least 30 seconds in duration to indicate that all blasting has ceased.

3.18 CHECK FOR MISFIRES

A. The CONTRACTOR shall observe the entire blast area for a minimum of five minutes following a blast to guard against rock fall before commencing WORK in the cut. The five minute delay between blasting and allowing anyone but the Blast Control Specialist to enter the area is needed to make sure that no misfires have occurred.

B. During the five minute delay, it is the Blast Control Specialist's responsibility to go into the shot area and check all holes to make sure that they have detonated. If any holes have not fired, the Blast Control Specialist shall handle these misfires before others enter the WORK area.

C. The ENGINEER shall, at all times, have the authority to prohibit or halt the CONTRACTOR's blasting operations, if it is apparent that through the methods being employed, the required slopes are not being obtained in a stable condition or the safety and convenience of the landfill operations staff or the public is being jeopardized.

3.19 PUBLIC MEETINGS

A. The CONTRACTOR shall make their qualified vibration and air blast specialists and Blasting Consultant available for one (1) day to conduct a public meeting to better inform the public about anticipated drilling and blasting operations. The specialists shall be prepared to answer any questions dealing with the magnitude of seismic motion, air blast overpressure, and fly rock expected to impact the public.

END OF SECTION

SECTION 31 23 19 – DEWATERING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Surface water control system.

B. Related Sections:
   1. Section 31 05 16 - Aggregates for Earthwork: Filter sand.
   2. Section 31 23 16 - Excavation: Excavation for structures below ground water table.
   3. Section 31 23 17 - Trenching: Trenching for utilities below ground water table.
   4. Section 31 25 00 - Erosion and Sedimentation Controls: Surface water runoff control.

1.2 DEFINITIONS

A. Surface Water Control: Removal of surface water within open excavations.

1.3 PERFORMANCE REQUIREMENTS

A. Design surface water control systems to:
   1. Collect and remove surface water and seepage entering excavation.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data for each of the following:
   1. Pumping equipment for control of surface water within excavation.

1.5 QUALITY ASSURANCE

A. Comply with authorities having jurisdiction for the following:
   1. Water discharge and disposal from pumping operations.

1.6 SEQUENCING

A. Section 01 10 00 - Summary: Requirements for sequencing.

B. Sequence work to install and test surface water control systems minimum 7 days before starting excavation, trenching, tunneling or shaft drilling.

1.7 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

B. Coordinate work to permit the following construction operations to be completed on dry stable substrate.
   1. Excavation for structures specified in Section 31 23 16.
   2. Trenching for utilities specified in Section 31 23 17.

PART 2 PRODUCTS

2.1 DEWATERING EQUIPMENT

A. Surface Water Pumps: Self priming, engine driven type sufficient to remove surface water from excavations.
   1. Furnish pumps with screened suction hose and discharge hoses as required to suit application.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

3.2 PREPARATION

A. Protect existing adjacent buildings, structures, and improvements from damage caused by dewatering operations.

3.3 SURFACE WATER CONTROL SYSTEM

A. Provide ditches, berms, and other devices to divert and drain surface water from excavation area as specified in Section 31 25 00 and as shown on the drawings.

B. Divert surface water and seepage water within excavation areas into sumps and well points, pump water into drainage channels, storm drains and settling basins in accordance with requirements of agencies having jurisdiction.

C. Control and remove unanticipated water seepage into excavation.

3.4 SYSTEM OPERATION AND MAINTENANCE

A. When dewatering system cannot control water within excavation, notify Owner's Representative and stop excavation work.
   1. Supplement or modify dewatering system and provide other remedial measures to control water within excavation.

B. Modify surface water control systems when operation causes or threatens to cause damage to new construction, existing site improvements, adjacent property, or adjacent water wells.

3.5 SYSTEM REMOVAL

A. Remove dewatering and surface water control systems after dewatering operations are discontinued.

B. Repair damage caused by dewatering and surface water control systems or resulting from failure of systems to protect property.

END OF SECTION

SECTION 31 23 23 - FILL

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Backfilling site structures to subgrade elevations.
2. Fill under slabs-on-grade.
3. Fill under paving.
4. Fill for over-excavation.

B. Related Sections:
1. Section 31 05 13 - Soils for Earthwork: Soils for fill.
2. Section 31 05 16 - Aggregates for Earthwork: Aggregates for fill.
3. Section 31 22 13 - Rough Grading: Site filling.
4. Section 31 23 16 - Excavation.
5. Section 31 23 17 - Trenching: Backfilling of utility trenches.
6. Section 31 37 00 - Riprap.
7. Section 32 91 19 - Landscape Grading: Filling of vegetative growth media to finish grade elevation.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:
1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 10-lb Rammer and a 18-in. Drop.

B. ASTM International:
1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400 ft-lbf/ft3.
2. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft-lbf/ft3.
4. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
5. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
6. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data for geotextile fabric indicating fabric and construction.

C. Samples: Submit sample of each type of fill to testing laboratory.

D. Materials Source: Submit name of imported fill materials suppliers.

E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

PART 2 PRODUCTS

2.1 FILL MATERIALS

A. Aggregates for Earthwork: As specified in Section 31 05 16.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify subdrainage, dampproofing, or waterproofing installation has been inspected.

C. Request inspection by Owner's Representative, testing, approval and recording of locations of underground utilities

D. Verify structural ability of unsupported walls to support loads imposed by fill.

3.2 PREPARATION

A. Compact subgrade to density requirements for subsequent backfill materials.

B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with subsequent fill material and compact to density equal to or greater than requirements for subsequent fill material.

C. Scarify subgrade surface to depth of 3 inches.

D. Proof roll to identify soft spots; fill and compact to density equal to or greater than requirements for subsequent fill material.

3.3 BACKFILLING

A. Backfill areas to contours and elevations with unfrozen materials.

B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.

C. Place geotextile fabric as indicated on the Drawings.

D. Place material in continuous layers as indicated in specification section 31 22 13 and on the drawings.

E. Employ placement method that does not disturb or damage other work.

F. Maintain optimum moisture content of backfill materials to attain required compaction density.

G. Make gradual grade changes. Blend slope into level areas.

H. Remove surplus backfill materials from site.

I. Leave fill material stockpile areas free of excess fill materials.

3.4 TOLERANCES

A. Section 01 40 00 - Quality Requirements: Tolerances.

B. Top Surface of Backfilling Under Paved Areas: Plus or minus 0.1 foot from required elevations.

C. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

3.5 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

B. Perform laboratory material tests in accordance with ASTM D698.

C. Perform in place compaction tests in accordance with the following:
   1. Density Tests: ASTM D1556, ASTM D2167, or ASTM D2922.
   2. Moisture Tests: ASTM D3017.

D. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

E. Frequency of Tests: Per Section 31 22 13, 3.6 Rough Grading, Field Quality Control.

F. Proof roll compacted fill surfaces under paving,.

3.6 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting finished work.

B. Reshape and re-compact fills subjected to vehicular traffic.

3.7 SCHEDULE

A. Adjacent to Structures: Compact each layer backfill or fill material to at least 92 percent of maximum dry density.

B. Lawn or Unpaved Areas: Compact each layer backfill or fill material to at least 90 percent of maximum dry density.

C. Pavements: Compact subgrade and each layer of gravel borrow, subbase material, and base material to at least 95 percent of maximum dry density.

D. Pipe Trenches: in accordance with section 31 22 13.

E. Dikes and Embankments: In accordance with section 31 22 13.

F. Liner Subgrade: In accordance with section 31 22 13.

G. Cover Material: In accordance with section 31 22 13.

END OF SECTION

SECTION 31 25 00 - EROSION AND SEDIMENTATION CONTROLS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: control of erosion, siltation and sedimentation.
   1. The requirements of this section apply to Project-related construction activities away from the project site, such as borrow pits, off-site storage areas, and haul and work roads.

B. Related Sections:
   1. Section 31 05 13 - Soils for Earthwork.
   2. Section 31 05 16 - Aggregates for Earthwork.
   3. Section 31 10 00 - Site Clearing.
   4. Section 31 23 16 - Excavation.
   5. Section 31 23 23 - Fill.
   6. Section 31 37 00 - Riprap.
   7. Section 32 91 19 - Landscape Grading.
   8. Section 32 92 19 - Seeding and Soil Supplements.
   9. Section 33 42 13 - Pipe Culverts.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:
   1. AASHTO T88 - Standard Specification for Particle Size Analysis of Soils.
   2. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 10-lb Rammer and a 18-in. Drop.

B. American Concrete Institute:
   1. ACI 301 - Specifications for Structural Concrete.

C. ASTM International:
   1. ASTM C127 - Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.
   2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400 ft-lbf/ft3.
   3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft-lbf/ft3.
   4. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
   5. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

D. Precast/Prestressed Concrete Institute:
   1. PCI MNL-116S - Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Product Data: Submit data on geotextile.

C. Test Reports: Indicate certified tests results for granular backfill.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with requirements of Section 31 05 13, Section 31 05 16, Section 31 23 23, Section 31 10 00, Section 31 23 16, Section 31 23 23, Section 31 37 00, Section 33 42 13, Section 32 91 19 and Section 32 92 19.

B. Provide at least one person who shall be present at all times during erosion control operations and who shall be thoroughly familiar with the types of materials being installed and the best method for their installation and who shall direct all work performed under this Section

C. Perform Work in accordance with the North Carolina Erosion and Sediment Control Planning and Design Manual and all other Federal, state and local laws, ordinances, rules and regulations.

1.5 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

PART 2 PRODUCTS

2.1 ROCK AND GEOTEXTILE MATERIALS

A. Rock: As specified in Section 31 37 00.

B. Geotextile Fabric: As specified in Section 31 37 00.

2.2 STRAW MULCH

A. Straw mulches shall be reasonably free from swamp grass, weeds, twigs, debris and other deleterious material, and free from rot, mold, primary noxious weed seeds, and rough or woody materials. Mulches containing mature seed of species which would volunteer and be detrimental to the permanent seeding, or would result in overseeding, or would produce growth which is aesthetically unpleasing, is not permitted.

B. Properly aired native straw, Sudan grass straw, legume straw, or similar straw or grass mowings. When air-dried in the loose state, the contents of the representative bale shall lose not more than 15 percent of the resulting air-dry weight of the bale.

C. Apply straw mulch at 2 tons/acre.

D. Accessories:
   1. Mulch Stabilizers: "Curasol" applied at a rate of 40 gallons per acre or Dow "Mulch Binder" applied at a rate of 45 gallons per acre.
   2. Permanent Type Mulch Nets: "Curlex" blanket as manufactured by American Excelsior, or approved equal.

2.3 PLANTING MATERIALS

A. Temporary Seed Mixture: Annual or Perennial Ryegrass.

B. Permanent Seed Mixture: as indicated in section 32 92 19.

2.4 SILT FENCE

A. Manufacturers:
   1. Envirofence by Mirafi, Inc. or approved equal.

2.5 SOURCE QUALITY CONTROL (AND TESTS)

A. Material manufacturers and vendors shall be reputable, qualified firms regularly engaged in producing the required types of materials.

B. Perform tests on cement, aggregates, and mixes to ensure conformance with specified requirements.

C. Test samples in accordance with ACI 301.

D. Make rock available for inspection at producer's quarry prior to shipment. Notify Engineer and Owner at least seven days before inspection is allowed.

E. Allow witnessing of inspections and test at manufacturer's test facility. Notify Engineer and Owner at least seven days before inspections and tests are scheduled.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify compacted subgrade is acceptable and ready to support devices and imposed loads.

C. Verify gradients and elevations of base for other work are correct.

3.2 SITE STABILIZATION

A. Take every reasonable precaution and do whatever is necessary to avoid any erosion and to prevent silting of rivers, streams, lakes, reservoirs, impoundment's and drainage ditches and swales.

B. Incorporate erosion control devices indicated on the Drawings into the Project at the earliest practicable time.

C. Construct, stabilize and activate erosion controls before site disturbance within tributary areas of those controls.

D. Stockpile and waste pile heights shall not exceed 35 feet. Slope stockpile sides at 2: 1 or flatter.

E. Stabilize any disturbed area of affected erosion control devices on which activity has ceased and which will remain exposed for more than 20 days.
   1. During non-germinating periods, apply mulch at recommended rates.
   2. Stabilize disturbed areas which are not at finished grade and which will be disturbed within one year in accordance with Section 32 92 19.
   3. Stabilize disturbed areas which are either at finished grade or will not be disturbed within one year in accordance with Section 32 92 19 .

F. Stabilize diversion channels, sediment traps, and stockpiles immediately.

G. Install straw mulch immediately after each area has been properly prepared. When permanent seed or seed for temporary erosion control is shown prior to placing the mulch, place mulch on seeded areas within 24 hours after seeding. Engineer may authorize the blowing of chopped mulch provided that 95% of the mulch fibers will be 6" or more in length and that it can be applied in such a manner that there will be a minimum amount of matting that would retard the growth of plants. Straw mulch should cover the ground enough to shade it, but the mulch should not be so thick that a person standing cannot see the ground through the mulch. Remove matted mulch or branches.
   1. Apply a system of pegs and strings, a chemical stabilizer, or temporary type netting to the mulch, where mild winds may blow the mulch, or when ground slopes exceed 15%, or when otherwise required to maintain the mulch firmly in place. Unless otherwise directed, remove the strings and netting prior to the acceptance of the Work.
   2. Apply temporary type netting over the mulch and take whatever measures are necessary to maintain the mulch firmly in place, where high winds exist, or heavy rainstorms are likely, or where ground surfaces are steep, or where other conditions require.
   3. Use of permanent type netting is not permitted without prior approval of Engineer, unless otherwise specified,

H. Erect silt fences and bury bottom edge in accordance with manufacturer's recommended installation instructions. Provide a sufficient length of fence to accommodate runoff without causing any flooding and to adequately store any silt, sediment and debris reaching it.
   1. Leave silt fences in place until permanent erosion control measures have stopped all erosion and siltation, then remove and dispose of properly.

I. Provide silt stops wherever erosion control measures may not be totally capable of controlling erosion, such as in drainage channels and where steep slopes may exist.

J. Take special precautions in the use of construction equipment to minimize erosion. Do not leave wheel tracks where erosion might happen.

K. Should any protective measures employed indicate any deficiencies or erosion taking place, immediately provide additional materials or employ different techniques to correct the situation and to prevent subsequent erosion.

3.3 FIELD QUALITY CONTROL

A. Inspect erosion control devices on a weekly basis and after each runoff event. Make necessary repairs to ensure erosion and sediment controls are in good working order.

B. Compaction Testing: As specified in Section 31 23 23.

C. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

D. Frequency of Compaction Testing: One for each lift.

3.4 CLEANING

A. When sediment accumulation in sedimentation structures has reached a point one-third depth of sediment structure or device, remove and dispose of sediment.

B. Do not damage structure or device during cleaning operations.

C. Do not permit sediment to erode into construction or site areas or natural waterways.

D. Clean channels when depth of sediment reaches approximately one half channel depth.

3.5 MAINTENANCE

A. If any temporary erosion and sediment control measures are disturbed, repair them immediately. Check erosion control devices weekly and after any heavy rain storms.

B. If seed is washed out before germination, repair any damage, refertilize, and reseed.

C. Maintain mulched and matted areas, silt stops, and other temporary control measures until the permanent control measures are established and no further erosion is likely.

END OF SECTION

SECTION 31 35 26.15 – GEOSYNTHETIC CLAY LINER

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Geosynthetic Clay Liner

B. Related Sections:
   1. Contract Drawings.
   2. Specification Sections.
   3. General Provisions of Contract.
   4. Submittals: Section 01 33 00.
   5. Summary of Work: Section 01 11 00
   6. Geotextiles: Section 31 05 19.13
   7. Geomembrane: Section 31 05 19.16

1.2 DESCRIPTION OF WORK

A. Furnish and install a geosynthetic clay liner (GCL) as part of the composite liner in the landfill as shown in the drawings. Sufficient liner material shall be furnished to cover all areas shown on the drawings including overlaps at field seams and anchor trenches.

1.3 QUALIFICATIONS AND WARRANTIES

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

B. Installer's Qualifications: Firms regularly engaged in installation of products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

1.4 QUALITY CONTROL DOCUMENTATION

A. A plan showing the proposed liner layout.

B. All required manufacturer's quality control certifications, including, but not limited to, the following:
   1. verification that clay component of the finished product is 70 to 90 percent sodium montmorillonite clay from the Wyoming/North Dakota "Black Hills" region of bentonite deposits;
   2. verification that the proper mass per unit area of bentonite clay has been added to the finished product;
   3. verification that the actual geotextiles used in the finished product meet the manufacturer's specification based on the minimum average roll value (MARV) concept; and

4. Verification that needle-punched non-woven geotextiles have been inspected continuously for the presence of broken needles using an in-line metal detector.
5. The manufacture supplying the GCL shall demonstrate previous experience by letter of certification. Certification shall indicate that the manufacture has produced, and has in service in similar applications for a period of not less than one (1) year, at least (5) million sq.ft. of GCL material meeting these Specifications.

C. Furnish certified copy of laboratory test results and material sample as evidence that material is similar and equal in the minimum values listed.

1.5 CONFORMANCE TESTING

A. Upon delivery of the GCL to the field site, the QARE officer should see that conformance test samples are obtained. These samples are to be sent to the QARE laboratory for testing to assure that the GCL conforms to the project plan and specifications. Samples should be taken from selected rolls by removing the protective wrapping and cutting a full width 3-foot long sample from the outer wrap of the selected rolls. The rolls should be immediately rewrapped and replaced in the shipping trailers or in the temporary field storage area. Test samples should be identified by type, style, lot, and roll numbers. The machine direction should also be noted on the samples with a waterproof marker. Conformance testing will be performed on a per-lot basis and not less than one conformance test per 100,000 square foot. A lot is defined as a group of consecutively numbered rolls from the same manufacturing line. Material conformance testing will include the following:
1. Bentonite mass per unit area per ASTM D 5993
2. Free swell of clay component per ASTM D 5890
3. Hydraulic conductivity per ASTM D 5887-99
4. Grab strength per ASTM D 4632
5. Peel strength ASTM 6496-99

1.6 SUBMITTALS

A. Submit the number and type of project submittals as indicated in Specification Section 01 33 00.

PART 2 PRODUCTS

2.1 GEOSYNTHETIC CLAY LINER

A. The GCL liner shall be a needlepunch reinforced GCL comprised of a uniform layer or granular sodium bentonite encapsulated between a two nonwoven geotextiles that meet the following properties.

Material Property	Test Method	Required Values
Bentonite Swell Index	ASTM D 5890	24 mL min.
Bentonite Fluid Loss	ASTM D 5891	18 mL max.
Bentonite Mass/Area^2	ASTM D 5993	0.75 lb/ft^2
GCL Grab Strength	ASTM D 4632	95 lbs (660N)
GCL Peel Strength	ASTM D 6496-99	2 lbs/inch

GCL Index Flux	ASTM 5887	$1x10^{-8}$ m^3/m^2/sec.
GCL Permeability	ASTM 5084	$5x10^{-9}$ cm/sec.
GCL Hydrated Internal Shear Strength	ASTM D 6243	500 psf (24 kPa) Typical

B. The liner shall be manufactured by the mechanical bonding of the needlepunch process to enhance the friction characteristics of the liner and to maintain the integrity of the liner under hydration. No glues or adhesive shall be used in lieu of the needlepunch process so as to retain these characteristics.

Needled GCLs are those which, by the process of a needling board (similar to that used in the manufacture of standard nonwoven geotextiles) have fibers of a nonwoven geotextile pushed through the bentonite clay core and integrated into a woven or nonwoven geotextile without the use of any chemical binders or adhesives.

C. The geocomposite liner shall have a hydraulic conductivity equal to or less than $5x10^{-9}$ cm/sec at 5 psi confining stress.

D. The geotextiles used in the manufacture of the GCL shall be made up from polypropylene fibers. Any and all substitutions shall be approved by the Project Manager prior to their use.

PART 3 QUALITY ASSURANCE

3.1 GEOCOMPOSITE CLAY LINER DELIVERY

A. Covering of the Rolls:
1. Manufacturers should clearly stipulate the type of protective covering and the manner of cover placement. The covering should be verified as to its capability for safe storage and proper transportation of the product.
2. The covering should be placed around the GCL in a workmanlike manner so as to effectively protect the product on all of its exposed surfaces and edges.
3. The central core should be accessible for handling by forklift vehicles. For wide GCLs (e.g. wider than approximately 11.5 feet) handling should be by overhead cranes utilizing two dedicated slings provided on each roll at approximately the 1/3rd points.
4. Clearly visible labels should identify the name and address of the manufacturer, trademark, date of manufacture, location of manufacture, style, roll number, lot number, serial number, dimensions, and weight in accordance with ASTM D 4873.

B. Storage at the Manufacturing Facility:
1. GCLs should always be stored indoors until they are ready to be transported to the field site.
2. Handling of the GCL should be such that the protective wrapping is not damaged. If it is, it must be immediately rewrapped by machine or hand; in the case of minor tears it may be taped.
3. Placement and stacking of rolls should be done in a manner so as to prevent thinning of the product at points of contact with the storage frame or with one another.

C. Shipment:
1. The GCLs should be shipped by themselves with no other cargo which could damage them in transit during stops or while off-loading other materials.

2. Method of loading GCLs rolls, transporting them, and off-loading them at the job site should not cause any damage to the GCL, its core or its protective wrapping.
3. Any protective wrapping that is damaged or stripped off the rolls should be repaired immediately or the roll should be moved to an enclosed facility until its repair can be made to the approval of the quality assurance personnel.
4. If any clay has been lost during transportation or from damage of any type, the outer layers of the GCL should be discarded until undamaged product is evidenced. The remaining roll must be wrapped in accordance with the manufacturer's original method to prevent hydration or further damage to the remaining roll.

D. Storage at the Site:
1. Handling of the GCLs should be done in a competent manner such that damage does not occur to the product nor to its protective wrapping.
2. The location of temporary field storage should not be in areas where water can accumulate. The rolls should be stored on high, flat ground or elevated off the ground so as not to form a dam creating the ponding of water. It is recommended to construct a platform so that GCL rolls are continuously supported along their length.
3. The rolls should not be stacked so high as to cause thinning of the product at points of contact. Furthermore, they should be stacked in such a way that access for conformance testing is possible.
4. If outdoor storage of rolls is to be longer than a few weeks, particular care (e.g. using tarpins) should be taken to minimize moisture pick-up or accidental damage. For storage periods longer than one season, a temporary enclosure should be placed over the rolls or they should be moved within an enclosed facility.

3.2 INSTALLATION

A. Installation of the GCL shall include the following considerations:
1. Place in the manner and at the locations shown on the drawings. The GCL shall be installed with the non-woven side facing up.
2. Rolls shall be handled utilizing a 3-inch schedule 80 steel pipe through the core and slings or straps attached to the ends of the pipe (core pipe). The core pipe shall be suspended from a spreader bar so that the edges of the liner are not damaged by the suspending straps or chains. Panels shall be placed with the woven side against the underdrain sand and the non-woven side oriented upwards.
3. Work on the slopes shall be undertaken before the bottom to permit drainage in the event of rainfall. Panels may be pulled up from the bottom of the slope to the anchor trench or anchored first and the roll slowly lowered down the slope. Seams shall be perpendicular to the toe of the slope at all times. Seams at the base of the slope shall be a minimum of 5 feet away from the toe of the slope. Roll end seams or joints will not be allowed on the sideslopes.
4. Seam areas or runs shall be flat and clear of any large rocks, debris, or ruts. Contacting surfaces shall be clean and clear of dirt or native soil with all edges pulled tight to maximize contact and to smooth out any wrinkles or creases. Overlaps shall be a minimum of 6 inches and verified by QA/QC personnel. A proper seam shall cover the lap line and leave the match line exposed.
5. Seams shall be augmented with granular bentonite to insure seam integrity. Granular bentonite shall be spread evenly from the panel edge to the lap line at a minimum rate of 1/4 pound per lineal foot. This rate of application will be assured by using one 50-pound bag of

granular bentonite (evenly spaced along the seam) per roll of GCL. Accessory bentonite shall be of the same type as the material within the composite liner itself. Fasteners, anchor pins, or adhesives may be used on seams to keep panels in place during backfill operations if necessary. All butt seams shall have a minimum of 2-foot overlap.

6. The contractor shall only work on an area that can be completed in one working day. Completion shall be defined as the full installation of the liner and placement of the geomembrane cover (see section 8. below). Prior to deployment of the GCL, the underdrain sand will be smooth to provide a smooth surface free of debris, roots, and angular rocks. The GCL subgrade will be inspected and certified by the CQA personnel prior to placement of the GCL. Deployment of the GCL will be visually inspected to assure that no potentially harmful objects are present (e.g., stones, cutting blades, small tools, sandbags, etc.).
7. For any penetrations or structures the liner will contact, a small notch shall be cut along the edge of the area. The liner shall be brought up to the appurtenance and trimmed to fit snugly. The contractor shall then hand apply and compact a pure bead or dry mixture of 1 part bentonite to 4 parts soil (by volume), blended dry, into half of the notch. The liner shall then be inserted into the notch, with the remaining area in the notch refilled with the 1 to 4 mixture and compacted.
8. Large rips, or tears shall be repaired by placing a patch over the defect, with a minimum overlap of 12 inches on all edges. Accessory bentonite shall be placed between the patch and the repaired material at a rate of 1/4 pound per lineal foot of edge.
9. For protection and proper performance, the geomembrane liner (60-mil HDPE textured liner) shall be applied immediately over the GCL liner. During geomembrane installation, care shall be taken to avoid sharp turns and any quick stops or starts so as to avoid pinching or moving the GCL.
10. Overlap joints and seams shall be measured as a single layer of geotextile.
11. Securely anchor GCL as shown on the drawings.
12. The GCL will be rejected if allowed to hydrate before placement of the HDPE geomembrane. Replacement of hydrated GCL shall be the Contractor's responsibility.
13. During deployment of the GCL the material shall not be dragged over the underdrain sand.

B. Protection of Geosynthetic Clay Liner:
   1. Exercise necessary care while transporting and installing the geocomposite to prevent damaging it.
   2. Stored rolls shall be on a flat dry surface and tarped to avoid any unnecessary stress on the packaging.

END OF SECTION

SECTION 31 37 00 - RIPRAP

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Riprap placed loose.

B. Related Sections:
   1. Section 31 05 16 - Aggregates for Earthwork.
   2. Section 31 22 13 - Rough Grading.
   3. Section 31 23 16 - Excavation: Excavating for riprap.
   4. Section 31 23 17 - Trenching
   5. Section 31 23 23 - Fill.
   6. Section 32 91 19 - Landscape Grading: Topsoil placement.
   7. Section 33 42 13 - Pipe Culverts.

1.2 SUBMITTALS

A. Product Data: Submit data for geotextile fabric.

1.3 QUALITY ASSURANCE

A. Furnish each aggregate material from single source throughout the Work.

B. Perform Work in accordance with the North Carolina Erosion and Sediment Control Planning and Design Manual.

PART 2 PRODUCTS

2.1 MATERIALS

A. Riprap: Broken stone, shall weigh from 10 lbs to 200 lbs with a mean diameter (D_{50} size) as indicated on the drawings. Stones used for riprap shall be solid and nonfriable.
   1. Exposed stone shall be angular and as nearly rectangular in cross-section as practicable. Rounded boulders or cobbles will not be permitted.

B. Aggregate Type As specified in Section 31 05 16.

C. Geotextile Fabric: Non-biodegradable, woven, Mirafi 600x, or approved equal.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Do not place riprap over frozen or spongy subgrade surfaces.

3.2 PLACEMENT

A. Place geotextile fabric over substrate, lap edges and ends.

B. Place riprap at as indicated on Drawings.

C. Installed Thickness: As indicated on Drawings.

D. Place rock evenly and carefully in one consistent operation to preclude disturbance or displacement of substrate.

END OF SECTION

SECTION 32 12 16 - ASPHALT PAVING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Asphalt materials.
   2. Aggregate materials.
   3. Aggregate subbase.
   4. Asphalt paving base course, binder course, and wearing course.
   5. Asphalt paving overlay for existing paving.
   6. Surface slurry.

B. Related Requirement:
   1. Section 31 05 16 – Aggregates for Earthwork: ABC Gravel
   2. Section 31 22 13 - Rough Grading: Preparation of site for paving [and base].
   3. Section 31 23 23 - Fill: Compacted subbase for paving.

1.2 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:
   1. AASHTO M17 - Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
   2. AASHTO M29 - Standard Specification for Fine Aggregate for Bituminous Paving Mixtures.
   3. AASHTO M140 - Standard Specification for Emulsified Asphalt.
   4. AASHTO M208 - Standard Specification for Cationic Emulsified Asphalt.
   5. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications.
   6. AASHTO M320 - Standard Specification for Performance-Graded Asphalt Binder.
   7. AASHTO M324 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
   8. AASHTO MP1a - Standard Specification for Performance-Graded Asphalt Binder.

B. Asphalt Institute:
   1. AI MS-2 - Mix Design Methods for Asphalt Concrete and Other Hot- Mix Types.
   2. AI MS-19 - Basic Asphalt Emulsion Manual.
   3. AI SP-2 - Superpave Mix Design.

C. ASTM International:
   1. ASTM C1371[-2004a] - Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers.
   2. ASTM C1549[-2004] - Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer.
   3. ASTM D242 - Standard Specification for Mineral Filler For Bituminous Paving Mixtures.
   4. ASTM D692 - Standard Specification for Coarse Aggregate for Bituminous Paving Mixtures.

5. ASTM D946 - Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction.
6. ASTM D977 - Standard Specification for Emulsified Asphalt.
7. ASTM D1073 - Standard Specification for Fine Aggregate for Bituminous Paving Mixtures.
8. ASTM D1188 - Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples
9. ASTM D2027 - Standard Specification for Cutback Asphalt (Medium-Curing Type).
10. ASTM D2397 - Standard Specification for Cationic Emulsified Asphalt.
11. ASTM D2726 - Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.
12. ASTM D2950 - Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods.
13. ASTM D3381 - Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction.
14. ASTM D3515 - Standard Specification for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
15. ASTM D3549 - Standard Test Method for Thickness or Height of Compacted Bituminous Paving Mixture Specimens.
16. ASTM D3910 - Standard Practices for Design, Testing, and Construction of Slurry Seal.
17. ASTM D6690 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
18. ASTM E408[-1971(1996)e1] - Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.
19. ASTM E903[-1996] - Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres.
20. ASTM E1918[-1997] - Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field.
21. ASTM E1980[-2001] - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:
   1. Submit product information for asphalt and aggregate materials.
   2. Submit mix design with laboratory test results supporting design.

C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Mixing Plant: Conform to State of North Carolina Department of Transportation standard.

B. Obtain materials from same source throughout.

C. Perform Work in accordance with State of North Carolina Department of Transportation standard.

1.5 QUALIFICATIONS

A. Installer: Company specializing in performing work of this section with minimum 5 years documented experience.

1.6 AMBIENT CONDITIONS

A. Do not place asphalt mixture between December 15 and March 16, unless otherwise approved.

B. Do not place asphalt mixture when ambient air or base surface temperature is less than 45 degrees F, or surface is wet or frozen.

C. Place asphalt mixture when temperature is not more than 15 degrees F less than initial mixing temperature.

PART 2 PRODUCTS

2.1 ASPHALT PAVING

1. Asphalt Binder: In accordance with State of North Carolina Department of Transportation standard.
2. Primer: In accordance with State of North Carolina Department of Transportation standard.

B. Tack Coat: In accordance with State of North Carolina Department of Transportation standard standards.

1. Reclaimed Asphalt Pavement (RAP): Processed material obtained by milling or full depth removal of existing asphalt paving.
2. Oil: In accordance with State of North Carolina Department of Transportation standard

C. Aggregate Materials:

1. Coarse Aggregate: In accordance with Section 31 05 16.
2. Fine Aggregate: In accordance with Section 31 05 16.
3. Mineral Filler: ASTM D242 or AASHTO M17; finely ground mineral particles, free of foreign matter.

D. Aggregate Subbase: Specified in Section 31 05 16.

2.2 MIXES

A. Use dry material to avoid foaming. Mix uniformly.

B. Asphalt Paving Mixtures: Deigned in accordance with State of North Carolina Department of Transportation (NCDOT) standard.

1. Intermediate Course: NCDOT Type I19.0C.
2. Surface Course: NCDOT Type S9.5C.

2.3 ACCESSORIES

A. Geotextile Fabric: AASHTO M288; non-woven, polypropylene.

2.4 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Testing, inspection and analysis requirements.

B. Submit proposed mix design of each class of mix for review prior to beginning of Work.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify utilities indicated under paving are installed with excavations and trenches backfilled and compacted.

B. Verify compacted subbase is dry and ready to support paving and imposed loads.

C. Verify gradients and elevations of base are correct.

3.2 PREPARATION

A. Prepare subbase in accordance with State of North Carolina Department of Transportation standard.

3.3 DEMOLITION

A. Saw cut and notch existing paving as indicted on Drawings.

B. Clean existing paving to remove foreign material, excess joint sealant and crack filler from paving surface.

C. Repair surface defects in existing paving to provide uniform surface to receive new paving.

3.4 INSTALLATION

A. Subbase:
   1. Aggregate Subbase: Install as specified in Section 31 05 16.

B. Primer:
   1. Apply primer on aggregate subbase at uniform rate of 1/3 gal/sq yd.
   2. Use clean sand to blot excess primer.

C. Tack Coat:
   1. Apply tack coat in accordance with State of North Carolina Department of Transportation standard.

D. Double Course Asphalt Paving:
   1. Place asphalt intermediate course within 24 hours of applying primer or tack coat.
   2. Place binder course to thickness indicated on Drawings.

3. Place surface course within 24 hours of placing and compacting intermediate course. When intermediate course is placed more than 24 hours before placing surface course, clean surface and apply tack coat before placing intermediate course.
4. Place surface course to thickness indicated on Drawings.
5. Compact each course by rolling to specified density. Do not displace or extrude paving from position. Hand compact in areas inaccessible to rolling equipment.
6. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

3.5 TOLERANCES

A. Section 01 40 00 - Quality Requirements: Tolerances.

B. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.

C. Scheduled Compacted Thickness: Within 1/4 inch.

D. Variation from Indicated Elevation: Within 1/2 inch.

3.6 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting, testing.

B. Take samples and perform tests in accordance with State of North Carolina Department of Transportation standards.

C. Asphalt Paving Mix Temperature: Measure temperature at time of placement.

D. Asphalt Paving Thickness: ASTM D3549; test one core sample from every 1000 square yards compacted paving.

E. Asphalt Paving Density: ASTM D2950 nuclear method; test one location for every 1000 square yards compacted paving.

3.7 PROTECTION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Immediately after placement, protect paving from mechanical injury for 24 hours or until surface temperature is less than 140 degrees F.

END OF SECTION

SECTION 32 17 23 - PAVEMENT MARKINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Traffic lines and markings.
   2. Paint.

B. Related Requirements:
   1. Section 32 12 16 - Asphalt Paving.

1.2 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:
   1. AASHTO M247 - Standard Specification for Glass Beads Used in Traffic Paint.

B. ASTM International:
   1. ASTM D34 - Standard Guide for Chemical Analysis of White Pigments.
   2. ASTM D126 - Standard Test Methods for Analysis of Yellow, Orange, and Green Pigments Containing Lead Chromate and Chromium Oxide Green.
   3. ASTM D562 - Standard Test Method for Consistency of Paints Measuring Krebs Unit (KU) Viscosity Using a Stormer-Type Viscometer.
   4. ASTM D711 - Standard Test Method for No-Pick-Up Time of Traffic Paint.
   5. ASTM D713 - Standard Practice for Conducting Road Service Tests on Fluid Traffic Marking Materials.
   6. ASTM D969 - Standard Test Method for Laboratory Determination of Degree of Bleeding of Traffic Paint.
   7. ASTM D1301 - Standard Test Methods for Chemical Analysis of White Lead Pigments.
   8. ASTM D1394 - Standard Test Methods for Chemical Analysis of White Titanium Pigments.
   9. ASTM D1475 - Standard test Method for Density of Liquid Coatings, Inks, and Related Products.
   10. ASTM D1640 - Standard Test Methods for Drying, Curing, or Film Formation of Organic Coatings at Room Temperature.
   11. ASTM D2202 - Standard Test Method for Slump of Sealants.
   12. ASTM D2371 - Standard Test Method for Pigment Content of Solvent-Reducible Paints.
   13. ASTM D2621 - Standard Test Method for Infrared Identification of Vehicle Solids From Solvent-Reducible Paints.
   14. ASTM D2743 - Standard Practices for Uniformity of Traffic Paint Vehicle Solids by Spectroscopy and Gas Chromatography.

1.3 SUBMITTALS

A. Product Data: Submit paint formulation for each type of paint.

B. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

C. Test and Evaluation Reports: Submit source and acceptance test results in accordance with AASHTO M247.

D. Manufacturer's Instructions: Submit instructions for application temperatures, eradication requirements, application rate, line thickness, and any other data on proper installation.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

B. Applicator: Company specializing in performing work of this section with minimum 5 years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Invert containers several days prior to use when paint has been stored more than 2 months. Minimize exposure to air when transferring paint. Seal drums and tanks when not in use.

1.6 AMBIENT CONDITIONS

A. Do not apply materials when surface and ambient temperatures are outside temperature ranges required by paint product manufacturer.

B. Do not apply exterior coatings during rain or snow when relative humidity is outside humidity ranges, or moisture content of surfaces exceed those required by paint product manufacturer.

C. Do not apply paint when temperatures are expected to fall below 50 degrees F for 24 hours after application.

D. Volatile Organic Content (VOC). Do not exceed State or Environmental Protection Agency maximum VOC on traffic paint.

1.7 WARRANTY

A. Furnish one year manufacturer's warranty for traffic paints.

PART 2 PRODUCTS

2.1 PAINTED PAVEMENT MARKINGS

A. Performance / Design Criteria:
   1. Paint Adhesion: Adhere to road surface forming smooth continuous film one minute after application.
   2. Paint Drying: Tack free by touch so as not to require coning or other traffic control devices to prevent transfer by vehicle tires within two minutes after application.

B. Paint: Ready mixed, conventional and fast dry waterborne traffic paints, lead-free, non-toxic, NASSHTO Test Deck, minimum retroreflectance of 100 mcds, durability rating of 6 or more after in place for 9 months; within following limits:
   1. Pigment, percent by weight: 60 plus or minus 2
   2. Vehicle, percent by weight: 40 plus or minus 2
   3. Non-Volatile, percent by weight of paint: 76.0
   4. Weight per gallon, pounds minimum 13.0
   5. Viscosity: 80-95 Kreb Units at 77 degrees F.
   6. Grind (Hegeman Gauge), minimum Field Tested no tracking time under ambient conditions: 20-90 seconds.
   7. Dry Through Time, 15 mils wet at 90 percent relative humidity, 72 degrees F, ASTM D1640: 125 minutes maximum.

2.2 EQUIPMENT

A. Continuous Longitudinal Line Application Machine: Use application equipment with following capabilities.
   1. Dual nozzle paint gun to simultaneously apply parallel lines of indicated width in solid or broken patterns or various combinations of those patterns.
   2. Measuring device to automatically and continuously measure length of each line placed, to nearest foot.
   3. Device to heat paint to 110 degrees F for fast dry applications.

B. Machine Calibration:
   1. Paint Line Measuring Device: Calibrate automatic line length gauges to maintain tolerance of plus or minus 25 feet per mile.
   2. Cycle Length/Paint Line Length Timer: Calibrate cycle length to maintain tolerance of plus or minus 6inches per 40 feet; calibrate paint line length to maintain tolerance to plus or minus 3 inches per 10 feet.
   3. Paint Guns: Calibrate to simultaneously apply paint binder at uniform rates as specified with an allowable tolerance of plus or minus 1 mil.

C. Other Equipment:
   1. For application of crosswalks, intersections, stop lines, legends and other miscellaneous items by walk behind stripers, hand spray or stencil trucks, apply with equipment meeting requirements of this section. Do not use hand brushes or rollers.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not apply paint to concrete surfaces until concrete has cured for 28 days.

3.2 PREPARATION

A. Maintenance and Protection of Traffic:
   1. Prevent interference with marking operations and to prevent traffic on newly applied markings before markings dry.

2. Maintain travel lanes between 7: 00 AM to 9: 00 AM, and between 4: 00 PM and 6: 00 PM.
3. Maintain access to existing businesses, and other properties requiring access.

B. Surface Preparation.
1. Clean and dry paved surface prior to painting.
2. Blow or sweep surface free of dirt, debris, oil, grease or gasoline.
3. Spot location of final pavement markings as specified and as indicated on Drawings by applying pavement spots 25 feet on center.
4. Notify Architect/Engineer after placing pavement spots and minimum 3 days prior to applying traffic lines.

3.3 DEMOLITION

A. Remove existing markings in an acceptable manner. Do not remove existing pavement markings by painting over with blank paint. Remove by methods that will cause least damage to pavement structure or pavement surface. Satisfactorily repair any pavement or surface damage caused by removal methods.

B. Clean and repair existing remaining or reinstalled lines and legends.

3.4 APPLICATION

A. Agitate paint for 15 minutes prior to application to ensure even distribution of paint pigment.

B. Dispense paint at ambient 110 degrees F to wet-film thickness of 15 mils, except dispense edge markings to wet-film thickness of 12 mils.

C. Apply markings to indicated dimensions at indicated locations.

D. Prevent splattering and over spray when applying markings.

E. Unless material is track free at end of paint application convoy, use traffic cones to protect markings from traffic until track free. When vehicle crosses a marking and tracks it or when splattering or over spray occurs, eradicate affected marking and resultant tracking and apply new markings.

F. Collect and legally dispose of residues from painting operations.

3.5 TOLERANCES

A. Maximum Variation from Wet Film Thickness: 1 mil.

B. Maximum Variation from Wet Paint Line Width: Plus or minus 1/8 inch.

C. Maintain cycle length for skip lines at tolerance of plus or minus 6 inches per 40 feet and line length of plus or minus 3 inches per 10 feet.

D. Maximum Variation from Specified Application Temperature: Plus or minus 5 degrees F

3.6 FIELD QUALITY CONTROL

A. Inspect for incorrect location, insufficient thickness, line width, coverage, retention, uncured or discolored material, and insufficient bonding.

B. Repair lines and markings, which after application and curing do not meet following criteria:
   1. Incorrect Location: Remove and replace incorrectly placed patterns.
   2. Insufficient Thickness, Line Width, Paint Coverage, Glass Bead Coverage or Retention: Prepare defective material by acceptably grinding or blast cleaning to remove substantial amount of beads and to roughen marking surface. Remove loose particles and debris. Apply new markings on cleaned surface in accordance with this Section.
   3. Uncured or Discolored Material, Insufficient Bonding: Remove defective markings in accordance with this Section and clean pavement surface one foot beyond affected area. Apply new markings on cleaned surface in accordance with this Section.

C. Replace defective pavement markings as specified throughout 1 year warranted period. Replace markings damaged by anti-skid materials, studded tires, tire chains, chemical deicers, snow plowing or other loss of marking material regardless of cause. When markings are damaged by pavement failure or by Owner's painting, crack sealing, or pavement repair operations, Contractor is released from warranty requirements for damaged work.

D. Prepare list of defective areas and areas requiring additional inspection and evaluation to decide where material may need to be replaced. Provide traffic control as necessary if markings require more detailed evaluation.

E. Replace failed or defective markings in entire section of defective markings within 30 days after notification when any of the following exists during warranty period:
   1. Average retroreflectivity within any 528 foot section is less than 1225 mcd/m2/1x for white pavement markings and 100 mcd/m2/1x for yellow pavement markings.
   2. Marking is discolored or exhibits pigment loss, and is determined to be unacceptable by three member team based on visual comparison with beaded color plates.
   3. More than 15 percent of area of continuous line, or more than 15 percent of combined area of skip lines, within any 528 foot section of roadway is missing.

F. Replace pavement marking material under warranty using original or better type material. Continue warranty to end of original 1 year period even when replacement materials have been installed as specified.

G. When eradication of existing paint lines is necessary, eradicate by shot blast or water blast method. Do not gouge or groove pavement more than 1/16 inch during removal. Limit area of removal to area of marking plus 1 inch on all sides. Prevent damage to transverse and longitudinal joint sealers, and repair any damage according to requirements in Section 32 12 16.

H. Maintain daily log showing work completed, results of above inspections or tests, pavement and air temperatures, relative humidity, presence of any moisture on pavement, and any material or equipment problems. Make legible entries in log in ink, sign and submit by end of each work day. Enter environmental data into log prior to starting work each day and at two additional times during day.

3.7 PROTECTION

A. Protect painted pavement markings from vehicular and pedestrian traffic until paint is dry and track free. Follow manufacturer's recommendations or use minimum of 30 minutes. Consider barrier cones as satisfactory protection for materials requiring more than 2 minutes dry time.

3.8 MAINTENANCE

A. Furnish service and maintenance of traffic paints for one years from Date of Substantial Completion.

END OF SECTION

SECTION 32 91 13 - SOIL PREPARATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Preparation of subsoil.
   2. Soil testing.
   3. Placing vegetative growth media.

B. Related Sections:
   1. Section 31 22 13 - Rough Grading: Rough grading of site.
   2. Section 31 23 17 - Trenching: Rough grading over cut.
   3. Section 32 91 19 - Landscape Grading: Preparation of subsoil and placement of vegetative growth media in preparation for the Work of this section.
   4. Section 32 92 19 - Seeding

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Submit sample of vegetative growth media proposed. Forward sample to approved testing laboratory in sealed containers to prevent contamination.

C. Test Reports: Indicate vegetative growth media nutrient and pH levels with recommended soil supplements and application rates.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.3 COORDINATION

A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

PART 2 PRODUCTS

2.1 SOIL MATERIALS

A. Vegetative Growth Media: Vegetative soil shall be loam, sandy loam, silt loam, sandy clay loam, silty clay loam, clay loam, or loamy sand. Vegetative layer shall be fertile, friable soil free of roots stumps, stones larger than 3 inches in diameter, live plants, noxious weeds, and foreign matter. It shall contain more than of 1.5% organic matter by weight and should have a pH of above 3.6 before liming, and should have less than 500 parts per million of soluble salts.

2.2 SOURCE QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Testing, inspection and analysis requirements.

B. Analyze to ascertain percentage of nitrogen, phosphorus, potash, soluble salt content, organic matter content, and pH value.

C. Provide recommendation for fertilizer and lime application rates for specified seed mix as result of testing.

D. Testing is not required when recent tests and certificates are available for imported vegetative growth media. Submit these test results to testing laboratory. Indicate, by test results, information necessary to determine suitability.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify prepared soil base is ready to receive the Work of this section.

3.2 PREPARATION OF SUBSOIL

A. Prepare sub-soil to eliminate uneven areas and low spots. Maintain lines, levels, profiles and contours. Make changes in grade gradual. Blend slopes into level areas.

B. Remove foreign materials, weeds and undesirable plants and their roots. Remove contaminated sub-soil.

C. Scarify subsoil to depth of 3 inches where vegetative growth media is to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading vegetative growth media, has compacted sub-soil.

3.3 PLACING VEGETATIVE GROWTH MEDIA

A. Spread vegetative growth media to minimum depth of 4 inches over area to be seeded. Rake until smooth.

B. Place vegetative growth media during dry weather and on dry unfrozen subgrade.

C. Remove vegetable matter and foreign non-organic material from vegetative growth media while spreading.

D. Grade vegetative growth media to eliminate rough, low or soft areas, and to ensure positive drainage.

E. Install edging at periphery of seeded areas in straight lines to consistent depth.

END OF SECTION

SECTION 32 91 19 - LANDSCAPE GRADING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Final grade vegetative growth media for finish landscaping.

B. Related Sections:
   1. Section 31 05 13 – Soils for Earthwork
   2. Section 31 22 13 - Rough Grading: Site contouring.
   3. Section 31 23 17 - Trenching: Backfilling trenches.
   4. Section 31 23 23 - Fill: Backfilling at building areas.
   5. Section 32 92 19 - Seeding and Soil Supplements

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures

B. Samples: Submit sample of each type of fill to testing laboratory.

C. Materials Source: Submit name of imported materials source.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.3 QUALITY ASSURANCE

A. Furnish each vegetative growth media from single source throughout the Work.

PART 2 PRODUCTS

2.1 MATERIAL

A. Vegetative Growth Media: as specified in Section 32 91 13-1.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify building and trench backfilling have been inspected.

C. Verify substrate base has been contoured and compacted.

3.2 PREPARATION

A. Protect landscaping and other features remaining as final Work.

B. Protect existing structures, fences, sidewalks, utilities, paving, and curbs.

3.3 SUBSTRATE PREPARATION

A. Eliminate uneven areas and low spots.

B. Remove debris, roots, branches, stones, in excess of 1 inch in size. Remove contaminated subsoil.

C. Scarify surface to depth of 3 inches where vegetative growth media is scheduled. Scarify in areas where equipment used for hauling and spreading vegetative growth media has compacted subsoil.

3.4 PLACING TOPSOIL

A. Place vegetative growth media in areas where seeding to thickness as shown on drawings. Place vegetative growth media during dry weather.

B. Fine grade vegetative growth media to eliminate rough or low areas. Maintain profiles and contour of subgrade.

C. Remove roots, weeds, rocks, and foreign material while spreading.

D. Manually spread vegetative growth media close to plant material, building, and site structures to prevent damage.

E. Roll placed vegetative growth media.

F. Remove surplus subsoil and vegetative growth media from site.

3.5 TOLERANCES

A. Top of Vegetative Growth Media: Plus or minus 1/2 inch.

3.6 PROTECTION OF INSTALLED WORK

A. Prohibit construction traffic over vegetative growth media.

END OF SECTION

SECTION 32 92 19 - SEEDING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Fertilizing.
2. Seeding.
3. Hydroseeding.
4. Mulching.
5. Maintenance.

B. Related Sections:
1. Section 31 05 13 – Soils for Earthwork
2. Section 31 22 13 - Rough Grading: Rough grading of site.
3. Section 31 23 17 - Trenching: Rough grading over cut.
4. Section 32 91 13 - Soil Preparation
5. Section 32 91 19 - Landscape Grading: Preparation of subsoil and placement of vegetative growth media in preparation for the Work of this section.

1.2 REFERENCES

A. ASTM International:
1. ASTM C602 - Standard Specification for Agricultural Liming Materials.

1.3 DEFINITIONS

A. Weeds: Vegetative species other than specified species to be established in given area.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data for seed mix, fertilizer, mulch and other accessories.

C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Provide seed mixture in containers showing percentage of seed mix, germination percentage, inert matter percentage, weed percentage, year of production, net weight, date of packaging, and location of packaging.

B. Source Quality Control:
1. General: Ship landscape materials with certificates of inspection as required by governmental authorities. Comply with governing regulations applicable to landscape materials.

2. Analysis and Standards: Package standard products with manufacturer's certified analysis. For other materials, provide analysis by recognized laboratory made in accordance with methods established by the Association of Official Agricultural Chemists, wherever applicable or as further specified.

3. Grass Seed: All seed shall be certified as to mixture, germination, and purity, as being in conformity with the following requirements:
   a. Each variety of seed shall have a percentage of germination of not less than 80, a percentage of purity of not less than 85, and shall have not more than one percent of weed content.
   b. All seed shall be from the same or previous year's crop unless recent tests by an approved testing agency demonstrate that older seed meets the above requirements.

1.6 QUALIFICATIONS

A. Seed Supplier: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing work of this section with minimum 5 years documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable.

B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

1.8 MAINTENANCE SERVICE

A. Maintain seeded areas immediately after placement until grass is well established and exhibits vigorous growing condition.

B. Maintain each seeded area until acceptance of the individual area.

PART 2 PRODUCTS

2.1 SEED MIXTURES

A. Permanent Seed Mixture:

The seed mixtures shall consist of seeds proportioned by weight as follows:

Permanent Seeding		Temporary Seeding	
Kentucky 31	105 lbs/acre	Annual Rye	40 lbs/acre
Creeping Red Fescue	24 lbs/acre		
Kentucky Blue Grass	24 lbs/acre		
Sericea Lespadeza	24 lbs/acre		
Korean Lespadeza	21 lbs/acre		
Annual Rye	21 lbs/acre		
White Dutch Clover	6 lbs/acre		

B. Temporary Seed Mixture: Perennial Ryegrass – 40 lbs/acre.

2.2 ACCESSORIES

A. Mulching Material: Hay or straw mulch shall consist of long fibered hay or straw, reasonably free from noxious weeds and other undesirable material. No material shall be used which is too wet, decayed, or compacted as to inhibit even and uniform spreading. No chopped hay, grass clippings or other short fibered material shall be used unless directed.

B. Mulching Material: Cellulose fiber mulch shall consist of natural wood, recycled paper or humus cellulose fiber containing no materials which will inhibit seed germination or plant growth. Sufficient non-toxic water soluble green dye shall be added to provide a definite color contrast to the ground surface to aid in even distribution. Cellulose fiber mulch shall be supplied in moisture resistant, sealed bags marked with the manufacturer's name, the air dry weight, and composition of the contents.

C. Mulch Binder: Material for mulch tackifier shall be a non –asphaltic base product.
   1. Manufactures: Hydro Glass Corporation Hydrotack or approved equal.

D. Fertilizer: Commercial grade; recommended for grass; of proportion necessary to eliminate deficiencies of vegetative growth media, as indicated in analysis.

E. Lime: Natural limestone containing not less than 90% of total carbonates, ground so that not less than 100% passes a 10-mesh sieve, not less than 90% passes a 20 mesh sieve, and not less than 50% passes a 100 mesh sieve.

F. Water: Clean, fresh and free of substances or matter capable of inhibiting vigorous growth of grass.

G. Erosion Fabric: Jute matting, open weave.

H. Stakes: Softwood lumber, chisel pointed.

I. String: Inorganic fiber.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify prepared soil base is ready to receive the Work of this section.

3.2 FERTILIZING

A. Apply lime at application rate recommended by soil analysis. Work lime into top 2 inches of soil.

B. Apply fertilizer at application rate recommended by soil analysis.

C. Apply after smooth raking of vegetative growth media.

D. Do not apply fertilizer at same time or with same machine used to apply seed.

E. Mix fertilizer thoroughly into upper 2 inches of vegetative growth media.

F. Lightly water soil to aid dissipation of fertilizer. Irrigate top level of soil uniformly.

3.3 HYDROSEEDING

A. All areas shall be hydroseeded unless alternative methods are approved by the Owner's Representative.

B. Apply fertilizer, mulch and seeded slurry with hydraulic seeder at rate indicated in Part 2 evenly in one pass.

C. After application, apply water with fine spray immediately after each area has been hydroseeded. Saturate to 4 inches of soil and maintain moisture levels two to four inches.

D. If Owner's Representative finds application uneven or otherwise unsatisfactory, he may require an alternative method as specified in section 3.4.

3.4 SEEDING

A. Apply seed at rate indicated in Part 2 evenly in two intersecting directions. Rake in lightly.

B. Do not seed areas in excess of that which can be mulched on same day.

C. Do not sow immediately following rain, when ground is too dry, or when winds are over 12 mph.

D. Roll seeded area with roller not exceeding 112 lbs/linear foot.

E. Immediately following seeding, apply mulch to thickness of 1/8 inches. Maintain clear of shrubs and trees.

F. Apply water with fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.

3.5 SEED PROTECTION

A. Cover seeded slopes with erosion fabric as indicated on the drawings. Roll fabric onto slopes without stretching or pulling.

B. Lay fabric smoothly on surface, bury top end of each section in 6 inch deep excavated vegetative growth media trench. Overlap edges and ends of adjacent rolls minimum 12 inches. Backfill trench and rake smooth, level with adjacent soil.

C. Secure outside edges and overlaps at 36 inch intervals with stakes.

D. Lightly dress slopes with vegetative growth media to ensure close contact between fabric and soil.

E. At sides of ditches, lay fabric laps in direction of water flow. Lap ends and edges minimum 6 inches.

3.6 MAINTENANCE AND ACCEPTANCE

A. Seeding, March 1 to September 15, Inclusive: The Contractor shall maintain each seeded area until acceptance of the individual area. Maintenance shall consist of providing protection by erecting necessary signs and barriers and by repairing damaged areas as directed. Damaged areas and areas which do not produce a satisfactory stand of grass shall be repaired to re-establish the condition and grade of the area prior to the original seeding and then refertilized, reseeded and remulched as specified to produce satisfactory results.

B. Seeding, September 16 to February 28, Inclusive: The Contractor shall maintain each seeded area until acceptance of the individual area. Maintenance shall consist of providing protection by erecting necessary signs or barriers and by repairing damaged areas as directed. Damaged areas shall be repaired by re- establishing the grade of the area prior to damage and by reapplying mulch. Refertilizing and reseeding will not be required during this period. Necessary maintenance or repairs will not be paid for but shall be considered incidental to the Contract.

C. Mow grass at regular intervals to maintain at maximum height of 2-1/2 inches. Do not cut more than 1/3 of grass blade at each mowing. Perform first mowing when seedlings are 40 percent higher than desired height.

D. Neatly trim edges and hand clip where necessary.

E. Immediately remove clippings after mowing and trimming. Do not let clippings lay in clumps.

F. Water to prevent grass and soil from drying out.

G. Control growth of weeds. Apply herbicides. Remedy damage resulting from improper use of herbicides.

H. Immediately reseed areas showing bare spots.

I. Repair washouts or gullies.

J. Protect seeded areas with warning signs during maintenance period.

K. Seeded areas will be accepted only upon attainment of a reasonable thick uniform stand of not less than 90 percent coverage of permanent grasses, free from sizable thin or bare spots.

END OF SECTION

SECTION 33 05 13 - MANHOLES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Modular precast concrete manhole with tongue-and-groove joints with masonry transition to cover frame, covers, anchorage, and accessories.
   2. Bedding and cover materials.

B. Related Sections:
   1. Section 04 05 14 - Masonry Mortaring and Grouting: Mortar and grout.
   2. Section 04 20 00 - Unit Masonry: Product requirements for clay brick units for use in manhole construction.
   3. Section 31 05 13 - Soils for Earthwork: Soil for backfill in trenches.
   4. Section 31 05 16 - Aggregates for Earthwork: Aggregate for backfill in trenches.
   5. Section 31 23 16 - Excavation: Excavating for manholes.
   6. Section 31 23 23 - Fill: Backfilling after manhole installation.
   7. Section 33 05 16 - Utility Structures.
   8. Section 33 71 19 - Electrical Underground Ducts and Manholes.

1.2 REFERENCES

A. American Concrete Institute:
   1. ACI 318 - Building Code Requirements for Structural Concrete.
   2. ACI 530/530.1 - Building Code Requirements for Masonry Structures and Specifications for Masonry Structures.

B. ASTM International:
   1. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
   2. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   3. ASTM C55 - Standard Specification for Concrete Brick.
   4. ASTM C62 - Standard Specification for Building Brick (Solid Masonry Units Made From Clay or Shale).
   5. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
   6. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
   7. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.
   8. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.
   9. ASTM D3753 - Standard Specification for Glass-Fiber-Reinforced Polyester Manholes and Wetwells.

1.3 DESIGN REQUIREMENTS

A. Equivalent strength: Based on structural design of reinforced concrete as outlined in ACI 318.

B. Design of Lifting Devices for Precast Components: In accordance with ASTM C913.

C. Design of Joints for Precast Components: In accordance with ASTM C913; maximum leakage of 0.025 gallons per hour per foot of joint at 3 feet of head.

D. Design of anti-flotation collar per manufacturer's recommendation.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate manhole and structure locations, elevations, piping, conduit, and sizes and elevations of penetrations.

C. Product Data: Submit cover and frame construction, features, configuration and dimensions.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

1.6 DELIVERY, STORAGE AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Comply with precast concrete manufacturer's instructions for unloading, storing and moving precast manholes.

C. Store precast concrete manholes to prevent damage to Owner's property or other public or private property. Repair property damaged from materials storage.

D. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers shown on Drawings to indicate its intended use.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Section 01 60 00 - Product Requirements.

B. Cold Weather Requirements: ACI 530.

PART 2 PRODUCTS

2.1 MANHOLES

A. Manhole Sections: Reinforced precast concrete in accordance with ASTM C478 with gaskets in accordance with ASTM C923.

B. Manholes shall be reinforced for H-20 loading (4,000 psi concrete).

2.2 FRAMES AND COVERS

A. Product Description: ASTM A48/A48M, Class 30B Cast iron construction, machined flat bearing surface, removable lid, closed cover design; constructed for H-20 loading; cover molded with the word SEWER or DRAIN and logo.

2.3 COMPONENTS

A. Waterproofing:
   1. Minimum 1 primer coat of epoxy paint 3 to 5 mils and 2 topcoats 4 to 6 mils thick.
   2. Cement base coating suitable for brush coat application.

B. Pipe Connection:
   1. Manufactures: Kor-N-Seal manhole penetration by NPS or Approved Equal.

2.4 CONFIGURATION

A. Shaft Construction: Concentric with concentric cone top section; lipped male/female joints; sleeved to receive pipe sections.

B. Shape: Cylindrical.

C. Clear Inside Dimensions: As indicated on Drawings.

D. Design Depth: As indicated on Drawings.

E. Clear Cover Opening: As indicated on Drawings.

F. Pipe Entry: Furnish openings as indicated on Drawings.

G. Steps: As indicated on Drawings or as required by code.

2.5 BEDDING AND COVER MATERIALS

A. Bedding: as indicated on drawings and specified in Section 31 05 16.

B. Cover: Fill Type, as indicated on the drawings and specified in Section 31 05 16.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify items provided by other sections of Work are properly sized and located.

C. Verify built-in items are in proper location, and ready for roughing into Work.

D. Verify correct size of manhole excavation.

3.2 PREPARATION

A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.

B. Do not install structures where site conditions induce loads exceeding structural capacity of structures.

C. Inspect precast concrete structures immediately prior to placement in excavation to verify structures are internally clean and free from damage. Remove and replace damaged units.

3.3 INSTALLATION

A. Excavation and Backfill:
   1. Excavate for manholes in accordance with Section 31 23 16 in location and to depth shown. Provide clearance around sidewalls of structure for construction operations.
   2. When groundwater is encountered, prevent accumulation of water in excavations. Place manholes in dry trench.
   3. Where possibility exists of watertight structure becoming buoyant in flooded excavation, anchor structure to avoid flotation.

B. Install manholes supported at proper grade and alignment as shown on Drawings.

C. Backfill excavations for manholes in accordance with Section 31 23 23.

D. Set cover frames and covers level without tipping, to correct elevations.

E. Coordinate with other sections of Work to provide correct size, shape, and location.

3.4 PRECAST CONCRETE MANHOLE INSTALLATION

A. Lift precast components at lifting points designated by manufacturer.

B. When lowering manholes into excavations and joining pipe to units, take precautions to ensure interior of pipeline and structure remains clean.

C. Set precast structures bearing firmly and fully on crushed stone bedding, compacted in accordance with provisions of Section 31 23 23 or on other support system shown on Drawings.

D. Assemble multi-section structures by lowering each section into excavation. Lower, set level, and firmly position base section before placing additional sections.

E. Remove foreign materials from joint surfaces and verify sealing materials are placed properly. Maintain alignment between sections by using guide devices affixed to lower section.

F. Joint sealing materials may be installed on site or at manufacturer's plant.

G. Verify manholes installed satisfy required alignment and grade.

H. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe. Fill annular space with mortar.

I. Cut pipe to finish flush with interior of structure.

J. Shape inverts through manhole as shown on Drawings.

3.5 FRAME AND COVER INSTALLATION

A. Set frames using mortar and masonry. Install radially laid concrete brick with 1/4 inch thick vertical joints at inside perimeter. Lay concrete brick in full bed of mortar and completely fill joints. Where more than one course of concrete brick is required, stagger vertical joints.

B. Set frame and cover 2 inches above finished grade for manholes with covers located within unpaved areas to allow area to be graded away from cover beginning 1 inch below top surface of frame.

3.6 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

B. Test concrete manhole and structure sections in accordance with ASTM C497.

C. Vertical Adjustment of Existing Manholes:
   1. Where required, adjust top elevation of existing manholes to finished grades shown on Drawings.
   2. Reset existing frames, grates and covers, carefully removed, cleaned of mortar fragments, to required elevation in accordance with requirements specified for installation of castings.
   3. Remove concrete without damaging existing vertical reinforcing bars when removal of existing concrete wall is required. Clean vertical bars of concrete and bend into new concrete top slab or splice to required vertical reinforcement, as indicated Drawings.
   4. Clean and apply sand-cement bonding compound on existing concrete surfaces to receive cast-in-place concrete in accordance with Section 03 30 00.

END OF SECTION

SECTION 33 41 00 - STORM UTILITY AND LEACHATE DRAINAGE PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Storm drainage piping.
2. Trench drain piping.
3. Strip drain piping.
4. Leachate collection and transport piping
5. Accessories.
6. Bedding and cover materials.

B. Related Sections:
1. Section 31 05 16 - Aggregates for Earthwork: Aggregate for backfill in trenches.
2. Section 31 23 16 - Excavation: Product and execution requirements for excavation and backfill required by this section.
3. Section 31 23 17 - Trenching: Execution requirements for trenching required by this section.
4. Section 31 23 23 - Fill: Requirements for backfill to be placed by this section.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:
1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 10-lb Rammer and a 18-in. Drop.

B. ASTM International:
1. ASTM C969 - Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.
2. ASTM C1103 - Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.
3. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3).
4. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3).
5. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
6. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
7. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
8. ASTM D2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
9. ASTM D2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
10. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.

11. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
12. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
13. ASTM D3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
14. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data indicating pipe and pipe accessories.

C. Manufacturer's Installation Instructions: Submit special procedures required to install Products specified.

D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

1.5 Record Documents:

A. Project
1. Accurately record actual locations of pipe runs, connections, and invert elevations.

1.6 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

PART 2 PRODUCTS

2.1 STORM DRAINAGE LEACHATE PIPING

A. Provide pipes of the following materials, of weight/class indicated. Provide pipe fittings, cleanouts and all accessories of same material and weight/class as pipes, with joining method as indicated on Drawings.

B. High Density Polyethylene (HDPE) Pipe and Fittings:

1. Physical Properties:

Property	Unit	Test Method	Value
Material Listing	-	PPI TR-4	PE 3408
Cell Classification	-	ASTM D 3350	PE 345464C
Density	g/cm^3	ASTM D 1505	>0.940
Melt Index	g/10 min	ASTM D1238	<0.15
Flexural Modulus	psi	ASTM D 790	>110,000 and < 160,000
Tensile Strength (yield)	psi	ASTM D 638	3000-3500
PENT	hours	ASTM F 1473	100
Hydrostatic Design Basis	psi	ASTM D 2837	1600 @ 23° C
UV Stabilizer	% Carbon Black	ASTM D 1603	2 to 3
Elastic Modulus	psi	ASTM D 638	110,000
Thermal Expansion	1 in./in./° F	ASTM D 696	8×10^{-5}
Molecular Weight Category	-	-	Extra High

C. General:

1. The pipe used to fabricate the system supplied under this specification shall be high density, extra high molecular weight polyethylene pipe. The pipe and fittings shall be designated PE 3408. The pipe and fittings shall be made from the same resin base that meets this specification.
2. Density of base resin shall be within the limits of 0.940 to 0.955, ASTM D-1505 (Test Methods).
3. The HDPE pipe must conform to ASTM D 3035 and D 3350.
4. Outside diameter of pipe shall conform to International Standard Organization (ISO) recommendations for outside diameters.
5. 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.
6. Perforated pipe shall be provided as indicated on the Contract Drawings. Perforations shall be oriented as shown on the Contract Drawings.
7. HDPE Fittings, molded or fabricated, shall have the same pressure rating and strength as the pipe to which joining is intended. Fitting markings shall include a production code from which the location and date of manufacture can be determined. Upon request, the manufacturer shall provide an explanation of his production code.
8. Marking: Each standard and random length of pipe and fitting in compliance with this standard shall be clearly marked with the following information:
   a. ASTM Standard Designation
   b. Pipe Size
   c. Class and Profile Number
   d. Production Code
   e. Dimension Ratio

D. Pipe Schedule
   1. 6-inch leachate collection - SDR 11
   2. 12-inch leachate collection/transport – SDR 11
   3. 12-inch trench drain– SDR 11
   4. 12-inch strip drain – SDR 11

2.2 ACCESSORIES

A. Filter Fabric: Non-biodegradable, as indicated on Drawings.

2.3 BEDDING AND COVER MATERIALS

A. Bedding: Fill Type as indicated on drawings and specified in Section 31 05 16.

B. Cover: Fill Type as indicated on drawings and specified in Section 31 05 16.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL:

A. Pipe may be rejected for failure to conform to Specifications for the following:
   1. Fractures or cracks passing through pipe wall, except a single crack not exceeding 2 inches in length at either end of the pipe which can and will be cut off and discarded.
   2. Cracks sufficient to impair strength, durability or serviceability of pipe.
   3. Defects indicating improper proportioning, mixing, or molding.
   4. Damaged ends,
   5. If required by Engineer, provide a pyrometer to record and verify the temperature of heating plate surface (at a minimum of three locations) once every two hours. Maintain records of these temperature measurements including, temperature, date, time, and fusing technician for the duration of the project. Provide the Engineer with a copy of the temperature measurements.

B. Acceptance of fittings, stubs, or other specifically fabricated pipe sections (e.g. butt-fusion joints) shall be based on visual inspection at the job site and documentation of conformance to these Specifications.

C. Prior to backfilling, the Contractor shall obtain as-built top of pipe coordinates and elevations as grade changes, fittings, and at least every 50 feet along the length of pipe.

3.2 PIPE JOINTING

A. All materials shall be stored and handled in accordance with the manufacturer's recommendations.

B. All joints shall be made in a dry trench or area that is protected from adverse weather or dust, and in accordance with the manufacturer's recommendations and the best practices for class of pipe installed. The ends of the pipe shall be wiped clean with a dry cloth before making each joint.

C. Butt Fusion Joints:
   1. Pipes: Join to one another and to HDPE fittings by thermal butt-fusion in accordance with ASTM D2657.
   2. The tensile strength at yield of the butt-fusion joints shall not be less than the pipe.

D. Flange Jointing:
   1. Use when connecting or transitioning to flanged steel pipe in manholes or pump stations
   2. Connect slip-on type 316 stainless steel backup flanges and nuts and bolts to flange adapters
   3. Butt fuse fabricated flange adapters to pipe.
   4. Observe the following in connection of flanged joints:
      a. Align flanges or flange valve connection to provide tight seal. Provide nitrile-butadiene gaskets if needed to achieve seal. Gaskets are required all flanged connections.
   5. Make Flanged connections according to Section 02450.

E. Electro-Fusion Joints:
   1. Electro-fusion couplings shall be installed per manufacturer's specifications.
   2. The electro-fusion machines record of each fusion shall be downloaded from the machine and a copy sent to the Engineer.
   3. Joints using electro-fusion couplings shall be performed in the trench so as not to overstress the joint and achieve proper alignment.

F. Pipe Cutting:
   1. Where required, sections of pipe may be cut to provide shorter sections of pipe necessary for the construction. The cutting of the pipe shall be done in accordance with the pipe manufacturer's recommendations and subject to the approval of the Engineer.
   2. In general, the pipe material shall be cut by using a saw or milling process, approved by the pipe manufacturer and not by using any impact device, such as a hammer and chisel, to break the pipe. The pipe shall be cut, not broken. The cut end of the pipe shall be square to the axis of the pipe and any rough edges ground smooth.

G. Inspection: Pipe installation shall be subject to inspection by the Engineer for quality, adherence to line and grade, jointing, and proper backfill. Any joint not satisfactory to the Engineer shall be removed and remade to his satisfaction at the Contractor's expense. No pipe shall be backfilled until it has been approved by the Engineer.

3.3 INSTALLATION – PIPE AND FITTINGS

A. Inspect piping before installation to detect apparent defects. Mark defective materials with white paint and promptly remove from site.

B. Install pipe, fittings, and accessories in accordance with ASTM D2321. Seal joints watertight.

C. Place pipe on minimum 6 inch deep bed of filter aggregate.

D. Place bell ends or groove ends of piping facing upstream.

E. Lay pipe to slope gradients noted on drawings with maximum variation from indicated slope of 1/8 inch in 10 feet.

F. Install aggregate at sides and over top of pipe, compact to 95 percent.

G. Refer to Section 31 23 23 for backfilling and compacting requirements. Do not displace or damage pipe when compacting.

H. Connect to existing storm and leachate drainage systems.

3.4 CLEANING

A. Clear interior of piping of dirt or other superfluous material as work progresses.

B. Maintain swab or drag in line and pull past each joint as it is completed.

C. In large accessible piping, brushes and brooms may be used for cleaning.

3.5 FIELD QUALITY CONTROL

A. Request inspection prior to and immediately after placing aggregate cover over pipe.

B. Interior Inspection: Inspect piping to determine whether line displacement or other damage has occurred. If inspection indicates poor alignment, debris, displaced pipe, infiltration, or other defects, correct such defects and reinspect.

C. Leakage and Testing: After the completed solid pipeline has been installed, the trench has been compacted to specification requirements, and joints showing noticeable streams or jets have been repaired and/or replaced the Contractor shall perform all exfiltration tests. The Contractor shall be responsible for furnishing all labor, materials and equipment so that such tests can be accomplished at the times and locations the Engineer deems necessary. The rate of exfiltration shall not exceed 200 gallons per inch of pipe diameter per mile of pipe per day.
   1. THE ATTENTION OF THE CONTRACTOR IS DIRECTED TO THE STRICT REQUIREMENTS RELATIVE TO MAXIMUM RATES OF EXFILTRATION AND TO THE IMPORTANCE OF THESE SPECIFICATIONS RELATIVE TO TIGHT JOINTS REQUIRED. SEWERS NOT MEETING THE ABOVE REQUIREMENTS SHALL BE REPAIRED AS NECESSARY AT THE CONTRACTOR'S EXPENSE.

D. Infiltration Test: Test in accordance with ASTM 969.

E. Pressure Test: Test in accordance with ASTM C924 and ASTM C1103, depending on size of pipe.
   1. Air Test: For making low-pressure air tests, the Contractor shall use equipment specifically designed and manufactured for the purpose of testing sewer pipelines using low-pressure air. The equipment shall be provided with an air regulator valve or air safety valve so set that the internal air pressure in the pipeline cannot exceed eight psig.
   2. Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe to be tested. Pneumatic plugs shall resist internal test pressure without requiring external bracing or blocking.
   3. All air used shall pass through a single control panel.

4. Low-pressure air shall be introduced into the sealed line until the internal air pressure reaches four psig greater than the maximum pressure exerted by groundwater that may be above the invert of the pipe at the time of the test. However, the internal air pressure in the sealed line shall not be allowed to exceed eight psig.
5. At least two minutes shall be allowed for the air pressure to stabilize in the section under test. After the stabilization period, the low-pressure air supply hose shall be quickly disconnected from the control panel. The time required in minutes for the pressure in the section under test to decrease from 3.5 to 3.0 psig (greater than the maximum pressure exerted by groundwater that may be above the invert of the pipe) shall not be less than that shown in the following table:

Pipe diameter in inches	Minutes
6	4.0
8	5.0
10	6.5
12	7.5
14	9.0
15	9.5
18	11.5

Note: For larger diameter pipe, minimum time = 7.7 x dia. (ft).

6. When the sewer section to be tested contains more than one size of pipe, the minimum allowable time shall be based on the largest diameter pipe in the section.

3.6 PROTECTION OF FINISHED WORK

A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.
   1. Take care not to damage or displace installed pipe and joints during construction of pipe supports, backfilling, testing, and other operations.
   2. Repair or replace pipe that is damaged or displaced from construction operations.

END OF SECTION

SECTION 33 42 13 - PIPE CULVERTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Corrugated steel pipe culvert.
2. Concrete pipe culvert.
3. Joints and accessories.
4. Bedding.
5. Slope protection at pipe end.

B. Related Sections:
1. Section 03 30 00 - Cast-In-Place Concrete: Concrete grout fill to adjacent construction.
2. Section 31 05 16 - Aggregates for Earthwork.
3. Section 31 23 16 - Excavation: Excavating for culvert piping.
4. Section 31 23 17 - Trenching: Backfilling over piping up to subgrade elevation
5. Section 31 37 00 - Riprap.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:
1. AASHTO M294 - Specification for Corrugated Polyethylene Pipe, 12- to 36-in. Diameter.
2. AASHTO T99 - Standard Specification for the Moisture-Density Relations of Soils Using a 5.5-lb Rammer and a 12-in. Drop.
3. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 10-lb Rammer and a 18-in. Drop.

B. ASTM International:
1. ASTM A929/A929M - Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe.
2. ASTM C14 - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
3. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
4. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
5. ASTM C506 - Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe.
6. ASTM C507 - Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe.
7. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort 12,400 ft-lbf/ft3.
8. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft-lbf/ft3.
9. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

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

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit data on pipe, fittings, and accessories.

C. Manufacturer's Installation Instructions: Submit special procedures required to install Products specified.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents:
1. Accurately record actual locations of pipe runs, connections, and invert elevations.

C. Operation and Maintenance Data: Procedures for submittals.

1.5 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene one week prior to commencing Work of this section.

PART 2 PRODUCTS

2.1 PLASTIC CULVERT PIPE

A. The stormwater pipes shall be annular smooth interior corrugated high-density polyethylene pipe.

B. Corrugated pipe shall be ADS N-12 brand polyethylene pipe with watertight joints or Engineer-approved equal.

2.2 BEDDING AND COVER MATERIALS

A. Bedding: Fill Type as indicated on drawings and specified in Section 31 05 16.

B. Cover: Fill Type as indicated on drawings and specified in Section 31 05 16.

2.3 ACCESSORIES

A. Fill at Pipe Ends: Riprap as specified in Section 31 37 00.

B. Anti-seep Collars: Provide in accordance with dimensions and specifications on the Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on drawings.

3.2 PREPARATION

A. Remove large stones or other hard matter which could damage piping or impede consistent backfilling or compaction.

3.3 EXCAVATION AND BEDDING

A. Excavate culvert trench to 12 inches below pipe invert, in accordance with Section for work of this Section. Hand trim excavation for accurate placement of pipe to elevations indicated.

B. Place bedding material at trench bottom, level fill materials in one continuous layer not exceeding 6 inches compacted depth, compact to 90 percent.

C. Maintain optimum moisture content of bedding material to attain required compaction density.

3.4 INSTALLATION - PIPE

A. Lift or roll pipe into position. Do not drop or drag pipe over prepared bedding.

B. Shore pipe to required position; retain in place until after compaction of adjacent fills. Ensure pipe remains in correct position and to required slope.

C. Repair surface damage to pipe protective coating with two coats of compatible bituminous paint coating.

D. Install cover at sides and over top of pipe.

E. Maintain optimum moisture content of bedding material to attain required compaction density.

F. Refer to Section 31 23 17 for backfilling and compacting requirements. Do not displace or damage pipe when compacting.

3.5 PIPE ENDS

A. Place fill at pipe ends, as indicated on Drawings.

3.6 ANTI-SEEP COLLARS

A. Place anti-seep collars in accordance with the lines, dimensions, and specifications shown on the plans.

3.7 ERECTION TOLERANCES

A. Lay pipe to alignment and slope gradients noted on Drawings; with maximum variation from indicated slope of 1/8 inch in 10 feet.

B. Maximum Variation From Intended Elevation of Culvert Invert: 1/2 inch.

C. Maximum Offset of Pipe From Indicated Alignment: 1 inch.

D. Maximum Variation in Profile of Structure from Intended Position: 1 percent.

3.8 FIELD QUALITY CONTROL

A. Request inspection prior to and immediately after placing aggregate cover over pipe.

B. Compaction Testing: In accordance with ASTM D1556.

C. When tests indicate Work does not meet specified requirements, remove Work, replace, and retest.

D. Frequency of Tests: refer to section 31 23 17.

3.9 PROTECTION OF INSTALLED CONSTRUCTION

A. Protect pipe and bedding from damage or displacement until backfilling operation is in progress.

END OF SECTION

QUALITY ASSURANCE/ QUALITY CONTROL PLAN FOR LANDFILL NO. 6 AREA D NORTH CANTON, NORTH CAROLINA

Prepared for

EVERGREEN PACKAGING
CANTON, NORTH CAROLINA

August 2013

SME
Sevee & Maher Engineers, Inc.

ENVIRONMENTAL • CIVIL • GEOTECHNICAL • WATER • COMPLIANCE

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1.0 SCOPE

This Quality Assurance/Quality Control Plan (Plan) addresses construction quality assurance and quality control for the construction of Landfill No. 6 Amendment Area D – South of the Evergreen Packaging Canton Mill (Canton Mill). The Landfill No. 6 Amendment Area 6D North construction encompasses approximately 17.4 acres, and will be constructed east of Areas C Upper and 6A West, with a 12-inch compacted soil liner, GCL, a 60-mil geomembrane, 16 oz. non-woven geotextile, and 15 inches of drainage stone.

This plan addresses the manufacturing and installation quality assurance and quality control procedures associated with selecting and placing the HDPE geomembrane liner, non-woven geotextile, and GCL. This plan also outlines the characterization of the borrow source soil's physical properties to determine its ability to achieve the project's performance criteria; defines procedures for soil placement; defines tests and frequency of testing to assure the construction meets or exceeds design criteria; and provides a method for documenting the soil placement.

1.1 Parties

The parties discussed in this section are associated with the ownership, design, installation, and quality assurance of the liner system. The definitions, qualifications, and responsibilities of these parties are outlined in the following subsections.

Project Manager. The project manager is the official representative of the Canton Mill. In this manual the term Project Manager shall apply equally to Construction Coordinator. The Project Manager is responsible for coordinating construction and quality assurance activities for the project. The Project Manager shall serve as communications coordinator for the project, and is responsible for initiating the pre-bid, pre-construction, and construction meetings. As construction coordinator, the Project Manager shall serve as a liaison between all parties involved in the project to assure that communications are maintained. The Project Manager shall also be responsible for proper resolution of all quality assurance issues that arise during

construction. For the construction of Landfill No. 6 Amendment Area D – North of Landfill No. 6, the Project Manager is Guy Cote, P.E. of Sevee & Maher Engineers, Inc.

Qualifications. The selection of the Project Manager is the direct responsibility of the Canton Mill. Qualifications for this position include familiarity with the following:

1. Applicable QAMs.
2. All applicable regulatory requirements.
3. Policies and procedures for project management.
4. Placement techniques of low hydraulic conductivity material.

Designer (Engineer). The designer (Engineer) is the individual and/or firm responsible for the preparation of the design including, project specific engineering drawings, technical specifications and the Quality Assurance Manual. The Engineer is responsible for approving all design and specification changes, manufacturer's material certifications and contractor submittals, and for making any design clarifications during the contract bidding process and construction of the liner system. The Engineer may attend the pre-bid, pre-construction, and construction meetings upon the request of the Project Manager. The Engineer may also act as the Owner's Representative and Construction Quality Assurance Agent (CQA Agent) during construction of the project. The Design Firm for the cell development of the Landfill is Sevee & Maher Engineers, Inc. (SME) of Cumberland, Maine. The Project Engineer for the development is Guy Cote, P.E. of SME.

Construction Quality Assurance Agent. The CQA Agent is responsible for review of the borrow source and in-place material testing results and for the observation of the Contractor's work to assure that the liner system meets the design specifications. Qualifications for this position include familiarity with the following:

1. Applicable QAMs.
2. All applicable regulatory requirements.
3. Placement techniques of low hydraulic conductivity material.

4. Experience with soil inspection of landfill projects.

The CQA Agent is also responsible for the following:

- Approval/disapproval of borrow source material test results for the liner;

- The in-place testing and approval of the materials placed by the Contractor; and

- Ensure that the placement techniques utilized conform to industry standard and this QAM, and as described in Technical Specification Section 02200 Part 3.2, including the following:

  - measuring barrier soil lift thickness;
  - monitoring and measuring as necessary the maximum clod size of the soil;
  - assuring the proper lift benching techniques are followed; and
  - assuring that proper lift bonding of the soil is achieved.

The CQA Agent will provide continuous monitoring during placement of the soil. It is anticipated that only one CQA Agent will be necessary during construction of the soil liner. However, should the Contractor begin placing the till over separate areas of the landfill simultaneously, additional CQA Agents will be added for oversight. The CQA Agent will be under the direction of a State of North Carolina registered Professional Engineer.

Geosynthetic Construction Quality Assurance Agent. The Geosynthetic Construction Quality Assurance Agent (CQA) is a firm independent from the Manufacturer(s) and Installer that shall be responsible for observing and documenting activities related to the quality assurance of the production and installation of the geosynthetic system on behalf of the Canton Mill.

In this QAM the term Geosynthetic Quality Assurance Engineer (QAE) shall be used to designate the engineer (working for the Geosynthetic CQA) in charge of the quality assurance

work. In some cases the duties of the QAE described below may be shared by two individuals: a Geosynthetic Quality Assurance Managing Engineer located at the headquarters of the Geosynthetic CQA; and a Geosynthetic Quality Assurance Site Manager located at the site. The personnel of the Geosynthetic CQA also include Geosynthetic Quality Assurance Monitors who are located at the site for construction observation and documentation. The CQA agent will provide sufficient personnel on-site to enable complete (100%) observation of all deployment, seaming, and testing activities. The required CQA staff level will be a function of the installer's schedule.

The Geosynthetic CQA is responsible for observing and documenting activities related to the quality assurance of the production and installation of the geosynthetic system. The Geosynthetic CQA is responsible for implementation of the project QAP prepared by the Project Manager and management of the Geosynthetic Quality Assurance Laboratory. The Geosynthetic CQA is also responsible for issuing a final certification report, sealed by a registered professional engineer.

The specific duties of the Geosynthetic CQA personnel are as follows:

1. The Geosynthetic QAE:

    a. Reviews all design drawings and specifications.

    b. Reviews other site-specific documentation, including proposed layouts, and manufacturer's and installer's literature.

    c. Develops a site-specific addendum for quality assurance of geosynthetics (if necessary) with the assistance of the Project Manager.

    d. Administers the geosynthetic portions of the QAP, e.g. assigns and manages all geosynthetic quality assurance personnel, reviews all field

reports, and provides engineering review of all quality assurance related issues.

e. Reviews all changes to design drawings and specifications as issued by the Designer.

f. Acts as the on-site (resident) representative of the Geosynthetic CQA.

g. Familiarizes all Geosynthetic Quality Assurance Monitors with the site and the project QAP.

h. Attends all quality assurance related meetings, e.g., resolution, pre-construction, daily, weekly.

i. Reviews all Manufacturer and Installer certifications and documentation and makes appropriate recommendations.

j. Reviews the Installer's personnel qualifications for conformance with those qualifications pre-approved for work on site.

k. Manages the preparation of the as-built drawing(s).

l. Reviews the calibration certification of the on-site tensiometer, if applicable.

m. Reviews all Geosynthetic Quality Assurance Monitor's daily reports, logs, and photographs.

n. Notes any on-site activities that could result in damage to the geosynthetics.

o. Reports to the Project Manager, and logs in the daily report, any relevant observations reported by the Geosynthetic Quality Assurance Monitors.

p. Prepares his own daily report.

q. Prepares a daily summary of the quantities of geosynthetics installed that day.

r. Prepares the weekly summary of geosynthetic quality assurance activities.

s. Oversees the marking, packaging, and shipping of all laboratory test samples.

t. Reviews the results of laboratory testing and makes appropriate recommendations.

u. Designates a Geosynthetic Quality Assurance Monitor to represent the QAE whenever he is absent from the site while operations are ongoing.

v. Reports any unapproved deviations from the QAP to the Project Manager.

w. Prepares the final certification report.

x. Monitors the subgrade condition and overburden soil placement.

y. Perform the following responsibilities during the various weather conditions:

The Geosynthetic Quality Assurance Monitor:

1. Monitors, logs, photographs and/or documents all geosynthetic installation operations. Photographs shall be taken routinely and in critical areas of the installation sequence. These duties shall be assigned by the Geosynthetic QAE.

2. Monitors the following operations for all geosynthetics.

    a. Material delivery.
    b. Unloading and on-site transport and storage.
    c. Sampling for conformance testing.
    d. Deployment operations.
    e. Joining and/or seaming operations.
    f. Condition of panels as placed.
    g. Visual inspection by walkover.
    h. Repair operations.

3. Monitors and documents the geomembrane seaming operations, including:

    a. Trial seams.
    b. Seam preparation.
    c. Seaming.
    d. Nondestructive seam testing.
    e. Sampling for destructive seam testing.
    f. Field tensiometer testing.
    g. Laboratory sample marking.
    h. Repair operations.

4. Documents any on-site activities that could result in damage to the geosynthetics. Any problems noted shall be reported as soon as possible to the Geosynthetic QAE.

The Geosynthetic CQA shall be pre-qualified by the Canton Mill. The Geosynthetic CQA shall be experienced in quality assurance of geosynthetics with emphasis on polyethylene geomembranes. The Geosynthetic CQA shall be experienced in the preparation of quality assurance documentation including: quality assurance forms, reports, certifications, and manuals.

The Geosynthetic Quality Assurance Managing Engineer shall hold a B.S., M.S., or Ph.D. engineering degree and be registered as a professional Engineer in the State of North Carolina. The Geosynthetic Quality Assurance Site Manager shall be specifically experienced in the installation of geosynthetics and shall be trained and certified by the Geosynthetic CQA in the duties of a Geosynthetic QAE.

Geosynthetic Quality Assurance Monitors shall be quality assurance personnel who have been specifically trained in the quality assurance of geosynthetics. The CQA site manager will have a minimum of 5,000,000 ft^2 of field experience in polyethylene geomembrane quality assurance. Other site monitors will have between 500,000 and 1,000,000 ft^2 of experience in polyethylene geomembrane quality assurance.

To be considered for pre-qualification, the Geosynthetic CQA must provide the following information:

1. Corporate background and information.

2. Quality assurance capabilities:

    a. A summary of the firm's experience with geosynthetics.

    b. A summary of the firm's experience in quality assurance, including installation quality assurance of geosynthetics.

c. A summary of quality assurance documentation and methods used by the firm, including sample quality assurance forms, reports, certifications, and manuals prepared by the firm.

d. Resumes of key personnel.

Prior to beginning work on a project, the Geosynthetic CQA must provide the Project Manager with the following information:

1. Resumes of personnel to be involved in the project including Geosynthetic QAE, and Geosynthetic Quality Assurance Monitors.

2. Proof of professional engineering registration for the engineer to be designated as the Geosynthetic QAE.

3. Proof of the required quality assurance experience of all of the quality assurance personnel with emphasis on polyethylene geomembranes.

Geosynthetic Quality Assurance Laboratory. The Geosynthetic Quality Assurance Laboratory (QAL) is a firm, independent from the Manufacturer(s) and Installer responsible for conducting tests on samples of geosynthetics taken from the site.

The Geosynthetic QAL shall be responsible for conducting the appropriate laboratory tests as directed by the Geosynthetic QAE. The test procedures shall be done in accordance with the test methods outlined in this QAM and/or the project QAP.

The Geosynthetic QAL shall have experience in testing geosynthetics and be familiar with American Society for Testing and Materials (ASTM), Federal Test Method Standard (FTMS), National Sanitation Foundation (NSF), and other applicable test standards. The Geosynthetic QAL shall be capable of providing verbal results of destructive seam tests within 24 hours of

receipt of test samples and shall maintain that standard throughout the installation. The Geosynthetic QAL shall be approved by the Canton Mill.

On-site laboratory facilities may be used by the Geosynthetic QAL provided they are appropriately equipped and approved by the Geosynthetic CQA and the Project Manager.

The Geosynthetic QAL shall submit all destructive seam test results to the Geosynthetic QAE in written form within 48 hours of receipt of test samples unless otherwise specified by the Project Manager. Geomembrane destructive test results shall typically be provided verbally to the Geosynthetic QAE within 24 hours of receipt of test samples. Written test results shall be in an easily readable format and include references to the standard test methods used.

General Contractor. The general contractor (Contractor) is responsible for construction of the liner system including supplying labor, material, equipment, and supervision for placement of the liner system. The primary responsibility of the general contractor is to ensure the liner system is constructed in accordance with the design and specifications developed by the Engineer and approved by the permitting agency. The Superintendent is the Contractor's designee who is responsible for the Contractor's field crew. The Superintendent shall represent the Contractor at all site meetings and shall be responsible for acting as the Contractor's spokesman for the project. The Contractor shall be responsible for all aspects of liner placement, including but not limited to, placement of all erosion control measures, subgrade preparation, placement of granular drainage material, placement of low hydraulic conductivity soil, vegetative growth media, seeding, fertilizing, and mulching. The Contractor is also responsible for informing the Owner, the Engineer, and the CQA Agent of the scheduling and occurrence of all construction activities and of any discrepancies, errors, or omissions in the Contract Documents.

The Contractor shall be pre-qualified and approved by the Canton Mill. The Superintendent must be qualified based on previously demonstrated construction experience and management ability. Services of the Contractor will be procured through a competitive bid process. Bid

packages for the solicitation of construction services will require the Contractor to identify and demonstrate familiarity and experience with the various aspects of landfill construction.

Subcontractors. Subcontractors are responsible for that portion of the work that they are designated to perform by the General Contractor. Subcontractors' work as agents of the General Contractor and as such the General Contractor is responsible for the work and actions of the Subcontractor.

Materials Testing Lab. The materials testing lab is a qualified geotechnical laboratory contracted by the General Contractor, Owner or Owner's Representative to test the borrow source and in-place cover system materials. The material testing laboratory will determine the quality of the borrow source and in-place material in accordance with the ASTM test methods described in the project specifications. The materials testing laboratory will be independent from the General Contractor and the Owner.

Manufacturer. The Manufacturer is the firm responsible for production of any of the various geosynthetic liner system components outlined in this QAM. Each Manufacturer is responsible for the production of its geosynthetic product. In addition, each Manufacturer is responsible for the condition of the geosynthetic until the material is accepted by the Project Manager upon delivery. Each Manufacturer shall produce a consistent product meeting the project specifications. Each Manufacturer shall provide quality control documentation for its product as specified in this QAM.

Each Manufacturer shall be pre-qualified by the Canton Mill. Each Manufacturer shall provide sufficient production capacity and qualified personnel to meet the demands of the project. Each Manufacturer shall have an internal quality control program for its product that meets the requirements presented in this QAM.

A Manufacturer shall meet the following requirements and submit the following information to be considered for pre-qualification:

1. Corporate background and information.

2. Manufacturing capabilities:

   a. Information on plant size, equipment, personnel, number of shifts per day, and capacity per shift.

   b. Daily production quantity available for the Canton Mill's facilities.

   c. A list of material properties including certified test results, to which are attached geosynthetic samples.

   d. A list of at least 15 completed landfill or surface impoundment facilities totaling a minimum of 15,000,000 ft^2 (1,500,000 m^2), for which the Manufacturer has manufactured a geosynthetic. For each facility, the following information shall be provided:

      (1) Name and purpose of facility, its location and date of installation.
      (2) Name of owner, project manager, designer, fabricator (if any) and installer.
      (3) Type of geosynthetic, surface area of geosynthetic manufactured.
      (4) Available information on the performance of the lining system and the facility.

3. The Manufacturer's quality control manual, including a description of the quality control laboratory facilities.

4. The origin (supplier's name and production plant) and identification (brand name and number) of resin used to manufacture the product.

5. A fingerprint of the Manufacturer's geosynthetic product (for polyethylene-based geosynthetics) in accordance with fingerprinting protocol listed in the project specifications.

Prior to the installation of any geosynthetic material, a Manufacturer must submit to the Project Manager all quality control documentation required by the appropriate section of this QAM. This documentation shall be reviewed by the Geosynthetic Construction Quality Assurance Agent before installation can begin.

Installer. The Installer is the firm responsible for installation of the geosynthetics. The Installer may be affiliated with the Manufacturer.

The Superintendent is responsible for the Installer's field crew. The Superintendent shall represent the Installer at all site meetings and shall be responsible for acting as the Installer's spokesman on the project.

The Master Seamer shall be the most experienced seamer of the Installer's field crew. The Master Seamer shall provide direct supervision over less experienced seamers.

The Installer shall be responsible for field handling, storing, deploying, seaming, temporary restraining and all other aspects of the geosynthetics installation. The Installer may also be responsible for transportation of these materials to the site and for anchor systems, if required by the project specifications. The Installer shall be responsible for submittal of the documentation from the manufacturer.

The Installer shall be pre-qualified and approved by the Canton Mill. The Installer shall be able to provide qualified personnel to meet the demands of the project. At a minimum, the Installer shall provide a Superintendent and a Master Seamer as described below.

The Superintendent must be qualified based on previously demonstrated experience, management ability, and authority. The Superintendent, unless otherwise approved by the

Project Manager, shall have previously managed, at a minimum, two installation projects which entailed the installation of at least a total of 2,000,000 ft^2 (200,000 m^2) of polyethylene geomembrane.

For geomembrane installation all personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests. The Master Seamer shall have experience seaming a minimum of 1,000,000 ft^2 (100,000 m^2) of polyethylene geomembrane using the same type of seaming apparatus to be used at the site.

To be considered for pre-qualification, the Installer shall submit the following information:

1. Corporate background and information.

2. Description of installation capabilities:

    a. Information on equipment (numbers and types), and personnel (number of superintendents, number of crews).

    b. Average daily production anticipated.

    c. Samples of field geomembrane seams and a list of minimum values for geomembrane seam properties.

3. A list of at least ten completed facilities, totaling a minimum of 5,000,000 ft^2 (500,000 m^2) for which the Installer has installed geosynthetics. For each installation, the following information shall be provided:

    a. Name and purpose of facility, its location, and date of installation.

    b. Name of owner, project manager, designer, manufacturer, fabricator (if any), and name of contact at the facility who can discuss the project.

c. Name and qualifications of the Superintendent(s) of the Installer's crew(s).

d. Type of geosynthetic, and surface area installed.

e. Type of seaming and type of seaming apparatus used.

f. Duration of installation.

g. Available information on the performance of the lining system and the facility.

4. The Installer's quality control manual.

5. A copy of a letter of recommendation supplied by the geomembrane manufacturer.

Prior to commencement of the installation, the Installer must submit to the Project Manager:

1. Resume of the Superintendent to be assigned to this project, including dates and duration of employment.

2. Resume of the Master Seamer to be assigned to this project, including dates and duration of employment.

3. A panel layout drawing showing the installation layout identifying field seams as well as any variance or additional details which deviate from the engineering drawings. The layout shall be adequate for use as a construction plan and shall include dimensions, details, etc.

4. Installation schedule.

5. A list of personnel performing field seaming operations along with pertinent experience information.

6. All geosynthetic quality control certificates as required by this QAM (unless submitted directly to the Project Manager by the Manufacturer).

7. Certification that extrudate to be used is comprised of the same resin as the geomembrane to be used.

This documentation shall be reviewed by the Geosynthetic Construction Quality Assurance Agent before installation of the geosynthetic can begin.

During the installation, the Installer shall be responsible for the submission of:

1. Quality control documentation recorded during installation.

2. Subgrade surface acceptance certificates for each area to be covered by the lining system, signed by the Installer.

Upon completion of the installation, the Installer shall submit:

1. The warranty obtained from the Manufacturer.

2. The installation warranty.

1.2 Communication

To guarantee a high degree of quality during installation and assure a final product that meets all project specifications, clear, open channels of communication are essential. This section discusses appropriate lines of communication and describes all necessary meetings.

Lines of Communication. The CQAs shall be capable of direct communication with the Project Manager at all times. Access to the Canton Mill's personnel is also available for issue resolution if necessary.

Pre-Construction Meeting. A pre-construction meeting shall be held at the site prior to beginning geosynthetic deployment. Typically, the meeting shall be attended by the Project Manager, Designer, CQA Agent, Contractor, Supervisor, Installer, Geosynthetic QAE, and a Canton Mill representative.

Specific topics considered for this meeting include review of the project QAP for any problems or additions. In addition, the responsibilities of each party should be reviewed and understood clearly. The meeting shall be documented by a person designated at the beginning of the meeting, and minutes shall be transmitted to all parties.

Progress Meetings. A weekly progress meeting shall be held between the Canton Mill representative, Superintendent, CQA Agent, Geosynthetic QAE, Installer's Superintendent, Project Manager, and any other concerned parties. This meeting shall discuss current progress, planned activities for the next week, issues requiring resolution, and any new business or revisions to the work. The CQAs shall log any problems, decisions, or questions arising at this meeting in his weekly report. If any matter remains unresolved at the end of this meeting, the Project Manager shall be responsible for the resolution of the matter and the communication of the decision to the appropriate parties.

2.0 GEOMEMBRANES

2.1 Quality Control Documentation

Prior to the installation of any geomembrane material, the Manufacturer or Installer shall provide the Project Manager with the following information:

1. The origin (resin supplier's name and resin production plant), identification (brand name and number), and production date of the resin.

2. Copies of the quality control certificates issued by the resin supplier.

3. Reports on tests conducted by the Manufacturer to verify that the quality of the resin used to manufacture the geomembrane meets the specifications.

4. Reports on quality control tests conducted by the Manufacturer to verify that the geomembrane manufactured for the project meets the project specifications.

5. A statement indicating that the amount of reclaimed polymer added to the resin during manufacturing was done with appropriate cleanliness and does not exceed 2 percent by weight.

6. A list of the materials which comprise the geomembrane, expressed in the following categories as percent by weight: polyethylene, carbon black, other additives.

7. A specification for the geomembrane which includes all properties contained in the specifications measured using the appropriate test methods.

8. Written certification that minimum values given in the specification are guaranteed by the Manufacturer.

9. A characterization of the geomembrane based on the results of fingerprinting tests.

10. Quality control certificates, signed by a responsible party employed by the Manufacturer. Each quality control certificate shall include roll identification numbers, sampling procedures, and results of quality control tests. At a minimum, results shall be given for:

    a. Density
    b. Carbon black content
    c. Carbon black dispersion
    d. Thickness
    e. Tensile properties
    f. Tear resistance

These quality control tests shall be performed in accordance with the test methods specified in the specifications, for every 40,000 ft^2 (4,000 m^2) of geomembrane produced.

The Manufacturer shall identify all rolls of geomembranes with the following:

1. Manufacturer's name
2. Product identification
3. Thickness
4. Roll number
5. Roll dimensions

<u>2.1.1 Product Review</u>: The Project Manager shall verify that:

1. Property values certified by the Manufacturer meet all of its guaranteed specifications.

2. Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.

3. Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.

4. Roll packages are appropriately labeled.

5. Certified minimum properties meet the specifications.

2.2 Conformance Testing

Upon delivery of the rolls of geomembrane, the Geosynthetic CQA shall assure that conformance test samples are obtained for the geomembrane. These samples shall then be forwarded to the Geosynthetic QAL for testing to assure conformance to the specifications.

If the Project Manager desires, the Geosynthetic CQA can perform the conformance test sampling at the manufacturing plant. This may be advantageous in expediting the installation process for very large projects.

The following conformance tests shall be conducted:

1. Density
2. Carbon black content
3. Carbon black dispersion
4. Thickness
5. Tensile properties

These conformance tests shall be performance in accordance with the test methods specified in the specifications.

2.2.1 Sampling Procedures: The rolls to be sampled shall be selected by the Geosynthetic CQA. Samples shall be taken across the entire width of the roll and shall not include the first 3 feet (1 m). Unless otherwise specified, samples shall be 3 feet (1 m) long by the roll width. The Geosynthetic CQA shall mark the machine direction on the samples with an arrow.

A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designated by the Geosynthetic CQA based on a review of all roll information including quality control documentation and manufacturing records.

Unless otherwise specified, samples shall be taken at a rate of one per lot, not to exceed one conformance test per 100,000 ft^2 (10,000 m^2) of geomembrane.

2.2.2 Test Results. All conformance test results shall be reviewed and accepted or rejected by the Geosynthetic CQA prior to the deployment of the geomembrane.

The Geosynthetic CQA shall examine all results from laboratory conformance testing and shall report any nonconformance to the Project Manager. The Geosynthetic CQA shall be responsible for checking that all test results meet or exceed the property values listed in the project specifications.

If the Manufacturer has reason to believe that failing tests may be the result of the Geosynthetic QAL incorrectly conducting the tests, the Manufacturer may request that the sample in question be retested by the Geosynthetic QAL with a technical representative of the Manufacturer present during the testing. This retesting shall be done at the expense of the Manufacturer. Alternatively, the Manufacturer may have the sample retested at two different approved independent laboratories at the expense of the Manufacturer. If both laboratories produce passing results, the material shall be accepted. If both laboratories do not produce passing results, then the original Geosynthetic QAL test results shall be accepted. The use of these procedures for dealing with failed test results is subject to the approval of the Project Manager.

If a test result is in nonconformance, all material from the lot represented by the failing test should be considered out of specification and rejected. Alternatively, at the option of the Project Manager, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting specification (note that this procedure is valid only when all rolls in the lot are consecutively produced and numbered from one manufacturing line). To isolate the out of specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If both additional tests pass, the roll that represents the initial failed test and the roll manufactured immediately after that roll (next larger roll number) shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot.

2.3 Subgrade Preparation

2.3.1 Surface Preparation: The earthwork contractor shall be responsible for preparing the supporting soil for geomembrane placement. The Project Manager shall coordinate the work of the earthwork contractor and the Installer so that the requirements of the specification are met.

Before the geomembrane installation begins, the Geosynthetic CQA shall verify that:

1. A qualified land surveyor has verified all lines and grades.

2. A qualified geotechnical engineer has verified that the supporting soil meets the density specified in the project specifications.

3. The surface to be lined has been rolled, compacted, or handworked so as to be free of irregularities, protrusions, loose soil, and abrupt changes in grade.

4. The surface of the supporting soil does not contain stones which may be damaging to the geomembrane.

5. There is no area excessively softened by high water content.

6. There is no area where the surface of the soil contains desiccation cracks with dimensions exceeding those allowed by the project specifications.

The Installer shall certify in writing that the surface on which the geomembrane will be installed is acceptable. A certificate of acceptance shall be given by the Installer to the Geosynthetic CQA prior to commencement of geomembrane deployment in the area under consideration. The Project Manager shall be given a copy of this certificate by the Geosynthetic CQA.

After the supporting soil has been accepted by the Installer, it is the Installer's responsibility to indicate to the Project Manager any change in the supporting soil condition that may require repair work. The Project Manager may consult with the Geosynthetic CQA regarding the need for repairs. If the Geosynthetic CQA concurs with Installer, the Project Manager shall assure that the supporting soil is repaired.

At any time before or during the geomembrane installation, the Geosynthetic CQA shall indicate to the Project Manager any locations which may not be adequately prepared for the geomembrane.

2.3.2 Anchor Trench: The Geosynthetic CQA shall verify that the anchor trench has been constructed according to the design drawings and specifications.

If the anchor trench is excavated in a clay material susceptible to desiccation, the amount of trench open at any time should be minimized. The Geosynthetic CQA shall inform the Project Manager of any signs of significant desiccation associated with the anchor trench construction.

Slightly rounded corners shall be provided in the trench so as to avoid sharp bends in the geomembrane. Excessive amounts of loose soil shall not be allowed to underlie the geomembrane in the anchor trench.

The anchor trench shall be adequately drained to prevent ponding or softening of the adjacent soils while the trench is open. The anchor trench shall be backfilled and compacted as outlined in the project specifications.

Care shall be taken when backfilling the trenches to prevent any damage to the geosynthetics. The Geosynthetic CQA shall observe the backfilling operation and advise the Project Manager of any problems. Any problems shall be documented by the Geosynthetic CQA in his daily report.

2.4 Geomembrane Deployment

2.4.1 Panel Nomenclature: A field panel is defined as a unit of geomembrane which is to be seamed in the field, i.e., a field panel is a roll or a portion of roll cut in the field.

It shall be the responsibility of the Geosynthetic CQA to assure that each field panel is given an identification code (number or letter-number) consistent with the layout plan. This identification code shall be agreed upon by the Project Manager, Installer, and Geosynthetic CQA. This field panel identification code shall be as simple and logical as possible. In general, it is not appropriate to identify panels using roll numbers since roll numbers established in the manufacturing plant are usually cumbersome and are not related to location in the field. The Geosynthetic CQA shall establish a table or chart showing correspondence between roll numbers and field panel identification codes. The field panel identification code shall be used for all quality assurance records.

The Geosynthetic CQA shall verify that field panels are installed at the locations indicated on the Installer's layout plan, as approved by the Project Manager.

2.4.2 Panel Deployment Procedure: The Geosynthetic CQA shall review the panel deployment progress of the Installer (keeping in mind issues relating to wind, rain, clay liner desiccation, and other site-specific conditions) and advise the Project Manager on its compliance with the approved panel layout drawing and its suitability to the actual field conditions. Once approved, only the Project Manager can authorize changes to the panel deployment procedure. The

Geosynthetic CQA shall verify that the condition of the supporting soil does not change detrimentally during installation.

The Geosynthetic CQA shall record the identification code, location, and date of installation of each field panel.

2.4.3 Deployment Weather Conditions: Geomembrane deployment shall not proceed at an ambient temperature below 32°F (0°C) or above 104°F (40°C) unless otherwise authorized, in writing, by the Project Manager. Geomembrane placement shall not be performed during any precipitation, in the presence of excessive moisture (e.g. fog, dew), in an area of ponded water, or in the presence of excessive winds. Geomembrane deployment shall not be undertaken if weather conditions will preclude material seaming following deployment.

The Geosynthetic CQA shall verify that the above conditions are fulfilled. Ambient temperature shall be measured by the Geosynthetic CQA in the area in which the panels are to be deployed. The Geosynthetic CQA shall inform the Project Manager of any weather related problems which may not allow geomembrane placement to proceed.

2.4.4 Method of Deployment: Before the geomembrane is handled on site, the Geosynthetic CQA shall verify that handling equipment to be used on the site is adequate and does not pose risk of damage to the geomembrane. During handling, the Geosynthetic CQA shall observe and verify that the Installer's personnel handle the geomembrane with care.

The Geosynthetic CQA shall verify the following:

1. Any equipment used does not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons, or other means.

2. The prepared surface underlying the geomembrane has not deteriorated since previous acceptance, and is still acceptable immediately prior to geomembrane placement.

3. Any geosynthetic elements immediately underlying the geomembrane are clean and free of debris.

4. All personnel do not smoke or wear damaging shoes while working on the geomembrane, or engage in other activities which could damage the geomembrane.

5. The method used to unroll the panels does not cause excessive scratches or crimps in the geomembrane and does not damage the supporting soil.

6. The method used to place the panels minimized wrinkles (especially differential wrinkles between adjacent panels).

7. The method used to place the panels prevents bridging of the geomembrane.

8. 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, continuous loading, e.g. by sand bags, is recommended along edges of panels to minimize risk of wind flow under the panels.

9. Direct contact with the geomembrane is minimized, and the geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials, in areas where excessive traffic may be expected.

The Geosynthetic CQA shall inform the Project Manager if the above conditions are not fulfilled.

2.4.5 Damage and Defects: Upon delivery to the site, the Geosynthetic CQA shall conduct a surface observation of all rolls for defects and for damage. This inspection shall be conducted without unrolling rolls unless defects or damages are found or suspected. The Geosynthetic

CQA shall advise the Project Manager, in writing, of any rolls or portions of rolls which should be rejected and removed from the site because they have severe flaws, and/or minor repairable flaws.

The Geosynthetic CQA shall inspect each panel, after placement and prior to seaming, for damage and/or defects. The Geosynthetic CQA shall advise the Project Manager which panels, or portions of panels, should be rejected, repaired, or accepted. Damaged panels, or portions of damaged panels, which have been rejected shall be marked and their removal from the work area recorded by the Geosynthetic CQA. Repairs shall be made using procedures described in Section 2.8.

2.4.6 Writing on the Liner: To avoid confusion, the Installer and the Geosynthetic CQA shall each use different colored markers that are readily visible for writing on the geomembrane. The markers used must be semi-permanent and compatible with the geomembrane.

2.5 Field Seaming

2.5.1 Seam Layout: Before installation begins, the Installer must provide the Project Manager and the Geosynthetic CQA with a panel layout drawing, i.e. a drawing of the facility to be lined showing all expected seams. The Geosynthetic CQA shall review the panel layout drawing and verify that it is consistent with accepted state-of-practice. No panels may be seamed without the written approval of the panel layout drawing by the Project Manager. In addition, panels not specifically shown on the panel layout drawing may not be used without the Project Manager's prior approval.

In general, seams should be oriented parallel to the line of maximum slope, i.e. oriented along, not across, the slope. In corners and odd-shaped geometric locations, the number of seams should be minimized. No horizontal seam should be less than 5 feet (1.5 m) from the toe of the slope, or areas of potential stress concentrations, unless otherwise authorized by the Project Manager.

A seam numbering system compatible with the panel numbering system shall be used by the Geosynthetic CQA.

2.5.2 Accepted Seaming Methods: Approved processes for field seaming are extrusion welding and fusion welding. Proposed alternate processes shall be documented and submitted by the Installer to the Project Manager for approval. Only apparatus which have been specifically approved by make and model shall be used. The Project Manager shall submit all documentation regarding seaming methods to be used to the Geosynthetic CQA for review.

2.5.2.1 Extrusion Process

The Geosynthetic CQA shall log ambient, seaming apparatus, and geomembrane surface temperatures at appropriate intervals and report any noncompliances to the Project Manager.

The Geosynthetic CQA shall verify that:

1. The Installer maintains on-site the number of spare operable seaming apparatus decided upon at the pre-construction meeting.

2. Equipment used for seaming is not likely to damage the geomembrane.

3. Prior to beginning a seam, the extruder is purged until all heat-degraded extrudate has been removed from the barrel.

4. Clean and dry welding rods or extrudate pellets are used.

5. The electric generator is placed on a smooth base such that no damage occurs to the geomembrane.

6. Grinding shall be completed no more than 1 hour prior to seaming.

7. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage.

8. The geomembrane is protected from damage in heavily trafficked areas.

9. Exposed grinding marks adjacent to an extrusion weld shall be minimized. In no instance shall exposed grinding marks extend more than 1/4 inch from the seamed area.

10. In general, the geomembrane panels are aligned to have a nominal overlap of 3 inch (75 mm) for extrusion welding. In any event, the final overlap shall be sufficient to allow peel tests to be performed on the seam.

11. No solvent or adhesive is used unless the product is approved in writing by the Project Manager prior to use (samples shall be submitted to the Project Manager for testing and evaluation).

12. The procedure used to temporarily bond adjacent panels together does not damage the geomembrane; in particular, the temperature of hot air at the nozzle of any temporary welding apparatus is controlled such that the geomembrane is not damaged or degraded.

2.5.2.2 Fusion Process

The Geosynthetic CQA shall log ambient, seaming apparatus, and geomembrane surface temperatures at appropriate intervals and report any noncompliances to the Project Manager.

The Geosynthetic CQA shall also verify that:

1. The Installer maintains on-site the number of spare operable seaming apparatus decided upon at the pre-construction meeting.

2. Equipment used for seaming is not likely to damage the geomembrane.

3. For cross seams, the edge of the cross seam is ground to an incline prior to welding.

4. The electric generator is placed on a smooth base such that no damage occurs to the geomembrane.

5. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage.

6. The geomembrane is protected from damage in heavily trafficked areas.

7. A movable protective layer is used as required by the Installer directly below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between the sheets and prevent debris from collecting around the pressure rollers.

8. In general, the geomembrane panels are aligned to have a nominal overlap of 5 inches (125 mm) for fusion welding. In any event, the final overlap shall be sufficient to allow peel tests to be performed on the seam.

9. No solvent or adhesive is used unless the product is approved in writing by the Project Manager prior to use (samples shall be submitted to the Project Manager for testing and evaluation).

2.5.3 Seam Preparation: The Geosynthetic CQA shall verify that prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris or foreign material of any kind. If seam overlap grinding is required, the Geosynthetic CQA must assure that the process is completed according to the Manufacturer's instructions within one hour of the seaming operation, and in a way that does not damage the geomembrane. The Geosynthetic CQA shall also verify that seams are aligned with the fewest possible number of wrinkles and "fishmouths."

2.5.4 Trial Seams: Trial seams shall be made on fragment pieces of geomembrane liner to verify that conditions are adequate for production seaming. Such trial seams shall be made at the beginning of each seaming period, and at least once each five hours, for each production seaming apparatus used that day. Each seamer shall make at least one trial seam each day. Trial seams shall be made under the same conditions as actual seams. Additional trial seams will be required after any change of operator, equipment shutdown, significant idle time, or significant weather change. Additional trial seams due to idle time or weather will be at the discretion of the Geosynthetic CQA.

The trial seam sample shall be at least 5 feet (1.0 m) long by 1 foot (0.3 m) wide (after seaming) with the seam centered lengthwise. Seam overlap shall be as indicated in Section 2.5.2.

Five specimens shall be cut from the sample with a 1 inch (25 mm) wide die. The specimens shall be cut by the Installer at locations selected randomly along the trial seam sample by the Geosynthetic CQA. Four specimens shall be tested in peel and one tested in shear using a field tensiometer. The tensiometer shall be capable of maintaining a constant jaw separation rate of 20 inches per minute. If a specimen fails, the entire operation shall be repeated. If the additional specimen fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial welds are achieved. The Geosynthetic CQA shall observe all trial seam procedures.

2.5.5 General Seaming Procedures: During general seaming, the Geosynthetic CQA shall be cognizant of the following:

1. For fusion welding, it may be necessary to place a movable protective layer of plastic directly below each overlap of geomembrane that is to be seamed. This is to prevent any moisture buildup between the sheets to be welded and prevent debris from collecting around the pressure rollers.

2. If required, a firm substrate shall be provided by using a flat board, a conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support.

3. Fishmouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fishmouths or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 inches (150 mm) beyond the cut in all directions.

4. If seaming operations are carried out at night, adequate illumination shall be provided.

5. Seaming shall extend to the outside edge of panels placed in the anchor trench.

6. All cross seam tees should be extrusion welded to a minimum distance of 4 inches on each side of the tee.

7. No field seaming shall take place without the Master Seamer being present.

The Geosynthetic CQA shall verify that the above seaming procedures (or any other procedures agreed upon and indicated in the project manual) are followed, and shall inform the Project Manager of any nonconformance.

2.5.6 Seaming Weather Conditions:

2.5.6.1 Normal Weather Conditions

The normal required weather conditions for seaming are as follows:

1. Ambient temperature between 32°F (0°C) and 104°F (40°C).

2. Dry conditions, i.e. no precipitation or other excessive moisture, such as fog or dew.

3. No excessive winds.

The Geosynthetic CQA shall verify that these weather conditions are fulfilled and notify the Project Manager in writing if they are not. Ambient temperature shall be measured by the Geosynthetic CQA in the area in which the panels are to be placed. The Project Manager will then decide if the installation is to be stopped or special procedures used.

2.5.6.2 Cold Weather Conditions

To assure a quality installation, if seaming is conducted when the ambient temperature is below 32°F (0°C), the following conditions must be met:

1. Geomembrane surface temperatures shall be determined by the Geosynthetic CQA at intervals of at least once per 100 foot of seam length to determine if preheating is required. For extrusion welding, preheating is required if the surface temperature of the geomembrane is below 32°F (0°C).

2. Preheating may be waived by the Project Manager based on a recommendation from the Geosynthetic CQA, if the Installer demonstrates to the Geosynthetic CQA's satisfaction that welds of equivalent quality may be obtained without preheating at the expected temperature of installation.

3. If preheating is required, the Geosynthetic CQA shall inspect all areas of geomembrane that have been preheated by a hot air device prior to seaming, to assure that they have not been overheated.

4. Care shall be taken to confirm that the surface temperatures are not lowered below the minimum surface temperatures specified for welding due to winds or other adverse conditions. It may be necessary to provide wind protection for the seam area.

5. All preheating devices shall be approved prior to use by the Project Manager.

6. Additional destructive tests (as described in Section 2.4) shall be taken at an interval between 500 feet and 250 feet of seam length, at the discretion of the Geosynthetic CQA.

7. Sheet grinding may be performed before preheating, if applicable.

8. Trial seaming shall be conducted under the same ambient temperature and preheating conditions as the actual seams. Under cold weather conditions, new trial seams shall be conducted if the ambient temperature drops by more than 5°F from the initial trial seam test conditions.

2.5.6.3 Warm Weather Conditions

At ambient temperatures above 104°F, no seaming of the geomembrane shall be permitted unless the Installer can demonstrate to the satisfaction of the Project Manager that geomembrane seam quality is not compromised.

Trial seaming, as described in shall be conducted under the same ambient temperature conditions as the actual seams.

At the option of the Geosynthetic CQA, additional destructive tests (as described in Section 2.4) may be required for any suspect areas.

2.6 Nondestructive Seam Testing

The Installer shall nondestructively test all field seams over their full length using a vacuum test unit, air pressure test (for double fusion seams only), or other approved method. Vacuum testing and air pressure testing are described in Sections 2.6.1 and 2.6.2, respectively. The purpose of nondestructive tests is to check the continuity of seams. It does not provide quantitative information on seam strength. Nondestructive testing shall be carried out as the seaming work progresses, not at the completion of all field seaming. At a minimum of once every 4 hours of seaming and when operation has been suspended for greater than one hour or if breakdown of seaming equipment occurs, weld samples will be tested in peel and shear in accordance with the destructive test requirements of the contract documents.

For all seams, the Geosynthetic CQA shall:

1. Observe nondestructive testing procedures.

2. Record location, data, test unit number, name of tester, and outcome of all testing.

3. Inform the Installer and Project Manager of any required repairs.

2.6.1 Vacuum Testing. The following procedures are applicable to vacuum testing.

1. The equipment shall consist of the following:

   a. A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom, a porthole or valve assembly, and a vacuum gauge.

   b. A pump assembly equipped with a pressure controller and pipe connections.

   c. A rubber pressure/vacuum hose with fittings and connections.

   d. A soapy solution of distilled water.

   e. A bucket and wide paint brush, or other means of applying the soapy solution.

2. The following procedures shall be followed:

   a. Energize the vacuum pump and reduce the tank pressure to approximately 2.5 to 3.0 psi gauge.

   b. Wet a strip of geomembrane approximately 12 inches by 48 inches (0.3 m x 1.2 m) with the soapy distilled water solution.

   c. Place the box over the wetted area.

   d. Close the bleed valve and open the vacuum valve.

e. Assure that a leak-tight seal is created.

f. For a period of not less than 15 seconds, apply vacuum and examine the geomembrane through the viewing window for the presence of soap bubbles.

g. If no bubble appears after 15 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 3 inches (75 mm) overlap, and repeat the process.

h. All areas where soap bubbles appear shall be marked and repaired in accordance with Section 2.8.

2.6.2 Air Pressure Testing. The following procedures are applicable to double fusion welding which produces a double seam with an enclosed space.

1. The equipment shall consist of the following:

   a. An air pump (manual or motor driven), equipped with pressure gauge capable of generating and sustaining a pressure between 25 and 30 psi (160 and 200 kPa) and mounted on a cushion to protect the geomembrane.

   b. A rubber hose with fittings and connections.

   c. A sharp hollow needle, or other approved pressure feed device.

2. The following procedures shall be followed:

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

b. Insert needle or other approved pressure feed device into the air channel created by the fusion weld.

c. Insert a protective cushion between the air pump and the geomembrane.

d. Energize the air pump to a pressure between 25 and 30 psi (160 and 200 kPa), close valve, allow 2 minutes for pressure to stabilize, and sustain pressure for at least 5 minutes.

e. If loss of pressure exceeds 4 psi (30 kPa) or does not stabilize, locate faulty area and repair in accordance with Section 2.8.

f. Cut opposite end of tested seam area once testing is completed to verify continuity of the air channel. If air does not escape, locate blockage and retest unpressurized area. Seal the cut end of the air channel.

g. Remove needle or other approved pressure feed device and seal.

2.6.3 Test Failure Procedures. The Installer shall complete any required repairs in accordance with Section 2.8. For repairs, the Geosynthetic CQA shall:

1. Observe the repair and testing of the repair.

2. Mark on the geomembrane that the repair has been made.

3. Document the repair procedures and test results.

2.7 Destructive Seam Testing. Destructive seam tests shall be performed at selected locations. The purpose of these tests is to evaluate seam strength. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming.

2.7.1 Location and Frequency. The Geosynthetic CQA shall select locations where seam samples will be cut out for laboratory testing. Those locations shall be established as follows:

1. A minimum frequency of one test location per 1,000 feet of seam length performed by each welder. This minimum frequency is to be determined as an average taken throughout the entire facility.

2. Test locations shall be determined during seaming at the Geosynthetic CQA's discretion. Selection of such locations may be prompted by suspicion of overheating, contamination, offset welds, or any other potential cause of imperfect welding.

The Installer shall not be informed in advance of the locations where the seam samples will be taken.

2.7.2 Sampling Procedures. Samples shall be cut by the Installer at locations chosen by the Geosynthetic CQA as the seaming progresses so that laboratory test results are available before the geomembrane is covered by another material. The Geosynthetic CQA shall:

1. Observe sample cutting.

2. Assign a number to each sample, and mark it accordingly.

3. Record sample location on layout drawing.

4. Record reason for taking the sample at this location (e.g. statistical routine, suspicious feature of the geomembrane).

All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures described in Section 2.8. The continuity of the new seams in the repaired area shall be tested according to the project specifications.

2.7.3 Sample Dimensions. At a given sampling location, two types of samples shall be taken by the Installer. First, two samples for field testing should be taken. Each of these samples shall be cut with a 1 inch (25 mm) wide die, with the seam centered parallel to the width. The distance between these two samples shall be 42 inches (1.1 m). If both samples pass the field test described in Section 2.6.3, a sample for laboratory testing shall be taken.

The sample for laboratory testing shall be located between the samples for field testing. The sample for laboratory testing shall be 12 inches (0.3 m) wide by 42 inches (1.1 m) long with the seam centered lengthwise. The sample shall be cut into three parts and distributed as follows:

1. One portion to the Installer for optional laboratory testing, 12 inches x 12 inches (0.3 m x 0.3 m).

2. One portion for Geosynthetic QAL testing, 12 inches x 18 inches (0.3 m x 0.5 m) and

3. One portion to the Project Manager for archive storage, 12 inches x 12 inches (0.3 m x 0.3 m).

Final determination of the sample sizes shall be made at the pre-construction meeting.

2.7.4 Field Testing. The two 1-inch (25 mm) wide strips mentioned in Section 2.7.3 shall be tested in the field using a tensiometer for peel and shear and shall not fail according to the criteria in the project specifications. The tensiometer shall be capable of maintaining a constant jaw separation rate of 20 inches per minute. If the test passes in accordance with this section, the sample qualifies for testing in the laboratory. If it fails, the seam should be repaired in accordance with Section 2.8. Final judgment regarding seam acceptability, based on the failure criteria, rests with the Geosynthetic CQA. Both tracks are to be tested in peel.

The Geosynthetic CQA shall witness all field tests and mark all samples and portions with their number. The Geosynthetic CQA shall also log the date and time, ambient temperature, number of seaming unit, name of seamer, welding apparatus temperatures and pressures, and pass or fail description, and attach a copy to each sample portion.

2.7.5 Laboratory Testing. Destructive test samples shall be packaged and shipped, if necessary, under the responsibility of the Geosynthetic QAL in a manner which will not damage the test sample. The Project Manager will be responsible for storing the archive samples. Test samples shall be tested by the Geosynthetic QAL.

Testing shall include properties as defined in the specifications. The minimum acceptable values to be obtained in these tests are indicated in the specifications. At least 5 specimens shall be tested in each shear and peel. Specimens shall be selected alternately by test from the samples (i.e. peel, shear, peel, shear...). Parent material strength will be determined by sampling the actual sheets adjacent to the destructive test location, in the same direction the seam is tested.

The Geosynthetic QAL shall provide verbal test results no more than 24 hours after they receive the samples. The Geosynthetic CQA shall review laboratory test results as soon as they become available, and make appropriate recommendations to the Project Manager.

2.7.6 Destructive Test Failure Procedures. The following procedures shall apply whenever a sample fails a destructive test, whether that test is conducted by the Geosynthetic QAL, or by field tensiometer. The Installer has two options:

1. The Installer can repair the seam between any two passing test locations.

2. The Installer can trace the welding path to an intermediate location (at 10 feet (3 m) minimum from the point of the failed test in each direction) and take a sample with a 1 inch (25 mm) wide die for an additional field test at each location. If these additional samples pass the test, then full laboratory samples are taken. If these laboratory samples pass the tests, then the seam is repaired

between these locations. If either sample fails, then the process is repeated to establish the zone in which the seam should be repaired.

All acceptable repaired seams shall be bound by two locations from which samples passing laboratory destructive tests have been taken. Passing laboratory destructive tests of trial seam samples taken as indicated in Section 2.5.4 may be used as a boundary for the failing seam. In cases exceeding 150 feet (50 m) of repaired seam, a sample taken from the zone in which the seam has been repaired must pass destructive testing. Repairs shall be made in accordance with Section 2.8.

The Geosynthetic CQA shall document all actions taken in conjunction with destructive test failures.

2.8 Defects and Repairs

2.8.1 Identification. All seams and non-seam areas of the geomembrane shall be examined by the Geosynthetic CQA for identification of defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane shall be clean at the time of examination. The geomembrane surface shall be cleaned by the Installer if the amount of dust or mud inhibits examination.

2.8.2 Evaluation. Each suspect location both in seam and non-seam areas shall be nondestructively tested using the methods described in Section 2.6 as appropriate. Each location which fails the nondestructive testing shall be marked by the Geosynthetic CQA and repaired by the Installer. Work shall not proceed with any materials which will cover locations which have been repaired until appropriate nondestructive and laboratory test results with passing values are available.

2.8.3 Repair Procedures. Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired. Several procedures exist for the repair of

these areas. The final decision as to the appropriate repair procedure shall be agreed upon between the Project Manager, Installer, and Geosynthetic CQA.

1. The repair procedures available include:

   a. Patching, used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter.

   b. Spot welding or seaming used to repair small tears, pinholes, or other minor, localized flaws.

   c. Capping, used to repair large lengths of failed seams.

   d. Extrusion welding the flap, used to repair areas of inadequate fusion seams, which have an exposed edge. Repairs of this type shall be approved by the Geosynthetic CQA and shall not exceed 50 feet (15 m) in length.

   e. Removing bad seam and replacing with a strip of new material welded into place.

2. For any repair method, the following provisions shall be satisfied:

   a. Surfaces of the geomembrane which are to be repaired using extrusion methods shall be abraded no more than one hour prior to the repair.

   b. All surfaces shall be clean and dry at the time of the repair.

   c. All seaming equipment used in repairing procedures shall meet the requirements of the QAM.

d. Patches or caps shall extend at least 6 inches (150 mm) beyond the edge of the defect, and all corners of patches shall be rounded with a radius of approximately 3 inches (75 mm).

2.8.4 Repair Verification. Each repair shall be numbered and logged. Each repair shall be nondestructively tested using the methods described in Section 2.6 as appropriate. Repairs which pass the nondestructive test shall be taken as an indication of an adequate repair. Repairs more than 150 feet long may be of sufficient extent to require destructive test sampling, at the discretion of the Geosynthetic CQA. Failed tests indicate that the repair shall be redone and retested until a passing test results. The Geosynthetic CQA shall observe all nondestructive testing of repairs and shall record the number of each repair, date, and test outcome.

2.8.5 Large Wrinkles. When seaming of the geomembrane is completed, and prior to placing overlying materials, the Geosynthetic CQA shall indicate to the Project Manager which wrinkles should be cut and reseamed by the Installer. The number of wrinkles to be repaired should be kept to an absolute minimum. Therefore, wrinkles should be located during the coldest part of the installation process, while keeping in mind the forecasted weather to which the uncovered geomembrane may be exposed. Wrinkles are considered to be large when the geomembrane can be folded over onto itself. This is generally the case for a wrinkle that extends 12 inches from the subgrade. Seams produced while repairing wrinkles shall be tested as outlined above.

When placing overlying material on the geomembrane, every effort must be made to minimize wrinkle development. If possible, cover should be placed during the coolest weather available. In addition, 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 Geosynthetic CQA to assure that wrinkle formation is minimized.

2.9 Geomembrane Protection

The quality assurance procedures indicated in this section are intended only to assure that the installation of adjacent materials does not damage the geomembrane.

2.9.1 Soils. A copy of the specifications prepared by the Designer for placement of soils shall be given to the Geosynthetic CQA by the Project Manager. The Geosynthetic CQA shall verify that these specifications are consistent with the state-of-practice such as:

1. Placement of soils on the geomembrane shall not proceed at an ambient temperature below 32°F (0°C) nor above 104°F (40°C) unless otherwise specified.

2. Placement of soil on the geomembrane should be done during the coolest part of the day to minimize the development of wrinkles in the geomembrane.

3. A geotextile or other cushion approved by the Designer is generally required between aggregate and the geomembrane.

4. Equipment used for placing soil shall not be driven directly on the geomembrane.

5. A minimum thickness of 1 foot (0.3 m) of soil is specified between a light dozer (ground pressure of 5 psi (35 kPa) or lighter) and the geomembrane.

6. In any areas traversed by any vehicles other than low ground pressure vehicles approved by the Project Manager, the soil layer shall have a minimum thickness of 3 feet (0.9 m). This requirement may be waived if provisions are made to protect the geomembrane through an engineered design. Drivers shall proceed with caution when on the overlying soil and prevent spinning of tires or sharp turns.

The Geosynthetic CQA shall measure soil thickness and verify that the required thicknesses are present. The Geosynthetic CQA must also verify that final thicknesses are consistent with the design and verify that placement of the soil is done in such a manner that geomembrane damage

is unlikely. The Geosynthetic CQA shall inform the Project Manager if the above conditions are not fulfilled.

2.9.2 Sumps and Appurtenances. A copy of the plans and specifications prepared by the Designer for appurtenances shall be given by the Project Manager to the Geosynthetic CQA. The Geosynthetic CQA shall review these plans and verify that:

1. Installation of the geomembrane in appurtenant areas, and connection of geomembrane to appurtenances have been made according to specifications.

2. Extreme care is taken while welding around appurtenances since neither non-destructive nor destructive testing may be feasible in these areas.

3. The geomembrane has not been visibly damaged while making connections to appurtenances.

The Geosynthetic CQA shall inform the Project Manager in writing if the above conditions are not fulfilled.

2.10 Lining System Acceptance

Upon written recommendation by the Geosynthetic CQA, the Project Manager shall consider accepting the geosynthetic lining system. The conditions of acceptance are described below. The Installer and Manufacturer(s) will retain all ownership and responsibility for the geosynthetics in the lining system until acceptance by the Canton Mill. At the Canton Mill's discretion, the geosynthetic lining system may be accepted in sections or at points of substantial completion.

The geosynthetic lining system shall be accepted by the Canton Mill when:

1. The installation of the lining system, or section thereof, is finished.

2. Verification of the adequacy of all seams and repairs, including associated testing, is completed.

3. All documentation of installation is completed.

4. The Geosynthetic CQA is able to recommend acceptance.

The Geosynthetic CQA shall certify that installation has proceeded in accordance with the geosynthetic portions of the project QAP except as noted to the Project Manager.

3.0 GEOTEXTILES

3.1 Quality Control Documentation

Prior to the installation of any geotextile, the Manufacturer or Installer shall provide the Project Manager with the following information:

1. The origin (resin supplier's name and resin production plant) and identification (brand name and number) of the resin used to manufacture the geotextile.

2. Copies of the quality control certificates issued by the resin supplier.

3. Reports on tests conducted by the Manufacturer to verify that the quality of the resin used to manufacture the geotextile meets the Manufacturer's resin specifications.

4. Reports on quality control tests conducted by the Manufacturer to verify that the geotextile manufactured for the project meets the project specifications.

5. A statement indicating that the reclaimed polymer added to the resin during manufacturing was done with appropriate cleanliness.

6. A list of the materials which comprise the geotextile, expressed in the following categories as percent by weight: base polymer, carbon black, other additives.

7. A specification for the geotextile which includes all properties contained in the project specifications measured using the appropriate test methods.

8. Written certification that minimum average roll values given in the specification are guaranteed by the Manufacturer.

9. For non-woven geotextiles, written certification that the Manufacturer has continuously inspected the geotextile for the presence of needles and found the geotextile to be needle free.

10. Quality control certificates, signed by a responsible party employed by the Manufacturer. The quality control certificates shall include roll identification numbers, sampling procedures, and results of quality control tests. At a minimum, results shall be given for those properties stated in Section 02272 Part 1.05(A) of the project specifications.

The Manufacturer shall identify all rolls of geotextiles with the following:

1. Manufacturer's name
2. Product identification
3. Roll number
4. Roll dimensions

3.1.1 Product Review: The Project Manager shall verify that:

1. Property values certified by the Manufacturer meet all of its guaranteed specifications.

2. Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.

3. Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.

4. Roll packages are appropriately labeled.

5. Certified minimum average roll properties meet the project specifications.

3.2 Geotextile Deployment

During shipment and storage, the geotextile shall be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. Geotextile rolls shall be shipped and stored in relatively opaque and watertight wrappings. Wrappings shall be removed shortly before deployment.

The Geosynthetic CQA shall observe rolls upon delivery at the site and any deviation from the above requirements shall be reported to the Project Manager.

The Installer shall handle all geotextiles in such a manner as to assure they are not damaged in any way, and the following shall be complied with:

1. On slopes, the geotextiles shall be securely anchored and then rolled down the slope in such a manner as to continually keep the geotextile sheet in tension.

2. In the presence of wind, all geotextiles shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during deployment and shall remain until replaced with cover material.

3. Geotextiles shall be cut using a geotextile cutter (hook blade) only. If in place, special care shall be taken to protect other materials from damage which could be caused by the cutting of the geotextiles.

4. The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geotextile.

5. During placement of geotextiles, care shall be taken not to entrap, in or beneath the geotextile, stones, excessive dust, or moisture that could damage the geomembrane, cause clogging of drains or filters, or hamper subsequent seaming.

6. A visual examination of the geotextile shall be carried out over the entire surface, after installation, to assure that no potentially harmful foreign objects, such as needles, are present.

The Geosynthetic QAL shall note any noncompliance and report it to the Project Manager.

3.3 Seaming Procedures

On slopes steeper than 10 horizontal:1 vertical, all geotextiles shall be continuously sewn (i.e., spot sewing is not allowed). Geotextiles shall be overlapped a minimum of 3 inches prior to seaming. In general, no horizontal seams shall be allowed on sideslopes (i.e., seams shall be along, not across, the slope), except as part of a patch.

On bottoms and slopes shallower than 10 (horizontal):1 (vertical), geotextiles shall be seamed as indicated above (preferred), or thermally bonded with the written approval of the Project Manager.

The Installer shall pay particular attention at seams to assure that no earth cover material could be inadvertently inserted beneath the geotextile.

Any sewing shall be done using polymeric thread with chemical and ultraviolet light resistance properties equal to or exceeding those of the geotextile. Sewing shall be done using machinery and stitch types specified in the project specifications or as approved in writing by the Project Manager.

3.4 Defects and Repairs

Any holes or tears in the geotextile shall be repaired as follows:

On slopes, a patch made from the same geotextile shall be sewn into place in accordance with the project specifications. Should any tear exceed 10 percent of the width of the roll, that roll shall be removed from the slope and replaced.

Care shall be taken to remove any soil or other material which may have penetrated the torn geotextile.

The Geosynthetic CQA shall observe any repair and report any noncompliance with the above requirements in writing to the Project Manager.

3.5 Geotextile Protection

All soil materials located on top of a geotextile shall be deployed in such a manner as to assure:

1. The geotextile and underlying lining materials are not damaged.

2. Minimal slippage of the geotextile on underlying layers occurs.

3. No excess tensile stresses occur in the geotextile.

Unless otherwise specified by the Geosynthetic CQA, all lifts of soil material shall be in conformance with the guidelines given in Section 4.9.1.

4.0 GEOSYNTHETIC CLAY LINERS (GCL)

4.1 Quality Control Documentation

Prior to the installation of any GCL, the Manufacturer or Installer shall provide the Project Manager with the following information:

1. The origin (bentonite and geotextile supplier's name and bentonite and geotextile production plant) and identification (brand name and number) of the bentonite and geotextile used to manufacture the GCL.

2. Copies of the quality control certificates issued by the bentonite and geotextile supplier.

3. Reports on tests conducted by the Manufacturer to verify that the quality of the bentonite and geotextile used to manufacture the GCL meets the Manufacturer's bentonite and geotextile specifications.

4. Reports on quality control tests conducted by the Manufacturer to verify that the GCL manufactured for the project meets the project specifications.

5. A specification for the GCL which includes all properties contained in the project specifications measured using the appropriate test methods.

6. Written certification that minimum average roll values given in the specification are guaranteed by the Manufacturer.

7. For non-woven geotextiles, written certification that the Manufacturer has continuously inspected the geotextile for the presence of needles and found the geotextile to be needle free.

8. Quality control certificates, signed by a responsible party employed by the Manufacturer. The quality control certificates shall include roll identification numbers, sampling procedures, and results of quality control tests. At a minimum, results shall be given for those properties stated in Section 02275 Part 1.04(B) of the project specifications.

   Quality control tests shall be performed in accordance with the test methods specified in the project specifications for at least every **50,000** ft^2 of GCL produced.

The Manufacturer shall identify all rolls of GCLs with the following:

1. Manufacturer's name
2. Product identification
3. Roll number
4. Roll dimensions

<u>4.1.1 Product Review</u>: The Project Manager shall verify that:

1. Property values certified by the Manufacturer meet all of its guaranteed specifications.

2. Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.

3. Quality control certificates have been provided at the specified frequency for all rolls, and that each certificate identifies the rolls related to it.

4. Roll packages are appropriately labeled.

5. Certified minimum average roll properties meet the project specifications.

4.2 Conformance Testing

Upon delivery of the rolls of GCLs, the Project Manager shall assure that conformance test samples are obtained for the GCL. Samples shall be obtained for conformance testing at a frequency of 1 sample per 100,000 ft^2 delivered, with a minimum of 1 per lift. These samples shall then be forwarded to an independent laboratory for testing to assure conformance to the project specifications.

The conformance tests shall be performed in accordance with the test methods indicated in Section 31 05 19.16 Part 1.6. Other conformance tests may be required by the Project Manager.

4.2.1 Sampling Procedures: The rolls to be sampled shall be selected by the Project Manager. Samples shall be taken across the entire width of the roll. Samples shall not be taken from any portion of a roll which has been subjected to excess pressure or stretching. Unless otherwise specified, samples shall be 3 ft long by the roll width. All lots of material and the particular test sample that represents each lot should be defined before the samples are taken.

A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designated by the Project Manager based on a review of all roll information including quality control documentation and manufacturing records.

Unless otherwise specified, samples shall be taken at a rate of one per lot, not less than one conformance test per 100,000 ft^2 of GCL.

4.2.2 Test Results. All conformance test results shall be reviewed and accepted or rejected by the Project Manager prior to the deployment of the GCL.

The Project Manager shall be responsible for checking that all test results meet or exceed the property values listed in the project specifications.

If the Manufacturer has reason to believe that failing tests may be the result of the independent laboratory incorrectly conducting the tests, the Manufacturer may request that the sample in question be retested by the independent laboratory with a technical representative of the Manufacturer present during the testing. This retesting shall be done at the expense of the Manufacturer. Alternatively, the Manufacturer may have the sample retested at two different approved independent laboratories at the expense of the Manufacturer. If both laboratories produce passing results, the material shall be accepted. If both laboratories do not produce passing results, then the original independent laboratory test results shall be accepted. The use of these procedures for dealing with failed test results is subject to the approval of the Project Manager.

If a test result is in nonconformance, all material from the lot represented by the failing test should be considered out of specification and rejected. Alternatively, at the option of the Project Manager, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting specification (note that this procedure is valid only when all rolls in the lot are consecutively produced and numbered from one manufacturing line). To isolate the out of specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If both additional tests pass, the roll that represents the initial failed test and the roll manufactured immediately after that roll (next larger roll number) shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot.

4.3 GCL Deployment

During shipment and storage, the GCL shall be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions. GCL rolls shall be shipped and stored in relatively opaque and watertight wrappings. Wrappings shall be removed shortly before deployment.

The Project Manager shall observe rolls upon delivery at the site and any deviation from the above requirements shall be reported to the Project Manager.

The Installer shall handle all GCLs in such a manner as to assure they are not damaged in any way, and the following shall be complied with:

1. On slopes, the GCLs shall be securely anchored and then rolled down the slope in such a manner as to continually keep the GCLs fully relaxed (but not wrinkled).

2. GCLs shall be cut using a utility knife or special (manufacturer) cutter only. If in place, special care shall be taken to protect other materials from damage which could be caused by the cutting of the GCLs.

3. The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the GCL.

4. A visual examination of the GCL shall be carried out over the entire surface, after installation, to assure that no potentially harmful foreign objects, such as needles, are present.

5. The Installer shall sign and submit subgrade surface acceptance certificates for each area to be covered by the GCL.

6. The Installer shall deploy no more GCL material than can be covered with geomembrane by the end of that working day; this shall be verified by the Project Manager.

7. The Installer shall use a core pipe to lift the GCL during deployment which does not bend excessively creating unacceptable tension in the GCL, this shall be verified by the Project Manager.

8. To prevent damage, the GCL panels should not be dragged along the subgrade surface.

4.4 Seaming Procedures

GCLs shall be overlapped a minimum of 6 inches prior to seaming. In general, no horizontal seams shall be allowed on sideslopes (i.e., seams shall be along, not across, the slope), except as part of a patch. The GCL shall be seamed with a minimum of 115 g/lf of bentonite.

The Project Manager shall pay particular attention at seams to assure that no earth cover material could be inadvertently inserted beneath the GCL.

4.5 Defects and Repairs

Any holes or tears in the GCL shall be repaired as follows:

Place a bead of granular bentonite at the minimum rate of one-half pound per linear foot around the damaged area, cut a batch of new GCL to fit over the damaged area and extending a minimum of two feet beyond it, and carefully backfill.

Care shall be taken to remove any soil or other material which may have penetrated the damaged GCL.

4.6 GCL Protection

All soil materials located on top of a GCL shall be deployed in such a manner as to assure:

1. The GCL is not damaged.

2. Minimal slippage of the GCL on underlying layers occurs.

3. No excess tensile stresses occur in the GCL.

4.7 Installation Documentation

The Project Manager shall prepare and submit the following information as part of the project documentation plan:

1. A panel layout drawing in which the GCL roll numbers are keyed to their location in the field. Location where damage was encountered and repaired shall also be marked.

2. All conformance testing results.

3. All daily reports detailing the GCL deployment.

4. Subgrade surface acceptance certifications signed by the responsible parties.

5. A compilation of all CQA checklists completed during the installation.

6. All manufacturer's certifications and accompanying test data.

7. A description of deviations, if any, made to the original CQA plan during the installation.

8. The Geosynthetic Construction quality Control Agent will accept the GCL prior to placement.

5.0 LINER SOIL QUALITY ASSURANCE

Approximately 620,000 cubic yards of common borrow soil will be required to cover the base and build the slopes of Landfill No. 6 Amendment Area 6D North. Common borrow No. 1 is the soil that will serve as bedding layer for the HDPE geomembrane liner. Common borrow No. 2 is the soil layer that will be used to create separation from the HDPE geomembrane from either groundwater/surface water and/or bedrock or to build embankments.

The Canton Mill will retain the services of a technician familiar with various aspects of landfill construction, to serve as the on-site representative during construction. Services of a general contractor will be procured through a competitive bid process. Bid packages for the solicitation of construction services will require the contractor to identify and demonstrate familiarity and experience with the various aspects of landfill construction. To control the quality of the soil materials used in the landfill development, this Quality Assurance/Quality Control (QA/QC) program will be implemented. The program will include borrow source testing to demonstrate compliance with material specifications, and construction testing to demonstrate that materials have been properly installed.

5.1 Borrow Source Testing

The contractor, as part of his proposal, will be required to identify the till borrow source. Once the construction contract has been awarded, the selected contractor will be required to perform an initial borrow source testing program. The contractor shall employ a testing laboratory acceptable to the Canton Mill to perform the soil testing of a potential borrow source to pre-qualify it. The intent of this program will be to determine the variability of the source properties, and its compliance with the project specifications. The Canton Mill's representative will accompany the contractor during the collection of the soil samples to develop an understanding of the variability of the till borrow source. The contractor will also be required to submit soil logs and a plan of the borrow source showing the locations where the samples were collected.

The laboratory shall perform the analysis as shown on Table 5-1 and Table 5-2.

TABLE 5-1

AREA 6D NORTH
BORROW SOURCE TESTING PROGRAM
COMMON BORROW NO. 1 (WITHIN 1 FOOT OF SYNTHETIC LINER)

Test	Method	Test Frequency[1]	Required Properties
Grain Size Analysis	ASTM D 422-63	1/3000 yd^3	Minimum 20% soil particles passing #200 sieve; maximum particle size <1 inch
Moisture/Density	ASTM D 1557	1/5000 yd^3	(2)

Notes:

1. Test frequency per source.
2. Moisture density tests used to define maximum dry density and associated optional moisture content.

TABLE 5-2

AREA 6D NORTH
BORROW SOURCE TESTING PROGRAM
NO. 78 LEACHATE COLLECTION STONE

Test	Method	Test Frequency[1]	Required Properties
Grain Size Analysis	ASTM D 422	1/3000 yd^3	(2)

Notes:

1. Test frequency per source.
2. Grain size distribution listed in specifications packet.

6.0 SOIL QUALITY CONTROL

The following quality control procedures and testing will be utilized by the Canton Mill to guide and document construction of the soil liner.

6.1 Subgrade Preparation

The areas receiving soil will be prepared by the Contractor prior to placing the till. Preparation of the subgrade will include grading of subgrade.

6.2 Liner Soil Placement

The following QA/QC procedures will be used during placement of the soil liner material.

6.2.1 Moisture Control. Moisture content of the common borrow No. 1 shall range from 0 to 4 percent higher than optimum, as determined by ASTM D 698 (standard proctor) or as determined necessary to meet the project specifications. Moisture content of the common borrow No. 2 soil must be less than 2 percent of optimum as determined by ASTM D 698. Where subgrade or a layer of soil material must be moisture conditioned before compaction, water will be uniformly applied to surface of subgrade, or layer of soil material, in proper quantities to prevent free water appearing on surface during or subsequent to compaction operations.

Soil material that is too wet to permit compaction to the specified density will be removed and replaced, or scarified and air dried.

Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. The soils may be disced, harrowed, or pulverized until moisture content is reduced to a satisfactory level.

6.2.2 Placement and Compaction. Placement of fill materials will be in layers not more than 15” in loose depth for material compacted by heavy compaction equipment, and not more than 6" in loose depth for material compacted by hand-operated tampers. Low hydraulic conductivity soil used for the geomembrane bedding layer will have a maximum in-place compacted lift thickness of 12 inches. Lift thickness will be measured by the Contractor and the CQA Agent during placement at the frequency of 5 tests per acre per lift. The Contractor may use driven wooden grade stakes to aid in the placement of each lift provided that all the grade stakes are collected and accounted for at the completion of the work and that all holes left behind by the grade stakes are filled with granular bentonite. Other methods of determining lift thickness such as GPS survey or free-standing flexible grade stakes can also be used. The CQA Agent may also determine lift thickness by digging small test pits through the loose soil lift into the underlying layer.

Before compaction, moisten or aerate each layer as necessary to provide the optimum moisture content. Compact each layer to required percentage of maximum dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

Place backfill and fill materials evenly adjacent to structures, to required elevations. Take care to prevent wedging action of backfill against structures by carrying the material uniformly around structure to approximately same elevation in each lift. To connect soil barrier layer lifts to a completed barrier layer section (as a result of repairs or sequential liner section at construction), offset the lifts by one-half the compaction equipment width to create a horizontal bench without continuous vertical joints through all lifts of the barrier layer.

To provide for clod break-up of the till material, a minimum number of 2 passes will be made with deep footed pad roller. The CQA Agent will perform visual inspections and measurements as necessary to assure the maximum clod size of the cover soil does not exceed 2 to 3 inches. The Contractor shall make the necessary adjustments including increasing the number of passes with the sheepsfoot roller, decreasing the lift thickness or adjusting the moisture content of the clay to control the clod size of the cover soil.

To eliminate desiccation cracks the surface will be moistened (as necessary) and reworked with 2 passes of a smooth drum roller. Desiccation is defined as moisture content below optimum, or cracks deeper than 1 inch.

Sealing the lifts will encourage runoff from storms, thus limiting development of excessively moist or wet lenses of soil within the barrier layer.

To promote good bonding between lifts, the lift surface shall be scarified or otherwise roughened by tracking with a bulldozer prior to placing the next lift of till. The Contractor shall scarify the in-place lift surface to an approximate depth of 1 inch. The CQA Agent shall visually assure that the soil has been properly scarified prior to placement of subsequent lifts. The scarified zone will be considered part of the loose lift thickness of the subsequent lift.

The following types of equipment will be specified for compaction:

Caterpillar 825H Pad Foot Roller or equivalent equipment approved by the CQA Agent. Equivalent equipment shall meet the following specifications:

Minimum Operating Weight	72,000 lbs
Maximum Drum Width	44.4 inches
Maximum Pad Tip Area	18 square inches
Minimum Pad Height	7.5 inches
Minimum Wheel Diameter	66 inches

The passage of compaction equipment in either direction (forward or backward) is considered a "pass."

The following equipment will be used to obtain a smooth roll surface.

Caterpillar CS563 Vibratory Drum Roller or equivalent equipment approved by the CQA Agent. Equivalent equipment shall meet the following specifications:

Minimum Operating Weight	24,500 lbs
Vibration Frequency	1400 to 1800 vpm
Centrifugal Force	
High amplitude	50,000 lbs
Low amplitude	35,000 lbs
Maximum Drum Width	7.0 feet

6.3 Geomembrane Protection

The quality assurance procedures indicated in this section are intended to assure that the installation of adjacent materials does not damage the geomembrane.

6.3.1 Soils. A copy of the specifications prepared by the Designer for placement of soils shall be given to the Geosynthetic CQA by the Project Manager. The Geosynthetic CQA shall verify that these specifications are consistent with the state-of-practice such as:

1. Placement of soils on the geomembrane shall not proceed at an ambient temperature below 32°F (0°C) nor above 104°F (40°C) unless otherwise specified.

2. Placement of soil on the geomembrane should be done during the coolest part of the day to minimize the development of wrinkles in the geomembrane.

3. A geotextile or other cushion approved by the Designer is required between aggregate and the geomembrane.

4. Equipment used for placing soil shall not be driven directly on the geomembrane.

5. A minimum thickness of 1 foot (0.3 m) of soil is specified between a light dozer (ground pressure of 5 psi (35 kPa) or lighter) and the geomembrane.

6. In any areas traversed by any vehicles other than low ground pressure vehicles approved by the Project Manager, the soil layer shall have a minimum thickness of 3 feet (0.9 m). This requirement may be waived if provisions are made to protect the geomembrane through an engineered design. Drivers shall proceed with caution when on the overlying soil and prevent spinning of tires or sharp turns.

The Geosynthetic CQA shall measure soil thickness and verify that the required thicknesses are present. The Geosynthetic CQA must also verify that final thicknesses are consistent with the design and verify that placement of the soil is done in such a manner that geomembrane damage is unlikely. The Geosynthetic CQA shall inform the Project Manager if the above conditions are not fulfilled.

6.3.2 Sumps and Appurtenances. A copy of the plans and specifications prepared by the Designer for appurtenances shall be given by the Project Manager to the Geosynthetic CQA. The Geosynthetic CQA shall review these plans and verify that:

1. Installation of the geomembrane in appurtenant areas, and connection of geomembrane to appurtenances have been made according to specifications.

2. Extreme care is taken while welding around appurtenances since neither non-destructive nor destructive testing may be feasible in these areas.

3. The geomembrane has not been visibly damaged while making connections to appurtenances.

The Geosynthetic CQA shall inform the Project Manager in writing if the above conditions are not fulfilled.

6.4 In-Place Testing

As the liner material is used in the landfill development, in-place testing will be performed by the owner's representative to monitor material placement and conformance with the criteria specified in the construction specifications. In-place material testing will be performed by a qualified materials testing laboratory and will be observed by the CQA Agent. Testing will be performed on each lift prior to placement of the subsequent lift. The contractor will be required to remove or rework material not conforming with material properties specified.

The owner's testing service shall perform the field moisture content and field density tests specified in Table 6-1 and Table 6-2 to document the liner soil in-place properties. The Contractor shall be responsible for grain size analysis.

TABLE 6-1

AREA 6D NORTH
IN-PLACE TESTING PROGRAM
LINER SOIL

Test	Method	Test Frequency[1]	Required Properties
Grain Size Analysis	ASTM D 422-63	1/1000 cy	Minimum 20% soil particles passing #200 sieve; maximum soil particle size <1 inch
Field Moisture Content	ASTM D 3017	10/acre/lift	0 to 6% above optimum
Field Density	ASTM D 2922	10/acre/lift	90% of maximum
Liner Thickness	Hand Auger	5/acre/lift	12 inch per lift

Note

1. Backfill all in-place test holes with bentonite.

TABLE 6-2

AREA 6D NORTH
IN-PLACE TESTING PROGRAM
NO. 78 LEACHATE COLLECTION STONE

Test	Method	Test Frequency	Required Properties
Grain Size Analysis	ASTM D 422-63	1/3000 cy	(1)

Note

1. Grain size distribution listed in specifications packet.

7.0 CONSTRUCTION DOCUMENTATION

During construction, the Canton Mill's representative will document that the compaction procedures are being followed, the soil and geosynthetic materials are provided and installed for the Valley Fill liner as specified. A full-time project representative will be assigned to the construction of the liner.

7.1 Inspection Reports

Inspection reports will be prepared daily and summarized weekly by the Canton Mill's representative during the closure of the Landfill. The reports will include, but is not limited to:

- Contractor submittals,
- Soil and geomembrane material test results,
- A summary of work progress,
- Photographs, and
- Record drawings.

The weekly summaries will be forwarded to the NCDENRDSW on a regular basis.

7.2 Final Construction Certification and Report

A final construction report will be submitted by the Canton Mill to the NCDENRDSW within 30 days following the completion of construction of the Valley Fill Cell at the Landfill. The report will include, but is not limited to:

- Written certification signed and stamped by Engineer supervising project inspection (Statement of Compliance),
- Submittals,
- Field changes and construction modifications,

- QA/QC testing reports,
- Daily reports, and
- Photographs.

The report will also contain a request that the NCDENRDSW conduct an inspection of the facility for a finding of compliance with the Solid Waste Management Regulations.