

**ROSEN SITE
CORTLAND, NEW YORK**

**FINAL DESIGN REPORT
REMEDIAL DESIGN**

January, 2001



**Barton
& Loguidice, P.C.**
Consulting Engineers

**290 Elwood Davis Road
Box 3107
Syracuse, New York 13220**

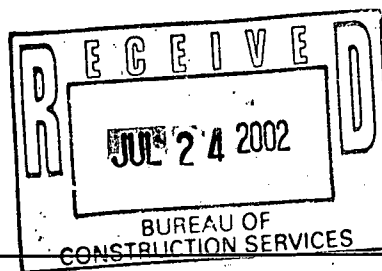


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1.0 INTRODUCTION

The Record of Decision (ROD), issued by the U.S. Environmental Protection Agency (USEPA) on March 23, 1998, outlined the general Remedial Design (RD) and Remedial Action (RA) activities to be undertaken at the Rosen Superfund Site, located in Cortland, New York. This report has been prepared by Barton & Loguidice, P.C. on behalf of the Rosen Site Joint Defense Group, and is provided in accordance with § V of the Statement of Work (SOW) associated with the Consent Decree for implementation of the ROD.

The SOW describes two Remedial Work Elements (RWEs) to be performed, which are summarized as follows:

RWE 1: Soil Excavation/Debris Relocation Cap/Cover RA

- Excavation and re-location/disposal of soils impacted by 1,1,1-trichloroethane (TCA) above 1 mg/kg.
- Excavation and re-location/disposal of soils impacted by polychlorinated biphenyls (PCBs). Note: This task has already been completed.
- Removal and consolidation of non-hazardous debris onto the former cooling pond.
- Design and placement of a 6 NYCRR Part 360 cap over the former three acre cooling pond.
- Construction of a chain link fence around the former cooling pond following cap placement.
- Placement of a surface cover over the remaining areas of the site.
- Implementation of storm-water management improvements to protect the cap and surface cover.

- Employment of dust and volatile organic compound (VOC) control/suppression measures during construction and excavation activities.
- Implementation of an operation and maintenance (O&M) program for the constructed remedial components.
- Securing institutional controls restricting 1) groundwater usage at and downgradient of the site, 2) excavation or other on-site activities which could compromise cap/cover integrity, and 3) residential use of the property.

RWE 2: Long-Term Monitoring RA

- Verifying that natural attenuation is successfully addressing groundwater contamination.
- Securing institutional controls restricting 1) groundwater usage at and downgradient of the site, 2) excavation or other on-site activities which could compromise cap/cover integrity, and 3) residential use of the property.

A five (5) acre northern parcel of the Rosen Site was remediated during the 1998 construction season. The RD presented herein outlines the remediation of the remaining portions of the site. The limit of work for this project is outlined on Sheet 1 of the Remedial Design Drawings and consists of the landfill area and the restoration area. As outlined in the RWE 1 summary above, soil and debris will be relocated to the former cooling pond area from the remaining areas of the site. For the purposes of this project, the cooling pond area will be known as the landfill area and the remaining areas of the site will be known as the restoration area. Both the landfill and restoration area limits have been designated on Sheet 2 of the Remedial Design Drawings.

The landfill area will encompass the former 1.1 acre cooling pond and an additional 2.4 acres in the vicinity of the cooling pond. The landfill will be capped with a standard 6 NYCRR Part 360 landfill cap consisting of an intermediate cover layer, a gas venting layer, geomembrane barrier layer, lateral drainage layer, barrier protection layer and topsoil layer. Prior to capping the landfill, non-hazardous debris and contaminated soil (less than 1 mg/kg TCA; less than 50 mg/kg PCB) will be relocated to within the limits of waste of the landfill from the restoration area.

Following debris and soil relocation, the restoration area will be graded and a final cover system applied. The final cover system will include a geotextile demarcation layer directly above the graded subgrade to delineate the location of the original soils at the site for possible future site development.

This report provides the final design for RWE 1 and also provides the plans required by the SOW.

2.0 SITE INFORMATION

2.1 General Description of Site Vicinity

The Rosen Site occupies an area of approximately 20 acres on the south side of the City of Cortland, Cortland County, New York. In general, the facility is bordered by Perplexity Creek, railroad tracks and several industries to the north, Perplexity Creek tributary to the south, Perplexity Creek tributary and Pendleton Street to the east and private lands and industries to the west. The Rosen Site is surrounded by a 7-foot high chain link fence with locked gates located on the east and west ends of the site.

2.2 Site History and Existing Conditions

A detailed description of the Rosen Site's history and summary of site investigations can be found in the Remedial Investigation Report, (Blasland, Bouck & Lee, Inc., October, 1992, Revised May, 1994). Industrial operations were conducted at the site from the early 1900's until 1985. These operations included a wire manufacturing facility from 1908 until 1971 as well as scrap processing operations from 1971 to 1985. A cooling pond was constructed on the south side of the site prior to 1954. Throughout industrial operations, industrial wastes, demolition debris and other wastes were disposed of in the cooling pond. Other waste disposal practices conducted at the site included disposal of crushed drums in small pits and disposal of liquid waste onto the ground.

As shown on Sheet No. 1 of the Remedial Design Drawings, a five (5) acre northern parcel of the Rosen Site was remediated during the 1998 construction season. This remediation included the relocation of debris from the northern parcel to the former cooling pond area. In addition to miscellaneous debris, contaminated soil with less than 50

mg/kg PCB was excavated from the northern parcel and transported to the former cooling pond area to be capped as part of the final remedial actions at the site. Following debris and soil relocation from the northern parcel, the 5 acre area was fine graded and a layer of stone was placed over the entire area.

Perplexity Creek and its tributary, which border the Rosen Site to the north and south, converge at the northeast corner of the site and flow into a catch basin which outlets to a culvert. The culvert directs the flow into an open channel south of the City of Cortland Department of Public Works facilities and then discharges into the Tioughnioga River. The New York State Department of Environmental Conservation (NYSDEC) classifies Perplexity Creek and its tributary as Class C water bodies which are intended to be suitable for fishing, fish propagation, primary and secondary contact recreation and other uses. The waters are not intended to be suitable as a water supply for drinking, culinary, or food processing.

3.0 PRE-REMEDIAL DESIGN ACTIVITIES

3.1 Cultural Resources Survey

A Stage 1A Cultural Resources Survey was performed at the site by Hartgen Archeological Associates. The report on the survey, dated October 1999, was submitted to USEPA. The report concluded that no further cultural resources or archeological investigation was warranted due to the absence of cultural resources on or near the site. Therefore, the Remedial Design does not further consider cultural resource or archeological issues.

3.2 Groundwater and Sediment Monitoring Plan

A draft Groundwater and Sediment Monitoring Plan was submitted to USEPA in May 1999. Comments on the plan were received in late December 1999, and a revised plan was submitted to USEPA in January 2000. The revised plan provides for monitoring activities during the RD phase, and during and following the RA phase.

4.0 PERFORMANCE STANDARDS AND DESIGN CRITERIA COMPLIANCE

The performance standards for the landfill capping system are drawn from the requirements contained in 6 NYCRR Part 360, which is the Applicable or Relevant and Appropriate Requirement (ARAR) for the landfill cap construction over the former cooling pond at the Rosen Site. Part 360, which regulates the management of solid waste in the State of New York, contains numerous design and construction requirements for the capping and closure of municipal solid waste (MSW) landfills. Table 1 identifies the applicable requirements of Part 360, and provides a summary of the design criteria compliance with these requirements.

**TABLE 1 - 6 NYCRR PART 360
LANDFILL CAPPING DESIGN REQUIREMENTS**

PART 360 REQUIREMENT	DESIGN CRITERIA COMPLIANCE	REPORT SECTION
Section 360-2.15(d)(1) The bottom layer of the final cover system must consist of at least 12 inches of soil with a permeability of 1×10^{-3} cm/sec. Gas venting risers must be spaced at one per acre.	Proposed gas venting with a permeability of 1×10^{-3} cm/sec. Gas venting risers must be spaced at one per acre.	Section 5.1.2 and Drawing No. 5.
Section 360-2.15(d)(2)(i) The gas venting layer shall be overlain by a geomembrane cover meeting the requirements of subdivision 360-2.13(r).	See description for Section 360-2.13(r), below.	N.A.
Section 360-2.13(r) A geomembrane cover must be constructed to preclude precipitation migration into the landfill.	The QA/QC requirements of the construction specifications will ensure that a competent geomembrane cover is installed, which will preclude the migration of precipitation into the landfill.	Appendix D
Settlement, erosion, and seepage forces must be considered in the design of the landfill cover system.	The landfill cap was designed to withstand settlement, erosion, and seepage factors.	Section 5.1.3 and Appendix B
Section 360-2.13(r)(1) The geomembrane must be chemically and physically resistant to materials it may come into contact with and accommodate the expected forces and stresses caused by waste settlement.	The specifications call for the geomembrane to be made of linear low density polyethylene (LLDPE), which is a commonly used capping material.	Appendix B and Drawing No. 5

**TABLE 1 - 6 NYCRR PART 360
LANDFILL CAPPING DESIGN REQUIREMENTS**

PART 360 REQUIREMENT	DESIGN CRITERIA COMPLIANCE	REPORT SECTION
Section 360-2.13(r)(2)(i) The geomembrane must have a minimum thickness of 40 mils.	The geomembrane specifications call for a minimum thickness of 40 mils.	Appendix B and Drawing No. 5
Section 360-2.13(r)(2)(ii) The geomembrane must be placed on a 4% minimum slope to promote drainage. The geomembrane must not be placed on slopes greater than 33% to ensure stability of the capping system.	The landfill cap will be graded prior to cap placement to ensure slopes are between 4% and 25%.	Section 5.1.3 and Drawing No. 3

**TABLE 1 - 6 NYCRR PART 360
LANDFILL CAPPING DESIGN REQUIREMENTS**

PART 360 REQUIREMENT	DESIGN CRITERIA COMPLIANCE	REPORT SECTION
<p>Section 360-2.13(r)(2)(iii) A barrier protection layer of soil not less than 24 inches thick must be installed on top of the geomembrane cover.</p> <p>The barrier protection layer must be adequate to protect the geomembrane cap from frost action and root penetration.</p> <p>The barrier protection layer must be adequate to resist erosion and be stable on the final design slopes of the landfill cover.</p> <p>The lower six inches of this layer must be reasonably free of stones.</p>	<p>The proposed barrier protection layer is 24 inches thick.</p> <p>The cap will be vegetated with herbaceous species, the roots of which will not penetrate through the barrier protection layer. Frost will not penetrate to the barrier layer.</p> <p>A 6-inch layer of topsoil will overlie the barrier protection layer to establish vegetative growth. Erosion control blankets will be installed. Analyses have been performed to ensure that the capping system will remain stable.</p> <p>A composite geonet will be installed above the geomembrane and will protect the geomembrane.</p>	<p>Section 5.1.5 and Drawing No. 5</p> <p>Drawing No. 5</p> <p>Section 5.1.5</p> <p>Section 5.1.4 and Drawing No. 5</p>
<p>Section 360-2.13(r)(3) The project engineer must certify the installation of the geomembrane cover.</p>	<p>The construction certification report will include the approved data resulting from the geomembrane QA/QC testing.</p>	<p>Appendix D</p>

**TABLE 1 - 6 NYCRR PART 360
LANDFILL CAPPING DESIGN REQUIREMENTS**

PART 360 REQUIREMENT	DESIGN CRITERIA COMPLIANCE	REPORT SECTION
Section 360-2.15(d)(5) Alternative individual components of the final cover system that meet the equivalent design provisions of this 360-2.13(w) may also be used.	Not applicable.	Not applicable.
Section 360-2.15(d)(6) Landfill closure activities must be completed in accordance with the final landfill closure plan.	Not applicable.	Not applicable.

5.0 FINAL DESIGN

The capping system of the landfill and related landfill closure activities were designed in accordance with the requirements of 6 NYCRR Part 360 and applicable sections of 24 CFR 264 Subpart G.

5.1 Landfill Capping System

The landfill capping system will be installed in the area of the former cooling pond and is estimated to be approximately 3.5 acres in size. The landfill slopes will be graded to a minimum of 4% to promote drainage and a maximum of 25% to ensure the long term stability of the site. The proposed landfill capping system consists of the following cross-section from top to bottom:

- 6-inch Topsoil Layer;
- 24-inch Barrier Protection Layer;
- Composite Geonet Lateral Drainage Layer;
- 40 mil Linear Low Density Polyethylene (LLDPE) Textured Geomembrane;
- 12-inch Gas Venting Layer; and
- 12-inch minimum Intermediate Cover Layer.

5.1.1 Capping System Preparation

Approximately 20,000 cubic yards of debris and contaminated soil (less than 1 mg/kg TCA; less than 50 mg/kg PCB) will be relocated to within limits of waste of the landfill from the restoration area of the site. A soil and debris relocation plan has been prepared and can be found on Sheet 2 of the Remedial Design Drawings.

Following debris relocation, a minimum 12-inch thick intermediate cover layer consisting of Type B Select Fill will be installed over the debris. The relocated material and intermediate cover will be compacted to provide a firm base to construct the landfill capping system.

5.1.2 Gas Venting Layer

Above the intermediate cover layer, a gas venting layer will be constructed. The gas venting layer will consist of 12-inch thick layer of Type B Select Fill containing a minimum permeability 1×10^{-3} cm/s and a maximum of 10% by weight passing the No. 200 sieve. A Type 1 non-woven geotextile will be installed below the gas venting layer. The gas venting layer will be the main gas control system for the landfill closure.

Landfill gas generation at the site is projected to be minimal since a majority of the debris in the landfill will be hard fill (bricks, metal, concrete, etc.). A minimum of 1 gas vent per acre will be installed into the debris to relieve the gas collected by the gas venting layer. Each gas vent will consist of 6-inch Schedule 40 perforated poly vinyl chloride (PVC) pipe below the geomembrane and 6-inch Schedule 40 solid PVC pipe above the geomembrane. The solid pipe will extend a minimum of

4-feet above the landfill capping system final grade and will be fitted with a gooseneck fitting and bird/insect screen. A layout of the landfill gas vents can be found on Sheet 3 of the Remedial Design Drawings.

5.1.3 Barrier Layer

The main hydraulic barrier of the capping system is a 40 mil LLDPE textured geomembrane. The geomembrane will be installed directly over the gas venting layer. LLDPE was chosen over other geomembranes due to its good chemical resistance, high quality seams with thermal and extrusion welding, and its moderate installation costs. The geomembrane will be textured on both sides to promote good interface friction and ensure landfill capping system veneer stability.

5.1.4 Lateral Drainage Layer

A lateral drainage layer will be installed directly above the hydraulic barrier of the capping system. The lateral drainage layer will consist of a composite geonet which exhibits a flow rate (transmissivity) of $1 \times 10^{-4} \text{ m}^3/\text{sec-m}$ at a normal load of 2000 psf and hydraulic gradient of 0.1. Calculations determining the required transmissivity of the composite geonet lateral drainage layer have been provided in Appendix A. The drainage layer was incorporated into the design to prevent the build up of excessive pore water above the hydraulic barrier that may lead to potential slope failures. The drainage layer will be terminated at toe of slope by a drain consisting of 4-inch diameter corrugated polyethylene (CPE) pipe that drains the collected water away from the geomembrane and discharges it to the surface water system.

A composite geonet was chosen over natural soil drainage layers due to its ease of construction and its transmissivity performance. The composite geonet will incorporate either a bi-planer or tri-planer geonet capable of meeting the required performance transmissivity as specified in Technical Specification Section 02237. To prevent clogging of the geonet, a 6 oz/sy non-woven geotextile will be welded/heat laminated to both sides of the geonet to form the composite. Placement of the material will be performed according to the technical specifications (Appendix B).

5.1.5 Barrier Protection Layer

The barrier protection layer will be constructed above the lateral drainage layer of the capping system. The barrier protection layer will consist of a 24-inch thick layer of common fill material as required by 6NYCRR Part 360. The barrier protection layer will be used to protect the geomembrane and lateral drainage layer from frost action and root penetration.

5.1.6 Topsoil Layer

A 6-inch thick layer of topsoil will be installed above the barrier protection layer. This layer will be fertilized and seeded upon completion. The purpose of the topsoil layer is to establish vegetative growth over the landfill that will help control erosion and increase the percentage of incident precipitation that is removed through evapotranspiration. Erosion control blankets will be used to prevent excessive erosion from occurring prior to the establishment of vegetation.

5.2 Slope Stability Analyses

This section presents the stability analyses used in the proposed landfill closure. These analyses were performed on the most critical components of the most critical cross-section of the landfill at the proposed final waste height. A site map showing this critical cross-section can be found in Appendix A. Three basic cases were analyzed, and with Case 1 and Case 2 a failure was analyzed for both the Northern and Southern slopes:

- *Case 1: Stability of the Waste Mass and Foundations Soils (Winstabl v. 2.5)*
- *Case 2: Veneer Stability of the Capping System (Giroud & Beech 1990)*
- *Case 3: Capping System Stability Under Construction Loading (Winstabl v. 2.5)*

5.2.1 Landfill Configuration and Cross-Sections

Sheet No. 3 of the Remedial Design Drawings shows the proposed landfill footprint. The landfill side slopes will have a maximum slope of 4H:1V (25%) and this was used in all three stability cases analyzed. To select the most critical cross-section for each of the three cases, the configuration of the landfill during post-closure as well as during construction was examined. A detailed cross-section of the landfill can be found in Appendix A.

The proposed cover system used in these analyses can be found on Sheet 5 of the Remedial Design Drawings. The components of the capping system, from the top to the bottom are as follows:

- 6-inch Topsoil Layer
- 24-inch Barrier Protection Layer
- Composite Geonet
- Linear Low Density Polyethylene Geomembrane (LLDPE)
- 12-inch Gas Venting Layer
- Type 1 Geotextile
- 12-inch Intermediate Cover Layer

5.2.2 Soil / Geosynthetic Properties

5.2.2.1 In-situ Soils and Structural Fill

A detailed description of the Rosen Site's geology can be found in the Remedial Investigation Report (Blasland, Bouck & Lee, Inc., October, 1992, Revised May, 1994). The location and thicknesses of the in-situ soils and structural fill layer at the site were estimated from the Remedial Investigation Report.

The existing soils at the site generally consist of a brown silt layer over an upper outwash layer (medium to coarse sand). For stability analyses, the in-situ soils were assumed to have a moist unit weight (γ_m) of 120 pcf, an internal cohesion of 0 psf and an internal friction angle (ϕ) of 30 degrees. These fall within the typical range of engineering properties for sand and silt as published in NAVFAC (1983).

A structural fill layer consisting mainly of brown sand lies above the silt layer at the site. The engineering properties used for the structural fill layer in the stability analyses included a moist unit weight (γ_m) of 110 pcf, an internal cohesion of 0 psf and an internal friction angle (ϕ) of 30 degrees. Again these values fall within the typical range of engineering properties for sand as published in NAVFAC (1983).

5.2.2.2 Relocated Debris and Waste Fill

On-site waste fill and relocated debris will have a varied composition with a majority of the debris consisting of concrete, wood and scrap metal. Although the relocated material resembles typical construction and demolition debris (C&D), typical properties of Municipal Solid Waste (MSW) were used in the analyses. The use of MSW properties is conservative in nature since the relocated debris will be much more interlocking than MSW resulting in higher shear strengths in the field than modeled in these stability analyses.

MSW shear strength data is relatively limited and is summarized in the USEPA seismic design guidance manual (USEPA 1995). The data shows that both laboratory and field tests consistently result in MSW shear strengths in excess of a cohesion (c) of 200 psf and an internal friction angle (ϕ) of 20 degrees. Conservatively, these values were chosen to be used in the stability analyses.

A typical MSW unit weight (γ_m) of approximately 65 pcf was used in model the relocated debris. Since this value falls within the range of MSW values summarized in the USEPA seismic design manual, it was used in the following analyses.

5.2.2.3 Capping System Components

The stability of the landfill capping system is governed by both the internal shear strength characteristics of the soil layers, as well as the shear strength characteristics of the soil/geosynthetic interfaces. Since both compacted cohesive soils and granular soils generally have higher shear strengths than soil/geosynthetic interfaces, the probable failure plane in the landfill capping system will occur along the interface with the lowest shear strength. Internal shear strength is represented by a combination of cohesion (c) and internal friction angle (ϕ). Similarly, interface shear strength is represented by a combination of adhesion (a) and interface friction angle (δ). Since the long-term contribution of

adhesion is uncertain, the analyses were conservatively performed assuming the adhesion of all interfaces to be zero. The interface shear strengths analyzed as part of the capping system stability analyses include:

- Barrier Protection / Geotextile: $a = 0$ psf ; $\delta = 32^\circ$
- Geotextile / Textured Geomembrane: $a = 0$ psf; $\delta = 35^\circ$
- Textured Geomembrane / Gas Venting Soil: $a = 0$ psf ; $\delta = 28^\circ$
(Critical)
- Gas Venting Soil / Geotextile: $a = 0$ psf ; $\delta = 32^\circ$

Engineering properties of the soils which lie above the critical interface are required as follows:

- Topsoil: $c = 0$ psf; $\phi = 30^\circ$; $\gamma_m = 140$ pcf
- Barrier Protection: $c = 0$ psf; $\phi = 30^\circ$; $\gamma_m = 140$ pcf

5.2.3 Cover System Head Buildup

The Hydrologic Evaluation of Landfill Performance (HELP) model version 3.03 (USEPA, 1994) was used to estimate the peak level of lateral drainage head above the hydraulic barrier on the side slope capping system. This level was then used to verify that there would not be a saturation of the composite geonet.

The HELP program is a quasi two-dimensional water balance computer model that accepts climatologic, soil and design data and uses a solution technique to distribute incident precipitation into surface runoff,

evapotranspiration, lateral drainage, soil moisture storage, and infiltration. The program performs the water budget calculation on a given cross-section and provides peak daily and average monthly outputs. HELP model output can be found in Appendix A.

Although there will not be a saturation of the composite geonet, conservatively, the head above the hydraulic barrier used in the analyses was equal to the thickness of the geonet.

5.2.4 Construction Loading Considerations

The Case 3 analyses models the proposed closure system under construction loadings. The maximum anticipated loading that will be encountered is 1183 psf. A calculation for this loading condition is included in Appendix A.

5.2.5 Seismic Design Considerations

Seismic stability is not required for the site since the site is not located within a seismic impact zone. A seismic impact zone is defined as any area with ten percent or greater probability of exceeding a maximum bedrock acceleration of 0.10 g in 250 years.

5.2.6 Methods of Analysis

Cases 1 and 3 were analyzed using a two-dimensional limit equilibrium slope stability program WINSTABL Version 2.5 developed as a Joint Highway

Research Project (JHRP-88/19) between the Indiana Department of Transportation and Purdue University, which was modified by the University of Wisconsin-Madison. These cases were analyzed for failures through both the northern (A) and southern (B) slopes. The circular failure was allowed to fail through the subgrade and the waste mass. The Winstabl V. 2.5 results are included in Appendix A.

Case 2 was analyzed using a two-dimensional, two part sliding wedge method presented by Giroud and Beech (1990). The method models the slope as two blocks; a sliding block along the slope above the critical interface and a toe buttress block at the base of the sliding block. The equation is summarized in the attached calculation found in Appendix A.

5.2.7 Summary of Results

A summary table of the stability analyses results can be found below.
All factors of safety were satisfactory.

Case	Description	Method	Required Fs min	Calculated Fs min
1A	Global Failure - Full Waste - North	WINSTABL V2.5	1.50	2.29
1B	Global Failure - Full Waste - South	WINSTABL V2.5	1.50	2.41
2	Side Slope Cap	Giroud & Beech (1990)	1.50	2.24
3A	Construction Failure - North	WINSTABL V2.5	1.50	2.01
3B	Construction Failure - South	WINSTABL V2.5	1.50	1.91

5.3 Restoration Area Final Cover System

The restoration area consists of approximately 7.6 acres. Following relocation of the debris and contaminated soil (less than 1 mg/kg TCA; less than 50 mg/kg PCB) from the remediation area to the landfill area, the restoration area will be graded to drain and a final cover system applied. The proposed final cover system consists of a Type 3 non-woven geotextile demarcation layer covered by a 8-inch thick common fill layer and 4-inch thick topsoil layer. The demarcation layer will be installed to delineate the location of the original or native soils at the site for future site development. The topsoil layer will be seeded, fertilized and mulched to establish vegetative growth.

5.4 Surface Water Control

Surface water runoff from the southern portion of the landfill will be allowed to flow into the Tributary of Perplexity Creek directly from the capping system. Runoff from the northern portion of the landfill capping system will be collected in a new surface water swale at the toe of slope that will direct the flow to the existing drainage ditch at the site. Due to the relatively short drainage lengths on the landfill cap (less than 150 feet), surface water control structures on the capping system are not necessary. Surface water runoff from the restoration area will be collected in either the new surface water swale mentioned above or the existing drainage ditch at the site. The existing drainage ditch at the site conveys storm water runoff to the Tributary of Perplexity Creek. The proposed grading plan of the new surface water swale is shown on Sheet 3 of the Remedial Design Drawings. Swale and culvert sizing calculations are included in Appendix A.

5.5 Roadways

A new gravel access road will be constructed at the site for access to the final landfill capping system. The gravel roadway will be constructed of a 6-inch layer of compacted granular fill. A non-woven geotextile will be placed below the gravel roadway. The layout of the new gravel roadway is outlined on Sheet 3 of the Remedial Design Drawings.

5.6 Construction Activities

Prior to commencing with construction activities, a construction field office and contractor's staging area will be established in the northeast corner of the site. The proposed main site access point will be the existing site entrance from Pendelton Street. The proposed site entrance and field office locations are shown on Sheet 1 of the Remedial Design Drawings.

Construction activities will commence with the clearing and grubbing of existing shrubs, trees and vegetation within the limits of work. When the landfill area is cleared, debris and contaminated soil (less than 1 mg/kg TCA; less than 50 mg/kg PCB) will be relocated to within limits of waste of the landfill from the restoration area of the site. A soil and debris relocation plan has been prepared and can be found on Sheet 2 of the Remedial Design Drawings. Intermediate cover will be placed over the relocated debris to provide a firm subgrade to construct the landfill capping system.

The limits of waste of the landfill will be verified prior to commencing with the capping system construction. Test pits will be excavated at a maximum of 200 feet apart around the perimeter of the landfill to establish the final limits of waste. The final limits of waste will be staked during the test pit verification and surveyed.

With the debris and contaminated soil (less than 1 mg/kg TCA; less than 50 mg/kg PCB) relocated and the final limits of waste known, the landfill capping system and the restoration area final cover system will be constructed as outlined in Section 5.1 and Section 5.2 of this report.

The entire Rosen Site is currently enclosed by a chain link fence as shown on Sheet 1 of the Remedial Design Drawings. Following landfill capping construction, a new chain link fence will be installed around the northern portion of the landfill area as shown on Sheet 3 of the Remedial Design Drawings. The new fence will segregate the closed landfill from the restoration area.

6.0 REQUIRED PLANS

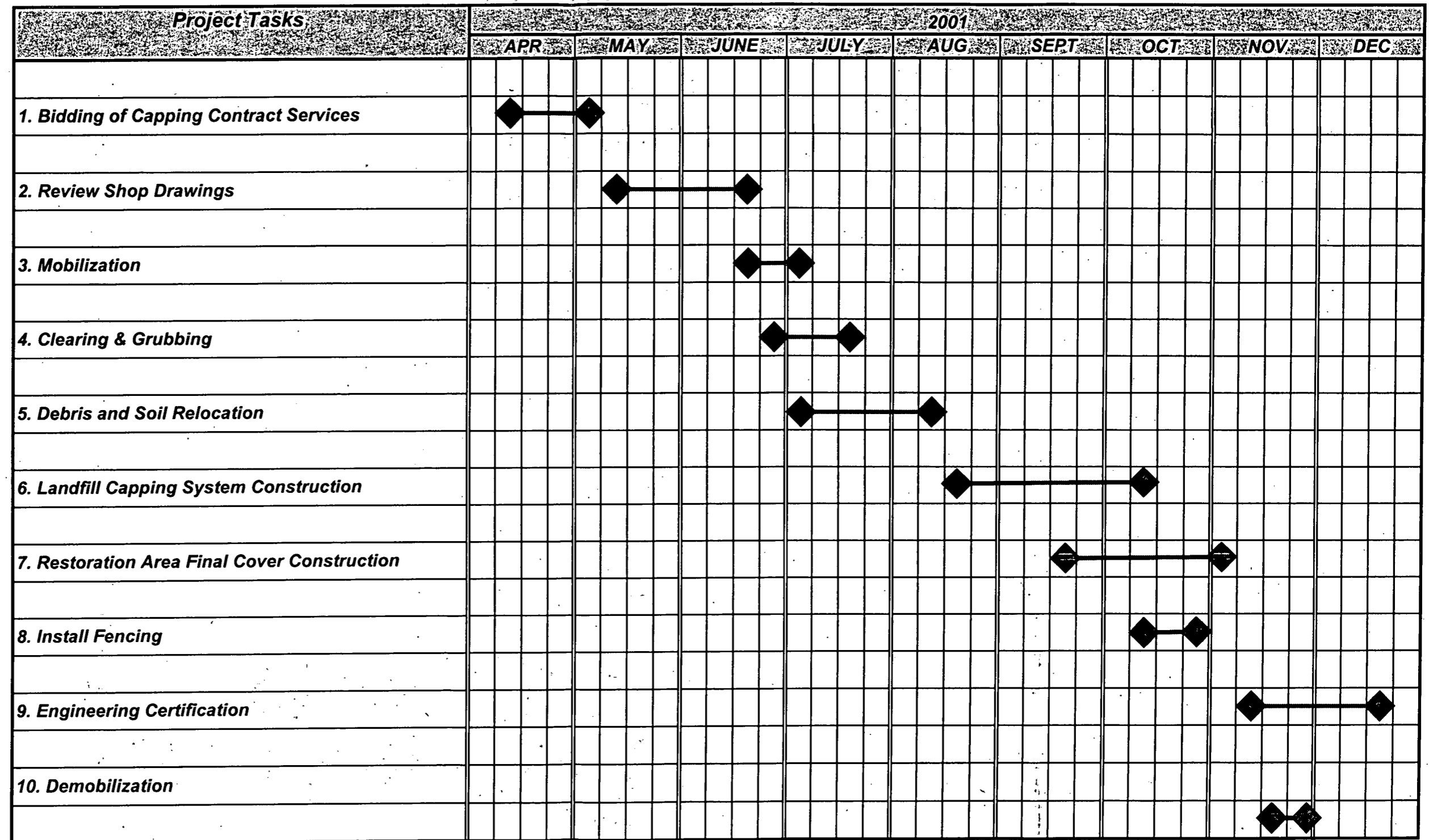
The SOW required the submission of specific plans and specifications. These plans are included in appendices, as follows:

<u>Appendix</u>	<u>Contents</u>
A	Engineering Calculations
B	Construction Specifications
C	Photographic Documentation Plan
D	Construction Quality Assurance Plan

7.0 CONSTRUCTION SCHEDULE

A Remedial Construction Schedule has been provided on the following Figure 1 -
Preliminary Construction Schedule.

**FIGURE 1 - CONSTRUCTION SCHEDULE
ROSEN SITE REMEDIAL DESIGN**



APPENDIX A
ENGINEERING CALCULATIONS

APPENDIX A

Engineering Calculations

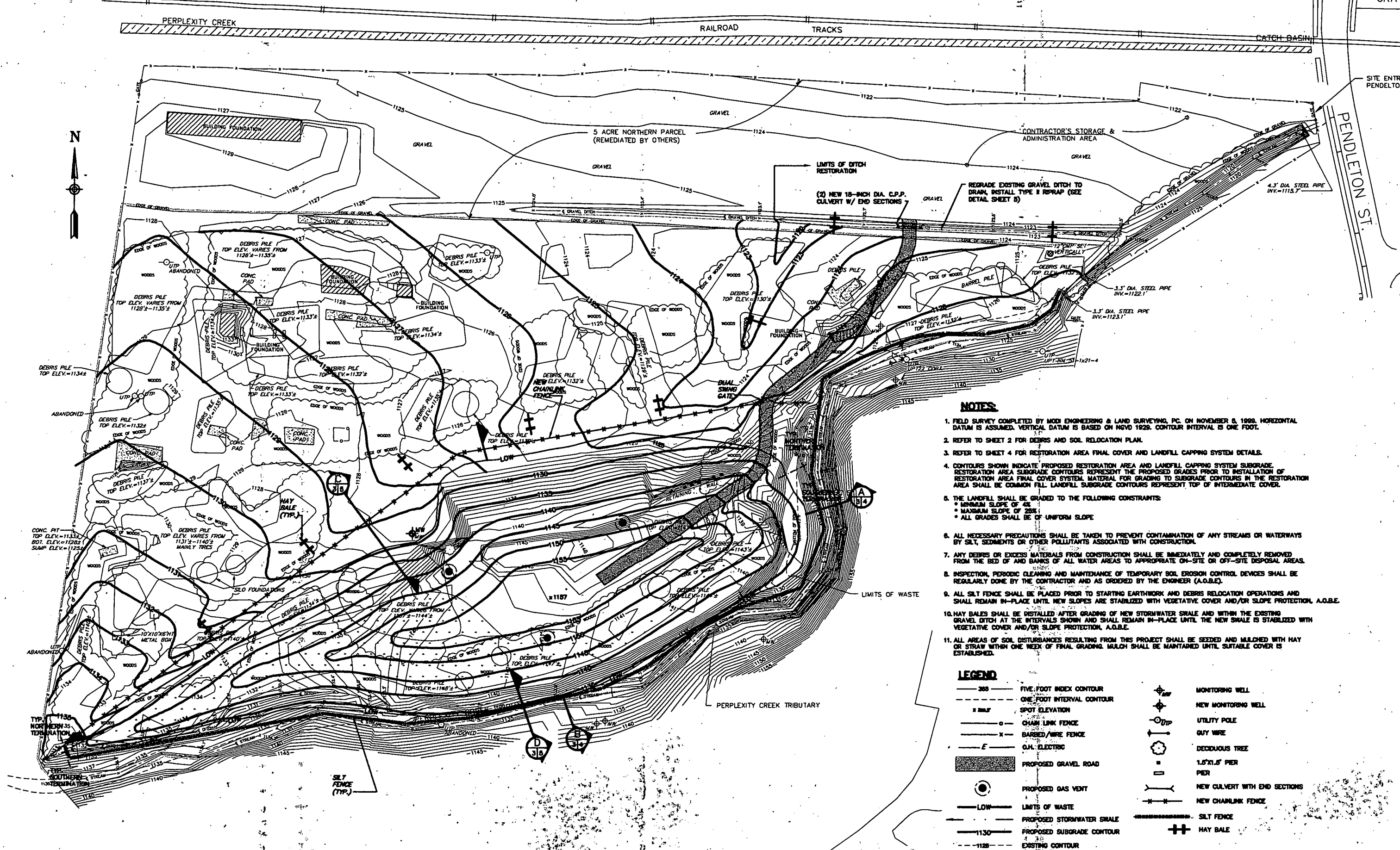
1. Slope Stability Calculations
 - A. Site Map
 - B. Cross-Section
 - C. Soil Properties
 - D. Case 1A and Case 1B Outputs
 - E. Case 2 Output
 - F. Case 3A and Case 3B Outputs
 - G. Construction Loading Calculation
2. Stormwater Calculations
 - A. H.E.L.P. Model Outputs
 - B. Drainage Composite Calculation
 - C. Surface Water Swale Design

APPENDIX A.1

SLOPE STABILITY CALCULATIONS

APPENDIX A.1.A

SITE MAP



NOTES

- FIELD SURVEY COMPLETED BY MODI ENGINEERING & LAND SURVEYING, P.C. ON NOVEMBER 8, 1999. HORIZONTAL DATUM IS ASSUMED. VERTICAL DATUM IS BASED ON NGVD 1929. CONTOUR INTERVAL IS ONE FOOT.
- REFER TO SHEET 2 FOR DEBRIS AND SOIL RELOCATION PLAN.
- REFER TO SHEET 4 FOR RESTORATION AREA FINAL COVER AND LANDFILL CAPPING SYSTEM DETAILS.
- CONTOURS SHOWN INDICATE PROPOSED RESTORATION AREA AND LANDFILL CAPPING SYSTEM SUBGRADE. RESTORATION AREA SUBGRADE CONTOURS REPRESENT THE PROPOSED GRADES PRIOR TO INSTALLATION OF RESTORATION AREA FINAL COVER SYSTEM. MATERIAL FOR GRADING TO SUBGRADE CONTOURS IN THE RESTORATION AREA SHALL BE COMMON FILL. LANDFILL SUBGRADE CONTOURS REPRESENT TOP OF INTERMEDIATE COVER.
- THE LANDFILL SHALL BE GRADED TO THE FOLLOWING CONSTRAINTS:
 - MINIMUM SLOPE OF 4%
 - MAXIMUM SLOPE OF 25%
 - ALL GRADES SHALL BE OF UNIFORM SLOPE
- ALL NECESSARY PRECAUTIONS SHALL BE TAKEN TO PREVENT CONTAMINATION OF ANY STREAMS OR WATERWAYS BY SILT, SEDIMENTS OR OTHER POLLUTANTS ASSOCIATED WITH CONSTRUCTION.
- ANY DEBRIS OR EXCESS MATERIALS FROM CONSTRUCTION SHALL BE IMMEDIATELY AND COMPLETELY REMOVED FROM THE BED OF AND BANKS OF ALL WATER AREAS TO APPROPRIATE ON-SITE OR OFF-SITE DISPOSAL AREAS.
- INSPECTION, PERIODIC CLEANING AND MAINTENANCE OF TEMPORARY SOIL EROSION CONTROL DEVICES SHALL BE REGULARLY DONE BY THE CONTRACTOR AND AS ORDERED BY THE ENGINEER (A.O.B.E.).
- ALL SILT FENCE SHALL BE PLACED PRIOR TO STARTING EARTHWORK AND DEBRIS RELOCATION OPERATIONS AND SHALL REMAIN IN-PLACE UNTIL NEW SLOPES ARE STABILIZED WITH VEGETATIVE COVER AND/OR SLOPE PROTECTION, A.O.B.E.
- HAY BALES SHALL BE INSTALLED AFTER GRADING OF NEW STORMWATER SWALE AND WITHIN THE EXISTING GRAVEL DITCH AT THE INTERVALS SHOWN AND SHALL REMAIN IN-PLACE UNTIL THE NEW SWALE IS STABILIZED WITH VEGETATIVE COVER AND/OR SLOPE PROTECTION, A.O.B.E.
- ALL AREAS OF SOIL DISTURBANCES RESULTING FROM THIS PROJECT SHALL BE SEEDED AND MULCHED WITH HAY OR STRAW WITHIN ONE WEEK OF FINAL GRADING. MULCH SHALL BE MAINTAINED UNTIL SUITABLE COVER IS ESTABLISHED.

LEGEND

- | | | | |
|----------|---------------------------|---|-------------------------------|
| — 360 — | FIVE FOOT INDEX CONTOUR | ⊕ | MONITORING WELL |
| — 120 — | ONE FOOT INTERVAL CONTOUR | ⊕ | NEW MONITORING WELL |
| — 120 — | SPOT ELEVATION | ⊕ | UTILITY POLE |
| — 0 — | CHAIN LINK FENCE | ⊕ | GUY WIRE |
| — X — | BARBED WIRE FENCE | ⊕ | DECIDUOUS TREE |
| — E — | O.H. ELECTRIC | ⊕ | 1.5'X1.5' PIER |
| — — — | PROPOSED GRAVEL ROAD | ⊕ | PIER |
| ⊕ | PROPOSED GAS VENT | ⊕ | NEW CULVERT WITH END SECTIONS |
| — LOW — | LIMITS OF WASTE | ⊕ | NEW CHAINLINK FENCE |
| — 1130 — | PROPOSED STORMWATER SWALE | ⊕ | SILT FENCE |
| — 1130 — | PROPOSED SUBGRADE CONTOUR | ⊕ | HAY BALE |
| — 1128 — | EXISTING CONTOUR | | |

in charge of	WFS	Date	JANUARY, 2001	REVISIONS	COMPLETED CONSTRUCTION
Designed by	JFB	Scale	1" = 50'		Significant Construction Changes Are Shown
Drawn by	TLC				By _____ Date _____
Checked by					Ch'd _____ Date _____
NO ALTERATION PERMITTED HEREON EXCEPT AS PROVIDED UNDER SECTION 7209 SUBDIVISION 2 OF THE NEW YORK STATE EDUCATION LAW.					

Barton
Loguidice, P.C.
 Consulting Engineers
 290 Elwood Davis Road / Box 3107, Syracuse, New York 13220

REMEDIAL DESIGN ROSEN SUPERFUND SITE		Sheet Number	3
SUBGRADE GRADING PLAN		File Number	617.001-04F
CITY OF CORTLAND	CORTLAND COUNTY, NEW YORK		

APPENDIX A.1.B
CROSS-SECTION

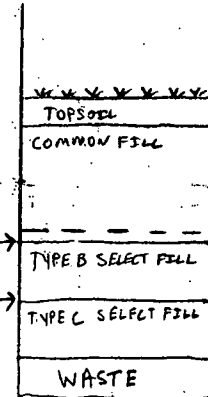
ROSEN SUPERFUND SITE - REMEDIAL DESIGN

CROSS SECTION FOR SLOPE STABILITY ANALYSIS

COORDINATE KEY

(TOP OF TOPSOIL)
(TOP OF LLDPE GEOMEMBRANE)
(TOP OF TYPE B SELECT FILL)
(SUBGRADE ELEVATION)
(TOP OF WASTE)

NUMBER WITHIN [] IS X-VALUE
FOR SOUTH-NORTH DIRECTION



LLDPE
GEOMEMBRANE
TYPE I
GEOTEXTILE

COMPOSITE
GEOWEB

ELEVATION ABOVE MSL (1929 DATUM)
(FEET)

1180 NORTH
1170
1160
1150
1140
1130
1120
1110
1100
1090

SOUTH

NEW CHAIN LINK FENCE

WASTE

FILL (BROWN SAND)

UPPER SILT
(BROWN SILT)

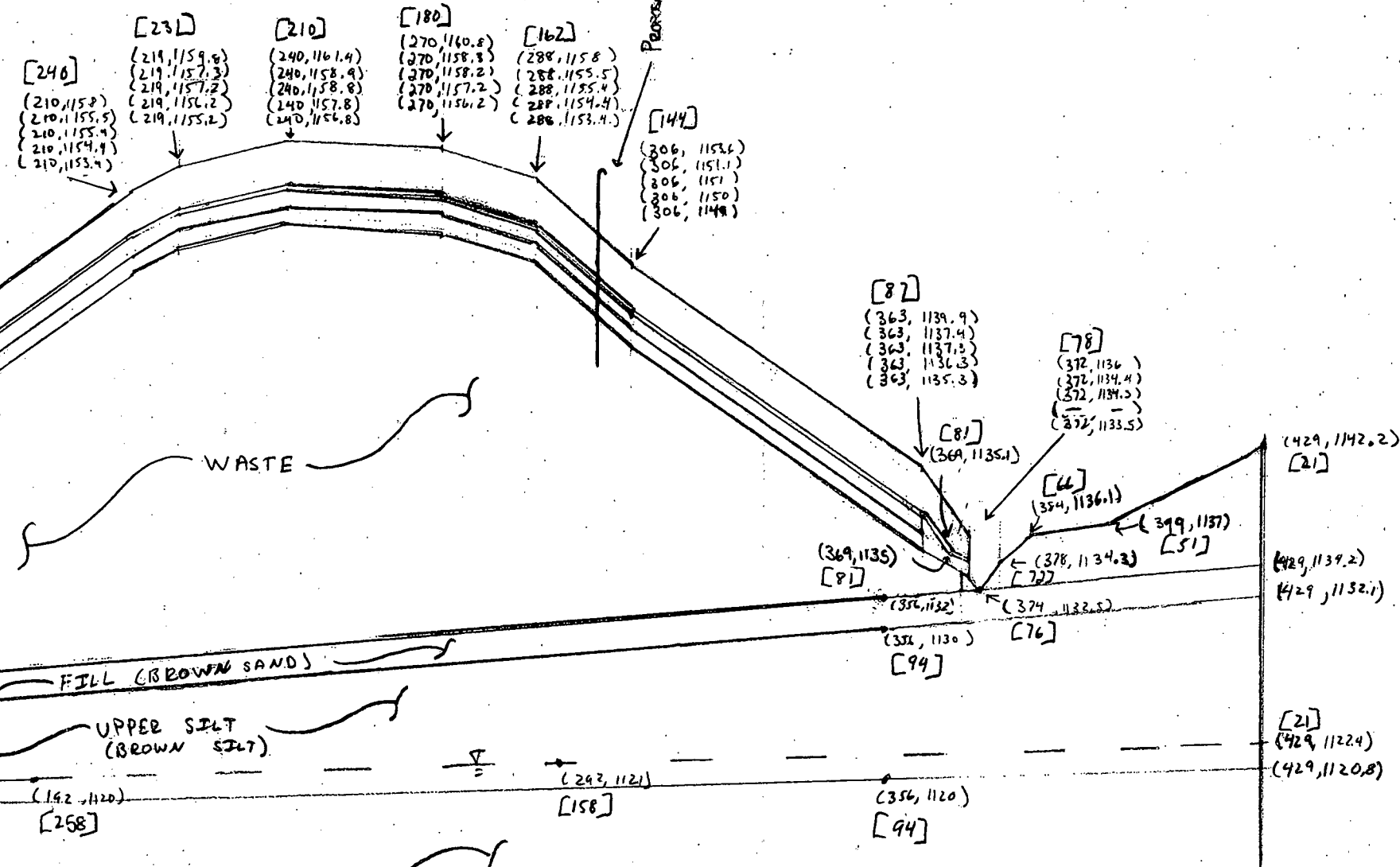
UPPER OUTWASH
(MEDIUM TO COARSE SAND)

PURGED GAS VENT

MPV
8/00

DISTANCE ALONG CROSS SECTION (FEET)

450 420 390 360 330 300 270 240 210 180 150 120 90 60 30 0



APPENDIX A.1.C
SOIL PROPERTIES

Soil No.	Soil / Interface Description	γ_m (pcf)	γ_{sat} (pcf)	Cohesion / Adhesion (psf)	ϕ / δ (degrees)
1	Upper Outwash	120	120	0	30
2	Upper Silt	120	120	0	30
3	Fill	110	110	0	30
4	Waste	65	65	200	20
5	Type C Select Fill	110	110	0	30
6	Type B Select Fill	110	110	0	30
7	LLDPE Geomembrane/Drainage Sand	0.1	0.1	0	28
8	Cap Cover Soil (Topsoil, Common Fill)	140	140	0	30
9	Restoration Area Cap (Common Fill)	140	140	0	30
10	Existing Cover - North Side	110	110	0	25
11	Existing Cover - South Side	110	110	0	25

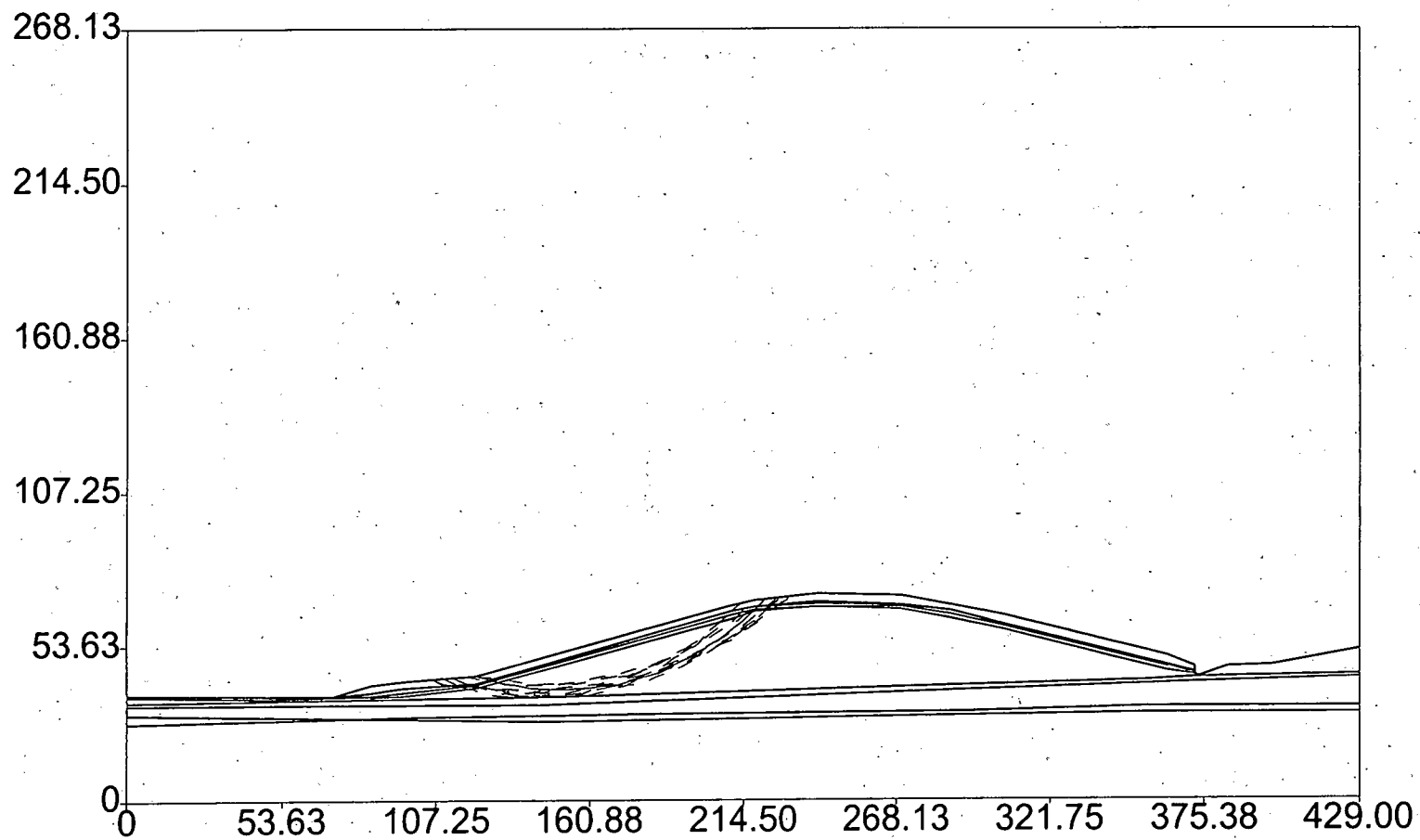
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& Loguidice, P.C.
 Consulting Engineers

APPENDIX A.1.D

CASE 1A AND CASE 1B OUTPUTS

Rosen Site - Case 1A North to South

Safety Factors



2.29
2.31
2.32
2.33
2.33
2.33
2.33
2.34
2.36
2.36

** PCSTABL6 **

by
Purdue University

modified by
Peter J. Bosscher
University of Wisconsin-Madison

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

PROBLEM DESCRIPTION Rosen Site - Case 1A North to South

BOUNDARY COORDINATES

14 Top Boundaries
75 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	37.50	48.00	36.50	9
2	48.00	36.50	72.00	37.20	9
3	72.00	37.20	84.00	40.50	8
4	84.00	40.50	96.00	41.60	8
5	96.00	41.60	121.00	43.80	8
6	121.00	43.80	210.00	68.00	8
7	210.00	68.00	219.00	69.80	8
8	219.00	69.80	240.00	71.40	8
9	240.00	71.40	270.00	70.80	8
10	270.00	70.80	288.00	68.00	8
11	288.00	68.00	306.00	63.60	8
12	306.00	63.60	363.00	49.90	8
13	363.00	49.90	372.00	46.00	8
14	372.00	46.00	372.00	43.50	8
15	72.00	36.20	84.00	38.00	7
16	84.00	38.00	96.00	39.10	7
17	96.00	39.10	121.00	41.30	7
18	121.00	41.30	210.00	65.50	7
19	210.00	65.50	219.00	67.30	7

20	219.00	67.30	240.00	68.90	7
21	240.00	68.90	270.00	68.30	7
22	270.00	68.30	288.00	65.50	7
23	288.00	65.50	306.00	61.10	7
24	306.00	61.10	363.00	47.40	7
25	363.00	47.40	369.00	45.10	7
26	369.00	45.10	372.00	44.40	7
27	72.00	36.10	84.00	37.90	6
28	84.00	37.90	96.00	39.00	6
29	96.00	39.00	121.00	41.20	6
30	121.00	41.20	210.00	65.40	6
31	210.00	65.40	219.00	67.20	6
32	219.00	67.20	240.00	68.80	6
33	240.00	68.80	270.00	68.20	6
34	270.00	68.20	288.00	65.40	6
35	288.00	65.40	306.00	61.00	6
36	306.00	61.00	363.00	47.30	6
37	363.00	47.30	369.00	45.00	6
38	369.00	45.00	372.00	44.30	5
39	0.00	36.50	48.00	35.50	10
40	48.00	35.50	72.00	36.10	10
41	72.00	36.10	84.00	36.90	10
42	84.00	36.90	96.00	38.00	5
43	96.00	38.00	121.00	40.20	5
44	121.00	40.20	210.00	64.40	5
45	210.00	64.40	219.00	66.20	5
46	219.00	66.20	240.00	67.80	5
47	240.00	67.80	270.00	67.20	5
48	270.00	67.20	288.00	64.40	5
49	288.00	64.40	306.00	60.00	5
50	306.00	60.00	363.00	46.30	5
51	84.00	35.90	96.00	37.00	4
52	96.00	37.00	121.00	39.20	4
53	121.00	39.20	210.00	63.40	4
54	210.00	63.40	219.00	65.20	4
55	219.00	65.20	240.00	66.80	4
56	240.00	66.80	270.00	66.20	4
57	270.00	66.20	288.00	63.40	4
58	288.00	63.40	306.00	59.00	4
59	306.00	59.00	363.00	45.30	4
60	363.00	45.30	372.00	43.50	4
61	372.00	43.50	374.00	42.50	4
62	374.00	42.50	378.00	44.30	11
63	378.00	44.30	384.00	46.10	11
64	384.00	46.10	399.00	47.00	11
65	399.00	47.00	429.00	52.20	11
66	0.00	35.00	144.00	36.00	3
67	144.00	36.00	356.00	42.00	3
68	356.00	42.00	374.00	42.50	3
69	374.00	42.50	429.00	44.20	3
70	0.00	33.00	144.00	34.00	2
71	144.00	34.00	356.00	40.00	2
72	356.00	40.00	429.00	42.10	2
73	0.00	30.00	144.00	28.00	1
74	144.00	28.00	356.00	30.00	1
75	356.00	30.00	429.00	30.80	1

ISOTROPIC SOIL PARAMETERS

11 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	120.0	0.0	30.0	0.00	0.0	1
2	120.0	120.0	0.0	30.0	0.00	0.0	1
3	110.0	110.0	0.0	30.0	0.00	0.0	0
4	65.0	65.0	200.0	20.0	0.00	0.0	0
5	110.0	110.0	0.0	30.0	0.00	0.0	0
6	110.0	110.0	0.0	30.0	0.00	0.0	0
7	0.1	0.1	0.0	28.0	0.00	0.0	0
8	140.0	140.0	0.0	30.0	0.00	0.0	2
9	140.0	140.0	0.0	30.0	0.00	0.0	0
10	110.0	110.0	0.0	25.0	0.00	0.0	0
11	110.0	110.0	0.0	25.0	0.00	0.0	0

2 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 7 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	27.50
2	24.00	28.00
3	100.00	29.00
4	192.00	30.00
5	292.00	31.00
6	356.00	32.00
7	429.00	32.40

Piezometric Surface No. 2 Specified by 12 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	72.00	36.22
2	84.00	38.02

3	96.00	39.12
4	121.00	41.32
5	210.00	65.52
6	219.00	67.32
7	240.00	68.92
8	270.00	68.32
9	288.00	65.52
10	306.00	61.12
11	363.00	47.42
12	372.00	44.42

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

400 Trial Surfaces Have Been Generated.

20 Surfaces Initiate From Each Of 20 Points Equally Spaced Along The Ground Surface Between $X = 48.00$ ft.
and $X = 121.00$ ft.

Each Surface Terminates Between $X = 210.00$ ft.
and $X = 239.00$ ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is $Y = 0.00$ ft.

5.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	121.00	43.80
2	125.77	42.30
3	130.61	41.05
4	135.51	40.06
5	140.46	39.33

6	145.44	38.86
7	150.43	38.66
8	155.43	38.73
9	160.42	39.06
10	165.39	39.65
11	170.31	40.51
12	175.19	41.62
13	179.99	43.00
14	184.72	44.62
15	189.36	46.50
16	193.89	48.62
17	198.30	50.97
18	202.58	53.56
19	206.71	56.37
20	210.69	59.39
21	214.51	62.62
22	218.15	66.05
23	221.60	69.67
24	221.90	70.02

*** 2.288 ***

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	113.32	43.12
2	118.00	41.37
3	122.77	39.89
4	127.63	38.69
5	132.54	37.78
6	137.51	37.15
7	142.49	36.82
8	147.49	36.77
9	152.49	37.02
10	157.46	37.55
11	162.39	38.38
12	167.27	39.49
13	172.07	40.88
14	176.78	42.55
15	181.39	44.50
16	185.87	46.70
17	190.23	49.17
18	194.43	51.88
19	198.46	54.83
20	202.32	58.02
21	205.98	61.42
22	209.44	65.03
23	212.38	68.48

*** 2.310 ***

Failure Surface Specified By 27 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	109.47	42.79
2	114.27	41.37
3	119.12	40.16
4	124.02	39.16
5	128.96	38.36
6	133.92	37.78
7	138.91	37.41
8	143.91	37.26
9	148.91	37.31
10	153.90	37.58
11	158.87	38.07
12	163.83	38.76
13	168.74	39.66
14	173.62	40.78
15	178.44	42.10
16	183.20	43.62
17	187.89	45.35
18	192.51	47.28
19	197.04	49.40
20	201.47	51.71
21	205.80	54.21
22	210.02	56.89
23	214.13	59.75
24	218.10	62.78
25	221.95	65.97
26	225.65	69.33
27	226.72	70.39

*** 2.316 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	117.16	43.46
2	122.07	42.53
3	127.02	41.80
4	131.99	41.27
5	136.98	40.94
6	141.98	40.82
7	146.98	40.90
8	151.97	41.18
9	156.94	41.66

10	161.90	42.35
11	166.82	43.24
12	171.70	44.33
13	176.53	45.61
14	181.31	47.09
15	186.02	48.76
16	190.66	50.63
17	195.22	52.68
18	199.69	54.91
19	204.07	57.32
20	208.35	59.91
21	212.52	62.67
22	216.57	65.60
23	220.50	68.69
24	222.07	70.03

*** 2.330 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	109.47	42.79
2	114.32	41.55
3	119.21	40.52
4	124.14	39.68
5	129.10	39.04
6	134.08	38.60
7	139.07	38.35
8	144.07	38.31
9	149.07	38.47
10	154.06	38.83
11	159.03	39.39
12	163.97	40.15
13	168.88	41.10
14	173.74	42.25
15	178.56	43.59
16	183.32	45.13
17	188.01	46.86
18	192.63	48.77
19	197.17	50.87
20	201.62	53.14
21	205.98	55.60
22	210.23	58.22
23	214.38	61.02
24	218.41	63.97
25	222.32	67.09
26	226.07	70.34

*** 2.330 ***

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	105.63	42.45
2	110.40	40.93
3	115.22	39.62
4	120.10	38.52
5	125.02	37.62
6	129.97	36.92
7	134.95	36.44
8	139.94	36.17
9	144.94	36.10
10	149.94	36.25
11	154.92	36.61
12	159.89	37.18
13	164.83	37.96
14	169.73	38.94
15	174.59	40.13
16	179.39	41.52
17	184.13	43.12
18	188.80	44.91
19	193.39	46.89
20	197.89	49.07
21	202.29	51.44
22	206.59	53.99
23	210.78	56.72
24	214.85	59.62
25	218.80	62.69
26	222.61	65.93
27	226.28	69.32
28	227.40	70.44

*** 2.334 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	109.47	42.79
2	114.24	41.26
3	119.07	39.98
4	123.96	38.95
5	128.90	38.17
6	133.87	37.65
7	138.87	37.38
8	143.87	37.36
9	148.86	37.61

10	153.84	38.10
11	158.78	38.86
12	163.68	39.86
13	168.52	41.11
14	173.29	42.61
15	177.97	44.35
16	182.57	46.33
17	187.05	48.54
18	191.42	50.98
19	195.65	53.64
20	199.74	56.51
21	203.68	59.59
22	207.46	62.87
23	211.07	66.33
24	213.25	68.65

*** 2.335 ***

Failure Surface Specified By 27 Coordinate Points

Point No..	X-Surf (ft)	Y-Surf (ft)
1	109.47	42.79
2	114.32	41.56
3	119.21	40.52
4	124.14	39.66
5	129.09	39.00
6	134.07	38.53
7	139.06	38.24
8	144.06	38.15
9	149.06	38.25
10	154.05	38.54
11	159.03	39.03
12	163.98	39.70
13	168.91	40.56
14	173.80	41.61
15	178.64	42.85
16	183.44	44.27
17	188.17	45.87
18	192.84	47.66
19	197.44	49.62
20	201.96	51.75
21	206.40	54.06
22	210.74	56.54
23	214.99	59.18
24	219.13	61.98
25	223.16	64.94
26	227.08	68.05
27	230.11	70.65

*** 2.340 ***

Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	121.00	43.80
2	125.92	42.89
3	130.87	42.17
4	135.84	41.64
5	140.82	41.30
6	145.82	41.14
7	150.82	41.18
8	155.82	41.40
9	160.80	41.81
10	165.76	42.41
11	170.70	43.20
12	175.61	44.18
13	180.47	45.34
14	185.28	46.68
15	190.05	48.21
16	194.75	49.91
17	199.38	51.80
18	203.94	53.85
19	208.41	56.08
20	212.80	58.47
21	217.10	61.03
22	221.29	63.75
23	225.38	66.63
24	229.36	69.66
25	230.60	70.68

*** 2.360 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	105.63	42.45
2	110.49	41.24
3	115.38	40.24
4	120.32	39.44
5	125.28	38.84
6	130.27	38.45
7	135.26	38.27
8	140.26	38.29
9	145.26	38.51
10	150.24	38.94
11	155.20	39.58

12	160.13	40.42
13	165.02	41.46
14	169.86	42.70
15	174.65	44.14
16	179.38	45.78
17	184.03	47.60
18	188.60	49.62
19	193.09	51.83
20	197.48	54.22
21	201.78	56.78
22	205.96	59.52
23	210.02	62.44
24	213.96	65.51
25	217.78	68.75
26	218.89	69.78

*** 2.362 ***

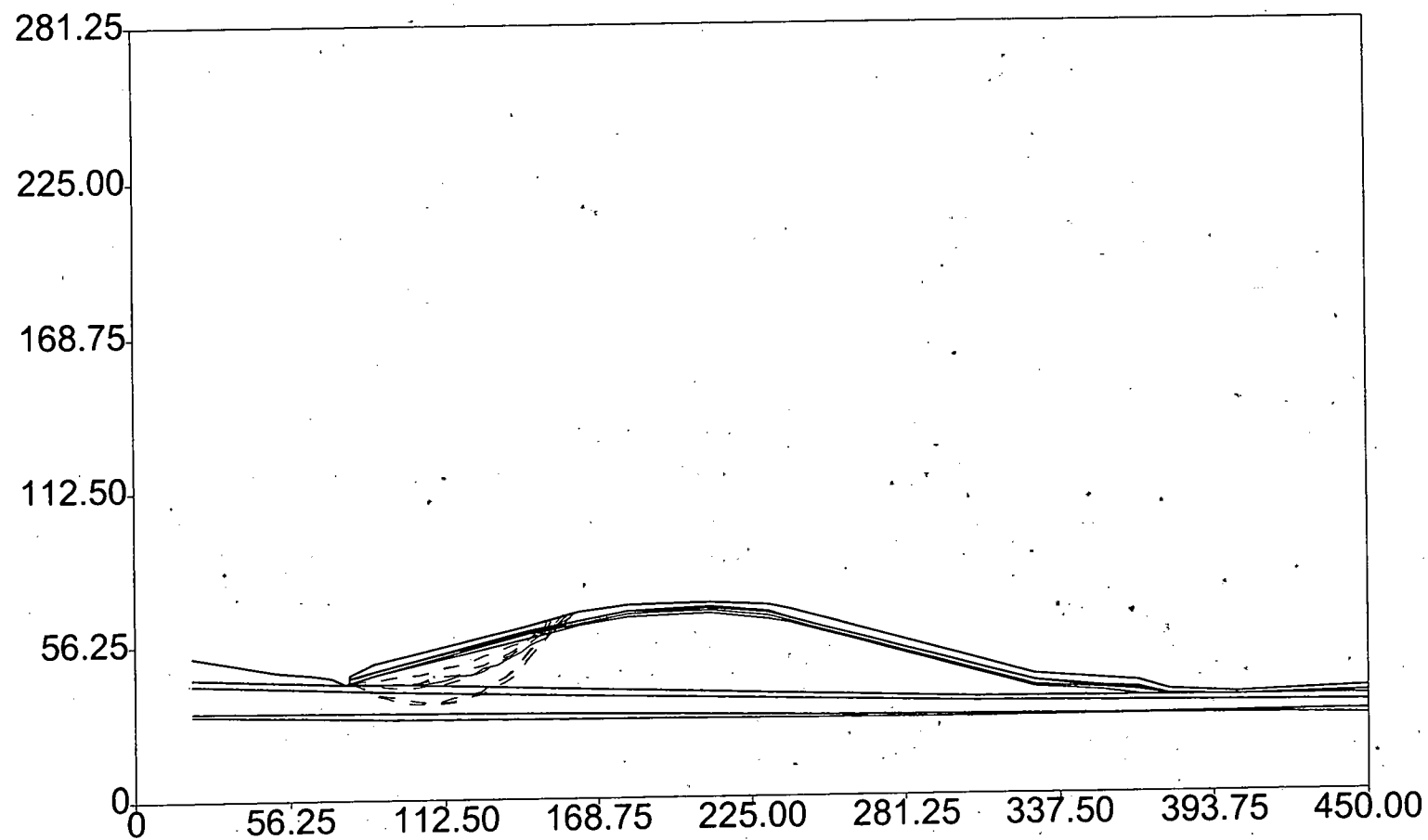
	Y	A	X	I	S	F	T
	0.00	53.63	107.25	160.88	214.50	268.13	

X	0.00	+	-----W**-----+
		-	
		-	
		-	W
		-	
		-	*
	53.63	+	..
		-
		-*
		-**
		-
		-	....W.**
A	107.25	+	.....3
		-	.....32
		-**
		-	.....11
		-	.....***4.
		-	.....14.
X	160.88	+	.....14.
		-	.....11..
		-	.....614.
		-	....W.117.
		-	.....117.
		-	.....11**
I	214.50	+	.....112
		-**
		-	....8
		-	**
		-	

S	268.13	+		**
		-		**
		-	W	**
	321.75	+		
		-		
		-	***	
		-	**	
F	375.38	+	**	
		-	*	
		-		
		-	*	
		-		
T	429.00	+	*	*
		-	*	

Rosen Site - Case 1b South to North

Safety Factors



2.41
2.43
2.44
2.46
2.50
2.51
2.91
3.01
3.07
3.11

** PCSTABL6 **

by
Purdue University

modified by
Peter J. Bosscher
University of Wisconsin-Madison

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

PROBLEM DESCRIPTION Rosen Site - Case 1b South to North

BOUNDARY COORDINATES

19 Top Boundaries
75 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	21.00	52.20	51.00	47.00	11
2	51.00	47.00	66.00	46.10	11
3	66.00	46.10	72.00	44.30	11
4	72.00	44.30	76.00	42.50	11
5	76.00	42.50	78.00	43.50	4
6	78.00	43.50	78.00	46.00	8
7	78.00	46.00	87.00	49.90	8
8	87.00	49.90	144.00	63.60	8
9	144.00	63.60	162.00	68.00	8
10	162.00	68.00	180.00	70.80	8
11	180.00	70.80	210.00	71.40	8
12	210.00	71.40	231.00	69.80	8
13	231.00	69.80	240.00	68.00	8
14	240.00	68.00	329.00	43.80	8
15	329.00	43.80	354.00	41.60	8
16	354.00	41.60	366.00	40.50	8
17	366.00	40.50	378.00	37.20	8
18	378.00	37.20	402.00	36.50	9
19	402.00	36.50	450.00	37.50	9

20	78.00	44.40	81.00	45.10	7
21	81.00	45.10	87.00	47.40	7
22	87.00	47.40	144.00	61.10	7
23	144.00	61.10	162.00	65.50	7
24	162.00	65.50	180.00	68.30	7
25	180.00	68.30	210.00	68.90	7
26	210.00	68.90	231.00	67.30	7
27	231.00	67.30	240.00	65.50	7
28	240.00	65.50	329.00	41.30	7
29	329.00	41.30	354.00	39.10	7
30	354.00	39.10	366.00	38.00	7
31	366.00	38.00	378.00	36.20	7
32	78.00	44.30	81.00	45.00	6
33	81.00	45.00	87.00	47.30	6
34	87.00	47.30	144.00	61.00	6
35	144.00	61.00	162.00	65.40	6
36	162.00	65.40	180.00	68.20	6
37	180.00	68.20	210.00	68.20	6
38	210.00	68.80	231.00	67.20	6
39	231.00	67.20	240.00	65.40	6
40	240.00	65.40	329.00	41.20	6
41	329.00	41.20	354.00	39.00	6
42	354.00	39.00	366.00	37.90	6
43	366.00	37.90	378.00	36.10	6
44	87.00	46.30	144.00	60.00	5
45	144.00	60.00	162.00	64.40	5
46	162.00	64.40	180.00	67.20	5
47	180.00	67.20	210.00	67.80	5
48	210.00	67.80	231.00	66.20	5
49	231.00	66.20	240.00	64.40	5
50	240.00	64.40	329.00	40.20	5
51	329.00	40.20	354.00	38.00	5
52	354.00	38.00	366.00	36.90	5
53	366.00	36.90	378.00	36.10	10
54	378.00	36.10	402.00	35.50	10
55	402.00	35.50	450.00	36.50	10
56	78.00	43.50	87.00	45.30	4
57	87.00	45.30	144.00	59.00	4
58	144.00	59.00	162.00	63.40	4
59	162.00	63.40	180.00	66.20	4
60	180.00	66.20	210.00	66.80	4
61	210.00	66.80	231.00	65.20	4
62	231.00	65.20	240.00	63.40	4
63	240.00	63.40	329.00	39.20	4
64	329.00	39.20	354.00	37.00	4
65	354.00	37.00	366.00	35.90	4
66	21.00	44.20	76.00	42.50	3
67	76.00	42.50	94.00	42.00	3
68	94.00	42.00	306.00	36.00	3
69	306.00	36.00	450.00	35.00	3
70	21.00	42.10	94.00	40.00	2
71	94.00	40.00	306.00	34.00	2
72	306.00	34.00	450.00	33.00	2
73	21.00	30.80	94.00	30.00	1
74	94.00	30.00	306.00	28.00	1
75	306.00	28.00	450.00	30.00	1

ISOTROPIC SOIL PARAMETERS

11 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	120.0	0.0	30.0	0.00	0.0	1
2	120.0	120.0	0.0	30.0	0.00	0.0	1
3	110.0	110.0	0.0	30.0	0.00	0.0	0
4	65.0	65.0	200.0	20.0	0.00	0.0	0
5	110.0	110.0	0.0	30.0	0.00	0.0	0
6	110.0	110.0	0.0	30.0	0.00	0.0	0
7	0.1	0.1	0.0	28.0	0.00	0.0	0
8	140.0	140.0	0.0	30.0	0.00	0.0	2
9	140.0	140.0	0.0	30.0	0.00	0.0	0
10	110.0	110.0	0.0	25.0	0.00	0.0	0
11	110.0	110.0	0.0	25.0	0.00	0.0	0

2 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 6 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	21.00	32.40
2	158.00	31.00
3	258.00	30.00
4	350.00	29.00
5	426.00	28.00
6	450.00	27.50

Piezometric Surface No. 2 Specified by 12 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	78.00	44.42
2	87.00	47.42
3	144.00	61.12

4	162.00	65.52
5	180.00	68.32
6	210.00	68.92
7	231.00	67.32
8	240.00	65.52
9	329.00	41.32
10	354.00	39.12
11	366.00	38.02
12	378.00	36.22

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

400 Trial Surfaces Have Been Generated.

20 Surfaces Initiate From Each Of 20 Points Equally Spaced Along The Ground Surface Between X = 66.00 ft.
and X = 78.00 ft.

Each Surface Terminates Between X = 144.00 ft.
and X = 162.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = 0.00 ft.

5.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	78.00	43.50
2	82.95	42.81
3	87.93	42.37
4	92.93	42.17
5	97.93	42.23
6	102.92	42.54
7	107.89	43.10
8	112.82	43.91

9	117.71	44.97
10	122.54	46.27
11	127.29	47.81
12	131.97	49.58
13	136.55	51.59
14	141.02	53.83
15	145.37	56.29
16	149.60	58.96
17	153.68	61.84
18	157.62	64.93
19	160.83	67.71

*** 2.415 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	78.00	43.50
2	82.97	42.98
3	87.97	42.71
4	92.97	42.68
5	97.96	42.90
6	102.94	43.37
7	107.89	44.07
8	112.80	45.02
9	117.66	46.21
10	122.45	47.64
11	127.16	49.30
12	131.79	51.18
13	136.33	53.30
14	140.75	55.63
15	145.05	58.18
16	149.22	60.93
17	153.26	63.89
18	156.74	66.71

*** 2.433 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	78.00	43.50
2	82.98	43.04
3	87.97	42.81
4	92.97	42.81

5	97.97	43.05
6	102.95	43.52
7	107.90	44.22
8	112.81	45.14
9	117.68	46.30
10	122.48	47.68
11	127.22	49.28
12	131.87	51.10
13	136.44	53.13
14	140.91	55.38
15	145.27	57.83
16	149.51	60.48
17	153.62	63.32
18	157.60	66.35
19	158.55	67.16

*** 2.435 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	78.00	43.50
2	82.85	42.30
3	87.78	41.44
4	92.75	40.93
5	97.75	40.78
6	102.75	40.97
7	107.72	41.52
8	112.64	42.41
9	117.48	43.65
10	122.23	45.23
11	126.85	47.13
12	131.33	49.36
13	135.64	51.89
14	139.76	54.73
15	143.67	57.84
16	147.35	61.22
17	150.79	64.86
18	151.20	65.36

*** 2.460 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
--------------	----------------	----------------

1	78.00	43.50
2	83.00	43.66
3	87.99	43.98
4	92.97	44.45
5	97.93	45.08
6	102.86	45.86
7	107.78	46.80
8	112.65	47.89
9	117.50	49.13
10	122.30	50.53
11	127.06	52.07
12	131.76	53.76
13	136.41	55.60
14	141.00	57.58
15	145.53	59.71
16	149.98	61.98
17	154.37	64.38
18	158.67	66.92
19	159.35	67.35

*** 2.500 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	78.00	43.50
2	83.00	43.73
3	87.98	44.11
4	92.95	44.63
5	97.91	45.29
6	102.84	46.10
7	107.75	47.04
8	112.63	48.13
9	117.48	49.36
10	122.29	50.73
11	127.06	52.23
12	131.78	53.88
13	136.45	55.65
14	141.07	57.56
15	145.64	59.61
16	150.14	61.78
17	154.58	64.08
18	158.95	66.51
19	161.07	67.77

*** 2.510 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	78.00	43.50
2	82.45	41.21
3	87.08	39.33
4	91.86	37.88
5	96.76	36.86
6	101.72	36.29
7	106.72	36.17
8	111.71	36.50
9	116.65	37.28
10	121.50	38.50
11	126.22	40.16
12	130.77	42.23
13	135.11	44.71
14	139.21	47.57
15	143.04	50.79
16	146.56	54.34
17	149.75	58.19
18	152.57	62.31
19	154.77	66.23

*** 2.907 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	78.00	43.50
2	82.34	41.02
3	86.90	38.97
4	91.64	37.38
5	96.52	36.27
6	101.48	35.63
7	106.48	35.49
8	111.46	35.84
9	116.39	36.67
10	121.22	37.98
11	125.89	39.76
12	130.37	41.99
13	134.60	44.64
14	138.56	47.70
15	142.20	51.13
16	145.48	54.90
17	148.38	58.98
18	150.86	63.32
19	151.85	65.52

*** 3.012 ***

Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	78.00	43.50
2	82.29	40.94
3	86.82	38.81
4	91.53	37.12
5	96.37	35.90
6	101.32	35.16
7	106.31	34.90
8	111.31	35.13
9	116.26	35.84
10	121.11	37.02
11	125.83	38.67
12	130.37	40.77
13	134.68	43.30
14	138.73	46.24
15	142.47	49.55
16	145.88	53.22
17	148.91	57.19
18	151.54	61.44
19	153.75	65.93
20	153.77	65.99

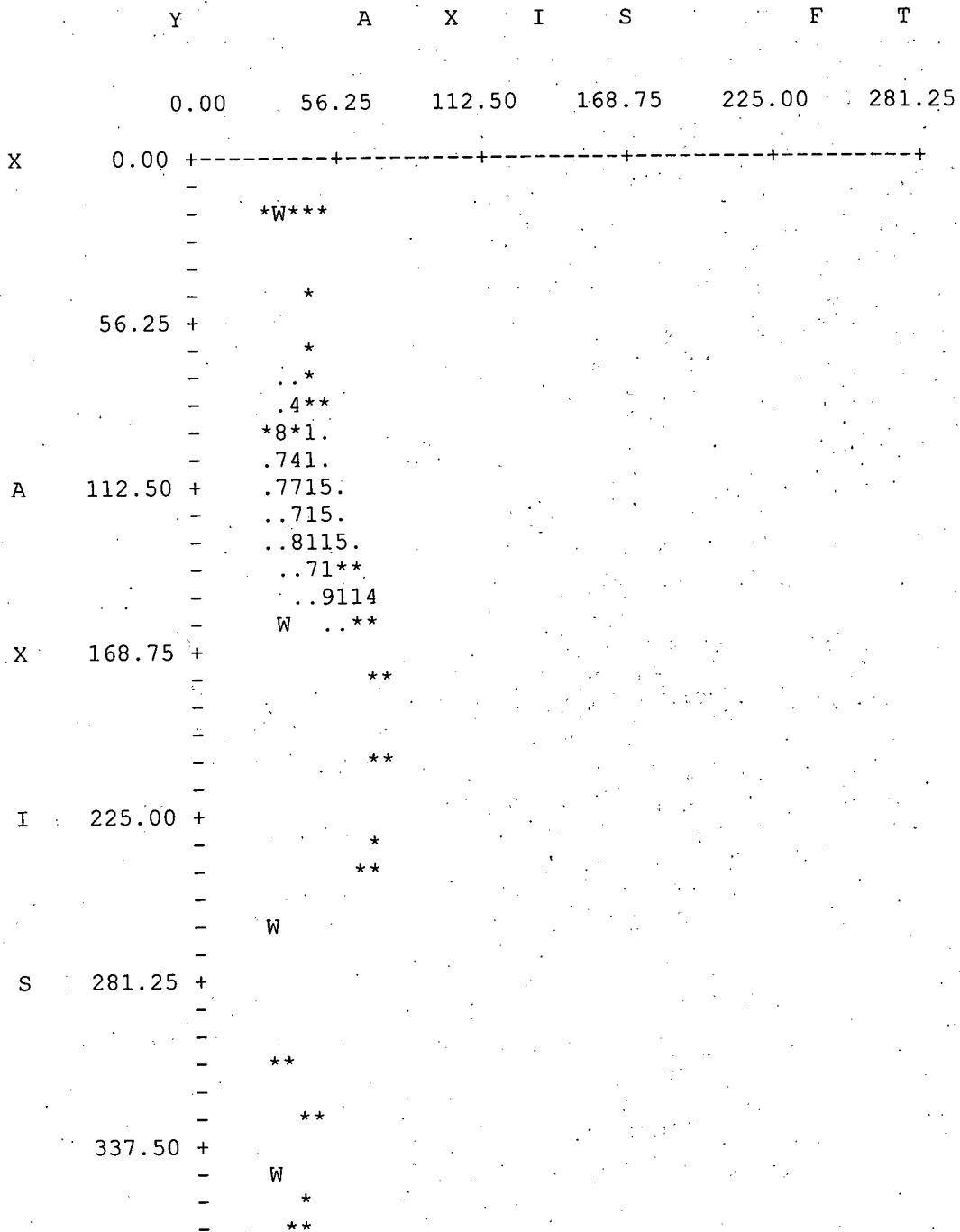
*** 3.067 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	78.00	43.50
2	82.24	40.86
3	86.74	38.66
4	91.43	36.95
5	96.28	35.73
6	101.23	35.01
7	106.23	34.82
8	111.22	35.14
9	116.15	35.97
10	120.96	37.31
11	125.62	39.15
12	130.06	41.45
13	134.23	44.20
14	138.10	47.36
15	141.62	50.91

16	144.76	54.81
17	147.47	59.01
18	149.74	63.46
19	150.39	65.16

*** 3.112 ***



**

F 393.75 +

*

W

T 450.00 +

APPENDIX A.1.E

CASE 2 OUTPUT

VENEER STABILITY ANALYSES

Giroud & Beech (1990)

Factor of Safety (FS) = (Sum of Resistive Forces)/(Sum of Driving Forces) = $\frac{[Fr(a) + Fr(Sc)] + [Fb(c) + Fb(\emptyset) - EQf]}{[Fd(soil) + Fd(water)]}$

$$FS = \frac{[(aH/\sin B) + (EQ_i \cdot G' \cdot T \cdot \tan Sc / (2 \sin B) \cdot (2H \cos B / T - 1))] + [(cT \cos \emptyset / (\sin B \cdot \cos(\emptyset + B))) + (G' \cdot T \cdot \sin \emptyset / (\sin 2B \cdot \cos(\emptyset + B))) - EQf]}{[(EQ_d \cdot G' \cdot T \cdot (H \cdot T / (2 \cos B))) + (G \sin B h L_h)]}$$

where:

- Fr(a) = Resistive force due to interface adhesion
- Fr(Sc) = Resistive force due to interface friction
- Fb(c) = Buttress force due to soil cohesion
- Fb(∅) = Buttress force due to soil internal friction
- Fd(soil) = Driving force due to soil weight
- Fd(water) = Driving force due to water above interface

EQf = Reduction in buttress force due to earthquake loading
 $= (ks \cdot G' \cdot T^2) / (\sin 2B \cdot (\cos B - \sin B \cdot \tan \emptyset))$

EQd = additional driving force due to earthquake loading = $1 + ks \cdot \tan B$

EQi = interface reduction factor due to earthquake loading = $1 - ks \cdot \tan B$

G' = soil unit weight accounting for buoyancy = $G - G_w(h/T)$

CASE 2: CAPPING SYSTEM			CRITICAL INTERFACE: Type C Select Fill / Textured LLDPE		
SOIL PARAMETERS			INTERFACE PARAMETERS		
G = moist unit weight =	140	pcf	Sc = interface friction angle =	28 °	
c = internal cohesion =	0	psf	a = interface adhesion =	0	psf
∅ = internal friction angle =	30	°			
T = cover thickness =	2.5	ft			
DESIGN PARAMETERS			EFFECTS OF WATER		
H = height of slope =	31.5	ft	h = head of water above interface =	0.02	ft
B = slope angle =	14.03	°	Gw = unit weight of water =	62.4	pcf
Slope run factor (H:V)	4.00	H:1V	G' = buoyant soil unit weight =	139.5	pcf
Lh = Horizontal slope length =	126.0	ft			
			EARTHQUAKE PARAMETERS		
			ks = pseudostatic seismic coefficient =	0	g

RESISTIVE FORCES		
	STATIC (lbs/ft)	SEISMIC (lbs/ft)
Fr(a) =	0	0
Fr(Sc) =	22,419	22,419
Fb(c) =	0	0
Fb(∅) =	1,289	1,289
EQf =	0	0
TOTAL =	23,708	23,708

DRIVING FORCES		
	STATIC (lbs/ft)	SEISMIC (lbs/ft)
Fd(soil) =	10,536	10,536
Fd(water) =	38	38
TOTAL =	10,574	10,574

Calculated By:
CWH, 12/26/00

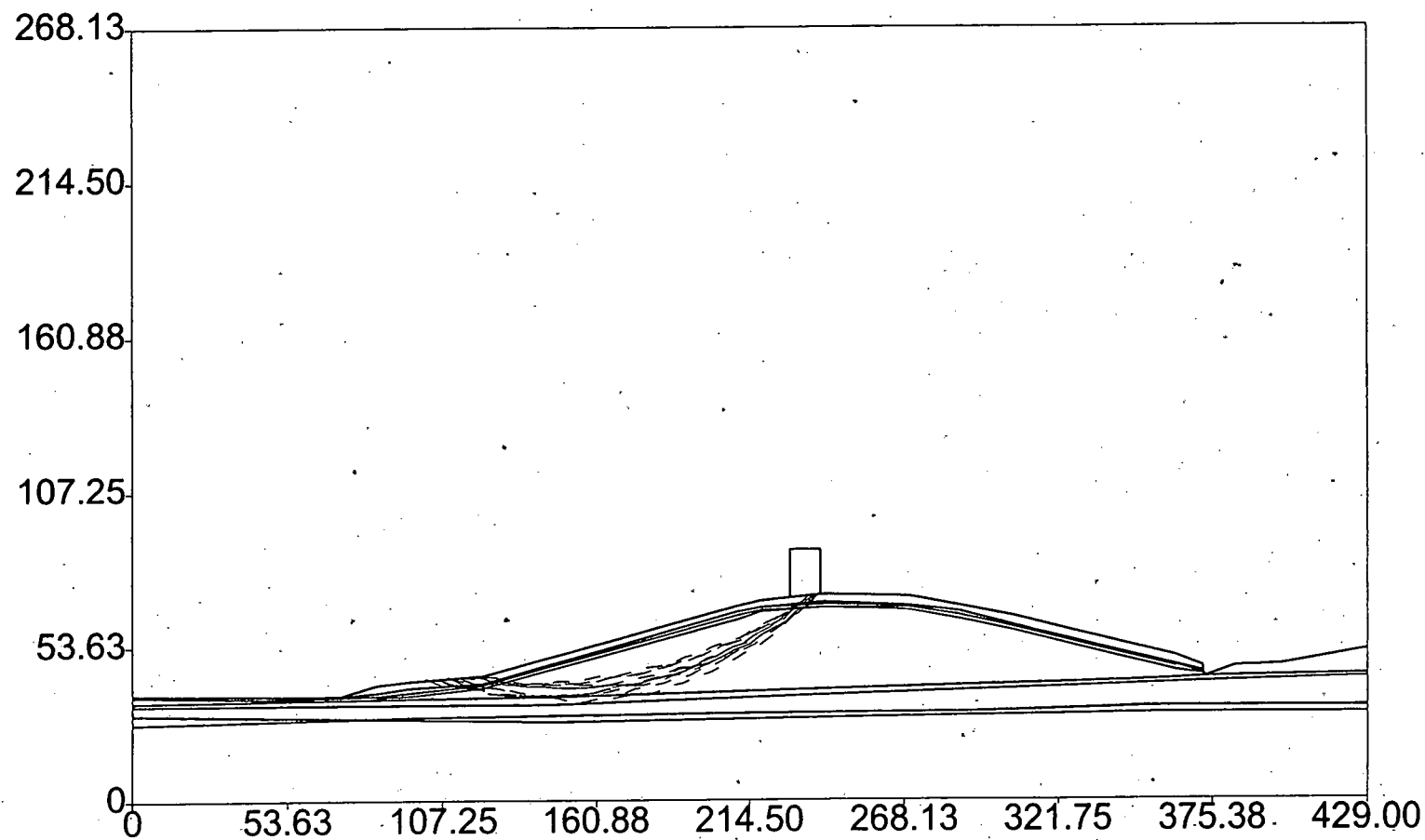
Checked By:

Barton
Giroud & Beech, P.C.
Consulting Engineers

FS(static) =	2.24	.....>	Tensile reinforcement req'd for (FS=1.25) =	0	lbs/ft
FS(seismic) =	2.24	.....>	Tensile reinforcement req'd for (FS=1.0) =	0	lbs/ft

Rosen Site – Case 3A – North to South

Safety Factors



2.01
2.03
2.05
2.06
2.09
2.13
2.13
2.14
2.14
2.18

** PCSTABL6 **

by
Purdue University

modified by
Peter J. Bosscher
University of Wisconsin-Madison

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

PROBLEM DESCRIPTION Rosen Site - Case 3 A North to South

BOUNDARY COORDINATES

14 Top Boundaries
75 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	37.50	48.00	36.50	9
2	48.00	36.50	72.00	37.20	9
3	72.00	37.20	84.00	40.50	8
4	84.00	40.50	96.00	41.60	8
5	96.00	41.60	121.00	43.80	8
6	121.00	43.80	210.00	68.00	8
7	210.00	68.00	219.00	69.80	8
8	219.00	69.80	240.00	71.40	8
9	240.00	71.40	270.00	70.80	8
10	270.00	70.80	288.00	68.00	8
11	288.00	68.00	306.00	63.60	8
12	306.00	63.60	363.00	49.90	8
13	363.00	49.90	372.00	46.00	8
14	372.00	46.00	372.00	43.50	8
15	72.00	36.20	84.00	38.00	7
16	84.00	38.00	96.00	39.10	7
17	96.00	39.10	121.00	41.30	7
18	121.00	41.30	210.00	65.50	7
19	210.00	65.50	219.00	67.30	7

20	219.00	67.30	240.00	68.90	7
21	240.00	68.90	270.00	68.30	7
22	270.00	68.30	288.00	65.50	7
23	288.00	65.50	306.00	61.10	7
24	306.00	61.10	363.00	47.40	7
25	363.00	47.40	369.00	45.10	7
26	369.00	45.10	372.00	44.40	7
27	72.00	36.10	84.00	37.90	6
28	84.00	37.90	96.00	39.00	6
29	96.00	39.00	121.00	41.20	6
30	121.00	41.20	210.00	65.40	6
31	210.00	65.40	219.00	67.20	6
32	219.00	67.20	240.00	68.80	6
33	240.00	68.80	270.00	68.20	6
34	270.00	68.20	288.00	65.40	6
35	288.00	65.40	306.00	61.00	6
36	306.00	61.00	363.00	47.30	6
37	363.00	47.30	369.00	45.00	6
38	369.00	45.00	372.00	44.30	5
39	0.00	36.50	48.00	35.50	10
40	48.00	35.50	72.00	36.10	10
41	72.00	36.10	84.00	36.90	10
42	84.00	36.90	96.00	38.00	5
43	96.00	38.00	121.00	40.20	5
44	121.00	40.20	210.00	64.40	5
45	210.00	64.40	219.00	66.20	5
46	219.00	66.20	240.00	67.80	5
47	240.00	67.80	270.00	67.20	5
48	270.00	67.20	288.00	64.40	5
49	288.00	64.40	306.00	60.00	5
50	306.00	60.00	363.00	46.30	5
51	84.00	35.90	96.00	37.00	4
52	96.00	37.00	121.00	39.20	4
53	121.00	39.20	210.00	63.40	4
54	210.00	63.40	219.00	65.20	4
55	219.00	65.20	240.00	66.80	4
56	240.00	66.80	270.00	66.20	4
57	270.00	66.20	288.00	63.40	4
58	288.00	63.40	306.00	59.00	4
59	306.00	59.00	363.00	45.30	4
60	363.00	45.30	372.00	43.50	4
61	372.00	43.50	374.00	42.50	4
62	374.00	42.50	378.00	44.30	11
63	378.00	44.30	384.00	46.10	11
64	384.00	46.10	399.00	47.00	11
65	399.00	47.00	429.00	52.20	11
66	0.00	35.00	144.00	36.00	3
67	144.00	36.00	356.00	42.00	3
68	356.00	42.00	374.00	42.50	3
69	374.00	42.50	429.00	44.20	3
70	0.00	33.00	144.00	34.00	2
71	144.00	34.00	356.00	40.00	2
72	356.00	40.00	429.00	42.10	2
73	0.00	30.00	144.00	28.00	1
74	144.00	28.00	356.00	30.00	1
75	356.00	30.00	429.00	30.80	1

ISOTROPIC SOIL PARAMETERS

11 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	120.0	0.0	30.0	0.00	0.0	1
2	120.0	120.0	0.0	30.0	0.00	0.0	1
3	110.0	110.0	0.0	30.0	0.00	0.0	0
4	65.0	65.0	200.0	20.0	0.00	0.0	0
5	110.0	110.0	0.0	30.0	0.00	0.0	0
6	110.0	110.0	0.0	30.0	0.00	0.0	0
7	0.1	0.1	0.0	28.0	0.00	0.0	0
8	140.0	140.0	0.0	30.0	0.00	0.0	2
9	140.0	140.0	0.0	30.0	0.00	0.0	0
10	110.0	110.0	0.0	25.0	0.00	0.0	0
11	110.0	110.0	0.0	25.0	0.00	0.0	0

2 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 7 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	0.00	27.50
2	24.00	28.00
3	100.00	29.00
4	192.00	30.00
5	292.00	31.00
6	356.00	32.00
7	429.00	32.40

Piezometric Surface No. 2 Specified by 12 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	72.00	36.22
2	84.00	38.02

3	96.00	39.12
4	121.00	41.32
5	210.00	65.52
6	219.00	67.32
7	240.00	68.92
8	270.00	68.32
9	288.00	65.52
10	306.00	61.12
11	363.00	47.42
12	372.00	44.42

BOUNDARY LOAD(S)

1 Load(s) Specified

Load No.	X-Left (ft)	X-Right (ft)	Intensity (lb/sqft)	Deflection (deg)
1	228.55	239.00	1183.0	0.0

NOTE - Intensity Is Specified As A Uniformly Distributed Force Acting On A Horizontally Projected Surface..

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

400 Trial Surfaces Have Been Generated.

20 Surfaces Initiate From Each Of 20 Points Equally Spaced Along The Ground Surface Between X = 48.00 ft.
and X = 121.00 ft.

Each Surface Terminates Between X = 210.00 ft.
and X = 239.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = 0.00 ft..

5.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 27 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	117.16	43.46
2	122.02	42.30
3	126.92	41.31
4	131.86	40.51
5	136.82	39.89
6	141.80	39.45
7	146.79	39.20
8	151.79	39.13
9	156.79	39.25
10	161.78	39.55
11	166.76	40.03
12	171.71	40.70
13	176.64	41.55
14	181.53	42.58
15	186.39	43.79
16	191.19	45.18
17	195.94	46.74
18	200.63	48.48
19	205.25	50.39
20	209.79	52.47
21	214.26	54.72
22	218.64	57.13
23	222.93	59.70
24	227.12	62.43
25	231.21	65.30
26	235.19	68.33
27	238.82	71.31

*** 2.009 ***

Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	109.47	42.79
2	114.29	41.45
3	119.15	40.28
4	124.06	39.30
5	128.99	38.50
6	133.95	37.88
7	138.94	37.45
8	143.93	37.20

9	148.93	37.13
10	153.93	37.25
11	158.92	37.55
12	163.89	38.03
13	168.85	38.70
14	173.78	39.55
15	178.67	40.58
16	183.52	41.78
17	188.33	43.17
18	193.08	44.73
19	197.76	46.47
20	202.39	48.38
21	206.93	50.46
22	211.40	52.70
23	215.79	55.10
24	220.08	57.67
25	224.27	60.39
26	228.36	63.27
27	232.34	66.29
28	236.21	69.46
29	238.26	71.27

*** 2.025 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	121.00	43.80
2	125.89	42.74
3	130.81	41.86
4	135.76	41.17
5	140.74	40.67
6	145.73	40.35
7	150.72	40.22
8	155.72	40.27
9	160.72	40.52
10	165.70	40.95
11	170.66	41.56
12	175.60	42.37
13	180.50	43.35
14	185.36	44.52
15	190.17	45.88
16	194.93	47.41
17	199.63	49.12
18	204.26	51.00
19	208.82	53.06
20	213.30	55.28
21	217.69	57.67
22	221.99	60.23
23	226.18	62.94
24	230.28	65.81

25	234.26	68.83
26	237.13	71.18

*** 2.054 ***

Failure Surface Specified By 30 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	105.63	42.45
2	110.42	41.00
3	115.25	39.72
4	120.13	38.63
5	125.05	37.72
6	129.99	36.98
7	134.96	36.43
8	139.95	36.07
9	144.95	35.89
10	149.95	35.89
11	154.94	36.07
12	159.93	36.44
13	164.90	37.00
14	169.84	37.73
15	174.76	38.65
16	179.64	39.75
17	184.47	41.03
18	189.25	42.48
19	193.98	44.11
20	198.64	45.91
21	203.24	47.89
22	207.76	50.03
23	212.19	52.34
24	216.54	54.80
25	220.80	57.43
26	224.95	60.21
27	229.00	63.14
28	232.94	66.22
29	236.76	69.45
30	238.82	71.31

*** 2.057 ***

Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	113.32	43.12

2	117.99	41.35
3	122.74	39.79
4	127.56	38.44
5	132.43	37.31
6	137.34	36.40
7	142.30	35.72
8	147.27	35.25
9	152.27	35.01
10	157.27	34.99
11	162.26	35.20
12	167.25	35.63
13	172.20	36.28
14	177.13	37.16
15	182.00	38.26
16	186.83	39.57
17	191.59	41.10
18	196.28	42.84
19	200.88	44.79
20	205.39	46.94
21	209.80	49.29
22	214.11	51.84
23	218.29	54.58
24	222.34	57.51
25	226.26	60.61
26	230.04	63.89
27	233.67	67.33
28	237.14	70.93
29	237.37	71.20

*** 2.090 ***

Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	109.47	42.79
2	114.42	42.06
3	119.39	41.48
4	124.37	41.03
5	129.36	40.72
6	134.35	40.55
7	139.35	40.52
8	144.35	40.63
9	149.35	40.87
10	154.33	41.26
11	159.30	41.78
12	164.26	42.45
13	169.20	43.25
14	174.11	44.18
15	178.99	45.26
16	183.84	46.46
17	188.66	47.81

18	193.44	49.28
19	198.17	50.89
20	202.86	52.63
21	207.50	54.50
22	212.08	56.50
23	216.61	58.62
24	221.07	60.87
25	225.47	63.24
26	229.81	65.74
27	234.07	68.35
28	238.26	71.08
29	238.56	71.29

*** 2.129 ***

Failure Surface Specified By 27 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	117.16	43.46
2	122.09	42.66
3	127.05	42.02
4	132.03	41.54
5	137.02	41.22
6	142.02	41.06
7	147.02	41.06
8	152.01	41.22
9	157.00	41.55
10	161.98	42.03
11	166.94	42.68
12	171.87	43.48
13	176.78	44.44
14	181.65	45.56
15	186.49	46.84
16	191.28	48.27
17	196.02	49.85
18	200.71	51.59
19	205.34	53.47
20	209.91	55.51
21	214.41	57.69
22	218.83	60.01
23	223.18	62.48
24	227.45	65.08
25	231.63	67.82
26	235.73	70.69
27	236.29	71.12

*** 2.129 ***

Failure Surface Specified By 30 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	101.79	42.11
2	106.64	40.89
3	111.53	39.84
4	116.45	38.94
5	121.39	38.21
6	126.36	37.65
7	131.34	37.25
8	136.34	37.02
9	141.34	36.95
10	146.34	37.05
11	151.33	37.31
12	156.31	37.74
13	161.28	38.34
14	166.22	39.10
15	171.13	40.02
16	176.01	41.11
17	180.85	42.36
18	185.65	43.76
19	190.40	45.33
20	195.09	47.06
21	199.73	48.93
22	204.30	50.97
23	208.79	53.15
24	213.22	55.48
25	217.56	57.96
26	221.82	60.57
27	225.99	63.33
28	230.07	66.23
29	234.04	69.26
30	236.32	71.12

*** 2.137 ***

Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	105.63	42.45
2	110.46	41.14
3	115.33	40.01
4	120.24	39.06
5	125.18	38.28
6	130.14	37.69
7	135.12	37.27
8	140.12	37.04
9	145.12	36.98

10	150.12	37.11
11	155.11	37.42
12	160.08	37.91
13	165.04	38.58
14	169.96	39.43
15	174.86	40.46
16	179.71	41.67
17	184.52	43.05
18	189.27	44.60
19	193.96	46.32
20	198.59	48.22
21	203.15	50.28
22	207.62	52.50
23	212.02	54.88
24	216.33	57.43
25	220.54	60.12
26	224.65	62.97
27	228.65	65.96
28	232.54	69.10
29	234.73	71.00

*** 2.140 ***

Failure Surface Specified By 27 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	113.32	43.12
2	118.28	42.51
3	123.25	42.03
4	128.24	41.69
5	133.24	41.49
6	138.24	41.43
7	143.24	41.51
8	148.23	41.73
9	153.22	42.09
10	158.20	42.59
11	163.15	43.23
12	168.09	44.01
13	173.01	44.92
14	177.90	45.97
15	182.75	47.16
16	187.57	48.49
17	192.36	49.95
18	197.10	51.54
19	201.79	53.27
20	206.43	55.12
21	211.02	57.11
22	215.55	59.22
23	220.02	61.46
24	224.43	63.82
25	228.77	66.30

26	233.04	68.91
27	236.45	71.13

*** 2.175 ***

Y	A	X	I	S	F	T
0.00	53.63	107.25	160.88	214.50	268.13	

X	0.00	+---W**+-----+-----+-----+-----+
		-
		- W
		- *
	53.63	+ ..
		-
		-*
		-**
		-
		-W.**
A	107.25	+.....82
		-41
		-**
		-11
		-***3.
		-13.
X	160.88	+.....13.
		-11..
		-410.
		- ...W513..
		-217..
		-11.**
I	214.50	+11..
		- ...1**
		- ..11/1
		- **1/
		-
S	268.13	+
		-
		- W
		- **
	321.75	+
		-
		- ***
		- **

F 375.38 + **

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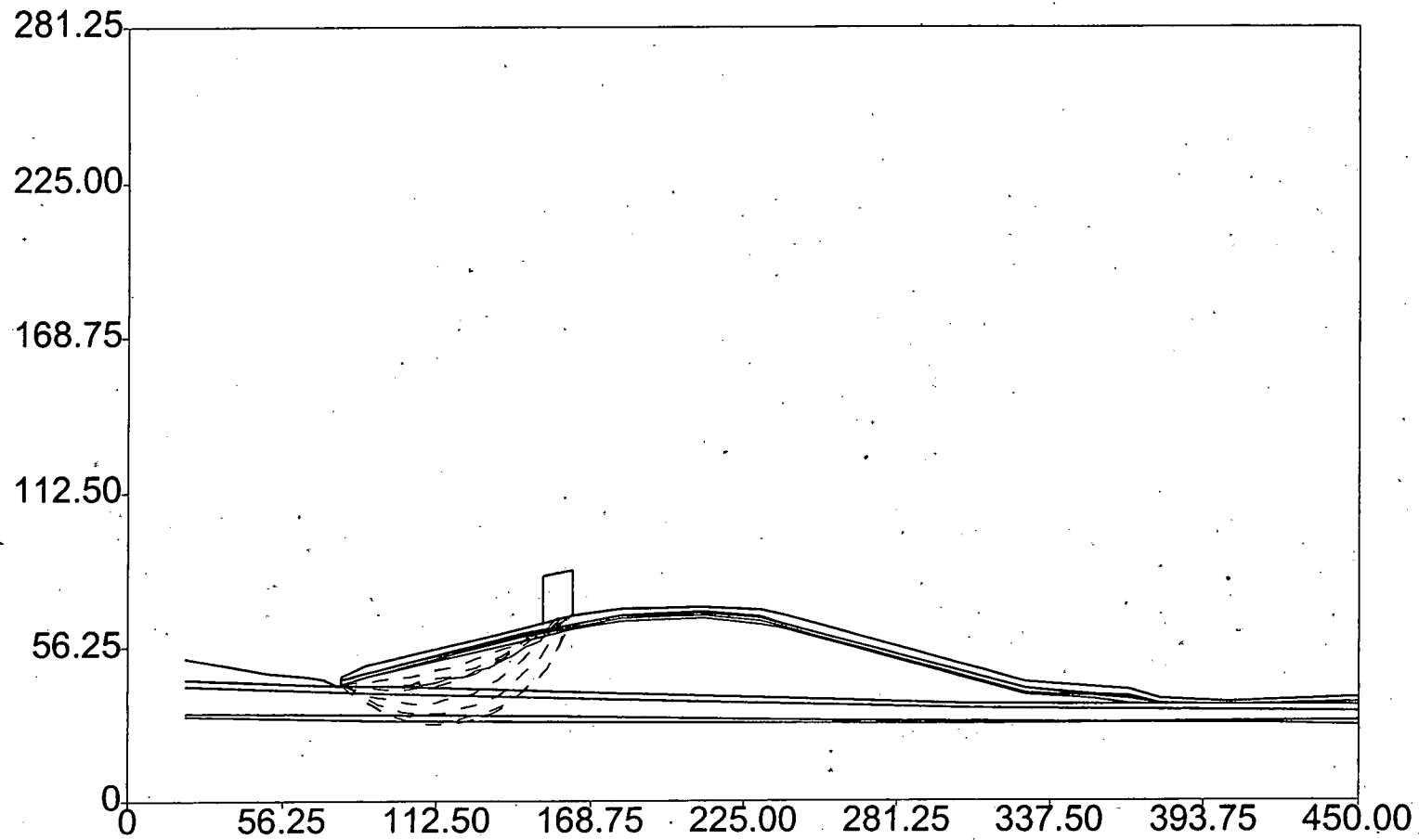
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T 429.00 + * * *

Rosen Site – Case 3B – South to North

Safety Factors



1.91
2.02
2.08
2.09
2.11
2.42
2.46
2.47
2.47
2.53

** PCSTABL6 **

by
Purdue University

modified by
Peter J. Bosscher
University of Wisconsin-Madison

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

PROBLEM DESCRIPTION Rosen Site - Case 3 B South to North

BOUNDARY COORDINATES

19 Top Boundaries
75 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	21.00	52.20	51.00	47.00	11
2	51.00	47.00	66.00	46.10	11
3	66.00	46.10	72.00	44.30	11
4	72.00	44.30	76.00	42.50	11
5	76.00	42.50	78.00	43.50	4
6	78.00	43.50	78.00	46.00	8
7	78.00	46.00	87.00	49.90	8
8	87.00	49.90	144.00	63.60	8
9	144.00	63.60	162.00	68.00	8
10	162.00	68.00	180.00	70.80	8
11	180.00	70.80	210.00	71.40	8
12	210.00	71.40	231.00	69.80	8
13	231.00	69.80	240.00	68.00	8
14	240.00	68.00	329.00	43.80	8
15	329.00	43.80	354.00	41.60	8
16	354.00	41.60	366.00	40.50	8
17	366.00	40.50	378.00	37.20	8
18	378.00	37.20	402.00	36.50	9
19	402.00	36.50	450.00	37.50	9

20	78.00	44.40	81.00	45.10	7
21	81.00	45.10	87.00	47.40	7
22	87.00	47.40	144.00	61.10	7
23	144.00	61.10	162.00	65.50	7
24	162.00	65.50	180.00	68.30	7
25	180.00	68.30	210.00	68.90	7
26	210.00	68.90	231.00	67.30	7
27	231.00	67.30	240.00	65.50	7
28	240.00	65.50	329.00	41.30	7
29	329.00	41.30	354.00	39.10	7
30	354.00	39.10	366.00	38.00	7
31	366.00	38.00	378.00	36.20	7
32	78.00	44.30	81.00	45.00	6
33	81.00	45.00	87.00	47.30	6
34	87.00	47.30	144.00	61.00	6
35	144.00	61.00	162.00	65.40	6
36	162.00	65.40	180.00	68.20	6
37	180.00	68.20	210.00	68.20	6
38	210.00	68.80	231.00	67.20	6
39	231.00	67.20	240.00	65.40	6
40	240.00	65.40	329.00	41.20	6
41	329.00	41.20	354.00	39.00	6
42	354.00	39.00	366.00	37.90	6
43	366.00	37.90	378.00	36.10	6
44	87.00	46.30	144.00	60.00	5
45	144.00	60.00	162.00	64.40	5
46	162.00	64.40	180.00	67.20	5
47	180.00	67.20	210.00	67.80	5
48	210.00	67.80	231.00	66.20	5
49	231.00	66.20	240.00	64.40	5
50	240.00	64.40	329.00	40.20	5
51	329.00	40.20	354.00	38.00	5
52	354.00	38.00	366.00	36.90	5
53	366.00	36.90	378.00	36.10	10
54	378.00	36.10	402.00	35.50	10
55	402.00	35.50	450.00	36.50	10
56	78.00	43.50	87.00	45.30	4
57	87.00	45.30	144.00	59.00	4
58	144.00	59.00	162.00	63.40	4
59	162.00	63.40	180.00	66.20	4
60	180.00	66.20	210.00	66.80	4
61	210.00	66.80	231.00	65.20	4
62	231.00	65.20	240.00	63.40	4
63	240.00	63.40	329.00	39.20	4
64	329.00	39.20	354.00	37.00	4
65	354.00	37.00	366.00	35.90	4
66	21.00	44.20	76.00	42.50	3
67	76.00	42.50	94.00	42.00	3
68	94.00	42.00	306.00	36.00	3
69	306.00	36.00	450.00	35.00	3
70	21.00	42.10	94.00	40.00	2
71	94.00	40.00	306.00	34.00	2
72	306.00	34.00	450.00	33.00	2
73	21.00	30.80	94.00	30.00	1
74	94.00	30.00	306.00	28.00	1
75	306.00	28.00	450.00	30.00	1

ISOTROPIC SOIL PARAMETERS

11 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	120.0	0.0	30.0	0.00	0.0	1
2	120.0	120.0	0.0	30.0	0.00	0.0	1
3	110.0	110.0	0.0	30.0	0.00	0.0	0
4	65.0	65.0	200.0	20.0	0.00	0.0	0
5	110.0	110.0	0.0	30.0	0.00	0.0	0
6	110.0	110.0	0.0	30.0	0.00	0.0	0
7	0.1	0.1	0.0	28.0	0.00	0.0	0
8	140.0	140.0	0.0	30.0	0.00	0.0	2
9	140.0	140.0	0.0	30.0	0.00	0.0	0
10	110.0	110.0	0.0	25.0	0.00	0.0	0
11	110.0	110.0	0.0	25.0	0.00	0.0	0

2 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 6 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	21.00	32.40
2	158.00	31.00
3	258.00	30.00
4	350.00	29.00
5	426.00	28.00
6	450.00	27.50

Piezometric Surface No. 2 Specified by 12 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	78.00	44.42
2	87.00	47.42
3	144.00	61.12

4	162.00	65.52
5	180.00	68.32
6	210.00	68.92
7	231.00	67.32
8	240.00	65.52
9	329.00	41.32
10	354.00	39.12
11	366.00	38.02
12	378.00	36.22

BOUNDARY LOAD(S)

1 Load(s) Specified

Load No.	X-Left (ft)	X-Right (ft)	Intensity (lb/sqft)	Deflection (deg)
1	151.55	162.00	1183.0	0.0

NOTE - Intensity Is Specified As A Uniformly Distributed Force Acting On A Horizontally Projected Surface.

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

400 Trial Surfaces Have Been Generated.

20 Surfaces Initiate From Each Of 20 Points Equally Spaced Along The Ground Surface Between X = 66.00 ft.
and X = 78.00 ft.

Each Surface Terminates Between X = 144.00 ft.
and X = 162.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = 0.00 ft.

5.00 ft. Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	78.00	43.50
2	82.95	42.81
3	87.93	42.37
4	92.93	42.17
5	97.93	42.23
6	102.92	42.54
7	107.89	43.10
8	112.82	43.91
9	117.71	44.97
10	122.54	46.27
11	127.29	47.81
12	131.97	49.58
13	136.55	51.59
14	141.02	53.83
15	145.37	56.29
16	149.60	58.96
17	153.68	61.84
18	157.62	64.93
19	160.83	67.71

*** 1.912 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	78.00	43.50
2	82.98	43.04
3	87.97	42.81
4	92.97	42.81
5	97.97	43.05
6	102.95	43.52
7	107.90	44.22
8	112.81	45.14
9	117.68	46.30
10	122.48	47.68
11	127.22	49.28
12	131.87	51.10
13	136.44	53.13
14	140.91	55.38
15	145.27	57.83

16	149.51	60.48
17	153.62	63.32
18	157.60	66.35
19	158.55	67.16

*** 2.023 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	78.00	43.50
2	83.00	43.73
3	87.98	44.11
4	92.95	44.63
5	97.91	45.29
6	102.84	46.10
7	107.75	47.04
8	112.63	48.13
9	117.48	49.36
10	122.29	50.73
11	127.06	52.23
12	131.78	53.88
13	136.45	55.65
14	141.07	57.56
15	145.64	59.61
16	150.14	61.78
17	154.58	64.08
18	158.95	66.51
19	161.07	67.77

*** 2.082 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	78.00	43.50
2	82.97	42.98
3	87.97	42.71
4	92.97	42.68
5	97.96	42.90
6	102.94	43.37
7	107.89	44.07
8	112.80	45.02
9	117.66	46.21
10	122.45	47.64

11	127.16	49.30
12	131.79	51.18
13	136.33	53.30
14	140.75	55.63
15	145.05	58.18
16	149.22	60.93
17	153.26	63.89
18	156.74	66.71

*** 2.085 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	78.00	43.50
2	83.00	43.66
3	87.99	43.98
4	92.97	44.45
5	97.93	45.08
6	102.86	45.86
7	107.78	46.80
8	112.65	47.89
9	117.50	49.13
10	122.30	50.53
11	127.06	52.07
12	131.76	53.76
13	136.41	55.60
14	141.00	57.58
15	145.53	59.71
16	149.98	61.98
17	154.37	64.38
18	158.67	66.92
19	159.35	67.35

*** 2.109 ***

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	78.00	43.50
2	81.77	40.22
3	85.85	37.33
4	90.20	34.86
5	94.77	32.83
6	99.52	31.26

7	104.40	30.18
8	109.36	29.59
9	114.36	29.49
10	119.35	29.89
11	124.27	30.78
12	129.07	32.16
13	133.72	34.00
14	138.16	36.30
15	142.35	39.03
16	146.25	42.17
17	149.81	45.67
18	153.01	49.51
19	155.82	53.65
20	158.20	58.05
21	160.13	62.66
22	161.59	67.44
23	161.69	67.92

*** 2.419 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	78.00	43.50
2	82.85	42.30
3	87.78	41.44
4	92.75	40.93
5	97.75	40.78
6	102.75	40.97
7	107.72	41.52
8	112.64	42.41
9	117.48	43.65
10	122.23	45.23
11	126.85	47.13
12	131.33	49.36
13	135.64	51.89
14	139.76	54.73
15	143.67	57.84
16	147.35	61.22
17	150.79	64.86
18	151.20	65.36

*** 2.460 ***

Failure Surface Specified By 21 Coordinate Points

Point	X-Surf	Y-Surf
-------	--------	--------

No.	(ft)	(ft)
1	78.00	43.50
2	82.07	40.60
3	86.41	38.11
4	90.97	36.05
5	95.70	34.46
6	100.58	33.34
7	105.54	32.70
8	110.53	32.55
9	115.52	32.89
10	120.45	33.72
11	125.28	35.03
12	129.95	36.81
13	134.43	39.04
14	138.66	41.70
15	142.62	44.76
16	146.25	48.19
17	149.53	51.97
18	152.42	56.05
19	154.90	60.39
20	156.94	64.95
21	157.60	66.92

*** 2.468 ***

Failure Surface Specified By 19 Coordinate Points

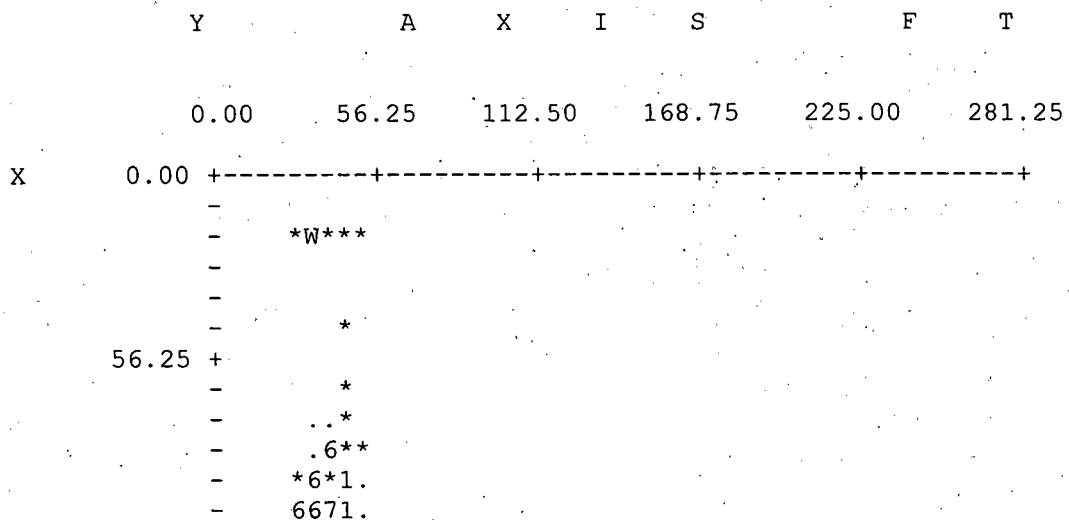
Point No.	X-Surf (ft)	Y-Surf (ft)
1	78.00	43.50
2	82.45	41.21
3	87.08	39.33
4	91.86	37.88
5	96.76	36.86
6	101.72	36.29
7	106.72	36.17
8	111.71	36.50
9	116.65	37.28
10	121.50	38.50
11	126.22	40.16
12	130.77	42.23
13	135.11	44.71
14	139.21	47.57
15	143.04	50.79
16	146.56	54.34
17	149.75	58.19
18	152.57	62.31
19	154.77	66.23

*** 2.475 ***

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	78.00	43.50
2	81.63	40.06
3	85.59	37.01
4	89.84	34.38
5	94.35	32.21
6	99.05	30.51
7	103.90	29.31
8	108.86	28.62
9	113.85	28.44
10	118.84	28.77
11	123.77	29.62
12	128.58	30.97
13	133.23	32.81
14	137.67	35.12
15	141.84	37.88
16	145.70	41.05
17	149.22	44.61
18	152.35	48.50
19	155.07	52.70
20	157.33	57.16
21	159.13	61.83
22	160.43	66.65
23	160.59	67.66

*** 2.530 ***



A	112.50	+	68913.
		-	68913.
		-	.68113.
		-	6681**
		-	666117/1
		-	W 06**1/
X	168.75	+	
		-	**
		-	
		-	**
I	225.00	+	
		-	*
		-	**
		-	
		-	W
S	281.25	+	
		-	**
		-	
		-	**
	337.50	+	
		-	W
		-	*
		-	**
		-	**
F	393.75	+	
		-	*
		-	
		-	W
T	450.00	+	***

APPENDIX A.1.G

CONSTRUCTION LOADING CALCULATION

Construction Loading Calculation:

Assumptions: From the Caterpillar Performance Handbook, Edition 20, a D7HLGP bulldozer exerts a ground pressure of 6.32 psi (910 psf) over two 36" x 10' 5.4" tracks. (9029 in² of contact)

The operating weight of machine is 57, 067 lbs.

Dynamic Braking Loading = $(0.3)(910\text{psf}) = 273\text{psf}$

Total Loading = $273\text{psf} + 910\text{psf} = 1183\text{psf}$

Therefore, this loading will be modeled as a **1183 psf force acting over a 10.45ft contact line.**

APPENDIX A.2

STORMWATER CALCULATIONS

APPENDIX A.2.A

H.E.L.P. MODEL OUTPUTS

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4710	VOL/VOL
FIELD CAPACITY	=	0.3420	VOL/VOL
WILTING POINT	=	0.2100	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4076	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.999999975000E-05	CM/SEC

LAYER 3

TYPE 2 - LATERAL DRAINAGE LAYER

MATERIAL TEXTURE NUMBER 0

THICKNESS	=	0.23	INCHES
POROSITY	=	0.8500	VOL/VOL
FIELD CAPACITY	=	0.0100	VOL/VOL
WILTING POINT	=	0.0050	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0185	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	10.0000000000	CM/SEC
SLOPE	=	25.00	PERCENT
DRAINAGE LENGTH	=	126.0	FEET

LAYER 4

TYPE 4 - FLEXIBLE MEMBRANE LINER

MATERIAL TEXTURE NUMBER 36

THICKNESS	=	0.02	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.	=	0.399999993000E-12	CM/SEC
FML PINHOLE DENSITY	=	1.00	HOLES/ACRE
FML INSTALLATION DEFECTS	=	1.00	HOLES/ACRE
FML PLACEMENT QUALITY	=	3	GOOD

LAYER 5

TYPE 1 - VERTICAL PERCOLATION LAYER

MATERIAL TEXTURE NUMBER 0

THICKNESS	=	12.00	INCHES
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.0620	VOL/VOL
WILTING POINT	=	0.0240	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0620	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.100000005000E-02	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE # 5 WITH A
FAIR STAND OF GRASS, A SURFACE SLOPE OF 25. %
AND A SLOPE LENGTH OF 126. FEET.

SCS RUNOFF CURVE NUMBER	=	68.80	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	1.000	ACRES
EVAPORATIVE ZONE DEPTH	=	20.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	8.609	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	9.336	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	3.288	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	12.865	INCHES
TOTAL INITIAL WATER	=	12.865	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
ITHACA NEW YORK

STATION LATITUDE	=	42.40	DEGREES
MAXIMUM LEAF AREA INDEX	=	2.00	
START OF GROWING SEASON (JULIAN DATE)	=	130	
END OF GROWING SEASON (JULIAN DATE)	=	279	
EVAPORATIVE ZONE DEPTH	=	20.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	10.30	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	74.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	69.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	75.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	76.00	%

NOTE: PRECIPITATION DATA FOR ITHACA NEW YORK
WAS ENTERED FROM THE DEFAULT DATA FILE.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ITHACA NEW YORK

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
22.20	22.70	32.20	44.50	54.80	64.30
68.80	67.10	60.20	49.60	39.30	27.60

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ITHACA NEW YORK
AND STATION LATITUDE = 42.40 DEGREES

MONTHLY TOTALS (IN INCHES) FOR YEAR 1974

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.84 1.24	2.39 3.21	3.14 4.98	2.54 2.08	3.88 3.72	4.92 3.08
RUNOFF	1.015 0.000	0.516 0.000	3.997 0.033	1.504 0.000	0.000 0.000	0.000 0.202
EVAPOTRANSPIRATION	0.435 4.502	0.482 1.422	0.361 3.374	1.740 1.853	3.599 1.252	3.536 0.311
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.2498 0.6641	0.0989 0.2587	0.0233 0.1046	1.4243 0.2243	0.6135 0.8389	0.2536 2.1304
PERCOLATION/LEAKAGE THROUGH LAYER 4	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	0.0001 0.0001	0.0001 0.0001	0.0000 0.0001	0.0000 0.0001	0.0001 0.0001	0.0001 0.0001

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON	0.001	0.000	0.000	0.004	0.001	0.001
TOP OF LAYER 4	0.002	0.001	0.000	0.001	0.002	0.005

STD. DEVIATION OF DAILY	0.000	0.000	0.000	0.005	0.001	0.001
HEAD ON TOP OF LAYER 4	0.001	0.000	0.000	0.001	0.002	0.003

ANNUAL TOTALS FOR YEAR 1974

	INCHES	CU. FEET	PERCENT
PRECIPITATION	37.02	134382.578	100.00
RUNOFF	7.268	26381.221	19.63
EVAPOTRANSPIRATION	22.868	83009.711	61.77
DRAINAGE COLLECTED FROM LAYER 3	6.8844	24990.439	18.60
PERC./LEAKAGE THROUGH LAYER 4	0.000102	0.369	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0014		
PERC./LEAKAGE THROUGH LAYER 5	0.000828	3.005	0.00
CHANGE IN WATER STORAGE	0.000	-1.786	0.00
SOIL WATER AT START OF YEAR	13.891	50424.352	
SOIL WATER AT END OF YEAR	13.891	50422.566	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.016	0.00

MONTHLY TOTALS (IN INCHES) FOR YEAR 1975

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.44	3.06	2.25	1.24	3.88	4.95
	3.64	4.36	7.75	3.24	1.95	3.22

RUNOFF	0.000	0.079	4.837	0.745	0.000	0.000
	0.000	0.000	2.074	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.507	0.468	0.305	1.372	3.074	4.737
	4.979	3.395	3.436	1.799	0.998	0.448
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.2498	0.0989	0.0233	1.4216	0.6023	0.5666
	0.4174	0.1615	0.0858	1.6688	0.8525	0.6380
PERCOLATION/LEAKAGE THROUGH LAYER 4	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	0.0001	0.0001	0.0000	0.0000	0.0001	0.0001
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 4	0.001	0.000	0.000	0.004	0.001	0.001
	0.001	0.000	0.000	0.004	0.002	0.002
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.004	0.001	0.001
	0.000	0.000	0.000	0.003	0.001	0.001

ANNUAL TOTALS FOR YEAR 1975

	INCHES	CU. FEET	PERCENT
	-----	-----	-----
PRECIPITATION	40.98	148757.406	100.00
RUNOFF	7.736	28081.338	18.88
EVAPOTRANSPIRATION	25.518	92628.719	62.27
DRAINAGE COLLECTED FROM LAYER 3	6.7865	24635.115	16.56
PERC./LEAKAGE THROUGH LAYER 4	0.000103	0.374	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0014		
PERC./LEAKAGE THROUGH LAYER 5	0.000844	3.063	0.00
CHANGE IN WATER STORAGE	0.939	3409.144	2.29
SOIL WATER AT START OF YEAR	13.891	50422.566	
SOIL WATER AT END OF YEAR	12.507	45399.820	

SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	2.323	8431.890	5.67
ANNUAL WATER BUDGET BALANCE	0.0000	0.033	0.00

MONTHLY TOTALS (IN INCHES) FOR YEAR 1976

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	3.00 8.44	2.27 3.66	2.81 3.37	3.80 5.91	3.32 1.63	4.47 1.77
RUNOFF	0.000 1.842	0.024 0.000	1.201 0.000	7.031 0.639	0.000 0.000	0.000 0.003
EVAPOTRANSPIRATION	0.466 6.306	0.531 3.669	0.630 2.645	1.522 1.793	3.599 1.043	4.015 0.464
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.2144 1.8468	0.0950 0.5465	0.0106 0.1641	1.0779 0.3043	1.6302 1.7771	0.3392 0.4151
PERCOLATION/LEAKAGE THROUGH LAYER 4	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	0.0001 0.0001	0.0001 0.0001	0.0000 0.0001	0.0000 0.0001	0.0001 0.0001	0.0001 0.0001

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 4	0.001 0.004	0.000 0.001	0.000 0.000	0.003 0.001	0.004 0.004	0.001 0.001
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 4	0.000 0.005	0.000 0.000	0.000 0.000	0.006 0.002	0.004 0.003	0.000 0.000

ANNUAL TOTALS FOR YEAR 1976

	INCHES	CU. FEET	PERCENT
PRECIPITATION	44.45	161353.516	100.00
RUNOFF	10.739	38983.719	24.16
EVAPOTRANSPIRATION	26.683	96857.781	60.03
DRAINAGE COLLECTED FROM LAYER 3	8.4213	30569.236	18.95
PERC./LEAKAGE THROUGH LAYER 4	0.000115	0.417	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0017		
PERC./LEAKAGE THROUGH LAYER 5	0.000771	2.798	0.00
CHANGE IN WATER STORAGE	-1.394	-5060.088	-3.14
SOIL WATER AT START OF YEAR	12.507	45399.820	
SOIL WATER AT END OF YEAR	11.781	42765.535	
SNOW WATER AT START OF YEAR	2.323	8431.890	5.23
SNOW WATER AT END OF YEAR	1.655	6006.088	3.72
ANNUAL WATER BUDGET BALANCE	0.0000	0.071	0.00

MONTHLY TOTALS (IN INCHES) FOR YEAR 1977

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.36 5.20	1.82 4.67	3.29 9.13	2.32 5.89	2.17 3.55	3.03 3.87
RUNOFF	0.185 0.000	1.530 0.000	3.266 1.400	1.945 1.093	0.000 0.007	0.000 1.644
EVAPOTRANSPIRATION	0.402 5.915	0.503 4.370	0.390 3.273	0.668 1.751	2.244 1.113	3.264 0.447
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.1377 0.1792	0.0503 0.0897	0.0000 1.3383	0.0022 4.0999	1.2874 2.2072	0.3946 0.6481

PERCOLATION/LEAKAGE THROUGH LAYER 4	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	0.0001	0.0001	0.0000	0.0000	0.0001	0.0001
	0.0001	0.0001	0.0000	0.0000	0.0001	0.0001

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.003	0.001
	0.000	0.000	0.003	0.010	0.005	0.002
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 4	0.000	0.000	0.000	0.000	0.002	0.000
	0.000	0.000	0.007	0.007	0.004	0.001

ANNUAL TOTALS FOR YEAR 1977

	INCHES	CU. FEET	PERCENT
PRECIPITATION	46.30	168069.031	100.00
RUNOFF	11.070	40182.922	23.91
EVAPOTRANSPIRATION	24.340	88353.031	52.57
DRAINAGE COLLECTED FROM LAYER 3	10.4345	37877.117	22.54
PERC./LEAKAGE THROUGH LAYER 4	0.000129	0.467	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0021		
PERC./LEAKAGE THROUGH LAYER 5	0.000663	2.406	0.00
CHANGE IN WATER STORAGE	0.456	1653.499	0.98
SOIL WATER AT START OF YEAR	11.781	42765.535	
SOIL WATER AT END OF YEAR	13.626	49460.980	
SNOW WATER AT START OF YEAR	1.655	6006.088	3.57
SNOW WATER AT END OF YEAR	0.266	964.143	0.57
ANNUAL WATER BUDGET BALANCE	0.0000	0.051	0.00

MONTHLY TOTALS (IN INCHES) FOR YEAR 1978

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	6.37 2.33	0.91 4.25	1.77 1.94	1.96 3.62	1.91 0.95	2.64 3.39
RUNOFF	2.092 0.000	0.649 0.000	4.791 0.000	1.399 0.000	0.000 0.000	0.000 0.000
EVAPOTRANSPIRATION	0.366 4.328	0.394 2.600	0.371 2.330	0.507 1.740	2.483 1.095	3.089 0.637
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.1731 0.1671	0.0801 0.0995	0.0000 0.0053	0.0000 0.0007	1.8763 0.0012	0.3660 0.0932
PERCOLATION/LEAKAGE THROUGH LAYER 4	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	0.0001 0.0001	0.0001 0.0001	0.0000 0.0000	0.0000 0.0000	0.0001 0.0000	0.0001 0.0001

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 4	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.005 0.000	0.001 0.000
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 4	0.000 0.000	0.000 0.000	0.000 0.000	0.000 0.000	0.006 0.000	0.000 0.000

ANNUAL TOTALS FOR YEAR 1978

	INCHES	CU. FEET	PERCENT
PRECIPITATION	32.04	116305.187	100.00
RUNOFF	8.931	32419.838	27.87
EVAPOTRANSPIRATION	19.940	72383.492	62.24

DRAINAGE COLLECTED FROM LAYER 3	2.8626	10391.338	8.93
PERC./LEAKAGE THROUGH LAYER 4	0.000044	0.160	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0006		
PERC./LEAKAGE THROUGH LAYER 5	0.000553	2.007	0.00
CHANGE IN WATER STORAGE	0.305	1108.515	0.95
SOIL WATER AT START OF YEAR	13.626	49460.980	
SOIL WATER AT END OF YEAR	12.291	44614.855	
SNOW WATER AT START OF YEAR	0.266	964.143	0.83
SNOW WATER AT END OF YEAR	1.906	6918.781	5.95
ANNUAL WATER BUDGET BALANCE	0.0000	0.003	0.00

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1974 THROUGH 1978

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

PRECIPITATION						

TOTALS	2.80	2.09	2.65	2.37	3.03	4.00
	4.17	4.03	5.43	4.15	2.36	3.07
STD. DEVIATIONS	2.10	0.80	0.63	0.94	0.94	1.09
	2.81	0.59	2.99	1.70	1.22	0.78
RUNOFF						

TOTALS	0.658	0.560	3.619	2.525	0.000	0.000
	0.368	0.000	0.701	0.346	0.001	0.370
STD. DEVIATIONS	0.905	0.606	1.498	2.555	0.000	0.000
	0.824	0.000	0.975	0.501	0.003	0.717
EVAPOTRANSPIRATION						

TOTALS	0.435	0.476	0.411	1.162	3.000	3.728
	5.206	3.091	3.012	1.787	1.100	0.461
STD. DEVIATIONS	0.055	0.051	0.126	0.543	0.625	0.664

0.871 1.128 0.495 0.045 0.096 0.116

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	0.2050	0.0847	0.0114	0.7852	1.2020	0.3840
	0.6549	0.2312	0.3396	1.2596	1.1354	0.7850
STD. DEVIATIONS	0.0491	0.0207	0.0117	0.7295	0.5812	0.1149
	0.6967	0.1887	0.5612	1.7178	0.8682	0.7851

PERCOLATION/LEAKAGE THROUGH LAYER 4

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	0.0001	0.0001	0.0000	0.0000	0.0001	0.0001
	0.0001	0.0001	0.0001	0.0000	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 4

AVERAGES	0.0005	0.0002	0.0000	0.0019	0.0029	0.0010
	0.0016	0.0006	0.0008	0.0030	0.0028	0.0019
STD. DEVIATIONS	0.0001	0.0001	0.0000	0.0018	0.0014	0.0003
	0.0016	0.0005	0.0014	0.0042	0.0021	0.0019

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1974 THROUGH 1978

	INCHES		CU. FEET	PERCENT
PRECIPITATION	40.16	(5.757)	145773.5	100.00
RUNOFF	9.149	(1.7177)	33209.80	22.782
EVAPOTRANSPIRATION	23.870	(2.6121)	86646.55	59.439
LATERAL DRAINAGE COLLECTED	7.07786	(2.78218)	25692.648	17.62504

FROM LAYER 3

PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00010 (0.00003)	0.357	0.00025
AVERAGE HEAD ON TOP OF LAYER 4	0.001 (0.001)		
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00073 (0.00012)	2.656	0.00182
CHANGE IN WATER STORAGE	0.061 (0.8814)	221.86	0.152

PEAK DAILY VALUES FOR YEARS 1974 THROUGH 1978

	(INCHES)	(CU. FT.)
PRECIPITATION	3.13	11361.900
RUNOFF	2.169	7873.1909
DRAINAGE COLLECTED FROM LAYER 3	0.33297	1208.66882
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000003	0.01056
AVERAGE HEAD ON TOP OF LAYER 4	0.025	
MAXIMUM HEAD ON TOP OF LAYER 4	0.006	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000003	0.01072
SNOW WATER	7.10	25775.8906
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.4608
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.1668

*** 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 1978

LAYER	(INCHES)	(VOL/VOL)
1	1.6820	0.2803
2	9.1220	0.3801
3	0.0023	0.0100
4	0.0000	0.0000
5	0.7403	0.0617
SNOW WATER	1.906	

APPENDIX A.2.B

DRAINAGE COMPOSITE CALCULATION

CALCULATION OF THE REQUIRED TRANSMISSIVITY FOR DRAINAGE GEOCOMPOSITE

Reference: Technical Paper "Design of Lateral Drainage Systems for Landfills", Richardson & Zhao, 1999

Design Parameters:	Slope Angle:	$\beta = 14.03^\circ$	
	Slope Length:	$L = 126 \text{ ft} = 38 \text{ m}$	
	Permeability of Cover Soil:	$K_{veg} = 1.0E-05 \text{ cm/s} = 1.0E-07 \text{ m/s}$	
	Standard Engineering Factor of Safety:	$FS = 2.0$	
	Transmissivity Reduction Factors:		
		RF intrusion =	1.5
		RF creep =	1.5
		RF biological clogging =	1.5
		RF chemical clogging =	1.5
	TOTAL FACTOR OF SAFETY:		8.0

Assumptions: 1. Assume that the final cover system is saturated and therefore the infiltration rate through the cover soil into the geocomposite grainage layer is equal to the permeability (K) of the cover soil. Worst case condition and is much more conservative than the HELP Model predicted infiltration rate.

Calculation:	$FS = Q_{out} / Q_{in}$	$Q_{in} = K_{veg} * L * \cos\beta$	Where: i = hydraulic gradient
		$Q_{out} = K_{geocomp} * A * i = K_{geocomp} * (1*t) * i$	t = thickness
			K = permeability
	$FS = (K_{geocomp} * t * i) / (K_{veg} * L * \cos\beta)$		A = area
	$FS = (\Psi * i) / (K_{veg} * L * \cos\beta)$		L = drainage length
	$\Psi = \frac{FS * K_{veg} * L * \cos\beta}{i}$		
	$\Psi = 1.23E-04 \text{ m}^3/\text{sec-m}$		

APPENDIX A.2.C

SURFACE WATER SWALE DESIGN

SURFACE WATER DRAINAGE CALCULATIONS

References: 6 NYCRR Part 360, Solid Waste Management Facilities
Phillips Driscopipe System Design Manual

A. STORM EVENT: 25 yr / 24 hr Storm

Based on 6NYCRR Part 360 - 2.15(k) 2

B. DRAINAGE AREAS

SWALE A: New swale on north side of the landfill: 4.43 acres

SWALE B: Combined swale before new CPP culvert: 2.63 acres

C. SWALE CALCULATIONS: (SEE ATTACHED SPREADSHEETS)

Capacity of Swale A: F.S. = 3.96

Capacity of Swale B: F.S. = 1.27

Velocity Swale A: 2.39 fps (Grass Lined)

Velocity Swale B: 2.56 fps (Stone Lined)

D. CULVERT SIZING

Q = 37 cfs

$Q_{all} = 98.3 A R_h^{2/3} S^{1/2}$ (Manning Equation)

Q = 16,613 gpm

where: Q_{all} = allowable flow (gpm)

A = Area (in²)

MAXIMUM FLOW: 16,613 gpm

R_h = Hydraulic Radius

ESTIMATED SLOPE: 1 %

S = Slope (ft /ft)

REQUIRED DIAMETER: 25.03 inch

CULVERT DIAMETER TO BE USED: TWO 18-INCH CULVERTS

Two 18-inch culverts contain adequate capacity for the maximum flow.

SURFACE WATER DRAINAGE CALCULATIONS ROSEN SITE REMEDIAL DESIGN

CALCULATED BY: JFB DATE: 1/22/01
CHECKED BY: CWH DATE: 1/22/01

SWALE A:

The Rational Method: $Q = CIA$

t_c = Time of Concentration: 4.4 (min) From Figure 5 - Time of Concentration for Small Drainage Basins

t_c = Storm Duration: 8.8 (min) From Figure 5 - Overland Flow, Grass Surfaces, Multiply t_c by 2.

Q = Max Flow Rate

C = Runoff Coefficient: 1.0 (Frozen Ground)

I = Rainfall Intensity (in/hr): 5.7 (Min Duration for Syracuse NY, 25yr Storm; From Intensity-Duration-Frequency Curves)

A = Area (acres) 4.43

$$Q_{max} = 25 \text{ cfs}$$

Manning's Equation:

$$Q = (1.486/n) A R^{2/3} S^{1/2}$$

Q = Flow Capacity

n = Roughness Coefficient: 0.02 (Grass Lined Swale)

A = Area (sf) 13.5

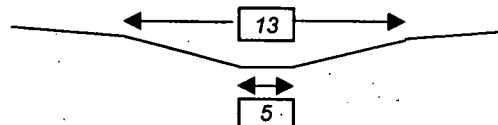
P = Wetted Perimeter 13.5

R = Hydraulic Radius = A/P 0.997

S = Slope: 0.01

$$Q_{allowed} = 100.1 \text{ cfs}$$

SWALE DESIGN:



Depth = 1.5 feet

$$F.S. = 3.96$$

SWALE B:

The Rational Method: $Q = CIA$

t_c = Time of Concentration: 8.5 (min) From Figure 5 - Time of Concentration for Small Drainage Basins

t_c = Storm Duration: 17 (min) From Figure 5 - Overland Flow, Grass Surfaces, Multiply t_c by 2.

Q = Max Flow Rate

C = Runoff Coefficient: 1.0 (Frozen Ground)

I = Rainfall Intensity (in/hr): 4.5 (Min Duration for Syracuse NY, 25yr Storm; From Intensity-Duration-Frequency Curves)

A = Area (acres) 2.63

$$Q_{max} = 12 \text{ cfs}$$

$$\text{Plus Flow From Swale A} = 25 \text{ cfs}$$

$$\text{TOTAL SWALE B} = 37 \text{ cfs}$$

Manning's Equation:

$$Q = (1.486/n) A R^{2/3} S^{1/2}$$

Q = Flow Capacity

n = Roughness Coefficient: 0.03 (Gravel Lined Swale)

A = Area (sf) 11.5

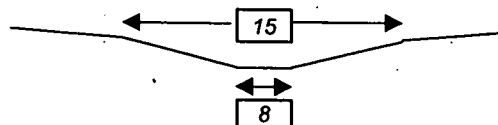
P = Wetted Perimeter 15.3

R = Hydraulic Radius = A/P 0.753

S = Slope: 0.01

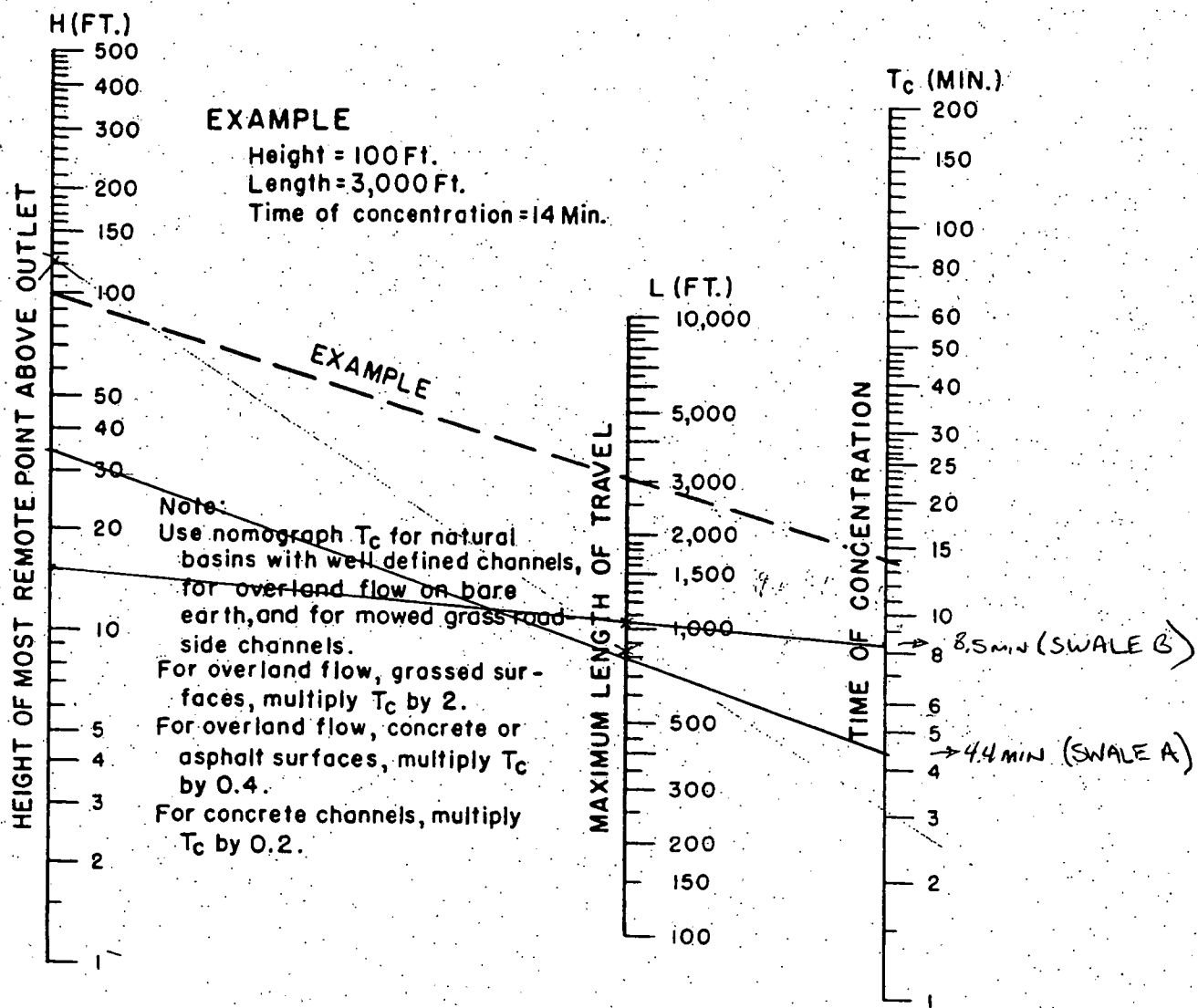
$$Q_{allowed} = 47.1 \text{ cfs}$$

SWALE DESIGN:



Depth = 1 feet

$$F.S. = 1.27$$

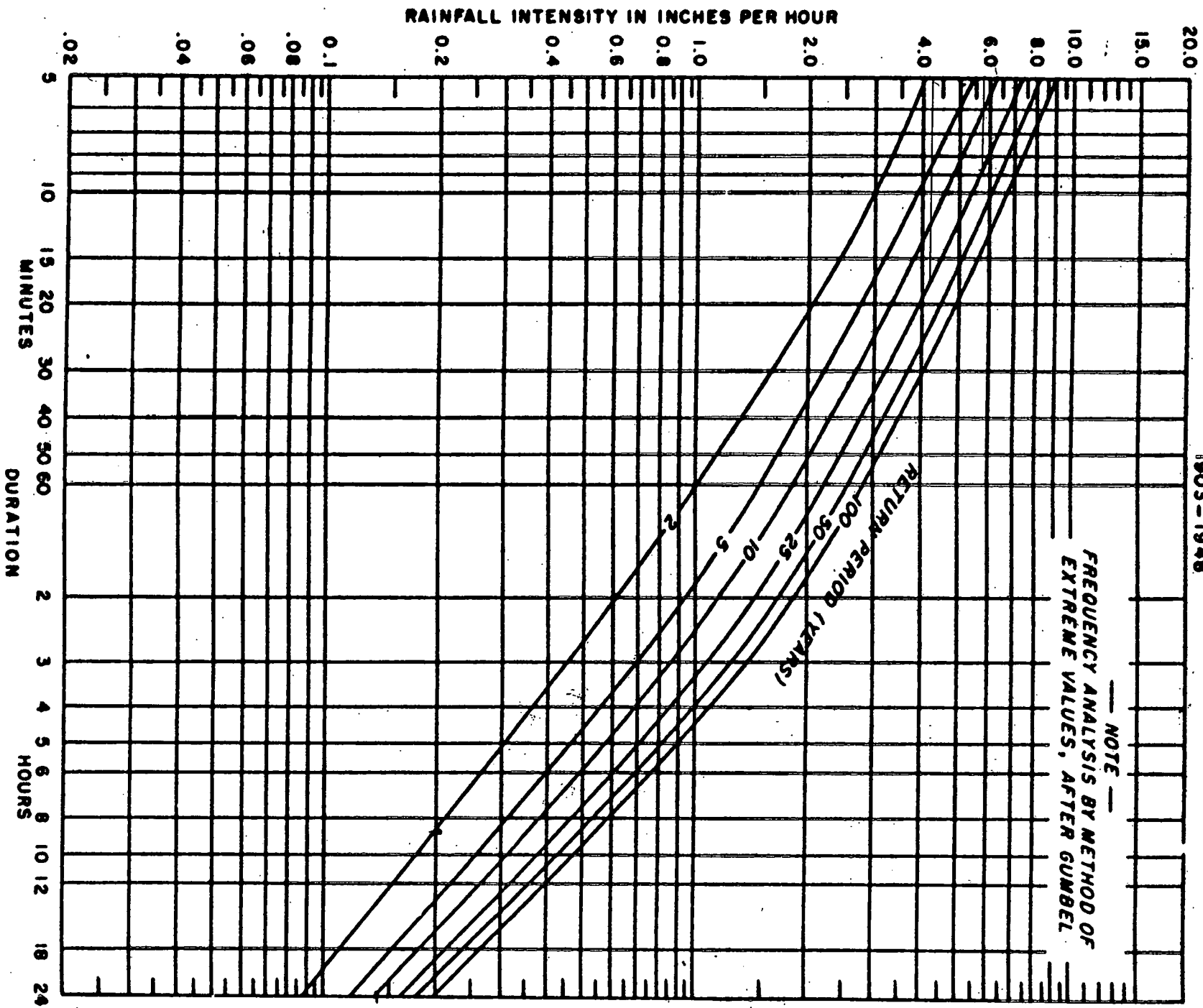


Based on study by P. Z. Kirpich,
 Civil Engineering, Vol. 10, No. 6, June 1940, p. 362

Figure 5.—Time of concentration of small drainage basins.

SYRACUSE, NEW YORK

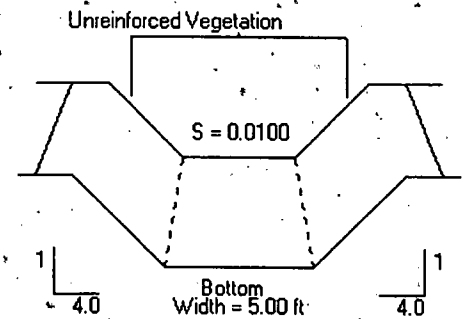
1903-1948



North American Green - Erosion Control Materials Design Software Ver. 4.1 - Channel			1/26/01	01:29 PM	COMPUTED BY: JFB
PROJECT NAME: ROSEN SITE REMEDIAL DESIGN			PROJECT NUMBER: 617.001		
FROM STATION/REACH:		TO STATION/REACH:		DRAINAGE AREA: SWALE A	DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft.)	Hydraulic Radius (ft)	Normal Depth (ft)
25.0	1.0	2.39	10.45	0.74	1.11



LINER RESULTS

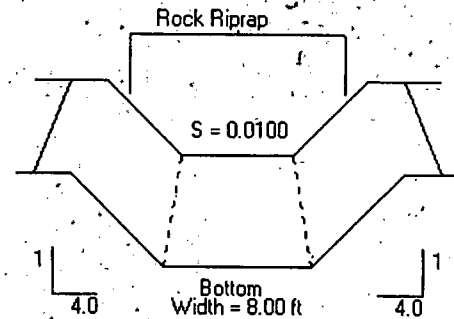
Not to Scale

Reach	Material Type	Phase	Veg. Type	Soil Type	Manning's 'n'	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
	Staple Pattern	Class	Veg. Density						
Straight	Unreinforced		Mix		0.051	3.33	0.69	4.82	STABLE
		D	50-75%	Sandy Loam		0.035	0.026	1.34	STABLE

North American Green - Erosion Control Materials Design Software Ver.4.1 - Channel			1/26/01	01:37 PM	COMPUTED BY: JFB
PROJECT NAME: ROSEN SITE REMEDIAL DESIGN			PROJECT NUMBER: 617.001		
FROM STATION/REACH:		TO STATION/REACH:	DRAINAGE AREA: SWALE B		DESIGN FREQUENCY:

HYDRAULIC RESULTS

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (fps)	Area (sq.ft.)	Hydraulic Radius(ft)	Normal Depth (ft)
37.0	12.0	2.56	14.43	0.83	1.15



LINER RESULTS

Not to Scale

Reach	Material Type	Phase	Veg. Type	Soil Type	Manning's 'n'	Permissible Shear Stress (psf)	Calculated Shear Stress (psf)	Safety Factor	Remarks
	Staple Pattern	Class	Veg. Density						
Straight	Rock Riprap				0.051	1.00	0.72	1.40	STABLE
	3in								

APPENDIX B
CONSTRUCTION SPECIFICATIONS

CONSTRUCTION SPECIFICATIONS

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<u>SECTION</u>	<u>DESCRIPTION</u>
02072	Geotextile
02102	Clearing & Grubbing
02220	Excavation
02221	Debris Excavation and Relocation
02222	Granular Fill
02226	Select Fill Materials
02237	Composite Geonet
02257	Common Fill
02271	Riprap
02435	PVC Plastic Pipe and Fittings
02444	Fence, Chain Link
02484	Topsoil
02485	Seeding
02598	Linear Low Density Polyethylene (LLDPE) Lining Material
02621	Corrugated Polyethylene (CPE) Drain Pipe
02641	Smooth Interior Corrugated Polyethylene Pipe and End Sections
13052	Landfill Gas Vents

SPECIFICATIONS

SECTION 02072

GEOTEXTILE

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Geotextile as shown on the Plans, as specified, and/or directed.

1.1.2 The Contractor shall furnish and install the geotextile as shown on the Contract Drawings, or as directed by the Engineer. The geotextile layers will be incorporated into the landfill system to serve as protective and filtration layers.

1.2 SUBMITTALS:

1.2.1 Prior to the installation or delivery of a geotextile, the Contractor shall submit to the Engineer, from the geosynthetic manufacturer, a list of guaranteed "minimum average roll values" (MARV) for the geotextile (the minimum average roll value is the minimum value obtained from the average values of the sampled rolls). The Contractor shall provide the Engineer, from the manufacturer, a written certification stating that the geosynthetic material meets or exceeds the guaranteed properties submitted.

1.2.2 In addition to submitting guaranteed physical properties, the Contractor shall submit to the Engineer, from the manufacturer, documentation demonstrating the chemical compatibility of the geosynthetic material. Such documentation shall include chemical compatibility testing results.

1.3 DELIVERY:

1.3.1 All geotextiles will be inspected on delivery, and materials that do not comply with the Specification will be rejected. The Contractor shall furnish all labor required to handle the geotextiles during inspection and shall remove the rejected material from the site of the work.

SECTION 02072

GEOTEXTILE

PART 2 - PRODUCTS

2.1 MATERIALS:

2.1.1 Geotextile:

2.1.1.1 The geotextile to be utilized shall be a nonwoven, needle-punched, polymeric geotextile. The fibrous structure of the geotextile must be able to withstand handling, placement and long-term loads associated with the incorporated Specifications.

2.1.1.2 The geotextile shall be protected from ultraviolet light, precipitation, mud, dirt, excessive dust, puncture, cutting and/or other damaging condition prior to and during delivery. The geotextile shall be capable of withstanding 30 days of sunlight without measurable deterioration.

2.1.1.3 Three types of nonwoven geotextiles will be supplied by the Contractor. All fabrics shall be similar materials except for the weight and the associated physical properties. Type 1 will be nominal six oz./square yard or heavier, Type 2 will be a nominal sixteen oz./square yard or heavier, and Type 3 will be a nominal four oz./square yard or heavier fabric. An equivalent substitution may be made subject to the approval of the Engineer. Geotextile properties/values are given in Paragraph 2.2.

2.1.1.4 All geotextiles shall be delivered on site in rolls contained within opaque plastic covers. These rolls will be tagged and display the following information.

- Manufacturer's name
- Product identification
- Lot number
- Roll number and dimensions

2.2 MINIMUM SPECIFIED VALUES:

2.2.1 Geotextile Minimum Average Roll Value (MARV) Specifications:

2.2.1.1 The table below lists the MARV specification values for the Type 1, Type 2, and Type 3 nonwoven geotextiles. In addition, the typical average specification values, as indicated, have been listed. Final approval of the geotextile properties shall be made by the Engineer based upon Contractor's submittals.

SECTION 02072

GEOTEXTILE

Non-Woven Geotextiles

<u>Property</u>	<u>Specification Limit</u>			<u>Test Method</u>
	<u>Type 1</u>	<u>Type 2</u>	<u>Type 3</u>	
*Mass per Unit Area (oz/yd ²)	6.0	16.0	4.0	ASTM D5261
*Thickness (mils)	60	160	40	ASTM D5199
**Apparent Opening Size (U.S. Sieve)	70-100	100-140	50-80	CW-02215 or ASTM D4751
*Burst Strength (psi)	220 575	215		ASTM D3786
*Grab Strength (lbs)	145 330	95		ASTM D4632
*Grab Elongation (%)	50	50	50	ASTM 04632
*Puncture Strength (lbs)	75	170	60	ASTM D4833
*Trapezoidal Tear Strength (lbs)	50	120	35	ASTM D4533
*Permittivity (sec ⁻¹)	1.5	0.4	2.0	ASTM D4491
*Water Flow Rate (gpm/ft ²)	90	40	140	ASTM D4491

*MARV Values Taken Along Weakest Principal Direction.

**Typical Average Values

SECTION 02072

GEOTEXTILE

PART 3 - EXECUTION

3.1 GEOTEXTILE INSTALLATION:

3.1.1 The following procedures and requirements will be followed during the installation of geotextile.

3.1.2 Placement:

3.1.2.1 The placement of the geotextile shall not be conducted during adverse weather conditions. The geotextile will be kept dry during storage and up to the time of deployment. During windy conditions, all geotextiles will be secured with sandbags or an equivalent approved anchoring system. Removal of the sandbags or equal will only occur upon placement of an overlying soil layer.

3.1.2.2 Proper cutting tools shall be used to cut and size the geotextile materials. Extreme care will be taken while cutting in-place geotextiles.

3.1.2.3 During the placement of geotextiles, all dirt, dust, sand or mud shall be kept off to prevent clogging. If excessive contaminant materials are present on the geotextile, it shall be cleaned or replaced as directed by the Engineer.

3.1.2.4 No equipment used will damage the geotextiles by handling, trafficking or other means. Equipment, including ATVs, will not be allowed to travel directly on the geotextiles during the installation of overlying soils or geosynthetic layers unless otherwise approved by the Engineer.

3.1.3 Seaming or Joining:

3.1.3.1 Geotextiles:

3.1.3.1.1 Geotextiles shall be seamed using either an eighteen inch overlap, heat lamination, (single wedge welder) or by sewing. The specific conditions requiring a sewn or heat laminated seam or simply an overlap are as follows:

SECTION 02072

GEOTEXTILE

- a. Seams on the landfill side slopes greater than 10% will be parallel to the line of slope and sewn or heat laminated 5 feet from the toe-of-slope upward over the length of the slope and into the anchor trench. No horizontal seams will be allowed on side slopes, except for patching.
- b. Geotextiles placed on the subgrade, or between two soil layers at less than 10 percent slope may utilize an 18-inch overlap seam.
- c. Where the slope is greater than 10 percent, or directly above a geomembrane, these seams shall be sewn or heat laminated as stated above.

3.1.3.1.2 Sewing will be done using a polymeric thread with chemical compatibility resistance equal to or exceeding the geotextile being sewn. Thread and the sewing device shall be approved by the Engineer prior to its use in the field.

3.1.3.1.3 Repair of tears or holes in the geotextile will require the following procedures:

- a. On slopes: A patch made from the same geotextile will be double seamed or heat laminated into place; with each seam 1/4-inch to 3/4-inch apart and no closer than 1-inch from any edge. Should any tear exceed 10% of the width of the roll, that roll will be removed from the slope and replaced.
- b. Flat slopes: A patch made from the same geotextile will be spot-seamed or heat laminated in place with a minimum of 24-inch overlap in all directions.

3.2 POST-CONSTRUCTION:

3.2.1 Upon completion of the installation, the Contractor shall submit to the Engineer:

- a. All quality control documentation.
- b. The warranty obtained from the Manufacturer/Fabricator.

SECTION 02072

GEOTEXTILE

PART 4 - MEASUREMENT & PAYMENT

4.1 MEASUREMENT - GEOTEXTILE:

4.1.1 Measurement of the quantity of Geotextile, allowed for payment shall be based on the number of square feet placed as measured to the nearest one foot of Geotextile placed, excluding any overlaps and material in the anchor trench, in accordance with the Specifications, Drawings or as approved by the Engineer.

4.2 PAYMENT - GEOTEXTILE:

4.2.1 For Geotextile, not included in other unit or lump sum price items, payment for Geotextile will be made at the applicable price stated in the Bid.

4.2.2 The Owner will pay for materials delivered and properly stored on-site upon receipt of all required submittals and conformance test results. After installation of the material, the Owner shall retain 10 percent of the price of the geotextile until the Contractor provides an acceptable warranty.

END OF SECTION

SPECIFICATIONS

SECTION 02102

CLEARING AND GRUBBING

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Clearing and Grubbing as shown on the Plans, as specified, and/or directed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION:

3.1 CLEARING:

3.1.1 Clearing shall consist of the felling, trimming and cutting of trees into sections and the satisfactory disposal of the trees and other vegetation designated for removal, including downed timber, snags, brush and rubbish occurring within the areas to be cleared. Cut off flush with or below the original ground surface trees, stumps, roots, brush and other vegetation in areas to be cleared.

3.2 GRUBBING:

3.2.1 Grubbing shall consist of the removal and disposal of roots, matted roots, and stumps from the indicated grubbing areas. Remove this material together with logs, organic and metallic debris, brush and refuse in areas indicated as construction areas under this Contract.

3.3 DISPOSAL OF CLEARED AND GRUBBED MATERIALS:

3.3.1 Wood which is cleared and grubbed must be reduced to chips by the use of an approved chipping machine or stump grinder. Chips shall be disposed of within the limits of waste. Matted roots, brush and wood larger than 24 inches in diameter are not required to be chipped prior to disposal.

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CLEARING AND GRUBBING

3.4 SALVAGING OF TIMBER:

3.4.1 Wood located within the limits of waste shall not be salvaged. Wood which is cleared and grubbed beyond the limits of waste can be cut into practical hauling lengths and moved off-site. Any wood that is cut up may be neatly piled on-site, but shall be removed off-site prior to completion of the work.

PART 4 – MEASUREMENT & PAYMENT

4.1 MEASUREMENT - CLEARING AND GRUBBING:

4.1.1 Measurement for Clearing and Grubbing shall include the cost of all materials, equipment, labor, submittals and testing for the work indicated in this Section.

4.2 PAYMENT – CLEARING AND GRUBBING:

4.2.1 For Clearing and Grubbing, not included in other unit or lump sum price items, payment for Clearing and Grubbing will be made at the applicable price stated in the Bid.

END OF SECTION

SPECIFICATIONS

SECTION 02220

EXCAVATION

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Excavation, as shown on the Plans, specified, and/or directed.

1.1.2 Excavation, in open cut, includes the loosening, removing, transporting, storage and disposal of all materials necessary to be removed for the construction and completion of all work under the Contract. Excavations shall be made to the widths and depths shown on the Plans, specified or directed.

1.2 DEFINITIONS:

1.2.1 The term "excavation" and the term "trenching" where used, shall be deemed and understood to cover the following described work, and the price bid for any and all items including "excavation", or "trenching" shall be deemed to include and cover all of the several following detailed operations:

- The loosening, removing, transporting, storage and rehandling of all materials;
- All sheeting, sheetpiling, bracing and shoring, and the placing, driving, cutting off and removing of the same;
- All diking, ditching, fluming, cofferdamming, pumping, well-pointing, bailing, dewatering and draining or otherwise disposing of water (surface and subsurface);
- The refilling of trenches, excavations and pits, and the furnishing and placing of material over trenches, excavations and pits to the original surface of the ground or to other grades as may be shown or directed;

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- The compacting of all materials used in filling or refilling by rolling, ramming, watering, puddling, etc., as may be required;
- The removing and disposing of all surplus materials from all excavations in the manner specified;
- The maintenance, accommodation and protection of travel;
- The supporting and protecting of all tracks, rails, buildings, curbs, sidewalks, pavements, overhead wires, poles, trees, vines, shrubbery, pipes, sewers, conduits or other structures or property and its appurtenances, in the vicinity of the work, whether over or underground or which appear within the excavations, and the restoration of the same in case of settlement or other injury;
- All temporary bridging and fencing and the removing of same, the temporary paving of highways, roads, driveways, and the permanent repairing or replacing and relaying of pavements, curbs, gutters and sidewalks removed, disturbed, or injured, the removing and clearing away of all construction rubbish, refuse, unused materials, plant and tools from the site;
- The dressing, topsoiling, sodding and/or seeding of all unpaved areas disturbed by the Contractor within and outside the limits of the Contract as may be necessary to leave the surface in as good condition as it was previous to the commencement of the work.

1.2.2 "Earth" includes all materials, such as sand, gravel, clay loam, pavements, ashes, cinders, muck, roots, or pieces of timber, soft or disintegrated rock, not requiring blasting, barring or wedging from their original beds, and specifically excludes all ledge or bed rock, and individual boulders or masonry larger than one-half cubic yard in volume.

1.2.3 "Backfill" includes selected materials for the backfilling or refilling of all excavations and trenches up to the original surface of the ground or to other grades as may be shown or directed.

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1.2.4 "Spoil" includes surplus excavated materials not required or not suitable for backfills or embankments.

1.2.5 "Embankments" include fills constructed of selected materials above the original surface of the ground.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS: Where used for general site fill, soil material shall be free of debris, roots, wood, scrap material, vegetable matter, refuse, soft unsound particles, frozen, deleterious, or objectionable materials.

2.2 CONTROLLED FILL: Provide where indicated and also within building lines and under concrete slabs and aprons. Fill to be granular fill as specified in Section 02222.

PART 3 - EXECUTION

3.1 EXCAVATION FOR STRUCTURES:

3.1.1 Excavation shall be of sufficient size, and only of sufficient size, to give suitable room for the proper construction of structures and appurtenances, including allowances for sheeting, dewatering, and other similar work necessary for completion of the Contract.

3.1.2 Excavations for structures shall be made only to the lines and grades shown on the Plans, specified or directed.

3.1.3 In no case will undercutting excavation faces for extended footings be permitted. Not less than twelve (12) inches clearance shall be provided between excavation faces and brick or block masonry exterior wall surfaces which are to be plastered.

3.1.4 Subgrade for all concrete structures shall be undisturbed original earth, thoroughly compacted where noted on drawings. Where excavation below subgrade is ordered, it shall be a thoroughly compacted and consolidated lining, special lining or special backfill as directed and as specified in Section 02224. It shall be sufficiently stable to remain firm and intact during the surfacing of subgrade, laying reinforcing steel and placing concrete thereon.

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3.1.5 Where necessary, a layer of Class "D" concrete of sufficient strength and thickness to withstand subsequent construction operations shall be installed below the specified subgrade elevation and the structural concrete deposited thereon. Subject to the approval of the Engineer, lining or special lining may be used for subsoil reinforcement if satisfactory results can be obtained thereby. Such material shall be applied in thin layers, each layer being entirely embedded in the subsoil by thorough tamping. All excess soil shall be removed to compensate for the displacement of the gravel or crushed stone and the finished elevation of any subsoil reinforced in this manner shall not be above the specified subgrade.

3.2 BACKFILLING AROUND STRUCTURES:

3.2.1 Backfilling around structures shall not be commenced until all lumber, refuse, rubbish and other similar materials are removed from the excavated area. Backfill around structures may be placed by machine, provided the work shall be done carefully to prevent damage to the structure. In no case shall backfill materials be allowed to fall directly on a structure, until at least twelve (12) inches of hand-placed material has been placed thereon and compacted.

3.2.2 Backfill around structures shall be deposited in horizontal layers not more than eight (8) inches in thickness and shall be thoroughly compacted. Compaction shall be by a vibrating tamper or other approved method and shall be to a minimum dry density of ninety-five (95) percent of the maximum dry weight density in pounds per cubic foot as determined by the AASHTO Standard Density Test or the Modified Proctor Compaction Test (ASTM D1557).

3.2.3 Backfilling shall be done immediately after work has been inspected and approved. No frozen material shall be used, nor shall backfilling be placed on or against frozen earth, debris or other deleterious matter not conducive to proper compaction. Backfill within building lines, under concrete slabs and aprons shall be granular fill as specified in Section 02222.

3.2.4 Backfilling against free standing walls shall be made against both sides at the same time. If backfill is required on one side only, the wall shall be adequately braced on the opposite side until properly cured to full strength.

3.2.5 Contractor shall take every necessary precaution during compaction of fill adjacent to foundations, walls, etc., that such items are not displaced from their proper location or damaged by compacting equipment. In the event damage or displacement occurs during or resulting from compaction of fill as specified above, the Contractor shall be responsible for correcting the same, to approval of the Engineer and at no expense to the Owner.

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3.3 TRENCHING:

3.3.1 The alignment, depth and pipe subgrades of all pipe trenches shall be determined by overhead grade lines parallel to the pipe invert, or other grade control devices, installed and maintained by the Contractor.

3.3.2 Under ordinary conditions, excavation shall be by open cut from the ground surface. Where the depth of trench and soil conditions permit, tunneling may be required beneath crosswalks, curbs, gutters, pavements, concrete driveways, railroad tracks and other surface structures. No additional compensation will be allowed for such tunneling over the price bid for open cut excavation of equivalent depths below the ground surface unless such tunnel excavation is specifically provided for in unit or lump sum price items.

3.3.3 Trenches shall not be opened for more than three hundred (300) feet in advance of the completed pipe or sewer nor left unfilled for more than one hundred (100) feet in the rear thereof without consent of the Engineer. Excavation of the trench shall be fully completed at least twenty (20) feet in advance of the pipe laying or construction of the invert unless specifically permitted otherwise.

3.3.4 Width and Depth of Trenches:

3.3.4.1 The trenches in which pipelines are to be constructed, shall be excavated in all cases in such manner and to such depths and widths as will give suitable room for the pipelines which the trenches are to contain, for sheeting, pumping, dewatering, well-pointing and draining of water, and for removing the material not suitable for pipe subgrade.

3.3.4.2 Trenches for pipes shall be not less than six (6) inches wider than the hubs of the pipe in the clear on each side, measured over the hubs of the pipe. Width of trenches, measured at a point twelve (12) inches above the top of the pipe shall not exceed twelve (12) inches on each side. Width of trenches greater than specified above will be permitted in the vicinity of joints for welded steel pipe where access for the welding of joints is required.

3.3.4.3 Where, as required by loading conditions, the width of the lower portion of the trench, measured at twelve (12) inches above top of pipe, exceeds the maximum for the size of pipe, additional concrete cradle or concrete encasement shall be installed by the Contractor at his own expense.

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3.3.4.4 Ledge rock, shale, boulders and large stones shall be removed to provide minimum bottom and side clearances, for the size of pipe being laid in each case, as follows:

<u>Size of Pipe (Inches)</u>	<u>Minimum Clearance Below Pipe (Inches)</u>	<u>Minimum Clearance At Sides (Inches)</u>
12 or smaller	4	6
15, 18, and 21	5	6
24 to 36	7	6
Over 36	9	7

Where concrete embedment or cradle is to be placed, it shall be placed directly on the rock, and the bottom clearance shall be adjusted as directed by the Engineer.

3.4 EARTH SUBGRADE PREPARATION FOR PIPES:

3.4.1 Unless otherwise permitted by the Engineer, the trench shall have a flat bottom conforming to the grade to which the pipe is to be laid.

3.4.2 Except where concrete cradle or encasement is required below the specified pipe subgrade, mechanical excavation of trenches for pipe shall not extend lower than one (1) inch above the finished pipe subgrade elevation at any point. The remainder of the trench excavation shall be made with hand tools.

3.4.3 Pipe subgrade preparation shall be performed immediately prior to installing the pipe in the trench. The trench bottom shall be accurately graded by means of hand tools in such a manner that a uniform and continuous bearing and support on solid and undisturbed ground is provided for each pipe for its entire length or between bell holes.

3.4.4 All trenches shall be so graded that the spigot end of the pipe will be accurately centered in the adjacent pipe bell when laid, without raising the pipe off the trench bottom. Regrading of a trench bottom which is too high will be permitted. Correction of a subgrade that is too low shall be done only by placing and compacting lining over the entire width of the trench and regrading.

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3.4.5 The trench bottom shall be accurately graded and ready for the installation of the pipe thereon prior to excavating bell holes if and where required.

3.4.6 Each bell hole shall be excavated immediately prior to laying the pipe therefor. Bell holes shall have a length, measured at the elevation of the pipe subgrade, not in excess of nine (9) inches and shall be of sufficient size so that no part of the pipe bell will be in contact with the trench bottom or granular fill thereon.

3.5 PIPE EMBEDMENT:

3.5.1 All pipe shall be protected from lateral displacement and possible damage resulting from superimposed backfill loads, impact or unbalanced loading during backfilling operations by being adequately embedded in suitable pipe embedment material. Except where loading or subsoil conditions require the use of concrete cradle or encasement, all pipe embedment shall be placed so as to insure adequate lateral and vertical stability of the installed pipe during pipe jointing and embedment operations. A sufficient amount of the specified pipe embedment material to hold the pipe in rigid alignment shall be uniformly deposited and thoroughly compacted on each side, and back of the bell, of each pipe laid.

3.5.2 Pipe embedment materials placed at any point below an elevation six (6) inches above the top of pipe or sewer, shall be deposited and compacted in layers not to exceed four (4) inches in uncompacted depth, and such deposition and compactations shall be done simultaneously and uniformly on both sides of the pipe. Compaction shall be by vibrating tamper or other approved method and shall be to a minimum dry density of ninety-five (95) percent of the maximum dry weight density in pounds per cubic foot as determined by the Modified Proctor Compaction Test. All such materials shall be placed in the trench with hand tools in such a manner that they will be scattered alongside the pipe and not dropped into the trench in compact masses.

3.5.3 Concrete cradle and encasement of the class specified shall be installed where and as shown on the Plans or ordered by the Engineer. Before concrete cradle or encasement is placed, the pipe shall be braced in all directions to prevent movement or flotation.

3.6 BACKFILL ABOVE PIPE EMBEDMENT:

3.6.1 The portion of pipe trenches between the top of the pipe embedment (see paragraph 3.7) and the upper limit of backfill shall be refilled with suitable materials.

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3.6.2 Where trenches are within the ditch-to-ditch or curb-to-curb limits of any street, road, driveway or other recognized traveled vehicular way, or within other limits that may be specifically shown or specified for this purpose, the backfill materials shall be deposited in the trench in horizontal layers not more than eight (8) inches in thickness, and each layer shall be compacted by vibrating tamper or other approved method and shall be to a minimum dry density of ninety-five (95) percent of the maximum dry weight density in pounds per cubic foot as determined by the Modified Proctor Compaction Test (ASTM D1557).

3.6.3 Where trenches are outside the ditch-to-ditch or curb-to-curb limits of any street, road, driveway or other recognized traveled vehicular way, and outside of other limits that may be specifically shown or specified as areas in which mechanical compaction in layers is to be performed, the backfill material may be deposited in the trench by mechanical means for the full depth of the trench between the top of pipe embedment and ground surface with no special compaction. In such case the backfill materials shall be mounded over the trench to an elevation slightly above desired finished grade to allow for settlement and compaction by natural means, and the Contractor shall return to the area during his clean-up operations to remove any excess materials remaining above finished grade or add sufficient additional backfill to bring the completed work to grade. If a hazard should be created by such excess materials, or by settlement below finished grade, prior to the performance of clean-up operations, the Contractor shall remove such excess, or add additional backfill, at the time the hazard is created or when directed.

3.6.4 Any additional material added during clean-up operations, or at any other time to prevent or remove a hazard, shall be placed in horizontal layers not more than eight (8) inches in thickness, with each layer adequately compacted by mechanical means, by the Contractor at his own expense.

3.7 REMOVAL OF WATER:

3.7.1 The Contractor shall at all times during construction provide and maintain proper and satisfactory means and devices for the removal of all water entering the excavations, and shall remove all such water as fast as it may collect, in such manner as shall not interfere with the prosecution of the work or the proper placing of pipe, masonry, concrete, structures, or other work.

3.7.2 Removal of water includes the construction and removal of cofferdams, sheeting and bracing, the furnishing of materials, equipment and labor necessary therefore, the excavation and maintenance of ditches and sluice-ways and the furnishing and operation of pumps, wellpoints, and appliances needed to maintain thorough drainage of the work in a satisfactory manner.

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3.7.3 Water shall not be allowed to rise over or come in contact with any masonry, concrete or mortar, until at least twenty-four (24) hours after placement, and no stream of water shall be allowed to flow over such work until such time as the Engineer may permit.

3.7.4 Unless otherwise specified, all excavations which extend down to below the ground water elevation at the sites of structures shall be dewatered by lowering and maintaining the ground water beneath such excavations at an elevation not less than that specified herein at all times when work thereon is in progress, during subgrade preparation and the placing of the structures or pipe thereon.

3.7.5 Where an upward pressure or flow of water in combination with a fine-grained subsurface material causes a quick condition, the Contractor shall install wellpoints to stabilize the subgrade. Where wellpoints are used, the ground water table shall be continuously (day and night) maintained to an elevation of not less than twenty-four (24) inches below the excavation and when subgrade is reached the ground water shall be maintained not less than twenty-four (24) inches below the subgrade. Unless otherwise permitted by the Engineer, the ground water shall be maintained not less than twenty-four (24) inches below the subgrade until completion of the backfilling to an elevation at least twelve (12) inches above natural ground water level. Wellpoint headers, points, and other pertinent equipment shall not be placed within the limits of the excavation in such a manner or location as to interfere with the laying of pipe or trenching operations or with the excavation for and construction of other structures.

3.7.6 In areas where ground water enters the excavation but does not cause a quick condition, the ground water may be removed by any practical method which does not damage the subgrade, cause the same to become unstable or interferes with construction operations.

3.7.7 The ground water control requirements specified for wellpointing operations apply to other dewatering methods.

3.7.8 Suitable stand-by pumping equipment shall be provided to insure the maintenance of the specified lowering of the water table.

3.7.9 Water pumped or drained from excavations, or any sewers, drains, or water courses encountered in the work, shall be disposed of in a suitable and environmental manner without injury to adjacent property, the work under construction, or to pavements, roads, and drives. No water shall be discharged to sanitary sewers. Sanitary sewage shall be pumped to sanitary sewers or shall be disposed of by an approved method.

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3.7.10 Any damage caused by improper handling of water shall be repaired by the Contractor at his own expense.

3.8 SHEETING & BRACING:

3.8.1 The Contractor shall furnish, place and maintain such sheeting, bracing and shoring as may be required to support the sides and ends of excavations in such manner as to prevent any movement which could, in any way, injure the pipe, sewers, masonry, or other work; diminish the width necessary; otherwise damage or delay the work; or endanger existing structures, pipes or pavements; cause the excavation limits to exceed the right-of-way limits; or to occasion a hazard to persons engaged on the project or to the general public.

3.8.2 In no case will bracing be permitted against pipes or structures in trenches or other excavations.

3.8.3 The Contractor shall be solely responsible for the safety and adequacy of all sheeting and bracing. He shall make good any damage resulting from failure of supports with no additional cost to Owner.

3.8.4 Removal of Sheeting & Bracing:

3.8.4.1 In general, all sheeting and bracing, whether of steel, timber or other material, used to support the sides of trenches or other open excavations, shall be withdrawn as the trenches or other open excavations are being refilled. That portion of the sheeting extending below the top of a pipe or sewer shall be withdrawn, unless directed, before more than six (6) inches of earth is placed above the top of the pipe or sewer and before any bracing is removed. The voids left by the sheeting shall be carefully refilled with selected material and rammed tight with tools especially adapted for the purpose, or otherwise as may be approved.

3.8.4.2 The Engineer may order the Contractor to delay the removal of sheeting and bracing, if in his judgement the installed work has not attained the necessary strength to permit placing of backfill.

3.8.5 Sheeting & Bracing Left In Place:

3.8.5.1 If, to serve any purpose of his own, the Contractor files a written request for permission to leave sheeting or bracing in the trench or excavation, the Engineer may grant such permission, in writing, on condition that the cost of such sheeting and bracing be assumed and paid by the Contractor.

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3.8.5.2 The Contractor shall leave in place all sheeting, shoring and bracing which are shown on the Drawings or specified to be left in place or which the Engineer may order, in writing, to be left in place. All shoring, sheeting, and bracing shown or ordered to be left in place will be paid for under the appropriate item of the Contract. No payment allowance will be made for wasted ends or for portions above the proposed cut-off level which are driven down instead of cut-off.

3.8.5.3 In case sheeting is left in place, it shall be cut off or driven down as directed so that no portion of the same shall remain within twelve (12) inches of the finished street or ground surface.

3.8.5.4 All timber sheeting and bracing to be left in place and paid for under an item of the Contract shall be new, sound and straight, free from cracks, shakes and large or loose knots, and shall otherwise conform with National Design Specifications for Stress Grade Lumber for lumber of a minimum fiber stress of 1,200 pounds per square inch.

3.8.5.5 Steel sheeting and bracing left in place and paid for under an item of the Contract shall be new and shall conform with ASTM Des: A7, with a minimum thickness of 3/8-inch.

3.8.5.6 Sheeting and bracing left in place and paid for under an item of the Contract shall be driven as the excavation progresses and in such manner as to maintain pressure against the original ground at all times. The sheeting shall be driven vertical with the edges tight together, and all bracing shall be of such design and strength as to maintain the sheeting in its proper position.

3.9 STORAGE OF MATERIAL:

3.9.1 All excavation materials shall be stored in locations so as not to endanger the work, and so that easy access may be had at all times to all parts of the excavation. Stored materials shall be kept neatly piled and trimmed, so as to cause as little inconvenience as possible to public travel or to adjoining property holders. All stockpiled fill material shall be stored only in those fill areas as approved by the Engineer and the New York State Department of Environmental Conservation.

3.9.2 All excavated materials shall be kept clear of all sidewalks, driveway entrances, street crossings, and any other points that may inconvenience the public. Special precautions must be taken to permit access at all times to fire hydrants, fire alarm boxes, police and fire department driveways, and other points of public convenience.

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3.9.3 Where traffic is to be maintained, at least one-half (1/2) of the street width must be kept open at all times. Approved types of bridging across trenches shall be constructed and maintained where necessary. Where conditions do not permit storage of materials, the material excavated from the first one hundred (100) feet of any opening, or from such additional length as may be required, shall be removed from the street by the Contractor, at his own cost and expense, as soon as excavated. The material subsequently excavated shall be used to refill the trench where the facility has been built, provided it be of suitable character.

3.9.4 If more material is excavated from any trench, excavation, or pit than can be refilled over the completed work or stored on the street, leaving space for traffic as herein provided, or within the limits of the right-of-way, the excess material shall be spoiled at locations selected and obtained by the Contractor. A copy of the signed agreement between the property owner and Contractor granting permission to deposit spoil shall be given to the Engineer prior to placement. When the facility is complete, the Contractor shall, at his own cost and expense, bring back adequate amounts of satisfactory excavated materials as may be required to properly refill the trenches, excavations, or pits. If directed by the Engineer, the Contractor shall refill such trenches, excavations, or pits with special backfill or other suitable materials, and excess excavated materials shall be disposed of as spoil.

3.10 DRAINAGE:

3.10.1 All material deposited in roadway ditches or other water courses crossed by the line of trench or near a structure shall be removed immediately after backfilling is completed and the section grades and contours of such ditches or water course restored to their original condition, in order that surface drainage will be obstructed no longer than necessary.

3.10.2 Backfilling of trenches for pipes installed beneath or across roadways, driveways, walks and other traffic ways adjacent to drainage ditches and water courses shall not be done prior to the completion of backfilling to the original ground surface of the trench on the upstream side of such traffic-way in order to prevent the impounding of water at any point after the pipe has been laid, and all necessary bridges and other temporary structures required to maintain traffic across such unfilled trenches shall be constructed and maintained. All backfilling shall be done in such a manner that water will not accumulate in unfilled or partially filled trenches.

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3.10.3 Where trenches are constructed in or across roadway ditches or other water courses, the backfill shall be protected from surface erosion by adequate and environmentally sound means. Where trenches cross such waterways; the backfill surface exposed on the bottom and slopes thereof shall be protected by means of stone or concrete riprap, at no additional cost to the Owner.

3.11 ADDITIONAL EXCAVATION:

3.11.1 In case the materials encountered at the locations and grades shown on the Plans or specified are not suitable, or in case it is found desirable or necessary to excavate additional materials to secure good support for the structure or pipeline, the excavation shall be carried to such additional limits as the Engineer may direct. The Contractor shall refill such additional excavated space with either lining, special lining, Class "D" or "E" concrete or other material, as the Engineer may direct. Additional excavation, lining, special backfill, concrete or other materials so ordered, will be paid for under the appropriate items of the Contract.

3.12 UNAUTHORIZED EXCAVATION:

3.12.1 Whenever excavations are carried beyond or below the lines and grades shown on the Plans, or as given or directed by the Engineer, all such excavated space shall be refilled with lining, special backfill, concrete or other materials as the Engineer may direct. Beneath structures, all such excavated space shall be refilled with Class "D" concrete. All refilling of unauthorized excavations shall be at the Contractor's own expense.

3.12.2 All material which slides, falls or caves into the established limits of excavations due to any cause whatsoever shall be removed and disposed of at the Contractor's own expense, and no extra compensation will be paid the Contractor for any materials ordered for refilling the void areas left by the slide, fall or cave-in.

3.13 DISPOSAL OF MATERIALS:

3.13.1 All spoil shall be transported and placed on the Site of the work at the locations and to the elevations and grades shown on the Plans, or if spoil areas are not shown, all spoil materials shall be disposed off the Site at appropriate locations selected and obtained by the Contractor and approved by the Engineer and the New York State Department of Environmental Conservation. No environmental sensitive areas shall be used for spoil areas. A copy of the signed agreement between the property owner and the Contractor granting permission to deposit spoil shall be given to the Engineer prior to placement.

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3.13.2 The surface of all spoil placed on the Site shall be graded and dressed, and no unsightly mounds or heaps shall be left on completion of the work.

3.14 UNFINISHED WORK:

3.14.1 When for any reason the work is left unfinished, all trenches and excavations shall be filled and all roadways and sidewalks left unobstructed with their surfaces in a safe and satisfactory condition.

3.15 HAULING MATERIAL ON STREETS:

3.15.1 When it is necessary to haul material over the streets or pavements, the Contractor shall provide suitable tight vehicles so as to prevent deposits on the streets or pavements. In all cases where any materials are dropped from the vehicles, the Contractor shall clean up the same at least daily or as often as directed and keep the crosswalks, streets and pavements clean and free from dirt, mud, stone and other hauled material.

3.16 TEST PITS:

3.16.1 For the purpose of locating underground obstructions, the Contractor shall make such excavations in advance of the work as directed. Payment for the excavations of test pits will be made under an appropriate item of the Contract.

PART 4 - MEASUREMENT & PAYMENT

4.1 MEASUREMENT - EXCAVATION - GENERAL:

4.1.1 The quantity of Excavation - General for which payment will be made shall be the number of cubic yards actually removed, measured as the volume occupied by it (including rocks) before its removal; the maximum limits of such volumes shall not exceed those defined by the drawings, specified or ordered.

4.2 PAYMENT - EXCAVATION - GENERAL:

4.2.1 For Excavation - General, not included in other unit or lump sum price items, will be made at the applicable price stated in the Bid and shall include the cost of all the several detailed operations incidental to the excavation. No additional payment will be made for excavation of rock, boulders, masonry or concrete encountered in the work. No payment will be made for material not excavated between the actual excavation and the maximum payment limits, if shown.

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4.3 MEASUREMENT - EXCAVATION BELOW SUBGRADE:

4.3.1 The quantity of Excavation Below Subgrade, for which payment will be made, shall be the number of cubic yards (including rock) removed in accordance with the drawings, specified and/or ordered.

4.4 PAYMENT - EXCAVATION BELOW SUBGRADE:

4.4.1 For Excavation Below Subgrade, not included in other unit or lump sum price items, will be made at the applicable price stated in the Bid and shall include and cover all costs incidental to Excavation Below Subgrade when ordered. No additional payment will be made for excavation of rock, boulders, masonry, or concrete encountered in the work.

4.5 MEASUREMENT - EXCAVATION - TRENCHING:

4.5.1 The quantity for which payment will be made for Excavation - Trenching shall be the number of lineal feet, horizontal measurement, on the center line of the trench. The depth shall be measured on the center line of the trench from the invert or grade line to the original ground surface. Excavation - Trenching will be measured continuously through standard drop manholes, and no deduction will be made therefor. For other structures, deduction shall be made for length of trench occupied by the structures.

4.6 PAYMENT - EXCAVATION - TRENCHING:

4.6.1 For Excavation - Trenching, not included in other unit or lump sum price items, payment for Excavation - Trenching will be made at the price bid per lineal foot of Trenching for the various depths stated and shall include and cover all costs incidental to the trenching. No additional payment will be made for excavation of rock, boulders, masonry, or concrete encountered in the work. If so stated in the Additional Instructions, a percentage of the funds or unit amount to be retained under Excavation - Trenching will be withheld until all surface restoration is completed.

SECTION 02220

EXCAVATION

4.7 MEASUREMENT - EXCAVATION FOR STRUCTURES:

4.7.1 The quantity of Excavation for Structures for which payment will be made shall be the number of cubic yards actually removed, measured as the volume occupied by it (including rock) before its removal unless otherwise specified; the maximum limits of such volumes shall not exceed those defined upon drawings, specified and/or ordered.

4.8 PAYMENT - EXCAVATION FOR STRUCTURES:

4.8.1 For Excavation For Structures, not included in other unit or lump sum price items, payment for Excavation For Structures will be made at the applicable unit price stated in the Bid and shall include and cover the cost of all the several detailed operations incidental to the excavation. No additional payment will be made for excavation of rock, boulders, masonry, or concrete encountered in the work. No payment shall be made for material not excavated between the actual excavation and the maximum payment limits if shown.

4.9 MEASUREMENT AND PAYMENT - EXCAVATION - TEST PITS:

4.9.1 Measurement and Payment for Excavation - Test Pits, not included in other unit or lump sum price items will be made in accordance with the following schedule:

4.9.1.1 If a specific item for Excavation - Test Pits is included in the Bid, payment shall be made at the applicable unit price stated in the Bid.

Measurement of quantity shall be the actual number of cubic yards removed and replaced, measured as the volume occupied by it before its removal in accordance with the limits ordered by the Engineer.

4.9.1.2 If no specific item for Excavation - Test Pits is included in the Bid, Excavation - Test Pits shall be measured and paid for in accordance with the Section entitled - Measurement & Payment, Excavation - General.

4.9.1.3 If neither of the above two items are included in the Bid, Excavation - Test Pits shall be measured and paid for in accordance with the Section entitled - Measurement & Payment Excavation - Trenching.

END OF SECTION

SPECIFICATIONS

SECTION 02221

DEBRIS EXCAVATION AND RELOCATION

PART 1 – GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Debris Excavation and Relocation, as shown on the Plans, specified, and/or directed.

1.1.2 Excavation includes the loosening, removing, handling, transporting and disposal of waste and debris located within the restoration area to the landfill capping area or off-site. Debris to be relocated includes brick, rebar, tires, steel, concrete pads and piers, concrete foundations, lumber, construction & demolition debris and other wastes within the limits of work.

1.1.3 Specifications and protocols for the excavation, sampling, handling and off-site or on-site disposal of contaminated soils within the restoration area is outlined in the Remedial Action Workplan for the site.

PART 2 – PRODUCTS

2.1 MATERIALS:

2.1.1 Following removal of the debris and wastes from the restoration area, a final cover system shall be installed over the entire restoration area. The final cover system is detailed on Sheet No. 5 of the Remedial Design Drawings. The entire restoration area shall be graded to drain as shown on the Subgrade Grading Plan on Sheet No. 3 of the Remedial Design Drawings. Any necessary fill needed to achieve the subgrade elevations prior to the final cover system placement shall consist of common fill material.

2.1.2 An area of fill located within the limits of waste shown on Sheet No. 2 of the Remedial Design Drawings is potentially clean material which can be used as common fill material in the restoration area subgrade grading and final cover system. Excavation of this material will be under supervision of the Engineer. Excavation will cease and the material left in place upon evidence of contamination within the material, encountering groundwater within the excavation and/or as determined by the Engineer.

SECTION 02221

DEBRIS EXCAVATION AND RELOCATION

PART 3 – EXECUTION

3.1 CLEARING AND GRUBBING:

3.1.1 Clearing and grubbing of existing vegetation and land clearing debris piles shall be in accordance with Section 02102, Clearing and Grubbing.

3.2 GENERAL DEBRIS AND WASTE EXCAVATION AND RELOCATION:

3.2.1 Prior to installation of the landfill capping system, all debris and contaminated soil acceptable for on-site disposal shall be excavated and relocated to within the limits of waste.

3.2.2 All known tire debris piles are shown on the Remedial Design Drawings. All tires located on-site shall be collected and transported off-site to a permitted tire processing or disposal facility.

3.2.3 Concrete foundations, pads and piers may remain in-place where the final grades will cover them by a foot of soil or more. Concrete foundations and pads that must be relocated to within the limits of waste shall be broken up by mechanical means into manageable pieces prior to removal and disposal.

3.2.4 Debris piles located within the landfill's limits of waste shall be graded off and incorporated into the subgrade grading plan.

3.1.5 Abandoned utility poles shall be removed and segmented into thirds prior to disposal within the limits of waste.

3.2.6 The relocated debris shall be placed in lifts not exceeding two (2) feet. Relocated debris shall be compacted and re-worked to provide a base suitable for supporting the construction loads required during capping system construction. Soil shall be mixed with the waste to stabilize the material as required. The relocated waste shall be covered with a minimum 1-foot of intermediate cover prior to capping system construction. Intermediate cover shall be compacted to a minimum dry density of 85% of the maximum modified proctor density.

3.2.7 A Type 3 non-woven geotextile shall be installed over the entire restoration area following debris excavation and relocation. The geotextile shall be installed prior to adding any additional fill as part of subgrade grading and/or final cover system construction.

SECTION 02221

DEBRIS EXCAVATION AND RELOCATION

3.3 CONTAMINATED SOIL EXCAVATION AND HANDLING

3.3.1 Specifications and protocols for the excavation, sampling, handling and off-site and on-site disposal of contaminated soils within the restoration area is outlined in the Remedial Action Workplan for the site.

PART 4 – MEASUREMENT AND PAYMENT

4.1 MEASUREMENT – DEBRIS EXCAVATION AND RELOCATION:

4.1.1 The quantity of Debris Excavation and Relocation for which payment will be made shall be the number of cubic yards actually relocated, measured as the volume occupied by it before its removal unless otherwise specified; the maximum limits of such volumes shall not exceed those defined upon drawings, specified and/or ordered.

4.2 PAYMENT – DEBRIS EXCAVATION AND RELOCATION:

4.2.1 For Debris Excavation and Relocation, not included in other unit or lump sum price items, will be made at the applicable price stated in the Bid and shall include and cover all costs incidental to Debris Excavation and Relocation when ordered.

END OF SECTION

SPECIFICATIONS

SECTION 02222

GRANULAR FILL

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Granular Fill, as shown on the Plans, as specified, and/or directed.

PART 2 - PRODUCTS

2.1 GRANULAR FILL:

2.1.1 The Granular Fill shall consist of clean, durable, gravel or stone, well graded from coarse to fine, conforming to New York State Department of Transportation Standard Specifications Item 304.03 (Subbase Course Type 2).

2.1.1.1 Granular Fill material shall be provided for roadway construction.

2.1.2 The Contractor shall submit to the Engineer a certified sieve analysis by an independent testing laboratory showing that the materials meet the required gradation, at no cost to the Owner.

PART 3 - EXECUTION

3.1 PLACING:

3.1.1 In general, the Granular Fill shall be spread in horizontal layers so that the maximum thickness of any layer after compaction shall not exceed six (6) inches. Compaction shall be by travelling vibrators or other approved method and shall be to a minimum dry density of ninety percent (90%) of the maximum dry density as determined by the Modified Proctor Test, ASTM D1557. Each layer shall be thoroughly compacted before placement of overlying layers.

SECTION 02222

GRANULAR FILL

3.2 COMPACTION TEST:

3.2.1 The Contractor shall employ an approved commercial testing laboratory at his own expense to conduct the compaction tests as directed by the Engineer.

3.2.2 Each layer shall be tested, and approved by the Engineer before succeeding layers are placed. A minimum of one field density test shall be made for each fifty (50) cubic yards of material placed and/or as shown or specified in the drawings.

3.2.3 The Contractor shall provide one optimum moisture-maximum density curve for each type of soil encountered in subgrade and fills under the mat, building slabs and grade beams as directed by the Engineer.

3.2.4 The following reports in quadruplicate shall be submitted directly to the Engineer:

- a. Report and Certification of Gradation.
- b. Field Density Reports.
- c. One optimum moisture-maximum density curve for each type of soil encountered and fills under slabs.

3.2.5 Based on the reports of the testing laboratory and inspection, if the subgrade or fills which have been placed and compacted are below the specified density, the Engineer will ask for additional compaction and testing at the expense of the Contractor.

PART 4 - MEASUREMENT & PAYMENT

4.1 MEASUREMENT - GRANULAR FILL:

4.1.1 The quantity of Granular Fill allowed for payment shall be computed by using the product of the length, depth as directed, and the actual width, but not to exceed the Maximum Payment Width as shown on the Contract Drawings, less the volume occupied by the pipe or structure, if any.

SECTION 02222

GRANULAR FILL

4.2 PAYMENT - GRANULAR FILL:

4.2.1 For Granular Fill, not included in other unit or lump sum price items, payment for Granular Fill will be made at the applicable price stated in the Bid.

END OF SECTION

SPECIFICATIONS

SECTION 02226

SELECT FILL MATERIALS

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Select Fill Materials as shown on the Plans, as specified, and/or directed.

1.1.2 Work under this Section shall include furnishing, transport, dumping and placement of Select Fill Materials in the areas and to the depths and grades shown on the engineering drawings and/or directed by the Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS:

2.1.1 Select fill materials shall be of the types listed below:

Type (C) - Select Fill

Type (D) - Select Fill

2.1.1.1 Type (C) - Select fill shall consist of clean, sound, medium to coarse sand, less than 1 inch in the maximum dimension and free from organic material and coatings.

2.1.1.2 Type (D) - Select fill shall consist of clean, washed, sound, fine gravel, conforming to New York State Department of Transportation #2 Stone, possessing a minimum permeability of 1×10^{-1} cm/s with a relative density of 90%, with the gradation shown below:

<u>% Passing By Weight</u>	<u>Sieve</u>
100	1-1/2"
90 - 100	1"
0 - 15	1/2"
0 - 3	#200

SECTION 02226

SELECT FILL MATERIALS

2.1.2 Special Considerations:

2.1.2.1 Material to be utilized for Type D select fill shall have a calcium carbonate content of less than 30% as determined by ASTM D3042.

2.1.3 Submittals:

2.1.3.1 The Contractor shall submit to the Engineer for approval a certified sieve analysis for each type of select fill material, the minimum permeability for Type D select fill, calcium carbonate content for Type D select fill, and Modified Proctor Compaction Test for Type C select fill as determined by an independent testing laboratory at no cost to the Owner. All tests will be performed in accordance with the methods outlined in this Section.

PART 3 - EXECUTION

3.1 USAGE:

3.1.1 Type (C) - Select fill material will be used to construct the intermediate cover above the debris, or as directed by the Engineer.

3.1.2 Type (D) - Select fill material will be used to construct the toe of slope drains, gas vent backfill, or as directed by the Engineer.

3.2 PLACEMENT:

3.2.1 Select fill materials shall be installed in accordance with Specification Section 02220, "Excavation", except as modified herein.

3.2.2 For all Select Fill Materials, the following preparation and inspection shall be conducted prior to placement:

- a. Insure all placement procedures do not damage any underlying soil or geosynthetic layers. Equipment must access on approved temporary haul roads.
- b. Verify stockpiled material to be used is approved for the particular layer.
- c. Verify areas to be filled are properly compacted and all geosynthetics are in place.

SECTION 02226

SELECT FILL MATERIALS

- d. Verify areas to be backfilled are free of debris, snow, ice or water and ground surfaces are not frozen.
- e. Identify required lines, levels, contours and datums.
- f. Proof roll existing subgrade as directed by the Engineer.
- g. Multiple cover spreading points will not be allowed. One initial spreading location shall be established, and the work shall proceed from this location towards a free end of the geomembrane. Select fill material must be placed using vertical placement techniques. No horizontal pushing of the initial soil lift above the geomembrane will be allowed.
- h. The landfill capping system must be constructed utilizing practices which will minimize the potential for slope failures. Gradual starting and stopping of all construction equipment will help reduce any dynamic loading which could cause a failure during the construction process.

3.2.3 For Type (C) select fill material, the following specific placement procedures shall be followed:

- a. Place select fill to contours and elevations shown on Contract Drawings. Use unfrozen materials.
- b. Spread select fill in loose lifts up to 12 inches thick and compact using the weight of the dozer and/or a smooth drum roller to a minimum 85% modified proctor density. Hand tamp or vibrate as required in areas not accessible to heavy compaction equipment.
- c. Where heavy compaction equipment cannot access, hand tamp or vibrate select fill in 6-inch lifts, and/or as directed by the Engineer.

3.2.4 For Type D select fill material, the following specific placement procedures shall be followed:

- a. Place select fill to contours and elevations shown on Contract Drawings.
- b. Hand tamp or vibrate in 6-inch lifts and/or as directed by the Engineer.

SECTION 02226

SELECT FILL MATERIALS

3.3 FIELD TESTING AND QUALITY CONTROL:

3.3.1 In-place density will be visually approved by the Engineer for the Type D select fill. For Type C select fill materials, in-place field density tests will be performed at a minimum frequency of 1 per 5,000 sf per lift or as requested by the Engineer at the Contractor's expense.

3.3.2 In addition to field density testing, the following laboratory testing will be performed at the Contractor's expense by an independent testing laboratory on samples of the select fill material. All samples of the select fill materials will be taken from in-place material.

- a. One grain size (ASTM D422) analysis every 1,000 cubic yards of in-place material, or as directed by the Engineer.
- b. One laboratory permeability test in accordance with ASTM D2434 per every 2,500 cubic yards of in-place Type D select fill, or as directed by the Engineer.

3.4 CRITERIA AND TOLERANCES:

3.4.1 Criteria and tolerances of the select fill material are as listed in Paragraph 2.1.

3.5 REMEDIATION OF FAILED TEST RESULTS:

3.5.1 If laboratory test results indicate that the in-place material fails to meet the required specifications, additional samples shall be taken in the field and tested in order to isolate the unacceptable area. Once the limits of unacceptable material have been defined, the Contractor shall remove the unacceptable material, replace it and retest the new material, at no additional cost to the Owner.

3.5.2 If unacceptable material is in the initial lift directly above a geomembrane, the unacceptable material will be removed to within 4 inches of the geomembrane and replaced. Testing of the final layer will be performed on a sample representative of the actual completed lift.

SECTION 02226

SELECT FILL MATERIALS

PART 4 - MEASUREMENT & PAYMENT

4.1 MEASUREMENT - SELECT FILL MATERIALS:

4.1.1 For Select Fill Materials, not included in other payment items, the quantity allowed for payment shall be computed by using the product of the length, depth as directed and the actual width, but not to exceed the Maximum Payment Width as shown on the Contract Drawings, less the volume occupied by the pipe or structure, if any.

4.2 PAYMENT - SELECT FILL MATERIALS:

4.2.1 For Select Fill Materials, not included in other unit or lump sum price items, payment for Select Fill Materials will be made at the applicable price stated in the Bid.

END OF SECTION

SPECIFICATIONS

SECTION 02237

COMPOSITE GEONET

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment to install a factory welded/heat laminated geocomposite consisting of geonet sandwiched between 6 oz/sq. yd nonwoven geotextile (both sides), as shown on the Plans, as specified, and/or directed.

1.1.2 Composite geonet shall be utilized as the gas venting layer below the capping system geomembrane and as the lateral drainage layer above the geomembrane.

1.2 SUBMITTALS:

1.2.1 Prior to the installation or delivery of composite geonet, the Contractor shall submit to the Engineer, from the geosynthetic manufacturer, guaranteed properties of the geonet, geotextile, and composite geonet to be used in liner construction, as outlined in Article 2.2 of this Section. The Contractor shall provide the Engineer, from the manufacturer, a written certification stating that the materials meet or exceed the guaranteed properties submitted.

1.2.2 In addition to submitting guaranteed physical properties, the Contractor shall submit to the Engineer the following documentation:

- A sample of Composite Geonet (6-inch x 6-inch minimum);
- Copies of quality control certificates issued by the raw material supplier;
- Results of tests conducted to verify the quality of the resin used to manufacture the composite geonet rolls assigned to the project;
- Certification that no post consumer reclaimed polymer is added to the resin during manufacturing. Rework material of the same or similar resin type is allowed up to 10%;
- Documentation demonstrating the chemical compatibility of the materials with leachate generated from mixed municipal solid waste. Such documentation shall include chemical compatibility testing results.
- Manufacturing quality control (QC) certificates for the geotextile material used in composite geonet manufacturing, signed by a responsible party of the manufacturer. QC certificates shall include roll numbers and identification and results of QC tests including test methods.

SECTION 02237

COMPOSITE GEONET

1.2.3 Transmissivity Testing Requirements

1.2.3.1 One performance transmissivity test result shall be submitted to the Engineer by the Contractor demonstrating that the composite geonet intended for use on the project meets the required transmissivity for the following conditions:

- Test Method: ASTM D4716
- Boundary Conditions:
 - Steel Plate
 - Site Specific Barrier Protection Soil
 - Composite Geonet
 - 40 mil textured LLDPE Geomembrane
 - Steel Plate
- Normal Load: 2,000 psf
- Gradient: 0.10
- Seat Time: 100 hrs

The required performance transmissivity for this project is $1.0 \times 10^{-4} \text{ m}^2/\text{sec}$. The composite geonet shall be tested in the machine direction as to be installed in the field.

1.2.3.2 Index transmissivity testing shall be performed on the same material tested for performance transmissivity in accordance with ASTM D4716. The test conditions shall include testing the composite geonet between two steel plates at a normal load of 2,000 psf and a gradient of 0.1. The seat time shall be 15 minutes. A minimum of three complete index transmissivity test results shall be submitted to the Engineer by the Contractor.

1.2.3.3 A ratio between the average index transmissivity testing results and the performance transmissivity test results shall be established and submitted to the Engineer by the Contractor.

1.2.3.4 Index transmissivity testing of conformance samples multiplied by the ratio established in 1.2.3.3 shall not have a minimum transmissivity of $1.0 \times 10^{-4} \text{ m}^2/\text{sec}$, and not vary more than 5% from the performance transmissivity test result.

SECTION 02237

COMPOSITE GEONET

1.2.4 Prior to delivery, the Contractor shall submit a construction drawing(s) illustrating the following aspects of the composite geonet installation:

- panel or sheet layout
- location and orientation of field seams or overlap splices
- any variances from the Contract Drawings
- any required details

1.2.4.1 The layout must be reviewed and approved by the Engineer prior to installation. All plans and details will be dimensional and of adequate scale to be used during construction.

1.2.5 Pre-Qualification: The Contractor shall submit the following information to the Engineer, for approval of the installer.

1.2.5.1 Copy of installer's letter of approval or license by the manufacturer and/or fabricator.

1.2.5.2 Corporate background and information.

1.2.5.3 Description of installation capabilities, including:

- a. information on equipment and personnel
- b. average daily production anticipated
- c. quality control procedures

1.2.5.4 Resume of the field engineer or installation supervisor to be assigned to this project, including dates and duration of employment.

1.2.6 Prior to delivery, the Contractor shall submit a sample of the warranty to be provided as described in paragraph 3.3.1.

1.3 DELIVERY:

1.3.1 All composite geonet will be inspected on delivery, and materials that do not comply with the Specification will be rejected. The Contractor shall furnish all labor required to handle the composite geonet during inspection and shall remove the rejected material from the site of the work.

SECTION 02237

COMPOSITE GEONET

1.4 CONFORMANCE TESTING:

1.4.1 Within one week of delivery and at the Engineer's direction, the Contractor shall provide the necessary labor, tools and equipment to obtain samples from the rolled composite geonet material, and send these samples to an independent quality assurance laboratory for testing at the Contractor's expense. As a minimum, the following tests will be performed on all composite geonets:

HDPE Geonet Core:

- carbon black content - ASTM D4218
- density - ASTM D1505
- thickness - ASTM D5199
- melt flow index - ASTM D1238

Composite Geonet:

- ply adhesion (both top and bottom interfaces) - ASTM D413
- index transmissivity - ASTM D4716

1.4.2 Samples will be taken by cutting along the width and 5 feet from the end of a rolled or folded geosynthetic material. The sampling frequency for the composite geonet will be one sample per every 100,000 square feet of respective material delivered.

1.4.3 For each lot number of composite geonet that arrives at the site, a sample shall be taken by the Contractor and provided to the Owner for archiving. This sample shall be 3 feet by the width of the roll of composite geonet.

SECTION 02237

COMPOSITE GEONET

PART 2 - PRODUCTS

2.1 MATERIALS:

2.1.1 Composite Geonet:

2.1.1.1 The composite geonet to be utilized in the landfill construction shall consist of a profiled mesh made by extruding a minimum of two sets of high density polyethylene strands together to form a bi-planar or tri-planar drainage net, sandwiched between and factory welded/heat-laminated to 6 oz./sq. yd. non-woven geotextile fabric layers (both sides). The resultant structure shall provide a high flow along the plane of the net. Composite geonet shall be produced and/or distributed by GSE Lining Technology, Tenax Corporation, SKAPS, or approved equal.

2.1.1.2 The composite geonet shall be protected from mud, dirt, dust, tearing, puncture, or any other damaging condition during shipment and storage. The composite geonet shall be capable of withstanding direct outdoor exposure for at least one year.

2.1.1.3 The composite geonet must be capable of retaining its structure during handling, placement, and long-term loading. Foamed HDPE products shall not be accepted.

2.1.1.4 The composite geonet shall be delivered on-site in bound rolls tagged with the following information:

- manufacturer's name
- product identification
- lot number
- roll number and dimensions

2.2 MINIMUM SPECIFIED VALUES:

2.2.1 Geonet Core Typical Specifications:

2.2.1.1 The table below lists the typical specification values for HDPE high compression load geonet. Final approval of geonet properties shall be made by the Engineer based upon Contractor's submittals.

SECTION 02237
COMPOSITE GEONET

TABLE 2A
TYPICAL DRAINAGE NET CORE PROPERTIES

PROPERTY	TEST METHOD	VALUE	UNITS
Thickness	ASTM D5199	250 (min.)	mil
Tensile Strength (MD / CD)	ASTM D4595	50 / 25 (min.)	lb/in
Density	ASTM D1505	0.935 (min.) to 0.955 (max.)	g/cm ³
Melt Flow Index	ASTM D1238	1.1 (max.)	g/10 min
Carbon Black Content	ASTM D4218	2 (min.)	%

MD = Machine Direction
CD = Cross Direction

2.2.2 Geotextile Typical Specifications:

TABLE 2B
TYPICAL GEOTEXTILE PROPERTIES

PROPERTY	TEST METHOD	VALUE	UNITS
Mass Per Unit Area	ASTM D3776	6 (MARV)	oz/sy
AOS	ASTM D4751	70 (MARV)	US Sieve
Permittivity	ASTM D4491	1.3 (MARV)	sec-1
Permeability	ASTM D4491	0.2 (MARV)	cm/sec
Grab Tensile Strength	ASTM D4632	160 (MARV)	lbs.
Grab Elongation	ASTM D4632	50 (MARV)	%
Trapezoid Tear	ASTM D4533	65 (MARV)	lbs
Puncture Strength	ASTM D4833	90 (min.)	lbs
Mullen Burst	ASTM D3786	325 (MARV)	psi
UV Resistance @ 500 hrs	ASTM D4355	70 (min)	%

MARV = Minimum Average Roll Value

SECTION 02237
COMPOSITE GEONET

2.2.3 Composite Geonet Typical Specifications:

TABLE 2C
TYPICAL COMPOSITE GEONET PROPERTIES

PROPERTY	TEST METHOD	VALUE	UNITS
Ply Adhesion	ASTM D413	1.0 (min.)	lb/in
Performance Transmissivity	ASTM D4716	1.0×10^{-4}	m ² /sec
Index Transmissivity	ASTM D4716	See Article 1.2.3.4	m ² /sec

PART 3 - EXECUTION

3.1 COMPOSITE GEONET INSTALLATION:

3.1.1 The following procedures and requirements will be followed during the installation of composite geonets.

3.1.2 Placement:

3.1.2.1 The placement of composite geonets shall not be conducted during adverse weather conditions. During windy conditions, all composite geonets will be secured with sandbags or an equivalent approved anchoring system. Removal of the sandbags or equal will only occur upon placement of an overlying soil layer or geosynthetic.

3.1.2.2 Proper cutting tools shall be used to cut and size the composite geonet material. Extreme care will be taken while cutting in-place geosynthetics, to obviate concerns of damaging underlying geomembrane liners or geosynthetic materials.

3.1.2.3 During the placement of composite geonets, all dirt, dust, sand or mud shall be kept off to prevent clogging. If contaminant materials are present on the composite geonet, then the net shall be hosed down with water until the contaminants are flushed free. Prior to placement of an overlying geosynthetic, the Engineer will verify that the geonet is free of potential clogging materials. If excessive contaminant materials are present on the geonet, it shall be cleaned or replaced as directed by the Engineer.

SECTION 02237

COMPOSITE GEONET

3.1.2.4 No equipment used will damage the composite geonet by handling, trafficking, or other means. Equipment, including ATVs, will not be allowed to travel directly on the material during the installation of overlying soils or geosynthetic layers unless otherwise determined by the Engineer.

3.1.3 Seaming or Joining:

3.1.3.1 Composite Geonets:

3.1.3.1.1 Composite geonets will be joined using the following procedures:

- a. Adjacent rolls will be placed such that the geotextile is overlapped by at least 3 inches and the geonet overlapped by at least 4 inches.
- b. The top geotextile overlap will be continuously sewn and the bottom geotextiles will be overlapped. Geonet overlaps will be secured by spot welding or tying.
- c. Tying can be achieved by plastic fasteners, or polymer braid. All ties will be white or yellow for easy observation.
- d. Spot welding or tying will be every 5 feet along the slope, every 2 feet across the slope and every 6 inches in the anchor trench. Spot welding or tying will be every 10 feet on slopes less than 10%.
- e. In the corners of the side slopes, where overlaps between perpendicular geonet strips are required, an extra layer of geonet will be unrolled along the slope, on top of the previously installed geonets, from top to bottom of the slope.

3.1.3.1.2 All damage to geonet will be repaired by placing geonet material over the damaged area with an overlap of 2 feet and then tying the patch every 6 inches using an approved tying method. Where damage to a geonet is greater than 50 percent of the roll width, the damaged portion will be removed and a new length of geonet spliced into the open area using the tying procedures above.

SECTION 02237

COMPOSITE GEONET

3.2 POST-CONSTRUCTION:

3.2.1 Upon completion of the installation, the Contractor shall submit to the Engineer:

- a. All quality control documentation to the Engineer.
- b. The warranty obtained from the manufacturer/fabricator.

3.3 WARRANTY:

3.3.1 The Contractor shall obtain and submit to the Engineer from the manufacturer a standard warranty provided for the composite geonet. The warranty shall guarantee that the composite geonet shall remain free from defects for a minimum of one (1) year from the date of substantial completion of the project. The Engineer will review the warranty for completeness prior to the Owner accepting its provisions.

PART 4 - MEASUREMENT & PAYMENT

4.1 MEASUREMENT - COMPOSITE GEONET:

4.1.1 Measurement for payment for Composite Geonet shall be based on the number of square feet placed as measured to the nearest foot excluding any overlaps and material in the anchor trench.

4.2 PAYMENT - COMPOSITE GEONET:

4.2.1 For Composite Geonet, not included in other unit or lump sum price items, payment for Composite Geonet will be made at the applicable price stated in the Bid.

4.2.2 The Owner shall pay for the cost of material delivered and properly stored on site upon receipt of all submittals and acceptable conformance test results. After installation of the material, the Owner shall retain 10 percent of the price of Composite Geonet until the Contractor provides the quality control documentation and the acceptable warranty.

END OF SECTION

SPECIFICATIONS

SECTION 02257

COMMON FILL

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Common Fill Material, as shown on the Plans, as specified, and/or directed.

1.1.2 Work under this Section shall include, but not necessarily be limited to excavating, transporting, dumping, spreading and compacting common fill material in the locations and to the depths and grades shown on the Contract Drawings or as directed by the Engineer.

1.1.3 Common Fill will be used to construct the barrier protection layer of the landfill capping system as well as the soil cover of the restoration area final cover system.

1.2 SUBMITTALS: The Contractor shall submit to the Engineer for approval a certified sieve analysis, Modified Proctor, Atterberg Limits and Triaxial Permeability Test as determined by an independent testing laboratory for each common fill material to be used at the site at no cost to the Owner. All tests will be performed in accordance with the methods outlined in this Section.

PART 2 - PRODUCTS

2.1 MATERIALS:

2.1.1 Common Fill Material shall be natural soil, free from excessive moisture, frost, stumps, trees, roots, sod, muck, marl, vegetable matter or other unsuitable materials.

2.1.2 Common Fill Material shall be well graded from fine to coarse with a minimum of 15 percent passing by weight the No. 200 sieve. Stones, if any shall not exceed six (6) inches in the greatest dimension. In addition, the material shall possess a maximum permeability of 1.0×10^{-5} cm/sec at a minimum of 90 percent modified proctor compaction.

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COMMON FILL

PART 3 - EXECUTION

3.1 PLACEMENT:

3.1.1 The entire surface to be covered with common fill shall be stripped of all grass, vegetation, top soil, rubbish, or other unsuitable materials before backfilling.

3.1.2 In general, common fill shall be placed in horizontal layers not exceeding eight (8) inches in loose thickness and shall be compacted according to the criteria and tolerances of Paragraph 3.3 unless otherwise noted in this Section. Stones, if any, shall not exceed six (6) inches in greatest dimension and shall be well distributed throughout the mass. Subgrade for common fill shall be approved by the Engineer. Where common fill is to be constructed across ground which will not support the weight of the construction equipment, the fill shall be constructed by placing 16 oz/yd² nonwoven geotextile on the subgrade or the soft soils excavated and replaced with suitable backfill as approved by the Engineer.

3.1.3 For barrier protection layer construction, the material shall be placed in one twelve (12) inch lift. For restoration area construction, the material shall be placed in one eight (8) inch lift.

3.1.4 Each layer of common fill material shall be thoroughly tamped or rolled to the required degree of compaction by sheepsfoot, mechanical tampers, or vibrators. Successive layers shall not be placed until the layer under construction has been thoroughly compacted and properly scarified to promote interlift bonding.

3.1.5 Sheepsfoot rollers shall be used wherever possible to compact common fill soil and shall have a weight on each row of feet of not less than two hundred (200) nor more than five hundred (500) pounds per square inch of foot surface.

3.1.6 Common Fill placed above geosynthetics shall be spread with a minimum initial lift thickness of 12 inches using tracked equipment with ground pressures not exceeding 7 pounds per square inch. No construction equipment will be driven directly on the geosynthetics. All rubber-tired vehicles will access construction above geosynthetics from temporary access roads built a minimum of 3 feet above the geosynthetics.

SECTION 02257

COMMON FILL

3.1.7 Trucks or other heavy equipment shall not be operated over pipelines until a minimum of twenty-four (24) inches of backfill above the crown of the trenched pipe has been placed and properly compacted by tampers or other approved method.

3.1.8 Where required, the Contractor shall, at his own expense, moisture condition the fill to meet the compaction requirements of the specification. If, due to rain or other causes, the material is too wet for satisfactory compaction, it shall be allowed to dry or be removed as required, before compaction.

3.2 FIELD TESTING AND QUALITY CONTROL:

3.2.1 Common fill shall be compacted to a minimum dry density of ninety (90) percent of the maximum dry weight density in pounds per cubic foot as determined by the Modified Proctor Compaction Test, ASTM D1557 unless otherwise noted on the Contract Drawings or Specifications. Modified Proctor, Grain Size Analyses (ASTM D422 and 2217) and Atterberg Limits (ASTM D4318) shall be performed for each 5,000 cubic yard of fill placed by an independent testing laboratory at the Contractor's expense.

3.2.2 For barrier protection layer construction, one laboratory permeability test using a triaxial cell with back pressure (D5084) shall be performed for each 5,000 cubic yard of fill placed. Permeability testing for material placed for the common fill soil cover of the restoration area final cover system is not required.

3.2.3 In-place density testing according to ASTM D2922, D2167 or D1556 procedures will be conducted at the frequencies given below:

- in-place testing will be performed at a frequency of one per 10,000 square feet per lift of common fill.

3.2.4 All in-place density tests will be located according to an approved testing grid system. Elevations will be established from known existing benchmarks by Contractor. Contractor shall establish the grid system in the field such that work areas can be easily located by the Engineer.

SECTION 02257

COMMON FILL

3.3. CRITERIA AND TOLERANCES:

3.3.1 Criteria and tolerances of common fill are as follows:

- Compaction - a minimum of 90 percent of the maximum dry density as determined by the Modified Proctor Method unless otherwise specified or directed.
- Requirements stated in Article 2.1 of this Section.

PART 4 - MEASUREMENT & PAYMENT

4.1 MEASUREMENT - COMMON FILL:

4.1.1 Measurement of the quantity of Common Fill, allowed for payment, shall be computed, after compaction, by using the product of the length, depth as directed, and the actual width, but not to exceed the established lines as shown on the drawings or as directed by the Engineer, less the volume occupied by any pipe or structures, if any.

4.2 PAYMENT - COMMON FILL:

4.2.1 For Common Fill, not included in other unit or lump sum price items, payment for Common Fill will be made at the applicable price stated in the Bid.

END OF SECTION

SPECIFICATIONS

SECTION 02271

RIPRAP

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Riprap, as shown on the Plans, as specified, and/or directed.

1.1.2 The Contractor shall furnish all plant, labor, equipment and materials and perform all work necessary to place a protective covering of erosion-resistant Riprap at locations shown on the Plans and as directed by the Engineer. The work shall be done in accordance with these specifications and in conformity with the lines and grades shown on the Plans or established by the Engineer. The type of Riprap to be used shall be as indicated on the Contract Drawings.

PART 2 - PRODUCTS

2.1 RIPRAP:

2.1.1 Stone used for Riprap shall be hard, durable, angular in shape, resistant to weathering and to water action, free from overburden, spoil, shale and organic material, and shall meet the gradation requirements for the type specified. Neither breadth nor thickness of a single stone should be less than one-third its length. Rounded stone or boulders will not be accepted unless authorized by the Engineer. Broken concrete may be substituted for stone when authorized by the Engineer. Shale and stone with shale seams are not acceptable. The minimum unit weight of the stone shall be 155 pounds per cubic foot as computed by multiplying the specific gravity (bulk-saturated-surface-dry basis, AASHTO Test T85) times 62.4 pounds per cubic foot.

2.1.2 The sources from which the stone will be obtained shall be selected for approval by the Engineer well in advance of the time when the stone will be required in the work. The acceptability of the stone will be determined by service records and/or by suitable tests, as required by the Engineer. If testing is required, suitable samples of stone shall be taken in the presence of the Engineer at least 25 days in advance of the time when the placing of Riprap is expected to begin. The approval of some rock fragments from a particular quarry site shall not be construed as constituting the approval of all rock fragments taken from that quarry.

SECTION 02271

RIPRAP

2.1.3 The quality of all material used for Riprap shall be determined by the Magnesium Sulfate Soundness Test, if so elected by the Engineer. A maximum 10 percent loss at ten (10) cycles, by weight, shall be acceptable.

2.1.4 The types of Riprap to be provided shall conform to the following gradation requirements:

<u>Type</u>	<u>% Passing</u>	<u>Stone Size</u>
I	90-100	Smaller than 8 inches
	50-100	Larger than 3 inches
	0-10	No. 10
II	90-100	Lighter than 100 lbs.
	50-100	Larger than 6 inches
	0-10	Smaller than 1/2 inch
III	50-100	Heavier than 100 lbs.
	0-10	Smaller than 4 inches
IV	50-100	Heavier than 600 lbs.
	0-10	Smaller than 6 inches

2.1.5 Each load of Riprap shall be reasonably well graded from the smallest to the maximum size specified. Stones smaller than the specified 10 percent size and spalls will not be permitted in an amount exceeding 10 percent by weight of each load.

2.1.6 Control of gradation will be by visual inspection. If requested by the Engineer, the Contractor shall provide two samples of rock of at least 5 tons each, meeting the gradation for the type specified. The sample at the construction site may be a part of the finished Riprap covering. The other sample shall be provided at the quarry. These samples shall be used as a frequent reference for judging the gradation of the Riprap supplied. Any difference of opinion between the Engineer and the Contractor shall be resolved by dumping and checking the gradation of two random truck loads of stone. Mechanical equipment, a sorting site, and labor needed to assist in checking gradation shall be provided by the Contractor at no additional cost to the Owner.

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RIPRAP

2.1.7 In addition to meeting the gradation requirements set forth in this section for the type of Riprap indicated, Riprap shall consist of stones shaped as nearly as practicable in the form of right rectangular prisms. One dimension of the majority of the stones furnished shall be at least equal to the thickness as shown on the Plans.

2.2 BEDDING:

2.2.1 Bedding material shall be provided below the Riprap if indicated on the Plans or directed by the Engineer. Bedding material shall be composed of crushed stone, crushed air cooled blast furnace slag, or gravel, free of soft nondurable particles, organic material, and thin or elongated particles.

2.2.2 Bedding material shall meet the following gradation requirements:

<u>Sieve Designation</u>	<u>% Passing</u>
4 inches	100
1 inch	15-60
1/4 inch	0-25
No. 40	0-10

PART 3 - EXECUTION

3.1 PLACEMENT:

3.1.1 Slopes to be protected by Riprap shall be free of brush, topsoil, trees, stumps, and other objectionable material and shall be dressed to a smooth surface. All soft or spongy material shall be removed to the depth shown on the Plans or as directed by the Engineer and replaced with approved material. Filled areas will be compacted as specified. If shown on the Plans, a toe trench shall be dug and maintained until the Riprap is placed.

SECTION 02271

RIPRAP

3.1.2 Protection for structure foundations shall be provided as early as the foundation construction permits. The area to be protected shall be cleaned of waste materials and the surfaces to be protected prepared as shown on the Plans. The type of Riprap specified will be placed in accordance with these Specifications.

3.1.3 When shown on the Plans, a bedding material blanket shall be placed on the prepared slope or area to be provided with Riprap as specified in Paragraph 3.2.1 before the stone is placed.

3.1.4 Stone for Riprap shall be placed on the prepared slope or area in a manner which will produce a reasonably well-graded mass of stone with the minimum practicable percentage of voids. The entire mass of stone shall be placed so as to be in conformance with the lines, grades, and thicknesses shown on the Plans. Riprap shall be placed to its full course thickness in one operation and in such a manner as to avoid displacing the underlying material. Placing of Riprap in layers, or by dumping into chutes, or by similar methods likely to cause segregation will not be permitted.

3.1.5 The larger stones shall be well distributed, and the entire mass of stone shall conform to the gradation specified in Paragraph 2.1.4. All material going into Riprap protection shall be so placed and distributed that there will be no large accumulations of either the larger or smaller sizes of stone.

3.1.6 It is the intent of these Specifications to produce a fairly compact Riprap protection in which all sizes of material are placed in their proper proportions. Hand placing or rearranging of individual stones by mechanical equipment may be required to the extent necessary to secure the results specified.

3.1.7 Unless otherwise authorized by the Engineer, the Riprap protection shall be placed in continuous progression with the construction of the embankment. The Contractor shall maintain the Riprap protection until accepted, and any material displaced by any cause shall be replaced to the lines and grades shown on the Plans at no additional cost to the Owner.

3.1.8 When Riprap and bedding material are placed under water, thickness of the layers shall be increased as shown on the Plans; and methods shall be used that will minimize segregation.

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RIPRAP

3.1.9 Riprap shall be placed so that the dimension approximately equal to the layer thickness is perpendicular to the slope surface and that the weight of the stone is carried by the underlying material and not by the adjacent stones. On slopes, the largest stones shall be placed at the bottom of the slope. The Riprap shall be properly aligned and placed so as to minimize void spaces between adjacent stones. The spaces between the stones shall be filled with spalls of suitable size.

3.2 BEDDING MATERIAL:

3.2.1 Bedding material shall be placed where shown on the Plans or as directed by the Engineer. The bedding material shall be placed on the prepared area to the full specified thickness of each layer in one operation, using methods which will not cause segregation of particle sizes. Contamination of bedding material by natural soils or other materials shall be prevented at all times. Bedding material that becomes contaminated shall be removed and replaced with uncontaminated bedding material at the Contractor's own expense. Filter fabric shall be placed below the bedding material, if shown on the Plans.

PART 4 - MEASUREMENT & PAYMENT

4.1 MEASUREMENT - RIPRAP:

4.1.1 The quantity of Riprap and bedding material to be paid for, of specified thickness and extent, in place and accepted, shall be the number of cubic yards as computed from surface measurements parallel to the Riprap surface and thickness measured normal to the Riprap surface.

4.2 PAYMENT - RIPRAP:

4.2.1 For Riprap, not included in other unit or lump sum price items, payment for Riprap will be made at the applicable price stated in the Bid.

END OF SECTION

SPECIFICATIONS

SECTION 02435

PVC PLASTIC PIPE AND FITTINGS

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all referenced materials for PVC Plastic Pipe And Fittings, as shown on the Plans, as specified, and/or directed.

1.1.2 Material in this Section shall be used in the construction of the landfill gas vents.

1.2 SUBMITTALS:

1.2.1 The Contractor shall submit six (6) copies of the Manufacturer's material Specifications for each item to be supplied under this Section.

PART 2 - PRODUCTS

2.1 PVC PLASTIC PIPE AND FITTINGS: All PVC pipe and fittings shall be Schedule 40.

2.1.1 PVC material for the pipe and fittings shall meet the requirements of ASTM D1784 for Rigid Poly (Vinyl Chloride) Compounds and Chlorinated Poly (Vinyl Chloride) Compounds, Class 12454-B, or Class 12454-C.

2.1.2 The PVC pipe and fittings shall be extruded or molded in such a manner that all cross sections shall be dense, homogeneous, and free from porosity or other imperfections. The molded or extruded pipe and fittings shall conform to ASTM D1785 for Polyvinyl Chloride (PVC) Plastic Pipe and ASTM D2467 for Polyvinyl Chloride (PVC) Plastic Pipe Fittings.

2.1.3 Standard length of all pipe shall be 10 or 20 feet. Provide one coupling for each length of pipe provided. All pipe and fittings shall be of the solvent weld type unless otherwise indicated. Provide adequate solvent cement for the number of couplings and fittings provided.

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PVC PLASTIC PIPE AND FITTINGS

2.1.3.1 The solvent cement shall be a solution of unplasticized PVC, tetrahydrofuran and cyclohexanone. The solvent cement shall meet the requirements of ASTM D2564 for Solvent Cements for Schedule 40 PVC plastic pipe and fittings. The solvent cement shall be heavy-bodied, grey cement specifically designated for use with Schedule 40 PVC pipe and humid weather. Primer shall be purple primer meeting the requirements of ASTM F656 for Primers/Cleaners for PVC piping systems.

2.1.4 Where perforated pipe is specified, perforations shall be 5/8-inch diameter holes on 5-inch centers, in four rows, 90 degrees apart. Slotted PVC pipe can be substituted for perforated pipe. When slotted is specified, slot shall be 2-inch typ., 0.020 slot.

PART 3 - EXECUTION

3.1 QUALITY ASSURANCE:

3.1.1 All pipe, fittings, and specials will be inspected on delivery, and materials that do not comply with the Specification will be rejected. The Contractor shall furnish all labor required to handle the pipe and related materials during inspection and shall remove the rejected materials from the site of work.

3.2 INSTALLATION:

3.2.1 Installation of all pipe, fittings, specials, adapters and appurtenances shall conform to the manufacturer's recommendations and the following summary of installation recommendations. Where Specifications and recommendations conflict, the strictest shall apply.

3.2.2 Proper implements, tools and facilities satisfactory to the Engineer shall be provided and used by the Contractor for the safe and convenient execution of the work.

3.2.3 Pipe shall be installed to the lines and grades on a prepared special embedment or support system, as shown, specified, or directed.

3.2.4 The interior surface of all pipe shall be clean when installed, and shall be kept clean until final acceptance. Removable end caps shall be placed on all open ends of pipe lines when pipe laying is not actively in progress. The bulkheads shall be designed to prevent the entrance of dirt, debris or small animals, and shall not be removed until pipe laying is resumed.

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PVC PLASTIC PIPE AND FITTINGS

PART 4 - MEASUREMENT & PAYMENT

4.1 MEASUREMENT - PVC PLASTIC PIPE AND FITTINGS:

4.1.1 Measurement of the quantity of PVC Plastic Pipe and Fittings, allowed for payment shall be the actual linear feet of pipe installed and the number of each type of fitting installed.

4.2 PAYMENT - PVC PLASTIC PIPE AND FITTINGS:

4.2.1 For PVC Plastic Pipe And Fittings, not included in other unit or lump sum price items, payment for PVC Plastic Pipe And Fittings will be made at the applicable price stated in the Bid.

END OF SECTION

SPECIFICATIONS

SECTION 02444

FENCE, CHAIN LINK

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Fence, Chain Link, including accessory items of work herein described, as shown on the Plans, as specified and/or directed.

1.2 REFERENCES: The publications listed below and their latest revisions form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only.

1.2.1 American Society for Testing and Materials (ASTM) Publications:

A123	Standard Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated From Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A392	Standard Specification for Zinc-Coated Chain-Link Fence Fabric
A491	Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric
A817	Standard Specification for Metallic Coated Steel Wire for Chain-Link Fence Fabric
F567	Standard Practice for Installation of Chain-Link Fence
F1083-9	Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures

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FENCE, CHAIN LINK

F1083-9

Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures

1.3 SUBMITTALS:

1.3.1 Shop Drawings and Catalog Cuts: Show all fencing components, details of fencing and accessories. These drawings or cuts shall be accompanied by a layout drawing showing spacing of posts, end and pull posts. Drawing shall also show fence height and concrete footing details.

1.3.2 Manufacturer's Certificate of Conformance: Certify that materials and coatings furnished have been tested and conform to the referenced ASTM Specification.

- a. Posts
- b. Braces
- c. Framing
- d. Rails
- e. Tension Wire
- f. Fabric

1.4 DELIVERY, STORAGE, AND PROTECTION: Deliver materials to the site in an undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact.

PART 2 - PRODUCTS

2.1 POSTS, RAILS, BRACES AND GATE FRAMES: All posts, rails, gate frames, and post braces shall be hot-dip galvanized Schedule 40 standard steel pipe.

2.1.1 Minimum pipe diameters shall be as follows:

End, corner and pull posts	2-7/8" OD, 5.79 lb per foot
Line posts	2-3/8" OD, 3.65 lb per foot

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FENCE, CHAIN LINK

Swing gate posts

- | | |
|-----------------------------------|-----------------------------|
| a. Single swing (up to 6 feet) | 2-7/8" OD, 5.79 lb per foot |
| Single swing (from 6 to 13 feet) | 4" OD, 9.11 lb per foot |
| b. Double swing (up to 12 feet) | 2-7/8" OD, 5.79 lb per foot |
| Double swing (from 12 to 26 feet) | 4" OD, 9.11 lb per foot] |
| Top rail | 1-5/8" OD, 2.27 lb per foot |
| Horizontal post braces | 1-5/8" OD, 2.27 lb per foot |

2.1.2 All posts shall be equipped with pressed steel combination tops. Tops shall be provided with a hole to permit through passage of the top rail.

2.2 FENCE FABRIC:

2.2.1 Wire for chain link fence fabric shall be No. 9 coated wire gauge carbon steel produced in accordance with ASTM A392 or ASTM 491, Class 2 with a 2-inch mesh; twisted selvage at top, knuckled selvage at bottom. The fabric shall be stretched taut and anchored so that a pull of 150 pounds at the middle of a panel will not lift the bottom of the fabric more than 6 inches.

2.2.2 Coated fence fabric shall be produced from helically wound and interwoven steel wire forming a continuous 2-inch mesh.

2.2.3 Ties or clips of adequate strength shall be provided in sufficient number for attachment of the fabric to line posts at intervals not exceeding 16 inches and to the top rail and bottom tension wire at a maximum 24-inch spacing.

2.3 TENSION BARS: Tension bars shall be minimum 3/16-inch by 3/4-inch flat steel plates and no more than 2 inches shorter than the fabric height. Bars shall be hot-dip galvanized.

2.4 TERMINAL POST BANDS: Bands or clips of adequate strength shall be provided in sufficient number for attachment of the fabric and stretcher bars to all terminal posts at intervals not exceeding 15 inches. Tension bands shall be formed from No. 12 gauge flat or beveled steel and attached with 3/8-inch diameter carriage bolts hot-dip galvanized.

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FENCE, CHAIN LINK

2.5 FENCING ACCESSORIES: All accessories shall have zinc coatings.

2.6 TENSION WIRE: Bottom tension wire shall be 7 gauge galvanized coil spring wire.

2.7 GATES:

2.7.1 Gates shall be swing type as shown on Engineer's design drawings, complete with latches, stops, keepers and hinges.

2.7.2 Gate frames shall be constructed of Schedule 40, 1-7/8-inch OD standard steel pipe hot-dip galvanized. Frames shall be welded at corners or assembled with fittings, and when fittings are used, 3/8-inch minimum diameter truss rods shall be provided to prevent sag or twist.

2.7.3 Gate leaves shall have vertical intermediate bracing as required, spaced so that no members are more than 8 feet apart. Gate leaves 10 feet or over shall have a horizontal brace or one 3/8-inch minimum diameter diagonal truss rod.

2.7.4 Gate fabric shall be the same type as used in the fence construction.

2.7.5 Hinges for swing gates shall permit full opening to a position parallel to the fence. Hinges shall not twist or turn under gate motion, and shall be non-removable after installation. The gate should be easily opened by one person.

2.7.6 Gate latches, stops, and keepers shall be provided for gates. Latches shall have a plunger-bar arranged to engage the center stop, except that for single gates for openings less than 10 feet wide a forked latch may be provided. Catches shall be arranged for locking. Center stops shall consist of a device arranged to be set in concrete and to engage a plunger bar of the latch of double gates. No stop is required for single gates. Keepers shall consist of a mechanical device for securing the free end of the gate in the full open position.

2.7.7 All gate hardware shall be zinc coated.

2.8 FOOTINGS:

2.8.1 Where posts are set in earth, concrete foundations 36 inches deep shall be provided. If bedrock is encountered, post excavation shall be continued to the 36-inch depth or 18 inches into the rock, whichever is less. Concrete foundations shall be circular in horizontal section, not less

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FENCE, CHAIN LINK

than 10 inches in diameter for line posts, and with a diameter not less than the post OD plus 9 inches for terminal and gate posts, except that foundations in bedrock shall be a minimum of 6 inches larger than the outside dimension of the post. Foundations shall extend above the ground surface and shall be crowned approximately 1 inch.

2.8.2 Concrete for foundations shall conform to the following:

1. Minimum strength at 28 days shall be 3,000 psi.
2. Portland cement - Type I - ASTM C150.
3. Course and fine aggregates - ASTM C33.
4. Air entrainment - 5 to 7% - by admixture only.
5. Maximum slump - 3".
6. Maximum water-cement ratio to be 0.46.

2.8.2.1 Ready mix concrete from an established company can be used if it conforms to ASTM C94 and this Specification.

2.8.3 Placement:

2.8.3.1 Before placing concrete, all debris, water, snow and ice shall be removed from the footing excavation.

2.8.3.2 Do not suspend or interrupt placing of concrete once a pour has started for each footing.

2.8.3.3 All concrete shall be protected against injury by sun, rain, freezing, premature drying or other damage. Maintain concrete above 50°F in a moist or wet condition for at least the first 7 days. Cover footing with wet burlap, wet sand, curing paper or insulating blankets.

2.8.3.4 Cold weather protection shall conform to ACI 306R-88. Hot weather protection shall conform to ACI 305R-89.

2.8.3.5 Do not pour concrete against frozen soil. Protect concrete against freezing and subgrade from heaving. Any frozen concrete or heaved footings will be removed and replaced at the Contractor's expense.

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FENCE, CHAIN LINK

2.8.4 Concrete shall cure for a minimum of 72 hours after posts are set before fence installation continues.

PART 3 - EXECUTION

3.1 INSTALLATION: Install fence in accordance with the fence manufacturer's written installation instructions except as modified herein. Fencing shall consist of galvanized steel framework and steel fabric with a height of 7 feet. The fence shall have a top rail and bottom tension wire.

3.1.1 Grading: Establish a graded fence line prior to fencing installation. Clear the fence line of all obstacles that will interfere with the fencing.

3.1.2 Post Spacing: Provide line posts spaced equidistant apart, not to exceed 10-foot centers maximum.

3.1.3 Bracing: Brace gate, end and corner posts to the nearest adjoining line post at mid height with a horizontal standard steel pipe used as a compression member and a diagonal truss rod and truss tightener used as a tension member. Diagonal tension bracing provided from end, corner, or gate posts to line posts shall consist of 3/8-inch minimum diameter steel truss rods with turnbuckles or equivalent provision for adjustment.

3.1.4 One tension bar shall be provided for each end and gate post, and two (2) for each corner and pull post.

3.1.5 Post Caps: Design post caps to accommodate the top rail. Install post caps as recommended by the manufacturer.

3.1.6 Top Rails: Install top rails before installing chain-link fabric. Pass top rail through intermediate post caps. Rails shall be furnished in random lengths averaging a minimum of 18 feet. Joints shall be made up with extra long pressed steel sleeves (6 inches long) to provide a rigid connection while permitting expansion and contraction. Expansion springs shall be provided in every fifth coupling.

SECTION 02444

FENCE, CHAIN LINK

3.1.7 Bottom Tension Wires: Install bottom tension wires before installing chain-link fabric, and pull wires taut. Bottom tension wires shall be within 8 inches and the respective fabric edge. Fabric shall be attached to wires at 24 inches on center.

3.1.8 Padlocks: Provide padlocks for gate openings and provide chains that are securely attached to gate or gate posts. Provide padlocks keyed alike, and provide two keys for each padlock.

3.2 CLEANUP: Remove waste fencing materials and other debris from the fencing site.

PART 4 - MEASUREMENT & PAYMENT

4.1 MEASUREMENT - FENCE, CHAIN-LINK:

4.1.1 Measurement for Fence, Chain Link shall include the cost of all materials, equipment, labor, submittals and testing for the work indicated in this Section.

4.2 PAYMENT - FENCE, CHAIN LINK:

4.2.1 For Fence, Chain Link, not included under other unit or lump sum price items, payment for Fence, Chain Link will be made at the applicable price stated in the Bid.

END OF SECTION

SPECIFICATIONS

SECTION 02484

TOPSOIL

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Topsoil as shown on the Plans, as specified, and/or directed.

PART 2 - PRODUCTS

2.1 MATERIAL:

2.1.1 The Contractor shall furnish topsoil from an approved source or sources off the Site. The off-site material shall contain no admixture of refuse or any material toxic to plant growth and shall be free from subsoil, stumps, roots, brush, stones, clay lumps or similar objects larger than two inches in greatest dimension. Sod and herbaceous growth such as grass and weeds need not be removed. Topsoil shall not be delivered or placed in a frozen or muddy condition.

2.1.3 Contractor to condition topsoil as necessary. Topsoil from off-site sources shall have an acidity range of pH 5.0 to 8.0 and shall contain 2 to 6% organic matter as determined by loss of ignition of moisture-free samples dried at 100 degrees C.

1. Where topsoil pH is below 5.0, lime shall be added at a rate of 2-1/2 lbs. per cubic yard of topsoil to raise the pH value one full point.
2. Where topsoil pH is above 8.0, aluminum sulfate shall be added at a rate of 2-1/2 lbs. per cubic yard of topsoil to lower the pH value one full point.

2.2 SOIL AMENDMENTS:

2.2.1 Lime: Natural dolomitic limestone containing not less than 85 percent of total carbonates with a minimum of 30 percent magnesium carbonates, ground so that not less than 90 percent passes a 10-mesh sieve and not less than 50 percent passes a 100-mesh sieve.

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TOPSOIL

2.2.2 Aluminum Sulfate: Commercial grade, in dry powder form.

2.3 SUBMITTALS:

2.3.1 The Contractor shall submit six (6) copies of a pH test and organic content test for the Engineer's review for each source of topsoil to be used.

PART 3 - EXECUTION

3.1 QUALITY ASSURANCE

3.1.1 Topsoil will be visually inspected upon delivery and material that does not comply with the Specification will be rejected. If a noticeable change in topsoil quality is identified by the Engineer, the Contractor shall perform additional pH and organic content tests of the new material at no additional cost to the Owner.

3.2 PLACING:

3.2.1 Topsoil shall include fine grading the surface of the ground upon which topsoil is to be placed and the furnishing and placing of topsoil in the areas to be seeded or planted.

3.2.2 Depth of topsoil shall be minimum of 6 inches for the landfill capping system and a minimum of 4 inches over the restoration area, unless otherwise shown or directed.

3.2.3 After approval by the Engineer of the fine grading of the subgrade, the topsoil shall be spread and compacted with a light roller to the lines, grades and elevations shown on the drawings, or directed by the Engineer, without unsightly variations, ridges or other depressions which will hold water. Any stone, litter or objectionable material (roots, branches, etc.) shall be removed from the topsoil and the surface raked to true lines. Any uneven spots shall be leveled. The work shall not be performed during unsuitable weather.

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TOPSOIL

PART 4 - MEASUREMENT & PAYMENT

4.1 MEASUREMENT - TOPSOIL:

4.1.1 The quantity allowed for payment for Topsoil shall be the actual number of cubic yards of compacted material in place computed as the area covered times the thickness.

4.2 PAYMENT - TOPSOIL:

4.2.1 For Topsoil, not included in other unit or lump sum price items, payment for Topsoil will be made at the applicable price stated in the Bid and shall cover all costs and expense incidental to excavating from storage, transporting, rehandling and placing in the completed work as shown, specified and directed. No payment will be made for any portion of this item until the Topsoil has been placed in final location.

END OF SECTION

SPECIFICATIONS

SECTION 02485

SEEDING

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Seeding as shown on the Plans, as specified, and/or directed.

1.1.2 The Contractor shall seed new areas and disturbed areas where shown on the Drawings, specified or directed by the Engineer. Contractor shall prepare the seed bed by scarifying or otherwise loosening soil to a depth of 2 inches, applying fertilizer, lime, seed and mulch at the rates specified.

PART 2 - PRODUCTS

2.1 MATERIALS:

2.1.1 Fertilizer:

2.1.1.1 Commercial fertilizer (19-19-19) shall contain not less than nineteen percent nitrogen, nineteen percent available phosphoric acid and nineteen percent water soluble potash. The fertilizer shall be inorganic or a combination of inorganic and organic substances.

2.1.1.2 If, as an alternative, the Contractor wishes to substitute another fertilizer, such as 10-20-10 to 6-12-6, he may do so with the approval of the Engineer, and the rate of fertilizer to be used shall be whatever amount is required to furnish the same amount of nitrogen as would be supplied by the 19-19-19.

2.1.1.3 Commercial fertilizer shall be delivered in original bags of the manufacturer, showing weight, analysis and the name of the manufacturer.

2.1.1.4 If the commercial fertilizer is not used immediately after delivery, the Contractor shall store it in such a manner that its effectiveness will not be impaired.

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SEEDING

2.1.2 Seed:

2.1.2.1 Grass seed shall be a mixture of the species and/or varieties specified, mixed in the proportions specified.

2.1.2.2 The seed shall be fresh, recleaned and of the latest crop year. It shall conform to Federal and State Standards. Each type of grass in the mixture shall meet or exceed the minimum percentage purity and germination listed for that type of grass.

2.1.2.3 The following seed mixture shall be used for ditches, slopes and all areas disturbed by construction.

<u>Percentage by Weight</u>	<u>Species or Variety</u>	<u>Percent Germination</u>
40	"Lancer" Perennial Pea	85%
20	Perennial Ryegrass	85%
10	New Zealand White Clover	85%
10	Timothy Grass	85%
10	Orchard Grass	85%
10	Smooth Bromegrass	85%

2.1.2.4 For excessively wet areas, Reed Canary Grass shall be utilized.

2.1.2.5 The balance of material in an acceptable seed mixture, other than specified pure live seed shall, for the most part consist of non-viable seed, chaff, hulls, live seeds of crop plants and harmless inert matter. The percentage of weed shall not exceed one percent by weight for the mixture.

2.1.2.6 All seed mixtures furnished under this Item shall be mixed by the vendor and shall be delivered in standard sized bags of the vendor, showing the weight, analysis and vendor's name.

2.1.2.7 All seed shall be properly stored by the Contractor at the site of the work and any seed damaged during storage shall be replaced.

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SEEDING

2.1.3 Mulch:

2.1.3.1 Straw or hay mulch shall consist of oats, wheat, rye or other approved crops which are free of noxious weeds. Weight shall be calculated on the basis of the straw having not more than 15% of moisture content.

2.1.4 Erosion Control Blankets:

2.1.4.1 The erosion control blanket shall be a machine-produced mat of 100% agricultural straw. The blanket shall be of consistent thickness with the straw evenly distributed over the entire area of the mat. The blanket shall be covered on the top and bottom sides with a lightweight photodegradable polypropylene netting having an approximate 1/2-inch x 1/2-inch mesh. The blanket shall be sewn together on 1.5-inch centers with degradable thread.

2.1.4.2 The straw erosion control blankets shall be S150 as manufactured by North American Green, or equivalent. The erosion control blanket shall have the following material content:

Straw	-	100% (1/2 lb/sy)
Netting	-	Both sides lightweight photodegradable (1.64 lb/1,000 sf)
Thread	-	Degradable

2.1.4.3 All erosion control blankets shall be properly stored by the Contractor at the site per manufacturer's recommendations. Any blankets damaged during storage shall be replaced at the Contractor's expense.

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SEEDING

PART 3 - EXECUTION

3.1 INSTALLATION:

3.1.1 Time For Seeding:

3.1.1.1 Grass seed shall be sown from March 15th to May 15th or from August 15th to October 1st, unless in a favorable season, and upon written permission of the Engineer, the seeding period is extended. All seeding shall be done in a dry or moderately dry soil and at times when the wind does not exceed a velocity of five miles per hour.

3.1.2 Preparation of Seed Bed:

3.1.2.1 After the finished grading is completed and just before seeding, the areas to be seeded shall be loosened to a depth of two inches and free from depressions which will hold water. All sticks, stones, clods, roots or other objectionable material which might interfere with the formation of a fine seed bed shall be removed from the soil.

3.1.2.2 Commercial fertilizer shall be evenly applied at the rate of 300 pounds per acre.

3.1.3 Seeding:

3.1.3.1 Grass seed mixture shall be sown at the rate of 200 pounds per acre.

3.1.3.2 The seed shall be sown by hand or by an approved machine, in such a manner that a uniform stand will result.

3.1.3.3 After sowing, seeded areas shall be rolled with a light lawn roller weighing not more than one hundred pounds per foot of width.

3.1.4 Mulching:

3.1.4.1 Within three days after the seed is sown, the seeded areas shall be covered with a uniform blanket of straw mulch at the rate of 1,000 pounds per acre of seeded area or as required to provide 90% coverage (i.e., lightly cover 90% of the surface).

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SEEDING

3.1.5 Hydroseeding:

3.1.5.1 The Contractor may substitute a hydroseeding process for hand seeding and mulching as specified above.

3.1.5.2 Where hydroseeding is used, the Contractor shall mix water, seed fertilizer, mulch and mulch anchorage at the following rates and apply to the prepared seed bed by means of a hand-held hose. No truck mounted spraying equipment shall be driven over the areas to be seeded. Discharge shall be in an uphill direction only.

- | | |
|--------------------|--|
| a. Fertilizer | - 1000 lbs. per acre |
| b. Seed | - 250 lbs. per acre |
| c. Mulch | - Sufficient to equal 90% straw mulch coverage |
| d. Mulch Anchorage | - Per Manufacturer's instructions |
| Chemical | 750 lbs. wood fiber/acre |
| Wood Cellulose | |

3.1.5.3 Where the mulch anchorage is provided ready mixed with the mulch, no additional mulch anchorage will be required.

3.1.5.4 Mulch shall be a commercial cellulose hydromulch such as "Conwed 2000", "Turf Fiber", or equal. Soil seal or mulch anchorage used shall be approved by the Engineer. An asphalt emulsion shall not be used as mulch anchorage.

3.1.6 Erosion Control Blanket Installation:

3.1.6.1 The erosion control blankets shall be installed as indicated on the Contract Drawings and/or directed. Conventional straw mulch (Article 3.1.4.1) shall not be installed where erosion control blankets are to be placed. Erosion control blankets can be installed directly over hydroseeded areas.

3.1.6.2 At the top of the slope, the blanket shall be anchored in a 6-inch deep x 6-inch wide trench. Backfilling and compaction of the trench shall be performed shortly after stapling the blanket in the trench.

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SEEDING

3.1.6.3 Blankets shall be installed either down or horizontally across the slope. Edges of parallel blankets must be stapled with a minimum 3-inch overlap. When blankets are spliced down the slope, shingle the blankets with a minimum 6-inch overlap.

3.1.6.4 Staples shall be 6-inch wire staples, or approved equal. Staples shall be applied at a minimum of 1 staple per square yard on the blankets and a maximum of 12 inches apart on all overlap areas and in anchor trenches.

3.2 MAINTENANCE AND PROTECTION:

3.2.1 The Contractor shall maintain and protect all seeded areas until final acceptance of the Seeding portion of the Contract.

3.2.2 Final acceptance will not be made until an acceptable uniform stand of grass is obtained in all newly seeded areas except that the Engineer at his discretion may accept a portion or portions of the work at various times.

3.2.3 Upon final acceptance of a seeded area by the Engineer, the Owner will assume responsibility for maintenance and protection of that area.

3.2.4 Any portions of seeded areas which are unacceptable, and which fail to show a uniform stand of grass from any cause, shall be reseeded as before except the fertilizer shall be applied at one-half the original rate. The seeding shall be repeated until the seeded areas are satisfactorily covered with grass.

PART 4 - MEASUREMENT & PAYMENT

4.1 MEASUREMENT - SEEDING:

4.1.1 The quantity for which payment will be made shall be the actual number of acres covered.

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SEEDING

4.2 PAYMENT - SEEDING:

4.2.1 For Seeding, not included in other unit or lump sum price items, payment for Seeding will be made at the applicable price stated in the Bid.

END OF SECTION

SPECIFICATIONS

SECTION 02598

LINEAR LOW DENSITY POLYETHYLENE (LLDPE) LINING MATERIAL

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Linear Low Density Polyethylene (LLDPE) Lining Material as shown on the Plans, as specified and/or directed.

1.1.2 The lining material will be used as the barrier layer of the capping system.

1.1.3 The lining material will be textured on both sides for all applications.

1.2 PRE-QUALIFICATIONS:

1.2.1 Geomembrane Manufacturer:

1.2.1.1 The Contractor shall submit to the Owner and the Engineer for approval the following qualification information regarding the Geomembrane Manufacturer:

- a. Corporate background and information.
- b. Manufacturing capabilities including:
 - daily production quantity available for this Contract.
 - quality control procedures for manufacturing
 - list of material properties including certified test results, to which geomembrane samples are attached.
- c. A list of at least ten completed facilities, totaling a minimum of 10,000,000 square feet, for which the Manufacturer has manufactured a geomembrane. For each facility, the following information will be provided:

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- name and purpose of facility, its location and date of installation
 - name of Owner, Project Manager, Designer, Fabricator (if any), and Installer
 - thickness of geomembrane, surface area of geomembrane manufactured
 - available information on the performance of the lining system and the facility.
- d. Origin (resin supplier's name, resin production plan) and identification (brand name, number) of the resin.

1.2.2 Geomembrane Fabricator (if required):

1.2.2.1 The Contractor shall submit to the Engineer for approval the following written information in regards to the Geomembrane Fabricator (if required).

- a. Copy of Geomembrane Manufacturer's letter of approval of license.
- b. Corporate background and information.
- c. Fabrication Capabilities:
 - daily fabrication quantity available for this Contract
 - quality control procedure
 - samples of fabricated seams and a certified list of minimum values of seam properties and employed test methods.
- d. A list of at least ten completed facilities for which the Fabricator has fabricated liner factory panels of the type of geomembrane to be used in this project, totaling a minimum of 3,000,000 square feet, the following information will be provided for each fabrication:
 - name and purpose of facility, its location, and date of installation
 - name of Owner, Project Manager, Designer, Manufacturer, Installer, and the name of the contact at the site who can discuss the project
 - thickness of liner and surface area of liner fabricated
 - type of seaming and type of seaming apparatus used
 - available information on the performance of the lining system and the facility.

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1.2.3 Installer:

1.2.3.1 The Installer must be trained and qualified to install geomembrane and must be approved and/or licensed by the Geomembrane Manufacturer and/or Fabricator.

1.2.3.2 The Contractor shall submit to the Engineer for approval the following written information, relative to the Installer.

- a. Copy of Installer's letter of approval or license by the Manufacturer and/or Fabricator.
- b. Corporate background and information.
- c. Description of installation capabilities, including:
 - information on equipment and personnel
 - average daily production anticipated
 - quality control procedures.
- d. A list of at least ten completed facilities, totaling a minimum of 3,000,000 square feet for which the Installer has installed geomembrane of the type for this project. For each installation, the following information will be provided:
 - name and purpose of facility, its location and date of installation
 - name of contact at the facility who can discuss the project
 - name and qualifications of the supervisor(s) of the Installer's crew(s)
 - thickness of geomembrane and surface area of the installed liner
 - type of seaming and type of seaming apparatus used
 - duration of installation
 - available information on the performance of the lining system and the facility.
- e. Resume of the "master seamer" to be assigned to this project, including dates and duration of employment.

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- f. Resume of the field engineer or installation supervisor to be assigned to this project, including dates and duration of employment.

1.2.3.3 All personnel performing seaming operations will be qualified by experience or by successfully passing seaming tests. At least one seamer will have experience seaming a minimum of 3,000,000 square feet of geomembrane of the type for this project, using the same type of seaming apparatus in use at the site.

1.2.4 Sheet Quality:

1.2.4.1 The Contractor shall submit to the Engineer the following information regarding sheet quality and properties:

- a. A material properties sheet including, at a minimum, all specified properties, measured using test methods indicated in the specifications, or equivalent.
- b. A list and description of materials other than the base polymer which comprise the geomembrane.
- c. A written certification that property values given in the properties sheet are guaranteed by the Geomembrane Manufacturer.

1.2.5 Roll Quality:

1.2.5.1 Prior to shipment, the Contractor will provide the Engineer with a quality control certificate for each roll of geomembrane provided. The quality control certificate will be signed by a responsible party employed by the Geomembrane Manufacturer, such as the Production Manager. The Quality Control Certificate will include:

- a. Roll numbers and identification.

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- b. Documentation certifying the geomembrane was continuously inspected for uniformity, damage, imperfections, holes, cracks, thin spots, foreign materials, tears, punctures and blisters.
- c. Sampling results of quality control tests; as a minimum, results will be given for thickness, tensile strength, tear resistance and seam strength evaluated in accordance with the methods indicated in the specifications or equivalent methods approved by the Engineer.
- d. Documentation certifying non-destructive seam testing was performed on all fabricated seams over their full length using a test method acceptable to the Engineer.

1.2.6 Prior to delivery of material, the Contractor shall submit a sample of the warranty to be provided as described in paragraph 3.2.3.

1.3 DELIVERY, HANDLING AND STORAGE:

1.3.1 The Contractor will be liable for all damages to the materials incurred prior to and during transportation to the site.

1.3.2 Handling, storage and care of the geosynthetic materials prior to and following installation at the site, is the responsibility of the Contractor. The Contractor will be liable for all damages to the materials incurred prior to final acceptance of the lining system by the Owner.

1.3.3 The Contractor shall notify the Owner of the anticipated delivery time.

1.4 CONFORMANCE TESTING:

1.4.1 Within one week of delivery of the geomembrane, and at the Engineer's direction, the Contractor shall provide the necessary labor, tools and equipment to obtain samples of the geomembrane at the specified frequency for forwarding to the approved testing laboratory for testing at the Contractor's expense to ensure conformance to both the design specifications and the list of guaranteed properties.

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1.4.2 As a minimum, tests to determine the following characteristics will be performed on geomembranes:

- a. density, ASTM D792/D1505
- b. carbon black content, ASTM D1603
- c. carbon black dispersion, ASTM D5596
- d. thickness, ASTM D5199
- e. tensile properties, ASTM D638 Type IV

1.4.3 Geomembrane samples will be taken across the entire width of the roll. Unless otherwise specified, samples will be 2.0 feet long by the roll width. The Engineer will mark the machine direction on the samples with an arrow.

1.4.4 Unless otherwise specified, geomembrane samples will be taken at a maximum rate of one per 100,000 square feet.

1.4.5 For each lot number of geomembrane material that arrives at the site, a sample shall be taken by the Contractor and provided to the Owner for archiving. This sample shall be 3.0 feet long by the width of the roll.

1.4.6 Any samples which fail the conformance testing will require the failed material to be removed from site and replaced with new material at the Contractor's expense.

1.5 WARRANTY:

1.5.1 The Contractor shall submit a draft copy of the warranty to be provided upon completion of the project. The warranty shall meet the requirements of Article 3.2.3 of this Specification.

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1.6 ADDITIONAL SUBMITTALS:

1.6.1 The Contractor shall submit detailed shop drawings. Shop drawings shall contain all necessary panel layouts, details, dimensions, penetration fabrications, etc., sufficient to assure that fabrication shall meet the intended use and will conform to the geometry of its intended application.

PART 2 - PRODUCTS

2.1 MATERIALS:

2.1.1 Raw Materials:

2.1.1.1 Prior to installation of any geomembrane material, the Contractor shall submit to the Engineer the following information regarding resin quality.

- a. A copy of the Quality Control Certificates issued by the Resin supplier.
- b. Reports on the tests conducted by the Manufacturer to verify the quality of the resin used to manufacture the geomembrane rolls assigned to the considered facility. These tests should include for resins, specific gravity (ASTM D792 Method A), melt flow index (ASTM D1238 Condition E), percent carbon black (ASTM D1603) and percent carbon dispersion (ASTM D3015).
- c. A statement of origin and identification of raw materials used.
- d. Documentation demonstrating the chemical compatibility of the materials to withstand leachate generated by municipal solid waste.

2.1.2 LLDPE Geomembrane Minimum Specifications:

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LINEAR LOW DENSITY POLYETHYLENE (LLDPE) LINING MATERIAL

2.1.2.1 LLDPE liner material shall meet the minimum Specification values listed below.

LLDPE Geomembrane Resin:

<u>Property</u>	<u>Specification Limit</u>	<u>Test Method</u>
Specific Gravity (max.)	0.939 g/ml	ASTM D1505/D792
Melt Flow Index	0.1-1.1 g/10	ASTM D1238 Condition E
Carbon Black Content	2.0 - 3.0%	ASTM D1603
Carbon Dispersion	Cat. 1 or 2	ASTM D5596

LLDPE Geomembrane Rolls:

<u>Property</u>	<u>Specification Limit</u>	<u>Test Method</u>
<u>Mechanical</u>		
Thickness (min. avg.)	38 mil Lowest indiv. for 8 out of 10 = 36 mil Lowest indiv. for any 10 = 34 mil	ASTM D5994
Asperity Height	10 mil (min. avg.)	GR GM12
Specific Gravity (max.)	0.939 g/ml	ASTM D1505

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<u>Property</u>	<u>Specification Limit</u>	<u>Test Method</u>
<u>Mechanical</u> - Continued		
Tensile Properties		ASTM D638 Type IV
Tensile Strength at Break (min. avg.)	60 lbs./in.	
Elongation at Break (min.avg.)	250%	
2% Modulus (max.)	60,000 psi	ASTM D5323
Tear Resistance (min.avg.)	22 lbs.	ASTM D1004
Puncture Resistance (min.avg.)	44 lbs.	ASTM D4833
Axi-Symetric Break Strain (min. avg.)	30%	ASTM D5617
Oxidative Induction Time (OIT) Standard OIT (min. avg)	100 minutes	ASTM D3895
Oven Aging at 85 C Standard OIT - (min. avg.)	35% Retained After 90 Days	ASTM D5721 ASTM D3895
UV Resistance High Pressure OIT (min. avg)	35% Retained After 1,600 hours	ASTM D5885

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<u>Property</u>	<u>Specification Limit</u>	<u>Test Method</u>
<u>Environmental</u>		
Water Vapor Transmission Rate	0.45 g/m ² - day	ASTM E96
Low Temperature Brittleness	<-112° F	ASTM D746
Water Absorption (max. % wt. change)	0.1%	ASTM D570
Volatile Loss (max.)	0.1%	ASTM D1203
Dimensional Stability (each direction, % change max.)	+/-1%	ASTM D1204

2.1.3 Labeling Geomembrane Rolls:

2.1.3.1 Labels on each roll or factory panel will identify:

- The thickness of the material.
- The length and width of the roll or factory panel.
- The Manufacturer.
- Directions to unroll the material.
- Product identification.
- Lot number.
- Roll or field panel number.

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PART 3 - EXECUTION

3.1 GEOMEMBRANE INSTALLATION:

3.1.1 Related Earthwork:

3.1.1.1 The Contractor shall insure that all related earthwork requirements under this Section are complied with:

- a. Geomembrane liners will be installed as shown on the construction drawings. The geomembrane installations will be performed on a firm, smooth, soil or geosynthetic constructed according with the Specifications. The final surface will be free from stones, clumps, sticks or any other material that may puncture the membrane. Installation of the geomembrane on loose or gravelly soils is prohibited.
- b. No geomembrane will be placed onto an area which has become softened by precipitation or which has cracked due to desiccation. Appropriate methods of moisture control are the responsibility of the Contractor.
- c. The Geomembrane Installer shall certify in writing that the final soil material or geosynthetic surface on which the membranes are to be installed are acceptable.
- d. Free edges of LLDPE liner shall be secured in such a manner as to prevent uplift by wind or the intrusion of water under the liner. Edge protection shall include sandbags, polyethylene sheeting or other methods as deemed necessary by the Contractor and approved by the Engineer. Any damage to underlying soil material or geosynthetic shall be repaired at the Contractor's expense.
- e. The LLDPE membrane will be temporarily anchored within an anchor trench constructed to the dimensions shown in the Contract Drawings. Care will be taken while backfilling the trenches to prevent damage to the geomembrane.

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3.1.2 Geomembrane Deployment:

3.1.2.1 LLDPE membrane will be deployed according to the following procedures:

- a. Placement of the geomembrane panels will be according to the approved location and position plan provided by the Installer. Placement will follow all instructions on the boxes or wrapping containing the geomembrane materials which describe the proper methods of unrolling panels. The field panel installation schedule is left to the preference of the Contractor, but the method chosen must minimize erosion of the underlying soil material and the potential for wind damage.
- b. The method of placement must ensure that:
 - Deployed geomembrane must be visually inspected for uniformity, tears, punctures, blisters or other damage or imperfections. Any such imperfections shall be immediately repaired and reinspected.
 - No equipment used will damage the geomembrane by handling, trafficking, leakage of hydrocarbons, or other means. Equipment or ATVs, will not be allowed to travel directly on the geomembrane during the installation of overlying soils or geosynthetic layers unless otherwise determined by the Engineer.
 - No personnel working on the geomembrane will smoke, wear damaging shoes, or engage in other activities which could damage the geomembrane.
 - The prepared surface underlying the geomembrane must not be allowed to deteriorate after acceptance and must remain acceptable up to the time of geomembrane placement and until completion of the project.
 - Adequate temporary loading and/or anchoring (e.g., sand bags, tires), not likely to damage the geomembrane, will be placed to prevent uplift by wind (in case of high winds, continuous loading is recommended along edges of panels to minimize risk of wind flow under the panels).
 - Direct contact with the geomembrane will be minimized; i.e., the geomembrane in excessively high traffic areas will be protected by geotextiles, extra geomembrane, or other suitable materials.

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- c. Any damage to the geomembrane panels or portions of the panels as a result of placement must be replaced or repaired at no cost to the Owner. The decision to replace or repair any panel or portions of panels will be made by the Engineer.
- d. The Engineer will assign an "identification number" to each geomembrane panel placed. This number will be consistent with the number used by the Installer. The number system used will be simple, logical and identify the relative location in the field.
- e. When deploying a textured LLDPE geomembrane over a GCL or geocomposite, a temporary slip sheet will be used to minimize friction and to allow the textured geomembrane to be more easily moved into its final position. To prevent premature hydration, only the amount of GCL that can be inspected, repaired, and covered in the same day shall be installed.

3.1.3 Seaming:

3.1.3.1 The seaming procedures below shall be implemented, where applicable, during installation of the geomembrane. The seaming procedures are as follows:

- a. Generally, all seams whether field or factory will be orientated parallel to the line of slope, not across slope. This specification applies to all slopes in excess of 10 percent grade. All horizontal seams will be a minimum of 5 feet from the toe of the side slopes. At liner penetrations and corners the number of seams will be minimized.
- b. The area of the geomembrane to be seamed shall be cleaned and prepared according to the procedures specified by the material manufacturer. Any abrading of the geomembrane will not extend more than one-half inch on either side of the weld. Care will be taken to eliminate or minimize the number of wrinkles and "fishmouths" resulting from seam orientation.

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- c. Field seaming is prohibited when either the air or sheet temperature is below 32°F or when the sheet temperature exceeds 158°F or when the air temperature is above 104°F. At air or sheet temperatures between 32°F and 40°F seaming shall be conducted directly behind a preheating device. In addition, seaming shall not be conducted when geomembrane material is wet from precipitation, dew, fog, etc., or when winds are in excess of 20 miles per hour.
- d. Seaming shall not be performed on frozen or excessively wet underlying soil surfaces.
- e. Seams will have an overlap beyond the weld large enough to perform destructive peel tests, but not exceed 5 inches. Any material used to temporarily bond adjacent geomembrane panels must not damage or leave the geomembrane altered in any manner.
- f. The Contractor shall perform trial seams on excess geomembrane material. A 1 foot by 3 foot seamed liner sample will be fabricated with the seam running down the 3 foot length in the center of the sample. Such trial seaming will be conducted prior to the start of each seaming succession for each seaming crew, change in machine or every 4 hours, after any significant change in weather conditions or geomembrane temperature, or after any change in seaming equipment. From each trial seam, two field test specimens will be taken. The test specimens will be 1-inch by 12-inch strips cut perpendicular to the trial seam. These specimens will be peel tested using a field tensiometer, and recorded as pass (failure of liner material) or fail (failure of seam). Upon initial failure, a second trial seam will be made; if both test specimens do not pass, then the seaming device and its operator will not perform any seaming operations until the deficiencies are corrected and two successive passing trial seam test specimens are produced. Completed trial seam samples cannot be used as portions of a second sample and must be discarded.
- g. Seams will be continuous through the anchor trench. No fishmouths shall be allowed within the seam area. Where fishmouths occur, the material shall be cut, overlapped and an overlap weld shall be applied. Where necessary, patching using the same liner material will be welded to the geomembrane sheet.

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- h. Where seams cannot be nondestructively tested in accordance with Section 3.1.4.1 of this Specification due to the geometry of the completed seams, a single layer of geomembrane shall be cap seamed over the subject seam and nondestructively tested if practical.
- i. Acceptable seaming methods for LLDPE geomembrane are:
 - extrusion welding using extrudate with identical physical, chemical and environment properties
 - hot wedge welding using a proven fusion welder and master seamer.
- j. Seaming device shall not have any sharp edges which might damage the geomembrane liner. Where self-propelled seaming devices are used, it will be necessary to prevent "bulldozing" of the device into the underlying soil or geosynthetic material.

3.1.4 Seam Testing:

3.1.4.1 The Contractor shall perform nondestructive seam testing on 100 percent of all field seams. The following test method and procedures may be used:

- a. Vacuum testing will be used on all seams not tested using air pressure testing. Using an approved vacuum box, the following procedures will be followed:
 - apply a soapy water mixture over the seam
 - place vacuum box over soapy seam and form a tight seal
 - create a vacuum by reducing the vacuum box pressure to 5 psi (35 KPa)
 - observe through the vacuum box window any bubbles
 - where bubbles are observed, mark seam for repair
 - move vacuum box further down seam overlapping tested seam by 3 inches
 - where hot wedge seaming has been performed, the overlap must be cut back to the weld
 - all vacuum testing will be conducted under the direct observation of the Engineer.
- b. Air pressure testing may be used in place of the vacuum box if double track hot wedge welding has been utilized to seam LLDPE geomembrane. Using approved pressure testing equipment, the following procedures will be followed:

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- seal one end of the air channel separating the double hot wedge welds
- insert pressure needle into air channel at this end
- seal open end of channel, and pressurize the air channel to 25 psi
- monitor pressure gauge for 3 minutes and determine whether pressure is maintained without a loss of more than 3 psi.
- if the pressure test fails, then localize the leak and mark the area for repair
- air pressure testing will be conducted under the direct observation of the Engineer.

3.1.4.2 In addition to nondestructive seam testing, the Contractor will perform destructive testing. The destructive testing procedures are as follows:

- a. Test samples will be prepared by the Installer every 500 feet of seam length, a minimum of one test for each seaming machine per day, or more frequently at the discretion of the Engineer. Sample location and size will be selected by the Engineer. The sample size (12 x 56 inches) will be large enough to produce three sets of test specimens for the following tests:
 - Seam Shear Strength, ASTM D4437
 - Peel Adhesion, D4437
- b. Ten specimens will compose a set. Half of these will be tested for peel and the other half for shear strength. Each specimen will be 1-inch wide and 12-inches long with the field seam at the center of the specimen. The 56-inch sample length will first be cut at the ends to produce two field peel test specimens. The remaining 54-inches will be divided into thirds and one-third submitted to the Contractor, one-third to the independent testing laboratory and one-third to the Engineer for storage and future reference.
- c. Test specimens will be considered passing if the minimum values below are met or exceeded for four of the five test specimens tested by the independent laboratory. All acceptable seams will lie between two locations where samples have passed.

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LINEAR LOW DENSITY POLYETHYLENE (LLDPE) LINING MATERIAL

<u>Field Seam Properties</u>	<u>Specification Limit LLDPE</u>	<u>Test Method</u>
Shear Strength at Yield (lb/in width)	53	ASTM/D4437
Peel Strength (lb/in)	44 and Film Tear Bond	ASTM D4437

3.1.4.3 If a sample fails destructive testing, the Contractor shall ensure that: the seam is reconstructed in each direction between the location of the sample which failed and the location of the next acceptable sample; or the welding path is retraced to an intermediate location at least ten feet in each direction from the location of the sample which failed the test, and a second sample is taken for an additional field test. If this second test sample passes, the seam must be then reconstructed between the location of the second test and the original sampled location. If the second sample fails, the process must be repeated.

3.1.4.4 If double track hot-wedge welding is used, the Engineer and the Installer must agree on the track weld that will be used in the destructive testing. The weld chosen inside or outside must be consistently tested and pass according to the criteria above.

3.1.4.5 All holes created by cutting out destructive samples will be patched by the Contractor immediately with an oval patch of the same material welded to the membrane using extrusion welding. The patch seams will be tested using a vacuum box and using the procedures described above. Work will not proceed with materials covering the geomembrane until passing results of destructive testing have been achieved.

3.1.5 Liner Repair:

3.1.5.1 All imperfections, flaws, construction damage, destructive and nondestructive seam failures will be repaired by the Installer. The appropriate methods of repair are listed below:

- patching, used to repair holes, tears, undispersed raw materials and contamination by foreign matter
- grinding and rewelding, used to repair small sections of extruded seams

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- spot welding or seaming, used to repair pinholes or other minor, localized flaws
- capping, used to repair large lengths of failed seams
- topping, used to repair areas of inadequate seams, which have an exposed edge
- removing bad seam and replacing with a strip of new material welded into place (used with large lengths of fusion seams).

3.1.5.2 The actual method used will be agreed upon by the Engineer, Installer and Contractor. All repair requiring abrading will be patched within one hour of the abrasion procedure. All defects that are patched will have the patch overlap the edge of the defect by a minimum of 6 inches. The patch will be cut with rounded edges (no corners). In the case of a large patch, the underlying geomembrane will be cut appropriately to avoid trapping gases and moisture between the two sheets.

3.1.5.3 During repair, the Engineer must be present and observe the procedures as well as all nondestructive testing of the repair seams. If the repair is very large, destructive testing may be required at the discretion of the Engineer. Any failure of repaired seams will require that the patch be removed, replaced and retested until passing results are achieved.

3.1.6 Construction Material Placement and Penetrations:

3.1.6.1 All granular materials placed above geomembrane shall be spread with a minimum initial lift thickness of 12 inches using tracked equipment with ground pressures not exceeding 7 pounds per square inch. No construction equipment will be driven directly on the geomembrane.

All rubber-tired vehicles will access construction above geomembranes from temporary access roads built a minimum of 3 feet above the liner. Extra geotextile or geomembrane layers shall be placed on or beneath all access roads or high trafficked areas. Any placement operation which results in damage to the underlying geomembrane, or in the opinion of the Engineer, has the potential of damaging the underlying geomembrane, shall immediately cease and be modified to prevent such damage.

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3.1.6.2 Placement of overlying select fill or common fill shall be performed in a systematic manner in accordance with this Section and Section 02226 and/or Section 02257. Multiple cover spreading points will not be allowed. One initial spreading location shall be established, and the work shall proceed from this location towards a free end of the geomembrane where possible. Soil material must be placed using vertical placement techniques. No horizontal pushing of the initial soil lift above the geomembrane will be allowed.

3.1.6.3 To minimize the potential for slope failures, the initial soil lift above the geomembrane must be installed pushing up slope. Downslope lift placement is prohibited.

3.1.6.4 Wrinkles that develop from normal placement procedures must be controlled such that the underlying geomembrane does not fold over. Small wrinkles, defined as having their height less than or equal to one-half their base width, may be trapped and pushed down by the overlying soil. Any wrinkle which becomes too large and uncontrollable or which folds the geomembrane over must be brought to the attention of the Engineer. The Engineer will determine how to proceed, and his decision will be final. If necessary, the geomembrane will be uncovered, cut, laid flat, seamed by extrusion welding and non-destructively tested.

3.1.6.5 Cover system penetrations will be constructed for the landfill cap development. The configuration of these penetrations is detailed in the Contract Drawings. A prefabricated LLDPE boot shall be installed around each cover system penetration as shown. The penetration assembly shall be attached to each respective geomembrane liner by the extrusion weld process. Seams and materials used at these locations will be carefully constructed and inspected to insure proper construction has been achieved. Nondestructive testing will be performed on all seams where such testing is possible, otherwise refer to Paragraph 3.1.3.1(h).

3.2 POST-CONSTRUCTION:

3.2.1 The Installer of the geomembrane materials will prepare and the Contractor shall submit, to the Engineer, record drawings illustrating the following information:

- dimensions of all geomembrane field panels
- panel locations referenced to the Contract Drawing Plans
- identify all field seams and panels with the appropriate number or code
- location of all patches, repairs and destructive testing samples

SECTION 02598

LINEAR LOW DENSITY POLYETHYLENE (LLDPE) LINING MATERIAL

3.2.2 Record drawing(s) will be submitted for each geomembrane layer constructed.

3.2.3 Warranty: The Contractor shall obtain and submit to the Engineer from the Manufacturer and Installer separate written warranties guaranteeing for a 20 year and 2 year period (respectively) from the date of issuance of the Certificate of Substantial Completion that the liner materials and workmanship specifically provided or performed under this Contract shall be free from defects. Said warranty shall apply to normal use and service by the Owner as described in Contract Specifications and as shown on the Contract Drawings. It shall specifically exclude mechanical abuse or puncture by machinery, equipment, or people, exposure of the liner to harmful chemicals or catastrophe due to earthquake, flood or tornado. Such written warranty shall provide for the repair or replacement of the defect or defective area of lining materials upon written notification and demonstration by the Owner of the specific nonconformance of the lining material or installation with the project Specifications. Such defects or nonconformance shall be repaired or replaced within a reasonable period of time of such notification. The Owner agrees to pay an amount equal to the then current sales and installation price of the defective portion of the lining material multiplied by a fraction, the numerator of which shall be the number of years elapsed since the commencement of the warranty period and the denominator of which shall be the warranty period, provided that portion of the area in question has been made available to the Manufacturer/Installer and that such areas have been cleared of all liquids, sludges, earth, sand or gravel.

END OF SECTION

SPECIFICATIONS

SECTION 02621

CORRUGATED POLYETHYLENE (CPE) DRAIN PIPE

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for corrugated polyethylene (CPE) drain pipe as shown on the Plans, as specified and/or directed.

1.1.2 The CPE drain pipe shall be used in the construction of the drainage layer terminations at the toe-slope drains.

1.2 SUBMITTALS: The Contractor shall submit six (6) copies of the manufacturer's material specifications for each item to be supplied under this Section.

PART 2 - PRODUCTS

2.1 MATERIALS:

2.1.1 The drainage pipe shall consist of nominal 4-inch diameter corrugated polyethylene drainage piping.

2.1.2 The pipe shall exhibit a minimum stiffness as determined by AASHTO M252 of 35 psi at 5% deflection.

2.1.3 Perforated pipe shall exhibit a minimum of 4 square inches of open perforated area per foot of length.

PART 3 - EXECUTION

3.1 CONSTRUCTION:

3.1.1 The Contractor shall be responsible for the protection of the pipe against damage during transportation to the site, during storage at the site, and during installation. Only non-damaged pipe shall be included within the construction. Any damaged material, as determined by the Engineer, shall be replaced by the Contractor at no cost to the Owner.

SECTION 02621

CORRUGATED POLYETHYLENE (CPE) DRAIN PIPE

3.1.2 The pipe shall be laid to the lines and grades required or shown in the Construction Plans.

3.1.3 A split coupling shall be used where two pipe sections are to be coupled together.

3.1.4 The Contractor shall be responsible for keeping the interior of the pipe free of silt, soil or debris during construction.

3.1.5 All fittings, couplings, elbows, tees, etc., shall be of the same material as the pipe and manufactured by the same manufacturer.

PART 4 - MEASUREMENT & PAYMENT

4.1 MEASUREMENT - CORRUGATED POLYETHYLENE (CPE) DRAIN PIPE:

4.1.1 Measurement for which payment will be made for CPE Drain Pipe shall be the number of lineal feet of piping measured along the top of the pipe furnished and installed.

4.2 PAYMENT - CORRUGATED POLYETHYLENE (CPE) DRAIN PIPE:

4.2.1 For CPE Drain Pipe, not included in other unit or lump sum price items, payment for CPE Drain Pipe will be made at the applicable price stated in the Bid.

4.2.2 The price bid shall include the cost of the 4-inch polyethylene pipe, excavation, and all materials, equipment and labor necessary to complete the work as shown or specified.

END OF SECTION

SPECIFICATIONS

SECTION 02641

SMOOTH INTERIOR CORRUGATED POLYETHYLENE PIPE AND END SECTIONS

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Smooth Interior Corrugated Polyethylene Pipe and End Sections as shown on the Plans, as specified and/or directed.

PART 2 - PRODUCTS

2.1 MATERIALS:

2.1.1 Smooth interior corrugated polyethylene pipe shall conform to the requirements of Section 706-12 of the New York State Standard Specifications latest edition. The units shall conform to the shape, dimensions and thickness shown on the Contract Drawings or as listed in the Additional Instructions.

2.1.2 Polyethylene end sections shall conform to the requirements of Section 706-12 of the New York State Standard Specifications, latest edition.

2.1.3 All smooth interior corrugated polyethylene pipe and end sections shall be of the same manufacturer and shall be designed to be joined by couplings or other positive mechanical means approved by the Engineer.

2.2 SUBMITTALS:

2.2.1 The Contractor shall submit six (6) copies of the manufacturer's material specifications for each item to be supplied under this Section.

SECTION 02641

SMOOTH INTERIOR CORRUGATED POLYETHYLENE PIPE AND END SECTIONS

PART 3 - EXECUTION

3.1 CONSTRUCTION:

3.1.1 Smooth interior corrugated polyethylene pipe shall be installed in the locations shown on the Contract Drawings. Connections and embedment shall be performed in strict accordance with all manufacturer's recommendations and as indicated on the Drawings.

3.1.2 All pipe shall be laid in reasonably close conformity to line and grade and shall have a full firm and even bearing at each joint and along the entire length of pipe. Pipe laying shall begin at the downstream end and progress upstream. Any single run of pipe, including end sections, shall consist wholly of the same material unless otherwise directed by the Engineer.

3.1.3 All pipe shall be handled and assembled in accordance with the manufacturer's instructions except as modified on the Plans or by the Engineer's written order.

3.1.4 Special care shall be exercised in placing and compacting material immediately adjacent to pipes in order to avoid damage to the pipe and to prevent pipe misalignment.

3.1.5 Movement of construction equipment, vehicles and loads over and adjacent to any pipe shall be done at the Contractor's risk.

3.1.6 Corrugated polyethylene pipe connections for making field joints shall consist of corrugated bands, so constructed as to lap on equal portions of each culvert section to be connected. All connections shall be an approved type, fabricated and installed so that a secure and firm pipe connection may be readily made in the field.

PART 4 - MEASUREMENT & PAYMENT

4.1 MEASUREMENT - SMOOTH INTERIOR CORRUGATED POLYETHYLENE PIPE:

4.1.1 Measurement for which payment will be made for Smooth Interior Corrugated Polyethylene Pipe shall be the number of linear feet of straight pipe incorporated in the work, in accordance with the Plans and orders, measured along the center line of the finished sewer less the space occupied by drainage structures. For all structures, measurement will be to the outside face of the structure.

SECTION 02641

SMOOTH INTERIOR CORRUGATED POLYETHYLENE PIPE AND END SECTIONS

4.2 PAYMENT - SMOOTH INTERIOR CORRUGATED POLYETHYLENE PIPE:

4.2.1 For Smooth Interior Corrugated Polyethylene Pipe, not included in other unit or lump sum price items, payment for Smooth Interior Corrugated Polyethylene Pipe will be made at the applicable price stated in the Bid.

4.2.2 The price bid shall include the cost of excavation, lining, special backfill, maintenance of traffic, topsoil and seeding, asphaltic concrete paving and saw cutting asphalt pavement or concrete pavement as required, and all materials, equipment and labor necessary to complete the work as shown and specified.

4.3 MEASUREMENT - END SECTIONS:

4.3.1 Measurement for which payment will be made for End Sections shall be the number of end sections incorporated in the work, in accordance with the Contract Drawings.

4.4 PAYMENT - END SECTIONS:

4.4.1 For End Sections, not included in other unit or lump sum price items, payment for End Sections will be made at the applicable price stated in the Bid.

END OF SECTION

SPECIFICATIONS

SECTION 13052

LANDFILL GAS VENTS

PART 1 - GENERAL

1.1 DESCRIPTION:

1.1.1 Under this Section, the Contractor shall furnish all labor, materials and equipment for Landfill Gas Vents, as shown on the Plans, as specified, and/or directed.

1.1.2 The work shall include but not necessarily be limited to:

- Excavation
- 6" Schedule 40 PVC Gas Vent Pipe with Gooseneck and bird screens
- Perforated 6" PVC Pipe
- Type D Select Fill, Section 02226, or approved material
- Installation as shown on Contract Drawings
- Pipe boot for geomembrane cap installations or bentonite backfill for soil barrier layer cap installation

1.1.3 The Contractor shall maintain the installed gas vents free of any obstruction (cave-in, backfill) and damage during placement of the soil layers and until final acceptance of the work required by this Contract.

1.2 This Specification presents gas vent installation for both soil caps and geomembrane caps. Refer to Contract Drawings for type of installation required.

PART 2 - PRODUCTS

2.1 MATERIALS:

2.1.1 PVC pipe, fittings and miscellaneous related materials as specified in Section 02435.

2.1.2 Type D select fill as specified in Section 02226 or approved alternate material.

SECTION 13052

LANDFILL GAS VENTS

2.1.3 Geotextile, if required, as specified in Section 02072 and as shown on the Contract Drawings.

2.1.4 Common fill material as specified in Section 02257 and as shown on the Contract Drawings.

2.1.5 Geomembrane boot with associated materials as specified in Section 02598 and as shown on the Contract Drawings.

PART 3 - EXECUTION

3.1 GAS VENT INSTALLATION:

3.1.1 Installation of the gas vent shall be completed as the layers for the final cap are placed.

3.1.2 After grading the in-place intermediate cover layer, excavation to install the gas vent shall be performed. A backhoe or power auger shall be used to excavate a minimum of 5 feet into the refuse. Contractor shall take precautions to prevent damage to the geotextile layers outside the vent excavation by cutting prior to penetration with power equipment. Excavation shall be in accordance with Section 02220.

3.1.3 The PVC pipe for the gas vent shall be centered in the excavation and backfilled with Type D select fill to the top of the intermediate cover layer. A coupling shall be installed on the PVC pipe such that there is about 6 inches of stick-up above the intermediate cover layer.

3.1.4 The geomembrane shall be cut to fit over the extended PVC pipe for the gas vent. A geomembrane boot shall be installed in accordance with the applicable Specification for the type of geomembrane being used.

3.1.5 The remainder of the PVC pipe for the vent shall be installed after the geosynthetics are installed. If additional layers of geosynthetics are to be placed in upper layers, an additional joint can be installed in the PVC pipe.

SECTION 13052

LANDFILL GAS VENTS

3.1.6 Common fill soils shall be placed on the geotextile layer in the configuration as shown on the Contract Drawings and as specified in Section 02257.

PART 4 - MEASUREMENT & PAYMENT

4.1 MEASUREMENT - LANDFILL GAS VENTS:

4.1.1 Measurement for payment shall be based on the actual number of gas vents installed as shown on the Contract Drawings or as directed by the Engineer.

4.2 PAYMENT - LANDFILL GAS VENTS:

4.2.1 For Landfill Gas Vents, not included in other unit or lump sum price items, payment for Landfill Gas Vents will be made at the applicable price stated in the Bid.

END OF SECTION

**APPENDIX C
PHOTOGRAPHIC
DOCUMENTATION PLAN**

APPENDIX C PHOTOGRAPHIC DOCUMENTATION PLAN

ROSEN SITE REMEDIAL PROGRAM

This specification provides the procedures which will be used to prepare and maintain photographic documentation during the remedial construction.

Equipment

A conventional 35 mm camera will be kept at the site for documentation of construction activities. The camera will have adequate zoom features to allow for photographing panoramic views as well as detailed views of construction features. Several rolls of fresh film will be kept on hand in the event unusual conditions are encountered and require documentation. Unless otherwise needed, photographs will be developed into standard photograph size pictures (approximately 3-1/2 inches by 5 inches). Exposed film rolls will be dropped off for development on a weekly basis.

Photograph Frequency

The intent of the photographic record is to be able document that construction activities were performed in accordance with the approved design and to document approved field changes, where necessary. The following table provides the anticipated minimum frequency of photographic documentation:

CONSTRUCTION ACTIVITY	PHOTO TYPE	MINIMUM FREQUENCY
Pre-construction	Panorama	Once
Clearing/Debris and Soil Relocation	Panorama	Weekly
Site grading	Panorama	Weekly
Placement of gas venting layer	Closeup	Daily
	Panorama	Weekly
Placement of geomembrane	Closeup	Daily
	Panorama	Weekly
Welding of seams	Closeup	Daily
	Panorama	Weekly
Placement of cap cover layer(s)	Closeup	Daily
	Panorama	Weekly
Installation of drainage facilities	Closeup	Daily
	Panorama	Weekly
Seeding/vegetation placement	Closeup	Daily
	Panorama	Weekly
Site restoration	Panorama	Weekly
Waste exhumation (if performed)	Closeup	Daily
	Panorama	Weekly

Maintenance of Photographs

A log will be maintained by the on-site engineer's representative which will be used to record the date and subject of each exposure. Upon receipt of developed photographs, the on-site engineer will compare the photographs to the log description, and transcribe the log information

onto the back of the photograph, and add pertinent details, if necessary. Photographs and negatives will be stored in labeled photographs albums in chronological order.

APPENDIX D
CONSTRUCTION QUALITY
ASSURANCE PLAN

APPENDIX D
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APPENDIX D

CONSTRUCTION QUALITY ASSURANCE PLAN

1.0 INTRODUCTION

This Construction Quality Assurance Plan (CQAP) has been prepared by Barton & Loguidice, P.C., Supervising Engineer for the Remedial Action (RA) at the Rosen Site located in Cortland New York, on behalf of the Rosen Site Joint Defense Group. This CQAP is an element of the Remedial Design (RD), and has been prepared in accordance with the approved RD Work Plan and the Statement of Work (SOW) associated with the Consent Decree (CD) for implementation of the Record of Decision (ROD) for the Rosen site.

The SOW describes two Remedial Work Elements (RWEs) to be performed, which are summarized as follows:

RWE 1: Soil Excavation/Debris Relocation Cap/Cover RA

- Excavation and re-location/disposal of soils impacted by 1,1,1-trichloroethane (TCA) above 1 mg/kg.
- Excavation and re-location/disposal of soils impacted by polychlorinated biphenyls (PCBs). Note: This task has already been completed.
- Removal and consolidation of non-hazardous debris onto the former cooling pond.
- Design and placement of a 6 NYCRR Part 360 cap over the former three acre cooling pond.

- Construction of a chain link fence around the former cooling pond following cap placement.
- Placement of a surface cover over the remaining areas of the site.
- Implementation of storm-water management improvements to protect the cap and surface cover.
- Employment of dust and volatile organic compound (VOC) control/suppression measures during construction and excavation activities.
- Implementation of an operation and maintenance (O&M) program for the constructed remedial components.
- Securing institutional controls restricting 1) groundwater usage at and downgradient of the site, 2) excavation or other on-site activities which could compromise cap/cover integrity, and 3) residential use of the property.

RWE 2: Long-Term Monitoring RA

- Verifying that natural attenuation is successfully addressing groundwater contamination.
- Securing institutional controls restricting 1) groundwater usage at and downgradient of the site, 2) excavation or other on-site activities which could compromise cap/cover integrity, and 3) residential use of the property.

This plan provides a detailed description of the sampling, analysis, testing and monitoring activities which will be performed during the Remedial Action (RA) phase of work at the site. This plan provides the project organization, identifies and provides the qualifications for the Independent Quality Assurance Team (IQAT), and provides the procedures for the following:

- Inspection and certification of remedial construction work
- Measurement and recordkeeping during remedial construction
- Field performance and testing
- Preparation of as-built drawings and logs
- Testing to determine attainment of design specifications
- Testing methods

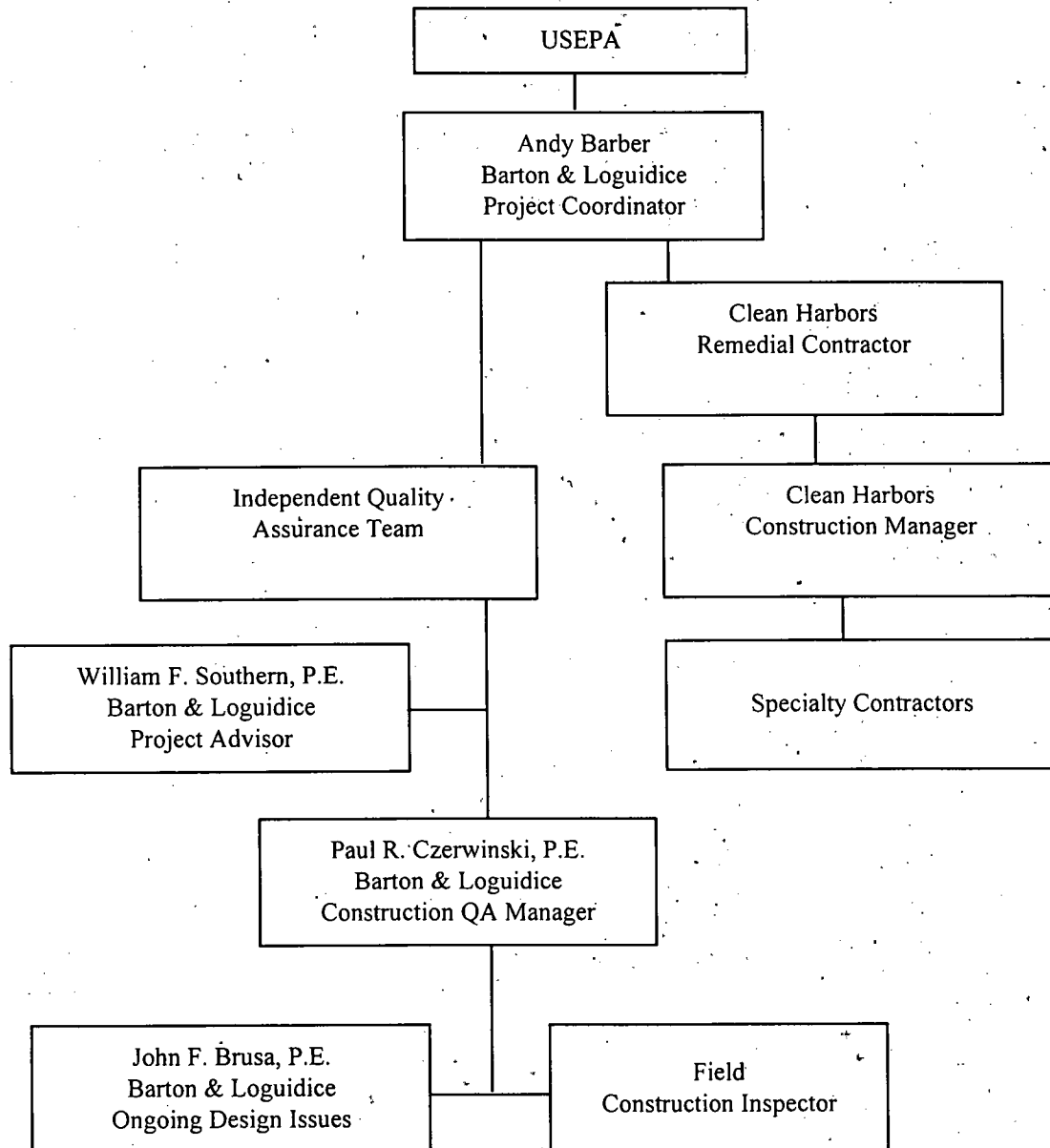
2.0 PROJECT MANAGEMENT

The project management team is shown on Figure 1. Barton & Loguidice, P.C. has been approved by USEPA as the Supervising Engineer for the RA at the site. Clean Harbors will be the Remedial Construction contractor and will be responsible for construction of the approved RD.

The SOW requires the assignment of an Independent Quality Assurance Team (IQAT) to implement the CQAP. This role will be filled by an independent construction QA manager from Barton & Loguidice who has not been involved with the RD. The construction QA manager may involve members of the Remedial Design (RD) team, if appropriate, during the performance of the RA. The IQAT members will be responsible for ensuring that the remedy is constructed in accordance with the approved design, industry standards and applicable regulatory requirements. In the event that design modifications are necessary because of differing site conditions, the IQAT will have the authority to render engineering judgement and advice to the Remedial Construction contractor. The responsibilities and authorities for the IQAT members are described below:

Project Advisor: The Project Advisor will have overall responsibility for the implementation of the QA program and will serve as the Engineer of Record for the construction, and will sign and stamp the Certification Report. The Project Advisor will attend project meetings on an as-needed basis and will be available for technical consultation. The Project Advisor will also provide input to the Construction Manager on contract administration issues, on an as-needed basis.

**FIGURE 1 - PROJECT MANAGEMENT ORGANIZATION
ROSEN SITE REMEDIAL ACTION**



Construction QA Manager: The Construction QA Manager will be responsible for the day to day implementation of the QA program. He will ensure that there is adequate field staffing to fulfill the requirements of this plan and will also ensure that design engineers are effectively integrated into the review process for field modifications of the approved design.

Field Construction Inspector: The Field Construction Inspector will be responsible for daily implementation of construction QA procedures at the site. He will interface with the Construction Manager on a regular basis to coordinate QA activities with construction activities. If necessary, additional staff will be assigned to the Field Construction Inspector to complete QA tasks.

Ongoing Design Staff: There will be a design engineer assigned to the IQAT who will have the primary responsibility for supporting the field QC efforts and providing modifications to the approved design if required by the Construction QA Manager.

Resumes for the IQAT members are provided in Appendix A to this plan.

Construction progress meetings will be held on a regular basis at the site. These meetings will be attended by representatives of Clean Harbors, IQAT, USEPA (if possible), and specialty contractors, if necessary. The meetings will be used for the following purposes:

- Assess project progress against schedule
- Coordinate contractors and work elements
- Schedule labor and equipment
- Identify scheduling conflicts

- Delivery of materials
- Review testing results
- Identify and resolve problems
- Review QA issues and design changes, if any
- Review contractual issues
- Review health and safety issues

Minutes of each meeting will be kept and will be distributed to attendees and other necessary parties (e.g. – Project Coordinator). Action items will be clearly identified along with the responsible party for the assignment and due date.

3.0 CONSTRUCTION INSPECTION AND TESTING.

Assurance that the remedy is constructed in accordance with the approved design will be provided through a rigorous testing and inspection (Construction Quality Assurance / Construction Quality Control) program. This program will apply to the materials to be used in the remedial construction, as well as to the constructed and installed components of the RA. Appropriate test methods and inspection procedures are outlined within the Technical Specifications. Materials QA/QC testing summaries have been included at the end of this Section (Table 1).

3.1 Subgrade Preparation

Debris and contaminated soil will be relocated to within limits of waste of the landfill from the remediation area of the site. Following debris relocation, a minimum 12-inch thick intermediate cover layer consisting of Type C Select Fill will be installed over the debris. The intermediate cover will be graded to accommodate positive drainage to the contours of the subgrade grading plan. The intermediate cover will be compacted to provide a firm base to construct the landfill capping system.

Material requirements and Construction Quality Assurance / Construction Quality Control (CQA/CQC) requirements for Type C Select Fill can be reviewed in the Technical Specification Section 02226. Grain Size Analyses and minimum/maximum relative density tests will be performed on the Type C Select Fill at the specified frequencies as outlined in the Specifications.

3.2 Gas Venting Layer

Above the prepared subgrade, a gas venting layer will be constructed. The gas venting layer will consist of 12-inch thick layer of Type B Select Fill containing a minimum permeability 1×10^{-3} cm/s and a maximum of 10% passing by weight the No. 200 sieve. A Type 1 non-woven geotextile will be installed below the gas venting layer. A minimum of 1 gas vent per acre will be installed into the debris to relieve the gas collected by the gas venting layer. Each gas vent will consist of 6-inch Schedule 40 perforated poly vinyl chloride (PVC) pipe below the geomembrane and 6-inch Schedule 40 solid PVC pipe above the geomembrane. The perforated pipe below the geomembrane will be installed within a stone pocket of Type D Select Fill wrapped in Type 1 Geotextile. The solid pipe will extend a minimum of 4-feet above the landfill capping system final grade and will be fitted with a gooseneck fitting and bird/insect screen. Material requirements for PVC pipe can be reviewed in Technical Specification Section 02435.

Material requirements and CQA/CQC requirements for Type B and Type D Select Fill can be reviewed in the Technical Specification Section 02226. Grain size analyses, permeability testing and minimum/maximum relative density tests will be performed on the Select Fill Materials at the specified frequencies as outlined in the Specifications.

Extensive visual inspection will be performed by the IQAT on the material entering the site for change in color, texture and any foreign debris. During inspection, the IQAT will ensure that the gas venting layer is free of objects that could puncture the geomembrane and that the final surface is compacted and properly graded for installation of the geomembrane.

3.3 Geomembrane

A 40 mil Linear Low Density Polyethylene (LLDPE) geomembrane will be used as the barrier layer. The geomembrane will be textured on all sides for all applications. All construction and CQA/CQC requirements for the geomembrane can be found in Section 02598 of the Technical Specifications.

Prior to placement of the geomembrane, the Remedial Construction contractor will provide data and information for the geomembrane to the IQAT, including resin quality, sheet properties, and quality control certificate(s). This data and information will be reviewed for compliance with the approved specifications. Upon delivery of the geomembrane panels, the IQAT will ensure that samples are collected at the specified frequency (see Table 1) and submitted to the quality assurance laboratory for testing. For each lot number of the geomembrane delivered to the site, a sample will also be taken for fingerprinting of the roll. The extra samples will be stored at room temperature out of direct sunlight for possible future testing. The delivered geomembrane panels will be visually inspected for uniformity, damage and imperfections. The panels will be stored in a manner to protect them from excessive dust, dirt, shock or other sources of damage.

The geomembrane will be placed according to the approved construction sequence. Depolyment of geomembrane panels will be performed in accordance with manufacturer's instructions. The IQAT will inspect the deployment process to ensure that the geomembrane is not damaged during placement. The geomembrane will be seamed in accordance with the approved specifications. The IQAT will monitor and inspect the seaming work, and will ensure that sampling and testing are conducted on the proper frequency (see Table 1).

3.4 Lateral Drainage Layer

A lateral drainage layer will be installed directly above the geomembrane. The lateral drainage layer will consist of a composite geonet possessing a minimum transmissivity of $1 \times 10^{-4} \text{ m}^3/\text{sec-m}$.

Material requirements and CQA/CQC requirements for composite geonet can be reviewed in the Technical Specification Section 02237. Prequalification and conformance testing will be performed on the composite geonet at the specified frequencies as outlined in the Technical Specifications.

3.5 Barrier Protection Layer

The barrier protection layer will be constructed above the lateral drainage layer of the capping system. The barrier protection layer will consist of a 24-inch thick layer of common fill material.

Common fill material will be well graded from fine to coarse with a minimum of 15 percent passing by weight the No. 200 sieve and possessing a maximum permeability of $1 \times 10^{-5} \text{ cm/sec}$. Stones, if any, shall not exceed six (6) inches in the greatest dimension. The methods and procedures utilized to spread the soil material must insure that no damage is rendered to the underlying layers of the capping system. Material requirements and necessary CQA/CQC requirements can be reviewed in Technical Specification Section 02257.

3.6 Topsoil Layer

A 6-inch thick layer of topsoil will be installed above the barrier protection layer. This layer will be fertilized and seeded upon completion. The purpose of the topsoil layer is to establish vegetative growth over the landfill that will help with runoff and control erosion. Material requirements and all necessary CQA/CQC requirements can be reviewed in Technical Specification Sections 02484 and 02485.

3.7 Restoration Area Final Cover System

Following relocation of the debris and contaminated soil from the restoration area to the landfill area, the restoration area will be graded to drain according to the subgrade grading plan and a final cover system applied. The proposed final cover system consists of a Type 3 Geotextile demarcation layer covered by a 8-inch thick common fill layer and 4-inch topsoil layer. The topsoil layer will be seeded, fertilized and mulched to establish vegetative growth.

Material requirements and Construction Quality Assurance / Construction Quality Control (CQA/CQC) requirements for common fill material can be reviewed in Technical Specification Section 02257, and for topsoil in Technical Specification Section 02484

3.8 Geotextiles

Geotextiles will be utilized as a separation fabric between layers of the capping system as well as for geomembrane cushioning. All necessary CQA/CQC requirements can be reviewed in the Technical Specification Section 02072.

Prior to placement of the geotextile, the Contractor will provide data and information for the geotextile to the IQAT, including a list of guaranteed "minimum average roll values". This data and information will be reviewed for compliance with the approved specifications. Upon delivery of the geotextile, the IQAT will ensure that samples are collected at the specified frequency (see Table 1) and submitted to the quality assurance laboratory for testing. For each lot number of the geotextile delivered to the site, a sample will also be taken for fingerprinting of the roll. The extra samples will be stored at room temperature out of direct sunlight for possible future testing. The delivered geotextile rolls will be visually inspected for uniformity, damage and imperfections. The rolls will be stored in a manner to protect them from excessive dust, dirt, shock or other sources of damage.

Geotextile deployment will be performed in accordance with manufacturer's instructions. The IQAT will inspect the deployment process to ensure that the geotextile is not damaged during placement. The geotextile will be seamed in accordance with the approved specifications. The IQAT will monitor and inspect the seaming work.

3.9 Drainage Ditches, Roadways and Site Facilities

The IQAT will inspect the construction and/or improvement of roadways and drainage ditches to ensure that they are constructed according to the approved design. The IQAT will also be responsible for inspecting other site-related construction including erosion and sediment control structures and installation of new fencing.

TABLE 1
MATERIALS QUALITY ASSURANCE / QUALITY CONTROL TESTING SUMMARY
SOILS AND GEOSYNTHETIC MATERIALS
ROSEN SUPERFUND SITE

MATERIAL	USE	QUALITY CONTROL TESTING (STOCKPILE MATERIAL TESTING)		QUALITY ASSURANCE TESTING (IN-PLACE MATERIAL TESTING)	
		Frequency	Test Method	Frequency	Test Method
Type B Select Fill	Gas Venting Layer	Prequalification Prequalification Prequalification	Grain Size Analysis (ASTM D422) Permeability Test (ASTM D2434) Min/Max Relative Density (ASTM D4253/4254)	1,000 cy in-place 2,500 cy in-place 5,000 cy in-place As Requested	Grain Size Analysis (ASTM D422) Permeability Test (ASTM D2434) Min/Max Relative Density (ASTM D4253/4254) In-Place Moisture Density Testing
Type C Select Fill	Intermediate Cover	Prequalification Prequalification	Grain Size Analysis (ASTM D422) Min/Max Relative Density (ASTM D4253/4254)	1,000 cy in-place 5,000 cy in-place As Requested	Grain Size Analysis (ASTM D422) Min/Max Relative Density (ASTM D4253/4254) In-Place Moisture Density Testing
Type D Select Fill	Gas Vent Backfill & Toe Drain Pipe Backfill	Prequalification Prequalification Prequalification	Grain Size Analysis (ASTM D422) Permeability Test (ASTM D2434) Min/Max Relative Density (ASTM D4253/4254)	1,000 cy in-place 2,500 cy in-place 5,000 cy in-place As Requested	Grain Size Analysis (ASTM D422) Permeability Test (ASTM D2434) Min/Max Relative Density (ASTM D4253/4254) In-Place Moisture Density Testing
Granular Fill	Road Construction	Prequalification Prequalification	Modified Proctor Density (ASTM D1557) Grain Size Analysis (ASTM D422)	One per 50 cy of Material Placed	In-Place Moisture Density Testing
Common Fill	Capping System Barrier Protection Layer	Prequalification Prequalification Prequalification Prequalification	Grain Size Analysis (ASTM D422) Atterburg Limits (ASTM D4318) Modified Proctor Density (ASTM D1557) Remolded Permeability (ASTM D5084)	5,000 cy in-place 5,000 cy in-place 5,000 cy in-place 2,500 cy in-place One per 10,000 sf/lift	Grain Size Analysis (ASTM D422) Atterburg Limits (ASTM D4318) Modified Proctor Density (ASTM D1557) Remolded Permeability (ASTM D5084) In-Place Moisture Density Testing
	Restoration Area Final Cover System	Prequalification Prequalification Prequalification	Grain Size Analysis (ASTM D422) Atterburg Limits (ASTM D4318) Modified Proctor Density (ASTM D1557)	5,000 cy in-place 5,000 cy in-place 5,000 cy in-place One per 10,000 sf/lift	Grain Size Analysis (ASTM D422) Atterburg Limits (ASTM D4318) Modified Proctor Density (ASTM D1557) In-Place Moisture Density Testing
Topsoil	Topsoil Layer	Prequalification Prequalification	Organic Content pH	NA	NA
Type 1, 2 & 3 Geotextiles	Separation and Cushion Layers	100,000 sf 100,000 sf 100,000 sf 100,000 sf 100,000 sf	Mass per Unit Area (ASTM D5261) Burst Strength (ASTM D3786) Grab Strength (ASTM D4632) Puncture Strength (ASTM D4833) Trap. Tear Strength (ASTM D4533)	NA	NA
40 mil Textured LLDPE Geomembrane	Barrier Layer	100,000 sf 100,000 sf 100,000 sf 100,000 sf 100,000 sf	Density (ASTM D792/D1505) Carbon Black Content (ASTM D1603) Carbon Black Dispersion (ASTM D3015) Thickness (ASTM D1593) Tensile Properties (ASTM D638)	100% of All Seams 500 LF of Seam	Non-Destructive Testing Destructive Sample Taken and Tested for: Seam Shear Strength (ASTM D4437) Peel Adhesion (ASTM D4437)
Composite Geonet	Lateral Drainage Layer	100,000 sf 100,000 sf 100,000 sf 100,000 sf 100,000 sf 100,000 sf	Specific Gravity (ASTM D1505) Thickness (ASTM D1593) Mass per Unit Area (ASTM D5261) Melt Flow Index (ASTM D1238) Ply Adhesion (ASTM D413) Index Transmissivity (ASTM 4716)	NA	NA

4.0 RECORDKEEPING AND REPORTING

In addition to the logs and records maintained by the Construction Manager, the IQAT will maintain a separate set of records and logs to demonstrate that the remedy was constructed according to the approved design. The records and logs that will be kept by the IQAT include the following:

- Daily log of activities
- Testing results
- Project meeting minutes
- Photographic log
- Completed chain of custody forms
- Working sketches
- Telephone conversation log
- Manufacturer's specifications and warranties
- Vendor submittals

Changes to the approved design will be clearly recorded using a colored pencil on a single set of drawings that will be maintained by the IQAT. These drawings will be used to prepare the final completed construction drawings at the completion of the project. A certification report will be prepared at the completion of the project which will contain the results of inspections and testing conducted by the IQAT to demonstrate the construction of the remedy in accordance with the approved design. This report will include the completed construction drawings, material certifications, and construction photographs.

