REMEDIAL DESIGN REPORT 100% FINAL
REMEDIAL DESIGN OF A LANDFILL CAP, WASTE CONSOLIDATION, INSTITUTIONAL CONTROLS AND INTERIM ACTIONS, OPERABLE UNIT (OU6)
for
Raymark Industries, Inc. Superfund Site
Stratford, Connecticut

Contract No. W912WJ-11-D-0005
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PREFACE

AMEC Environment & Infrastructure, Inc. (AMEC), under contract with the United States Army Corps of Engineers, New England District, is providing engineering services related to remedial actions at the Raymark Industries, Inc. Superfund Site in Stratford, Connecticut. AMEC is providing the remedial design of a landfill cap for the selected remedy specified by the New England District Environmental Protection Agency's (EPA's) September 2011 Record of Decision for the Site.

This Remedial Design Report (RDR) for the remediation of Raymark Industries, Inc. Superfund Site was prepared in accordance with information presented in the *Record of Decision for Final Source Control Actions at Four Properties Within Operable Unit 6 (Additional Properties) and Interim Actions at Other Locations Containing Raymark Waste* (EPA, July 2011) and the requirements under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980. This RDR provides information regarding the design and construction of the selected remedy for the Site historically referred to as 576/600 East Broadway in Stratford, Connecticut. Remediation activities will include excavating the contaminated soil, backfilling these areas with clean fill and restoring vegetation, consolidating the waste on the property, and using a low-permeable Resource Conservation and Recovery Act cap to contain the Raymark waste. The project Site will be graded so that final property contours rise toward the center, raising the Site approximately 4 to 5 feet after waste consolidation. Background information originated from a variety of sources, which have been identified in the reference section of this RDR.

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LIST OF ACRONYMS

ACM	Asbestos Containing Material
AMEC	AMEC Environment & Infrastructure, Inc.
ARAR	applicable or relevant and appropriate requirements
bgs	below ground surface
BMP	Best Management Practice
CAMU	Corrective Action Management Unit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CGS	Connecticut General Statutes
cm/s	Centimeters per second
cm^2/s	Centimeters squared per second
CSF	Cancer Slope Factor
CTDEEP	Connecticut Department of Energy and Environmental Protection
CTDEP	Connecticut Department of Environmental Protection
CWA	Clean Water Act
DEC	direct exposure criteria
ELUR	Environmental Land Use Restriction
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FOS	factor of safety
FS	Feasibility Study
ft	foot/feet
GCL	geosynthetic clay liner
GDL	geocomposite drainage layer
LLDPE	linear low-density polyethylene
MSL	Mean Sea Level
NESHAPS	National Emission Standards for Hazardous Air pollutants
NHPA	National Historic Preservation Act
NPDES	National Pollutant Discharge Elimination System
PACM	presumed asbestos containing material
PCB	polychlorinated biphenyl
PCD	polycarbonatediol
PMC	pollutant mobility criteria
ppm	parts per million

RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RCSA	Regulations of Connecticut State Agencies
RDR	Remedial Design Report
RfD	Risk Reference Doses
RI	Remedial Investigation
ROD	Record of Decision
RSR	Connecticut Remediation Standard Regulations
SPT	Standard Penetration Testing
TSCA	Toxic Substances Control Act
USACE	United States Army Corps of Engineers
USC	United States Code
USEPA	United States Environmental Protection Agency

EXECUTIVE SUMMARY

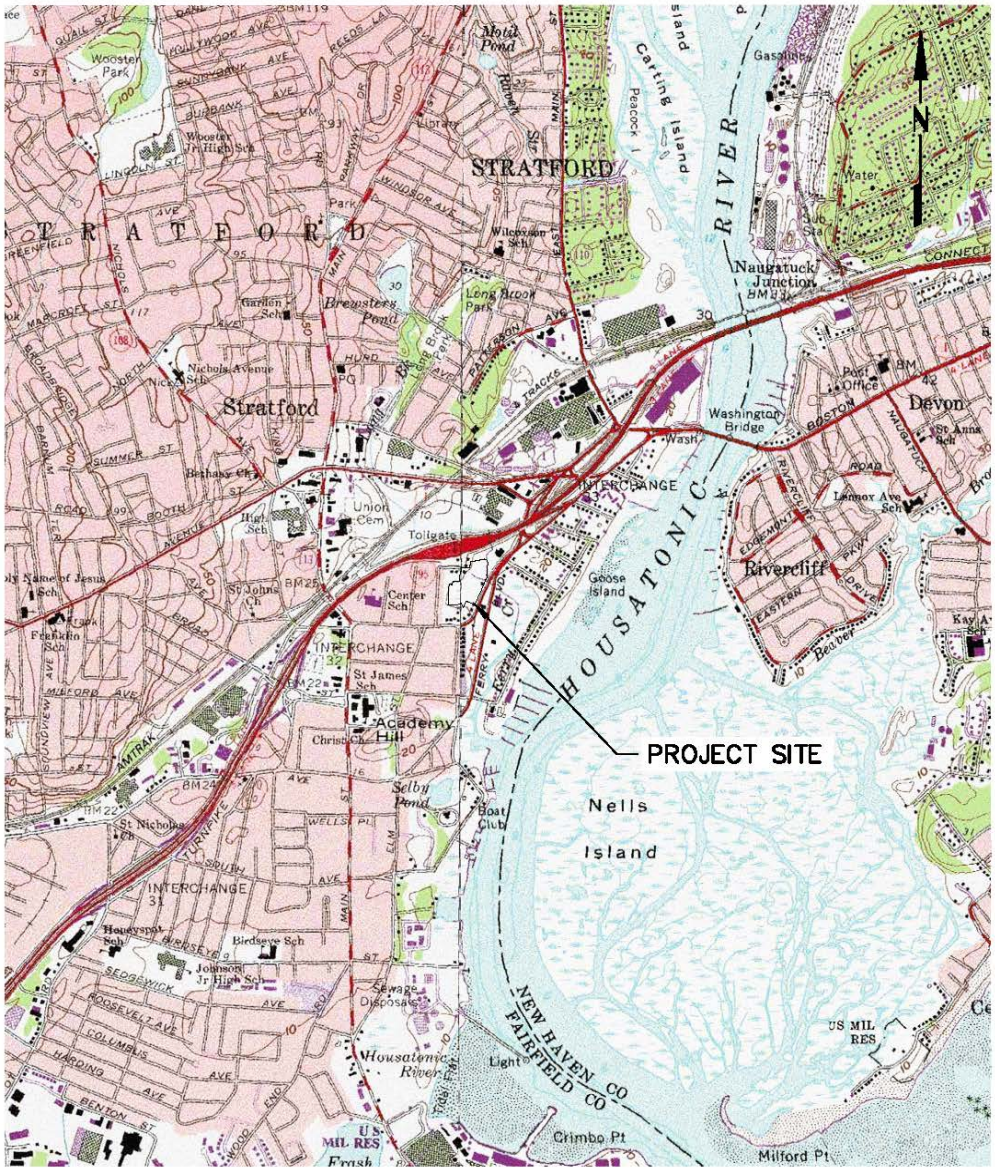
This Remedial Design Report (RDR) summarizes the scope and technical approach for remediation of the Raymark Industries, Inc. Superfund Site located at 576/600 East Broadway, Stratford, Connecticut (see Figure 1). It has been determined that Raymark waste, which is present in the fill material at the project location, poses a potential risk to human health and the environment. The remediation of 576/600 East Broadway is being performed as a Comprehensive Environmental Response, Compensation, and Liability Act remedial action under the *Record of Decision for Final Source Control Actions at Four Properties Within Operable Unit 6 (Additional Properties) and Interim Actions at Other Locations Containing Raymark Waste* (United States Environmental Protection Agency [USEPA] July, 2011). As discussed in the Record of Decision (ROD), the selected remedial action for the two East Broadway properties is to excavate Raymark waste beyond the cap limits identified in the ROD, consolidate the waste on the upland portion of the two properties, and contain the area with a low-permeable cap. This will result in an increase in elevation of approximately five feet at the center of the properties.

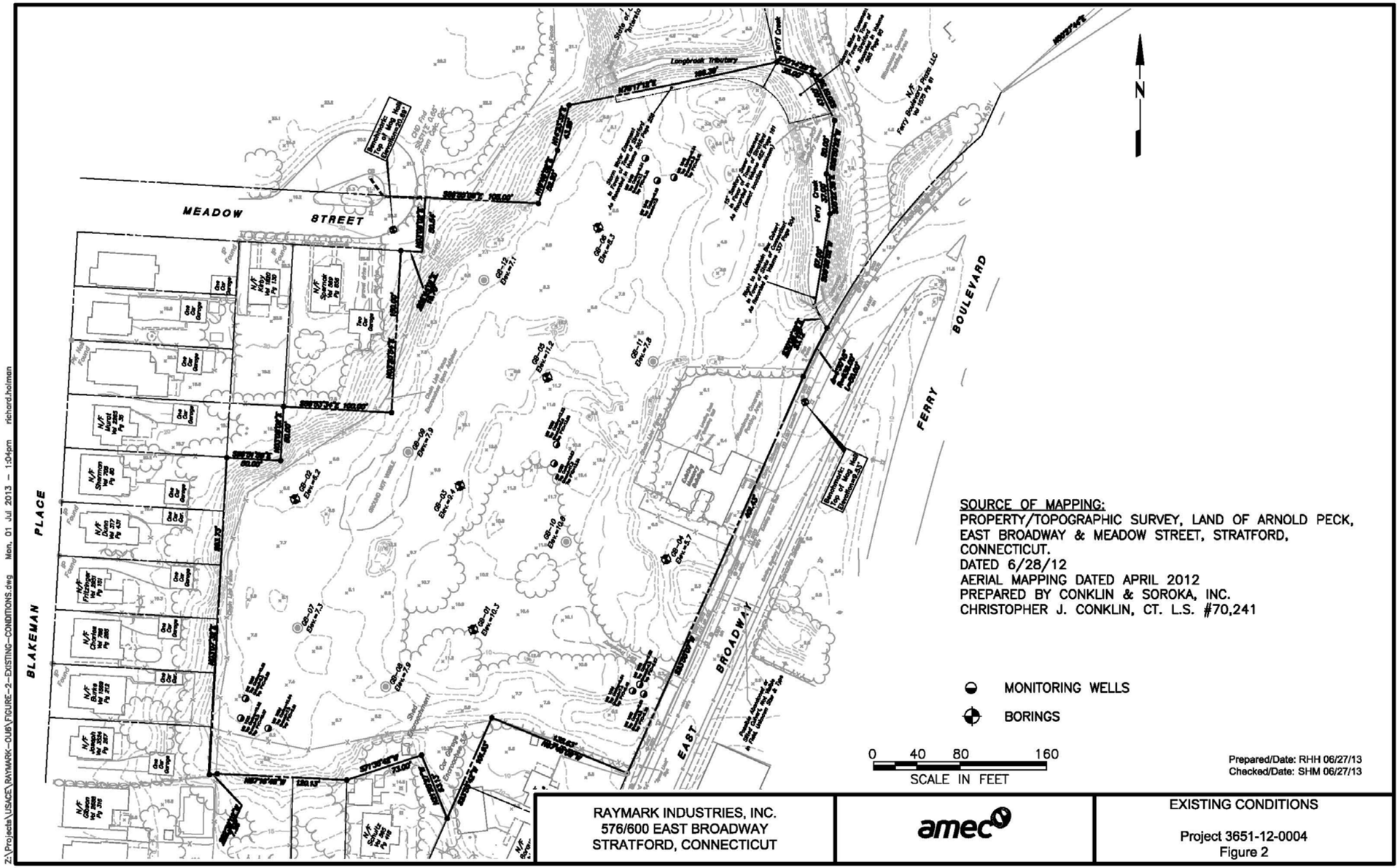
The cap limits defined in the ROD are based on historic 100-year floodplain delineations and waste was to be consolidated above this limit. Recent Federal Emergency Management Act (FEMA) mapping indicate the 100-year floodplain is near Elevation 11 MSL (North American Vertical Datum 29). The proposed cap will consist of short 3:1 slopes with a vertical rise of 4 to 6 feet. The current 100-year flood event may inundate the cap side slopes but have minimal impact on the upper plateau of the cap system. The agencies involved have concurred that the cap encroachment into the 100-year floodplain will have minimal impact on surrounding flood areas and the cap design should be consistent with the limits identified in the ROD.

The project Site includes both 576 and 600 East Broadway which are abutting properties and together encompasses approximately 5.7 acres. The Site is bordered by Ferry Creek on the northeastern property line and Longbrook Tributary along the north property line. East Broadway runs along the east of the Site and private properties at higher elevation bound the Site to the south and west. There are two buildings currently on the property connected by a narrow, covered corridor which occupy approximately 3,000 square ft. These structures are currently scheduled to remain during and after remediation activities.

The low-permeable cap will prevent potential direct contact exposures to Raymark waste and will minimize infiltration during precipitation events and protect ecological receptors from exposure to underlying contaminated soil and wastes. The cap will be finished at ground surface with topsoil, grass, and in limited areas of gravel (access road). The Site will be graded so that the final contours rise to the center of the Site. A utility corridor has been included into the cap design to allow utility lines to enter the Site and be installed above the cap hydraulic barrier. In addition the cap grades have been designed to provide the necessary capacity to potentially accept Raymark waste from 35 Third Avenue which is an additional property within Operable Unit 6.

Remediation of the Raymark Industries, Inc. Superfund Site in Stratford, Connecticut is intended to provide protection of human health and the environment, to meet the remedial action objectives in the ROD, and to comply with applicable or relevant and appropriate requirements identified in the ROD for this remedial action.


PROJECT SITE
STRATFORD
Stratford
Devon
Nells
Island
HOUSATONIC
RIVER
Carting Island
Peacock I
Naugatuck Junction
Washington Bridge
INTERCHANGE
Riverdale
Goose Island
Tollgate
Academy Hill
Selby Pond
Boat Club
Brewsters Pond
Long Brook Park
Wooster Park
Wooster Jr High Sch
Nichols Avenue Sch
Union Cem
Center Sch
St James Sch
St Johns Ch
St Nicholas Ch
Birdseye Sch
Johnson Jr High Sch
Sewage Disposal
Housatonic River
Crimbo Pt
Milford Pt
US MIL RES
NEW HAVEN CO
FAIRFIELD CO
Post Office
Water
Gasoline
Motel Pond
Library
Wilcoxson Sch
Garden Sch
Nichols Sch
High Sch
Franklin Sch
Holy Name of Jesus Sch
Bethany Ch
Lamor Ave Sch
St Anna Sch
Kay A Sch
Wash
Light
N
0 1000 2000 4000
SCALE IN FEET
Prepared/Date: RHH 07/19/12
Checked/Date: SHM 07/19/12
RAYMARK INDUSTRIES, INC.
576/600 EAST BROADWAY
STRATFORD, CONNECTICUT
amec
SITE LOCATION MAP
Project 3651-12-0004
Figure 1
Z:\Projects\USACE\RAYMARK-OUB\FIGURE-1.dwg Fri, 20 Jul 2012 - 2:35pm richard.holmon


MEADOW STREET
BLAKEMAN PLACE
EAST BROADWAY
FERRY BOULEVARD
Longbrook Tributary
Ferry Creek
N
SOURCE OF MAPPING:
PROPERTY/TOPOGRAPHIC SURVEY, LAND OF ARNOLD PECK,
EAST BROADWAY & MEADOW STREET, STRATFORD,
CONNECTICUT.
DATED 6/28/12
AERIAL MAPPING DATED APRIL 2012
PREPARED BY CONKLIN & SOROKA, INC.
CHRISTOPHER J. CONKLIN, CT. L.S. #70,241
MONITORING WELLS
BORINGS
0 40 80 160
SCALE IN FEET
Prepared/Date: RHH 06/27/13
Checked/Date: SHM 06/27/13
RAYMARK INDUSTRIES, INC.
576/600 EAST BROADWAY
STRATFORD, CONNECTICUT
amec
EXISTING CONDITIONS
Project 3651-12-0004
Figure 2
Z:\Projects\USACE\RAYMARK-OU6\FIGURE-2-EXISTING-CONDITIONS.dwg Mon, 01 Jul 2013 - 1:04pm richard.holman

1.0 INTRODUCTION

1.1 Description of the Remedial Design Report

This Remedial Design Report (RDR) summarizes the scope and technical approach for remediation of the Raymark Industries, Inc. Superfund Site, 576/600 East Broadway properties, as described in the Record of Decision (ROD) for Final Source Control Actions at Four Properties Within Operable Unit 6 (Additional Properties) and Interim Actions at Other Locations Containing Raymark Waste (United States Environmental Protection Agency [USEPA], July 2011). This RDR presents assumptions, references, and design criteria used in the development of the remedial design for the Site; and technical specifications and design drawings are included in the appendices.

1.2 Purpose of the Remedial Design Report

The purpose of the RDR is to provide a detailed description of the planned Raymark Industries, Inc. Superfund Site remedial activities at 576/600 East Broadway, Stratford, Connecticut. This RDR includes the following:

- The scope of work elements to be implemented under the remedy.
- A Site description.
- The remedial design activities.
- Design analysis and supporting Appendices.
- Remedial design drawings and specifications.
- A discussion of the remedial construction activities and schedule.

1.3 Scope of the Remedial Action

The scope of the remedial action will meet the *ROD* remedial action objectives (RAOs) for the Raymark Industries, Inc. Superfund Site landfill cap system. In summation, the RAOs are to:

- Protect the public and the environment from hazardous wastes, and
- Mitigate further impact to groundwater.

The scope of the remedial action for the Raymark Industries, Inc. Superfund Site will consist of the following detailed activities:

- Excavation of Raymark waste as identified in the ROD and consolidation within a proposed Resource Conservation and Recovery Act (RCRA) cap located on upland areas, which will increase the elevation at the center of the project Site to

approximately 5 feet (ft) above existing grade, and sloping down from the center to meet existing grade at the cap limits;

- Mitigating and restoring excavations by backfilling to existing grade with clean fill resulting in no net loss of flood storage;
- Construction of a low-permeable cap;
- Construction of a utility corridor;
- Performing other construction-related tasks associated with construction of the above-referenced items; and
- Verifying the completed project meets the performance objectives.

In addition to the construction of the cap, institutional controls, in the form of an Environmental Land Use Restriction (ELUR), may be put in place and will include restrictions on excavations and use of the groundwater at the Site. A groundwater monitoring program will be also be developed utilizing existing upgradient and downgradient wells as appropriate as well as supplemental wells if needed.

1.4 Site Description

1.4.1 576/600 East Broadway

Historic reports and the ROD identify the project site as 576/600 East Broadway as shown on Figure 2. Upon review of tax assessor and town clerk databases at the time of this RDR it is suspected that these properties have been combined into a single address of 576 East Broadway. Further investigation should be completed prior to construction to verify the legal description of the property; however, this will have no impact on the defined limit of work. For the purpose of this RDR the work area will continue to be described as 576/600 East Broadway.

1.4.2 576 East Broadway

The 576 East Broadway property is approximately 1.4 acres of commercially-zoned (light industrial) land. Located in Stratford, Connecticut, this property contains two buildings. The buildings consist of a wood shop and a warehouse, along with an asphalt parking lot. The buildings currently occupy 3,000 square ft while the existing asphalt parking lot occupies approximately 0.3 acres of the land. A chain-link fence runs along the northern, western and southern edges of the pavement area, separating the buildings and existing pavement from the wooded area of the property. These buildings are scheduled to remain during remedial activities.

A tributary of Longbrook Stream bisects the northern location of the property and enters Ferry Creek, located on the northeastern property line adjacent to the 335 Ferry Boulevard parcel. The undeveloped 600 East Broadway parcel is located to the west of the 576 parcel.

The 576 parcel is generally flat with a slight downward slope to the northwest, toward Ferry Creek and away from East Broadway. No known stormwater drains are located in the parking lot.

The fill on this property consists of both natural and manmade materials. The manmade materials include the following: presumed asbestos containing material (PACM) (fibrous asbestos mats and pads), asphalt, brake pads, brick, cinders, coal, concrete, gasket material, glass, metal debris, plastic, steel, and tiles. Raymark waste found in fill materials on this property consisted of asbestos, lead, copper and/or Aroclor 1268.

1.4.3 600 East Broadway

The 600 East Broadway property is approximately 4.3 acres of commercially-zone (light industrial) land. Beginning in the late 1980's, this property was an active industrial waste disposal area. Currently, the property is undeveloped and overgrown. There is an open field located near the central portion of the property with grasses, weeds, shrubs and large trees around the perimeter of the parcel. Approximately 3,500 square ft along the southeastern section of the property has a 3-inch thick gravel layer. Construction debris fill, such as concrete blocks, have been discovered around the northern section of the property. A chain-link fence surrounds the property on the east, south and western property lines. However, public access is unrestricted along the northern property line by Ferry Creek.

The 576 East Broadway parcel, along with East Broadway, border this property on the east. Residential properties are located on the south and west, and a vacant lot close to Interstate Route 95, and Longbrook Stream, is located to the north.

The fill on this property consists of both natural and manmade materials. The manmade materials include the following: PACM (fibrous asbestos mats and pads), asbestos fibers, asphalt, brake pads, brick, cinders, broken rock, concrete, glass, metal debris, nails, roofing shingles, rubber soles, slag and wood. These materials were discovered with natural fill consisting of sand, silty sand and sand-silt mixtures, gravelly silty sand, and sand and gravel. Raymark waste found in fill materials on this property consisted of asbestos, lead, copper and/or Aroclor 1268.

2.0 REMEDIAL DESIGN ACTIVITIES

This section describes the pre-design activities, and the remedial design approach for the project.

2.1 Pre-Design Activities

The following pre-design activities have been completed:

- Topographic Survey
- Geotechnical Investigations

2.1.1 Topographic Survey

A topographic survey was conducted at the 576/600 East Broadway, and 35 Third Avenue, properties in support of the remedial design and the preparation of Environmental Land Use Restrictions. The survey included locating existing Site features, fencing, buildings, property lines, monitoring wells, geotechnical borings, and utilities. Aerial photogrammetric flight was completed in April 2012 by Golden Aerial Surveys and field verification of the aerial topography was completed in June 2012 by Conklin & Soroka, Inc. Conklin & Soroka performed additional topographic survey work in February 2013 to establish locations and elevations of existing wells and supplemental geotechnical borings. The survey information is included in the design drawings.

2.1.2 Geotechnical Investigations

AMEC Environment & Infrastructure, Inc. (AMEC) developed and implemented geotechnical investigation programs to obtain information on Site soil conditions and to provide geotechnical data to support remedial design and construction.

Previous Investigations

First, AMEC reviewed available reports from prior investigations (by others) to develop scopes for the geotechnical investigation and laboratory testing programs. The Remedial Investigation Report (Tetra Tech NUS, 2005) indicated that nine soil borings had previously been made at 576 East Broadway and that 28 borings had previously been made at 600 East Broadway. Four of the borings on the 600 East Broadway property were advanced to bedrock; most of the remaining borings were generally sampled to depths of not more than 22 ft below ground surface (bgs). However, no geotechnical lab testing was performed on the Site soils during prior investigations. AMEC prepared a brief Technical Memorandum to summarize relevant data from prior investigations (AMEC, 2013a).

Based on the previous borings, the surficial geology at the Site from the ground surface downward consists of 7 to 14 ft of loose to very dense soil (sand, silt, gravel) and man-

made (asphalt shingles, brake pads, brick, concrete, glass) fill materials; 1 to 10 ft of native loose/soft marsh deposits consisting of peat and organic silts, 60 to 100 ft of medium to very dense alluvial and outwash sand and gravel, and in some localized areas glacial till.

Pre-Design Investigation

AMEC conducted a geotechnical pre-design investigation to characterize the thickness and compressibility of the marsh deposit (peat and organic silt) identified during prior investigations by others. Subsurface explorations were performed by Aquifer Drilling and Testing, Inc. of Mineola, New York between May 30th and June 7th 2012 and consisted of drilling six geotechnical borings (GB-01 through GB-06) to depths ranging from 23 to 35 ft bgs. An AMEC geotechnical engineer logged the borings and monitored the drilling activities.

The pre-design investigation included the following primary tasks:

- Completion of six geotechnical borings via rotary drive-and-wash techniques with 4-inch diameter flush-joint steel casing.
- Standard Penetration Testing (SPT) conducted at continuous intervals through the fill and into the marsh deposit.
- Obtaining soil samples for geotechnical laboratory testing including grain size analyses, Atterberg limits, moisture contents, and organic contents.
- Collection of five Shelby tube samples for geotechnical laboratory testing, including one-dimensional consolidation testing and strength testing.
- Extension of each boring 10 ft below the bottom of the marsh deposit/into the sand and gravel deposit.

The results of the investigation, including findings, boring logs, geotechnical laboratory testing data, and waste classification test data (for cuttings and water disposal) were presented in a Remedial Design Sampling Report (AMEC, 2013b) and submitted to the United States Army Corps of Engineers (USACE).

Supplemental Investigation

AMEC conducted a supplemental geotechnical investigation to further characterize the thickness, compressibility, and variability of the marsh deposit for the purpose of evaluating potential Site development scenarios (i.e., permanent structures). Subsurface explorations were performed by Aquifer Drilling and Testing, Inc. between January 28th and February 5th 2013 and consisted of drilling six geotechnical borings (GB-07 through GB-12) to depths ranging from 16 to 67 ft bgs. An AMEC geotechnical engineer logged the borings and monitored the drilling activities.

The supplemental investigation included the following primary tasks:

- Completion of six geotechnical borings via rotary drive-and-wash techniques.
- SPTs at regular intervals through the fill and at continuous to near continuous intervals within the marsh deposit.
- Obtaining soil samples for geotechnical laboratory testing including grain size analyses, Atterberg limits, moisture contents, and organic contents.
- Collection of eight Shelby tube samples for additional one-dimensional consolidation testing.

The supplemental boring logs and geotechnical laboratory testing data were presented in a Technical Memorandum (AMEC, 2013c) and submitted to the USACE.

2.1.3 Site Geology and Hydrogeology

The site-specific geotechnical investigation to characterize subsurface conditions and obtain geotechnical data to support the planning, design, and construction of the planned Remedial Action (AMEC, 2013a; AMEC, 2013b) indicates that the Site is underlain by the following primary soil strata:

- Fill: Heterogeneous fill materials comprised predominantly of sand, silt, gravel, and debris. Typically loose to medium dense. Thickness ranges from about 2 to 17 ft across the Site.
- Marsh Deposit: Marsh/floodplain deposit consisting primarily of organic silt (OH) with lesser amounts of organic clay (OH) and peat (PT). Variable amounts of sand throughout the deposit. Usually soft to medium stiff. Occasionally stratified with distinct layers of sand/silty sand (SM). Thickness varies from about 3.5 (GB-12) to about 17.5 ft (GB-03) across the Site.
- Fluvial Sand: Glacial fluvial deposit comprised of fine to coarse sand with varying amounts of silt and gravel. Typically medium dense to dense. Extends to Glacial Till and/or bedrock (based on site-specific monitoring well installations by others).

The one-dimensional consolidation testing data indicates that the Marsh Deposit is slightly over-consolidated with an average modified compression index. The Marsh Deposit is considered to be moderately to highly compressible based on the available geotechnical data. Consequently, this stratum is of prime concern for consolidation resulting from increases in effective stress due to grade raises.

In January and February of 2013, AMEC measured the depth to groundwater in several existing (i.e., previously installed by others) monitoring wells. The depths ranged from about 4.5 ft to 5.5 ft below the ground surface (bgs) in the shallow monitoring wells (i.e.,

screened within the fill materials and/or Marsh Deposit). Groundwater gradient generally slopes to the north east towards Ferry Creek.

2.2 Remedial Design

The Remedial Design has been developed to support the RAO's stated in the ROD. The objectives of the design were presented in Section 1.3. This section presents applicable or relevant and appropriate requirements (ARAR's), and provides a written description of the project's design elements.

The cap limits defined in the ROD are based on historic 100-year floodplain delineations and waste was to be consolidated above this limit. Recent Federal Emergency Management Agency (FEMA) mapping indicate the 100-year floodplain is near Elevation 11 MSL (North American Vertical Datum 88). The proposed cap will consist of short 3:1 slopes with a vertical rise of 4 to 6 ft. The current 100-year flood event would inundate the cap side slopes but have minimal impact on the upper plateau of the cap system. The agencies involved have concurred that the cap encroachment into the 100-year floodplain will have minimal impact on surrounding flood areas and the cap design should be consistent with the limits identified in the ROD.

2.2.1 Applicable or Relevant and Appropriate Requirements

This section of the RDR briefly states the ARARs associated with the project and identifies the enforcing agency and regulatory threshold for each requirement. A summary of the ARARs associated with the design is presented in Table 2.1. Project compliance with each ARAR is documented in the column entitled "Design."

TABLE 2.1 SUMMARY OF ARARS FOR 576/600 EAST BROADWAY				
AUTHORITY	**REQUIREMENT**	**REQUIREMENT SYNOPSIS**	**CONSIDERATION**	**DESIGN**
CHEMICAL-SPECIFIC ARAR's				
State Regulatory Requirements	Connecticut Remediation Standard Regulations (22a-133k, Appendices A and B)	These regulations establish numeric direct exposure (DEC) and pollutant mobility (PMC) criteria for cleanup of soils.	Contaminated soil within the Raymark waste footprint exceeding the DEC and PMC values will be managed according to the RSR regulations by excavation and off-property disposal, land use restrictions, and/or construction of an engineered control (capping).	Raymark waste beyond the cap limit will be excavated and consolidated on the upland portion of the property. Raymark waste locations will then be capped using a low-permeable RCRA cap.
	Connecticut Coastal Management Act (Sec. 22a-92, 93, 94, 98, and 100)	This statute establishes Connecticut's enforceable coastal zone policies in accordance with the federal Coastal Zone Management Act.	Activities performed in coastal areas, particularly in wetlands and floodplains, will conform to the substantive provisions of the enforceable coastal zone policies.	Excavated areas will be backfilled with clean fill and revegetated to reflect existing conditions. No wetland impacts are anticipated for this specific project.

TABLE 2.1 SUMMARY OF ARARS FOR 576/600 EAST BROADWAY				
AUTHORITY	**REQUIREMENT**	**REQUIREMENT SYNOPSIS**	**CONSIDERATION**	**DESIGN**
Criteria, Advisories, and Guidance	Toxic Substances Control Act (TSCA) polychlorinated biphenyl (PCB) Spill Clean-up Policy (40 Code of Federal Regulations [CFR] 761.120-135	This policy applies to recent PCB spills and establishes clean-up levels for PCB spills of 50 ppm of greater at 10 ppm for non-restricted access areas and 25 parts per million (ppm) for restricted access areas.	This document will be considered in responding to new and historical PCB spills.	No new spills are anticipated during implementation of this remedy.
	EPA Guidance on Remedial Actions for Superfund Sites with PCB Contamination (EPA/540/G-90/007)	This document describes the recommended approach for developing remediation goals and selecting remedies at Superfund sites with PCB contaminants.	This document was used as guidance for the development and selection of remedial alternatives.	The low permeability cap will prevent exposure to PCBs that remains on Site.
	EPA Risk Reference Doses (RfDs)	RfDs are dose levels developed by EPA for use in estimating the noncarcinogenic effects of exposure to toxic substances.	EPA RfDs were used to assess health risks due to exposure to noncarcinogenic contaminants present at the Site.	The low permeable cap will prevent direct contact to contaminants that remain on Site and will limit infiltration of water and leaching of contaminants post remedy.
	Cancer Slope Factors (CSFs)	Guidance values used to evaluate the potential carcinogenic risk caused by exposure to contaminants.	CSFs were used to evaluate health risks associated with Site-related contaminants.	The selected remedy addresses exposure risk.

TABLE 2.1 SUMMARY OF ARARS FOR 576/600 EAST BROADWAY				
AUTHORITY	**REQUIREMENT**	**REQUIREMENT SYNOPSIS**	**CONSIDERATION**	**DESIGN**
Federal Regulatory Requirements	Fish and Wildlife Coordination Act (16 USC 661 et seq.; 50 CFR Parts 81, 226, 402)	This Act protects fish and wildlife when federal actions result in the control or structural modification of a natural stream of body or water.	Alternatives that involve actions that might impact fish and wildlife will require consultation with the Fish and Wildlife Service to develop appropriate measures to protect resources.	Coordination pursuant to the Act occurred during the Remedial Investigation/Feasibility Study (RI/FS) and is reflected in the ROD and design.
	National Historic Preservation Act (NHPA) (16 U.S.C. 470)	Pursuant to Sections 106 and 110(f) of the NHPA, as amended, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) response actions are required to take into account the effects of the response activities on any historic property included or eligible for inclusion on the National Register of Historic Places.	Prior to any excavation or disturbance of soil or a structure, a review of potential impacts to historic structures or sites will be conducted. If any such impacts are identified, the substantive provisions of this ARAR will be complied with.	Consideration of NHPA occurred during the FS and is reflected in the ROD and design.
ACTION-SPECIFIC ARARS				

TABLE 2.1 SUMMARY OF ARARS FOR 576/600 EAST BROADWAY				
AUTHORITY	**REQUIREMENT**	**REQUIREMENT SYNOPSIS**	**CONSIDERATION**	**DESIGN**
Federal Regulatory Requirements	TSCA-polycarbonated oil (PCD) Storage, Capping and Disposal (40 CFR 761.61 (c))	These regulations establish standards for the storage, decontamination, capping, and response to PCB remediation work.	The storage and response to PCB contaminated soil will be conducted with approval by the Regional Administrator pursuant to TSCA's risk-based approval provisions.	Removed Raymark waste will be placed beneath a RCRA cap system. The regulations were considered in development of the ROD and design.
	CAA National Emission Standards for Hazardous Air pollutants (NESHAPS) (40 CFR 61 - Subpart M; 61.150 and 61.151)	These regulations specify requirements regarding removal, management, and disposal of asbestos.	Handling, treatment, and disposal of soils containing asbestos will comply with the substantive provisions of these regulations. The removal and handling of asbestos will be managed through air monitoring and best management practices.	Excavation and management of Raymark waste potentially containing asbestos containing material (ACM) is to be performed in a manner meeting the substantive provisions of the regulations. Air monitoring and best management practices are required in the specifications.
	Clean Water Act National Pollutant Discharge Elimination System (NPDES) Regulations (Stormwater Discharges) (40 CFR 122.26 (c)(ii)(c))	Discharge of stormwater associated with construction activities are required to implement measures, including best management practices, to control pollutants in stormwater discharges during and after construction activities.	Alternatives involving remedial construction will be designed and implemented to comply with the substantive provisions of the cited requirements and/or the requirements of the construction general permit for stormwater, such as best management practices.	Soil erosion and sedimentation control measures will be in place during excavation and all other construction activities.

TABLE 2.1 SUMMARY OF ARARS FOR 576/600 EAST BROADWAY				
AUTHORITY	**REQUIREMENT**	**REQUIREMENT SYNOPSIS**	**CONSIDERATION**	**DESIGN**
	RCRA Hazardous Waste Management: TSDF Standards 40 CFR Sections 264.19, 95, 96(a), 97, 98, 99, 111, 114, 117, and 310. (Note that Regulations of Connecticut State Agencies (RCSA) 22a-449(c)104 refers to the federal RCRA Regulations)	These sections establish standards for capping of hazardous substances. Specifically, they establish standards for a construction quality assurance program, groundwater monitoring, and closure/post-closure.	The construction and design of any cap of hazardous substances will comply with the substantive provisions of these requirements. Post-construction groundwater monitoring of the cap will also be conducted to comply with the substantive requirements.	The low permeable cap design complies with the substantive provisions of the Standards. Post-remedy groundwater monitoring is a requirement of the ROD and included with this design.
	Connecticut Remediation Standard Regulations (22a-133k-2(f)(2)(B)(i-iv)	These provisions provide standards for the use of an engineered control (i.e., a cap) to cover polluted soils.	Any low-permeable cap will meet the substantive requirements of this provision	The low permeable cap meets the substantive requirements of the Regulations.
	RCRA Hazardous Waste Management, Corrective Action Management Unit (CAMU) Standards: 40 CFR Section 264.552 (Note that RSCA 22a-449(c)104 refers to the federal RCRA Regulations.)	The CAMU provisions establish standards for the design of CAMUs and treatment of CAMU-eligible waste consolidated into a CAMU. CAMUs require liners and leachate collection unless the Regional Administrator approves alternative requirements. CAMU-eligible waste that would otherwise require treatment under the RCRA Land Disposal	Any remediation waste containing principal hazardous constituents will be sent off-site for treatment and disposal at an out-of-Town location and not consolidated into the CAMU.	The ROD established that an alternative CAMU design is appropriate for the remedy for 576/600 East Broadway. The design is consistent with the ROD requirements.

TABLE 2.1 SUMMARY OF ARARS FOR 576/600 EAST BROADWAY				
AUTHORITY	**REQUIREMENT**	**REQUIREMENT SYNOPSIS**	**CONSIDERATION**	**DESIGN**
		Restrictions and that contains "principal hazardous constituents" must be treated according to certain CAMU treatment standards. The regional Administrator may adjust such treatment standards.		
State Regulatory Requirements	Hazardous Waste Management: Generator & Handler Requirements - General Standards, Listing, and Identification (RCSA 22a-449(c)100-101)	These sections establish standards for listing and identification of hazardous waste. The standards of 40 CFR 260-261 are incorporated by reference.	Wastes that are generated during implementation of an alternative (i.e. excavated Raymark waste) will undergo testing for RCRA characteristics to determine the appropriate waste classification and disposal options.	This requirement applies to 35 Third Avenue property, the remediation of which is not included in this design. Raymark waste excavated from 576/600 East Broadway is to be placed within the limits of the cap without characterization sampling in accordance with the ROD as this material has already been characterized during the RI/FS phase.
	Hazardous Waste Management: Generator Standards (RCSA 22a-449(c)102)	This section establishes standards for various classes of generators. The standards of 40 CFR 262 are incorporated by reference. Storage requirements given at 40 CFR 265.15 are also included.	On-site storage of wastes determined to be RCRA hazardous (listed or characteristic) will comply with the substantive provisions of these requirements, including storage requirements.	The design requires compliance with the Standards should RCRA hazardous wastes be generated.

TABLE 2.1 SUMMARY OF ARARS FOR 576/600 EAST BROADWAY				
AUTHORITY	**REQUIREMENT**	**REQUIREMENT SYNOPSIS**	**CONSIDERATION**	**DESIGN**
	Connecticut Air Pollution Regulations - Fugitive Dust Emissions (Sec. 22a-174-18)	Requires that reasonable precautions be taken to prevent particulate matter from becoming airborne during demolition and construction activities and material handling operations.	Activities involving soil excavation or handling and cap construction will be conducted in a manner to minimize fugitive dust emissions. Air monitoring and best engineering practices will be employed to minimize fugitive dust emissions.	Dust control practices will be implemented and are required by the design specifications. Air monitoring for dust and asbestos is required by the design specifications.
	Control of Noise (RSCA Section 22a-69-1 to 69-7.4)	These Regulations establish allowable noise levels.	All remedial construction activities will comply with the substantive requirements of these regulations.	Noise requirements are included in the specifications.
	CT Guidelines for Soil Erosion and Sediment Control (May 2002) (adopted pursuant to Connecticut General Statutes [CGS] 22a-328)	The Guidelines provide technical and administrative guidance for the development, adoption, and implementation of erosion and sediment control programs.	Remedial construction (for example soil excavation) will be designed and implemented to comply with the substantive provisions of these Guidelines by use of best management practices such as hay bales and silt fences.	The design includes soil erosion and sediment control practices consistent with the Guidelines.
	Connecticut Remediation Standard Regulations (22a-133k-2(f)(2)(B)(i-iv)	These provisions provide standards for the use of an engineered control (i.e., a cap) to cover polluted soils.	Any CAMU cap will meet the substantive requirements of this provision.	The cap design meets the substantive requirements of the regulations.

TABLE 2.1 SUMMARY OF ARARS FOR 576/600 EAST BROADWAY				
AUTHORITY	**REQUIREMENT**	**REQUIREMENT SYNOPSIS**	**CONSIDERATION**	**DESIGN**
Criteria, Advisories, and Guidance	Technical Memorandum: Revised Landfill Cap Design Guidance proposed for Unlined Hazardous Waste Landfills in EPA Region 1 (February 5, 2001).	Provides guidance for landfill cap design for unlined hazardous waste landfills at Superfund sites in EPA Region 1.	Remedial alternatives involving on-property capping will consider this guidance during the design.	The low-permeable cap design meets these requirements and will consist of the following and : -24" Soil with Vegetated Cover -Geocomposite Drainage Layer -Geomembrane Hydraulic Barrier -Geosynthetic clay liner (GCL) - Gas Venting Layer -Subgrade Soil
	EPA Technical Guidance Document: Final Covers on Hazardous Waste Landfills and Surface Impoundments (EPA/530-SW-89-047)	Presents technical specifications for the design of multi-barrier covers at landfills at which hazardous wastes are disposed.	Remedial alternatives involving on-property capping will consider this guidance during the design.	The low-permeable cap design meets these requirements and will consist of the following and : -24" Soil with Vegetated Cover -Geocomposite Drainage Layer -Geomembrane Hydraulic Barrier -GCL - Gas Venting Layer -Subgrade Soil

TABLE 2.1 SUMMARY OF ARARS FOR 576/600 EAST BROADWAY				
AUTHORITY	**REQUIREMENT**	**REQUIREMENT SYNOPSIS**	**CONSIDERATION**	**DESIGN**
LOCATION-SPECIFIC ARARS				
Federal Regulatory Requirements	Executive Order 11988-Floodplain Management (40 CFR 6.302(b) and 40 CFR 6, App.A)	Federal agencies are required to avoid impacts associated with the occupancy and modification of a floodplain and avoid floodplain development wherever there is a practicable alternative.	Any alternative that includes activities within floodplain areas that might result in the occupancy or modification of the floodplain will need to comply with this order. Compensatory flood storage will be provided if necessary. EPA will seek public comment in the proposed Plan regarding floodplain impacts.	EPA and Connecticut Department of Energy and Environmental Protection (CTDEEP) have determined floodplain impacts are considered minimal and compensatory flood storage will not be required for this project.
	Executive Order 11990-Protection of Wetlands (40 CFR 6.302(a) and 40 CFR 6, App. A)	Federal agencies are required to minimize the destruction, loss, or degradation of wetlands, and the Order emphasizes the importance of avoiding harm to wetlands unless there is no practicable alternative to such construction.	Any alternative that includes activities within wetland areas that might result in the destruction, loss, or degradation of wetlands will need to comply with this order. EPA will seek public comment in the Proposed Plan regarding wetlands impacts. The Region will need to make a finding that there is no practical alternative to the selected remedy and that the selected remedy is the least environmentally damaging practical alternative.	Wetlands impacts were considered in development of the remedy and the Proposed Plan.

TABLE 2.1 SUMMARY OF ARARS FOR 576/600 EAST BROADWAY				
AUTHORITY	**REQUIREMENT**	**REQUIREMENT SYNOPSIS**	**CONSIDERATION**	**DESIGN**
	Federal Clean Water Act (CWA) Regulations governing dredge and fill activities in wetlands-Section 404. (33 USC 1344) (40 CFR 230) (33 CFR 320-323) 33CFR 332)	Discharge of dredged or fill material is prohibited to wetlands or other US Waters if there is a practical alternative which would have less adverse impact to the aquatic ecosystem, as long as the alternative does not have other significant impacts.	Design of excavation, capping, and/or consolidation alternatives will need to consider potential for disturbance of wetlands, and mitigate these disturbances accordingly. If there is no practical alternative to disturbing wetlands, compensatory measures will be required.	The design minimizes wetlands disturbances by limiting excavation of materials and restoration of the floodplain with a wetland conservation seed mix.
	RCRA Floodplain Restrictions for Hazardous Waste Facilities (40 CFR 264.18(b))	A hazardous waste cap located in a 100-year floodplain must be designed, constructed, operated and maintained to prevent washout or to result in no adverse effects on human health or the environment if washout were to occur.	Any caps of Raymark Waste located in a floodplain will be designed to prevent washouts or the accidental transport of contaminated media into floodplain areas.	The low permeable cap is to be constructed with relatively short side slopes and a proposed anchor trench for geosynthetic components to prevent washouts.
State Regulatory Requirements	Flood Management Act and Regulations (CGS 2568d) (RCSA 25-68h-1 to 3)	These regulations govern activities in flood plains to minimize flood risk and prevent flood hazards. The regulations also contain stormwater management standards.	Any work in floodplains will comply with the substantive provisions of the regulations. Compensatory flood storage will be provided if necessary. Stormwater will be managed using best management practices such as hay bales and silt fences.	Stormwater management during construction is required under the design specifications. Stormwater control using best management practices will be required.

TABLE 2.1 SUMMARY OF ARARS FOR 576/600 EAST BROADWAY				
AUTHORITY	**REQUIREMENT**	**REQUIREMENT SYNOPSIS**	**CONSIDERATION**	**DESIGN**
	Connecticut Inland Wetlands and Watercourses Act and Regulations (CGS 22a-36 to 22a-45) (RCSA 22a-39-1 to 15)	Regulates activities that are conducted within inland wetlands and surface water bodies.	Any work conducted within inland wetlands or in rivers, streams, or ponds will be subject to compliance with the substantive provisions of these regulations.	Coordination pursuant to the Act occurred during the RI/FS and is reflected in the ROD and design.
Criteria, Advisories, and Guidance	USEPA Memorandum, "Policy on Floodplains and Wetland Assessments for CERCLA Actions" (August 6, 1985)	This memorandum details situations that would require preparation of floodplains or wetlands assessments and the factors which should be considered in preparing an assessment of actions taken under Section 104 or 106 CERCLA.	Design of excavation and/or capping alternatives will need to consider the potential for disturbance of floodplains within or adjacent to Raymark waste areas, and mitigate any disturbance accordingly. EPA has delineated the floodplains on the OU6 properties. EPA will conduct further detailed assessments of floodplain impacts.	EPA and CT DEEP have determined floodplain impacts to be minimal and no compensatory flood storage will not be required for this project.

2.3 Design Analysis

2.3.1 576/600 East Broadway Landfill Cap

The remedial action will require the installation of a low-permeable cap over the 576/600 East Broadway properties. This section discusses the design criteria selected for the major cap design elements.

Cap Grades. The maximum cap slope (33 percent) will provide for slope stability, provide for ease of construction, and allow for unreinforced vegetated slopes. The minimum cap slope (4 percent) is consistent with RCRA guidance, CTDEEP requirements, accounts for potential settlement, and provide a factor of safety for adequate cap drainage. Fill placement will be necessary for waste consolidation and to provide subgrade contouring which will accommodate varying slopes and cap thickness.

The proposed fill thickness and available cap consolidation volumes were evaluated utilizing AutoCAD Civil 3D (2013). The maximum fill thickness will be approximately 5 ft at the center of the Site and subgrade contouring will provide an approximate waste consolidation volume of 6,800 cubic yards. This design consolidation capacity will allow for placement of the anticipated 5,300 cubic yards of on-site waste excavation as well as an additional 750 cubic yards of Raymark waste from the 3rd Avenue property. All waste volumes are based on estimates developed from remedial investigation sampling results and actual volumes may vary significantly based on post-excavation sidewall samples.

Cap Materials. Raymark waste will be excavated and consolidated and contained with a low-permeable consistent with the following regulations and guidance;

- RCRA Subtitle C Hazardous Waste Landfill Cap Regulations (40 CFR 264.310)
- EPA Technical Guidance Document (EPA/530-SW-89-047)
- EPA Region 1 Cap Design Guidance
- Connecticut Remediation Standard Regulations

The following table summarizes the cap design criteria outlined in these documents and provides the proposed cap components at 576/600 East Broadway:

Cap Design Criteria

Cap Component	Regulatory Requirements	Proposed 576/600 East Broadway Cap System
Soil Cover	60 cm	2 ft
Geosynthetic Drainage Layer	Transmissivity ≥ 3 x 10^{-5} Centimeters squared per second (cm^2/s)	Transmissivity ≥ 1.7 x 10^{-3} cm^2/s
Two-Layer Low Permeability Layer	Flexible Membrane Liner Low Permeability Soil Layer Hydraulic Conductivity ≤ 1 x 10^{-7} Centimeters per second (cm/s)	40-mil Textured linear low-density polyethylene (LLDPE) Membrane Geosynthetic Clay Liner Hydraulic Conductivity ≤ 5 x 10^{-9} cm/s
Optional Layers	Biotic Layer / Gas Venting Layer	16 oz Geotextile Gas Venting Layer with Collection and Vent Pipes

Cap Surface Drainage. The cap slopes have been designed with a minimum slope of 4.5 percent to provide adequate sheet runoff conditions. An analysis was completed within the cap footprint to evaluate the anticipated primary and secondary (30-year) settlements (Appendix A1). The total settlement throughout the cap area is anticipated to be in the order of 6 to 14-inches and the minimum post settlement slopes will be greater than 4.0 percent. Supporting calculations and profiles depicting post settlement slopes are included in Appendix A1.

Surface runoff from the cap area will be directed to the perimeter and sheet flow to the base of the 3:1 side slopes. The side slopes are relatively short and a vegetative surface will be provided to protect against surface erosion. Storm water infiltrating into the geocomposite drainage layer (GDL) will be discharged though a riprap toe drain located along the perimeter of the cap.

Storm drainage from the cap area will discharge to surrounding areas and follow the existing drainage patterns at the Site. Excavations outside the cap footprint will be backfilled with clean imported material and match existing grades. Further information on site drainage including existing and post remediation hydraulic analysis is provided in Appendix B.

Cap Utility Corridor. The proposed utility corridor shown on drawing C-103 has been provided to support future development. The need and location of this corridor should be evaluated at the time of remediation based on then current development plans

2.3.1.1 Subgrade Fill

General. Proper cap construction will require that appropriate underlying slopes, foundation conditions, and material gradations be established. The subgrade contouring design has been developed such that cap design requirements can be successfully met. The following paragraphs discuss the design criteria selected for the major design elements for subgrade fill and grading.

Design Criteria Development. The subgrade contouring design criteria have been developed based upon the scope of the selected remedy, health and safety concerns, preliminary information, industry standards, vendor information, regulatory requirements, and standard engineering practice. The subgrade design criteria are:

- Provide a firm foundation for the overlying cap;
- Meet gradation requirements to be protective of the overlying gas venting layer;
- Meet the grading requirements of the cap; and
- Provide sufficient volume capacity underneath the cap to accommodate the anticipated volume of Raymark Waste to be consolidated.

Existing Conditions. Approximately 42% of 576 East Broadway is estimated to contain Raymark waste. One third of this is covered with pavement and the rest with vegetation. The parcel is generally flat, with a slight slope to the northwest, away from East Broadway. Approximately 21% of 600 East Broadway is estimated to contain Raymark waste. A small portion, located in the southeast corner of the property, is covered with gravel, the remainder of the waste areas in this parcel are covered with grasses, shrubs and trees. The grades in the 576/600 East Broadway properties vary from a minimum elevation of approximately 7 ft in the southwest corner of the property, to a maximum of approximately 12.5 ft close to the center of the properties.

Limits of Waste. A topographic survey was conducted in June 2012 to more accurately identify and measure the existing grades within the Site. The information provided by the survey, was combined with the limits of Raymark Waste and floodplain limits provided in the Remedial Investigation (Terta Tech NUS, 2005) and Feasibility Study (Nobis, 2010), to develop proposed excavation limits, cap limits and estimate fill capacity underneath the cap.

Consolidation of Raymark Waste from Third Avenue Property. The property at 35 Third Avenue has been identified to contain Raymark Waste. The Third Avenue property encompasses approximately 0.3 acres of residentially-zoned land. The selected remedy for the Third Avenue property includes excavation of Raymark waste above and below the

groundwater Table. As part of the pre-design efforts, the estimated volume of Raymark waste at the Third Avenue property was estimated to be approximately 630 cubic yards (See Appendix F). With an added 20% contingency, the volume of Raymark waste from the Third Avenue property could be as much as 750 cubic yards. An overall waste consolidation volume of 6,800 cubic yards has been included in the 576/600 East Broadway cap design.

Selected Removals and Protections. Selected removals of manmade and natural features will be necessary to accommodate the cap. Pavement that needs to be removed to access Raymark wastes will be cut, sized and placed under the cap. The existing buildings are intended to remain during construction and after remediation is complete. These structures and associated utilities shall be protected during remediation activities.

Construction Surface. The initial earthwork effort will be to clear and grub (stump removal) the existing surface and proof roll the subgrade layer of soil over the entire limits of the cap. This soil will act as a construction working surface.

Coordination with Cap Design. The proposed cap design has generally dictated the design of the subgrade area and features. The subgrade design considers the cap requirements including maximum and minimum final cap slopes, cap construction thickness and materials, and cap drainage.

Subgrade Contouring Design. The subgrade contouring design provides fill capacity for consolidation of Raymark wastes from the surrounding excavation areas. When subgrade design grades are achieved, the cap will be constructed directly on the subgrade.

2.3.1.2 Gas Venting Layer

The gas venting layer is to be constructed overlying the subgrade. The gas venting layer is to be comprised of a16 oz geotextile and supplemented by a perforated gas vent pipe that will be installed along the top of the subgrade and connected to four gas vent risers extending 5 ft above grade. The gas venting system has been included in the remedial design to mitigate potential methane generation from the underlying organic marsh deposit.

2.3.1.3 Geosynthetic Clay Liner/Geomembrane Layer

The hydraulic barrier layer is to be constructed overlying the gas venting layer. The hydraulic barrier layer is to be comprised of a GCL and an overlying geomembrane. The geomembrane is specified to be a 40-mil textured LLDPE and the GCL will provide a maximum permeability of 5×10^{-9} cm/s. This system is compliant with the RCRA guidance.

2.3.1.4 Geocomposite Drainage Layer

A GDL is to be constructed overlying the hydraulic barrier layer. The GDL will collect infiltration and transport it outside the cap to the surrounding environment. The GDL is manufactured with a layer of geotextile fabric on the top and bottom sides, sandwiching a geonet between them. The proposed GDL will consist of a tri-planar geonet with a minimum Transmissivity $\geq 1.7 \times 10^{-3}$ cm^2/s. Complete analysis and calculations are provided in Appendix A-3.

2.3.1.5 Geocomposite Drainage Layer Cover Soil

A protective cover soil layer, 12-inches in thickness will be placed over the GDL. The protective cover soil layer gradation is specified to meet filter criteria related to the geotextile fabric used in the manufacture of the GDL. The protective cover soil gradation is specified to minimize the piping of fine soil particles into the GDL which could clog the GDL and impair its performance over time. The protective cover soil layer is to be placed in a single 12-inch lift using low ground pressure equipment. Placement in this manner will protect the geocomposite material from crushing damage. Once the protective cover soil layer is placed and compacted, installation of successive soil layers may be performed using low ground pressure equipment.

2.3.1.6 Vegetative Cover Soil/Seeding

The top layer of soil in the cap will provide a suitable growth medium for final Site stabilization with vegetation. This layer will be 12-inches in total thickness and will be comprised of 8-inches of vegetative support soil (select fill) overlain by 4-inches of soil meeting the topsoil requirements of CTDEEP (formerly Connecticut Department of Environmental Protection [CTDEP]). The vegetative support soil layer specification requires specific gradation and compaction requirements. The topsoil layer specification requires characteristics that meet *CT Guidelines for Soil Erosion and Sediment Control* (CTDEP, 2002). These characteristics include soil textural classification, organic carbon content, pH, limited soluble salts, and gradation requirements.

Final seeding of the cap will be specified to be appropriate for the region and restoration goals. Seeding and mulch application using the hydroseeding method or by other mechanical or hand methods will be permitted.

2.3.2 Geotechnical Design

Geotechnical analyses were performed to evaluate cap settlement, global stability of the cap, internal cap drainage, and interface stability of cap materials. The geotechnical design evaluations are included in Appendix A. The results of the evaluations are incorporated into the technical specifications and drawings.

2.3.2.1 Cap Settlement Evaluation

AMEC performed a settlement evaluation to estimate the magnitude and duration of primary consolidation settlement that could occur as a result of the grade raises associated with the planned remediation. AMEC also estimated the amount of secondary compression that might occur in a 30-year period due to the organic nature/content of the Marsh Deposit. The total settlement in the cap area is anticipated to be in the order of 6 to 14 inches and long term cap slopes will remain in excess of 4 percent. The cap settlement evaluation is presented in Appendix A-1.

2.3.2.2 Global Stability Evaluation

AMEC completed a global stability evaluation for the planned remedial construction (i.e., cap). The purpose of the evaluation was to assess the minimum static and limited seismic factors of safety (FOS) relative to global (i.e., deep-seated) rotational stability, based on the existing Site conditions, planned remediation/post-construction conditions, and temporary construction conditions. The evaluation was made utilizing SLOPE/W (GeoStudio 2012, Version 8.11.1.7283), an industry-standard two-dimensional slope stability software program developed and distributed by Geo-Slope International, Ltd. The results of the evaluation indicate that the Site is expected to remain stable during and post-construction with respect to global stability. The global stability evaluation is presented in Appendix A-2.

2.3.2.3 Drainage Layer Evaluation

AMEC performed a drainage layer evaluation in support of the low-permeable cap for the Site. The purpose of the evaluation was to assess the performance requirements for a GDL and to establish the spacing/location of intermediate drain pipes (if necessary), based on the planned cap configuration, materials, and grading. Given the relatively long upper slopes and the desire to eliminate or minimize the need for intermediate drainage pipes, a tri-planar GDL was evaluated based on its high hydraulic transmissivity (i.e., flow rate). Subsequently, a bi-planar GDL was assessed. The evaluation suggests that a tri-planar GDL with high flow capacity will be required for the planned cap configuration, materials, and grading. The drainage layer evaluation is presented in Appendix A-3.

2.3.2.4 Interface Stability Evaluation

AMEC performed an interface stability evaluation in support of the cap design. The purpose of the evaluation was to establish the interface strength parameters necessary to provide for acceptable interface stability within the cap system. The results of the evaluation indicate that smooth geomembrane is suitable (from an interface friction standpoint) for the upper 4.5% slopes. However, the results indicate that smooth geomembrane is not suitable (from an interface friction standpoint) for the perimeter 33.3% slopes. Textured geomembrane will be required for the perimeter 33.3% side slopes. A textured 40-mil LLDPE geomembrane has been proposed for the entire cap area to eliminate the need of welding smooth to textured components. The interface stability evaluation is presented in Appendix A-4.

2.3.3 Surface Water Runoff Management

General. The remedial design includes consideration of stormwater management of surface water during construction and for final (post-construction) conditions. In general, surface drainage is provided to adequately drain the cap area, divert off-site runoff, minimize potential for infiltration in the cap area, and mitigate impacts to downstream receiving areas. A Stormwater Evaluation is provided in Appendix B. The evaluation examines existing and post-remediation conditions and presents results supporting the remedy will not create any increase in peak discharge from the Site nor adversely impact surrounding properties. Best Management Practices for Sediment and Erosion Control will be followed.

2.3.3.1 Existing Conditions

The Site is approximately 5.7-acres and approximately 94% of the Site surface consists of pervious cover. The Site is primarily undeveloped and overgrown with vegetation; consisting mostly of grasses in the central portion surrounded by a mix of grasses and trees. A dirt road providing access to 600 East Broadway encompasses approximately 0.04 acres. A wood shop, warehouse, and associated asphalt parking lot are located in the eastern edge of the Site.

Longbrook Tributary (a tributary to Ferry Creek) abuts the Site to the north. East Broadway borders the site to the southeast. Ferry Creek runs along the northeastern property line. Private properties, which border the Site to the west and south, are at higher elevations than the Site. While there are steeper slopes along these property boundaries, the majority of the Site is relatively flat (slopes of 5% or less).

There is no existing stormwater drainage system (e.g., catch basins, storm sewer pipes) on the Site. The majority of stormwater runoff flows towards the north and drains directly to Ferry Creek via overland flow. The remaining runoff from the southern portion of the Site ponds in a series of topographic depressions located within the 100-year floodplain.

This drainage eventually overtops the depressions and flows towards East Broadway where it ponds in a deep depression from what appears to be a former culvert inlet. The deep depression allows for infiltration during storm events approaching the 100-year storm and may ultimately overtop East Broadway for storms exceeding the 100-year storm.

2.3.3.2 Proposed Conditions

Proposed conditions will reflect similar Site runoff conditions as the existing conditions, where no increase in Site runoff will occur. For proposed features, surface water management is a design criteria consideration, and drainage conveyance measures have been provided as applicable. Stormwater management at the Site will be improved as a result of the remedy due to establishment of a good vegetative cover across the cap area and restored excavation areas.

2.4 Remedial Design Drawings and Technical Specifications

Remedial design Drawings and Technical Specifications have been prepared and are included as Appendices C and D to this document.

2.5 Site Development Evaluation

Consideration of future Site development was introduced in the Proposed Plan and the ROD. Several design analyses and a cost estimate were conducted in order to evaluate what measures may be required to develop the Site after the cap is constructed. A description of the scope of the evaluations is presented below and the resulting evaluation memoranda are included in Appendix E. The four evaluations developed were:

1. A structural evaluation of foundation alternatives (See Appendix E-1);
2. A geotechnical evaluation of cap component survival under foundation loads; foundation soil stability and consolidation (See Appendix E-2);
3. A structural assessment of settlement on potential building (See Appendix E-3);
4. Ground improvements necessary to mitigate settlement concerns (See Appendix E-4).

2.5.1 Structural Evaluation of Foundation Alternatives

Implementation of the remedial action requires the consolidation of Raymark waste beneath a low permeable cap. The maximum increase in height, over existing grade, of the cap is restricted to approximately 5-ft. This height restriction makes construction of a traditional footing and frost wall foundation impractical. Cover soil over the cap is necessary to protect the cap from the foundation load. Assuming that separation between the cap and the bottom of the foundation footing is a minimum of 1-foot and a traditional

footing and frost wall foundation would be at least 4-ft in total height, the combined height is 5-ft and no capacity is left beneath the foundation for consolidation of Raymark waste. Therefore, an alternative foundation design would be necessary. The alternative foundation design would need to be shallower than 2-ft.

Given the geometric constraints, a mat foundation was selected as the most viable alternative to be used for a future building, as this may permit construction on a minimal thickness of soil. As part of this task, the load of the foundation and a building were estimated for three different building types:

1. Prefabricated metal building, single story.
2. Traditional wood framed office building, single story.
3. Light commercial store, single story.

A table presenting the assumed construction type of each building, and estimated foundation loads was prepared. These loads were then be used to evaluate settlement of the building and foundation as described in the following sections. The results of this evaluation are presented in Appendix E-1.

2.5.2 Geotechnical Evaluation of Cap Component Survival under Foundation Loads; Foundation Soil Stability and Consolidation

The loads applied by construction of a building on the cap will affect both the cap components (geosynthetic drainage, geomembrane, geosynthetic clay layer, gas venting layer), the waste fill, and the soils underlying the waste fill. An evaluation was performed for each of the cap components for the maximum predicted load developed in the Structural Evaluation of Foundation Alternatives for the worst-case building foundation scenario (single evaluation for one foundation design). The assumption was that lesser foundation loads will have less impact on the materials. The evaluation used manufacturer's and other published data on the specific geosynthetic materials included in the cap design. The following evaluations were completed:

- Compressive load affect on the material (will it crush, or become ineffective)
- Stability

The magnitude and duration of settlement to be induced by the worst-case building foundation loading scenario (single evaluation for one foundation design) was also estimated. This settlement will be in addition to that induced by the loading from planned grade raises to consolidate Raymark waste and construct the cap. The following evaluations were completed:

- Estimated total and differential settlement
- Estimated angular distortion resulting from differential settlement

- Estimated duration of primary consolidation settlement within the Marsh Deposit
- Estimation of long-term secondary compression within the Marsh Deposit

To maximize the build out potential of the Site, a perimeter retaining wall system could be necessary. As part of the Site Development Evaluation, AMEC identified and evaluated perimeter suitable earth retaining wall system, including wall type, maximum unreinforced (i.e., without geogrid) height, and backfill and drainage considerations. For this evaluation, it was assumed that retaining walls will not exceed 5 ft in height (exposed above grade) and that surcharge loads atop the walls will be limited to standard passenger vehicles. As such, the evaluation of an unreinforced “big block” modular wall system was conducted.

The results of these evaluations are presented in Appendix E-2.

2.5.3 Structural Assessment of Settlement on Potential Building

Settlement predictions developed in the evaluation described in Section 2.5.2 were analyzed to determine the potential to adversely impact the assumed building types developed in the evaluation described in Section 2.5.1. The results of the analysis provide recommendations for building framing and finish types based on the anticipated settlements and is presented in Appendix E-3.

2.5.4 Ground Improvements

As a result of the analyses that were performed to evaluate the potential for construction of a building on the Site after cap construction, it was determined that ground improvements would be required to mitigate the adverse effects of settlement on such a structure. AMEC evaluated potential ground improvement strategies to address settlement that is predicted to occur due to implementation of the remedy and subsequent potential Site development. Primary consolidation settlement, and a portion of secondary consolidation, would need to be addressed via the implementation of a monitored surcharge program. As such, an evaluation was conducted to estimate a surcharge configuration and duration necessary to minimize post-construction settlement of a potential Site development footprint.

The results of the evaluation are presented in Appendix E-4.

3.0 REMEDIAL CONSTRUCTION ACTIVITIES AND SCHEDULE

The following sections describe the anticipated remedial construction work elements and present a proposed Construction Schedule.

3.1 Mobilization Activities

Site mobilization will begin upon approval and completion of all pre-mobilization requirements. The requirements include establishing locations to set up office trailers/facilities and utility connections and determining the laydown and staging areas. All safety and security fences, signs, postings, lights, barricades, ropes, etc., will be identified, posted, marked, and routinely maintained for the duration of field operations. Additional mobilization activities will involve the follow:

- All required Site safety clearances will be obtained.
- Clearing and grubbing from light brush to trees several inches in diameter to facilitate access to excavation areas.
- Erosion control measures will be instituted as Best Management Practices (BMPs).
- Any Raymark waste soil stockpiling areas will consist of bermed areas surrounded by erosion controls to prevent migration of contaminants in the event of a rainstorm. Underliners will be installed at each stockpile to prevent intermingling between contaminated soil and underlying ground surface.
- All construction equipment will be inspected to ensure that it is operational and free of contamination. The equipment will be inspected at an off-site location to be determined prior to mobilization on-site.
- Proper decontamination facilities will be established for personnel and equipment and will include but not be limited to exclusion areas, dust controls/monitors, site security, etc.

3.2 Raymark Waste Excavation

After mobilization activities have been completed (materials and equipment staging, temporary utilities, soil erosion and sediment controls, Site security), and prior to the commencement of excavation, a Site survey will need to be completed to properly mark and identify the areas of Raymark waste. Excavation areas are depicted on the Design Drawings as Raymark waste areas. These excavation areas are based on sampling performed during the site remedial investigation and should be considered approximate. Actual limits of Raymark waste excavation will be determined in the field and verified by an approved confirmatory sampling program.

Raymark waste excavations will be sloped to provide stability and/or appropriate soil retention methods such as sheeting and/or shoring will be utilized.

Excavated materials will be transported by dump trucks or trailers to the working face where they will be consolidated within the limits of the proposed cap on the East Broadway properties. Dust control measures will be in place during the excavation process, and each truck will be decontaminated before leaving Site.

Approximately 5,300 cubic yards of Raymark waste will be excavated and consolidated within the proposed cap area (Nobis, 2010).

3.3 Backfill and Restoration

All excavations the limits of the proposed cap will be backfilled using imported clean soil. Backfill will be transported to the project Site from a local source. The backfill material will be placed into the open excavation and will be distributed and compacted in lifts. After each lift, a compaction test will be performed to ensure that the compaction requirements are being met.

The excavations of Raymark waste will be backfilled to original grade and surface conditions will be restored to pre-excavation conditions, as practical. Vegetated areas will be replanted with appropriate vegetation and any formerly paved areas will be restored with gravel. Final property contours will be designed to meet East Broadway and the surrounding parcels current elevations. Final property contours will rise toward the center of 600 East Broadway, where the final elevation will be 4-5 ft greater than existing conditions after waste consolidation.

3.4 576/600 East Broadway Low-Permeable Landfill Cap

The low-permeable landfill cap will be constructed to cover the upland portion of the 576 and 600 East Broadway parcels where consolidated wastes are located. The cap will minimize infiltration during precipitation and protect ecological receptors and workers/Site developers and the community from exposure to the underlying contaminated soils and waste.

The RCRA final closure rules for a hazardous waste facility (40 CFR 264.310) are considered relevant and appropriate requirements for the design of a low-permeable cap at 576/600 East Broadway. These requirements include the following:

- Provide long-term minimization of migration of liquids;
- Function with minimum maintenance;
- Promote drainage and minimize erosion or abrasion of the cover;
- Accommodate settling and subsidence so that the cover's integrity is maintained; and

- Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.

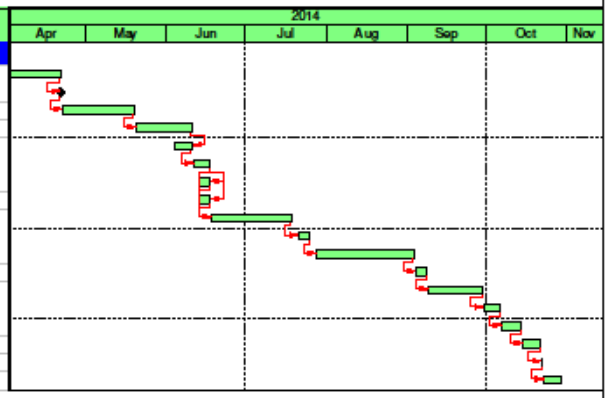
The landfill cap designed for this Site will be finished at the ground surface with topsoil and a vegetated cover, with the exception of the Site access road and disturbed pavement near the existing building that are to be finished with gravel.

3.5 Remedial Construction Schedule

The Draft Remedial Construction Schedule has been prepared based on the construction approach described in the previous sections.

Raymark Draft Remedial Construction Schedule
Landfill Cap Desing - 576/600 East Broadway
Raymark Superfund Site OU-6
Stratford, CT

Activity ID	Activity Name	Duration	Start	Finish
Raymark Draft Remedial Construction Schedule		**148**	**01-Apr-14**	**29-Oct-14**
A0500	Building Demolition	15	01-Apr-14	21-Apr-14
A1000	Contract Award	0		21-Apr-14
A1010	Plan Preparation	20	22-Apr-14	19-May-14
A1020	Materials Submittal	15	20-May-14	10-Jun-14
A1030	Mobilization	5	04-Jun-14	10-Jun-14
A1040	Soil Erosion Sedimentation Controls	5	11-Jun-14	17-Jun-14
A1050	Perimeter Air Monitoring Setup	3	13-Jun-14	17-Jun-14
A1060	Excavation Limits Stakeout	3	13-Jun-14	17-Jun-14
A1065	Demolition of Existing Structures	22	18-Jun-14	18-Jul-14
A1070	Clearing and Grubbing	5	21-Jul-14	25-Jul-14
A1080	Excavation, Placement, Compaction	27	28-Jul-14	03-Sep-14
A1090	Subgrade Preparation	3	04-Sep-14	08-Sep-14
A1100	GCL/Geomembrane Placement	15	09-Sep-14	29-Sep-14
A1110	Geocomposite Drainage Layer Placement	5	30-Sep-14	06-Oct-14
A1120	Protective Cover Soil	5	07-Oct-14	14-Oct-14
A1130	Vegetative Layer	5	15-Oct-14	21-Oct-14
A1140	Seeding	1	22-Oct-14	22-Oct-14
A1150	Site Cleanup & Demobilization	5	23-Oct-14	29-Oct-14



Actual Work Remaining Work Milestone

Page 1 of 1

01-Jul-13

4.0 REFERENCES

CTDEP Guidelines for Soil Erosion and Sediment Control (CTDEP, 2002)

EPA New England, Region 1, July 2011. "Record of Decision for Final Source Control Actions at Four Properties Within Operable Unit 6 (Additional Properties) and Interim Actions at Other Locations Containing Raymark Waste." Stratford, Connecticut.

Nobis Engineering, Inc., August 2010. Feasibility Study, Raymark Industries, Operable Unit 6 – Additional Properties. Stratford, Connecticut, August 2010.

Tetra Tech Nus, Inc., June 2005. Final Remedial Investigation, Raymark Industries, Inc. Superfund Site. 576/600 East Broadway. Stratford, Connecticut. July.

AMEC, 2013a. "Review and Evaluation of Existing Geotechnical Data, Raymark Remedial Investigation Reports for OU1, OU2, and OU6." February 19, 2013.

AMEC, 2013b. "Remedial Design Sampling Report, Remedial Design of a Landfill Cap, Waste Consolidation, Institutional Controls, and Interim Actions, Operable Unit (OU6)," February 14, 2013.

AMEC, 2013c. "Supplemental Investigation Data, Former Raymark Industries Site (OU6), Stratford, Connecticut," March 29, 2013.

APPENDIX A

GEOTECHNICAL EVALUATIONS

APPENDIX A-1

CAP SETTLEMENT EVALUATION

TECHNICAL MEMORANDUM

DATE: July 12, 2013

TO: Dean Brammer; USACE

COPY TO: Charles Collet, P.E. and Stephen Mitchell, P.E.; AMEC

FROM: Travis Carpenter, P.E. (Maine); AMEC

SUBJECT: Settlement Evaluation, Raymark Industries, Inc. Superfund Site (576/600 East Broadway), Stratford, Connecticut

PROJECT: 3651-12-0004

1.0 INTRODUCTION

AMEC Environment and Infrastructure, Inc. (AMEC) has performed a settlement evaluation in support of the Remedial Design (RD) of the Raymark Industries, Inc. Superfund Site, Operable Unit 6 (OU6), at 576/600 East Broadway in Stratford, Connecticut. The purpose of this evaluation was to estimate the magnitude and duration of settlement that could occur as a result of grade raises associated with the planned remedial construction.

This Technical Memorandum (TM) documents the work performed and presents the results of the evaluation. This TM is organized as follows:

- Section 2.0 briefly summarizes relevant project background information; and
- Section 3.0 presents the methodology, assumptions, results, and conclusions.

2.0 PROJECT BACKGROUND INFORMATION

Elevations reported herein are based on the North American Vertical Datum (NAVD) of 1988. Elevations are reported in units of feet. The horizontal datum is the Connecticut State Plane Coordinate System, based on the North American Datum (NAD) of 1983.

2.1 Site Description

OU6 of the Raymark Industries, Inc. Superfund Site (i.e., the Site) includes properties located at 576/600 East Broadway in Stratford, Connecticut. The two adjacent East Broadway properties encompass approximately 6 acres of commercially-zoned (light industrial) land that is presently overgrown and undeveloped, except for two small buildings and associated pavements situated on the 576 East Broadway parcel. Central portions of the Site are relatively flat and level with existing ground surface elevations generally ranging between +8.0 and +12.5 feet. The Site slopes downward toward the Site perimeter to an elevation of about +4.0 to +5.0 feet in most areas. Existing Site features and topography are depicted in Figure 1.

Beginning in the late 1980s, the Site received waste fill from the former Raymark Industries, Inc. facility. The fill consists of both natural and manmade materials. The manmade materials include presumed asbestos containing material (PACM) (fibrous asbestos mats and pads), asphalt, brake pads, brick, cinders, coal, concrete, gasket material, glass, metal debris, plastic, steel, tiles, shingles, slag, and wood. Raymark waste found in the fill materials at this Site consists of asbestos, lead, copper and/or Aroclor 1268.

Most of the Site was originally a tidal/seasonal floodplain marsh prior to filling. Much of the Site is still presently located within the 100-year floodplain.

2.2 Site-Specific Soil and Groundwater Conditions

AMEC carried out a site-specific geotechnical investigation to characterize subsurface conditions and obtain geotechnical data to support the planning, design, and construction of the planned Remedial Action (AMEC, 2013a; AMEC, 2013b). The geotechnical investigation indicates that the Site is underlain by the following primary soil strata:

- Fill: Heterogeneous fill materials comprised predominantly of sand, silt, gravel, and debris. Typically loose to medium dense. Thickness ranges from about 2 to 17 feet across the Site.
- Marsh Deposit: Marsh/floodplain deposit consisting primarily of organic silt (OH) with lesser amounts of organic clay (OH) and peat (PT). Variable amounts of sand throughout the deposit. Usually soft to medium stiff. Occasionally stratified with distinct layers of sand/silty sand (SM). Thickness varies from about 3.5 (GB-12) to about 17.5 feet (GB-03) across the Site.

- Fluvial Sand: Glacial fluvial deposit comprised of fine to coarse sand with varying amounts of silt and gravel. Typically medium dense to dense. Extends to Glacial Till and/or bedrock (based on site-specific monitoring well installations by others).

Figure 1 depicts the locations of site-specific geotechnical borings. Geotechnical Boring Records are provided in Attachment 1A. Tables 1A and 1B (attached) summarize the results of geotechnical laboratory testing performed on the Marsh Deposit. Site-specific consolidation testing data summaries are provided in Attachment 1B.

The one-dimensional consolidation testing data indicates that the Marsh Deposit is slightly over-consolidated with an average over-consolidation ratio (OCR) of 1.2. The data also indicate an average modified compression index ($C_{c\varepsilon}$) of 0.35, an average modified recompression index ($C_{r\varepsilon}$) of 0.07, and an average coefficient of consolidation (c_v) of about 0.20 feet^2/day. The Marsh Deposit is considered to be moderately to highly compressible based on the available geotechnical data. Consequently, this stratum is of prime concern for consolidation resulting from increases in effective stress due to grade raises.

In January and February of 2013, AMEC measured the depth to groundwater in several existing (i.e., previously installed by others) monitoring wells. The depths ranged from about 4.5 feet to 5.5 feet below the ground surface (bgs) in the shallow monitoring wells (i.e., screened within the fill materials and/or Marsh Deposit). These depths correspond to groundwater elevations of about +1.5 to +3.0 feet. The monitoring well locations are shown in Figure 1. Groundwater depths, elevations, and gradients are summarized in Table 2.

2.3 Planned Remedial Action

The remediation of 576/600 East Broadway is being performed as a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Action (RA) under the *Record of Decision for Final Source Control Actions at Four Properties Within Operable Unit 6 (Additional Properties) and Interim Actions at Other Locations Containing Raymark Waste* (USEPA, 2011). As described in the Record of Decision (ROD), the selected RA for this Site is to excavate Raymark waste from the 100-year floodplain, consolidate the waste on the upland portion of the Site, and contain the waste with a low-permeable Resource Conservation and Recovery Act (RCRA) cap.

The planned cap limits/extents and grading are depicted in Figure 1. A final grade/elevation of about +16.0 feet is indicated near the middle of the cap footprint. From this apex, the cap will slope downward gently (4.5% slope) toward the cap perimeter. There will be a grade break near the perimeter, at an elevation of about +11.0 feet, where

the cap grades will transition from 4.5% slopes to 33% slopes [3 horizontal to 1 vertical (3H:1V)]. The 3H:1V perimeter side slopes will be on the order of 3 to 4 feet tall. The proposed grading results in fills (i.e., grade raises) of about 3 to 5 feet in most areas within the cap footprint.

3.0 ESTIMATION OF SETTLEMENT

AMEC performed a settlement evaluation to estimate the magnitude and duration of primary consolidation settlement that could occur as a result of the grade raises associated with the planned remediation. AMEC also estimated the amount of secondary compression that might occur in a 30-year period due to the organic nature/content of the Marsh Deposit.

Settlement was assessed at eight distinct geotechnical boring locations (GB-01, GB-03, GB-05, GB-06, GB-07, GB-08, GB-09, and GB-10) within the footprint of the cap. Geotechnical boring locations are depicted in Figure 1. Settlement estimates assume that any primary consolidation due to historic and/or recent fill placement is complete.

3.1 Methodology and Assumed Compressibility Parameters

AMEC developed and utilized an in-house spreadsheet calculator to estimate primary consolidation settlement and secondary compression settlement at the referenced locations. The principal inputs and steps/calculations performed for each assessment point are summarized as follows:

1. Input existing grade and groundwater depth;
2. Input proposed grade and unit weight of proposed grading/capping fill;
3. Input subsurface soil profile;
4. Calculate in-situ stress and proposed stress versus depth (see Subsection 3.1.1);
5. Input compressibility parameters for applicable soil strata;
6. Indicate whether the principal compressible stratum is singly- or doubly-drained;
7. Calculate primary consolidation settlement (see Subsection 3.1.2);
8. Calculate the time-rate of primary consolidation (see Subsection 3.1.3); and
9. Calculate secondary compression settlement (see Subsection 3.1.4).

Spreadsheet calculations for each assessment point are provided in Attachment 2. A “hand-calculation” check of the spreadsheet calculator is also included in Attachment 2.

The calculations performed and the parameters utilized for this evaluation are further detailed in the subsections below.

3.1.1 Calculate In-Situ Stress and Proposed Stress vs. Depth

AMEC estimated in-situ total stress, pore pressure, and effective stress at the top, bottom, and middle of each primary soil stratum based on the subsurface soil and groundwater conditions at the referenced borehole location. At each assessment point, AMEC compared the planned final grade to the existing grade in order to estimate the proposed grade raise. The increase in effective stress was then estimated based on an assumed fill unit weight of 125 pounds per cubic foot (pcf).

3.1.2 Calculate Primary Consolidation Settlement

AMEC estimated primary consolidation settlement at each assessment point using standard consolidation theory equations (*Day, 2006*):

For normally consolidated soil (i.e., OCR = 1):

- $$S_c = C_{c\varepsilon} * H_o * \log(\sigma_{vo}' + \Delta\sigma_v)/\sigma_{vo}'$$

For over-consolidated soil (i.e., OCR > 1):

- Case I: $(\sigma_{vo}' + \Delta\sigma_v) \leq \sigma_p'$

  $$S_c = C_{r\varepsilon} * H_o * (\sigma_{vo}' + \Delta\sigma_v)/\sigma_{vo}'$$

- Case II: $(\sigma_{vo}' + \Delta\sigma_v) > \sigma_p'$

  $$S_c = C_{r\varepsilon} * H_o * \log(\sigma_p'/\sigma_{vo}') + C_{c\varepsilon} * H_o * \log(\sigma_{vo}' + \Delta\sigma_v)/\sigma_p'$$

Where:

- S_c = Primary consolidation settlement in feet;
- $C_{r\varepsilon}$ = Recompression index;
- $C_{c\varepsilon}$ = Compression index;
- H_o = Thickness of layer in feet;
- σ_p' = Estimated maximum past pressure in psf (from consolidation tests/OCR estimates);

- σ_{vo}' = Estimated existing effective stress in psf; and
- $\Delta\sigma_v$ = Change in vertical stress, equivalent to the weight of the grade raise fill, in psf.

For the purposes of this evaluation, the Marsh Deposit was assumed to be slightly over-consolidated (OCR = 1.2). The modified compression and recompression indices (strain based) utilized for this assessment are summarized in Table 3.

Table 3: Assumed Modified Compression/Recompression Indices

Stratum	Description	$C_{c\varepsilon}$	$C_{r\varepsilon}$
Marsh Deposit (Typical/Average)	Organic Silt/Clay/Peat (OH/PT)	0.35[1]	0.07
Marsh Deposit (Values used for GB-03)	Organic Silt/Clay/Peat (OH/PT) Stratified w/Sand Layers	0.18[2]	0.07
Marsh Deposit (Values used for GB-09)	Organic Silt/Clay/Peat (OH/PT) Sandy	0.30[3]	0.07

Notes:

1. Typical/average value used for most assessment points. Value based on the average of six one-dimensional consolidation tests.
2. Assumed value used for GB-03 only. Reduced compressibility based on observations of several distinct sand and inorganic silt layers within the Marsh Deposit. These sand/silt layers comprise nearly one-half of the overall Marsh Deposit thickness. As such, the typical/average value was reduced by approximately one-half.
3. Assumed value used for GB-09 only. Nominally reduced compressibility based on observations of higher (than typical) sand content within the Marsh Deposit soil matrix at this location.

3.1.3 Calculate Time-Rate of Primary Consolidation

AMEC estimated the time required for primary consolidation to occur at each point based on the Terzaghi theory of consolidation. Double drainage was assumed for the Marsh Deposit based on presence of granular soils above (Fill) and below (Fluvial Sand).

The coefficient of consolidation, c_v, was estimated based on the results of site-specific one-dimensional consolidation testing data, empirical correlations to published values utilizing index testing data (i.e., Atterberg Limits), and engineering judgment. The coefficients of consolidation utilized for this assessment are summarized in Table 4.

Table 4: Assumed Coefficient of Consolidation Parameters

Stratum	Description	c_v (feet^2/day)
Marsh Deposit (Typical/Average)	Organic Silt/Clay/Peat (OH/PT)	0.20[1]
Marsh Deposit (Values used for GB-03)	Organic Silt/Clay/Peat (OH/PT) Stratified w/Sand Layers	0.40[2]
Marsh Deposit (Values used for GB-09)	Organic Silt/Clay/Peat (OH/PT) Sandy	0.20[3]

Notes:

1. Typical/average value used for most assessment points. Value based on the average of six one-dimensional consolidation tests.
2. Assumed value used for GB-03 only. Increased rate of consolidation based on observations of several distinct sand and inorganic silt layers within the Marsh Deposit. These sand/silt layers comprise nearly one-half of the overall Marsh Deposit thickness.
3. The virgin compressibility parameter for GB-09 was nominally reduced (see Table 3) based on observations of higher (than typical) sand content within the Marsh Deposit soil matrix at this location. However, the coefficient of consolidation was not increased (based on increased sand content) for this evaluation, which may be slightly conservative.

The time to achieve primary consolidation was estimated using the following equation (Day, 2006):

- $t_p = T * H_{dr}^2 / c_v$

Where:

- $t_p =$ Time to achieve primary consolidation;

- $T =$ Time factor (e.g., 0.848 for 90 percent consolidation);
    - For $U_{avg} < 60\%$, $T = 1/4 * \Pi * (U_{avg}/100)^2$, where U_{avg} = avg. degree of consolidation
    - For $U_{avg} \geq 60\%$, $T = 1.781 - 0.933 * \text{Log}(100 - U_{avg})$
- $H_{dr} =$ Length of longest drainage path in feet; and
- $c_v =$ Coefficient of consolidation, in feet^2/day.

3.1.4 Calculate Secondary Compression

Secondary compression of organic soils can result in a substantial amount of additional settlement following the completion of primary consolidation and dissipation of load-induced excess pore pressure. Secondary compression may continue to occur throughout the design life of the project.

AMEC estimated the secondary compression using on an estimated secondary compression ratio ($C_{\acute{a}\varepsilon}$) of 0.02 (from consolidation testing data), a Marsh Deposit thickness ranging from about 7.5 to 17 feet (after primary consolidation), an estimated 0.5-year to 1.5-year primary consolidation period (from spreadsheet calculations), and a secondary compression period of 30 years.

Secondary compression was estimated using the following equation (Day, 2006):

- $S_{sec} = C_{\acute{a}\varepsilon} * H_o * \log(t_{sec}/t_p)$

Where:

- $S_{sec} =$ Secondary compression settlement in feet;
- $C_{\acute{a}\varepsilon} =$ Secondary compression index;
- $H_o =$ Thickness of layer in feet (after primary consolidation);
- $t_{sec} =$ Time of interest in secondary compression in years;
    - Commonly equivalent to the design life of the structure/facility, but other durations/periods may be considered
- $t_p =$ End of primary consolidation in years.

3.2 RESULTS

Table 5 summarizes the estimated settlements at the geotechnical boring locations referenced herein:

Table 5: Summary of Settlement

Location	Estimated Settlement (to nearest inch)				
	Primary Consolidation			Secondary Compression	Total
	Magnitude	Estimated Time To EOP[1]		30 Years[2]	After 30+ Years
	(inches)	(months)	(years)	(inches)	(inches)
GB-01	5	12	1.0	5	10
GB-03	7	11	1.0	3	10
GB-05	4	5	0.5	3	7
GB-06	7	5	0.5	3	10
GB-07	10	11	1.0	4	14
GB-08	7	17	1.5	5	12
GB-09	8	13	1.0	5	13
GB-10	2	6	0.5	4	6

Notes:

1. EOP = end of primary (based on estimate to approximately 99 percent primary consolidation). Rounded to the nearest month and to the nearest one-half year.
2. Thirty years of secondary compression (following an estimated primary consolidation period of about 0.5 to 1.5 years) equates to 1.3 to 1.8 log cycles [e.g., log (30/1) = 1.5].

3.3 DISCUSSION AND CONCLUSIONS

Primary consolidation settlement is estimated to range between 2 and 10 inches across the footprint of the cap. This relatively large range of primary consolidation settlement is driven by substantial variation among the following parameters:

- Variable thickness of the Marsh Deposit;
- Variable thickness of existing fill, which results in variable existing effective stress in Marsh Deposit; and
- Variable existing Site grades within the footprint of the cap (resulting in variable load increase due to final grading).

Following the completion of primary consolidation, secondary compression settlement will occur. After about thirty years (or about 1.3 to 1.8 log cycles), secondary compression is estimated to range from 3 and 5 inches across the cap footprint.

This evaluation suggests that the cap may experience 6 to 14 inches of total settlement (primary consolidation plus secondary compression) over 30 years. The planned geosynthetic cap materials can tolerate this amount of total (and associated differential) settlement. Similarly, any localized surface depressions that may form as a result of total and/or differential settlement can be addressed, if necessary, as part of a regular post-construction operations, monitoring, and maintenance program.

6.0 REFERENCES

AMEC, 2013a. "Remedial Design Sampling Report, Remedial Design of a Landfill Cap, Waste Consolidation, Institutional Controls, and Interim Actions, Operable Unit (OU6)," February 14, 2013.

AMEC, 2013b. "Technical Memorandum, Supplemental Investigation Data, Former Raymark Industries Site (OU6), Stratford, Connecticut", March 29, 2013.

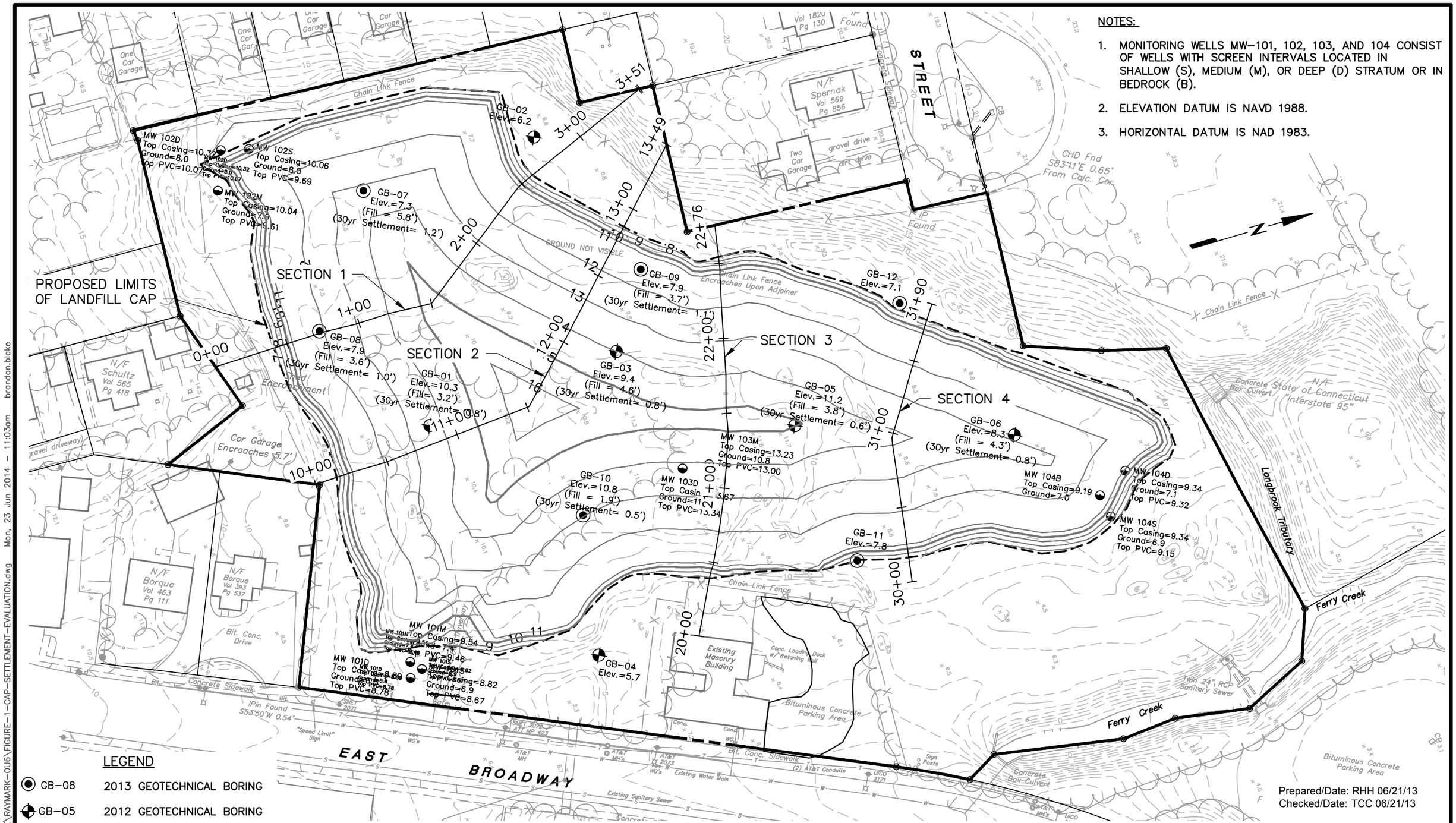
Day, Robert W., 2006. Foundation Engineering Handbook, The McGraw-Hill Companies, Inc., 2006.

Department of the Navy, Naval Facilities Engineering Command, 1982. "Soil Mechanics, Design Manual 7.1" (NAVFAC DM-7.1), May 1982.

FIGURES

NOTES:

1. MONITORING WELLS MW–101, 102, 103, AND 104 CONSIST OF WELLS WITH SCREEN INTERVALS LOCATED IN SHALLOW (S), MEDIUM (M), OR DEEP (D) STRATUM OR IN BEDROCK (B).
2. ELEVATION DATUM IS NAVD 1988.
3. HORIZONTAL DATUM IS NAD 1983.



LEGEND

- GB–08 2013 GEOTECHNICAL BORING
- GB–05 2012 GEOTECHNICAL BORING
- MW 103(D) 1994 MONITORING WELL
- EXISTING GROUND SURFACE ELEVATION CONTOUR
- PROPOSED CAP GRADING (95% REMEDIAL DESIGN)

0 30 60 120
SCALE IN FEET HORIZONTAL

Prepared/Date: RHH 06/21/13
Checked/Date: TCC 06/21/13

RAYMARK INDUSTRIES, INC.
576/600 EAST BROADWAY
STRATFORD, CONNECTICUT

amec

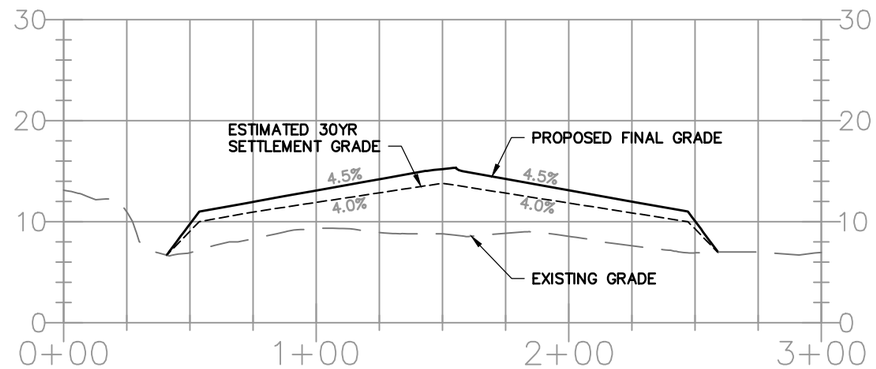
CAP SETTLEMENT EVALUATION

Project 3651-12-0004
FIGURE 1

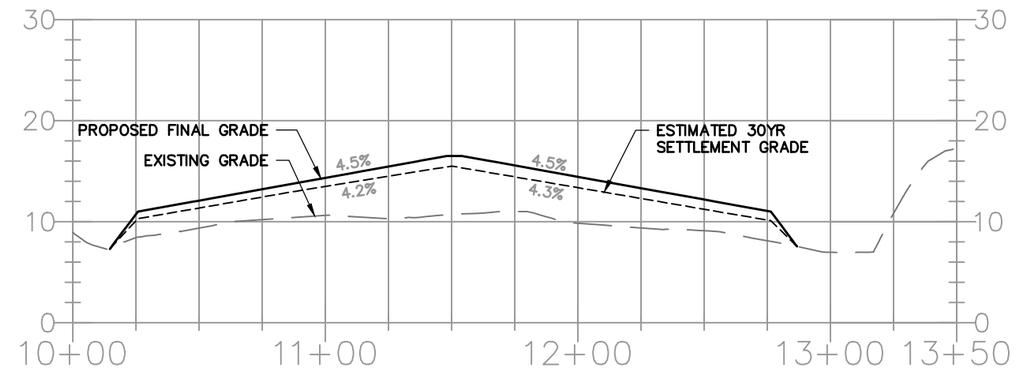
Z:\Projects\USACE\RAYMARK–OU6\FIGURE–1–CAP–SETTLEMENT–EVALUATION.dwg Mon, 23 Jun 2014 – 11:03am brandon.blake

NOTES:

1. MONITORING WELLS MW-101, 102, 103, AND 104 CONSIST OF WELLS WITH SCREEN INTERVALS LOCATED IN SHALLOW (S), MEDIUM (M), OR DEEP (D) STRATUM OR IN BEDROCK (B).
2. ELEVATION DATUM IS NAVD 1988.
3. HORIZONTAL DATUM IS NAD 1983.



SECTION 1



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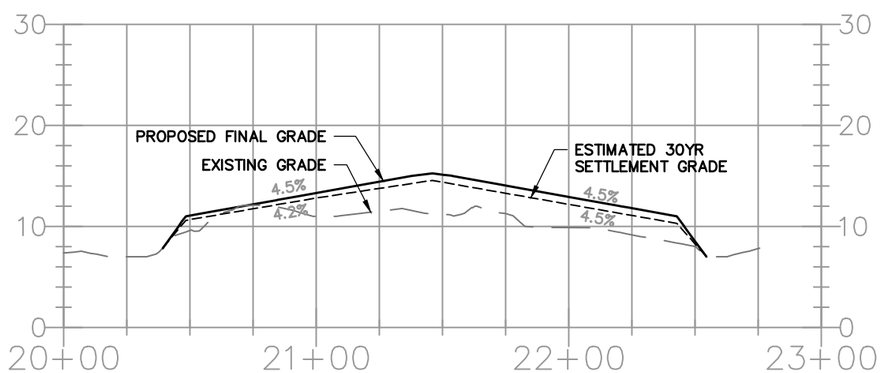

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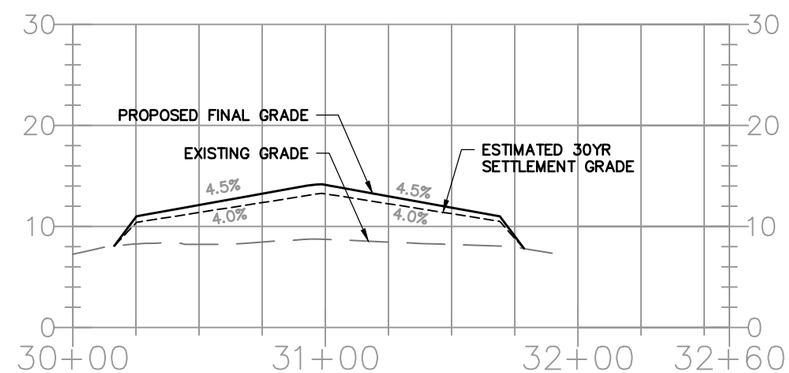

SECTION 4

0 30 60 120
SCALE IN FEET
HORIZONTAL

0 7.5 15 30
SCALE IN FEET
VERTICAL

Prepared/Date: RHH 06/21/13
Checked/Date: TCC 06/21/13

RAYMARK INDUSTRIES, INC.
576/600 EAST BROADWAY
STRATFORD, CONNECTICUT

amec

CAP SETTLEMENT EVALUATION
PROFILES
Project 3651-12-0004
FIGURE 2

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TABLES

Table 1A
Summary of Geotechnical Laboratory Testing Data - Marsh Deposit (All)

Borehole No.	Ground Elevation (ft bgs)	Sample Information							Laboratory Testing Data																						
		No.	Type	Depth Interval	In-Situ Effective Stress	Primary Stratum	USCS D 2487 / D 2488		Water Content D 2216	Organic Content D 2974	Total Unit Weight	Dry Unit Weight	Void Ratio	Satur.	Particle-Size Analysis D 422				Atterberg Limits D 4318						Specific Gravity D 854	Undrained Shear Strength		1-D Consolidation (Raw Lab Data) D 2435					
							Description	Symbol							Gravel	Sand	Silt	Clay	LL Wet Prep.	LL Oven Dried	LL ODLL WPLL Ratio	PL	PI	LI		Torvane	Lab Vane D 4648						
				(ft bgs)	(psf)				(%)	(%)	(pcf)	(pcf)		(%)	(%)	(%)	(%)	(%)								(psf)	(psf)				(ft²/day)	
GB-01	10.3	SS-09	Jar	16 - 18	-	Marsh Deposit	Organic Silt	OH	71.1	-	-	-	-	-	0.0	5.0	95.0		-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-10	Jar	20 - 22	-	Marsh Deposit	Organic Silt	OH	117.0	11.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-11	Jar	22 - 24	-	Marsh Deposit	Organic Silt	OH	114.8	-	-	-	-	-	-	-	-	-	143	-	-	67	76	0.6		-	-	-	-	-	-	-
		SS-12	Jar	24 - 26	-	Marsh Deposit	Organic Silt	OH	151.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GB-02	6.2	SS-04	Jar	06 - 08	-	Marsh Deposit	Silty Sand w/organics	SM	80.0	20.6	-	-	-	-	9.5	66.0	24.5		-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-07	Jar	12 - 14	-	Marsh Deposit	Organic Silt	OH	149.6	18.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GB-03	9.4	SS-05	Jar	08 - 10	-	Marsh Deposit	Silty Sand	SM	-	-	-	-	-	-	8.4	64.8	26.8		-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SH-07	Tube	12 - 14.5	900	Marsh Deposit	Organic Silt	OH	205.9	-	80.3	26.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									192.0	22.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									181.7	-	70.4	25.0	4.49	89.1	-	-	-	-	-	-	-	-	-	-	-	-	-	860	1.0	0.31	0.07	0.04	0.02
									206.0	-	-	-	-	-	-	-	-	-	191	-	-	88	103	1.1	-	-	-	-	-	-	-	-	-
									167.7	-	80.5	30.1	-	-	-	-	-	-	-	-	-	-	-	-	-	280	-	-	-	-	-	-
									205.9	-	33.9	11.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									205.9	-	70.4	23.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									107.4	-	79.1	38.2	2.60	90.9	0.0	16.8	83.2		-	-	-	-	-	-	2.20	-	-	-	-	-	-	-
		SS-09	Jar	16.5 - 18.5	-	Marsh Deposit	Organic Silt	OH	121.2	14.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-10	Jar	18.5 - 20.5	-	Marsh Deposit	Organic Silt	OH	169.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-11	Jar	20.5 - 22.5	-	Marsh Deposit	Organic Silt	OH	150.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-12	Jar	22.5 - 24.5	-	Marsh Deposit	Organic Silt	OH	179.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GB-05	11.2	SS-07A	Jar	12 - 14	-	Marsh Deposit	Sandy Organic Silt	OH	134.0	18.1	-	-	-	-	8.7	32.6	58.7		-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-09	Jar	16.5 - 18.5	-	Marsh Deposit	Organic Silt	OH	153.3	7.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GB-06	8.3	SS-07	Jar	12 - 14	-	Marsh Deposit	Organic Silt	OH	104.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SH-08	Tube	14 - 16.5	1000	Marsh Deposit	Organic Silt	OH	103.9	-	88.9	43.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									107.5	-	86.1	41.5	3.26	93.4	-	-	-	-	-	-	-	-	-	-	-	-	-	1100	1.1	0.24	0.06	0.16	0.01
									105.0	8.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									92.0	-	94.3	49.1	-	-	-	-	-	-	-	-	-	-	-	-	-	440	-	-	-	-	-	-
									103.9	-	88.9	43.6	-	-	-	-	-	-	128	-	-	58	70	0.7	-	-	-	-	-	-	-	-
									104.0	-	103.2	50.6	2.16	89.1	0.0	21.0	79.0		-	-	-	-	-	-	2.56	-	-	-	-	-	-	-
GB-07	7.3	VS-07B	Jar	17 - 19	-	Marsh Deposit	Organic Silt/Peat	OH/PT	260.5	-	-	-	-	-	-	-	-	-	341	NP	-	130	211	0.6	-	-	-	-	-	-	-	-
		SS-08	Jar	20 - 22	-	Marsh Deposit	Organic Silt/Peat	OH/PT	318.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ST-09	Tube	22.5 - 24.5	1275	Marsh Deposit	Organic Silt/Peat	OH/PT	259.0	38.0	-	-	-	-	-	-	-	-	475	NP	-	184	291	0.3	1.94	-	-	-	-	-	-	-
									370.8	-	63.8	13.6	-	-	-	-	-	-	-	-	-	-	-	-	-	600	580	-	-	-	-	-
									461.0	-	62.8	11.2	9.79	91.4	-	-	-	-	-	-	-	-	-	-	-	-	-	1600	1.3	0.55	0.08	0.16	0.02
		SS-10A	Jar	25 - 27	-	Marsh Deposit	Organic Silt	OH	119.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GB-08	7.9	SS-05B	Jar	12 - 14	-	Marsh Deposit	Organic Silt/Peat	OH/PT	274.0	49.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		VS-07B	Jar	16 - 18	-	Marsh Deposit	Organic Silt	OH	117.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ST-08	Tube	18 - 20	1175	Marsh Deposit	Organic Silt	OH	129.0	15.8	-	-	-	-	-	-	-	-	146	81	0.6	71	75	0.8	2.44	-	-	-	-	-	-	-
									116.8	-	79.2	36.5	-	-	-	-	-	-	-	-	-	-	-	-	-	620	560	-	-	-	-	-
									135.8	-	77.8	33.0	3.61	91.8	-	-	-	-	-	-	-	-	-	-	-	-	-	1450	1.2	0.36	0.06	0.20	0.02
		SS-09B	Jar	20 - 22	-	Marsh Deposit	Organic Silt/Peat	OH/PT	275.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-10	Jar	22.5 - 24.5	-	Marsh Deposit	Organic Silt/Peat	OH/PT	286.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-11B	Jar	25 - 27	-	Marsh Deposit	Organic Silt/Peat	OH/PT	208.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GB-09	7.9	SS-04	Jar	10 - 12	-	Marsh Deposit	Organic Silt	OH	143.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		VS-05	Jar	12.5 - 14.5	-	Marsh Deposit	Organic Silt/Peat	OH/PT	338.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-06	Jar	15 - 17	-	Marsh Deposit	Organic Silt/Peat	OH/PT	352.6	-	-	-	-	-	-	-	-	-	355	NP	-	163	192	1.0	-	-	-	-	-	-	-	-
		ST-07	Tube	17.5 - 19.5	775	Marsh Deposit	Sandy Organic Clay	OH	41.0	4.9	-	-	-	-	-	-	33.9		76	NP	-	33	43	0.2	-	-	-	-	-	-	-	-
									46.2	-	101.2	69.2	1.47	86.0	-	-	-	-	-	-	-	-	-	-	-	-	-	1300	1.7	0.18	0.02	0.19	0.01
GB-10	10.8	SS-06	Jar	17 - 19	-	Marsh Deposit	Organic Silt	OH	109.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ST-07	Tube	19 - 21	1550	Marsh Deposit	Organic Silt/Peat	OH/PT	189.0	28.9	-	-	-	-	-	-	-	-	239	NP	-	93	146	0.7	2.15	-	-	-	-	-	-	-
									175.2	-	71.7	26.1	-	-	-	-	-	-	-	-	-	-	-	-	-	660	580	-	-	-	-	-
									199.8	-	70.2	23.4	4.74	90.7	-	-	-	-	-	-	-	-	-	-	-	-	-	1600	1.0	0.43	0.07	0.51	0.02
		VS-08	Jar	22 - 24	-	Marsh Deposit	Organic Silt/Peat	OH/PT	172.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-09A	Jar	25 - 27	-	Marsh Deposit	Organic Silt	OH	98.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GB-11	7.8	SS-03	Jar	10 - 12	-	Marsh Deposit	Organic Silt	OH	101.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		VS-05	Jar	14 - 16	-	Marsh Deposit	Organic Silt/Peat	OH/PT	231.6	-	-	-	-	-	-	-	-	-	191	81	0.4	82	109	1.4	-	-	-	-	-	-	-	-
		SS-07A	Jar	18 - 20	-	Marsh Deposit	Organic Silt/Peat	OH/PT	245.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GB-12	7.1	SS-03	Jar	08 - 10	-	Marsh Deposit	Organic Silt	OH	116.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-04A	Jar	10 - 12	-	Marsh Deposit	Sandy Organic Silt	SM/OH	44.9	-	-	-	-	-	-	-	35.7		-	-	-	-	-	-	-	-	-	-	-	-	-	-
								Count:	57	13	18	18	-	-	-	-	-	-	10	-	-	10	10	10	5	-	-	6	6	6	6	6	6
								Minimum:	41.0	4.9	33.9	11.1	-	-	-	-	-	-	76	-	-	33	43	0.2	1.94	-	-	-	1.0	0.18	0.02	0.04	0.01
								Average:	**170.6**	**19.9**	**77.9**	**33.1**	-	-	-	-	-	-	**229**	-	-	**97**	**132**	**0.7**	**2.26**	-	-	-	**1.2**	**0.35**	**0.06**	**0.21**	**0.02**
								Maximum:	461.0	49.5	103.2	69.2	-	-	-	-	-	-	475	-	-	184	291	1.4	2.56	-	-	-	1.7	0.55	0.08	0.51	0.02
								Average (excluding min & max):	**167.6**	**18.6**	**79.1**	**32.2**	-	-	-	-	-	-	**217**	-	-	**94**	**123**	**0.7**	**2.26**	-	-	-	**1.2**	**0.34**	**0.07**	**0.18**	**0.02**

Table 1B
Summary of Geotechnical Laboratory Testing Data - Marsh Deposit (Shelby Tube Samples Only)

Borehole No.	Ground Elevation (ft bgs)	Sample Information							Laboratory Testing Data																					
		No.	Type	Depth Interval	In-Situ Effective Stress	Primary Stratum	USCS D 2487 / D 2488		Water Content	Organic Content	Total Unit Weight	Dry Unit Weight	Void Ratio	Satur.	Particle-Size Analysis D 422				Atterberg Limits D 4318						Specific Gravity	Undrained Shear Strength		1-D Consolidation (Raw Lab Data) D 2435					
					σ'_v		Description	Symbol	D 2216	D 2974	γ_t	γ_d	e_0	S	Gravel	Sand	Silt	Clay	LL Wet Prep.	LL Oven Dried	LL ODLL WPLL Ratio	PL	PI	LI	D 854	Torvane S_u	Lab Vane D 4648 S_u	$\sigma'_{p\text{-}max.}$	OCR	$C_{c\varepsilon}$	$C_{r\varepsilon}$	c_v	$C_{\alpha\varepsilon}$
				(ft bgs)	(psf)				(%)	(%)	(pcf)	(pcf)		(%)	(%)	(%)	(%)	(%)								(psf)	(psf)					(ft²/day)	
GB-03	9.4	SH-07	Tube	12 - 14.5	900	Marsh Deposit	Organic Silt	OH	205.9	-	80.3	26.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									192.0	22.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									181.7	-	70.4	25.0	4.49	89.1	-	-	-	-	-	-	-	-	-	-	-	-	-	860	1.0	0.31	0.07	0.04	0.02
									206.0	-	-	-	-	-	-	-	-	-	191	-	-	88	103	1.1	-	-	-	-	-	-	-	-	-
									167.7	-	80.5	30.1	-	-	-	-	-	-	-	-	-	-	-	-	-	280	-	-	-	-	-	-	-
									205.9	-	33.9	11.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									205.9	-	70.4	23.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									107.4	-	79.1	38.2	2.60	90.9	0.0	16.8	83.2		-	-	-	-	-	-	2.20	-	-	-	-	-	-	-	-
GB-06	8.3	SH-08	Tube	14 - 16.5	1000	Marsh Deposit	Organic Silt	OH	103.9	-	88.9	43.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									107.5	-	86.1	41.5	3.26	93.4	-	-	-	-	-	-	-	-	-	-	-	-	-	1100	1.1	0.24	0.06	0.16	0.01
									105.0	8.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									92.0	-	94.3	49.1	-	-	-	-	-	-	-	-	-	-	-	-	-	440	-	-	-	-	-	-	-
									103.9	-	88.9	43.6	-	-	-	-	-	-	128	-	-	58	70	0.7	-	-	-	-	-	-	-	-	-
									104.0	-	103.2	50.6	2.16	89.1	0.0	21.0	79.0		-	-	-	-	-	-	2.56	-	-	-	-	-	-	-	-
GB-07	7.3	ST-09	Tube	22.5 - 24.5	1275	Marsh Deposit	Organic Silt/Peat	OH/PT	259.0	38.0	-	-	-	-	-	-	-	-	475	NP	-	184	291	0.3	1.94	-	-	-	-	-	-	-	-
									370.8	-	63.8	13.6	-	-	-	-	-	-	-	-	-	-	-	-	-	600	580	-	-	-	-	-	-
									461.0	-	62.8	11.2	9.79	91.4	-	-	-	-	-	-	-	-	-	-	-	-	-	1600	1.3	0.55	0.08	0.16	0.02
GB-08	7.9	ST-08	Tube	18 - 20	1175	Marsh Deposit	Organic Silt	OH	129.0	15.8	-	-	-	-	-	-	-	-	146	81	0.6	71	75	0.8	2.44	-	-	-	-	-	-	-	-
									116.8	-	79.2	36.5	-	-	-	-	-	-	-	-	-	-	-	-	-	620	560	-	-	-	-	-	-
									135.8	-	77.8	33.0	3.61	91.8	-	-	-	-	-	-	-	-	-	-	-	-	-	1450	1.2	0.36	0.06	0.20	0.02
GB-09	7.9	ST-07	Tube	17.5 - 19.5	775	Marsh Deposit	Sandy Organic Clay	OH	41.0	4.9	-	-	-	-	-	-	33.9		76	NP	-	33	43	0.2	-	-	-	-	-	-	-	-	-
									46.2	-	101.2	69.2	1.47	86.0	-	-	-	-	-	-	-	-	-	-	-	-	-	1300	1.7	0.18	0.02	0.19	0.01
GB-10	10.8	ST-07	Tube	19 - 21	1550	Marsh Deposit	Organic Silt/Peat	OH/PT	189.0	28.9	-	-	-	-	-	-	-	-	239	NP	-	93	146	0.7	2.15	-	-	-	-	-	-	-	-
									175.2	-	71.7	26.1	-	-	-	-	-	-	-	-	-	-	-	-	-	660	580	-	-	-	-	-	-
									199.8	-	70.2	23.4	4.74	90.7	-	-	-	-	-	-	-	-	-	-	-	-	-	1600	1.0	0.43	0.07	0.51	0.02
								Count:	25	6	18	18	8	-	-	-	-	-	6	-	-	6	6	6	5	-	-	-	6	6	6	6	6
								Minimum:	41.0	4.9	33.9	11.1	1.5	-	-	-	-	-	76	-	-	33	43	0.2	1.94	-	-	-	1.0	0.18	0.02	0.04	0.01
								Average:	**168.5**	**19.9**	**77.9**	**33.1**	**4.0**	-	-	-	-	-	**209**	-	-	**88**	**121**	**0.6**	**2.26**	-	-	-	**1.2**	**0.35**	**0.06**	**0.21**	**0.02**
								Maximum:	461.0	38.0	103.2	69.2	9.8	-	-	-	-	-	475	-	-	184	291	1.1	2.56	-	-	-	1.7	0.55	0.08	0.51	0.02
								Average (excluding min & max):	**161.3**	**19.1**	**79.1**	**32.2**	**3.5**	-	-	-	-	-	**176**	-	-	**78**	**99**	**0.6**	**2.26**	-	-	-	**1.2**	**0.34**	**0.07**	**0.18**	**0.02**

Prepared By/Date: TCC/NDL/KL
Checked By/Date: TCC

Table 2
Summary of Water Depths, Elevations, & Gradients

Site Area	Well/Piezometer Information							Water Level Measurements									
	ID No.	Ground Ele.[1] (ft)	TOC Ele.[1] (ft)	TOR Ele.[1] (ft)	Screened Interval			1/28/13 to 1/30/13					02/04/13				
					Top Depth (ft bgs)	Bottom Depth (ft bgs)	Primary Stratum	Depth (ft btor)	Depth (ft bgs)	Elev. (ft)	Gradient (ft/ft)		Depth (ft btor)	Depth (ft bgs)	Elev. (ft)	Gradient (ft/ft)	
576/600 East Broadway	MW-101 S	6.9	8.8	8.7	5	15	Fill/Marsh	6.39	4.62	**2.28**	-0.11	-	7.25	5.48	**1.42**	-0.05	-
	MW-101 M	7.4	9.5	9.5	21	26	Fluvial Sand	8.69	6.63	0.77		0.00	8.68	6.62	0.78		0.01
	MW-101 D	6.8	8.9	8.8	59	69	Sand/Till	7.94	5.96	0.84	-		7.92	5.94	0.86	-	
	MW-102 S	8.0	10.1	9.7	6	10	Fill/Marsh	-	-	-	-		6.65	4.96	**3.04**	-0.04	-
	MW-102 M	7.9	10.0	9.6	20	30	Fluvial Sand	7.30	5.59	2.31			7.30	5.59	2.31		-0.01
	MW-102 D	8.0	10.2	10.1	102	112	Sand/Till	-	-	-			8.85	6.79	1.21	-	
	MW-103 M	10.8	13.2	13.0	28	38	Fill/Marsh	-	-	-	-		12.22	10.02	0.78	0.00	
	MW-103 D	11.3	13.7	13.3	73	83	Sand/Till	12.43	10.39	0.91			12.54	10.50	0.80		
	MW-104 S	6.9	9.3	9.2	7	11	Fill	6.86	4.61	2.29	-0.02		6.70	4.45	**2.45**	-0.03	
	MW-104 D	7.1	9.3	9.3	69	79	Sand/Till	8.65	6.43	0.67			8.95	6.73	0.37		
	MW-104 B	7.0	9.2	-	19	29	Fluvial Sand	-	-	-	-		-	-	-	-	

Notes:
1. 2012 Survey; NAVD 1988 Datum

Prepared By/Date: NDL 04-2013
Checked By/Date: TCC 04-2013

ATTACHMENT 1

SITE-SPECIFIC GEOTECHNICAL DATA

Attachment 1A

Geotechnical Boring Records

MAJOR DIVISIONS			GROUP SYMBOLS	GENERAL DESCRIPTIONS
COARSE GRAINED SOILS (More than 50% RETAINED on No. 200 sieve)	GRAVELS (More than 50% of coarse fraction RETAINED on No. 4 sieve)	CLEAN GRAVELS (Less than 5% fines)	GW	Well graded gravels or gravel-sand mixtures; trace or no fines.
			GP	Poorly graded gravels or gravel-sand mixtures; trace or no fines.
		GRAVELS WITH FINES (More than 12% fines)	GM	Silty gravels or gravel-sand-silt mixtures.
			GC	Clayey gravels or gravel-sand-clay mixtures.
	SANDS (50% or more of coarse fraction PASSES the No. 4 sieve)	CLEAN SANDS (Less than 5% fines)	SW	Well graded sands or sand-gravel mixtures; trace or no fines.
			SP	Poorly graded sands or sand-gravel mixtures, trace or no fines.
		SANDS WITH FINES (More than 12% fines)	SM	Silty sands or sand-gravel-silt mixtures.
			SC	Clayey sands or sand-gravel-clay mixtures.
FINE GRAINED SOILS (50% or more PASSES the No. 200 sieve)	SILTS AND CLAYS (Liquid Limit LESS than 50)		ML	Inorganic silts or rock flour. Non-plastic or very slightly plastic. PI < 4 or plots below "A" line.
			CL	Inorganic lean clay. Low to medium plasticity. PI > 7 and plots on or above "A" line.
			OL	Organic silts, clays, and silty clays. Low to medium plasticity.
	SILTS AND CLAYS (Liquid Limit of 50 or GREATER)		MH	Inorganic elastic silt. PI plots below "A" line.
			CH	Inorganic fat clay. High plasticity. PI plots on or above "A" line.
			OH	Organic silts and clays. High plasticity.
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils. Decomposed vegetable tissue. Fibrous to amorphous texture.

BOUNDARY CLASSIFICATIONS: Soils possessing characteristics of two groups are designated by combinations of group symbols.

SILT OR CLAY	SAND			GRAVEL		Cobbles	Boulders
	Fine	Medium	Coarse	Fine	Coarse		

No.200 No.40 No.10 No.4 3/4" 3" 12"

U.S. STANDARD SIEVE SIZE

References: ASTM D 2487 (Unified Soil Classification System) and ASTM D 2488 (Visual-Manual Procedure).

TYPICAL SYMBOLS

Shelby Tube	Auger Cuttings
Standard Split Spoon Sample	3" Split Spoon Sample
Rock Core	Dynamic Cone Penetrometer
Vane Shear	Bulk/Grab Sample
Geoprobe Sample	Sonic or Vibro-Core Sample
Water Table at time of drilling	Water Table after 24 hours

CORRELATION OF STANDARD PENETRATION TEST (SPT) WITH RELATIVE DENSITY AND CONSISTENCY

GRAVEL, SAND, & SILT (NON-PLASTIC)		SILT (PLASTIC) & CLAY		
N-Value	Relative Density	N-Value	Su (psf)	Consistency
0 - 4	Very Loose	0 - 2	0 - 250	Very Soft
4 - 10	Loose	2 - 4	250 - 500	Soft
10 - 30	Medium Dense	4 - 8	500 - 1000	Medium Stiff
30 - 50	Dense	8 - 15	1000 - 2000	Stiff
Over 50	Very Dense	15 - 30	2000 - 4000	Very Stiff
		Over 30	Over 4000	Hard

SPT Notes: WR = Weight of Rods; WH = Weight of Hammer

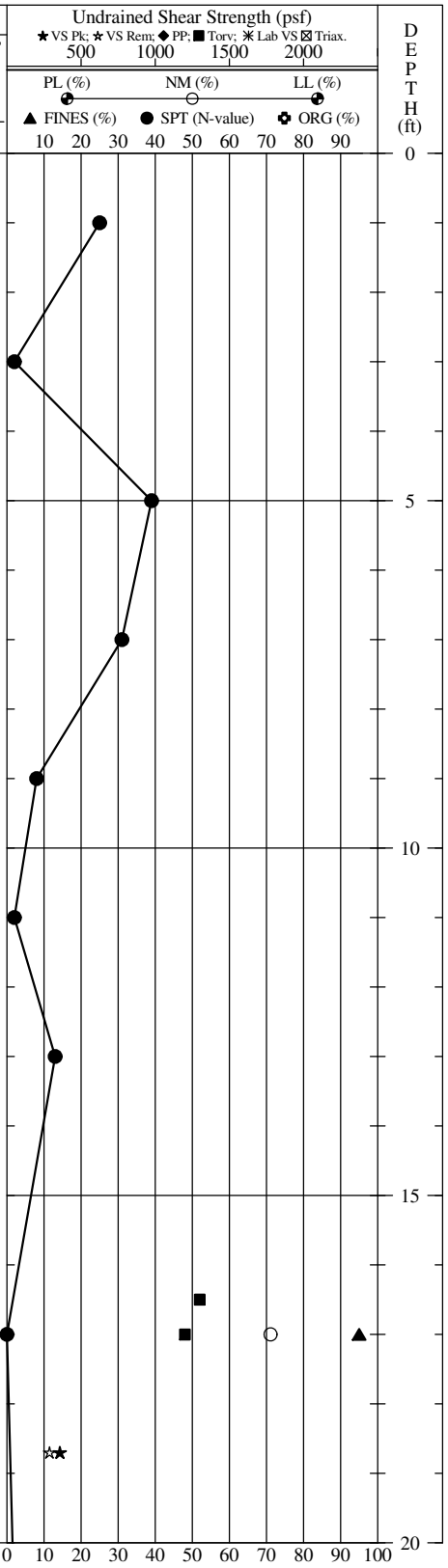
TERMS DESCRIBING SOILS (excludes particles > 3", organics, debris, etc.)	TERMS DESCRIBING MATERIALS (i.e. particles > 3", organics, debris, etc.)
Trace: Particles present, but < 5%	Occasional: Particles present, but < 10%
Few: 5% to 15%	Some: 10% to 25%
Little: 15% to 25%	Frequent: > 25%
Some: 25% to 50%	

TERMS DESCRIBING MOISTURE	TERMS DESCRIBING STRUCTURE
Dry: Absence of moisture; dusty	Layer: > 3" thick
Moist: Damp, but no visible water	Seam: 1/16" to 3" thick
Wet: Visible/free water	Parting: < 1/16" thick

KEY TO SYMBOLS AND DESCRIPTIONS

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
0	FILL (Sand, Silt, Gravel, Debris) Gravel and organics changing to Brown to reddish brown, fine to coarse SAND, some gravel, few/little silt (SW-SM/SM), very loose, dry to moist.		10.3	SS-01 [0]		4-12-13-12 (N = 25)
	- 2.0' to 2.2' bgs: cobble and asphalt fragments in spoon			SS-02 []		1-1-1-19 (N = 2)
	- 4.0' to 4.6' bgs: Brown, fine to coarse SAND, some gravel, little silt, (SM). - 4.6' to 5' bgs: fractured cobble					
5	Brown, fine to coarse SAND, trace silt (SW), dense, moist, occasional asphalt fragments.		5.3	SS-03 []		9-27-12-12 (N = 39)
	Brown, fine to coarse SAND, some gravel, few silt (SW-SM), dense, moist. - 6.6' bgs: fractured cobble					
	Dark brown, fine to coarse SAND, few to some silt (SM), dense, moist to wet, non-plastic. - 7.3' bgs: becomes wet			SS-04 [0]		28-19-12-10 (N = 31)
	- 8.0' bgs: becomes loose			SS-05 [0]		16-5-3-1 (N = 8)
10	Dark brown, fine to coarse SAND, little gravel, few silt (SW-SM), very loose, wet.		0.3	SS-06 [0]		3-1-1-4 (N = 2)
	- 12.0' to 13' bgs: fractured cobble					
	MARSH DEPOSIT (Silt, Sand, Organics/Peat)					
	Dark brown, SILT, trace fine sand, with organics (OH), stiff.			SS-07 []		12-10-3-3 (N = 13)
15			-4.7	ST-08 []		
	Dark Brown, SILT with organics, trace fine sand (OH), soft, moist, medium plasticity, slow dilatancy, strong organic odor.			SS-09 [0]		2-WH-WH-1
	VS-1 at 18.0' bgs: Su => 357 psf VS-1 at 18.0' bgs: Sremolded = 287 psf					
20			-9.7			



BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Truck rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/081012

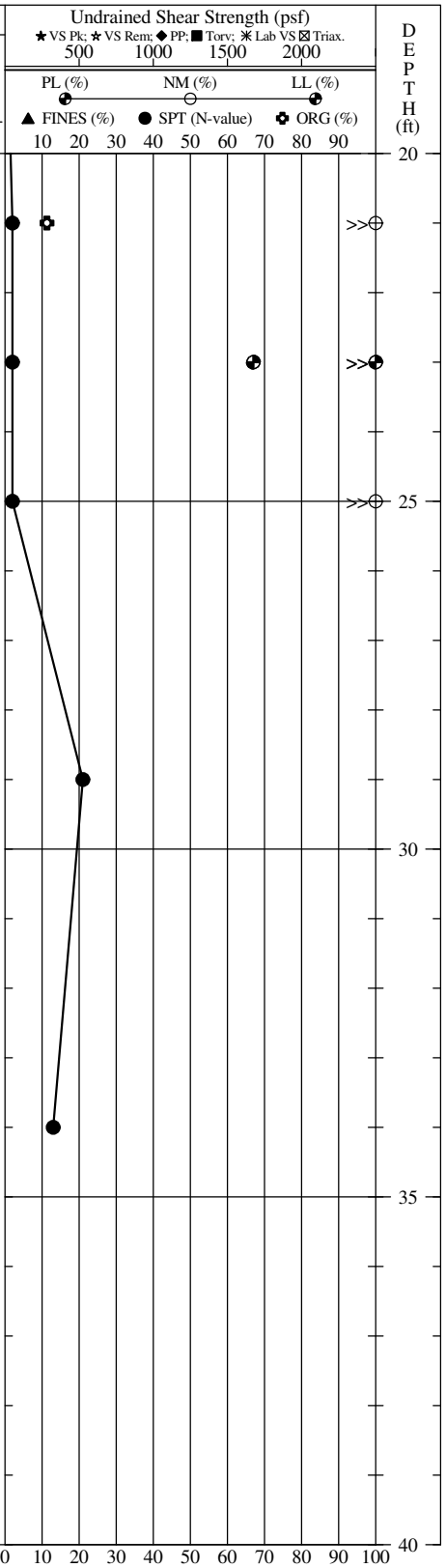
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-01
DRILLED: 5/30/12 - 6/1/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
20	MARSH DEPOSIT (Silt, Sand, Organics/Peat)		-9.7			
	Similar to SS-09; medium plasticity, slow dilatancy, strong organic odor.			SS-10 [0]		WH-1-1-2 (N = 2)
	Similar to SS-09.			SS-11 [0]		WH-1-1-1 (N = 2)
	Similar to SS-09.					
25			-14.7	SS-12 [0]		WH-1-1-6 (N = 2)
	FLUVIAL DEPOSIT (Sand, Gravel, Silt) Dark brown, fine to coarse SAND, few silt (SW-SM), wet.					
	Gray, fine to coarse SAND, trace gravel and silt (SW), medium dense, wet.			SS-13 [0]		14-11-10-8 (N = 21)
30			-19.7			
	Reddish-brown to grayish brown, fine SAND, little silt (SM), with bands of reddish brown to brown, fine to coarse SAND, little gravel, trace silt (SP), medium dense, wet.			SS-14 [0]		3-7-6-7 (N = 13)
35	Bottom of Exploration at 35 ft bgs.		-24.7			
40			-29.7			



BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Truck rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-01
DRILLED: 5/30/12 - 6/1/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLE IDENT	PID (ppm)	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
0	Topsoil, frequent organics FILL (Sand, Silt, Gravel, Debris) Fractured concrete Brown, fine to medium SAND, few/little silt (SM), pieces of asphalt, medium dense, dry. - 0.3' to 0.7' bgs: fractured asphalt Concrete	6.2	SS-01	[0]		10-8-10-50/3" (N = 18)
5	MARSH DEPOSIT (Silt, Sand, Organics/Peat) Primarily organic fibers in silt (PT), wet, slight odor.	1.2	SS-03	[0]		1-1-2-1 (N = 3)
	Brown, fine to coarse SAND, some silt, with organics (SM), wet, very loose, no to low plasticity, slow dilatancy, slight odor.		SS-04	[0]		3-2-1-1 (N = 3)
			ST-05	[]		
10	- 10.5' to 12.0' bgs: Dark brown, SILT with organics, little fine sand (OL), low plasticity, rapid dilatancy, strong organic odor. Changing to fine to coarse sandy SILT (OL), very soft, wet, low plasticity, rapid dialtancy. Dark brown, SILT with organics, few fine sand (OL-PT), very soft, wet, low plasticity, slow dilatancy, strong organic odor.	-3.8	SS-06	[]		1-WH-WH
			SS-07	[0]		WR-WR-WR-WH
	Dark brown, fine to medium SAND, some silt, with organics (SM-PT), very loose, wet.					
15		-8.8	SS-08	[0]		WR-WR-WH-WH
	Dark brown, fine to medium SAND, some silt, trace organics (SM). FLUVIAL DEPOSIT (Sand, Gravel, Silt) Grayish-brown, fine to coarse SAND, little silt, trace organics and gravel (SM), very loose, wet, slight organic odor.		SS-09	[0]		WH-WH-1-WH
	Gray, GRAVEL, some fine to coarse sand, few silt (GM), medium dense, wet.		SS-10	[0]		7-13-10-7 (N = 23)
20		-13.8				

Undrained Shear Strength (psf): ★ VS Pk; ☆ VS Rem; ◆ PP; ■ Torv; ✳ Lab VS ⊠ Triax. 500 1000 1500 2000

PL (%) NM (%) LL (%)

▲ FINES (%) ● SPT (N-value) ✿ ORG (%)

10 20 30 40 50 60 70 80 90

0 10 20 30 40 50 60 70 80 90 100

BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Track rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/081012

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-02
DRILLED: 6/7/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC	Undrained Shear Strength (psf) ★ VS Pk; ☆ VS Rem; ◆ PP; ■ Torv; ✳ Lab VS ⊠ Triax. 500 1000 1500 2000 / PL (%) NM (%) LL (%) / ▲ FINES (%) ● SPT (N-value) ✿ ORG (%) 10 20 30 40 50 60 70 80 90	DEPTH (ft)
20	FLUVIAL DEPOSIT (Sand, Gravel, Silt) Gray, fine to coarse SAND, few silt and fine gravel, changing to orange-brown fine to coarse SAND, some gravel, few silt, (SW-SM), medium dense, wet.		-13.8	SS-11 [0]		9-17-13-18 (N = 30)		20
25	Brown fine to coarse SAND with gravel, trace silt (SP), medium dense, wet.		-18.8	SS-12 []		18-12-14-35 (N = 26)	▲	25
	Bottom of Exploration at 27 ft bgs.							
30			-23.8					30
35			-28.8					35
40			-33.8				0 10 20 30 40 50 60 70 80 90 100	40

BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Track rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-02
DRILLED: 6/7/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLE IDENT [PID (ppm)]	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
0	FILL (Sand, Silt, Gravel, Debris)	9.4			
	Brown, fine to coarse SAND, few to little silt, trace to few gravel (SP-SM/SM), medium dense, moist. -1.0' to 2.0' bgs: fractured cobble		SS-01 [0]		2-5-10-6 (N = 15)
	- 2.0' to 2.2' bgs: fractured cobble and asphalt Brown, fine to medium SAND, few silt (SP-SM), medium dense, moist.		SS-02 [0]		5-6-7-8 (N = 13)
	Dark brown to reddish brown, fine to medium SAND, some silt, with organics (PT-SM), no to low plasticity, loose, wet.				
5		4.4	SS-03 [0]		6-4-3-6 (N = 7)
	Dark brown, fine to coarse SAND, little fine gravel, few silt and organics (SW-SM), wet, slight organic odor.				
	MARSH DEPOSIT (Silt, Sand, Organics/Peat) Grayish-brown, SILT, some fine to coarse sand (ML), medium stiff, wet, low plasticity, rapid dilatancy.		SS-04 [0]		4-4-1-1 (N = 5)
	Grayish-brown, coarse SAND, some silt, trace to few gravel (SM), very loose, wet.		SS-05 [0]		2-1-WH-1
10	Grayish-brown, SILT, few fine sand (ML), soft, wet.	-0.6	SS-06 [0]		2-1-2-1 (N = 3)
	Brown, SAND with silt and gravel (SP-SM)				
	Dark brown, SILT with sand and organics (OH)		ST-07 []		
	Grayish-brown, fine to coarse SAND, some silt, little gravel (SM), very loose, wet.				
15		-5.6	SS-08 [0]		2-1-1-2 (N = 2)
	Dark grayish-brown, SILT with organics, trace fine sand (OH), low plasticity, slow dilatancy, soft, wet, strong organic odor.		SS-09 [0.1]		2-1-1-2 (N = 2)
	Similar to SS-09, strong organic odor.				
20		-10.6	SS-10 [0]		WH-WH-2-2

Undrained Shear Strength (psf): ★ VS Pk; ☆ VS Rem; ◆ PP; ■ Torv; ✳ Lab VS ⊠ Triax. (500, 1000, 1500, 2000)

PL (%) NM (%) LL (%)

▲ FINES (%) ● SPT (N-value) ✿ ORG (%)

10 20 30 40 50 60 70 80 90

0 10 20 30 40 50 60 70 80 90 100

BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Track rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/081012

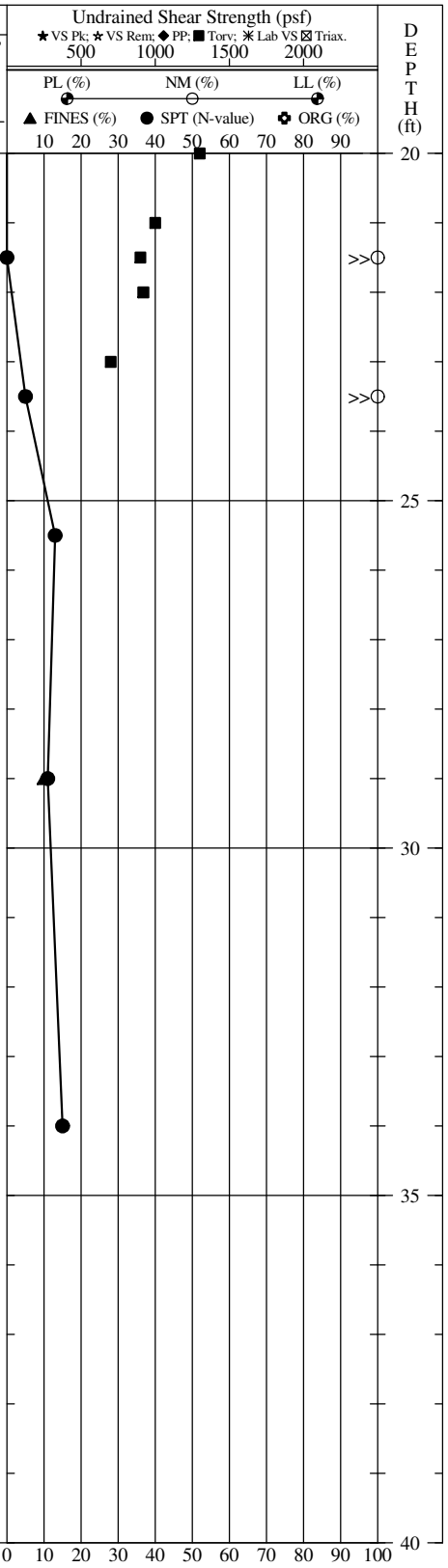
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-03
DRILLED: 6/6/12 - 6/7/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
20	MARSH DEPOSIT (Silt, Sand, Organics/Peat) Similar to SS-09, strong organic odor.		-10.6			
				SS-11 [0]		WH-WH-2-2
	Similar to SS-09, slight organic odor.					
				SS-12 [0]		WH-2-3-4 (N = 5)
	FLUVIAL DEPOSIT (Sand, Gravel, Silt)					
25			-15.6			
	Gray, fine to coarse SAND, trace silt and fine gravel (SW), medium dense, wet, slight organic odor.			SS-13 [0]		7-7-6-7 (N = 13)
	Orange-brown, fine to medium SAND, few silt (SW-SM), medium dense, wet, no odor.			SS-14 [0]		4-5-6-4 (N = 11)
30			-20.6			
	Similar to SS-14, brown, trace gravel.			SS-15 [0]		7-8-7-9 (N = 15)
35	Bottom of Exploration at 35 ft bgs.		-25.6			
40			-30.6			



BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Track rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-03
DRILLED: 6/6/12 - 6/7/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC	PL (%) NM (%) LL (%) ▲ FINES (%) ● SPT (N-value) ✪ ORG (%) 10 20 30 40 50 60 70 80 90	DEPTH (ft)
0	Topsoil, frequent organics		5.7					0
	FILL (Sand, Silt, Gravel, Debris) Brown, fine to coarse SAND, few to little silt, trace to few gravel (SW-SM/SM), very loose, moist.			SS-01 [0]		1-1-1-2 (N = 2)		
	MARSH DEPOSIT (Silt, Sand, Organics/Peat)							
	Dark brown, fine SAND and fibrous ORGANICS, some silt (SM/PT), very loose, moist to wet.			SS-02 [0]		1-WH-1-1		
	Dark gray, fine to coarse SAND, little gravel, little silt (SM), transitioning to black, decomposed organic fibers (PT), very loose, wet, moderate to strong organic odor.							
5			0.7	SS-03 [0]		1-1-1-1 (N = 2)		5
	Dark gray, fine to coarse SAND, few silt and fine gravel (SW-SM), changing to black fine SAND and ORGANICS, some silt (SM/PT), very loose, wet.			SS-04 [0]		1-1-1-1 (N = 2)		
	Similar to SS-04.			SS-05 [4.8]		3-2-1-1 (N = 3)		
10	Dark gray, GRAVEL, little fine to coarse sand, few silt (GM), very loose, wet, changing to dark gray, SILT, some fine sand (OL), slow dilatancy, low to medium plasticity, wet.		-4.3	SS-06 [0]		1-1-1-3 (N = 2)		10
	Similar to SS-06 with trace organics(GM/OL), coarse gravel in spoon.							
	FLUVIAL DEPOSIT (Sand, Gravel, Silt)			SS-07 [0]		1-1-1-1 (N = 2)		
	Dark gray, fine to coarse SAND, little gravel, little silt (SM), loose, wet.							
15			-9.3	SS-08 [0]		3-2-5-5 (N = 7)		15
	Grayish-brown, fine to coarse SAND, trace silt, trace gravel (SW), loose, wet.			SS-09 [0]		8-3-6-4 (N = 9)		
20			-14.3				0 10 20 30 40 50 60 70 80 90 100	20

BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Track rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/081012

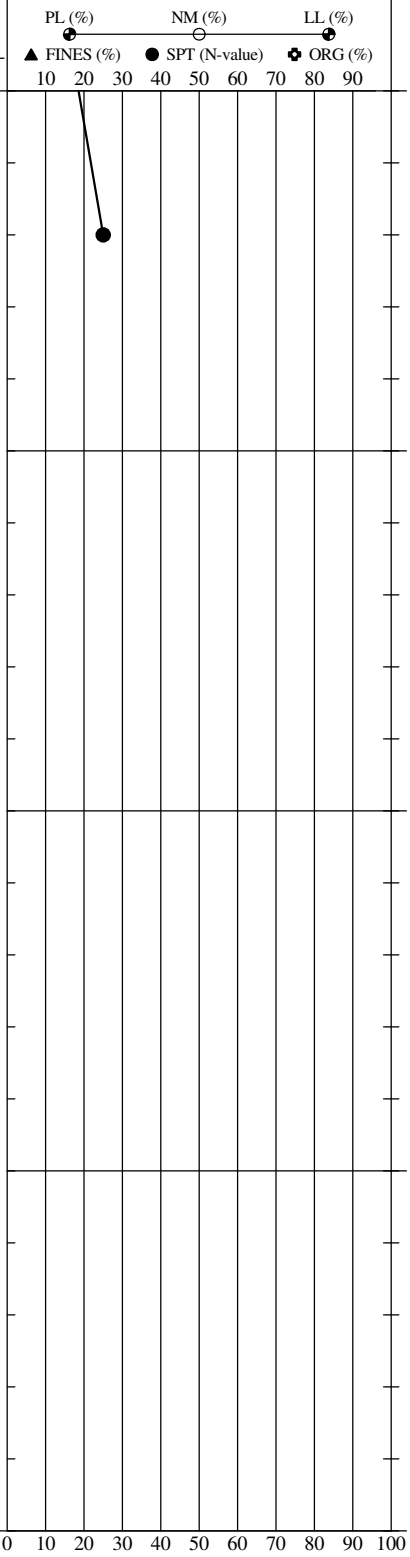
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-04
DRILLED: 6/6/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
20	FLUVIAL DEPOSIT (Sand, Gravel, Silt)		-14.3			
	Brown, fine to coarse SAND, little gravel, trace silt (SW), medium dense, wet.			SS-10 [0]		10-12-13-13 (N = 25)
	Bottom of Exploration at 23 feet bgs.					
25			-19.3			
30			-24.3			
35			-29.3			
40			-34.3			



BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Track rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

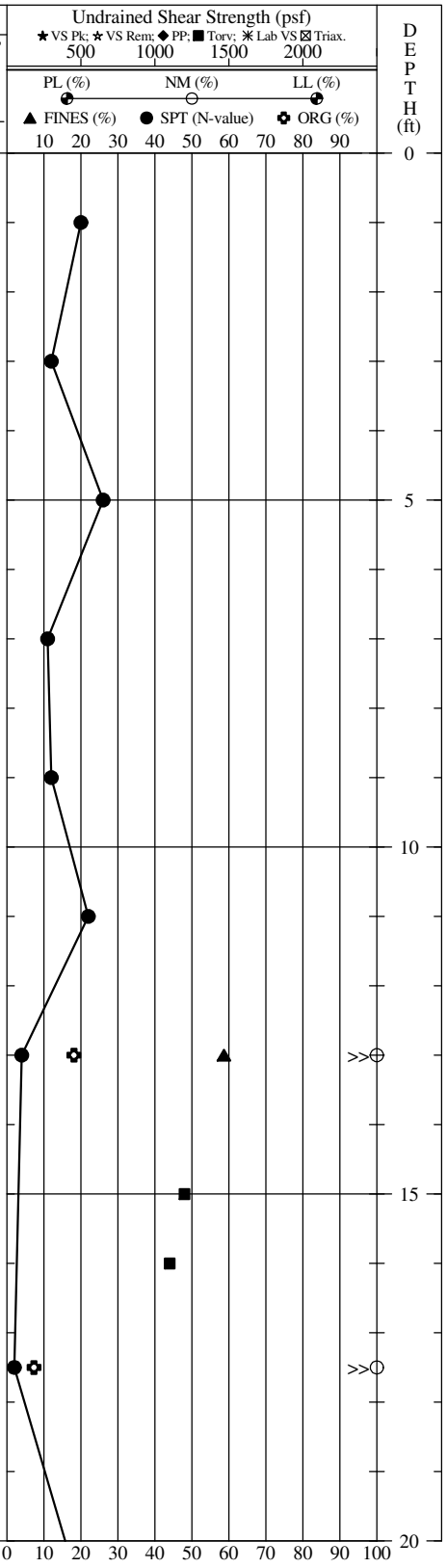
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-04
DRILLED: 6/6/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	IDENT	PID (ppm)	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
0	Topsoil, frequent organics	11.2				
	FILL (Sand, Silt, Gravel, Debris) Brown, fine to coarse SAND, few to little silt and gravel (SW-SM/SM), medium dense, moist.		SS-01	[0]		2-5-15-13 (N = 20)
	- 2.0' to 4.0' bgs: occasional organics (roots) - 2.1' to 2.4' bgs: fractured cobble		SS-02	[0]		13-8-4-5 (N = 12)
5	Dark brown to dark reddish brown, fine SAND, some silt (SM), medium dense, moist. - 5.0' to 6.0' bgs: occasional brick fragments and staining	6.2	SS-03	[0]		7-14-12-6 (N = 26)
			SS-04	[0]		5-5-6-7 (N = 11)
	Dark grayish brown, fine to coarse SAND, few/little silt and gravel (SM), medium dense, wet. - 8.0' to 8.7' bgs: brick fragment		SS-05	[0.1]		7-6-6-3 (N = 12)
10	Dark gray, fine to coarse SAND, few silt (SW-SM), medium dense, wet. - 10.0' to 12.4' bgs: frequent brick fragments and wood. - Note: Poor recovery in SS-06 and SS-07. Borehole was moved a few feet and resampled at those depths.	1.2	S3-06A	[]	a	17-14-8-6 (N = 22)
	MARSH DEPOSIT (Silt, Sand, Organics/Peat) Black, SILT, some fine to coarse sand with organics (OH), soft, moist, strong organic odor, wood fragment in tip.		S3-07A	[0]	a	7-2-2-4 (N = 4)
	Note: Shelby tube had no recovery. SS sample taken through tube depth. Sample descriptions obtained and torvanes performed on recovered sample.					
15	Grayish-brown, SILT with organics, trace fine sand (OH), low to medium plasticity, slow dilatancy, moist.	-3.8	ST-08	[0]		
	Similar to SS-08, saturated, soft.		SS-09	[0]		1-1-1-2 (N = 2)
	Sampled through vane test interval: 18.5 to 20.5': Grayish-brown, fine to coarse SAND, some silt, trace organics (SM), non-plastic, wet. - 19.5' to 20.5': Grayish-brown fine SAND, few silt, with organics (OH), wet, medium plasticity, slow dilatancy, strong organic odor.		S3-10	[0.3]	a	
20		-8.8				



BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Truck rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/081012

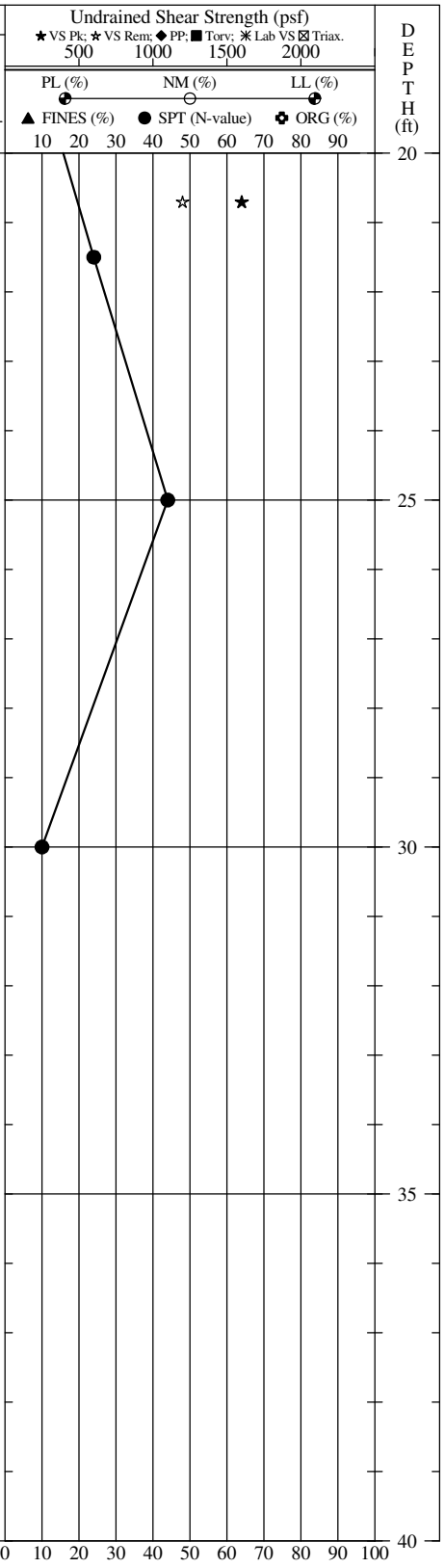
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-05
DRILLED: 6/4/12 - 6/5/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
20	MARSH DEPOSIT (Silt, Sand, Organics/Peat) VS-1 at 20.0' bgs: Su => 1600 psf (sand layer) VS-1 at 20.0' bgs: Sremolded = 1200 psf (sand layer)		-8.8			
	FLUVIAL DEPOSIT (Sand, Gravel, Silt) - 20.5' to 22.0' bgs: Grayish-brown, fine to coarse SAND, little gravel, few silt (SW-SM) - 22.0' to 22.5' bgs: Orange-brown, fine to coarse SAND, some gravel, few silt (SW-SM), medium dense, wet.			SS-11 [0]		10-12-12-10 (N = 24)
	Reddish-brown, fine to coarse SAND, some gravel, trace silt (SW), dense, wet.					
25			-13.8	SS-12 [0]		16-23-21-22 (N = 44)
	Brown, fine to coarse SAND, few gravel, trace silt (SW), loose, wet.					
30			-18.8	SS-13 [0]		4-4-6-6 (N = 10)
	Bottom fo Exploration at 31 feet bgs.					
35			-23.8			
40			-28.8			



BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Truck rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

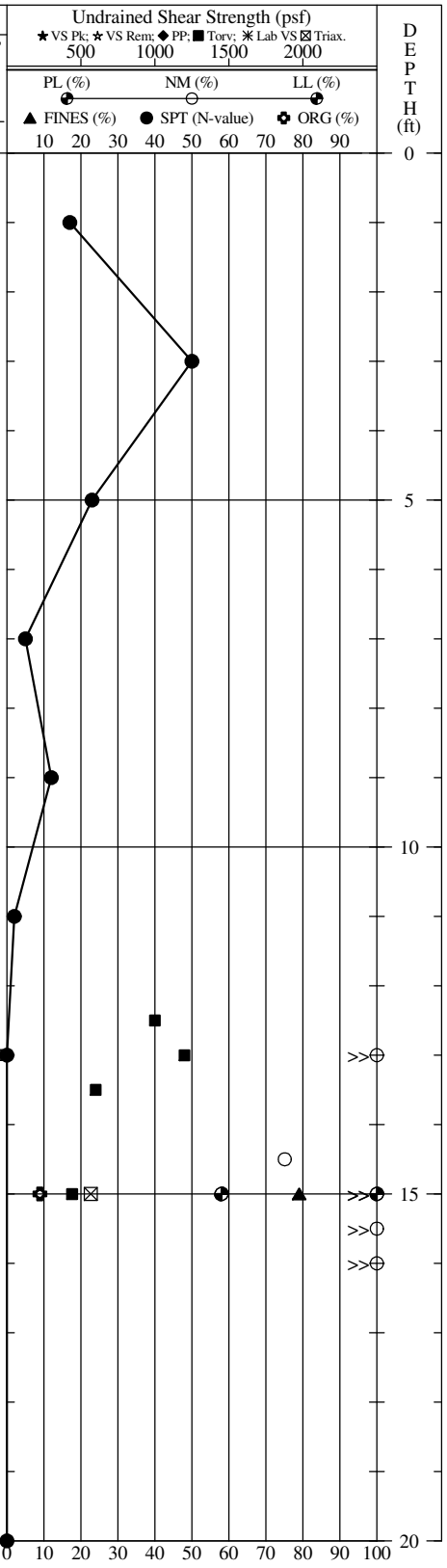
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-05
DRILLED: 6/4/12 - 6/5/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLE IDENT	PID (ppm)	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
0	Topsoil, frequent organics	8.3				
	FILL (Sand, Silt, Gravel, Debris) - 0.8' to 1.1' bgs: fractured cobble Light brown to dark brown, fine to coarse SAND, few to little silt, trace to little gravel (SW-SM/SM), medium dense to dense, dry to moist. - 2.0' to 6.0' bgs: occasional to frequent brick and asphalt fragments, organics - 2.0' to 3.0' bgs: organics		SS-01	[0]		1-9-8-10 (N = 17)
			SS-02	[0]		35-30-20-24 (N = 50)
5		3.3	SS-03	[0.6]		8-13-10-7 (N = 23)
	Gray, fine to coarse SAND, some silt, few gravel, occasional organics (SM), loose to medium dense, wet.		SS-04	[0.1]		5-3-2-2 (N = 5)
	- 8.0' to 10' bgs: frequent asphalt fragments		SS-05	[0.4]		10-7-5-1 (N = 12)
10	MARSH DEPOSIT (Silt, Sand, Organics/Peat)	-1.7				
	No recovery		SS-06	[]		WH-1-1-1 (N = 2)
	Grayish-brown, SILT with organics, trace fine sand (OH), medium plasticity, slow dilatancy, very soft, wet.		SS-07	[0]		WH-WH-WH-WH
	Similar to SS-07					
15		-6.7	ST-08	[0]		
	- sample was difficult to extract; likely disturbed		ST-09	[0]		
	FLUVIAL DEPOSIT (Sand, Gravel, Silt)					
	Dark grayish-brown, fine to coarse SAND, some silt, few gravel, with organic fibers (SM), very loose, wet, slight organic odor.					
20		-11.7				



BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Truck rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/081012

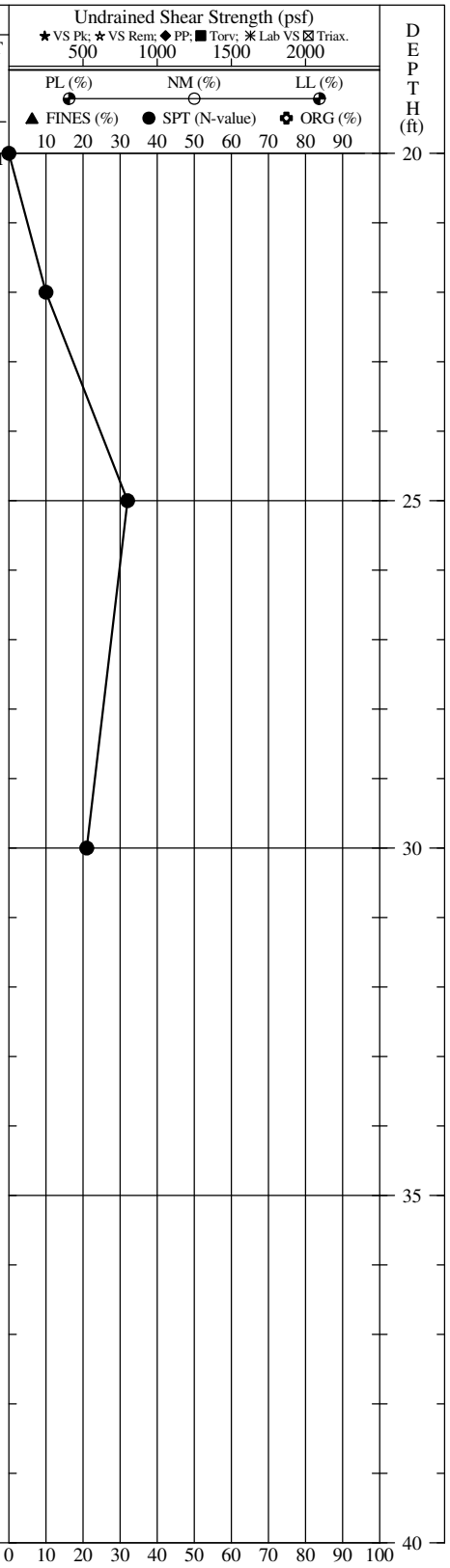
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-06
DRILLED: 6/1/12 - 6/4/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
20	FLUVIAL DEPOSIT (Sand, Gravel, Silt)		-11.7	SS-10 []		1-WH-WH-WH
	Grayish-brown, fine to coarse SAND, little silt, few gravel (SM) changing to brown GRAVEL, some fine to coarse sand, little silt (GM), loose, wet.			SS-11 []		1-5-5-4 (N = 10)
	Orange-brown, fine to coarse SAND, little silt, little to some gravel (SW-SM), dense, wet.					
25			-16.7	SS-12 []		5-16-16-8 (N = 32)
30	Similar to SS-12 changing to Grayish-brown, SILT, some fine sand (ML), non-plastic, medium dense, wet.		-21.7	SS-13 []		15-10-11-7 (N = 21)
	Bottom of Exploration at 31 ft bgs.					
35			-26.7			
40			-31.7			



BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Truck rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

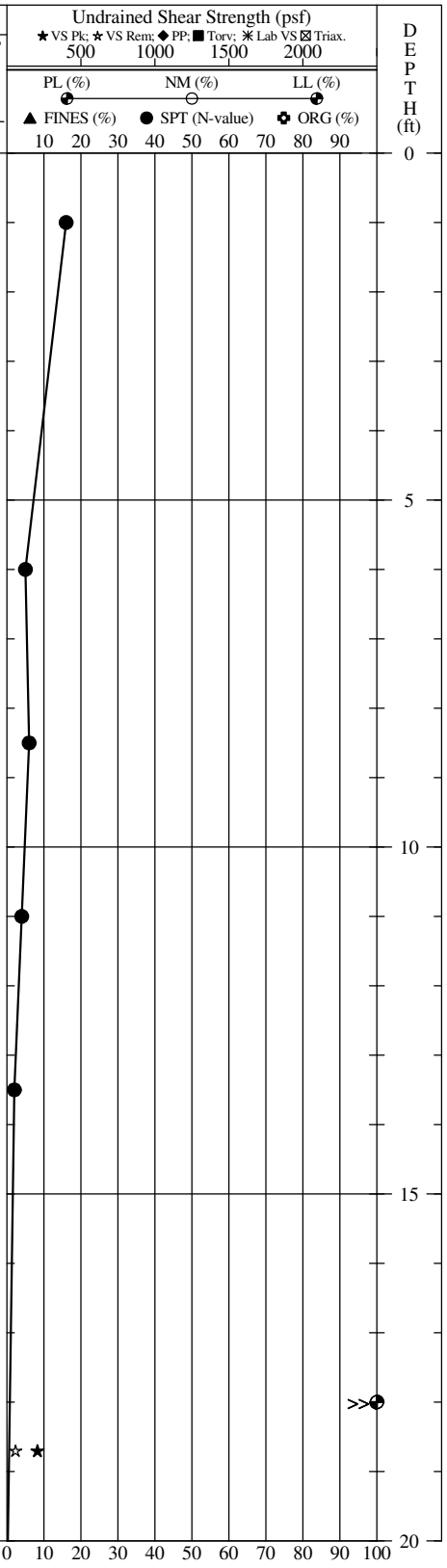
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-06
DRILLED: 6/1/12 - 6/4/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLE IDENT	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
0	Topsoil	7.3			
	FILL Orange brown to dark brown, fine to coarse SAND, little to some silt, few gravel, medium dense, moist (SM)		SS-1		1-4-12-20 (N = 16)
5	Dark gray, fine to coarse SAND, little to some silt, trace to little gravel, loose, wet (SM)	2.3	SS-2		5-2-3-2 (N = 5)
	Similar to SS-2		SS-3		2-3-3-2 (N = 6)
10	Similar to SS-2	-2.7	SS-4		4-3-1-2 (N = 4)
	Grayish brown, SILT/CLAY, some fine sand, medium stiff, wet (ML/CL) Dark gray, fine SAND, some silt, little gravel, loose, (SM)		SS-5		4-1-1-2 (N = 2)
15	MARSH DEPOSIT Grayish brown to dark brown, ORGANIC SILT, few fine sand, very soft to medium stiff, wet, low to moderate plasticity (OH) - occasional to frequent organics	-7.7	ST-6		
			VS-7		
20		-12.7			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	Rotary Wash with Water (Cased) to 30' bgs.
HOLE DIAM.:	4"
SPTs:	Automatic Hammer; NW rods
REMARKS:	Backfilled w/cement-bentonite grout.

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/3-28-13

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-07
DRILLED: 1/31/13 - 2/1/13
PROJECT: Former Raymark Industries (OU6)
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC	Undrained Shear Strength (psf) ★ VS Pk; ☆ VS Rem; ◆ PP; ■ Torv; ✳ Lab VS ⊠ Triax. 500 1000 1500 2000 / PL (%) NM (%) LL (%) / ▲ FINES (%) ● SPT (N-value) ✿ ORG (%) 10 20 30 40 50 60 70 80 90	DEPTH (ft)
20	MARSH DEPOSIT		-12.7					20
	Similar to ST-6			SS-8		WH-WH-1-2		
	Dark brown, ORGANIC SILT			ST-9			>>	
25			-17.7					25
	FLUVIAL SAND Gray to yellow brown, fine to coarse SAND, few to little silt, few gravel, loose to medium dense, wet (SW-SM/SM)			SS-10		3-2-6-11 (N = 8)		
30			-22.7					30
	Similar to SS-10			SS-11		6-3-6-7 (N = 9)		
	End of Exploration at 32' bgs							
35			-27.7					35
40			-32.7					40

0 10 20 30 40 50 60 70 80 90 100

BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER: ADT
RIG TYPE: Tracked CME-55 LC
METHOD: Rotary Wash with Water (Cased) to 30' bgs.
HOLE DIAM.: 4"
SPTs: Automatic Hammer; NW rods
REMARKS: Backfilled w/cement-bentonite grout.

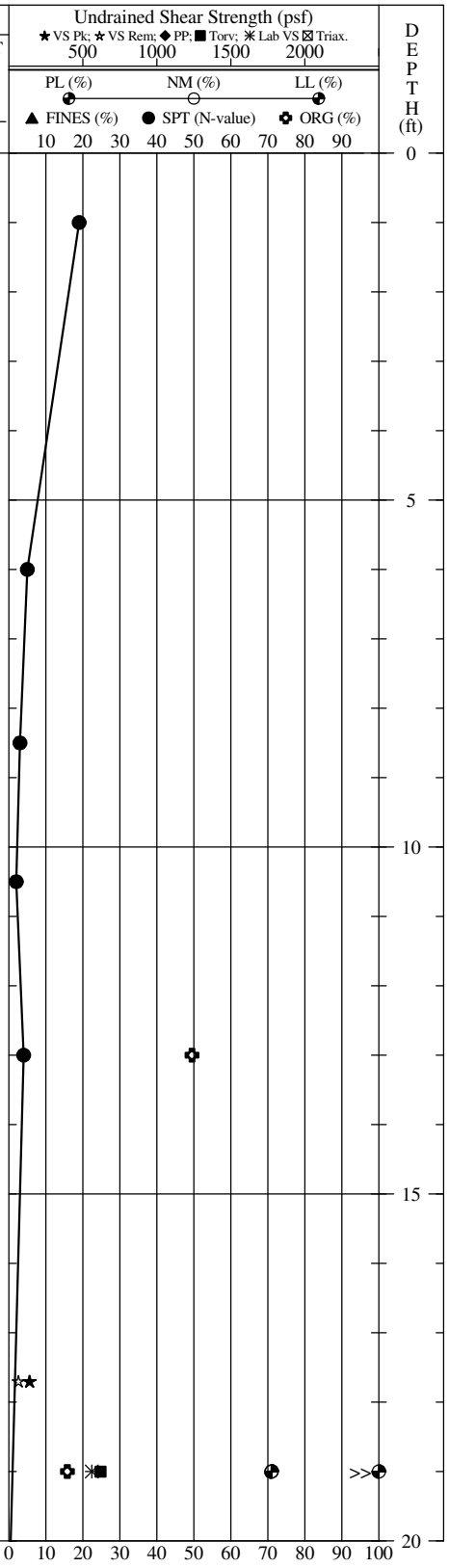
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-07
DRILLED: 1/31/13 - 2/1/13
PROJECT: Former Raymark Industries (OU6)
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLE IDENT	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
0	Topsoil	7.9			
	FILL Gray, GRAVEL, some fine to coarse sand, few silt, medium dense, dry (GP-GM)		SS-1		10-10-9-10 (N = 19)
5	Grayish brown, fine SAND, some silt, little gravel, very loose to loose, wet (SM) - 5.0' to 7.0' bgs: occasional organics	2.9	SS-2		4-3-2-3 (N = 5)
	SS-3: no recovery		SS-3		4-2-1-WH (N = 3)
10		-2.1	SS-4		2-1-1-2 (N = 2)
	Grayish brown, fine to medium SAND, little gravel, few silt, loose, wet (SP-SM)				
	MARSH DEPOSIT Brown, ORGANIC SILT, some fine sand, soft, wet, non-plastic (OH)		SS-5		8-2-2-2 (N = 4)
15		-7.1	ST-6		
	Grayish brown, ORGANIC SILT, few fine sand, very soft to medium stiff, wet, low to moderate plasticity (OH) - 16.0' to 22.0' bgs: occasional to frequent organics		VS-7		
	Similar to VS-7		ST-8		
20		-12.1			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER: ADT
RIG TYPE: Tracked CME-55 LC
METHOD: Rotary Wash with Water (Cased) to 33' bgs.
HOLE DIAM.: 4"
SPTs: Automatic Hammer; NW rods
REMARKS: Backfilled w/cement-bentonite grout.

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/3-28-13

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-08
DRILLED: 1/30/13 - 1/31/13
PROJECT: Former Raymark Industries (OU6)
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC	Undrained Shear Strength (psf) ★ VS Pk; ☆ VS Rem; ◆ PP; ■ Torv; ✳ Lab VS ⊠ Triax. (500, 1000, 1500, 2000)
20	MARSH DEPOSIT		-12.1				
	Similar to ST-8			SS-9		WH-WH-WH-3	
	Similar to SS-9			SS-10		WH-WH-2-2	
25	- 25.0' bgs: becomes brown to dark brown		-17.1				
	Similar to SS-10			SS-11		WH-WH-WH-1	
	FLUVIAL SAND Gray, fine to coarse SAND, fet to little gravel, few silt, loose to dense, wet (SW-SM)			SS-12		20-21-19-22 (N = 40)	
30			-22.1				
	SS-13: no recovery			SS-13		10-5-3-3 (N = 8)	
	Gray, SILT/CLAY, some fine sand, stiff, wet, low plasticity (ML/CL)						
	Gray, fine SAND, some silt, medium dense, wet (SM)			SS-14		7-15-14-6 (N = 29)	
35	End of Exploration at 35' bgs		-27.1				
40			-32.1				

Undrained Shear Strength (psf): 500 1000 1500 2000

PL (%) NM (%) LL (%)

▲ FINES (%) ● SPT (N-value) ✪ ORG (%)

10 20 30 40 50 60 70 80 90

0 10 20 30 40 50 60 70 80 90 100

BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	Rotary Wash with Water (Cased) to 33' bgs.
HOLE DIAM.:	4"
SPTs:	Automatic Hammer; NW rods
REMARKS:	Backfilled w/cement-bentonite grout.

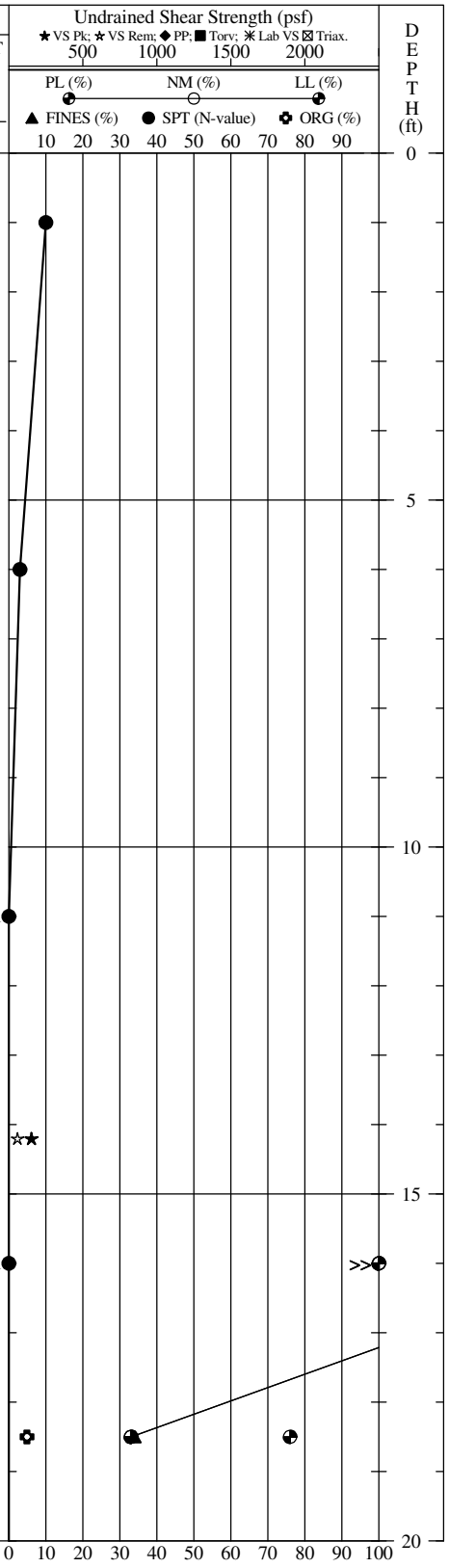
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.:	GB-08
DRILLED:	1/30/13 - 1/31/13
PROJECT:	Former Raymark Industries (OU6)
LOCATION:	Stratford, CT
PROJECT NO.:	3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
0	Topsoil		7.9			
	FILL Light brown, fine to medium SAND, few silt, medium dense, dry (SM) - occasional asphalt and concrete debris			SS-1		20-6-4-9 (N = 10)
	MARSH DEPOSIT					
5	Dark grayish brown, SILT, few fine sand, soft to medium stiff, wet, low plasticity (OH) - occasional to some organics		2.9	SS-2		2-2-1-2 (N = 3)
				ST-3		
10	Grayish brown, ORGANIC SILT/CLAY, few fine sand, very soft to soft, wet, low to moderate plasticity (CH/OH) - some to frequent organics		-2.1	SS-4		WH-WH-WH-1
				VS-5		
15	Similar to SS-4		-7.1	SS-6		WH-WH-WH-1
	Dark brown, ORGANIC CLAY			ST-7		
	FLUVIAL SAND					
20			-12.1			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	Rotary Wash with Water and/or Mud (Cased) to 67' bgs.
HOLE DIAM.:	4"; 3"
SPTs:	Automatic Hammer; NW rods
REMARKS:	Casing advanced to ~ 67' bgs. Abandon hole during roller bitting at ~ 60' bgs due to detached drive shoe/casing. Backfilled w/cement-bentonite grout.

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/3-28-13

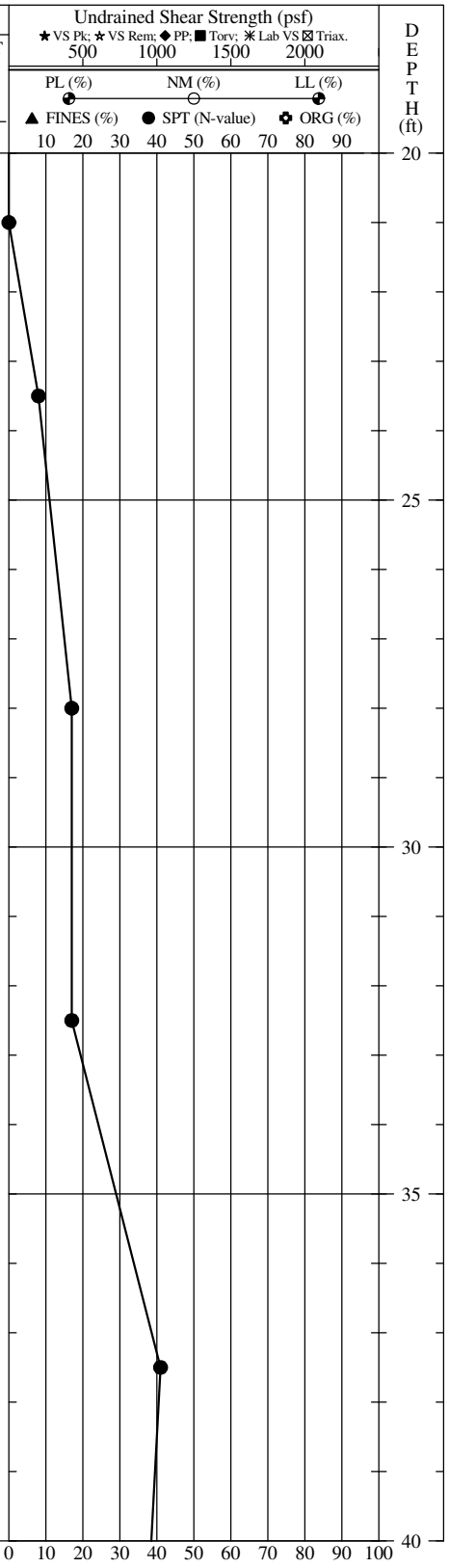
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.:	GB-09
DRILLED:	2/1/13 - 2/5/13
PROJECT:	Former Raymark Industries (OU6)
LOCATION:	Stratford, CT
PROJECT NO.:	3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLE IDENT	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
20	FLUVIAL SAND Gray, fine to coarse SAND, few to little silt, trace gravel, very loose, wet (SW-SM/SM)	-12.1	SS-8		WH-1-WH-1
	- 22.5' bgs: little gravel, becomes loose		SS-9		3-2-6-15 (N = 8)
25		-17.1			
	- 27.0' bgs: becomes grayish brown to orange brown, medium dense (SW-SM)		SS-10		3-7-10-14 (N = 17)
30		-22.1			
	Similar to SS-10		SS-11		7-9-8-6 (N = 17)
35		-27.1			
	- 36.5' bgs: becomes dense		SS-12		35-20-21-20 (N = 41)
40		-32.1			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	Rotary Wash with Water and/or Mud (Cased) to 67' bgs.
HOLE DIAM.:	4"; 3"
SPTs:	Automatic Hammer; NW rods
REMARKS:	Casing advanced to ~ 67' bgs. Abandon hole during roller bitting at ~ 60' bgs due to detached drive shoe/casing. Backfilled w/cement-bentonite grout.

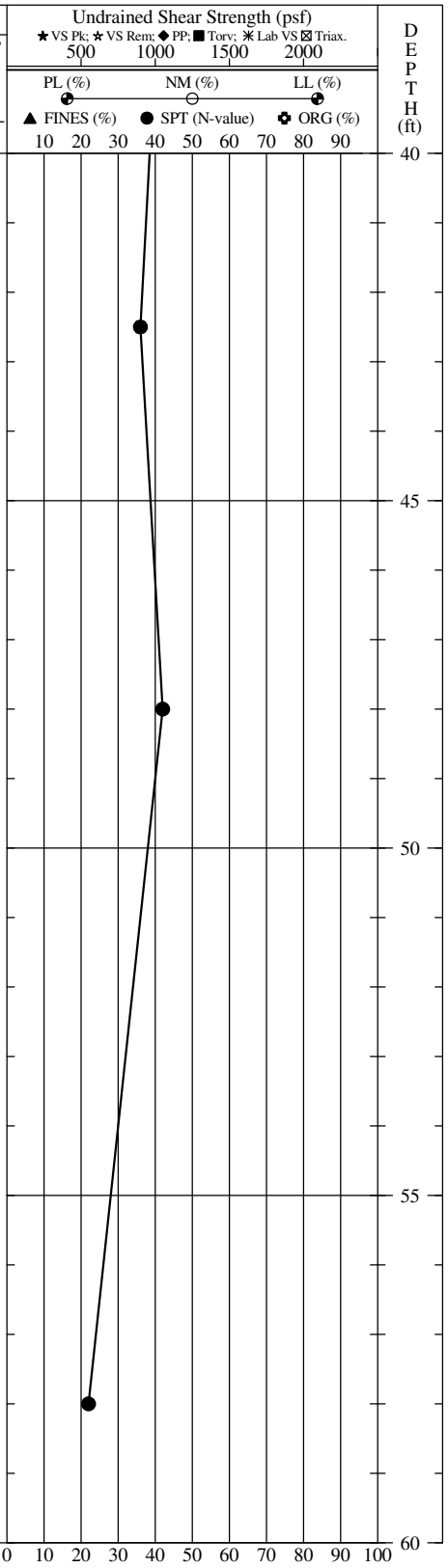
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.:	GB-09
DRILLED:	2/1/13 - 2/5/13
PROJECT:	Former Raymark Industries (OU6)
LOCATION:	Stratford, CT
PROJECT NO.:	3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
40	FLUVIAL SAND	-32.1			
	Similar to SS-12		SS-13		16-16-20-20 (N = 36)
45		-37.1			
	- 47.0' bgs: becomes light brown				
	Similar to SS-13		SS-14		14-23-19-16 (N = 42)
50		-42.1			
55		-47.1			
	Light brown to orange brown, fine to coarse SAND, few gravel, trace silt, medium dense, wet (SW)		SS-15		8-11-11-13 (N = 22)
60		-52.1			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	Rotary Wash with Water and/or Mud (Cased) to 67' bgs.
HOLE DIAM.:	4"; 3"
SPTs:	Automatic Hammer; NW rods
REMARKS:	Casing advanced to ~ 67' bgs. Abandon hole during roller bitting at ~ 60' bgs due to detached drive shoe/casing. Backfilled w/cement-bentonite grout.

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GEOTECHNICAL BORING RECORD

BORING NO.:	GB-09
DRILLED:	2/1/13 - 2/5/13
PROJECT:	Former Raymark Industries (OU6)
LOCATION:	Stratford, CT
PROJECT NO.:	3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC	Undrained Shear Strength (psf) ★ VS Pk; ☆ VS Rem; ◆ PP; ■ Torv; ✳ Lab VS ⊠ Triax. 500 1000 1500 2000	DEPTH (ft)
60	FLUVIAL SAND		-52.1					60
65			-57.1					65
	End of Exploration at 67' bgs							
70			-62.1					70
75			-67.1					75
80			-72.1					80

PL (%) NM (%) LL (%)
▲ FINES (%) ● SPT (N-value) ✿ ORG (%)
10 20 30 40 50 60 70 80 90
0 10 20 30 40 50 60 70 80 90 100

BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	Rotary Wash with Water and/or Mud (Cased) to 67' bgs.
HOLE DIAM.:	4"; 3"
SPTs:	Automatic Hammer; NW rods
REMARKS:	Casing advanced to ~ 67' bgs. Abandon hole during roller bitting at ~ 60' bgs due to detached drive shoe/casing. Backfilled w/cement-bentonite grout.

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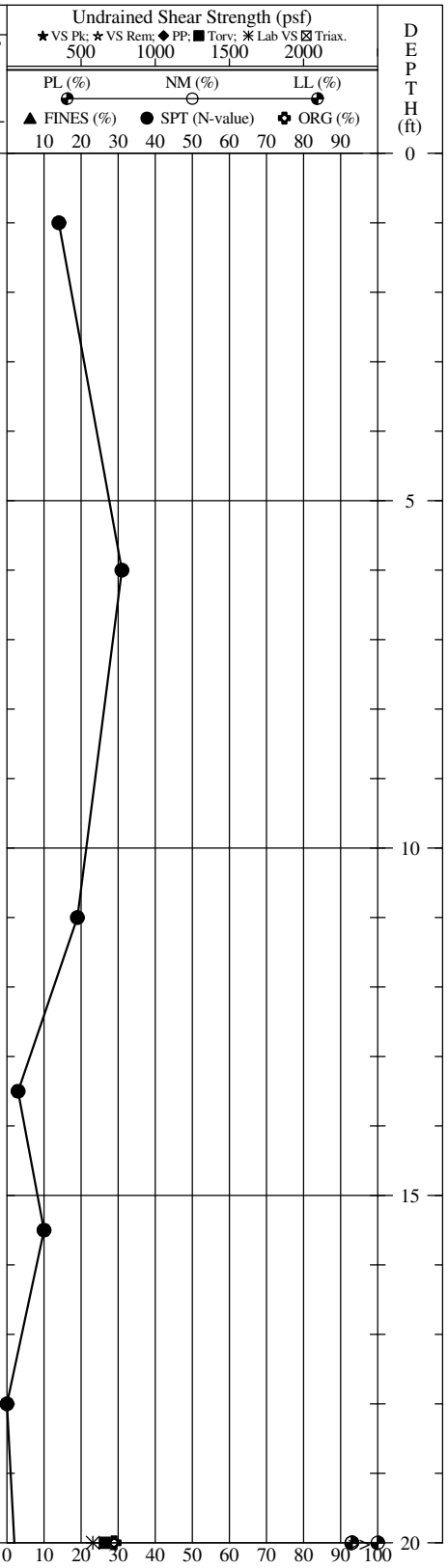
GEOTECHNICAL BORING RECORD

BORING NO.: GB-09
DRILLED: 2/1/13 - 2/5/13
PROJECT: Former Raymark Industries (OU6)
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLE IDENT	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
0	Topsoil	10.8			
	FILL Light brown, fine to coarse SAND, little silt and gravel, medium dense, dry (SM) - 0.5' to 2.0' bgs: occasional concrete fragments		SS-1		1-5-9-14 (N = 14)
5	Dark gray, fine to coarse SAND, little silt and gravel, dense, wet (SM) - 5.0' to 7.0' bgs: occasional debris	5.8	SS-2		5-13-18-11 (N = 31)
10	Yellowish gray to dark gray, fine to medium SAND, little silt, few gravel, medium dense, wet (SM) - 10.0' to 12.0' bgs: occasional debris - 12.5' to 14.5' bgs: very loose	0.8	SS-3		6-9-10-6 (N = 19)
	SS-4: no recovery		SS-4		6-2-1-2 (N = 3)
15	Dark grayish brown, fine to coarse SAND, little silt, trace fine gravel, medium dense, wet (SM)	-4.2	SS-5		9-7-3-3 (N = 10)
	MARSH DEPOSIT Brownish gray, ORGANIC SILT, little fine sand, very soft to medium stiff, wet, low plasticity (OH) - occasional organics		SS-6		WH-WH-WH-3
	- 19.0' to 21.0' bgs: stiff				
20		-9.2			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER: ADT
RIG TYPE: Tracked CME-55 LC
METHOD: Rotary Wash with Water (Cased) to 25' bgs.
HOLE DIAM.: 4"
SPTs: Automatic Hammer; NW rods
REMARKS: Backfilled w/cement-bentonite grout.

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/3-28-13

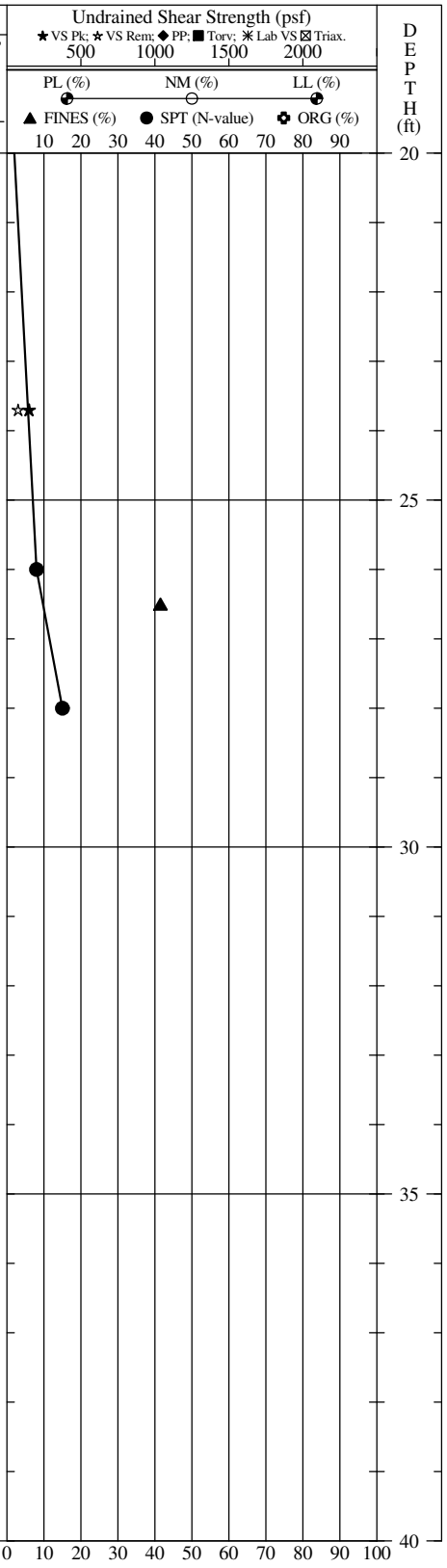
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-10
DRILLED: 1/30/13
PROJECT: Former Raymark Industries (OU6)
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
20	MARSH DEPOSIT Black, ORGANIC SILT		-9.2	ST-7		
	Brownish gray, ORGANIC SILT, few fine sand, very soft, wet, low to moderate plasticity (OH)			VS-8		
25	- 25.0' bgs: soft		-14.2			
	FLUVIAL SAND Grayish brown, fine SAND, some silt, loose, wet (SM)			SS-9		WH-2-6-11 (N = 8)
	Gray, fine to coarse SAND, few silt, little gravel, medium dense, wet (SW-SM)			SS-10		7-8-7-6 (N = 15)
	End of Exploration at 29' bgs					
30			-19.2			
35			-24.2			
40			-29.2			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	Rotary Wash with Water (Cased) to 25' bgs.
HOLE DIAM.:	4"
SPTs:	Automatic Hammer; NW rods
REMARKS:	Backfilled w/cement-bentonite grout.

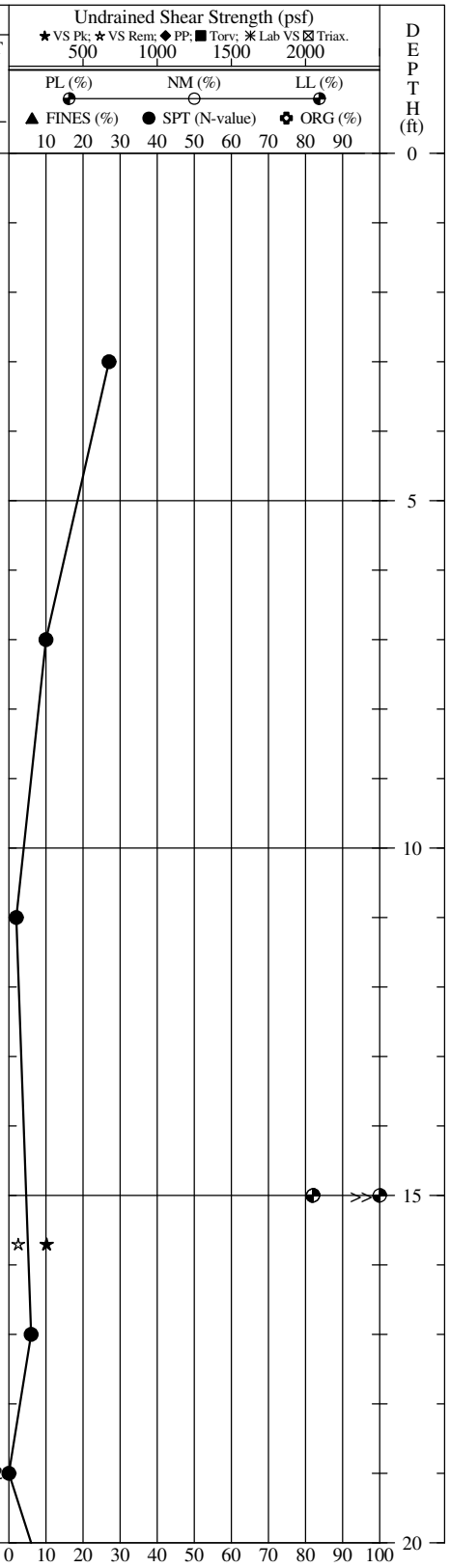
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.:	GB-10
DRILLED:	1/30/13
PROJECT:	Former Raymark Industries (OU6)
LOCATION:	Stratford, CT
PROJECT NO.:	3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLE IDENT [PID (ppm)]	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
0	FILL	7.8			
	Dark brown, fine to medium SAND, few silt and gravel, medium dense, dry to moist (SP-SM) - 2.0' to 4.0' bgs: occasional organics		SS-1 []		6-20-7-10 (N = 27)
5		2.8			
	Dark brown, fine to medium SAND, some gravel, few silt, loose to medium dense, wet (SM) - 6.0' to 8.0' bgs: some wood debris		SS-2 []		12-7-3-6 (N = 10)
	MARSH DEPOSIT				
10	Grayish brown, ORGANIC SILT, few to little fine sand, very soft to medium stiff, wet, moderate plasticity (OH) - some to frequent organics	-2.2	SS-3 [0.3]		1-1-1-1 (N = 2)
	Similar to SS-3		ST-4 []		
15		-7.2	VS-5 []		
	Brown, ORGANIC SILT, few fine to medium sand, soft to medium stiff, wet, low plasticity (OH) - some organics		SS-6 []		4-3-3-3 (N = 6)
	- 18.0' to 19.5' bgs: very soft		SS-7 []		WH-WH-WH-2
	FLUVIAL SAND				
20		-12.2			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	HSA to 5' bgs; Rotary Wash with Water (Cased) to 15'
HOLE DIAM.:	bgs; Rotary Wash with Water (Open-Hole) to 22' bgs.
SPTs:	4"
REMARKS:	Automatic Hammer; NW rods Backfilled w/cement-bentonite grout.

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/3-28-13

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-11
DRILLED: 1/28/13 - 1/29/13
PROJECT: Former Raymark Industries (OU6)
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC	Undrained Shear Strength (psf) ★ VS Pk; ☆ VS Rem; ◆ PP; ■ Torv; ✳ Lab VS ⊠ Triax. 500 1000 1500 2000 / PL (%) NM (%) LL (%) / ▲ FINES (%) ● SPT (N-value) ✿ ORG (%) 10 20 30 40 50 60 70 80 90	DEPTH (ft)
20	Gray, fine to medium SAND, some silt, trace fine gravel, loose, wet (SM) FLUVIAL SAND Gray to orange-brown, fine to coarse SAND, few gravel and silt, medium dense, wet (SW-SM)		-12.2	SS-8 []		3-4-8-9 (N = 12)		20
	End of Exploration at 22' bgs							
25			-17.2					25
30			-22.2					30
35			-27.2					35
40			-32.2				0 10 20 30 40 50 60 70 80 90 100	40

BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	HSA to 5' bgs; Rotary Wash with Water (Cased) to 15'
HOLE DIAM.:	bgs; Rotary Wash with Water (Open-Hole) to 22' bgs.
SPTs:	4"
REMARKS:	Automatic Hammer; NW rods Backfilled w/cement-bentonite grout.

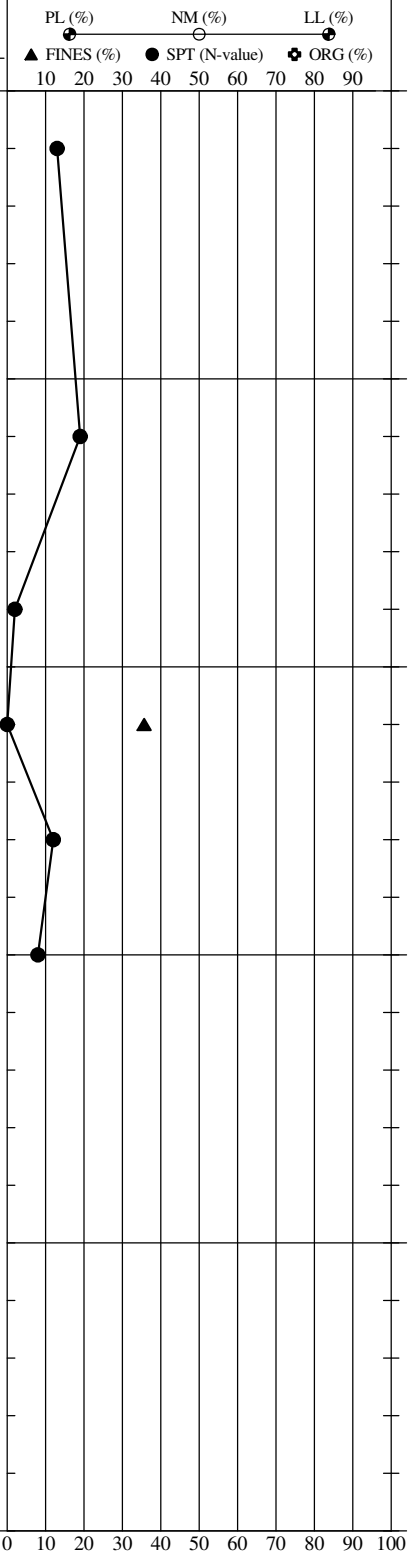
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-11
DRILLED: 1/28/13 - 1/29/13
PROJECT: Former Raymark Industries (OU6)
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
0	Topsoil		7.1			
	FILL Dark grayish brown, fine to medium SAND, some silt, little gravel, medium dense, moist, non-plastic (SM)			SS-1		3-6-7-6 (N = 13)
5	Gray, fine to medium SAND, little silt, trace fine gravel, medium dense, wet, non-plastic (SM) - 5.0' to 7.0' bgs: some concrete		2.1	SS-2		5-6-13-5 (N = 19)
	MARSH DEPOSIT Brownish gray, ORGANIC SILT, few fine sand, soft, wet, low to moderate plasticity (OH) - 8.0' to 11.5' bgs: occasional to frequent organics			SS-3		3-1-1-1 (N = 2)
10	- 10.0' to 11.5' bgs: fine to medium sand, some silt, trace gravel		-2.9	SS-4		WH-WH-1-2
	FLUVIAL SAND Brownish gray, fine to medium SAND, some silt, few gravel, loose, wet (SM) - 11.5' to 12.0' bgs: occasional organics Light brown, fine to coarse SAND, little silt, few gravel, medium dense, wet (SM)			SS-5		5-5-7-7 (N = 12)
15	Brown, fine to coarse SAND, few silt, loose, wet (SW-SM)		-7.9	SS-6		5-4-4-7 (N = 8)
	End of Exploration at 16' bgs					
20			-12.9			
25			-17.9			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER: ADT
RIG TYPE: Tracked CME-55 LC
METHOD: Rotary Wash with Water (Cased) to 14' bgs.
HOLE DIAM.: 4"
SPTs: Automatic Hammer; NW rods
REMARKS: Backfilled w/cement-bentonite grout.

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/3-28-13

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-12
DRILLED: 1/29/13
PROJECT: Former Raymark Industries (OU6)
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4E

amec

Attachment 1B

Consolidation Testing Data Summaries

Point	Applied Stress	% Strain	Slope C_{ce} or C_r	Max. Curvature % Change in Slope		
1	0.125	3.96	-	-	Cre	
2	0.250	7.48	0.117	59.7	0.15	**0.07**
3	0.500	13.10	0.187	42.3		
4	1.000	21.10	0.266	16.2	Cce	
5	2.000	30.40	0.309	-86.0	**0.31**	
6	0.500	27.80	0.043	92.3		
7	0.125	22.80	0.083	-76.0		
8	0.250	23.40	0.020	116.7		
9	0.500	24.70	0.043	115.4		
10	1.000	27.50	0.093	46.4		
11	2.000	31.60	0.136	102.4		
12	4.000	39.90	0.276	-		
13	-	-	-	-		
14	-	-	-	-		

MARSH DEPOSIT - ORGANIC SILT (OH)

Soil Boring:	GB-03			
Sample No.:	SH-07			
Sample Interval:	12.0 - 14.5			
Depth:	13.3			
In-Situ Eff. Stress:	0.45	tsf		
Est. Max. Past Press:	0.41	tsf	**0.9**	= OCR
Est. Future Stress:	1.04	tsf		

Conclusions: 24-hr load increm. Plot incl. substantial secondary comp.
Poor break (secondary), poss. sample disturbance.

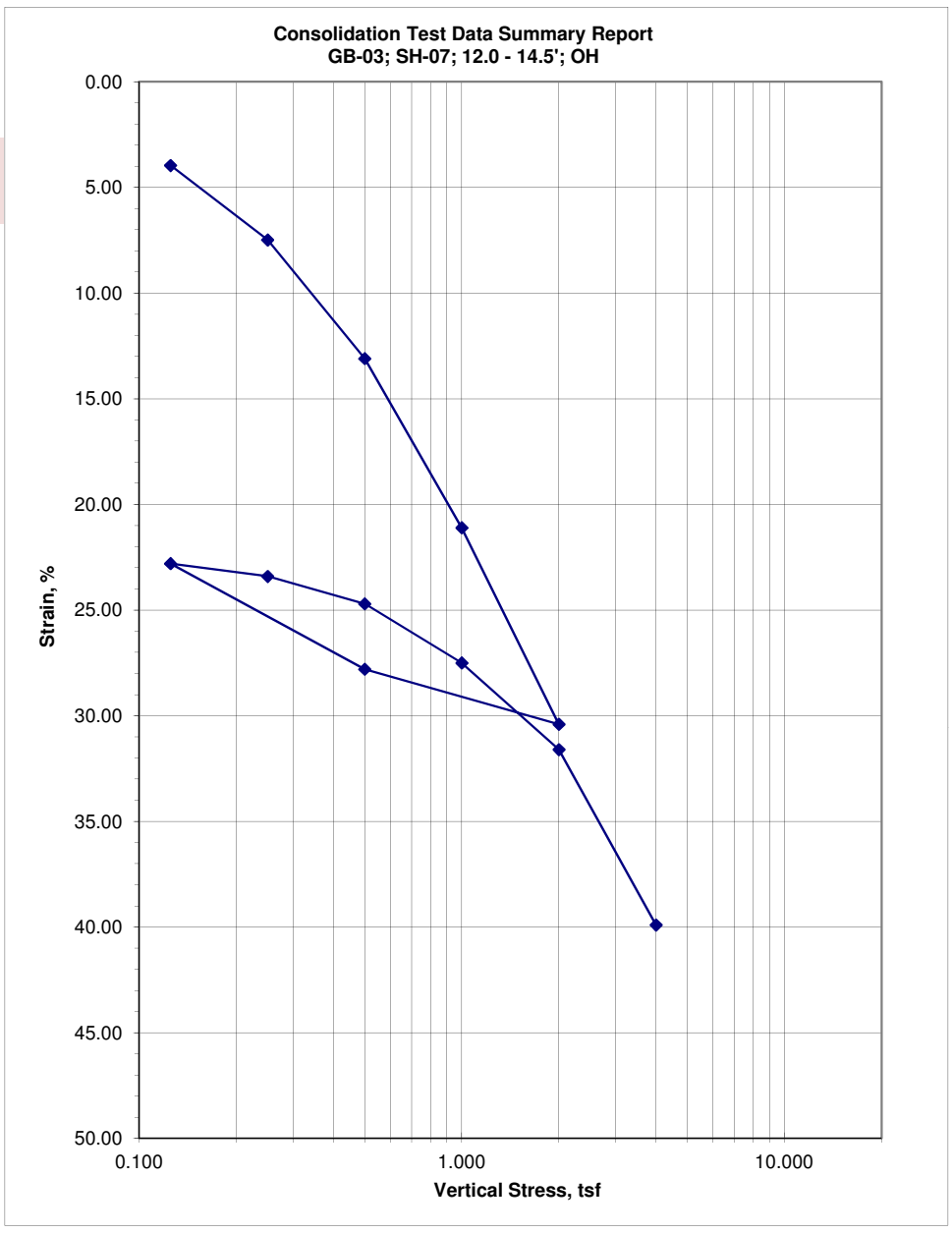
Point	Applied Stress	Sq. Rt. Of Time Cv (ft^2/s)	Cv (ft^2/day)		
1	0.125	1.11E-06	9.59E-02		
2	0.250	4.53E-07	3.91E-02		
3	0.500	4.98E-07	4.30E-02		
4	1.000	2.79E-07	2.41E-02	2.4E-02	3.0E-02
5	2.000	2.75E-07	2.38E-02		
6	0.500	3.44E-07	2.97E-02		
7	0.125	8.09E-08	6.99E-03		
8	0.250	5.14E-07	4.44E-02		
9	0.500	6.09E-07	5.26E-02		
10	1.000	5.56E-07	4.80E-02		
11	2.000	1.80E-07	1.56E-02		
12	4.000	1.49E-07	1.29E-02		
13	-	-	-		
14	-	-	-		

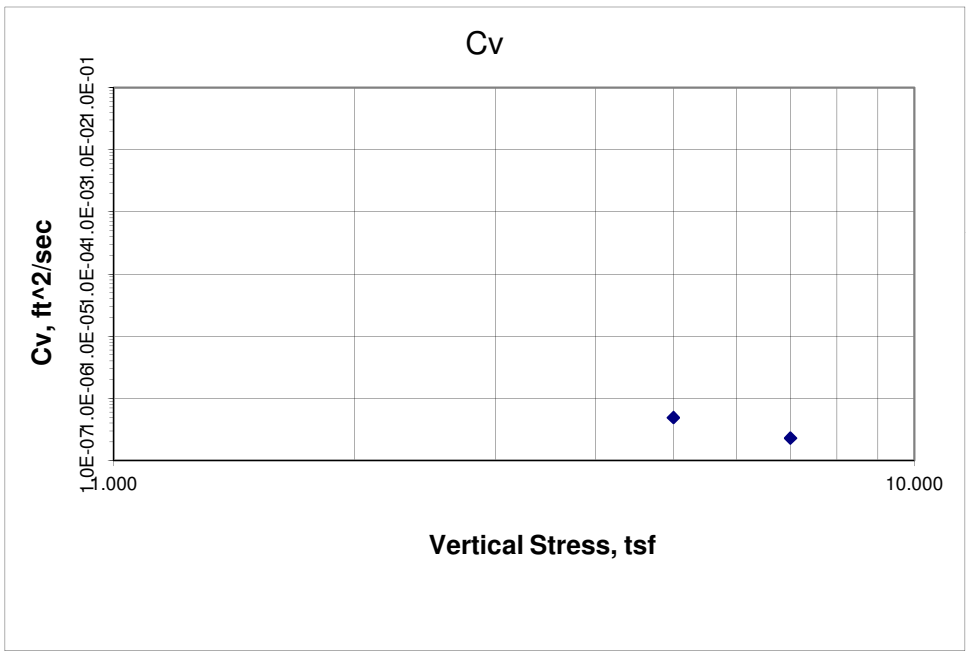
Point	Applied Stress	Log of Time Cv (ft^2/s)	Cv (ft^2/day)	
1	0.125	-	-	
2	0.250	-	-	
3	0.500	-	-	
4	1.000	-	-	
5	2.000	7.11E-07	6.14E-02	6.1E-02
6	0.500	7.97E-07	6.89E-02	
7	0.125	-	-	
8	0.250	-	-	
9	0.500	1.23E-06	1.06E-01	
10	1.000	-	-	
11	2.000	-	-	
12	4.000	3.12E-07	2.70E-02	
13	-	-	-	
14	-	-	-	

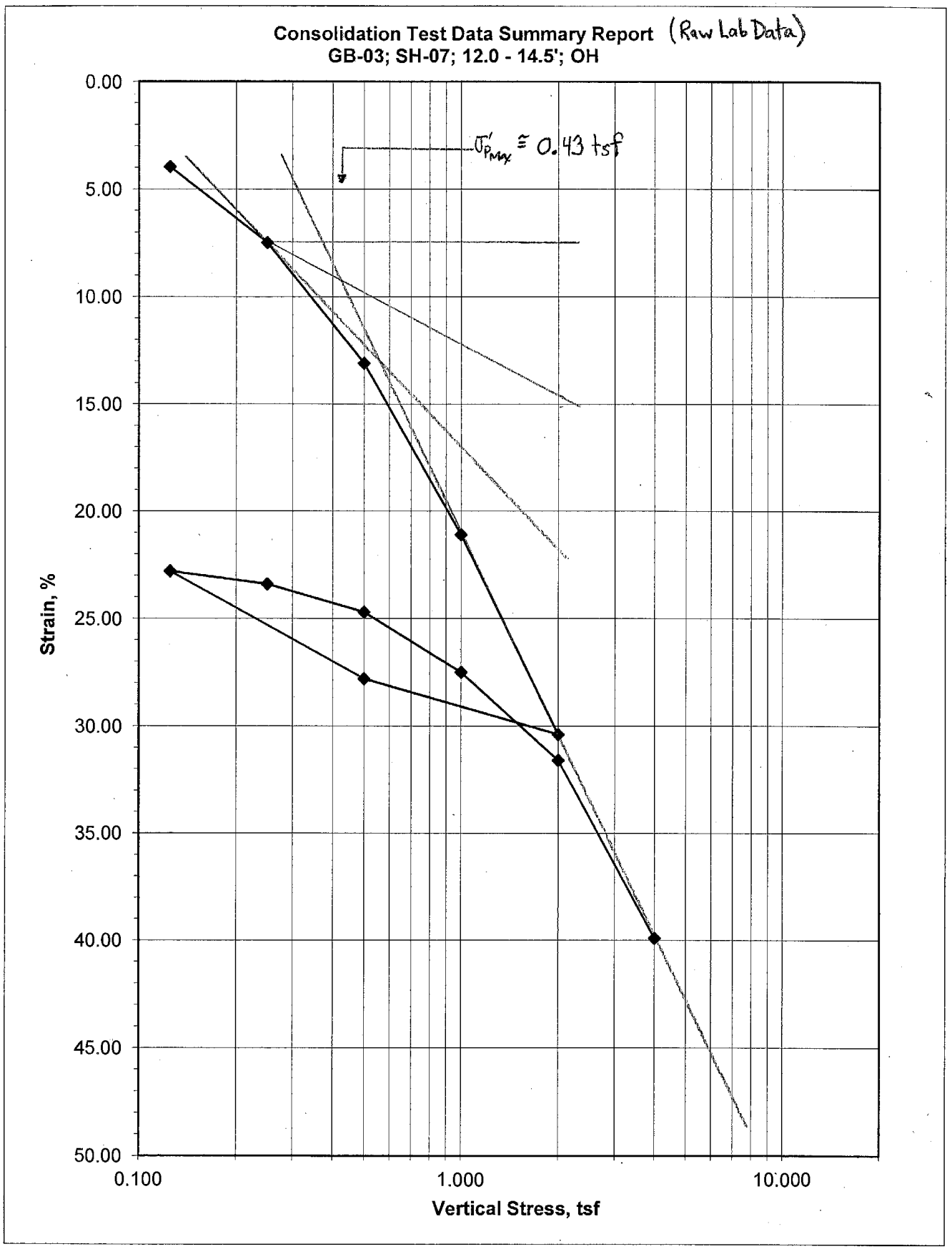
Point	Applied Stress	Average Cv (ft^2/s)	Cv (ft^2/day)	
1	0.125	-	-	
2	0.250	-	-	
3	0.500	-	-	
4	1.000	-	-	
5	2.000	4.93E-07	4.26E-02	**4.3E-02**
6	0.500	5.71E-07	4.93E-02	
7	0.125	-	-	
8	0.250	-	-	
9	0.500	9.20E-07	7.94E-02	
10	1.000	-	-	
11	2.000	-	-	
12	4.000	2.31E-07	1.99E-02	
13	-	-	-	
14	-	-	-	

MARSH DEPOSIT - ORGANIC SILT (OH)

Soil Boring:	GB-03
Sample No.:	SH-07
Sample Interval:	12.0 - 14.5
Depth:	13.3





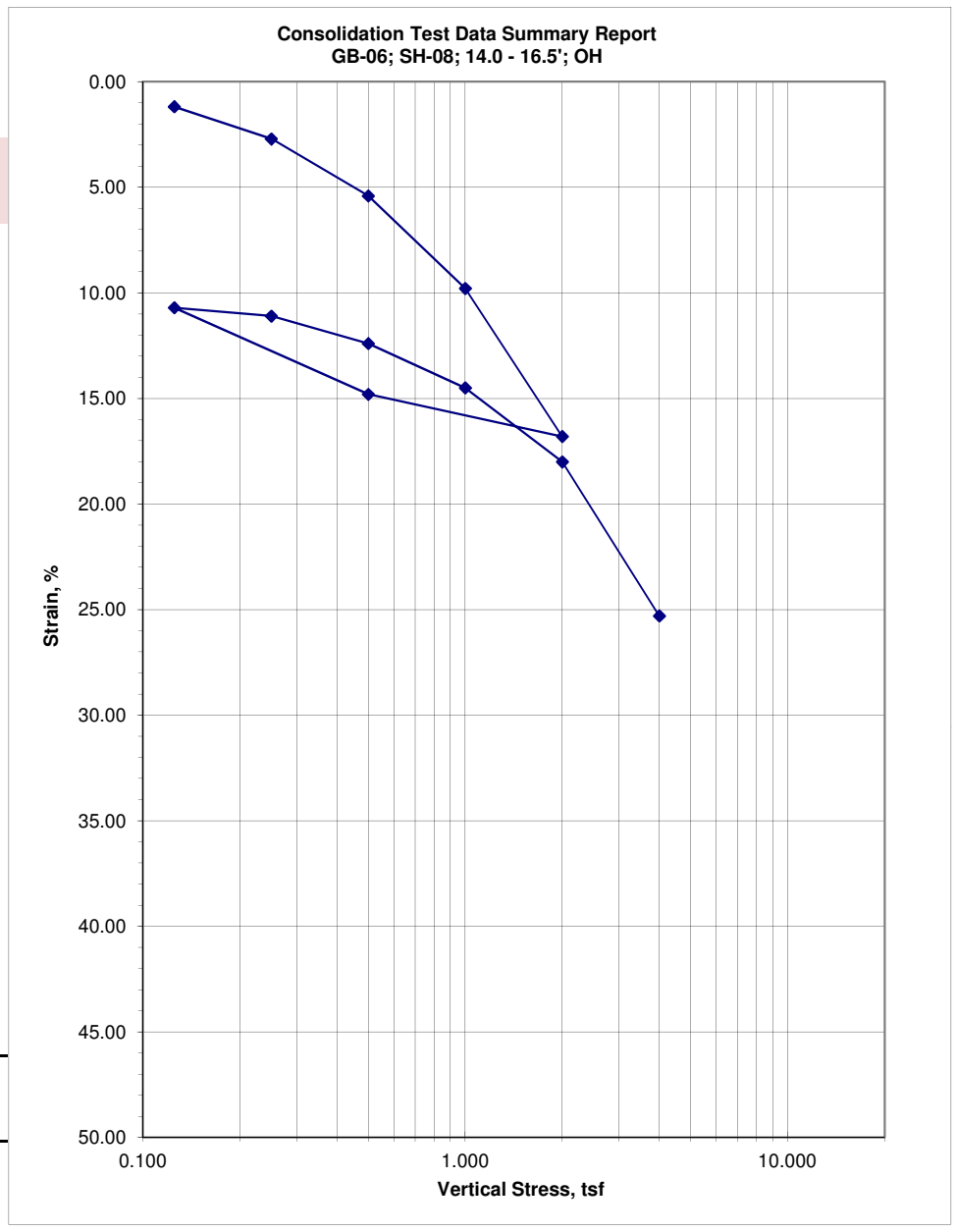

Consolidation Test Data Summary Report (Raw Lab Data)
GB-03; SH-07; 12.0 - 14.5'; OH
$\sigma'_{P_{max}} \cong 0.43$ tsf
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
Strain, %
0.100
1.000
10.000
Vertical Stress, tsf

Point	Applied Stress	% Strain	Slope C_{ce} or C_r	Max. Curvature % Change in Slope		
1	0.125	1.18	-	-	Cre	
2	0.250	2.71	0.051	76.5	0.07	**0.06**
3	0.500	5.41	0.090	62.2		
4	1.000	9.79	0.146	60.0	Cce	
5	2.000	16.80	0.233	-85.7	**0.24**	
6	0.500	14.80	0.033	105.0		
7	0.125	10.70	0.068	-80.5		
8	0.250	11.10	0.013	225.0		
9	0.500	12.40	0.043	61.5		
10	1.000	14.50	0.070	66.7		
11	2.000	18.00	0.116	108.6		
12	4.000	25.30	0.243	-		
13	-	-	-	-		
14	-	-	-	-		

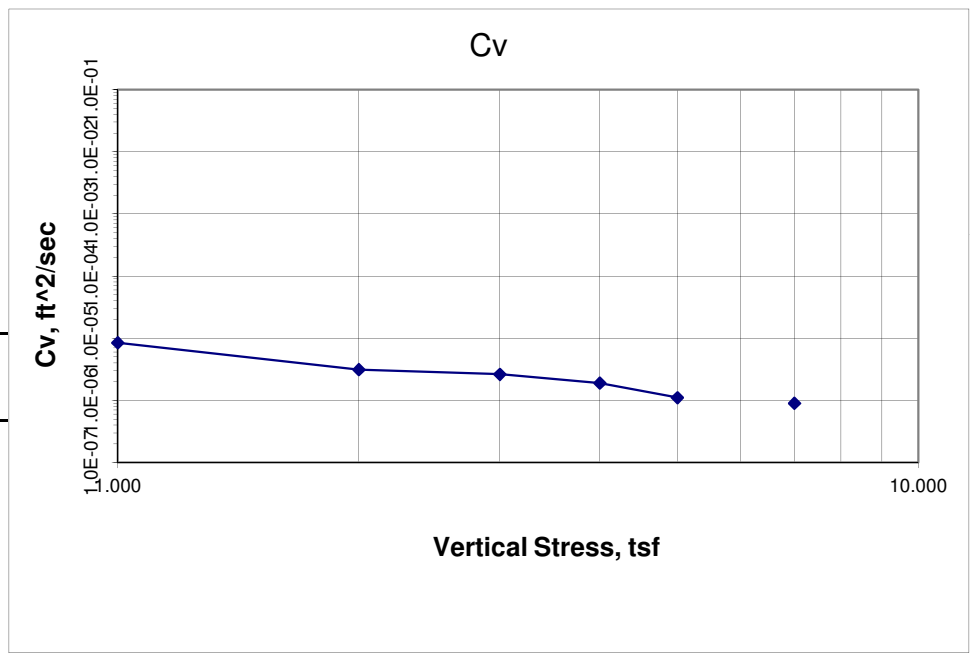
MARSH DEPOSIT - ORGANIC SILT (OH)

Soil Boring:	GB-06			
Sample No.:	SH-08			
Sample Interval:	14.0 - 16.5			
Depth:	15.3			
In-Situ Eff. Stress:	0.50	tsf		
Est. Max. Past Press:	0.55	tsf	**1.1**	= OCR
Est. Future Stress:	1.19	tsf		

Conclusions: 6-hr load increm. Plot incl. some secondary comp. Okay break.



Point	Applied Stress	Sq. Rt. Of Time Cv (ft^2/s)	Cv (ft^2/day)			
1	0.125	5.19E-06	4.48E-01			
2	0.250	2.77E-06	2.39E-01			
3	0.500	2.48E-06	2.14E-01	1.7E-01		
4	1.000	1.46E-06	1.26E-01		1.0E-01	1.4E-01
5	2.000	9.32E-07	8.05E-02			
6	0.500	1.94E-06	1.68E-01			
7	0.125	4.30E-07	3.72E-02			
8	0.250	2.33E-06	2.01E-01			
9	0.500	1.64E-06	1.42E-01			
10	1.000	2.07E-06	1.79E-01			
11	2.000	8.13E-07	7.02E-02			
12	4.000	7.67E-07	6.63E-02			
13	-	-	-			
14	-	-	-			

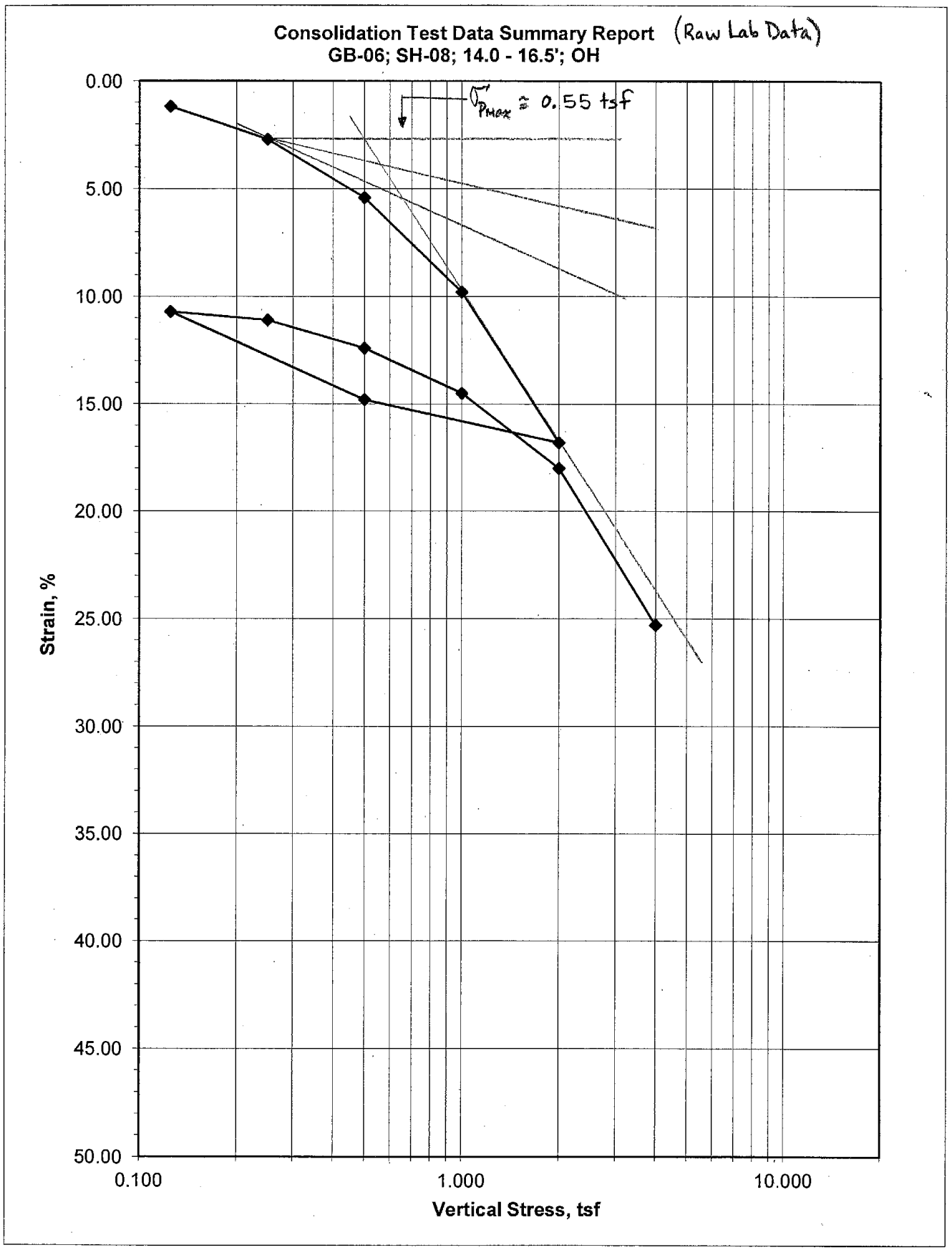


Point	Applied Stress	Log of Time Cv (ft^2/s)	Cv (ft^2/day)			
1	0.125	1.18E-05	1.02E+00			
2	0.250	3.51E-06	3.03E-01			
3	0.500	2.80E-06	2.42E-01	2.2E-01		
4	1.000	2.35E-06	2.03E-01		1.6E-01	1.9E-01
5	2.000	1.29E-06	1.11E-01			
6	0.500	2.14E-06	1.85E-01			
7	0.125	4.22E-07	3.65E-02			
8	0.250	-	-			
9	0.500	1.39E-06	1.20E-01			
10	1.000	1.70E-06	1.47E-01			
11	2.000	-	-			
12	4.000	1.04E-06	8.99E-02			
13	-	-	-			
14	-	-	-			

Point	Applied Stress	Average Cv (ft^2/s)	Cv (ft^2/day)			
1	0.125	8.50E-06	7.34E-01			
2	0.250	3.14E-06	2.71E-01			
3	0.500	2.64E-06	2.28E-01	2.0E-01		
4	1.000	1.91E-06	1.65E-01		1.3E-01	**1.6E-01**
5	2.000	1.11E-06	9.60E-02			
6	0.500	2.04E-06	1.76E-01			
7	0.125	4.26E-07	3.68E-02			
8	0.250	-	-			
9	0.500	1.52E-06	1.31E-01			
10	1.000	1.89E-06	1.63E-01			
11	2.000	-	-			
12	4.000	9.04E-07	7.81E-02			
13	-	-	-			
14	-	-	-			

MARSH DEPOSIT - ORGANIC SILT (OH)

Soil Boring:	GB-06
Sample No.:	SH-08
Sample Interval:	14.0 - 16.5
Depth:	15.3

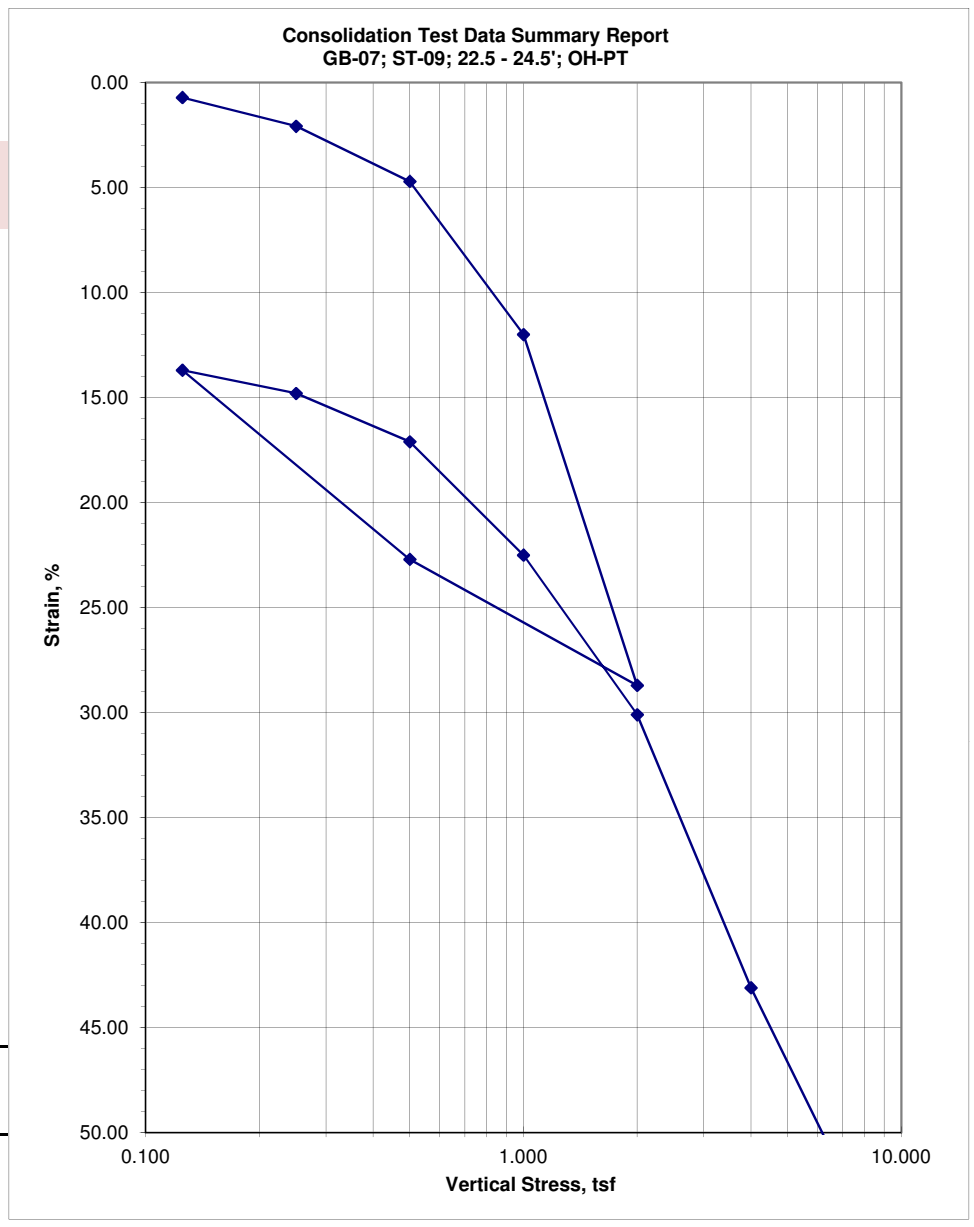

Consolidation Test Data Summary Report (Raw Lab Data)
GB-06; SH-08; 14.0 - 16.5'; OH
$\sigma'_{p_{max}} \approx 0.55$ tsf
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
Strain, %
0.100
1.000
10.000
Vertical Stress, tsf

Point	Applied Stress (tsf)	% Strain	Slope C_{ce} or C_r	Max. Curvature % Change in Slope		
1	0.125	0.71	-	-	Cre	
2	0.250	2.08	0.045	92.5	0.09	**0.08**
3	0.500	4.71	0.087	177.2		
4	1.000	12.00	0.242	129.1	Cce	
5	2.000	28.70	**0.555**	-82.0	**0.55**	
6	0.500	22.70	0.100	50.0		
7	0.125	13.70	0.149	-75.6		
8	0.250	14.80	0.037	109.1		
9	0.500	17.10	0.076	134.8		
10	1.000	22.50	0.179	40.7		
11	2.000	30.10	0.252	71.1		
12	4.000	43.10	0.432	-15.4		
13	8.000	54.10	0.365	-		

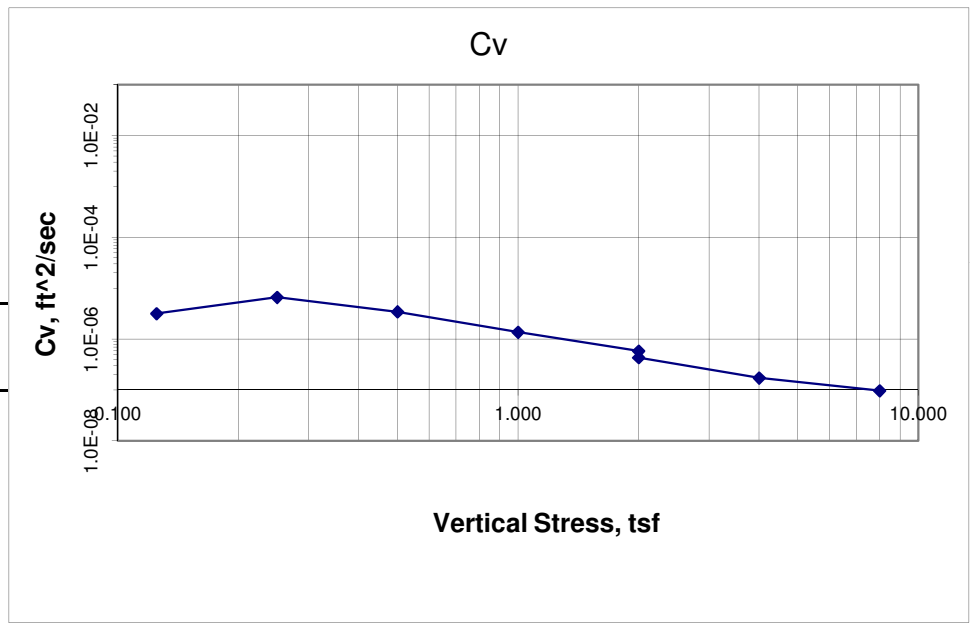
MARSH DEPOSIT - ORGANIC SILT/PEAT (OH/PT)

Soil Boring:	GB-07			
Sample No.:	ST-09			
Sample Interval:	22.5 - 24.5			
Depth:	23.5			
In-Situ Eff. Stress:	0.64	tsf		
Est. Max. Past Press:	0.80	tsf	**1.3**	= OCR
Pre-Load Max. Stress:	1.39	tsf		

Conclusions: 4-hr load increm. Plots incl. little secondary comp.
Good curve/break.



Point	Applied Stress	Sq. Rt. Of Time Cv (ft^2/s)	Cv (ft^2/day)			
1	0.125	3.06E-06	2.64E-01			
2	0.250	4.19E-06	3.62E-01			
3	0.500	3.78E-06	3.27E-01	2.0E-01		
4	1.000	7.85E-07	6.78E-02		6.2E-02	1.5E-01
5	2.000	6.45E-07	5.57E-02			
6	0.500	6.00E-07	5.18E-02			
7	0.125	2.18E-07	1.88E-02			
8	0.250	3.43E-06	2.96E-01			
9	0.500	1.09E-06	9.42E-02			
10	1.000	6.90E-07	5.96E-02			
11	2.000	4.39E-07	3.79E-02			
12	4.000	2.18E-07	1.88E-02			
13	8.000	1.23E-07	1.06E-02			

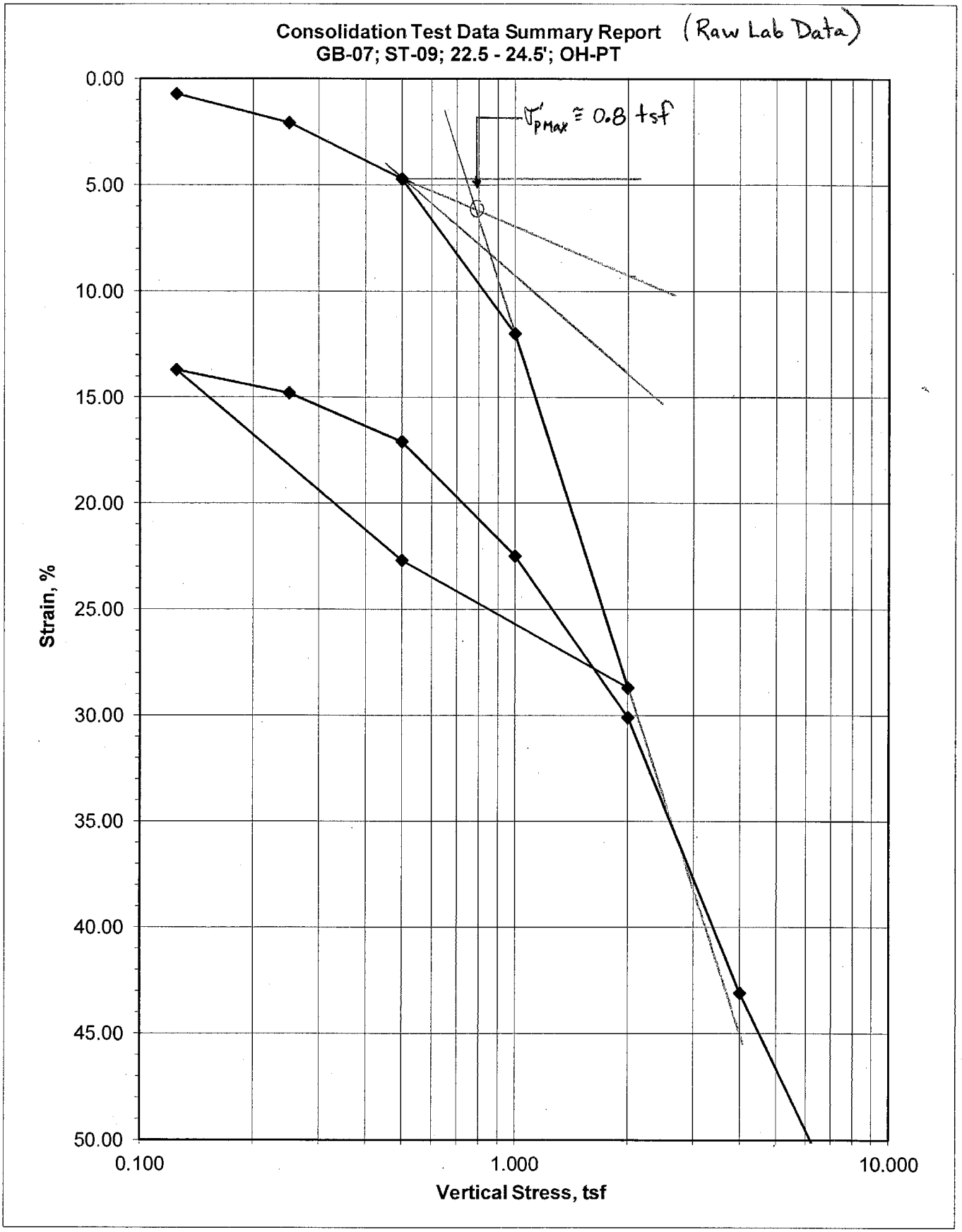


Point	Applied Stress	Log of Time Cv (ft^2/s)	Cv (ft^2/day)			
1	0.125	3.30E-06	2.85E-01			
2	0.250	9.16E-06	7.91E-01			
3	0.500	3.14E-06	2.71E-01	2.2E-01		
4	1.000	1.96E-06	1.69E-01		1.1E-01	1.6E-01
5	2.000	5.27E-07	4.55E-02			
6	0.500	3.83E-07	3.31E-02			
7	0.125	2.38E-07	2.06E-02			
8	0.250	-	-			
9	0.500	1.47E-06	1.27E-01			
10	1.000	5.94E-07	5.13E-02			
11	2.000	4.33E-07	3.74E-02			
12	4.000	1.29E-07	1.11E-02			
13	8.000	7.17E-08	6.19E-03			

Point	Applied Stress	Average Cv (ft^2/s)	Cv (ft^2/day)			
1	0.125	3.18E-06	2.75E-01			
2	0.250	6.68E-06	5.77E-01			
3	0.500	3.46E-06	2.99E-01	2.1E-01		
4	1.000	1.37E-06	1.19E-01		8.5E-02	**1.6E-01**
5	2.000	5.86E-07	5.06E-02			
6	0.500	4.92E-07	4.25E-02			
7	0.125	2.28E-07	1.97E-02			
8	0.250	-	-			
9	0.500	1.28E-06	1.11E-01			
10	1.000	6.42E-07	5.55E-02			
11	2.000	4.36E-07	3.77E-02			
12	4.000	1.74E-07	1.50E-02			
13	8.000	9.74E-08	8.41E-03			

MARSH DEPOSIT - ORGANIC SILT/PEAT (OH/PT)

Soil Boring:	GB-07
Sample No.:	ST-09
Sample Interval:	22.5 - 24.5
Depth:	23.5


Consolidation Test Data Summary Report (Raw Lab Data)
GB-07; ST-09; 22.5 - 24.5'; OH-PT
$\sigma'_{pMax} \cong 0.8$ tsf
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
Strain, %
0.100
1.000
10.000
Vertical Stress, tsf

Point	Applied Stress (tsf)	% Strain	Slope C_{ce} or C_r	Max. Curvature % Change in Slope		
1	0.125	0.87	-	-	Cre	
2	0.250	1.74	0.029	182.2	0.08	**0.06**
3	0.438	3.72	0.081	55.8		
4	0.765	6.80	0.127	81.7		
5	1.325	12.30	0.231	-81.1		
6	0.438	10.20	0.044	29.7		
7	0.125	7.12	0.057	-87.7		
8	0.250	7.33	0.007	483.9		
9	0.438	8.32	0.041	80.1		
10	0.765	10.10	0.073	77.2		
11	1.325	13.20	0.130	177.3	Cce	
12	2.625	23.90	0.360	-6.9	**0.36**	
13	5.250	34.00	0.336	-7.9		
14	10.500	43.30	0.309	-		

MARSH DEPOSIT - ORGANIC SILT (OH)

Soil Boring:	GB-08			
Sample No.:	ST-08			
Sample Interval:	18.0 - 20.0			
Depth:	19.0			
In-Situ Eff. Stress:	0.59	tsf		
Est. Max. Past Press:	0.73	tsf	**1.2**	= OCR
Pre-Load Max. Stress:	1.28	tsf		

Conclusions: 4-hr load increm. Plots incl. little secondary comp.
Good curve/break.

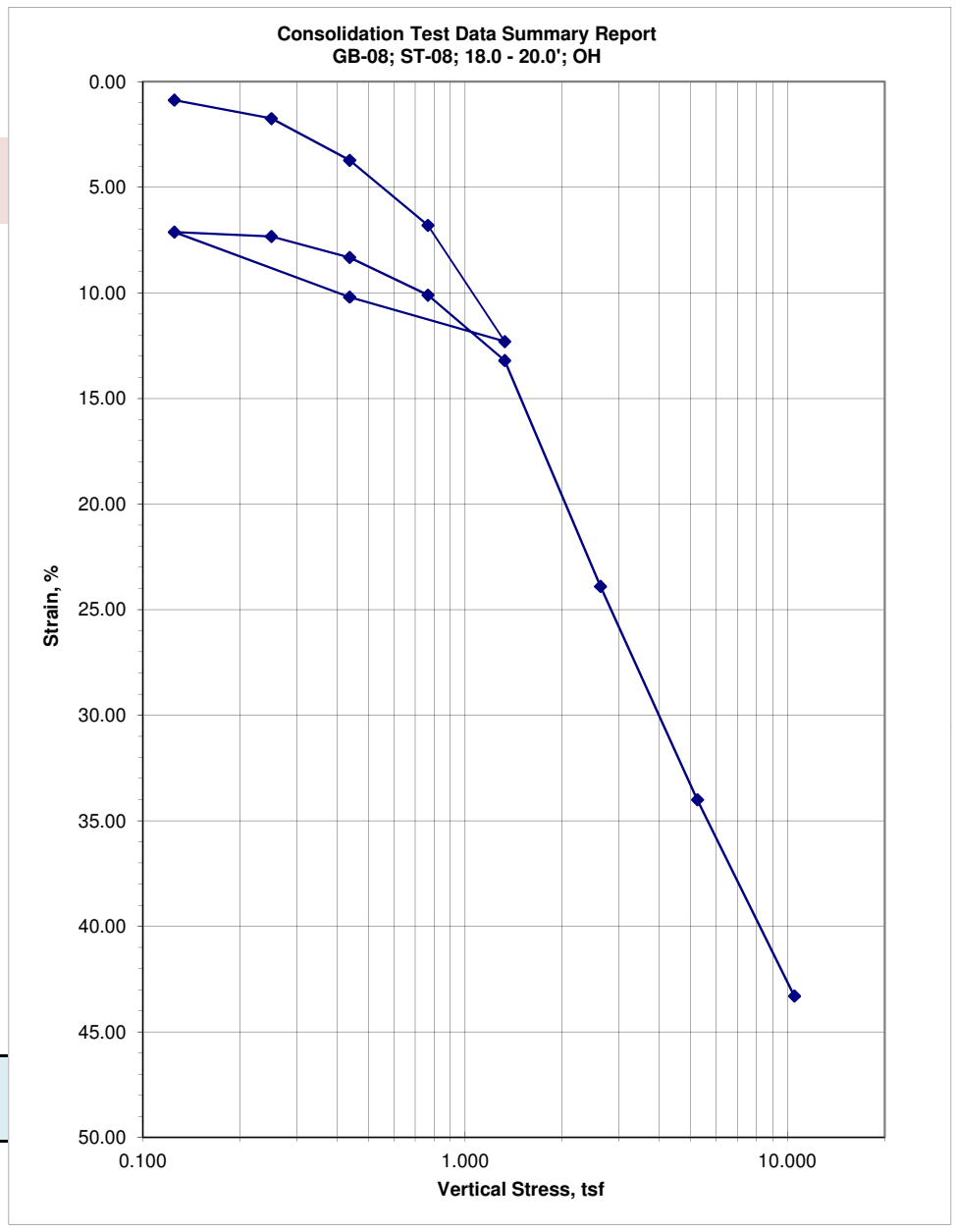
Point	Applied Stress	Sq. Rt. Of Time Cv (ft^2/s)	Cv (ft^2/day)			
1	0.125	3.23E-05	2.79E+00			
2	0.250	1.42E-06	1.23E-01			
3	0.438	3.11E-06	2.69E-01	2.7E-01		
4	0.765	3.14E-06	2.71E-01		1.7E-01	**2.0E-01**
5	1.325	8.10E-07	7.00E-02			
6	0.438	2.77E-06	2.39E-01			
7	0.125	7.54E-07	6.51E-02			
8	0.250	7.04E-07	6.08E-02			
9	0.438	1.17E-07	1.01E-02			
10	0.765	2.89E-06	2.50E-01			
11	1.325	1.14E-06	9.85E-02			
12	2.625	9.13E-07	7.89E-02			
13	5.250	7.67E-07	6.63E-02			
14	0.000	5.81E-07	5.02E-02			

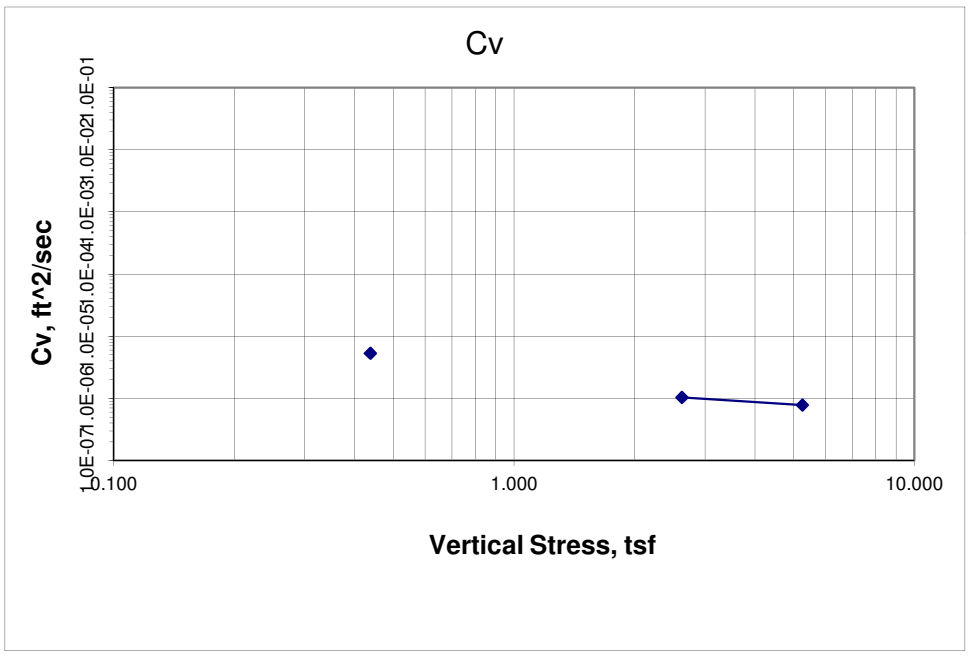
Point	Applied Stress	Log of Time Cv (ft^2/s)	Cv (ft^2/day)
1	0.125	-	-
2	0.250	-	-
3	0.438	7.59E-06	6.56E-01
4	0.765	-	-
5	1.325	-	-
6	0.438	4.08E-06	3.53E-01
7	0.125	1.14E-06	9.85E-02
8	0.250	7.87E-07	6.80E-02
9	0.438	-	-
10	0.765	4.46E-06	3.85E-01
11	1.325	-	-
12	2.625	1.17E-06	1.01E-01
13	5.250	8.04E-07	6.95E-02
14	10.500	5.99E-07	5.18E-02

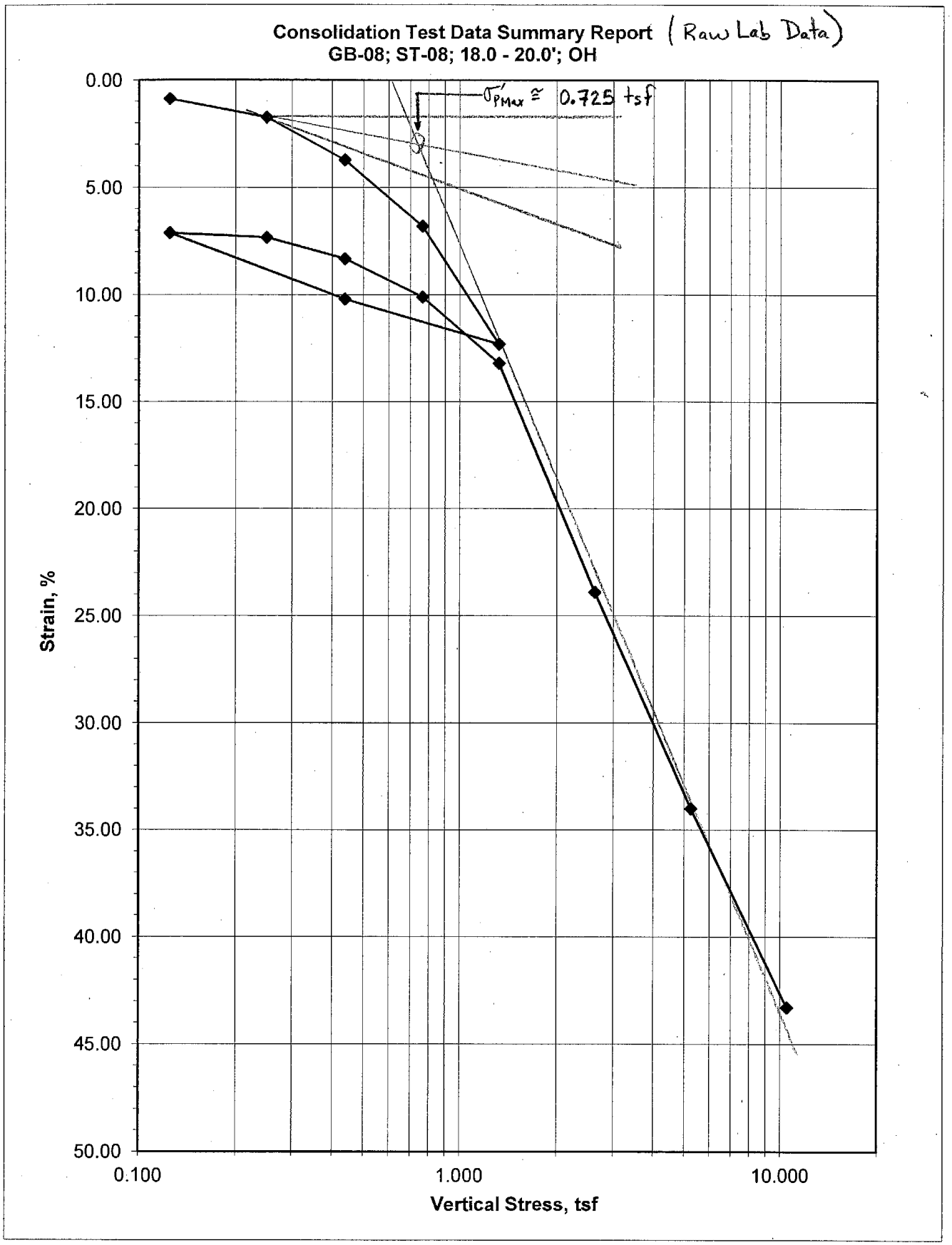
Point	Applied Stress	Average Cv (ft^2/s)	Cv (ft^2/day)
1	0.125	-	-
2	0.250	-	-
3	0.438	5.35E-06	4.62E-01
4	0.765	-	-
5	1.325	-	-
6	0.438	3.43E-06	2.96E-01
7	0.125	9.47E-07	8.18E-02
8	0.250	-	-
9	0.438	-	-
10	0.765	3.68E-06	3.18E-01
11	1.325	-	-
12	2.625	1.04E-06	9.00E-02
13	5.250	7.86E-07	6.79E-02
14	10.500	2.91E-07	2.51E-02

MARSH DEPOSIT - ORGANIC SILT (OH)

Soil Boring:	GB-08
Sample No.:	ST-08
Sample Interval:	18.0 - 20.0
Depth:	19.0





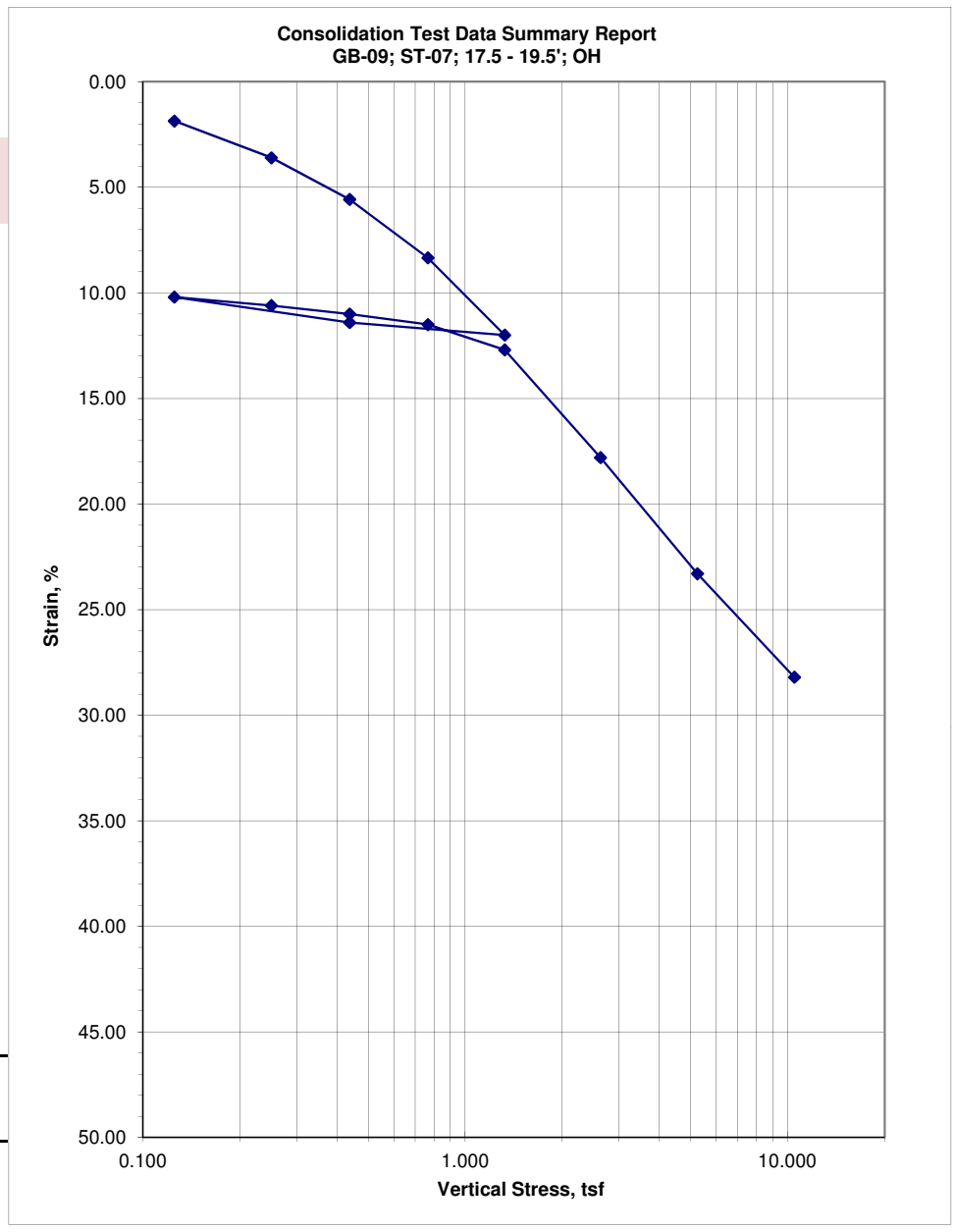

Consolidation Test Data Summary Report (Raw Lab Data)
GB-08; ST-08; 18.0 - 20.0'; OH
σ'PMax ≅ 0.725 tsf
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
Strain, %
0.100
1.000
10.000
Vertical Stress, tsf

Point	Applied Stress (tsf)	% Strain	Slope C_{ce} or C_r	Max. Curvature % Change in Slope		
1	0.125	1.86	-	-	Cre	
2	0.250	3.60	0.058	40.2	0.07	**0.02**
3	0.438	5.57	0.081	40.8		
4	0.765	8.34	0.114	34.4		
5	1.325	12.00	0.153	-91.9		
6	0.438	11.40	0.012	76.9		
7	0.125	10.20	0.022	-39.8		
8	0.250	10.60	0.013	23.9		
9	0.438	11.00	0.016	25.2		
10	0.765	11.50	0.021	144.2		
11	1.325	12.70	0.050	241.5		
12	2.625	17.80	0.172	6.4	Cce	
13	5.250	23.30	0.183	-10.9	**0.18**	
14	10.500	28.20	0.163	-		

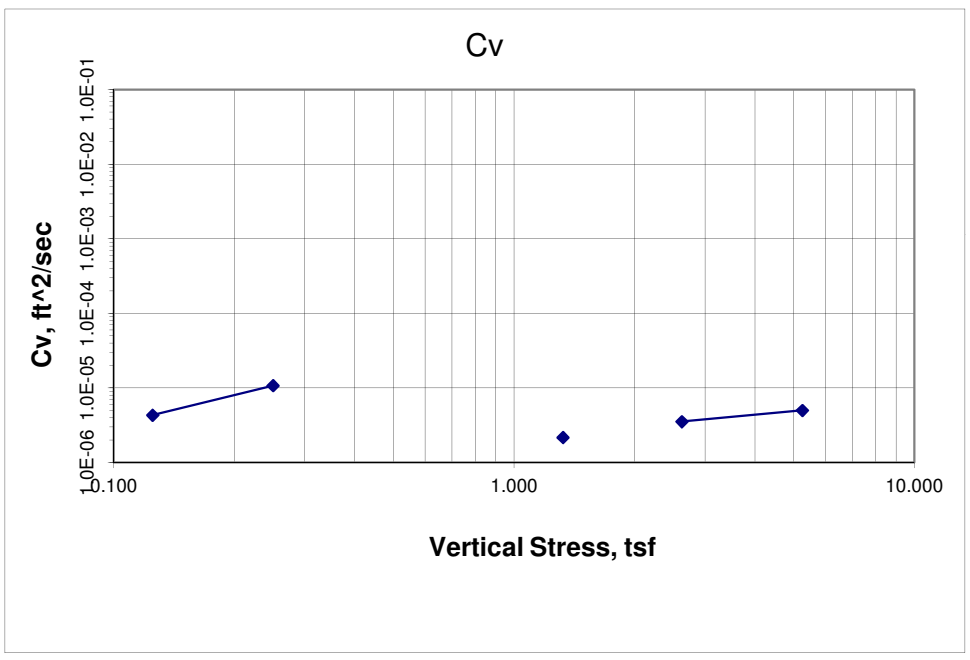
MARSH DEPOSIT - sandy ORGANIC CLAY (OH)

Soil Boring:	GB-09			
Sample No.:	ST-07			
Sample Interval:	17.5 - 19.5			
Depth:	18.5			
In-Situ Eff. Stress:	0.39	tsf		
Est. Max. Past Press:	0.65	tsf	**1.7**	= OCR
Pre-Load Max. Stress:	1.08	tsf		

Conclusions: 4-hr load increm. Plots incl. little secondary comp.
Poor break; Poss. sample disturbance; Sandy.



Point	Applied Stress	Sq. Rt. Of Time Cv (ft^2/s)	Cv (ft^2/day)			
1	0.125	1.82E-06	1.57E-01			
2	0.250	5.67E-06	4.90E-01			
3	0.438	2.23E-06	1.93E-01	1.8E-01		
4	0.765	1.84E-06	1.59E-01		1.6E-01	1.7E-01
5	1.325	1.78E-06	1.54E-01			
6	0.438	1.88E-05	1.62E+00			
7	0.125	2.03E-06	1.75E-01			
8	0.250	1.43E-06	1.24E-01			
9	0.438	1.12E-06	9.68E-02			
10	0.765	3.63E-06	3.14E-01			
11	1.325	7.90E-07	6.83E-02			
12	2.625	2.11E-06	1.82E-01			
13	5.250	2.59E-06	2.24E-01			
14	0.000	2.45E-06	2.12E-01			

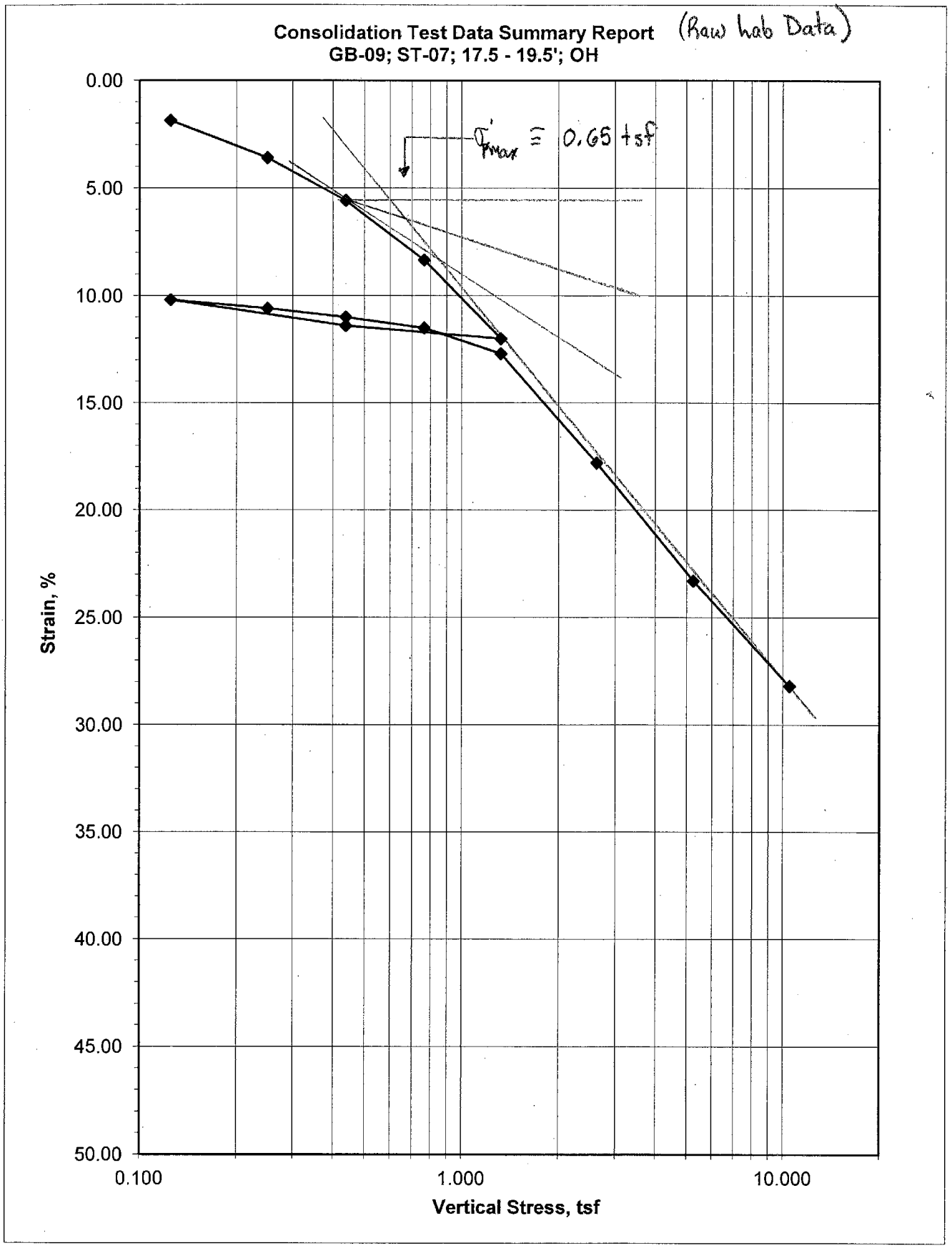


Point	Applied Stress	Log of Time Cv (ft^2/s)	Cv (ft^2/day)	
1	0.125	6.84E-06	5.91E-01	
2	0.250	1.59E-05	1.37E+00	
3	0.438	-	-	
4	0.765	-	-	
5	1.325	2.56E-06	2.21E-01	2.2E-01
6	0.438	-	-	
7	0.125	-	-	
8	0.250	-	-	
9	0.438	-	-	
10	0.765	-	-	
11	1.325	-	-	
12	2.625	4.97E-06	4.29E-01	
13	5.250	7.43E-06	6.42E-01	
14	10.500	7.11E-06	6.14E-01	

Point	Applied Stress	Average Cv (ft^2/s)	Cv (ft^2/day)	
1	0.125	4.33E-06	3.74E-01	
2	0.250	1.08E-05	9.32E-01	
3	0.438	-	-	
4	0.765	-	-	
5	1.325	2.17E-06	1.87E-01	**1.9E-01**
6	0.438	-	-	
7	0.125	-	-	
8	0.250	-	-	
9	0.438	-	-	
10	0.765	-	-	
11	1.325	-	-	
12	2.625	3.54E-06	3.06E-01	
13	5.250	5.01E-06	4.33E-01	
14	10.500	4.78E-06	4.13E-01	

MARSH DEPOSIT - sandy ORGANIC CLAY (OH)

Soil Boring:	GB-09
Sample No.:	ST-07
Sample Interval:	17.5 - 19.5
Depth:	18.5


Consolidation Test Data Summary Report
(Raw lab Data)
GB-09; ST-07; 17.5 - 19.5'; OH
σ'max ≅ 0.65 tsf
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
Strain, %
0.100
1.000
10.000
Vertical Stress, tsf

Point	Applied Stress (tsf)	% Strain	Slope C_{ce} or C_r	Max. Curvature % Change in Slope
1	0.125	1.56	-	-
2	0.250	2.94	0.046	63.8
3	0.500	5.20	0.075	130.1
4	1.000	10.40	0.173	146.2
5	2.000	23.20	0.425	-88.3
6	0.500	20.20	0.050	93.3
7	0.125	14.40	0.096	-79.3
8	0.250	15.00	0.020	150.0
9	0.500	16.50	0.050	120.0
10	1.000	19.80	0.110	78.8
11	2.000	25.70	0.196	118.6
12	4.000	38.60	0.429	-18.6
13	8.000	49.10	0.349	-
14	-	-	-	-

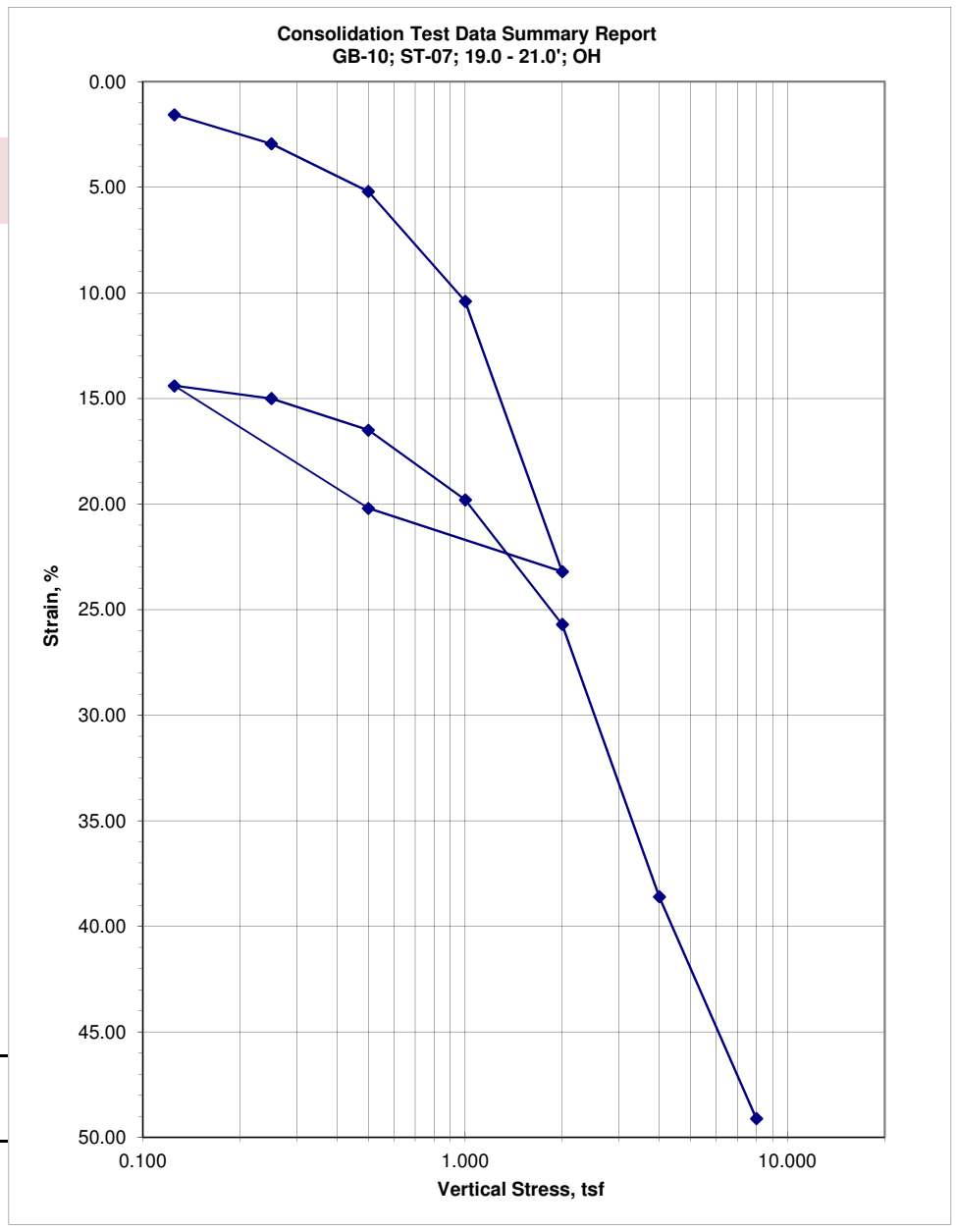
Cre	
0.06	**0.08**

Cce
0.43

MARSH DEPOSIT - ORGANIC SILT/PEAT (OH/PT)

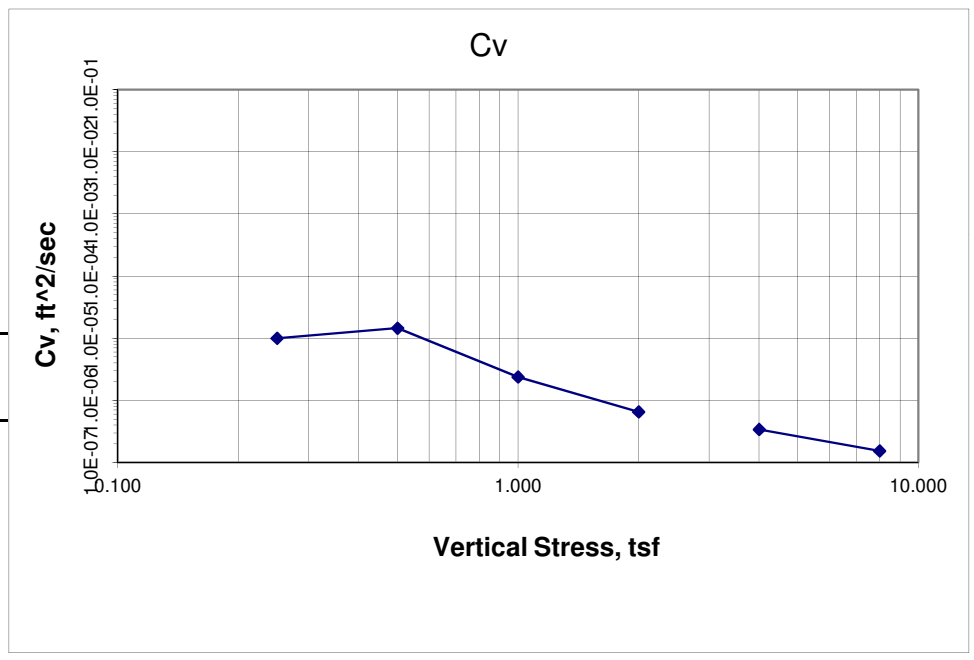
Soil Boring:	GB-10			
Sample No.:	ST-07			
Sample Interval:	19.0 - 21.0			
Depth:	20.0			
In-Situ Eff. Stress:	0.78	tsf		
Est. Max. Past Press:	0.80	tsf	**1.0**	= OCR
Pre-Load Max. Stress:	1.28	tsf		

Conclusions: 4-hr load increm. Plots incl. little secondary comp.
Good curve/break.



Point	Applied Stress	Sq. Rt. Of Time Cv (ft^2/s)	Cv (ft^2/day)
1	0.125	9.71E-06	8.39E-01
2	0.250	5.04E-06	4.35E-01
3	0.500	7.26E-06	6.27E-01
4	1.000	1.76E-06	1.52E-01
5	2.000	5.98E-07	5.17E-02
6	0.500	1.44E-06	1.24E-01
7	0.125	4.02E-07	3.47E-02
8	0.250	1.16E-05	1.00E+00
9	0.500	1.74E-06	1.50E-01
10	1.000	1.02E-06	8.81E-02
11	2.000	6.63E-07	5.73E-02
12	4.000	3.72E-07	3.21E-02
13	8.000	1.76E-07	1.52E-02
14	-	-	-

3.9E-01	1.0E-01	2.8E-01



Point	Applied Stress	Log of Time Cv (ft^2/s)	Cv (ft^2/day)
1	0.125	-	-
2	0.250	1.50E-05	1.30E+00
3	0.500	2.18E-05	1.88E+00
4	1.000	3.02E-06	2.61E-01
5	2.000	7.15E-07	6.18E-02
6	0.500	2.20E-06	1.90E-01
7	0.125	3.34E-07	2.89E-02
8	0.250	-	-
9	0.500	1.59E-06	1.37E-01
10	1.000	1.57E-06	1.36E-01
11	2.000	-	-
12	4.000	3.11E-07	2.69E-02
13	8.000	1.33E-07	1.15E-02
14	-		

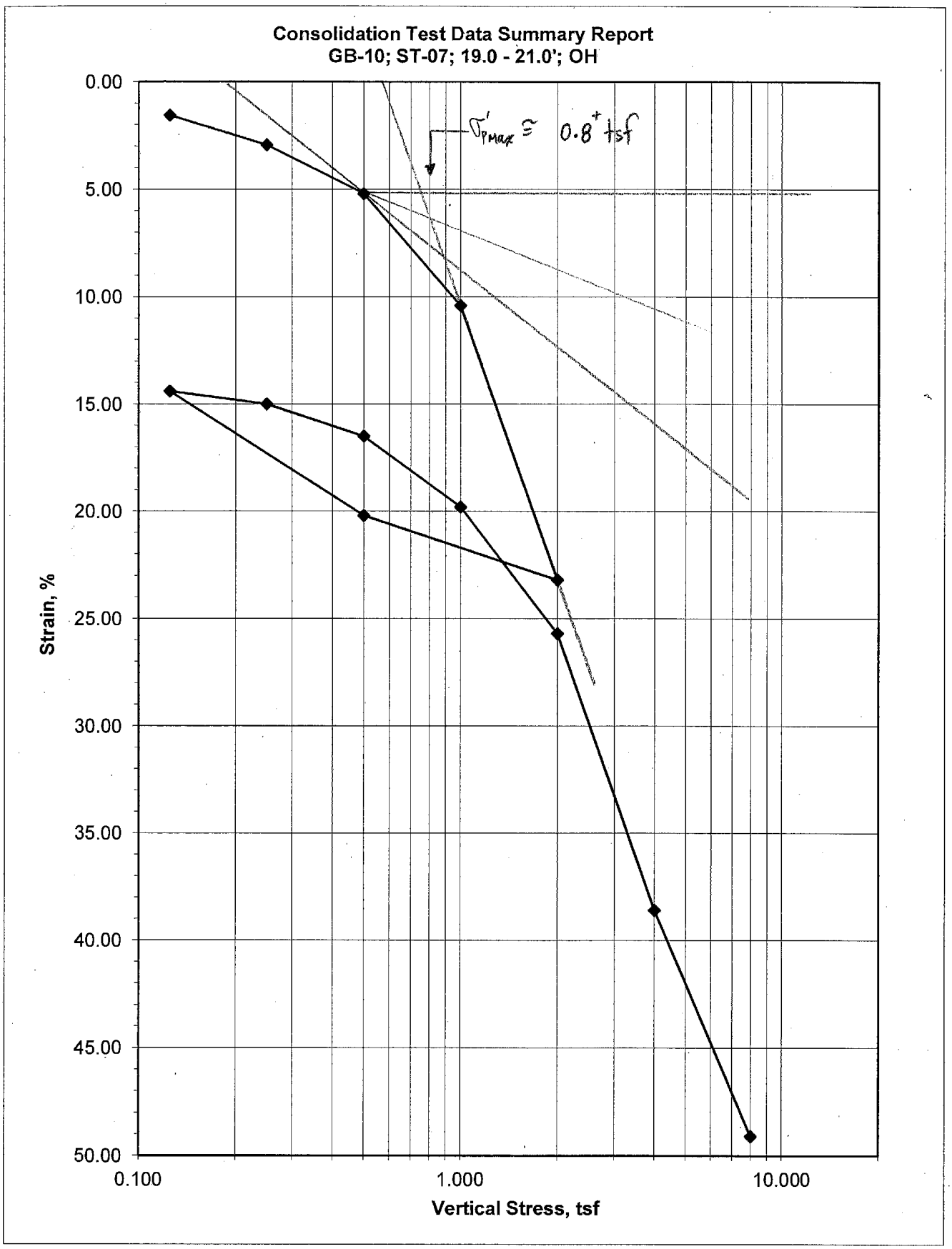
1.1E+00	1.6E-01	7.4E-01

Point	Applied Stress	Average Cv (ft^2/s)	Cv (ft^2/day)
1	0.125	-	-
2	0.250	1.00E-05	8.66E-01
3	0.500	1.45E-05	1.26E+00
4	1.000	2.39E-06	2.06E-01
5	2.000	6.57E-07	5.67E-02
6	0.500	1.82E-06	1.57E-01
7	0.125	3.68E-07	3.18E-02
8	0.250	-	-
9	0.500	1.67E-06	1.44E-01
10	1.000	1.30E-06	1.12E-01
11	2.000	-	-
12	4.000	3.42E-07	2.95E-02
13	8.000	1.55E-07	1.33E-02
14	-	-	-

7.3E-01	1.3E-01	**5.1E-01**

MARSH DEPOSIT - ORGANIC SILT/PEAT (OH/PT)

Soil Boring:	GB-10
Sample No.:	ST-07
Sample Interval:	19.0 - 21.0
Depth:	20.0


Consolidation Test Data Summary Report
GB-10; ST-07; 19.0 - 21.0'; OH
$\sigma'_{p_{max}} \cong 0.8^{+}$ tsf
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
Strain, %
0.100
1.000
10.000
Vertical Stress, tsf

ATTACHMENT 2

SETTLEMENT EVALUATION
(Spreadsheet Calculator Output)

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-01	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	10.25	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	7.75	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	13.75	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	0.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	4.7	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	4.2	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	5.9	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	12.4	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-01	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	17.00	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	6.8	-
Surcharge Height above Prop. Grade (ft):	3.3	-
Resultant Time to Consolidation:	7.5	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change + one log cycle of secondary comp.
@ % Surcharge Consolidation:	94%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	OKAY	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-01	-	
Surcharge Area/Point No:	-	-	
Coefficient of Secondary Compression, C_{α}	0.02	Marsh	(Cα expressed by change in strain per log cycle of time)
Coefficient of Secondary Compression, C_{α}	0.00	N/A	(Cα expressed by change in strain per log cycle of time)
Est. Time to End of Primary Consolidation, t_p	1.0	Years	
Secondary Compression Design Time, t_{sec}	30.0	Years	1.5 No. of log cycles

Method from NAVFAC DM 7.1-231: $H_{sec} = C\alpha * H_t * \log (t_{sec}/t_p)$

Where: H_{sec} = Secondary compression
H_t = Thickness of soil stratum

Est. Secondary Compression (inches):	4.5	Marsh
Est. Secondary Compression (inches):	0.0	N/A

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-01**	
Existing Grade:	10.3	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	7.8	feet bgs
Tot./Eff. Stress @ GWT =	891.3	psf

Analysis Point/Location:	**GB-01**	
Proposed Grade:	13.75	feet
Grade Change:	3.5	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	437.5	psf
Δ Stress (Bldg. Loading):	0.0	psf

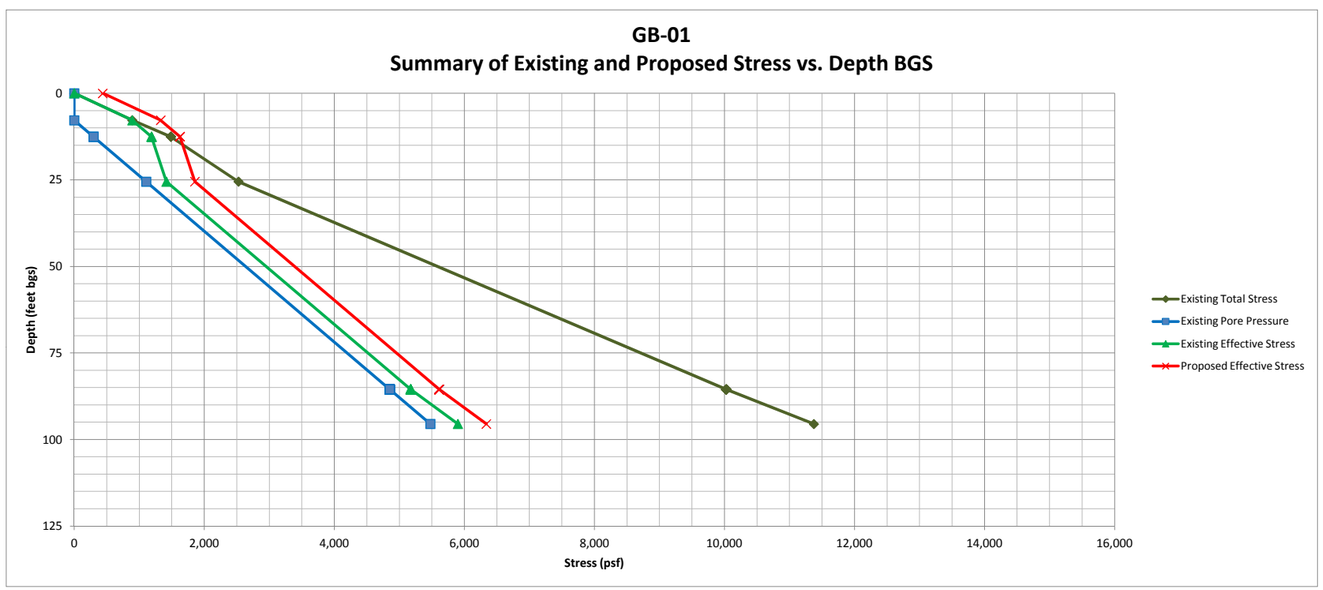
Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
Stratum	Top	Bottom		γ_t or γ_{sat}	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle
	(ft bgs)	(ft bgs)	(ft)	(pcf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)
		0.0	0.0			0.0			0.0			0.0			437.5	
F-Unsat	0.0	7.8	7.8	115	0.0	891.3	445.6	0.0	0.0	0.0	0.0	891.3	445.6	437.5	1328.8	883.1
F-Satur	7.8	12.5	4.8	125	891.3	1485.0	1188.1	0.0	296.4	148.2	891.3	1188.6	1039.9	1328.8	1626.1	1477.4
-	12.5	12.5	0.0	110	1485.0	1485.0	1485.0	296.4	296.4	296.4	1188.6	1188.6	1188.6	1626.1	1626.1	1626.1
-	12.5	12.5	0.0	120	1485.0	1485.0	1485.0	296.4	296.4	296.4	1188.6	1188.6	1188.6	1626.1	1626.1	1626.1
Marsh	12.5	25.5	13.0	80	1485.0	2525.0	2005.0	296.4	1107.6	702.0	1188.6	1417.4	1303.0	1626.1	1854.9	1740.5
Fluvial	25.5	85.5	60.0	125	2525.0	10025.0	6275.0	1107.6	4851.6	2979.6	1417.4	5173.4	3295.4	1854.9	5610.9	3732.9
-	85.5	85.5	0.0	125	10025.0	10025.0	10025.0	4851.6	4851.6	4851.6	5173.4	5173.4	5173.4	5610.9	5610.9	5610.9
-	85.5	85.5	0.0	120	10025.0	10025.0	10025.0	4851.6	4851.6	4851.6	5173.4	5173.4	5173.4	5610.9	5610.9	5610.9
-	85.5	85.5	0.0	125	10025.0	10025.0	10025.0	4851.6	4851.6	4851.6	5173.4	5173.4	5173.4	5610.9	5610.9	5610.9
-	85.5	85.5	0.0	120	10025.0	10025.0	10025.0	4851.6	4851.6	4851.6	5173.4	5173.4	5173.4	5610.9	5610.9	5610.9
-	85.5	85.5	0.0	125	10025.0	10025.0	10025.0	4851.6	4851.6	4851.6	5173.4	5173.4	5173.4	5610.9	5610.9	5610.9
-	85.5	85.5	0.0	120	10025.0	10025.0	10025.0	4851.6	4851.6	4851.6	5173.4	5173.4	5173.4	5610.9	5610.9	5610.9
-	85.5	85.5	0.0	125	10025.0	10025.0	10025.0	4851.6	4851.6	4851.6	5173.4	5173.4	5173.4	5610.9	5610.9	5610.9
-	85.5	85.5	0.0	120	10025.0	10025.0	10025.0	4851.6	4851.6	4851.6	5173.4	5173.4	5173.4	5610.9	5610.9	5610.9
-	85.5	85.5	0.0	125	10025.0	10025.0	10025.0	4851.6	4851.6	4851.6	5173.4	5173.4	5173.4	5610.9	5610.9	5610.9
-	85.5	85.5	0.0	120	10025.0	10025.0	10025.0	4851.6	4851.6	4851.6	5173.4	5173.4	5173.4	5610.9	5610.9	5610.9
Till	85.5	95.5	10.0	135	10025.0	11375.0	10700.0	4851.6	5475.6	5163.6	5173.4	5899.4	5536.4	5610.9	6336.9	5973.9

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date:	TCC	06-2013
Checked By/Date:	NDL	06-2013



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-01**	
Proposed Grade:	13.8	feet
Grade Change:	3.5	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	437.5	psf
Δ Stress (Bldg. Loading):	0.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(Due to Proposed Grade Change) (inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	0.83	-	-	-
F-Satur	1.0	0.03	-	-	0.26	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.35	0.07	0.20	3.41	6.5	0.848	179.1
Fluvial	2.0	0.02	0.01	10.00	0.19	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					4.69			

Estimated Settlement @ 90% Consolidation
(inches)
4.22

Days	**179.1**
Months	**5.9**
Years	**0.5**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 13.0 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 6.5 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**179.1**
Months	**5.9**
Years	**0.5**

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-03	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	9.50	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	7.00	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	14.00	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	0.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	6.8	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	6.2	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	5.3	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	11.2	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-03	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	17.00	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	7.5	-
Surcharge Height above Prop. Grade (ft):	3.0	-
Resultant Time to Consolidation:	6.9	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change + one log cycle of secondary comp.
@ % Surcharge Consolidation:	95%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	OKAY	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-03	-	
Surcharge Area/Point No:	-	-	
Coefficient of Secondary Compression, C_α	0.01	Marsh	(Cα expressed by change in strain per log cycle of time)
Coefficient of Secondary Compression, C_α	0.00	N/A	(Cα expressed by change in strain per log cycle of time)
Est. Time to End of Primary Consolidation, t_p	1.0	Years	
Secondary Compression Design Time, t_{sec}	30.0	Years	1.5 No. of log cycles
Method from NAVFAC DM 7.1-231:	$H_{sec} = C\alpha * H_t * \log (t_{sec}/t_p)$		Where: H_{sec} = Secondary compression; H_t = Thickness of soil stratum
Est. Secondary Compression (inches):	3.0	Marsh	
Est. Secondary Compression (inches):	0.0	N/A	

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-03**	
Existing Grade:	9.5	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	7.0	feet bgs
Tot./Eff. Stress @ GWT =	805.0	psf

Analysis Point/Location:	**GB-03**	
Proposed Grade:	14.00	feet
Grade Change:	4.5	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	562.5	psf
Δ Stress (Bldg. Loading):	0.0	psf

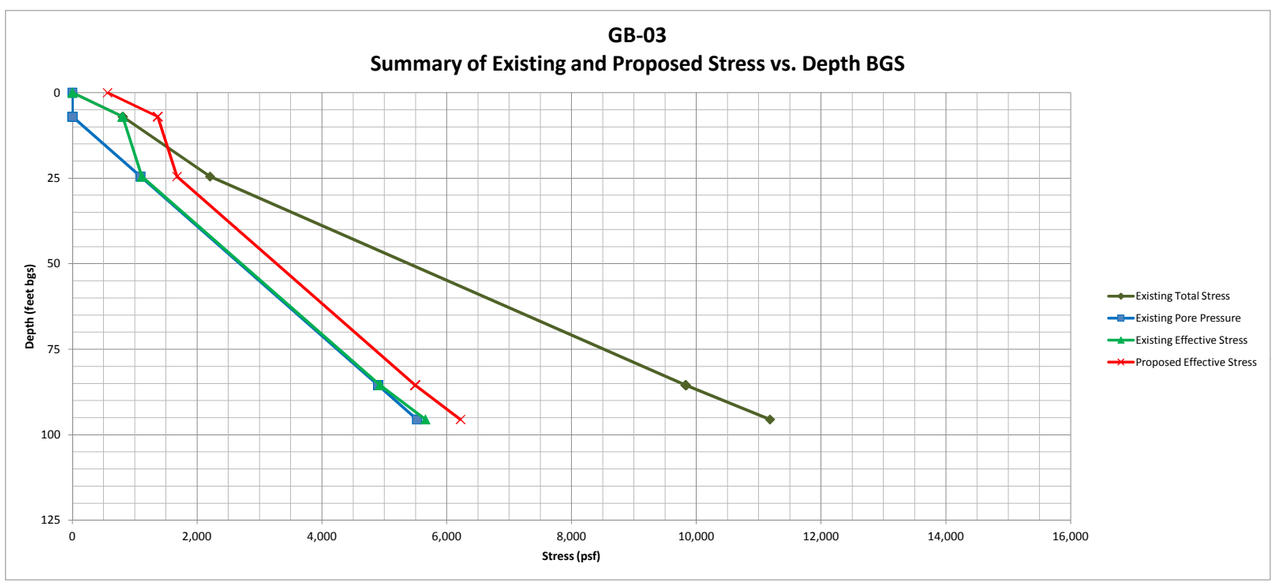
Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
Stratum	Top	Bottom		γ_t or γ_{sat}	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle
	(ft bgs)	(ft bgs)	(ft)	(pcf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)
		0.0	0.0			0.0			0.0			0.0			562.5	
F-Unsat	0.0	7.0	7.0	115	0.0	805.0	402.5	0.0	0.0	0.0	0.0	805.0	402.5	562.5	1367.5	965.0
F-Satur	7.0	7.0	0.0	125	805.0	805.0	805.0	0.0	0.0	0.0	805.0	805.0	805.0	1367.5	1367.5	1367.5
-	7.0	7.0	0.0	110	805.0	805.0	805.0	0.0	0.0	0.0	805.0	805.0	805.0	1367.5	1367.5	1367.5
-	7.0	7.0	0.0	120	805.0	805.0	805.0	0.0	0.0	0.0	805.0	805.0	805.0	1367.5	1367.5	1367.5
Marsh	7.0	24.5	17.5	80	805.0	2205.0	1505.0	0.0	1092.0	546.0	805.0	1113.0	959.0	1367.5	1675.5	1521.5
Fluvial	24.5	85.5	61.0	125	2205.0	9830.0	6017.5	1092.0	4898.4	2995.2	1113.0	4931.6	3022.3	1675.5	5494.1	3584.8
-	85.5	85.5	0.0	125	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	5494.1	5494.1	5494.1
-	85.5	85.5	0.0	120	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	5494.1	5494.1	5494.1
-	85.5	85.5	0.0	125	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	5494.1	5494.1	5494.1
-	85.5	85.5	0.0	120	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	5494.1	5494.1	5494.1
-	85.5	85.5	0.0	125	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	5494.1	5494.1	5494.1
-	85.5	85.5	0.0	120	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	5494.1	5494.1	5494.1
-	85.5	85.5	0.0	125	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	5494.1	5494.1	5494.1
-	85.5	85.5	0.0	120	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	5494.1	5494.1	5494.1
-	85.5	85.5	0.0	125	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	5494.1	5494.1	5494.1
-	85.5	85.5	0.0	120	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	5494.1	5494.1	5494.1
Till	85.5	95.5	10.0	135	9830.0	11180.0	10505.0	4898.4	5522.4	5210.4	4931.6	5657.6	5294.6	5494.1	6220.1	5857.1

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date:	TCC	06-2013
Checked By/Date:	NDL	06-2013



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-03**	
Proposed Grade:	14.0	feet
Grade Change:	4.5	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	562.5	psf
Δ Stress (Bldg. Loading):	0.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(Due to Proposed Grade Change) (inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	0.96	-	-	-
F-Satur	1.0	0.03	-	-	0.00	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.18	0.07	0.40	5.62	8.8	0.848	162.3
Fluvial	2.0	0.02	0.01	10.00	0.27	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					6.85			

Estimated Settlement @ 90% Consolidation
(inches)
6.16

Days	**162.3**
Months	**5.3**
Years	**0.4**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 17.5 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 8.8 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**162.3**
Months	**5.3**
Years	**0.4**

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-05	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	11.25	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	8.75	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	15.00	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	0.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	3.7	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	3.3	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	2.2	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	4.7	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-05	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	18.00	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	6.8	-
Surcharge Height above Prop. Grade (ft):	3.0	-
Resultant Time to Consolidation:	#NUM!	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change + one log cycle of secondary comp.
@ % Surcharge Consolidation:	111%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	#NUM!	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-05	-	
Surcharge Area/Point No:	-	-	
Coefficient of Secondary Compression, C_α	0.02	Marsh	(Cα expressed by change in strain per log cycle of time)
Coefficient of Secondary Compression, C_α	0.00	N/A	(Cα expressed by change in strain per log cycle of time)
Est. Time to End of Primary Consolidation, t_p	0.5	Years	
Secondary Compression Design Time, t_{sec}	30.0	Years	1.8 No. of log cycles
Method from NAVFAC DM 7.1-231:	$H_{sec} = C\alpha * H_t * \log (t_{sec}/t_p)$		Where: H_{sec} = Secondary compression; H_t = Thickness of soil stratum
Est. Secondary Compression (inches):	3.3	Marsh	
Est. Secondary Compression (inches):	0.0	N/A	

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-05**	
Existing Grade:	11.3	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	8.8	feet bgs
Tot./Eff. Stress @ GWT =	1006.3	psf

Analysis Point/Location:	**GB-05**	
Proposed Grade:	15.00	feet
Grade Change:	3.8	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	468.8	psf
Δ Stress (Bldg. Loading):	0.0	psf

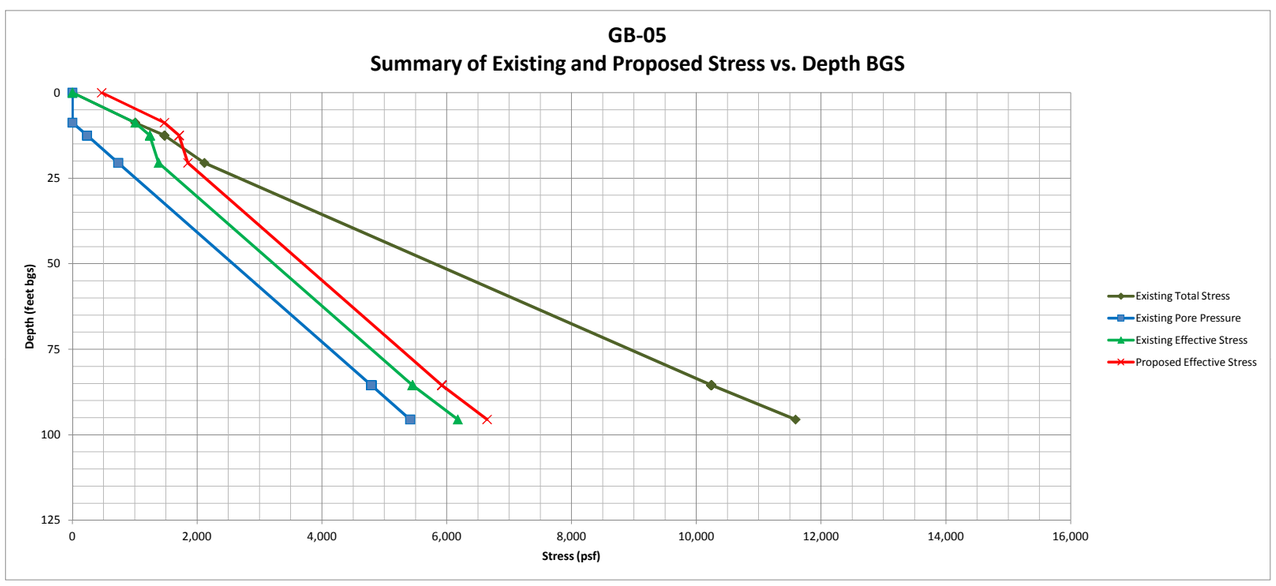
Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
Stratum	Top	Bottom		γ_t or γ_{sat}	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle
	(ft bgs)	(ft bgs)	(ft)	(pcf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)
		0.0	0.0			0.0			0.0			0.0			468.8	
F-Unsat	0.0	8.8	8.8	115	0.0	1006.3	503.1	0.0	0.0	0.0	0.0	1006.3	503.1	468.8	1475.0	971.9
F-Satur	8.8	12.5	3.8	125	1006.3	1475.0	1240.6	0.0	234.0	117.0	1006.3	1241.0	1123.6	1475.0	1709.8	1592.4
-	12.5	12.5	0.0	110	1475.0	1475.0	1475.0	234.0	234.0	234.0	1241.0	1241.0	1241.0	1709.8	1709.8	1709.8
-	12.5	12.5	0.0	120	1475.0	1475.0	1475.0	234.0	234.0	234.0	1241.0	1241.0	1241.0	1709.8	1709.8	1709.8
Marsh	12.5	20.5	8.0	80	1475.0	2115.0	1795.0	234.0	733.2	483.6	1241.0	1381.8	1311.4	1709.8	1850.6	1780.2
Fluvial	20.5	85.5	65.0	125	2115.0	10240.0	6177.5	733.2	4789.2	2761.2	1381.8	5450.8	3416.3	1850.6	5919.6	3885.1
-	85.5	85.5	0.0	125	10240.0	10240.0	10240.0	4789.2	4789.2	4789.2	5450.8	5450.8	5450.8	5919.6	5919.6	5919.6
-	85.5	85.5	0.0	120	10240.0	10240.0	10240.0	4789.2	4789.2	4789.2	5450.8	5450.8	5450.8	5919.6	5919.6	5919.6
-	85.5	85.5	0.0	125	10240.0	10240.0	10240.0	4789.2	4789.2	4789.2	5450.8	5450.8	5450.8	5919.6	5919.6	5919.6
-	85.5	85.5	0.0	120	10240.0	10240.0	10240.0	4789.2	4789.2	4789.2	5450.8	5450.8	5450.8	5919.6	5919.6	5919.6
-	85.5	85.5	0.0	125	10240.0	10240.0	10240.0	4789.2	4789.2	4789.2	5450.8	5450.8	5450.8	5919.6	5919.6	5919.6
-	85.5	85.5	0.0	120	10240.0	10240.0	10240.0	4789.2	4789.2	4789.2	5450.8	5450.8	5450.8	5919.6	5919.6	5919.6
-	85.5	85.5	0.0	125	10240.0	10240.0	10240.0	4789.2	4789.2	4789.2	5450.8	5450.8	5450.8	5919.6	5919.6	5919.6
-	85.5	85.5	0.0	120	10240.0	10240.0	10240.0	4789.2	4789.2	4789.2	5450.8	5450.8	5450.8	5919.6	5919.6	5919.6
Till	85.5	95.5	10.0	135	10240.0	11590.0	10915.0	4789.2	5413.2	5101.2	5450.8	6176.8	5813.8	5919.6	6645.6	6282.6

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date:	TCC	06-2013
Checked By/Date:	NDL	06-2013



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-05**	
Proposed Grade:	15.0	feet
Grade Change:	3.8	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	468.8	psf
Δ Stress (Bldg. Loading):	0.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(Due to Proposed Grade Change) (inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	0.90	-	-	-
F-Satur	1.0	0.03	-	-	0.20	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.35	0.07	0.20	2.33	4.0	0.848	67.8
Fluvial	2.0	0.02	0.01	10.00	0.22	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					3.65			

Estimated Settlement @ 90% Consolidation
(inches)
3.29

Days	**67.8**
Months	**2.2**
Years	**0.2**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 8.0 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 4.0 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**67.8**
Months	**2.2**
Years	**0.2**

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-06	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	8.25	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	5.75	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	13.00	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	0.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	6.7	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	6.0	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	2.5	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	5.3	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-06	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	17.00	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	8.8	-
Surcharge Height above Prop. Grade (ft):	4.0	-
Resultant Time to Consolidation:	2.6	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change + one log cycle of secondary comp.
@ % Surcharge Consolidation:	91%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	OKAY	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-06	-	
Surcharge Area/Point No:	-	-	
Coefficient of Secondary Compression, C_α	0.02	Marsh	(Cα expressed by change in strain per log cycle of time)
Coefficient of Secondary Compression, C_α	0.00	N/A	(Cα expressed by change in strain per log cycle of time)
Est. Time to End of Primary Consolidation, t_p	0.5	Years	
Secondary Compression Design Time, t_{sec}	30.0	Years	1.8 No. of log cycles
Method from NAVFAC DM 7.1-231:	$H_{sec} = C\alpha * H_t * \log (t_{sec}/t_p)$		Where: H_{sec} = Secondary compression; H_t = Thickness of soil stratum
Est. Secondary Compression (inches):	3.4	Marsh	
Est. Secondary Compression (inches):	0.0	N/A	

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-06**	
Existing Grade:	8.3	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	5.8	feet bgs
Tot./Eff. Stress @ GWT =	661.3	psf

Analysis Point/Location:	**GB-06**	
Proposed Grade:	13.00	feet
Grade Change:	4.8	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	593.8	psf
Δ Stress (Bldg. Loading):	0.0	psf

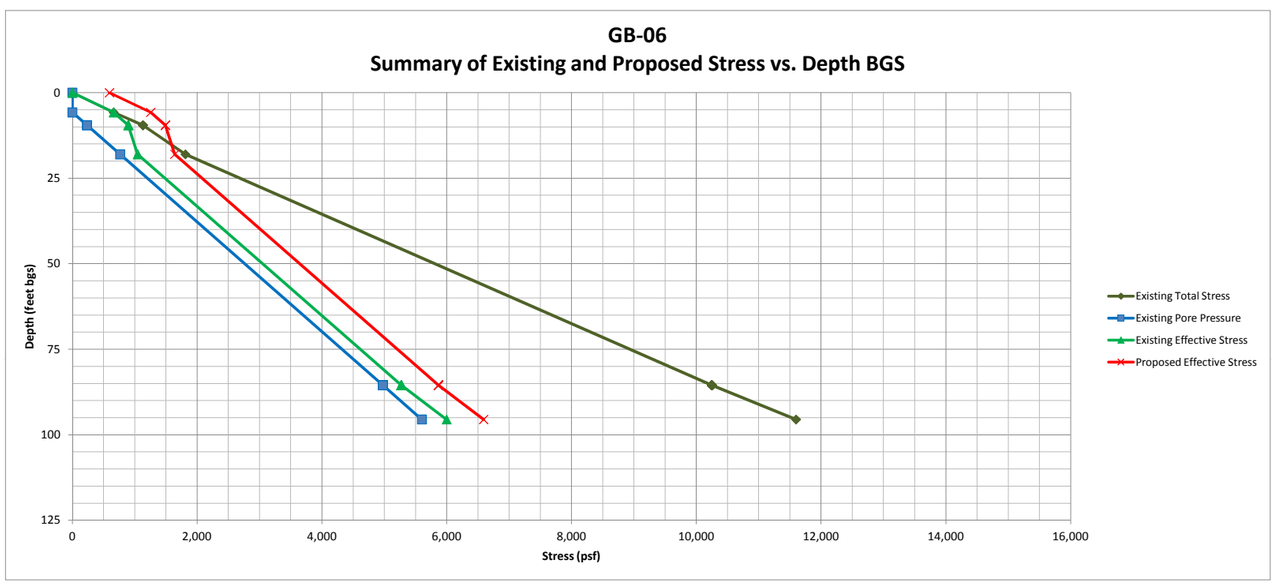
Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
Stratum	Top	Bottom		γ_t or γ_{sat}	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle
	(ft bgs)	(ft bgs)	(ft)	(pcf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)
		0.0	0.0			0.0			0.0			0.0			593.8	
F-Unsat	0.0	5.8	5.8	115	0.0	661.3	330.6	0.0	0.0	0.0	0.0	661.3	330.6	593.8	1255.0	924.4
F-Satur	5.8	9.5	3.8	125	661.3	1130.0	895.6	0.0	234.0	117.0	661.3	896.0	778.6	1255.0	1489.8	1372.4
-	9.5	9.5	0.0	110	1130.0	1130.0	1130.0	234.0	234.0	234.0	896.0	896.0	896.0	1489.8	1489.8	1489.8
-	9.5	9.5	0.0	120	1130.0	1130.0	1130.0	234.0	234.0	234.0	896.0	896.0	896.0	1489.8	1489.8	1489.8
Marsh	9.5	18.0	8.5	80	1130.0	1810.0	1470.0	234.0	764.4	499.2	896.0	1045.6	970.8	1489.8	1639.4	1564.6
Fluvial	18.0	85.5	67.5	125	1810.0	10247.5	6028.8	764.4	4976.4	2870.4	1045.6	5271.1	3158.4	1639.4	5864.9	3752.1
-	85.5	85.5	0.0	125	10247.5	10247.5	10247.5	4976.4	4976.4	4976.4	5271.1	5271.1	5271.1	5864.9	5864.9	5864.9
-	85.5	85.5	0.0	120	10247.5	10247.5	10247.5	4976.4	4976.4	4976.4	5271.1	5271.1	5271.1	5864.9	5864.9	5864.9
-	85.5	85.5	0.0	125	10247.5	10247.5	10247.5	4976.4	4976.4	4976.4	5271.1	5271.1	5271.1	5864.9	5864.9	5864.9
-	85.5	85.5	0.0	120	10247.5	10247.5	10247.5	4976.4	4976.4	4976.4	5271.1	5271.1	5271.1	5864.9	5864.9	5864.9
-	85.5	85.5	0.0	125	10247.5	10247.5	10247.5	4976.4	4976.4	4976.4	5271.1	5271.1	5271.1	5864.9	5864.9	5864.9
-	85.5	85.5	0.0	120	10247.5	10247.5	10247.5	4976.4	4976.4	4976.4	5271.1	5271.1	5271.1	5864.9	5864.9	5864.9
-	85.5	85.5	0.0	125	10247.5	10247.5	10247.5	4976.4	4976.4	4976.4	5271.1	5271.1	5271.1	5864.9	5864.9	5864.9
-	85.5	85.5	0.0	120	10247.5	10247.5	10247.5	4976.4	4976.4	4976.4	5271.1	5271.1	5271.1	5864.9	5864.9	5864.9
Till	85.5	95.5	10.0	135	10247.5	11597.5	10922.5	4976.4	5600.4	5288.4	5271.1	5997.1	5634.1	5864.9	6590.9	6227.9

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date:	TCC	06-2013
Checked By/Date:	NDL	06-2013



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-06**	
Proposed Grade:	13.0	feet
Grade Change:	4.8	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	593.8	psf
Δ Stress (Bldg. Loading):	0.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(Due to Proposed Grade Change) (inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	0.92	-	-	-
F-Satur	1.0	0.03	-	-	0.33	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.35	0.07	0.20	5.14	4.3	0.848	76.6
Fluvial	2.0	0.02	0.01	10.00	0.30	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					6.70			

Estimated Settlement @ 90% Consolidation
(inches)
6.03

Days	**76.6**
Months	**2.5**
Years	**0.2**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 8.5 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 4.3 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**76.6**
Months	**2.5**
Years	**0.2**

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-07	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	7.25	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	4.25	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	13.25	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	0.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	9.7	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	8.7	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	5.0	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	10.5	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-07	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	17.50	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	10.3	-
Surcharge Height above Prop. Grade (ft):	4.3	-
Resultant Time to Consolidation:	5.1	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change + one log cycle of secondary comp.
@ % Surcharge Consolidation:	90%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	OKAY	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-07	-	
Surcharge Area/Point No:	-	-	
Coefficient of Secondary Compression, C_{α}	0.02	Marsh	(Cα expressed by change in strain per log cycle of time)
Coefficient of Secondary Compression, C_{α}	0.00	N/A	(Cα expressed by change in strain per log cycle of time)
Est. Time to End of Primary Consolidation, t_p	1.0	Years	
Secondary Compression Design Time, t_{sec}	30.0	Years	1.5 No. of log cycles
Method from NAVFAC DM 7.1-231:	$H_{sec} = C\alpha * H_t * \log (t_{sec}/t_p)$		Where: H_{sec} = Secondary compression; H_t = Thickness of soil stratum
Est. Secondary Compression (inches):	4.0	Marsh	
Est. Secondary Compression (inches):	0.0	N/A	

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-07**	
Existing Grade:	7.3	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	4.3	feet bgs
Tot./Eff. Stress @ GWT =	488.8	psf

Analysis Point/Location:	**GB-07**	
Proposed Grade:	13.25	feet
Grade Change:	6.0	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	750.0	psf
Δ Stress (Bldg. Loading):	0.0	psf

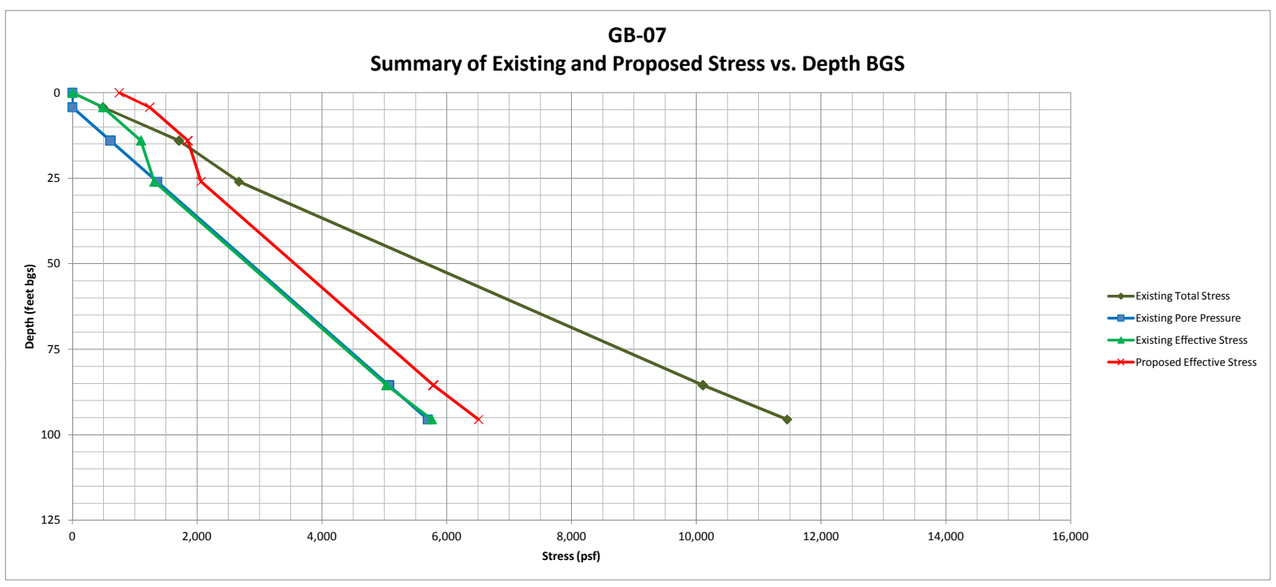
Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
Stratum	Top	Bottom		γ_t or γ_{sat}	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle
	(ft bgs)	(ft bgs)	(ft)	(pcf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)
		0.0	0.0			0.0			0.0			0.0			750.0	
F-Unsat	0.0	4.3	4.3	115	0.0	488.8	244.4	0.0	0.0	0.0	0.0	488.8	244.4	750.0	1238.8	994.4
F-Satur	4.3	14.0	9.8	125	488.8	1707.5	1098.1	0.0	608.4	304.2	488.8	1099.1	793.9	1238.8	1849.1	1543.9
-	14.0	14.0	0.0	110	1707.5	1707.5	1707.5	608.4	608.4	608.4	1099.1	1099.1	1099.1	1849.1	1849.1	1849.1
-	14.0	14.0	0.0	120	1707.5	1707.5	1707.5	608.4	608.4	608.4	1099.1	1099.1	1099.1	1849.1	1849.1	1849.1
Marsh	14.0	26.0	12.0	80	1707.5	2667.5	2187.5	608.4	1357.2	982.8	1099.1	1310.3	1204.7	1849.1	2060.3	1954.7
Fluvial	26.0	85.5	59.5	125	2667.5	10105.0	6386.3	1357.2	5070.0	3213.6	1310.3	5035.0	3172.7	2060.3	5785.0	3922.7
-	85.5	85.5	0.0	125	10105.0	10105.0	10105.0	5070.0	5070.0	5070.0	5035.0	5035.0	5035.0	5785.0	5785.0	5785.0
-	85.5	85.5	0.0	120	10105.0	10105.0	10105.0	5070.0	5070.0	5070.0	5035.0	5035.0	5035.0	5785.0	5785.0	5785.0
-	85.5	85.5	0.0	125	10105.0	10105.0	10105.0	5070.0	5070.0	5070.0	5035.0	5035.0	5035.0	5785.0	5785.0	5785.0
-	85.5	85.5	0.0	120	10105.0	10105.0	10105.0	5070.0	5070.0	5070.0	5035.0	5035.0	5035.0	5785.0	5785.0	5785.0
-	85.5	85.5	0.0	125	10105.0	10105.0	10105.0	5070.0	5070.0	5070.0	5035.0	5035.0	5035.0	5785.0	5785.0	5785.0
-	85.5	85.5	0.0	120	10105.0	10105.0	10105.0	5070.0	5070.0	5070.0	5035.0	5035.0	5035.0	5785.0	5785.0	5785.0
-	85.5	85.5	0.0	125	10105.0	10105.0	10105.0	5070.0	5070.0	5070.0	5035.0	5035.0	5035.0	5785.0	5785.0	5785.0
-	85.5	85.5	0.0	120	10105.0	10105.0	10105.0	5070.0	5070.0	5070.0	5035.0	5035.0	5035.0	5785.0	5785.0	5785.0
Till	85.5	95.5	10.0	135	10105.0	11455.0	10780.0	5070.0	5694.0	5382.0	5035.0	5761.0	5398.0	5785.0	6511.0	6148.0

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date:	TCC	06-2013
Checked By/Date:	NDL	06-2013



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-07**	
Proposed Grade:	13.3	feet
Grade Change:	6.0	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	750.0	psf
Δ Stress (Bldg. Loading):	0.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(Due to Proposed Grade Change) (inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	0.93	-	-	-
F-Satur	1.0	0.03	-	-	1.01	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.35	0.07	0.20	7.40	6.0	0.848	152.6
Fluvial	2.0	0.02	0.01	10.00	0.33	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					9.68			

Estimated Settlement @ 90% Consolidation
(inches)
8.71

Days	**152.6**
Months	**5.0**
Years	**0.4**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 12.0 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 6.0 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**152.6**
Months	**5.0**
Years	**0.4**

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-08	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	8.00	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	5.50	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	12.00	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	0.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	7.1	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	6.4	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	7.8	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	16.5	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-08	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	16.50	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	8.5	-
Surcharge Height above Prop. Grade (ft):	4.5	-
Resultant Time to Consolidation:	4.5	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change + one log cycle of secondary comp.
@ % Surcharge Consolidation:	75%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	OKAY	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-08	-		
Surcharge Area/Point No:	-	-		
Coefficient of Secondary Compression, C_α	0.02	Marsh	(Cα expressed by change in strain per log cycle of time)	
Coefficient of Secondary Compression, C_α	0.00	N/A	(Cα expressed by change in strain per log cycle of time)	
Est. Time to End of Primary Consolidation, t_p	1.5	Years	1.3	No. of log cycles
Secondary Compression Design Time, t_{sec}	30.0	Years		
Method from NAVFAC DM 7.1-231:	$H_{sec} = C\alpha * H_t * \log (t_{sec}/t_p)$		Where:	H_{sec} = Secondary compression H_t = Thickness of soil stratum
Est. Secondary Compression (inches):	4.5	Marsh		
Est. Secondary Compression (inches):	0.0	N/A		

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-08**	
Existing Grade:	8.0	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	5.5	feet bgs
Tot./Eff. Stress @ GWT =	632.5	psf

Analysis Point/Location:	**GB-08**	
Proposed Grade:	12.00	feet
Grade Change:	4.0	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	500.0	psf
Δ Stress (Bldg. Loading):	0.0	psf

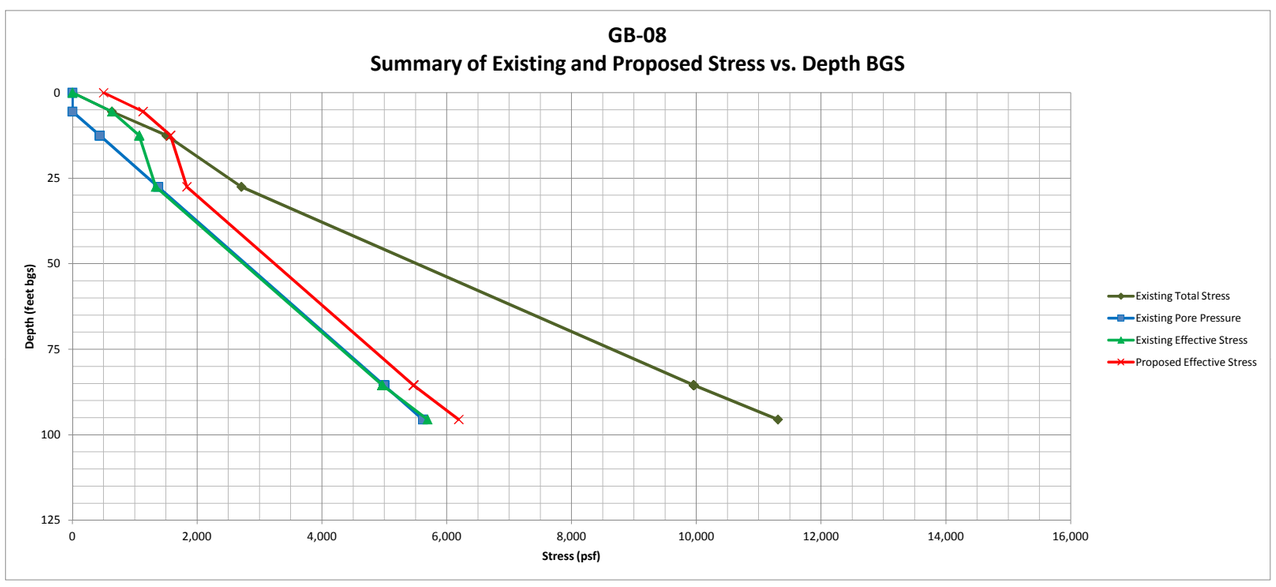
Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
Stratum	Top	Bottom		γ_t or γ_{sat}	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle
	(ft bgs)	(ft bgs)	(ft)	(pcf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)
		0.0	0.0			0.0			0.0			0.0			500.0	
F-Unsat	0.0	5.5	5.5	115	0.0	632.5	316.3	0.0	0.0	0.0	0.0	632.5	316.3	500.0	1132.5	816.3
F-Satur	5.5	12.5	7.0	125	632.5	1507.5	1070.0	0.0	436.8	218.4	632.5	1070.7	851.6	1132.5	1570.7	1351.6
-	12.5	12.5	0.0	110	1507.5	1507.5	1507.5	436.8	436.8	436.8	1070.7	1070.7	1070.7	1570.7	1570.7	1570.7
-	12.5	12.5	0.0	120	1507.5	1507.5	1507.5	436.8	436.8	436.8	1070.7	1070.7	1070.7	1570.7	1570.7	1570.7
Marsh	12.5	27.5	15.0	80	1507.5	2707.5	2107.5	436.8	1372.8	904.8	1070.7	1334.7	1202.7	1570.7	1834.7	1702.7
Fluvial	27.5	85.5	58.0	125	2707.5	9957.5	6332.5	1372.8	4992.0	3182.4	1334.7	4965.5	3150.1	1834.7	5465.5	3650.1
-	85.5	85.5	0.0	125	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5465.5	5465.5	5465.5
-	85.5	85.5	0.0	120	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5465.5	5465.5	5465.5
-	85.5	85.5	0.0	125	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5465.5	5465.5	5465.5
-	85.5	85.5	0.0	120	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5465.5	5465.5	5465.5
-	85.5	85.5	0.0	125	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5465.5	5465.5	5465.5
-	85.5	85.5	0.0	120	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5465.5	5465.5	5465.5
-	85.5	85.5	0.0	125	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5465.5	5465.5	5465.5
-	85.5	85.5	0.0	120	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5465.5	5465.5	5465.5
-	85.5	85.5	0.0	125	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5465.5	5465.5	5465.5
Till	85.5	95.5	10.0	135	9957.5	11307.5	10632.5	4992.0	5616.0	5304.0	4965.5	5691.5	5328.5	5465.5	6191.5	5828.5

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date:	TCC	06-2013
Checked By/Date:	NDL	06-2013



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-08**	
Proposed Grade:	12.0	feet
Grade Change:	4.0	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	500.0	psf
Δ Stress (Bldg. Loading):	0.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(Due to Proposed Grade Change) (inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	0.82	-	-	-
F-Satur	1.0	0.03	-	-	0.51	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.35	0.07	0.20	5.52	7.5	0.848	238.5
Fluvial	2.0	0.02	0.01	10.00	0.22	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					7.06			

Estimated Settlement @ 90% Consolidation
(inches)
6.36

Days	**238.5**
Months	**7.8**
Years	**0.7**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 15.0 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 7.5 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**238.5**
Months	**7.8**
Years	**0.7**

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-09	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	8.00	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	5.50	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	11.50	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	0.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	7.7	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	6.9	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	6.4	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	13.3	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-09	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	16.00	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	8.0	-
Surcharge Height above Prop. Grade (ft):	4.5	-
Resultant Time to Consolidation:	3.7	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change + one log cycle of secondary comp.
@ % Surcharge Consolidation:	76%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	OKAY	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-09	-	
Surcharge Area/Point No:	-	-	
Coefficient of Secondary Compression, C_{α}	0.02	Marsh	(Cα expressed by change in strain per log cycle of time)
Coefficient of Secondary Compression, C_{α}	0.00	N/A	(Cα expressed by change in strain per log cycle of time)
Est. Time to End of Primary Consolidation, t_p	1.0	Years	
Secondary Compression Design Time, t_{sec}	30.0	Years	1.5 No. of log cycles
Method from NAVFAC DM 7.1-231:	$H_{sec} = C\alpha * H_t * \log (t_{sec}/t_p)$		Where: H_{sec} = Secondary compression; H_t = Thickness of soil stratum
Est. Secondary Compression (inches):	4.6	Marsh	
Est. Secondary Compression (inches):	0.0	N/A	

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-09**	
Existing Grade:	8.0	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	5.5	feet bgs
Tot./Eff. Stress @ GWT =	632.5	psf

Analysis Point/Location:	**GB-09**	
Proposed Grade:	11.50	feet
Grade Change:	3.5	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	437.5	psf
Δ Stress (Bldg. Loading):	0.0	psf

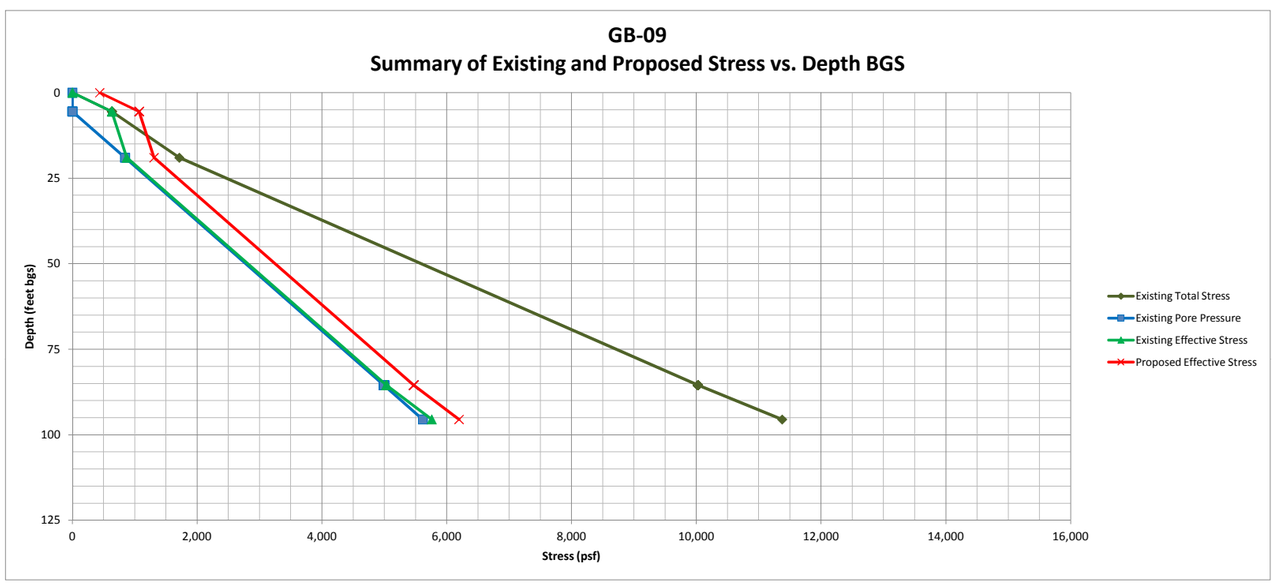
Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
Stratum	Top	Bottom		γ_t or γ_{sat}	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle
	(ft bgs)	(ft bgs)	(ft)	(pcf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)
		0.0	0.0			0.0			0.0			0.0			437.5	
F-Unsat	0.0	5.5	5.5	115	0.0	632.5	316.3	0.0	0.0	0.0	0.0	632.5	316.3	437.5	1070.0	753.8
F-Satur	5.5	5.5	0.0	125	632.5	632.5	632.5	0.0	0.0	0.0	632.5	632.5	632.5	1070.0	1070.0	1070.0
-	5.5	5.5	0.0	110	632.5	632.5	632.5	0.0	0.0	0.0	632.5	632.5	632.5	1070.0	1070.0	1070.0
-	5.5	5.5	0.0	120	632.5	632.5	632.5	0.0	0.0	0.0	632.5	632.5	632.5	1070.0	1070.0	1070.0
Marsh	5.5	19.0	13.5	80	632.5	1712.5	1172.5	0.0	842.4	421.2	632.5	870.1	751.3	1070.0	1307.6	1188.8
Fluvial	19.0	85.5	66.5	125	1712.5	10025.0	5868.8	842.4	4992.0	2917.2	870.1	5033.0	2951.6	1307.6	5470.5	3389.1
-	85.5	85.5	0.0	125	10025.0	10025.0	10025.0	4992.0	4992.0	4992.0	5033.0	5033.0	5033.0	5470.5	5470.5	5470.5
-	85.5	85.5	0.0	120	10025.0	10025.0	10025.0	4992.0	4992.0	4992.0	5033.0	5033.0	5033.0	5470.5	5470.5	5470.5
-	85.5	85.5	0.0	125	10025.0	10025.0	10025.0	4992.0	4992.0	4992.0	5033.0	5033.0	5033.0	5470.5	5470.5	5470.5
-	85.5	85.5	0.0	120	10025.0	10025.0	10025.0	4992.0	4992.0	4992.0	5033.0	5033.0	5033.0	5470.5	5470.5	5470.5
-	85.5	85.5	0.0	125	10025.0	10025.0	10025.0	4992.0	4992.0	4992.0	5033.0	5033.0	5033.0	5470.5	5470.5	5470.5
-	85.5	85.5	0.0	120	10025.0	10025.0	10025.0	4992.0	4992.0	4992.0	5033.0	5033.0	5033.0	5470.5	5470.5	5470.5
-	85.5	85.5	0.0	125	10025.0	10025.0	10025.0	4992.0	4992.0	4992.0	5033.0	5033.0	5033.0	5470.5	5470.5	5470.5
-	85.5	85.5	0.0	120	10025.0	10025.0	10025.0	4992.0	4992.0	4992.0	5033.0	5033.0	5033.0	5470.5	5470.5	5470.5
Till	85.5	95.5	10.0	135	10025.0	11375.0	10700.0	4992.0	5616.0	5304.0	5033.0	5759.0	5396.0	5470.5	6196.5	5833.5

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date:	TCC	06-2013
Checked By/Date:	NDL	06-2013



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-09**	
Proposed Grade:	11.5	feet
Grade Change:	3.5	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	437.5	psf
Δ Stress (Bldg. Loading):	0.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(Due to Proposed Grade Change) (inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	0.75	-	-	-
F-Satur	1.0	0.03	-	-	0.00	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.30	0.07	0.20	6.74	6.8	0.848	193.2
Fluvial	2.0	0.02	0.01	10.00	0.24	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					7.72			

Estimated Settlement @ 90% Consolidation
(inches)
6.95

Days	**193.2**
Months	**6.4**
Years	**0.5**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 13.5 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 6.8 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**193.2**
Months	**6.4**
Years	**0.5**

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-10	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	10.75	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	8.25	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	13.00	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	0.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	1.5	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	1.4	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	2.7	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	5.6	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-10	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	17.50	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	6.5	-
Surcharge Height above Prop. Grade (ft):	4.5	-
Resultant Time to Consolidation:	3.3	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change + one log cycle of secondary comp.
@ % Surcharge Consolidation:	94%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	OKAY	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-10	-	
Surcharge Area/Point No:	-	-	
Coefficient of Secondary Compression, C_α	0.02	Marsh	(Cα expressed by change in strain per log cycle of time)
Coefficient of Secondary Compression, C_α	0.00	N/A	(Cα expressed by change in strain per log cycle of time)
Est. Time to End of Primary Consolidation, t_p	0.5	Years	
Secondary Compression Design Time, t_{sec}	30.0	Years	1.8 No. of log cycles

Method from NAVFAC DM 7.1-231: $H_{sec} = C\alpha * H_t * \log (t_{sec}/t_p)$

Where: H_{sec} = Secondary compression
H_t = Thickness of soil stratum

Est. Secondary Compression (inches):	3.7	Marsh
Est. Secondary Compression (inches):	0.0	N/A

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-10**	
Existing Grade:	10.8	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	8.3	feet bgs
Tot./Eff. Stress @ GWT =	948.8	psf

Analysis Point/Location:	**GB-10**	
Proposed Grade:	13.00	feet
Grade Change:	2.3	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	281.3	psf
Δ Stress (Bldg. Loading):	0.0	psf

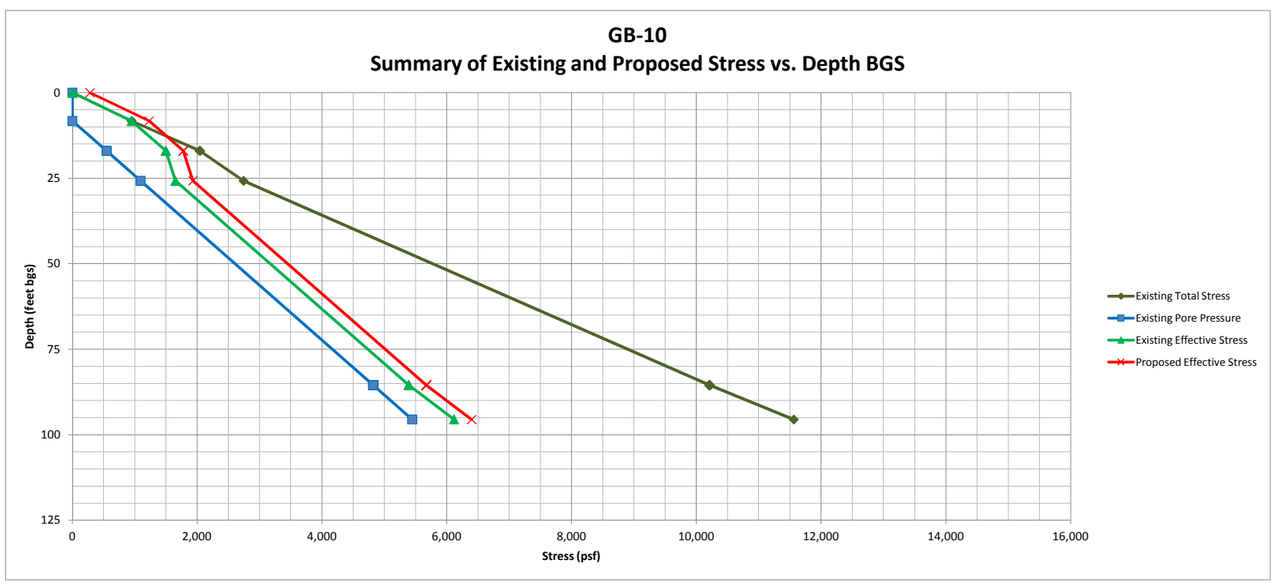
Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
Stratum	Top	Bottom		γ_t or γ_{sat}	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle
	(ft bgs)	(ft bgs)	(ft)	(pcf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)
		0.0	0.0			0.0			0.0			0.0			281.3	
F-Unsat	0.0	8.3	8.3	115	0.0	948.8	474.4	0.0	0.0	0.0	0.0	948.8	474.4	281.3	1230.0	755.6
F-Satur	8.3	17.0	8.8	125	948.8	2042.5	1495.6	0.0	546.0	273.0	948.8	1496.5	1222.6	1230.0	1777.8	1503.9
-	17.0	17.0	0.0	110	2042.5	2042.5	2042.5	546.0	546.0	546.0	1496.5	1496.5	1496.5	1777.8	1777.8	1777.8
-	17.0	17.0	0.0	120	2042.5	2042.5	2042.5	546.0	546.0	546.0	1496.5	1496.5	1496.5	1777.8	1777.8	1777.8
Marsh	17.0	25.8	8.8	80	2042.5	2742.5	2392.5	546.0	1092.0	819.0	1496.5	1650.5	1573.5	1777.8	1931.8	1854.8
Fluvial	25.8	85.5	59.8	125	2742.5	10211.3	6476.9	1092.0	4820.4	2956.2	1650.5	5390.9	3520.7	1931.8	5672.1	3801.9
-	85.5	85.5	0.0	125	10211.3	10211.3	10211.3	4820.4	4820.4	4820.4	5390.9	5390.9	5390.9	5672.1	5672.1	5672.1
-	85.5	85.5	0.0	120	10211.3	10211.3	10211.3	4820.4	4820.4	4820.4	5390.9	5390.9	5390.9	5672.1	5672.1	5672.1
-	85.5	85.5	0.0	125	10211.3	10211.3	10211.3	4820.4	4820.4	4820.4	5390.9	5390.9	5390.9	5672.1	5672.1	5672.1
-	85.5	85.5	0.0	120	10211.3	10211.3	10211.3	4820.4	4820.4	4820.4	5390.9	5390.9	5390.9	5672.1	5672.1	5672.1
-	85.5	85.5	0.0	125	10211.3	10211.3	10211.3	4820.4	4820.4	4820.4	5390.9	5390.9	5390.9	5672.1	5672.1	5672.1
-	85.5	85.5	0.0	120	10211.3	10211.3	10211.3	4820.4	4820.4	4820.4	5390.9	5390.9	5390.9	5672.1	5672.1	5672.1
-	85.5	85.5	0.0	125	10211.3	10211.3	10211.3	4820.4	4820.4	4820.4	5390.9	5390.9	5390.9	5672.1	5672.1	5672.1
-	85.5	85.5	0.0	120	10211.3	10211.3	10211.3	4820.4	4820.4	4820.4	5390.9	5390.9	5390.9	5672.1	5672.1	5672.1
-	85.5	85.5	0.0	125	10211.3	10211.3	10211.3	4820.4	4820.4	4820.4	5390.9	5390.9	5390.9	5672.1	5672.1	5672.1
-	85.5	85.5	0.0	120	10211.3	10211.3	10211.3	4820.4	4820.4	4820.4	5390.9	5390.9	5390.9	5672.1	5672.1	5672.1
Till	85.5	95.5	10.0	135	10211.3	11561.3	10886.3	4820.4	5444.4	5132.4	5390.9	6116.9	5753.9	5672.1	6398.1	6035.1

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date:	TCC	06-2013
Checked By/Date:	NDL	06-2013



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-10**	
Proposed Grade:	13.0	feet
Grade Change:	2.3	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	281.3	psf
Δ Stress (Bldg. Loading):	0.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(Due to Proposed Grade Change) (inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	0.60	-	-	-
F-Satur	1.0	0.03	-	-	0.28	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.35	0.07	0.20	0.52	4.4	0.848	81.2
Fluvial	2.0	0.02	0.01	10.00	0.12	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					1.53			

Estimated Settlement @ 90% Consolidation
(inches)
1.38

Days	**81.2**
Months	**2.7**
Years	**0.2**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 8.8 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 4.4 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**81.2**
Months	**2.7**
Years	**0.2**

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SETTLEMENT EVALUATION

Sample Calculations ("Hand-calc"/verification of Spreadsheet Calculator)

1. Select Settlement evaluation assessment point at an existing geotechnical boring.
   a. For this Sample Calculation, let's use GB-01
   b. Existing and proposed Conditions at GB-01.
      - Existing grade = 10.25 ft
      - Proposed grade = 13.75 ft
2. Establish Subsurface profile and groundwater Conditions
   a. Based on GB-01, the Subsurface profile is Summarized as follows:

Depth (ft bgs)	Stratum	
0 – 12.5	FILL (F)	→ γ_t = 115 pcf (above GWT), γ_t = 125 pcf (below GWT)
12.5 – 25.5	MARSH (M)	→ γ_t = 80 pcf
25.5 – 85.5	FLUVIAL (FL)	→ γ_t = 125 pcf
85.5 – 95.5	TILL (T)	→ γ_t = 135 pcf

   b. Groundwater depth is approximately 7.75 ft bgs (assume hydrostatic)
3. Calculate in-situ (existing) and proposed stress vs. depth
   - $\sigma'_{vo} = (\sigma_{vo} - u_o)$ Where: σ'_{vo} = Effective stress (psf); σ_{vo} = Total Stress (psf); u_o = Pore pressure (psf)
   - $\sigma_{vo} = \gamma_t D$ Where: γ_t = Total unit weight (pcf); D = Depth (ft)
   - $u_o = \gamma_w D$ Where: γ_w = Unit Weight of Water (62.4 pcf)

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3. Calculate in-situ and proposed Stress vs. depth - Continued

a. Calculate existing Stress at Top, Middle, and Bottom of each Stratum

- Fill(unsat) - Top ⇒ 115 x 0 = 0 psf
- Fill(unsat) - Mid ⇒ 115 x 3.875 = 445.6 psf
- Fill(unsat) - Bot ⇒ 115 x 7.75 = 891.3 psf

- Fill(sat) - Top ⇒ 115 x 7.75 = Fill(unsat)-Bot = 891.3 psf
- Fill(sat) - Mid ⇒ 891.3 + (125-62.4)(2.375) = 1039.9 psf
- Fill(sat) - Bot ⇒ 891.3 + (125-62.4)(4.75) = 1188.6 psf

- Marsh - Top ⇒ 1188.6 psf
- Marsh - Mid ⇒ 1188.6 + (80-62.4)(6.5) = 1303 psf
- Marsh - Bot ⇒ 1188.6 + (80-62.4)(13) = 1417.4 psf

- Fluvial - Top ⇒ 1417.4 psf
- Fluvial - Mid ⇒ 1417.4 + (125-62.4)(30) = 3295.4 psf
- Fluvial - Bot ⇒ 1417.4 + (125-62.4)(60) = 5173.4 psf

- Till - Top ⇒ 5173.4 psf
- Till - Mid ⇒ 5173.4 + (135-62.4)(5) = 5536.4 psf
- Till - Bot ⇒ 5173.4 + (135-62.4)(10) = 5899.4 psf

b. Calculate proposed stress at Top, Middle, and Bottom of each stratum

- Assume Subgrade and/or proposed grading fill $\gamma_t = 125$ pcf
- Proposed grade increase, 10.25 ft → 13.75 ft ⇒ 3.5 ft
- Proposed Stress increase due to proposed grading

$$\Rightarrow \Delta\sigma'_v = 125 \times 3.5 = 437.5 \text{ psf}$$

c. Summary of stresses at Midpoint of each stratum

Stratum	In-Situ (psf)	Proposed (psf)
Fill (unsat)	445.6	883.1
Fill (sat)	1039.9	1477.4
Marsh	1303.0	1740.5
Fluvial	3295.4	3732.9
Till	5536.4	5973.9

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4. Estimate primary Consolidation settlement due to proposed grading

(1) • $S_{pc} = C_{cE} H_o \log\left[\frac{\sigma'_{vo} + \Delta\sigma'_v}{\sigma'_{vo}}\right]$ for normally consolidated (NC) clay ($\sigma'_{vo} = \sigma'_p$)
σ'_p = Maximum past pressure

(2) • $S_{pc} = C_{rE} H_o \log\left[\frac{\sigma'_{vo} + \Delta\sigma'_v}{\sigma'_{vo}}\right]$ for overconsolidated clay (OC) ($\sigma'_{vo} < \sigma'_p$)
Where $\sigma'_{vo} + \Delta\sigma'_v < \sigma'_p$

(3) • $S_{pc} = C_{rE} H_o \log\left[\frac{\sigma'_p}{\sigma'_{vo}}\right] + C_{cE} H_o \log\left[\frac{\sigma'_{vo} + \Delta\sigma'_v}{\sigma'_p}\right]$ for OC clay where $\sigma'_{vo} < \sigma'_p < \sigma'_{vo} + \Delta\sigma'_v$

- Where: S_{pc} = Primary Consolidation Settlement
  C_{cE} = Modified virgin Compression Index ($C_c/1+e_o$)
  H_o = Initial layer thickness
  C_{rE} = Modified recompression Index ($C_r/1+e_o$)

a. Estimate primary settlement for each Compressible Stratum at GB-01

• Fill
- Assume NC
- Assume virgin Compression, $C_{cE} = 0.03$ → From NAVFAC w/ $C_c \cong 0.05 + 0.06$ for loose sands and $e_o \cong 1.0$.
- Assume equation (1) above

$$S_{pc(Fill\text{-}unSat)} = (0.03)(7.75)\log\left[\frac{445.6 + 437.5}{445.6}\right] = 0.069' = \underline{\underline{0.83''}}$$

$$S_{pc(Fill\text{-}Sat)} = (0.03)(4.75)\log\left[\frac{1039.9 + 437.5}{1039.9}\right] = 0.022' = \underline{\underline{0.26''}}$$

• Marsh
- Assume slightly OC ($OCR = 1.2$) ⇒ $\sigma'_{vo} = 1303$ psf, so $\sigma'_p = 1563.6$ psf
- $\sigma'_{vo} < \sigma'_p < \sigma'_{vo} + \Delta\sigma'_v = 1303 < 1563.6 < 1740.5$
- Use equation (3) above; $C_{rE} = 0.07$, $C_{cE} = 0.35$

$$S_{pc} = (0.07)(13)\log\left[\frac{1563.6}{1303}\right] + (0.35)(13)\log\left[\frac{1303 + 437.5}{1563.6}\right] = 0.28' = \underline{\underline{3.4''}}$$

• Fluvial
- Assume OC ($OCR = 2$) ⇒ $\sigma'_{vo} = 3295.4$, $\sigma'_p = 6590.8$
- Assume recompression, $3732.9 < 6590.8$
- Use equation (2), $C_{rE} = 0.005$

$$S_{pc} = (0.005)(60)\log\left[\frac{3295.4 + 437.5}{3295.4}\right] = 0.016' = \underline{\underline{0.19''}}$$

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4. Estimate primary settlement - Continued

a. Estimate primary settlement for each stratum - Continued

- Till
  - Assume incompressible

b. Total estimated primary consolidation settlement = $S_{pc\ proposed}$ = 4.68"

5. Estimate secondary compression following final grading

a. Organic soils can be susceptible to measurable amounts of secondary compression. The Marsh Deposit is of primary concern.

- $S_s = C_{\alpha\varepsilon} H_o \Delta \log(t)$ Where: S_s = Secondary Compression settlement
  $C_{\alpha\varepsilon}$ = Modified secondary Compression Ratio $\left(C_{\alpha\varepsilon} = \frac{C_\alpha'}{1+e_o}\right)$
  $\Delta \log_{10} t$ = Change in log time from end of primary to end of structure design life.

b. Estimate secondary compression for Marsh Deposit at GB-01. Assume 1 year primary consolidation period and 30-year design life.

- $S_s = (0.02)(13 - 0.28) \log_{10}\left(30/1\right) = 0.376' = 4.51''$

6. Estimate time rate of primary consolidation

a. Estimate time required to achieve 90% of the estimated primary consolidation settlement. Apply Terzaghi theory.

- $t = \frac{T H_{dr}^2}{C_v}$ where: t = time since load application
  T = Time factor = 0.848 for 90%
  H_{dr} = Height of drainage path
  C_v = Coefficient of consolidation
  - Assume Marsh deposit controls (settlement in other strata occur instantaneously)
  - Assume double drainage

- $t = \frac{(0.848)(13/2)^2}{0.20\ ft^2/day} = 179.1$ days = 5.9 months

b. Estimate time required to achieve 99% of primary consolidation. (T = 1.781)

- $t = \frac{(1.781)(13/2)^2}{0.20\ ft^2/day} = 376.2$ days = 12.4 months.

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RAYMARK COVER SLOPES

- **Purpose**
  - Determine the cover slopes (at 4 cross sections) after settlement due to proposed final grades has occurred
    1. After Primary Consolidation
    2. After Primary + Secondary Consolidation
  - Slopes were designed at 4.5%. Slopes must have 4% inclination after settlement occurs.

- **Approach/Methodology**
  - Assess settlement due to proposed final grades at 3 locations (at least) along each cross section.
  - Utilize subsurface conditions presented/used in Settlement Evaluation Tech Memo, dated 7/12/13.

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- Section 1 - STA. 0+00 to 3+51

  - STA. 0+54
    - Nearby Boring : GB-08
    - Existing Grade : ~+7.25'
    - Final Grade : +11.00' (~3.8' Fill)
    - Marsh EL : -4.0' to -19.0' (15' Thick)
    - GWT EL : +2.5'

      - S_p = 7.1"
      - S_s = 4.7"

      S_T = 11.8"

  - STA. 1+50 (Peak)
    - Composite Subsurface Profile :
      - Use average of 3 X-sects → GB-07 / GB-01
        → GB-08 / GB-03
        → GB-08 / GB-9

      - GB-07 Marsh EL → -6.7' to -18.7' ⇒ -4.5' to -17.0'
      - GB-01 Marsh EL → -2.2' to -15.2' Avg (12.5' Thick)

      - GB-08 Marsh EL → -4.6' to -19.6' ⇒ -1.0' to -17.25'
      - GB-03 Marsh EL → +2.5' to -15.0' Avg (16.25' Thick)

      - GB-08 Marsh EL → -4.6' to -19.6' ⇒ -1.0' to -15.25'
      - GB-09 Marsh EL → +2.5' to -11.0' Avg (14.25' Thick)

      AVG ↳ -2.0' to -16.5' (14.5' Thick)

    - Existing Grade : ~+8.75'
    - Final Grade : +15.33 (~6.4' fill)
    - GWT EL : +2.5'
    - Consolidation Properties Same as GB-08

      - S_p = 12.6"
      - S_s = 4.5"

      S_T = 17.1"

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- Section 1 - continued

  - STA. 2+48
    - Composite Subsurface Profile:
      - Use average of 1 X-sect + GB-02 → GB-07/GB-09
        → GB-02

      - GB-07 Marsh EL → -6.7' to -18.7'
      - GB-09 Marsh EL → +2.5' to -11.0'
      AVG → -2.0' to -15' (13' thick)

      - GB-02 Marsh EL → +0.2' to -10.7' (10.5')
      AVG → -1.0' to -13.0' (12' thick)

    - Existing Grade: ~+7.0'
    - Final Grade: +11.0' (~4.1' fill)
    - GWT EL: +2.5'
    - Consol Properties: GB-07 and GB-09

① GB-07

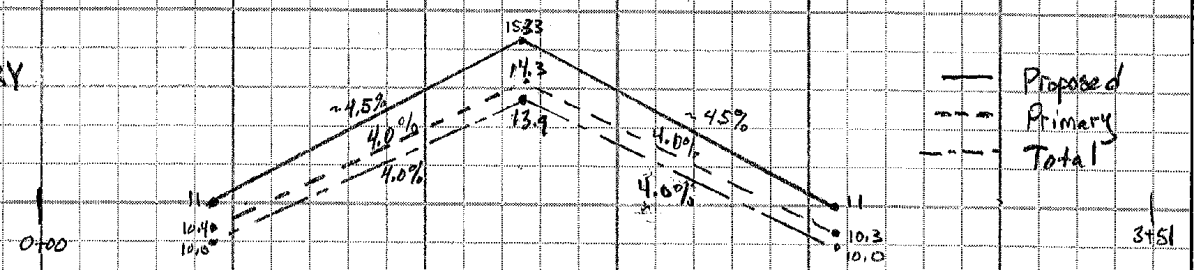
• S_p	=	8.3"
• S_s	=	4.2"
S_T	=	12.5"

② GB-09

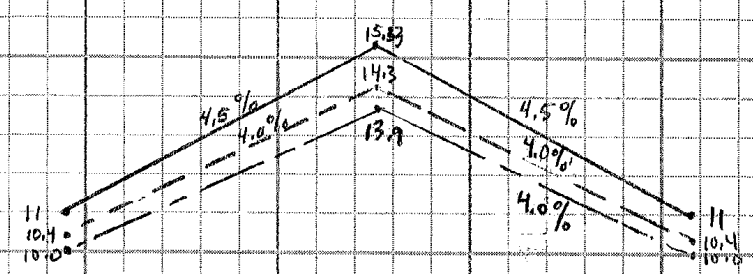
• S_p	=	7.5"
• S_s	=	4.2"
S_T	=	11.7"

- SUMMARY

①



②



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- Section 2 - STA. 10+00 to 13+49

- STA. 10+25
  - Nearby Boring : GB-01
  - Existing Grade : +8.5'
  - Final Grade : +11.0' (2.5' fill)
  - Marsh EL : -2.25' to -15.25' (13' thick)
  - GWT EL : +2.5

  - S_p = 3.5"
  - S_s = 4.5"
  - S_T = 8.0"

- STA. 11+50
  - Composite Subsurface Profile
    - Use average of 1 x-sect → GB-03/GB-01
    - GB-03 Marsh EL → +2.5' to -15.0'
    - GB-01 Marsh EL → -2.2' to -15.2
    - ⇒ +0.25' to -15.25 Avg
  - Existing Grade : +10.75
  - Final Grade : +16.5' (~5.8 Fill)
  - GWT EL : +2.5'
  - Consolidation Properties : GB-01 and GB-03

① GB-01		② GB-03		⇒ AVG
• S_p = 10.6"		• S_p = 6.7"		• S_p = 8.7"
• S_s = 4.6"		• S_s = 2.9"		• S_s = 3.7"
S_T = 15.2"		S_T = 9.6"		S_T = 12.4"

- STA. 12+75
  - Nearby Boring : GB-09
  - Existing Grade : 8.0'
  - Final Grade : 11.0' (3.0' fill)
  - Marsh EL : +2.5' to -11.0' (13.5' thick)
  - GWT EL : +2.5'

  - S_p = 6.5"
  - S_s = 4.5"
  - S_T = 11.0"

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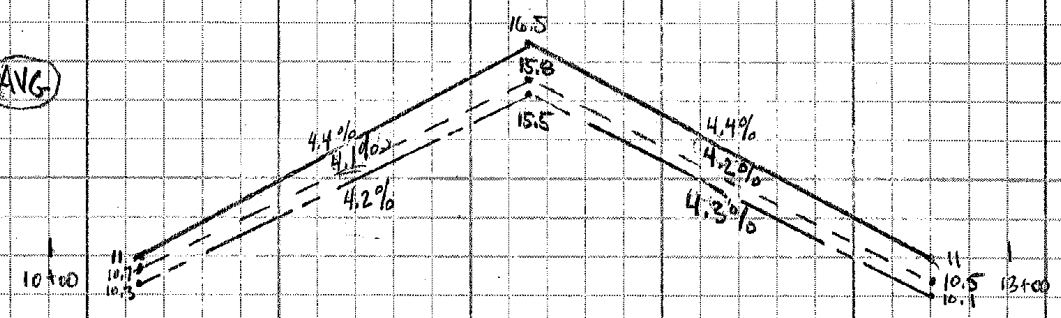
• Section 2 - Continued

• SUMMARY

(AVG)



JOB NO. 36511200004 SHEET 6 OF
PHASE 5C TASK
JOB NAME Raymark
BY NDL DATE 6/18/14
CHECKED BY TCC DATE 6/20/14

amec
511 Congress Street Suite 200
Portland, ME 04101
+1 (207) 775-5401 Fax +1 (207) 772-4762

- Section 3 - STA. 20+00 to 22+76

  - STA. 20+48
    - Composite Subsurface Profile
      - Use average of 2 x-sects → GB-10/GB-11
        → GB-4/GB-5

      - GB-10 Marsh EL → -6.25' to -15.0' → -4.0' to -13.5' (9.5' thick)
      - GB-11 Marsh EL → -1.75' to -11.75' Avg
      - GB-04 Marsh EL → +3.5' to -7.0' → +1.0' to -8.25 (9.25' thick)
      - GB-05 Marsh EL → -1.25 to -9.25' Avg

      Avg → -1.5' to -11.0' (9.5' thick)

    - Existing Grade : +9.5'
    - Final Grade : +11.0' (1.5' fill)
    - GWT EL : +2.5'
    - Consol Properties = GB-10

      - S_p = 1.2"
      - S_s = 3.9"

      S_T = 5.1"

  - STA. 21+45
    - Nearby Boring : GB-05
    - Existing Grade : +11.0'
    - Final Grade : +15.33
    - Marsh EL : -1.25' to -9.25'
    - GWT EL : +2.5'

      - S_p = 4.5"
      - S_s = 3.5"

      S_T = 8.0"

  - STA. 22+43
    - Composite Subsurface Profile
      - Use average of 1 x-sect → GB-09/GB-12

JOB NO. 36512.0004 SHEET 7 OF
PHASE 5C TASK
JOB NAME Raymark
BY NDL DATE 06/19/14
CHECKED BY TCC DATE 06/20/14

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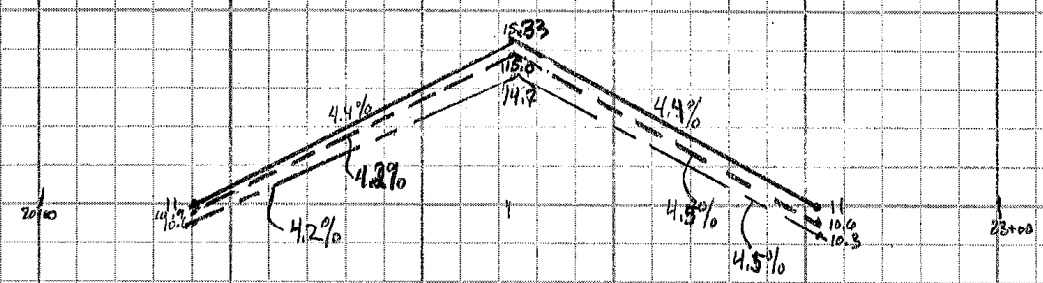
• Section 3 - Continued

- GB-09 Marsh EL → +2.5' to -11.0' → +1.5' to -8.75' (Skew towards GB-09)
- GB-12 Marsh EL → -1.0' to -4.5

- Existing Grade : +8.25'
- Final Grade : +11.00' (~2.7' fill)
- GWT EL : +2.5
- Consol properties = GB-09

• S_p = 4.3"
• S_s = 4.0"
S_T = 8.3"

• SUMMARY



JOB NO. 3651120004 SHEET 8 OF 9
PHASE SC TASK
JOB NAME Raymont
BY NDL DATE 6/18/14
CHECKED BY TRC DATE 6/20/14

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Portland, ME 04101
+1 (207) 775-5401 Fax +1 (207) 772-4762

- Section 4 - STA. 30+00 to 31+90

  - STA. 30+25
    - Nearby Boring : GB-11
    - Existing Grade : +8.25'
    - Final Grade : +11.00' (2.75' fill)
    - Marsh EL : -1.25' to -11.75' (10')
    - GWT EL : +2.5'

      - S_p = 3.7"
      - S_s = 4.0"

      S_T = 7.7"

  - STA. 30+97
    - Composite Subsurface Profile
      - Use average of 1 x-sect → GB-05/GB-06
      - GB-05 Marsh EL → -1.25' to -9.25'
      - GB-06 Marsh EL → -1.75' to -9.75'
      - → Avg -1.5' to -9.5'
    - Existing Grade : +8.75'
    - Final Grade : +14.25'
    - GWT EL : +2.5

      - S_p = 7.2"
      - S_s = 3.4"

      S_T = 10.6"

  - STA 31+69
    - Nearby Boring : GB-12
    - Existing Grade : +8.0'
    - Final Grade : +11.0'
    - Marsh EL : -1.0' to -5.75' (STA. 31+69 is ~ 1/4 of the distance to GB-06 Where Marsh is 8' thick. Add 1.25' of thickness to Marsh at GB-12 → 3.5 + 1.25 = 4.75' thick)
    - GWT EL : +2.5'

      - S_p = 2.9"
      - S_s = 2.6"

      S_T = 5.5"

JOB NO. 3651120004 SHEET 9 OF 9
PHASE SC TASK
JOB NAME Raymark
BY NDL DATE 6/18/14
CHECKED BY TCC DATE 6/20/14

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Portland, ME 04101
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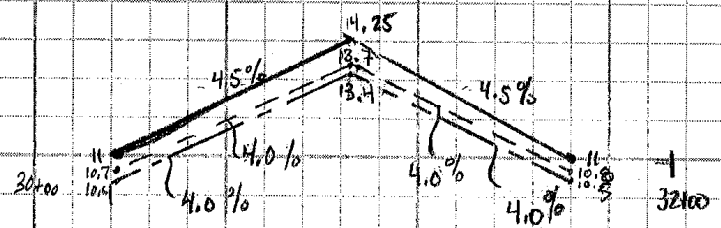
- Section 4 - Continued

  - SUMMARY



APPENDIX A-2

GLOBAL STABILITY EVALUATION

TECHNICAL MEMORANDUM

DATE: July 1, 2013

TO: Dean Brammer; USACE

COPY TO: Charles Collet, P.E. and Stephen Mitchell, P.E.; AMEC

FROM: Nicholas Langlais, EIT; AMEC
Travis Carpenter, P.E. (Maine); AMEC

SUBJECT: Global Stability Evaluation
Raymark Industries, Inc. Superfund Site (576/600 East Broadway)
Stratford, Connecticut

PROJECT: 3651-12-0004

1.0 INTRODUCTION

This memorandum summarizes slope stability evaluations of the Raymark Industries, Inc. Superfund Site. The primary objective of the evaluation was to assess the minimum static and limited seismic factors of safety (FOS) of the site relative to global (i.e., deep-seated) rotational stability, based on the existing site conditions, planned remediation/post-construction conditions, and temporary construction conditions.

The following sections of this memorandum review project information, the development of the SLOPE/W models, summarize the analyses conducted, and present the results and conclusions.

2.0 PROJECT BACKGROUND INFORMATION

The following subsections identify the project datum and provide general descriptions of the site, site-specific soil and groundwater conditions, and the proposed remedy.

2.1 Project Datum

Elevations reported herein are based on the North American Vertical Datum (NAVD) of 1988. Elevations are reported in units of feet. The horizontal datum is the Connecticut State Plane Coordinate System, based on the North American Datum (NAD) of 1983.

2.2 Site Description

The Raymark Industries, Inc. Superfund Site (i.e., the Site) is located at 576/600 East Broadway in Stratford, Connecticut. The two adjacent East Broadway properties encompass approximately 6 acres of commercially-zoned (light industrial) land that is presently overgrown and undeveloped, except for two small buildings and associated pavements situated on the 576 East Broadway parcel. The central portion of the Site is relatively flat with existing ground surface elevations generally ranging between +8.0 and +12.5 feet. The Site slopes downward in all directions toward the Site perimeter to an elevation of about +4.0 to +5.0 feet in most areas. Existing Site features and topography are depicted in Figure 1.

Beginning in the late 1980s, the Site received waste fill from the former Raymark Industries, Inc. facility. The fill consists of both natural and manmade materials. The manmade materials include presumed asbestos containing material (PACM) (fibrous asbestos mats and pads), asphalt, brake pads, brick, cinders, coal, concrete, gasket material, glass, metal debris, plastic, steel, tiles, shingles, slag, and wood.

Most of the Site was originally a tidal/seasonal floodplain marsh prior to filling. Much of the Site is still presently located within the 100-year floodplain.

2.3 Site-Specific Soil and Groundwater Conditions

AMEC carried out a site-specific geotechnical investigation to characterize subsurface conditions and obtain geotechnical data to support the planning, design, and construction of the planned Remedial Action and to evaluate the feasibility of site development. AMEC drilled 12 borings across the site, designated GB-01 through GB-12. Locations of the borings are presented on Figure 1. The geotechnical investigation indicates that the Site is underlain by the following primary soil strata from the ground surface downward:

- Fill: Heterogeneous fill materials comprised predominantly of sand, silt, gravel, and debris, as previously described. Typically loose to medium dense. Thickness ranges from about 2 to 17 feet across the Site.
- Marsh Deposit: Marsh/floodplain deposit consisting primarily of organic silt (OH) with lesser amounts of organic clay (OH) and peat (PT). Variable amounts of sand throughout the deposit. Usually soft to medium stiff. Occasionally stratified

with distinct layers of sand/silty sand (SM). Thickness varies from about 3.5 (boring GB-12) to about 17.5 feet (boring GB-03) across the Site.

- Fluvial Sand: Glacial fluvial deposit comprised of fine to coarse sand with varying amounts of silt and gravel. Typically medium dense to dense. Extends to Glacial Till and/or bedrock (based on site-specific monitoring well installations by others).

Geotechnical Boring Records and a laboratory data summary table are provided in Attachment A.

In January and February of 2013, AMEC measured the depth to groundwater in several existing (i.e., previously installed by others) monitoring wells. The depths ranged from about 4.5 feet to 5.5 feet below the ground surface (bgs) in the shallow monitoring wells (i.e., screened within the fill materials and/or Marsh Deposit). These depths correspond to groundwater elevations of about +1.5 to +3.0 feet. The monitoring well locations are shown in Figure 1.

2.4 Planned Remedial Action

The remediation of 576/600 East Broadway is being performed as a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Action (RA) under the *Record of Decision for Final Source Control Actions at Four Properties Within Operable Unit 6 (Additional Properties) and Interim Actions at Other Locations Containing Raymark Waste* (USEPA, 2011). As described in the Record of Decision (ROD), the selected RA for this Site is to excavate Raymark waste from the 100-year floodplain, consolidate the waste on the upland portion of the Site, and contain the waste with a low-permeable Resource Conservation and Recovery Act (RCRA) cap.

3.0 METHODOLOGY AND STABILITY MODEL DEVELOPMENT

AMEC identified three representative cross sections, A-A', B-B', and C-C', considering the geometry and configuration of existing and proposed grading and in conjunction with available geotechnical exploration data. Figure 1 depicts the cross-section locations in conjunction with existing and planned remediation conditions. The base SLOPE/W models for cross-sections A-A', B-B', and C-C' are presented in Figures 2, 3, and 4, respectively.

3.1 Methodology

The evaluation was made utilizing SLOPE/W (GeoStudio 2012, Version 8.11.1.7283), an industry-standard two-dimensional slope stability software program developed and distributed by Geo-Slope International, Ltd. For a given geometry and soil profile, the program evaluates a range of potential failure surfaces, and identifies the surface exhibiting the computed FOS. The Spencer Method was used in the evaluation because it satisfies both moment and horizontal force equilibrium.

In assessment of the stability, the calculated minimum FOS is compared to a minimum acceptable FOS. The minimum acceptable FOS is dependent upon the risks and implications of failure, the confidence or uncertainty in the definition of existing conditions (e.g., topography, subsurface soil and groundwater conditions, soil strength parameters, etc.), as well as the proposed site changes (e.g., equipment loading, final grading, etc.). For most slopes, a minimum FOS of 1.5 was acceptable for long-term static stability under normal loading conditions. The Site is relatively flat, and fill loading is low; accordingly, it was AMEC's opinion that a limited assessment of seismic stability was warranted. For this case, pseudo-static stability assessment was performed, and a minimum FOS of 1.1 was considered acceptable. These minimum acceptable FOS are consistent with those required by the majority of state and federal regulatory agencies for slopes where personal safety and/or environmental safety are a concern. Typically, the minimum acceptable FOS for short-term (i.e., during construction) static stability is reduced to 1.2 or 1.3 because the loading and/or changed conditions are temporary or transient in nature.

In general, development of each SLOPE/W model proceeded as discussed in the following subsections.

3.2 Define Overall Geometry and Remediation Conditions

The following subsections summarize existing and proposed Site topography.

3.2.1 Existing Conditions

Existing Site slopes, proximate to cross-sections A-A', B-B', and C-C', range between approximately 1 and 5 percent. Due to the relatively flat Site topography, global stability was not evaluated relative to existing Site conditions as part of this memorandum.

3.2.2 Remediation

The planned cap limits/extents and grading are depicted in Figure 1. A final grade/elevation of about +16.0 feet is indicated near the middle of the cap footprint. From this apex, the cap will slope downward gently (4.5% slope) toward the cap perimeter. There will be a grade break near the perimeter, at an elevation of about +11.0 feet, where the cap grades will transition from 4.5% slopes to 33% slopes [3 horizontal to 1 vertical (3H:1V)]. The 3H:1V perimeter side slopes will be on the order of 3 to 4 feet tall. The proposed grading results in fills (i.e., grade raises) of about 3 to 5 feet in most areas within the cap footprint.

3.2.3 Short-Term Construction Conditions

Constructing the remedy will require equipment (i.e., tractors, dozers, etc.) to access the site, resulting in temporary surcharge loading of the cap slopes. To assess short-term stability of the cap during construction, a vertical surcharge of 610 psf (low ground pressure D4K2 tracked tractor) was assumed to operate on the perimeter of the cap, as a “worst-case” scenario.

3.3 Define Subsurface Profile

Subsurface soil and groundwater conditions were based on the results of AMEC’s 2012 geotechnical investigation and historic monitoring well data. Soil boring data was utilized to establish the primary soil strata depths, thicknesses, etc. Monitoring well data was utilized to approximate groundwater elevations.

3.3.1 Assign Sediment/Soil Unit Weights and Strength Parameters

Assumed parameters are summarized in Table 1, and were developed as follows:

- Soil Unit Weights: Soil material unit weights were selected for each soil type based on the results of laboratory and field testing, in-situ conditions (e.g., compactness/consistency, above/below water table, etc.), empirical correlations to published data, and engineering judgment. The following material total unit weights were selected:

- Existing Fill, γ_t = 120 pounds per cubic foot (pcf), assumed based on published data and engineering judgment.
- Marsh Deposit, γ_t = 90 pcf, estimated based on 2012 and 2013 laboratory data.
- Fluvial Sand, γ_t = 125 pcf, assumed based on published data and engineering judgment.
- Capping Materials: Subgrade Fill, γ_t = 120 pcf and Cover Soils, γ_t = 120 pcf, assumed based on published data and engineering judgment.

- <u>Soil Strength Parameters:</u> Strength parameters for each soil layer were developed based on soil type, in-situ compactness/consistency, in-situ and field vane shear testing, laboratory shear strength tests, empirical correlations to published data, and engineering judgment. The following shear strength parameters were assumed for the analyses:
  - Existing Fill (granular): $\Phi = 30°$.
  - Marsh Deposit: $\Phi = 26°$ (drained); or undrained shear strength, S_u = 750 psf (undrained) as described in the following paragraph.
  - Fluvial Sand: $\Phi = 34°$.
  - Capping Materials: Subgrade Fill: $\Phi = 32°$, Cover Soils $\Phi = 30°$.

The geotechnical investigation indicated that the Marsh Deposit may range from soft to medium stiff, plastic, cohesive silt/clay/peat to loose, non-plastic, cohesionless silty sand. As such, two distinct sets of strength parameters (undrained and drained as previously discussed) were considered.

A summary of properties applied to the model is summarized in Table 1.

Table 1 - Assumed Soil Parameters

Material	Drained Shear Strength, Φ (degrees)	Undrained Shear Strength, S_u (psf)	Unit Weight, γ_t (pcf)
Existing Fill	30	--	120
Marsh Deposit	26[1,2]	--	90
	--	750[1,3]	90
Fluvial Sand	34	--	125
Subgrade Fill	32	--	120
Cover Soils	30	--	120

1. Apply either drained or undrained strengths, but not both or combination of drained/undrained.
2. Representative of very loose to loose conditions.
3. Representative of medium stiff conditions.

4.0 OVERVIEW OF ANALYSES

AMEC performed two distinct analyses for this memorandum: a global stability analysis considering long-term static, pseudo-static, and short term static conditions and a sensitivity analysis considering a range of undrained shear strength values for the Marsh Deposit. The following sections provide an overview of the global stability and sensitivity analyses.

4.1 Global Stability Analysis

The scenarios evaluated at each cross-section are summarized in the following paragraphs.

Static Long-Term Post-Construction Conditions. Long-term, static stability was assessed considering post-construction conditions following application of the proposed remediation described in Subsection 3.2.2. Selected SLOPE/W output files (with the resulting minimum FOS and the critical slip surface) for each run are provided in Attachments B, C, and D for cross-sections A-A', B-B', and C-C', respectively.

Limited Seismic Post-Construction Conditions. The pseudo-static stability was assessed considering post-construction conditions following the proposed remediation described in Subsection 3.2.2. Pseudo-static conditions represent conditions experienced during a seismic event. This condition was modeled assuming an applied horizontal load, or peak ground acceleration (PGA), of 0.11g (Figure 5) to represent a seismic event. Based on mapping by the USGS, a PGA of 0.11g has a 2 percent probability of

occurring in 50 years (2,500-year recurrence interval). Selected SLOPE/W output files (with the resulting minimum FOS and the critical slip surface) for each run are provided in Attachments B, C, and D for cross-sections A-A', B-B', and C-C', respectively.

Static Temporary Construction Conditions. Static stability of the cap was also assessed considering transient surcharge loading from construction equipment (i.e., a tracked tractor) as described in Subsection 3.2.3. Selected SLOPE/W output files (with the resulting minimum FOS and the critical slip surface) for each run are provided in Attachments B, C, and D for cross-sections A-A', B-B', and C-C', respectively.

4.2 Sensitivity Analysis

AMEC performed a sensitivity analysis on global stability with respect to undrained shear strength, S_u, of the Marsh Deposit for cross-section C-C' to account for spatial variability. During the geotechnical investigation, a range of S_u values were obtained via field vane shear and laboratory vane and torvane shear testing that indicate soft to medium stiff conditions within the Marsh Deposit. As such, AMEC evaluated the static long-term, pseudo-static, and short-term static global stability, as described in Section 4.1, of the site by reducing the Marsh Deposit undrained shear strength to S_u = 500 psf (soft/medium stiff).

The drained shear strength utilized $\Phi = 26°$, which is considered to be conservative for cohesionless materials; therefore, sensitivity of global stability with respect to Φ was not evaluated.

5.0 SUMMARY OF RESULTS

The following subsections summarize the results of the global stability and sensitivity evaluations.

5.1 Global Stability Results

The results of the global stability evaluation for sections A-A', B-B', and C-C' are summarized in Table 2.

Table 2 – Global Stability Summary

Loading Condition	Computed Global FOS	Attached Figure Number
Cross-Section A-A'		
Static Long-Term Post-Construction	3.2[1,2,5] 4.9[3,5] 5.7[3,6]	B.1 B.2 B.3
Pseudo-Static Post-Construction	2.1[1,2,5]	B.4
Temporary Construction	1.9[1,2,5]	B.5
Cross-Section B-B'		
Static Long-Term Post-Construction	2.9[1,2,5]	C.1
Pseudo-Static Post-Construction	2.0[1,2,5]	C.2
Temporary Construction	1.7[1,2,5]	C.3
Cross-Section C-C'		
Static Long-Term Post-Construction	3.0[1,2,5]	D.1
Pseudo-Static Post-Construction	1.8[1,3,6] 2.0[1,4,5]	D.2 D.3
Temporary Construction	1.8[1,2,5]	D.4

1. Minimum computed FOS.
2. Marsh Deposit drained and undrained shear strengths yield identical failure surfaces and FOS; drained results are shown in Appendices.
3. Marsh Deposit drained shear strength, $\Phi = 26°$.
4. Marsh Deposit undrained shear strength, $S_u = 750$ psf.
5. Failure surface within Existing Fill.
6. Failure surface within Marsh Deposit.

A discussion of the results for each loading condition are provided in the following paragraphs.

Static Long-Term Post-Construction Conditions. The results indicate that the estimated minimum long-term static FOS is on the order of 2.9 to 3.2, and exceeds the minimum acceptable FOS. In general, the critical failure surfaces are located at the perimeter of the cap and extend to approximately 5 feet below grade, within the existing fill above the

groundwater table. AMEC considers failure surfaces shallower than 5 feet to be veneer stability. The FOS generally increases as the failure surfaces increase in depth (Figures B.1, B.2, and B.3). These results exceed the minimum acceptable FOS (1.5) for long-term stability.

Limited Seismic Post-Construction Conditions. The results indicate that the estimated minimum pseudo-static post-construction FOS is on the order of 1.8 to 2.1 considering multiple strength parameters (undrained and drained) for the Marsh Deposit, and exceeds the minimum acceptable FOS. In general, the critical failure surfaces are located at the perimeter of the cap and extend to approximately 5 to 15 feet below grade, within the existing fill and Marsh Deposit, respectively. AMEC considers failure surfaces shallower than 5 feet to be veneer stability. In general, the FOS increase as the failure surfaces increase in depth. These results exceed the minimum acceptable FOS (1.1) for pseudo-static stability.

Temporary Construction Conditions. The results indicate that the minimum static FOS ranges from 1.7 to 1.9 when equipment is operating atop the slope at the perimeter of the cap, and exceeds the minimum acceptable FOS. In general, the critical failure surfaces extend to approximately 5 feet below grade, within the existing fill above the groundwater table. AMEC considers failure surfaces shallower than 5 feet to be veneer stability. In general, the FOS increase as the failure surfaces increase in depth. These results exceed the minimum acceptable FOS (1.2 to 1.3) for short-term static stability.

5.2 Sensitivity Results

The results of the sensitivity evaluation for section C-C' are summarized in Table 3 and Slope/W output files for each "sensitivity analysis" run are attached in Attachment E.

Table 3 – Sensitivity Summary

Loading Condition	Computed Global FOS	Attached Figure Number
Cross-Section C-C'		
Static Long-Term Post-Construction S_u = *500 psf*	3.0[1,2]	E.1
Pseudo-Static Post-Construction S_u = *500 psf*	1.7[1,3]	E.2
Temporary Construction S_u = *500 psf*	1.8[1,2]	E.3

1. Minimum computed FOS.
2. Failure surface occurs within Existing Fill.
3. Failure surface occurs within Marsh Deposit.

A discussion of the results is provided in the following paragraphs.

Static Long-Term Post-Construction Conditions. The result indicates that the estimated minimum long-term static FOS remains at 3.0, and exceeds the minimum acceptable FOS, for section C-C', despite reducing the undrained shear strength of the Marsh Deposit. The critical failure surface is still located at the perimeter of the cap and extends to approximately 5 feet below grade, within the existing fill above the groundwater table.

Pseudo-static Post-Construction Conditions. The result indicates that the estimated minimum pseudo-static post-construction FOS decreases to 1.7 from 2.0, and exceeds the minimum acceptable FOS, for section C-C', when a lower undrained shear strength for the Marsh Deposit is utilized. The critical failure surface is located at the perimeter of the cap and extends to approximately 20 feet below grade, within the Marsh Deposit.

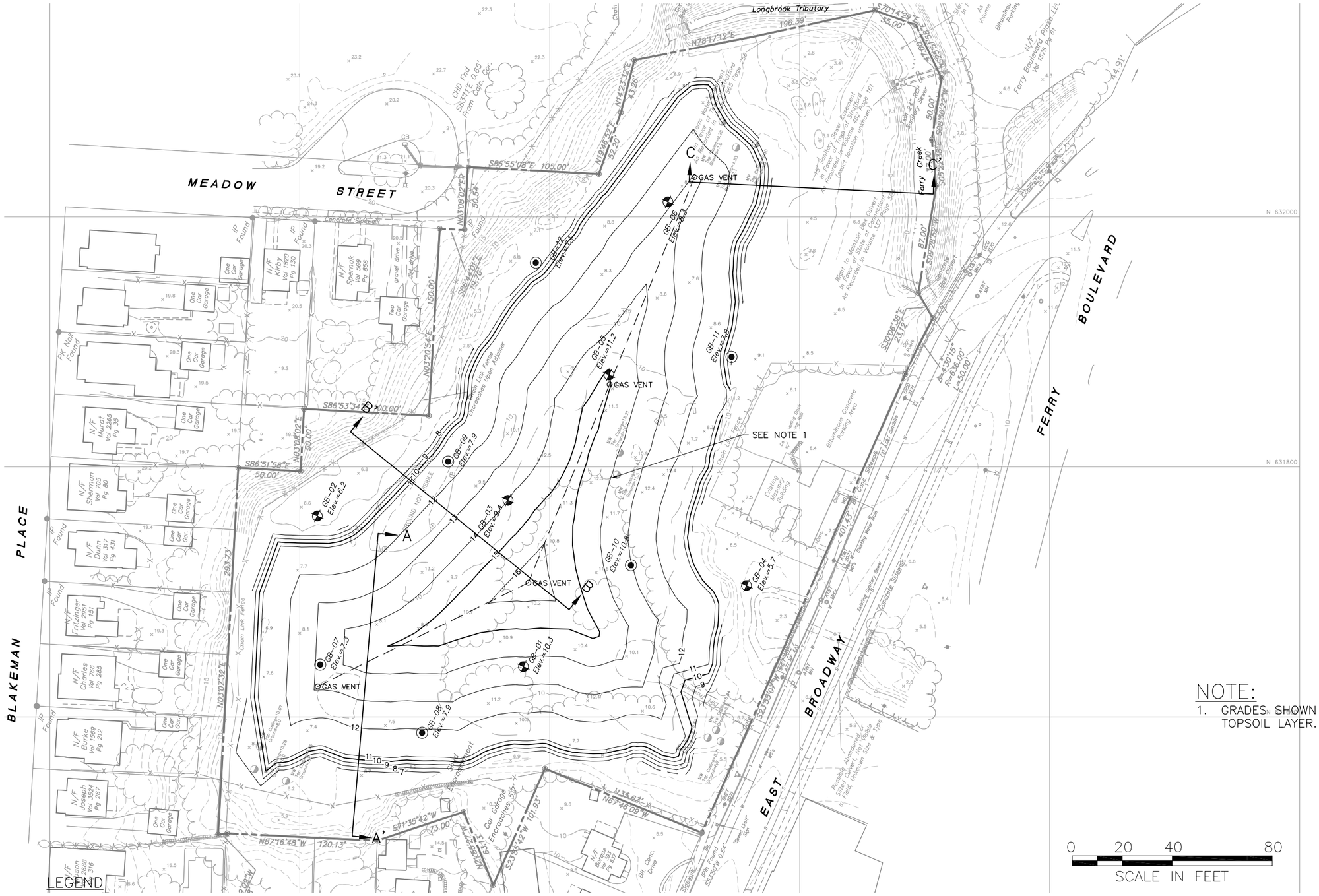
Temporary Construction Conditions. The result indicates that the minimum static FOS remains at 1.8, and exceeds the minimum acceptable FOS, for section C-C', when equipment is operating atop the slope at the perimeter of the cap when a lower undrained shear strength for the Marsh Deposit is utilized. The critical failure surface extends to approximately 5 feet below grade, within the existing fill above the groundwater table.

6.0 CONCLUSIONS

The results of this stability evaluation indicate that the site is expected to remain stable post-construction with respect to long-term static, pseudo-static, and short-term global stability. In general, the minimum computed FOS failure surfaces occur within the existing fill. Based on our evaluation, lowering the undrained shear strength of the Marsh Deposit to S_u = 500 psf, to reflect soft to medium stiff conditions, had minimal impact on the critical FOS for long-term static, pseudo-static, and short-term static global stability.

Veneer stability was not evaluated as part of this memorandum, as this is considered to be a site maintenance item and part of the overall cap design evaluation. However, the Subcontractor must evaluate and be responsible for veneer and global slope stability during construction. The evaluation must consider actual equipment to be employed in conjunction with actual sequence of work.

FIGURES



NOTE:

1. GRADES SHOWN REPRESENT FINAL GRADING OF TOPSOIL LAYER.

0 20 40 80

SCALE IN FEET

Prepared/Date: MRS 06/27/13
Checked/Date: NDL 06/27/13

LEGEND

GB-05	2012 GEOTECHNICAL BORING
GB-08	2013 GEOTECHNICAL BORING
MW 103(D)	APPROXIMATE LOCATION OF 1994 MONITORING WELL

RAYMARK INDUSTRIES, INC.
576/600 EAST BROADWAY
STRATFORD, CONNECTICUT

amec

GLOBAL STABILITY CROSS-SECTION LOCATION PLAN
Project 3651-12-0004
Figure 1

Z:\Projects\USACE\RAYMARK-OU6\FIGURES\GEOTECHNICAL REPORT\FIGURE 1 GLOBAL STABILITY X-SECT LOC PLAN.dwg Thu, 27 Jun 2013 - 2:06pm michelle.stacey

Name: Cover Soil Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Subgrade Fill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 32 ° Piezometric Line: 1
Name: Existing Fill Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Marsh Deposit (Granular) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 26 ° Piezometric Line: 1
Name: Fluvial Sand Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 34 ° Piezometric Line: 1

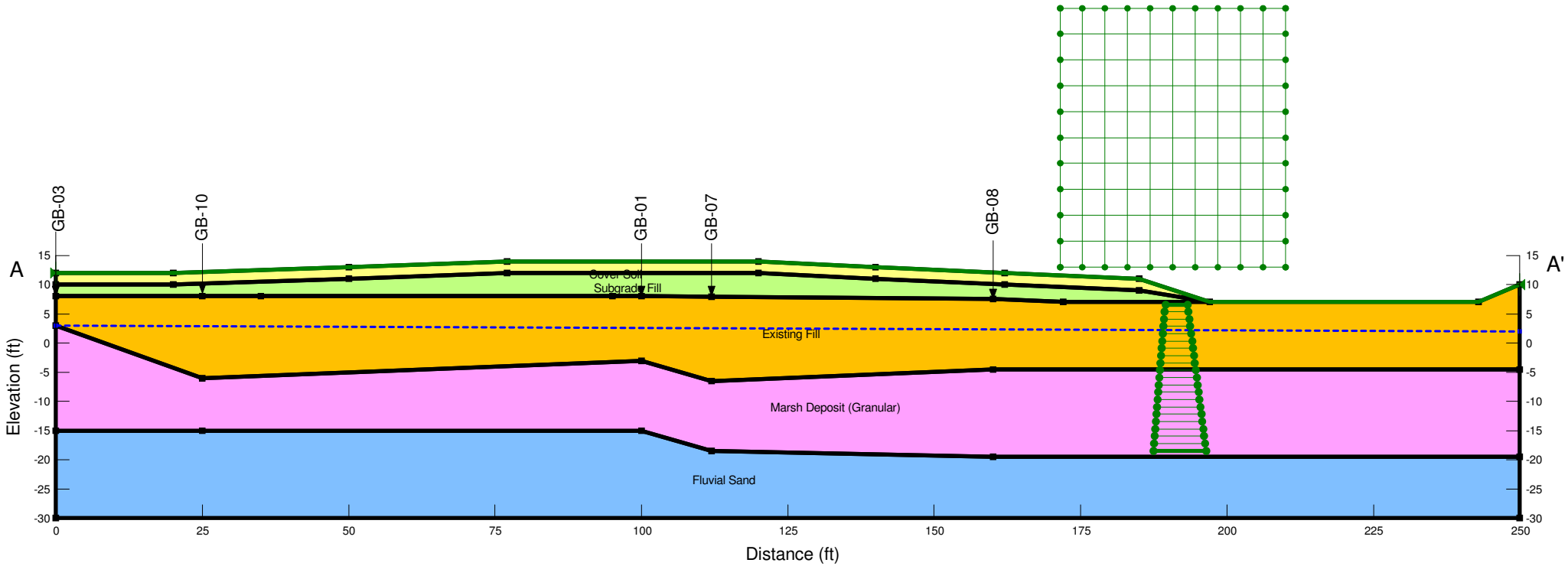


Figure 2
Section A-A'
Global Stability Evaluation
USACE Raymark - Stratford, CT

Name: Cover Soil Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Subgrade Fill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 32 ° Piezometric Line: 1
Name: Existing Fill Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Marsh Deposit (Granular) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 26 ° Piezometric Line: 1
Name: Fluvial Sand Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 34 ° Piezometric Line: 1

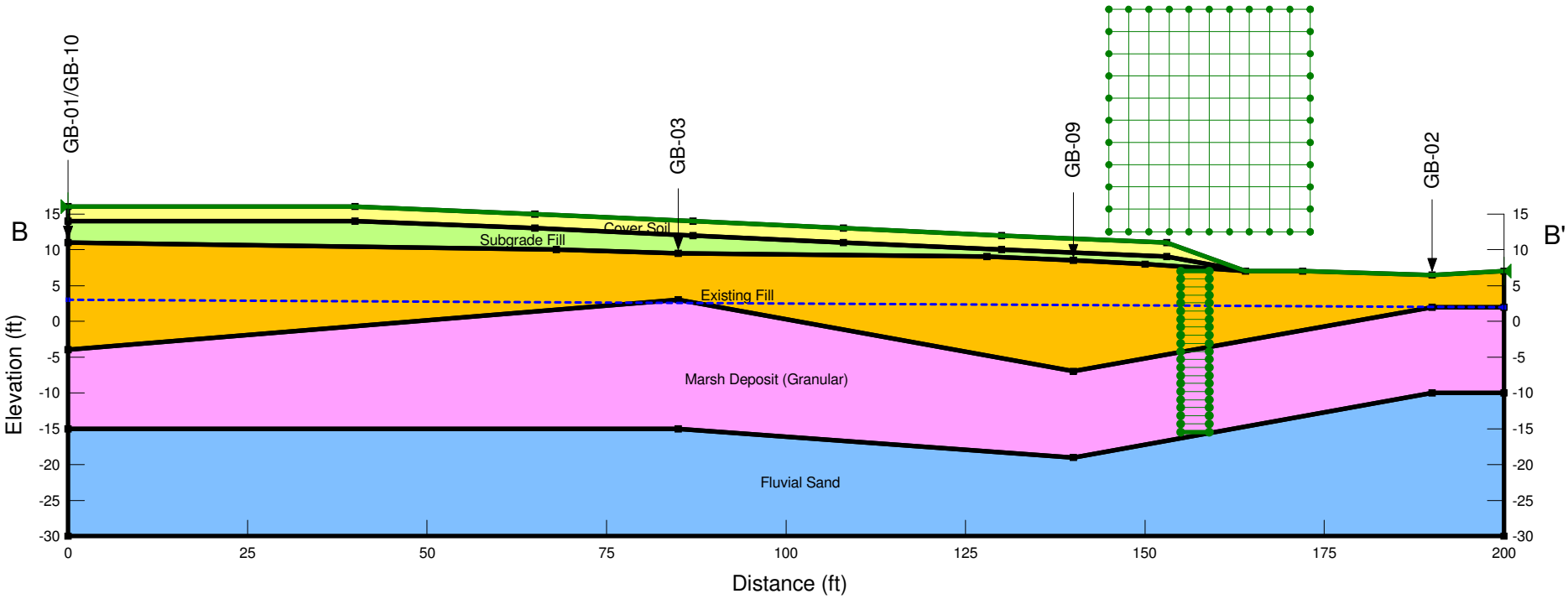


Figure 3
Section B-B'
Global Stability Evaluation
USACE Raymark - Stratford, CT

Name: Cover Soil Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Subgrade Fill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 32 ° Piezometric Line: 1
Name: Existing Fill Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Marsh Deposit (Granular) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 26 ° Piezometric Line: 1
Name: Fluvial Sand Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 34 ° Piezometric Line: 1

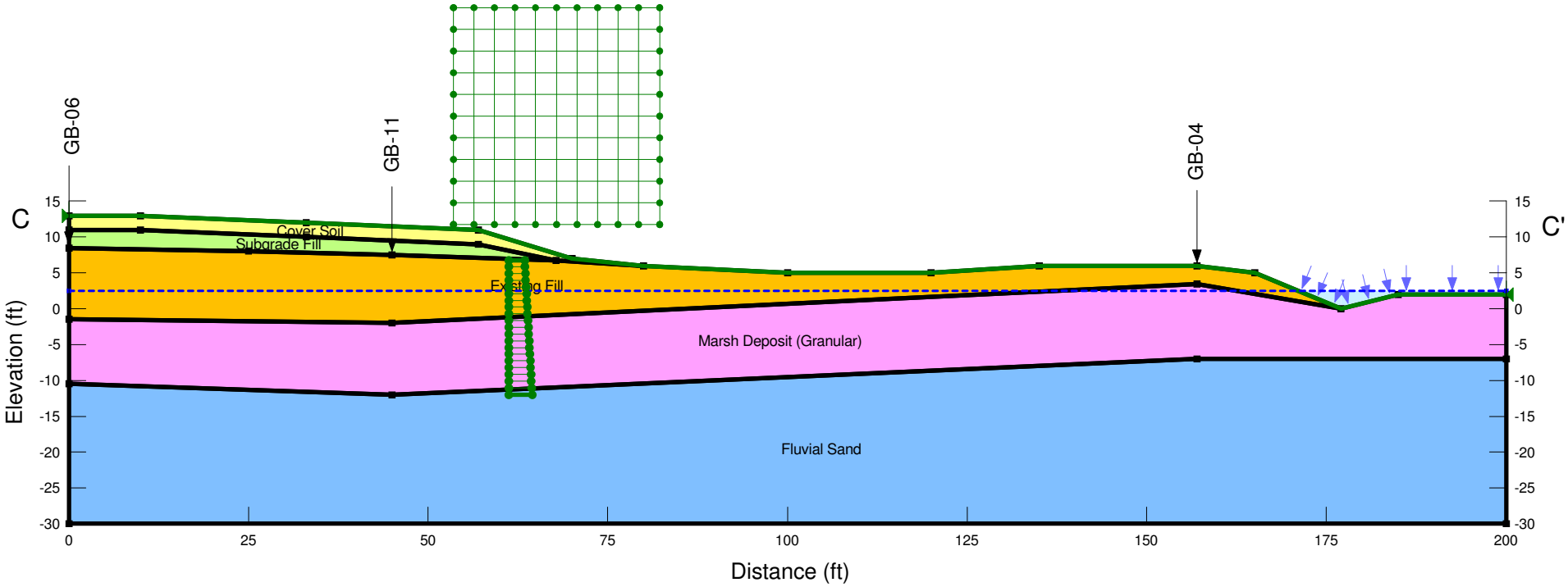


Figure 4
Section C-C'
Global Stability Evaluation
USACE Raymark - Stratford, CT

Courtesy of USGS

CT; PGA; 2% PE in 50 yrs

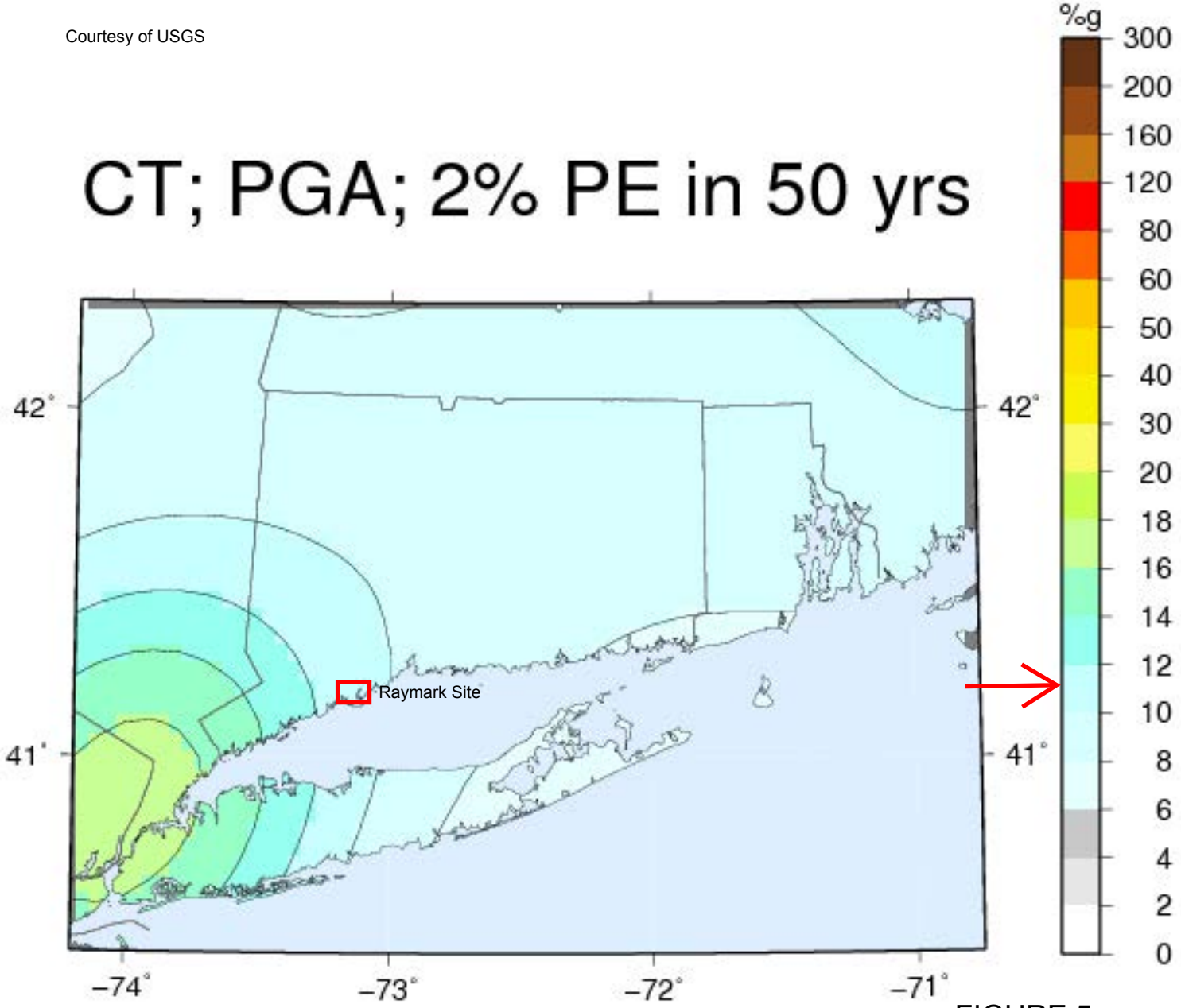


FIGURE 5

Peak Ground Acceleration

ATTACHMENT A

Summary of Geotechnical Laboratory Testing Data

Geotechnical Boring Records

Table 1
Summary of Geotechnical Laboratory Testing Data

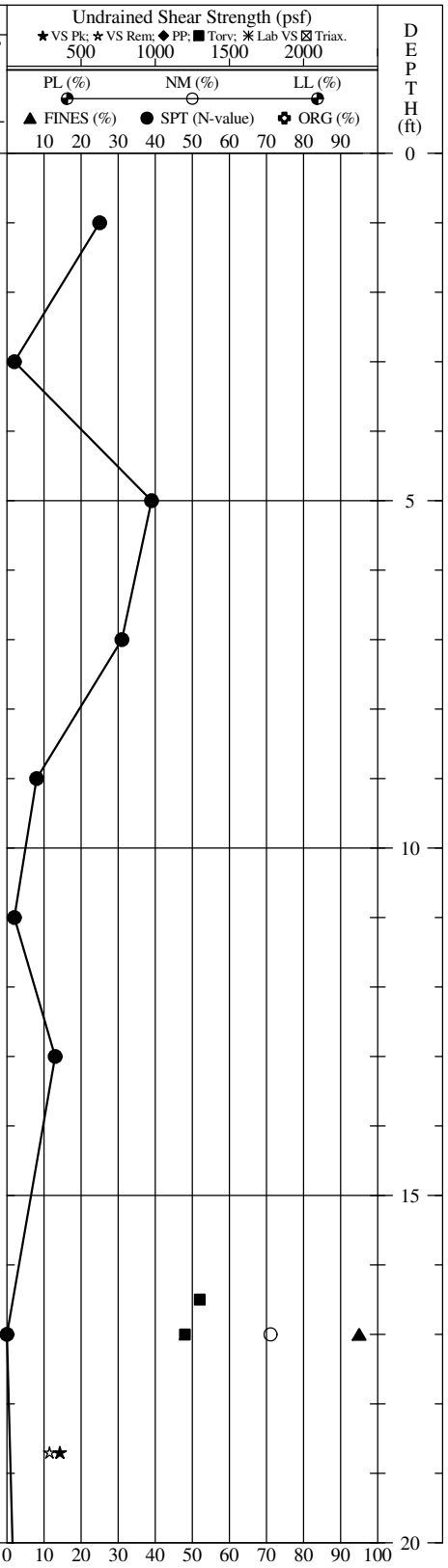
Borehole No.	Surface Elevation (ft bgs)	Sample Information							Laboratory Testing Data																							
		No.	Type	Depth Interval	In-Situ Effective Stress	Primary Stratum	USCS D 2487 / D 2488		Water Content D 2216	Organic Content D 2974	Total Unit Weight	Dry Unit Weight	Void Ratio	Satur.	Particle-Size Analysis D 422				Atterberg Limits D 4318						Specific Gravity D 854	Undrained Shear Strength		1-D Consolidation D 2435						
							Description	Symbol							Gravel	Sand	Silt	Clay	LL			PL	PI	LI		Torvane	Lab Vane D 4648						
					σ'_v						γ_t	γ_d	e_0	S					Wet Prep.	Oven Dried	ODLL WPLL Ratio					S_u	S_u	C_c	$C_{c\varepsilon}$	C_r	$C_{r\varepsilon}$	$C_{s\varepsilon}$	C_α	$C_{\alpha\varepsilon}$
				(ft bgs)	(psf)				(%)	(%)	(pcf)	(pcf)		(%)	(%)	(%)	(%)	(%)								(psf)	(psf)							
GB-01	10.3	SS-09	Jar	16 - 18	-	Marsh Deposit	silt with organics	OH	71.1	-	-	-	-	-	0.0	5.0	95.0		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-10	Jar	20 - 22	-	Marsh Deposit	silt with organics	OH	117.0	11.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-11	Jar	22 - 24	-	Marsh Deposit	silt with organics	OH	114.8	-	-	-	-	-	-	-	-	-	143	-	-	67	76	0.6		-	-	-	-	-	-	-	-
		SS-12	Jar	24 - 26	-	Marsh Deposit	silt with organics	OH	151.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GB-02	6.2	SS-04	Jar	06 - 08	-	Marsh Deposit	silty sand with organics	SM	80.0	20.6	-	-	-	-	9.5	66.0	24.5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-07	Jar	12 - 14	-	Marsh Deposit	silt with organics	OL-PT	149.6	18.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-12	Jar	25 - 27	-	Fluvial Deposit	sand with gravel	SP	-	-	-	-	-	-	33.0	62.2	4.8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GB-03	9.4	SS-05	Jar	08 - 10	-	Marsh Deposit	silty sand	SM	-	-	-	-	-	-	8.4	64.8	26.8		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SH-07	Tube	12 - 14.5	820	Marsh Deposit	silt with sand and organics	OH	205.9	-	80.3	26.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									192.0	22.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									181.7	-	70.4	25.0	4.49	89.1	-	-	-	-	-	-	-	-	-	-	-	-	-	1.76	0.32	0.33	0.06	-	0.04	0.01
									206.0	-	-	-	-	-	-	-	-	-	191	-	-	88	103	1.1	-	-	-	-	-	-	-	-	-
									167.7	-	80.5	30.1	-	-	-	-	-	-	-	-	-	-	-	-	-	280	-	-	-	-	-	-	-
									205.9	-	33.9	11.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									205.9	-	70.4	23.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									107.4	-	79.1	38.2	2.60	90.9	0.0	16.8	83.2		-	-	-	-	-	-	2.20	-	-	-	-	-	-	-	-
		SS-09	Jar	16.5 - 18.5	-	Marsh Deposit	silt with organics	OH	121.2	14.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-10	Jar	18.5 - 20.5	-	Marsh Deposit	silt with organics	OH	169.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-11	Jar	20.5 - 22.5	-	Marsh Deposit	silt with organics	OH	150.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-12	Jar	22.5 - 24.5	-	Marsh Deposit	silt with organics	OH	179.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-14	Jar	28 - 30	-	Fluvial Deposit	sand with silt	SW-SM	-	-	-	-	-	-	1.4	88.6	10.0		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GB-05	11.2	SS-07A	Jar	12 - 14	-	Marsh Deposit	sandy silt with organics	OH	134.0	18.1	-	-	-	-	8.7	32.6	58.7		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-09	Jar	16.5 - 18.5	-	Marsh Deposit	silt with organics	OH	153.3	7.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GB-06	8.3	SS-07	Jar	12 - 14	-	Marsh Deposit	silt with organics	OH	104.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SH-08	Tube	14 - 16.5	1100	Marsh Deposit	sand with silt to silt with sand and organics	OH	103.9	-	88.9	43.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									107.5	-	86.1	41.5	3.26	93.4	-	-	-	-	-	-	-	-	-	-	-	-	-	1.11	0.26	0.21	0.05	-	0.03	0.01
									105.0	8.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									92.0	-	94.3	49.1	-	-	-	-	-	-	-	-	-	-	-	-	-	440	-	-	-	-	-	-	-
									103.9	-	88.9	43.6	-	-	-	-	-	-	128	-	-	58	70	0.7	-	-	-	-	-	-	-	-	-
									104.0	-	103.2	50.6	2.16	89.1	0.0	21.0	79.0		-	-	-	-	-	-	2.56	-	-	-	-	-	-	-	-

Table 1
Summary of Geotechnical Laboratory Testing Data

Borehole No.	Surface Elevation (ft bgs)	Sample Information							Laboratory Testing Data																							
		No.	Type	Depth Interval	In-Situ Effective Stress	Primary Stratum	USCS D 2487 / D 2488		Water Content D 2216	Organic Content D 2974	Total Unit Weight	Dry Unit Weight	Void Ratio	Satur.	Particle-Size Analysis D 422				Atterberg Limits D 4318						Specific Gravity D 854	Undrained Shear Strength		1-D Consolidation D 2435						
					σ'_v		Description	Symbol			γ_t	γ_d	e_0	S	Gravel	Sand	Silt	Clay	LL			PL	PI	LI		Torvane S_u	Lab Vane D 4648 S_u	C_c	$C_{c\varepsilon}$	C_r	$C_{r\varepsilon}$	$C_{s\varepsilon}$	C_α	$C_{\alpha\varepsilon}$
				(ft bgs)	(psf)				(%)	(%)	(pcf)	(pcf)		(%)	(%)	(%)	(%)	(%)	Wet Prep.	Oven Dried	ODLL/WPLL Ratio					(psf)	(psf)							
GB-07	7.3	VS-07B	Jar	17 - 19	-	Marsh Deposit	silt with organics	OH	260.5	-	-	-	-	-	-	-	-	-	341	NP	-	130	211	0.6	-	-	-	-	-	-	-	-	-
		SS-08	Jar	20 - 22	-	Marsh Deposit	silt with organics	OH	318.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ST-09	Tube	22.5 - 24.5	1250	Marsh Deposit	silt with organics	OH	259.0	38.0	-	-	-	-	-	-	-	-	475	NP	-	184	291	0.3	1.94	-	-	-	-	-	-	-	-
									370.8	-	63.8	13.6	-	-	-	-	-	-	-	-	-	-	-	-	-	600	580	-	-	-	-	-	-
									461.0	-	62.8	11.2	9.79	91.4	-	-	-	-	-	-	-	-	-	-	-	-	-	5.5	0.51	1.4	0.13		
		SS-10A	Jar	25 - 27	-	Marsh Deposit	silt with organics	OH	119.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GB-08	7.9	SS-05B	Jar	12 - 14	-	Marsh Deposit	silt with organics	OH	274.0	49.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		VS-07B	Jar	16 - 18	-	Marsh Deposit	silt with organics	OH	117.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ST-08	Tube	18 - 20	925	Marsh Deposit	silt with organics	OH	129.0	15.8	-	-	-	-	-	-	-	-	146	81	0.6	71	75	0.8	2.44	-	-	-	-	-	-	-	-
									116.8	-	79.2	36.5	-	-	-	-	-	-	-	-	-	-	-	-	-	620	560	-	-	-	-	-	-
									135.8	-	77.8	33.0	3.61	91.8	-	-	-	-	-	-	-	-	-	-	-	-	-	1.70	0.37	0.28	0.06		
		SS-09B	Jar	20 - 22	-	Marsh Deposit	silt with organics	OH	275.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-10	Jar	22.5 - 24.5	-	Marsh Deposit	silt with organics	OH	286.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-11B	Jar	25 - 27	-	Marsh Deposit	silt with organics	OH	208.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GB-09	7.9	SS-04	Jar	10 - 12	-	Marsh Deposit	silt with organics	OH	143.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		VS-05	Jar	12.5 - 14.5	-	Marsh Deposit	silt with organics	OH	338.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-06	Jar	15 - 17	-	Marsh Deposit	silt with organics	OH	352.6	-	-	-	-	-	-	-	-	-	355	NP	-	163	192	1.0	-	-	-	-	-	-	-	-	-
		ST-07	Tube	17.5 - 19.5	925	Marsh Deposit	clay with organics	OH	41.0	4.9	-	-	-	-	-	-	33.9		76	NP	-	33	43	0.2	-	-	-	-	-	-	-	-	-
									46.2	-	101.2	69.2	1.47	86.0	-	-	-	-	-	-	-	-	-	-	-	-	-	0.44	0.18	0.05	0.02		
GB-10	10.8	SS-06	Jar	17 - 19	-	Marsh Deposit	silt with organics	OH	109.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ST-07	Tube	19 - 21	1500	Marsh Deposit	silt with organics	OH	189.0	28.9	-	-	-	-	-	-	-	-	239	NP	-	93	146	0.7	2.15	-	-	-	-	-	-	-	-
									175.2	-	71.7	26.1	-	-	-	-	-	-	-	-	-	-	-	-	-	660	580	-	-	-	-	-	-
									199.8	-	70.2	23.4	4.74	90.7	-	-	-	-	-	-	-	-	-	-	-	-	-	2.70	0.47	0.51	0.09		
		VS-08	Jar	22 - 24	-	Marsh Deposit	silt with organics	OH	172.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-09A	Jar	25 - 27	-	Marsh Deposit	silt with organics	OH	98.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-09B	Jar	25 - 27	-	Fluvial Sand	silty sand	SM	29.3	-	-	-	-	-	-	-	41.5		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GB-11	7.8	SS-03	Jar	10 - 12	-	Marsh Deposit	silt with organics	OH	101.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		VS-05	Jar	14 - 16	-	Marsh Deposit	silt with organics	OH	231.6	-	-	-	-	-	-	-	-	-	191	81	0.4	82	109	1.4	-	-	-	-	-	-	-	-	-
		SS-07A	Jar	18 - 20	-	Marsh Deposit	silt with organics	OH	245.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GB-12	7.1	SS-03	Jar	08 - 10	-	Marsh Deposit	silt with organics	OH	116.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-04A	Jar	10 - 12	-	Marsh Deposit	silty sand with gravel	SM	44.9	-	-	-	-	-	-	-	35.7		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Prepared By/Date: NDL 3/8/2013
Checked By/Date: KHL 3/27/2013

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
0	FILL (Sand, Silt, Gravel, Debris) Gravel and organics changing to Brown to reddish brown, fine to coarse SAND, some gravel, few/little silt (SW-SM/SM), very loose, dry to moist.		10.3	SS-01 [0]		4-12-13-12 (N = 25)
	- 2.0' to 2.2' bgs: cobble and asphalt fragments in spoon			SS-02 []		1-1-1-19 (N = 2)
	- 4.0' to 4.6' bgs: Brown, fine to coarse SAND, some gravel, little silt, (SM). - 4.6' to 5' bgs: fractured cobble					
5	Brown, fine to coarse SAND, trace silt (SW), dense, moist, occasional asphalt fragments.		5.3	SS-03 []		9-27-12-12 (N = 39)
	Brown, fine to coarse SAND, some gravel, few silt (SW-SM), dense, moist. - 6.6' bgs: fractured cobble					
	Dark brown, fine to coarse SAND, few to some silt (SM), dense, moist to wet, non-plastic. - 7.3' bgs: becomes wet			SS-04 [0]		28-19-12-10 (N = 31)
	- 8.0' bgs: becomes loose			SS-05 [0]		16-5-3-1 (N = 8)
10	Dark brown, fine to coarse SAND, little gravel, few silt (SW-SM), very loose, wet.		0.3	SS-06 [0]		3-1-1-4 (N = 2)
	- 12.0' to 13' bgs: fractured cobble					
	MARSH DEPOSIT (Silt, Sand, Organics/Peat)					
	Dark brown, SILT, trace fine sand, with organics (OH), stiff.			SS-07 []		12-10-3-3 (N = 13)
15			-4.7	ST-08 []		
	Dark Brown, SILT with organics, trace fine sand (OH), soft, moist, medium plasticity, slow dilatancy, strong organic odor.			SS-09 [0]		2-WH-WH-1
	VS-1 at 18.0' bgs: Su => 357 psf VS-1 at 18.0' bgs: Sremolded = 287 psf					
20			-9.7			



BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Truck rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/081012

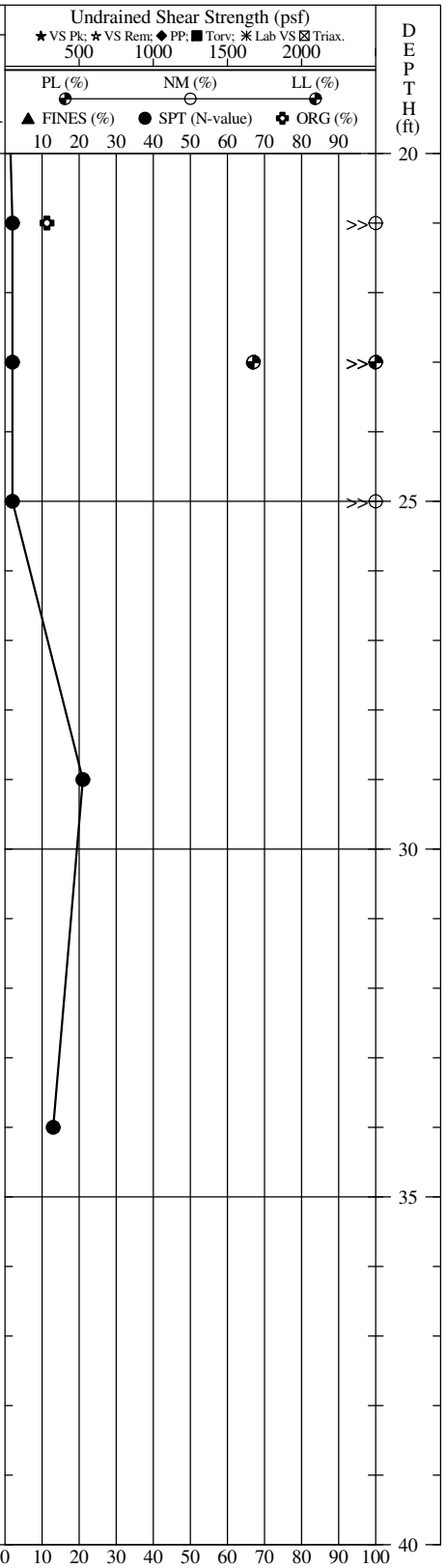
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-01
DRILLED: 5/30/12 - 6/1/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
20	MARSH DEPOSIT (Silt, Sand, Organics/Peat)		-9.7			
	Similar to SS-09; medium plasticity, slow dilatancy, strong organic odor.			SS-10 [0]		WH-1-1-2 (N = 2)
	Similar to SS-09.			SS-11 [0]		WH-1-1-1 (N = 2)
	Similar to SS-09.					
25			-14.7	SS-12 [0]		WH-1-1-6 (N = 2)
	FLUVIAL DEPOSIT (Sand, Gravel, Silt) Dark brown, fine to coarse SAND, few silt (SW-SM), wet.					
	Gray, fine to coarse SAND, trace gravel and silt (SW), medium dense, wet.			SS-13 [0]		14-11-10-8 (N = 21)
30			-19.7			
	Reddish-brown to grayish brown, fine SAND, little silt (SM), with bands of reddish brown to brown, fine to coarse SAND, little gravel, trace silt (SP), medium dense, wet.			SS-14 [0]		3-7-6-7 (N = 13)
35	Bottom of Exploration at 35 ft bgs.		-24.7			
40			-29.7			



BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Truck rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-01
DRILLED: 5/30/12 - 6/1/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLE IDENT	PID (ppm)	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
0	Topsoil, frequent organics FILL (Sand, Silt, Gravel, Debris) Fractured concrete Brown, fine to medium SAND, few/little silt (SM), pieces of asphalt, medium dense, dry. - 0.3' to 0.7' bgs: fractured asphalt Concrete	6.2	SS-01	[0]		10-8-10-50/3" (N = 18)
5	MARSH DEPOSIT (Silt, Sand, Organics/Peat) Primarily organic fibers in silt (PT), wet, slight odor.	1.2	SS-03	[0]		1-1-2-1 (N = 3)
	Brown, fine to coarse SAND, some silt, with organics (SM), wet, very loose, no to low plasticity, slow dilatancy, slight odor.		SS-04	[0]		3-2-1-1 (N = 3)
			ST-05	[]		
10	- 10.5' to 12.0' bgs: Dark brown, SILT with organics, little fine sand (OL), low plasticity, rapid dilatancy, strong organic odor. Changing to fine to coarse sandy SILT (OL), very soft, wet, low plasticity, rapid dialtancy. Dark brown, SILT with organics, few fine sand (OL-PT), very soft, wet, low plasticity, slow dilatancy, strong organic odor.	-3.8	SS-06	[]		1-WH-WH
			SS-07	[0]		WR-WR-WR-WH
	Dark brown, fine to medium SAND, some silt, with organics (SM-PT), very loose, wet.					
15		-8.8	SS-08	[0]		WR-WR-WH-WH
	Dark brown, fine to medium SAND, some silt, trace organics (SM). FLUVIAL DEPOSIT (Sand, Gravel, Silt) Grayish-brown, fine to coarse SAND, little silt, trace organics and gravel (SM), very loose, wet, slight organic odor.		SS-09	[0]		WH-WH-1-WH
	Gray, GRAVEL, some fine to coarse sand, few silt (GM), medium dense, wet.		SS-10	[0]		7-13-10-7 (N = 23)
20		-13.8				

Undrained Shear Strength (psf): ★ VS Pk; ☆ VS Rem; ◆ PP; ■ Torv; ✳ Lab VS ⊠ Triax. 500 1000 1500 2000

PL (%) NM (%) LL (%)

▲ FINES (%) ● SPT (N-value) ✿ ORG (%)

10 20 30 40 50 60 70 80 90

0 10 20 30 40 50 60 70 80 90 100

BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Track rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/081012

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-02
DRILLED: 6/7/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC	Undrained Shear Strength (psf) ★ VS Pk; ☆ VS Rem; ◆ PP; ■ Torv; ✳ Lab VS ⊠ Triax. 500 1000 1500 2000 / PL (%) NM (%) LL (%) / ▲ FINES (%) ● SPT (N-value) ✿ ORG (%) 10 20 30 40 50 60 70 80 90	DEPTH (ft)
20	FLUVIAL DEPOSIT (Sand, Gravel, Silt) Gray, fine to coarse SAND, few silt and fine gravel, changing to orange-brown fine to coarse SAND, some gravel, few silt, (SW-SM), medium dense, wet.		-13.8	SS-11 [0]		9-17-13-18 (N = 30)		20
25	Brown fine to coarse SAND with gravel, trace silt (SP), medium dense, wet.		-18.8	SS-12 []		18-12-14-35 (N = 26)	▲	25
	Bottom of Exploration at 27 ft bgs.							
30			-23.8					30
35			-28.8					35
40			-33.8				0 10 20 30 40 50 60 70 80 90 100	40

BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Track rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-02
DRILLED: 6/7/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLE IDENT [PID (ppm)]	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
0	FILL (Sand, Silt, Gravel, Debris)	9.4			
	Brown, fine to coarse SAND, few to little silt, trace to few gravel (SP-SM/SM), medium dense, moist. -1.0' to 2.0' bgs: fractured cobble		SS-01 [0]		2-5-10-6 (N = 15)
	- 2.0' to 2.2' bgs: fractured cobble and asphalt Brown, fine to medium SAND, few silt (SP-SM), medium dense, moist.		SS-02 [0]		5-6-7-8 (N = 13)
	Dark brown to reddish brown, fine to medium SAND, some silt, with organics (PT-SM), no to low plasticity, loose, wet.				
5		4.4	SS-03 [0]		6-4-3-6 (N = 7)
	Dark brown, fine to coarse SAND, little fine gravel, few silt and organics (SW-SM), wet, slight organic odor.				
	MARSH DEPOSIT (Silt, Sand, Organics/Peat) Grayish-brown, SILT, some fine to coarse sand (ML), medium stiff, wet, low plasticity, rapid dilatancy.		SS-04 [0]		4-4-1-1 (N = 5)
	Grayish-brown, coarse SAND, some silt, trace to few gravel (SM), very loose, wet.		SS-05 [0]		2-1-WH-1
10	Grayish-brown, SILT, few fine sand (ML), soft, wet.	-0.6	SS-06 [0]		2-1-2-1 (N = 3)
	Brown, SAND with silt and gravel (SP-SM)				
	Dark brown, SILT with sand and organics (OH)		ST-07 []		
	Grayish-brown, fine to coarse SAND, some silt, little gravel (SM), very loose, wet.				
15		-5.6	SS-08 [0]		2-1-1-2 (N = 2)
	Dark grayish-brown, SILT with organics, trace fine sand (OH), low plasticity, slow dilatancy, soft, wet, strong organic odor.		SS-09 [0.1]		2-1-1-2 (N = 2)
	Similar to SS-09, strong organic odor.				
20		-10.6	SS-10 [0]		WH-WH-2-2

Undrained Shear Strength (psf): ★ VS Pk; ☆ VS Rem; ◆ PP; ■ Torv; ✳ Lab VS ⊠ Triax. (500, 1000, 1500, 2000)

PL (%) NM (%) LL (%)

▲ FINES (%) ● SPT (N-value) ✿ ORG (%)

10 20 30 40 50 60 70 80 90

0 10 20 30 40 50 60 70 80 90 100

BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Track rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/081012

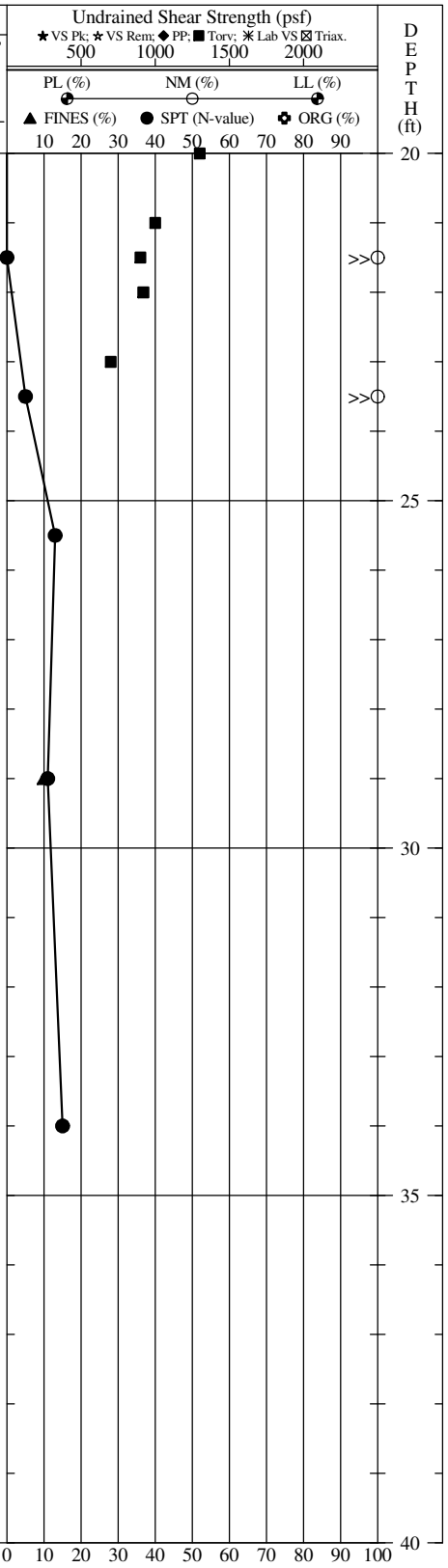
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-03
DRILLED: 6/6/12 - 6/7/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
20	MARSH DEPOSIT (Silt, Sand, Organics/Peat) Similar to SS-09, strong organic odor.		-10.6			
				SS-11 [0]		WH-WH-2-2
	Similar to SS-09, slight organic odor.					
				SS-12 [0]		WH-2-3-4 (N = 5)
	FLUVIAL DEPOSIT (Sand, Gravel, Silt)					
25			-15.6			
	Gray, fine to coarse SAND, trace silt and fine gravel (SW), medium dense, wet, slight organic odor.			SS-13 [0]		7-7-6-7 (N = 13)
	Orange-brown, fine to medium SAND, few silt (SW-SM), medium dense, wet, no odor.			SS-14 [0]		4-5-6-4 (N = 11)
30			-20.6			
	Similar to SS-14, brown, trace gravel.			SS-15 [0]		7-8-7-9 (N = 15)
35	Bottom of Exploration at 35 ft bgs.		-25.6			
40			-30.6			



BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Track rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-03
DRILLED: 6/6/12 - 6/7/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC	PL (%) NM (%) LL (%) ▲ FINES (%) ● SPT (N-value) ✪ ORG (%) 10 20 30 40 50 60 70 80 90	DEPTH (ft)
0	Topsoil, frequent organics		5.7					0
	FILL (Sand, Silt, Gravel, Debris) Brown, fine to coarse SAND, few to little silt, trace to few gravel (SW-SM/SM), very loose, moist.			SS-01 [0]		1-1-1-2 (N = 2)		
	MARSH DEPOSIT (Silt, Sand, Organics/Peat)							
	Dark brown, fine SAND and fibrous ORGANICS, some silt (SM/PT), very loose, moist to wet.			SS-02 [0]		1-WH-1-1		
	Dark gray, fine to coarse SAND, little gravel, little silt (SM), transitioning to black, decomposed organic fibers (PT), very loose, wet, moderate to strong organic odor.							
5			0.7	SS-03 [0]		1-1-1-1 (N = 2)		5
	Dark gray, fine to coarse SAND, few silt and fine gravel (SW-SM), changing to black fine SAND and ORGANICS, some silt (SM/PT), very loose, wet.			SS-04 [0]		1-1-1-1 (N = 2)		
	Similar to SS-04.			SS-05 [4.8]		3-2-1-1 (N = 3)		
10	Dark gray, GRAVEL, little fine to coarse sand, few silt (GM), very loose, wet, changing to dark gray, SILT, some fine sand (OL), slow dilatancy, low to medium plasticity, wet.		-4.3	SS-06 [0]		1-1-1-3 (N = 2)		10
	Similar to SS-06 with trace organics(GM/OL), coarse gravel in spoon.							
	FLUVIAL DEPOSIT (Sand, Gravel, Silt)			SS-07 [0]		1-1-1-1 (N = 2)		
	Dark gray, fine to coarse SAND, little gravel, little silt (SM), loose, wet.							
15			-9.3	SS-08 [0]		3-2-5-5 (N = 7)		15
	Grayish-brown, fine to coarse SAND, trace silt, trace gravel (SW), loose, wet.			SS-09 [0]		8-3-6-4 (N = 9)		
20			-14.3				0 10 20 30 40 50 60 70 80 90 100	20

BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Track rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/081012

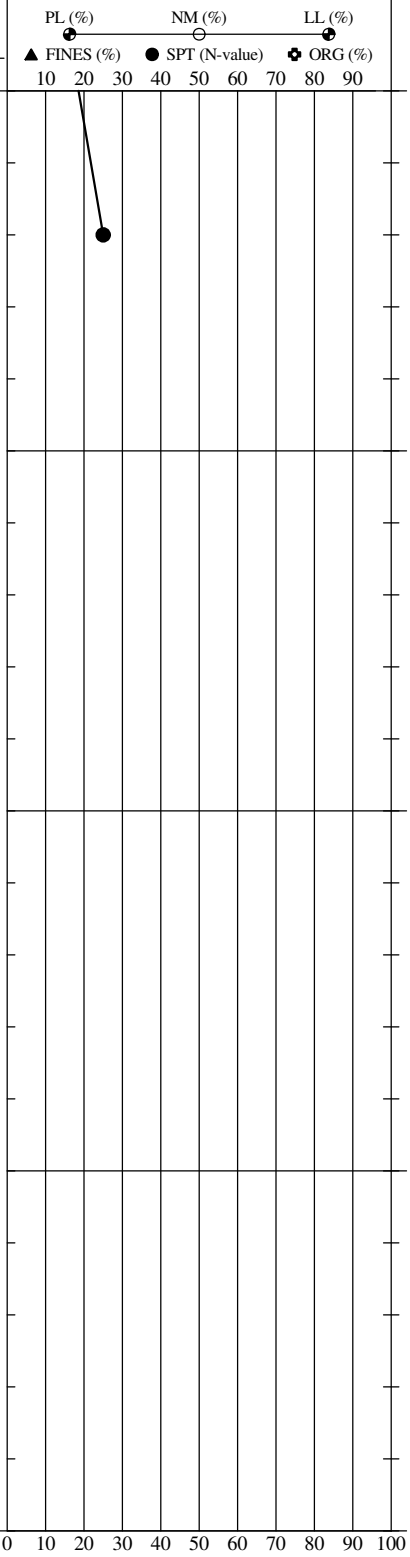
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-04
DRILLED: 6/6/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
20	FLUVIAL DEPOSIT (Sand, Gravel, Silt)		-14.3			
	Brown, fine to coarse SAND, little gravel, trace silt (SW), medium dense, wet.			SS-10 [0]		10-12-13-13 (N = 25)
	Bottom of Exploration at 23 feet bgs.					
25			-19.3			
30			-24.3			
35			-29.3			
40			-34.3			



BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Track rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

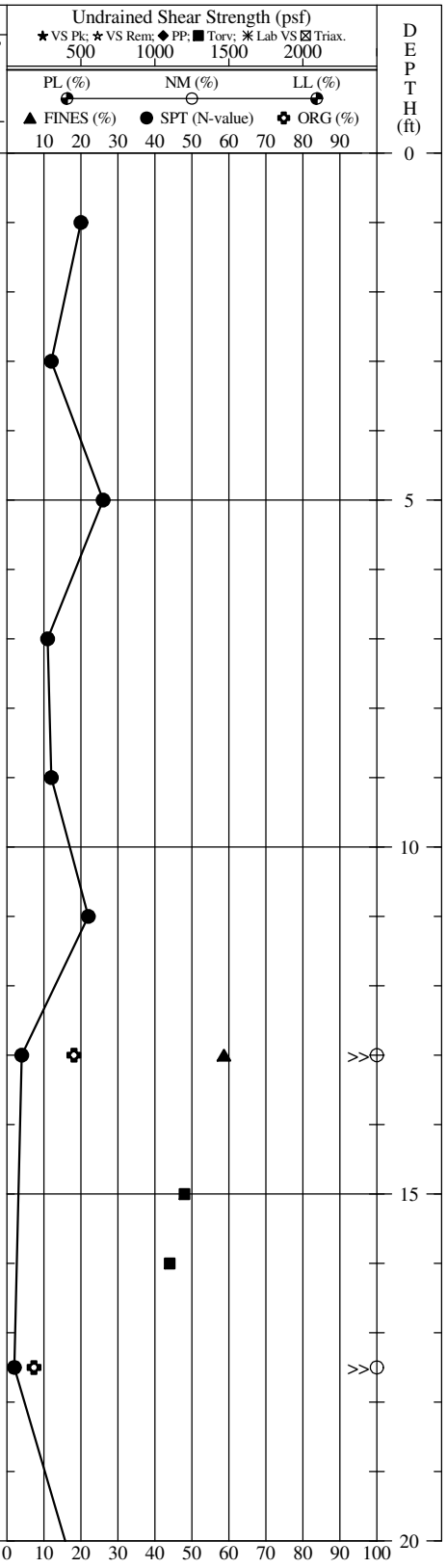
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-04
DRILLED: 6/6/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	IDENT	PID (ppm)	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
0	Topsoil, frequent organics	11.2				
	FILL (Sand, Silt, Gravel, Debris) Brown, fine to coarse SAND, few to little silt and gravel (SW-SM/SM), medium dense, moist.		SS-01	[0]		2-5-15-13 (N = 20)
	- 2.0' to 4.0' bgs: occasional organics (roots) - 2.1' to 2.4' bgs: fractured cobble		SS-02	[0]		13-8-4-5 (N = 12)
5	Dark brown to dark reddish brown, fine SAND, some silt (SM), medium dense, moist. - 5.0' to 6.0' bgs: occasional brick fragments and staining	6.2	SS-03	[0]		7-14-12-6 (N = 26)
			SS-04	[0]		5-5-6-7 (N = 11)
	Dark grayish brown, fine to coarse SAND, few/little silt and gravel (SM), medium dense, wet. - 8.0' to 8.7' bgs: brick fragment		SS-05	[0.1]		7-6-6-3 (N = 12)
10	Dark gray, fine to coarse SAND, few silt (SW-SM), medium dense, wet. - 10.0' to 12.4' bgs: frequent brick fragments and wood. - Note: Poor recovery in SS-06 and SS-07. Borehole was moved a few feet and resampled at those depths.	1.2	S3-06A	[]	a	17-14-8-6 (N = 22)
	MARSH DEPOSIT (Silt, Sand, Organics/Peat) Black, SILT, some fine to coarse sand with organics (OH), soft, moist, strong organic odor, wood fragment in tip.		S3-07A	[0]	a	7-2-2-4 (N = 4)
	Note: Shelby tube had no recovery. SS sample taken through tube depth. Sample descriptions obtained and torvanes performed on recovered sample.					
15	Grayish-brown, SILT with organics, trace fine sand (OH), low to medium plasticity, slow dilatancy, moist.	-3.8	ST-08	[0]		
	Similar to SS-08, saturated, soft.		SS-09	[0]		1-1-1-2 (N = 2)
	Sampled through vane test interval: 18.5 to 20.5': Grayish-brown, fine to coarse SAND, some silt, trace organics (SM), non-plastic, wet. - 19.5' to 20.5': Grayish-brown fine SAND, few silt, with organics (OH), wet, medium plasticity, slow dilatancy, strong organic odor.		S3-10	[0.3]	a	
20		-8.8				



BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Truck rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/081012

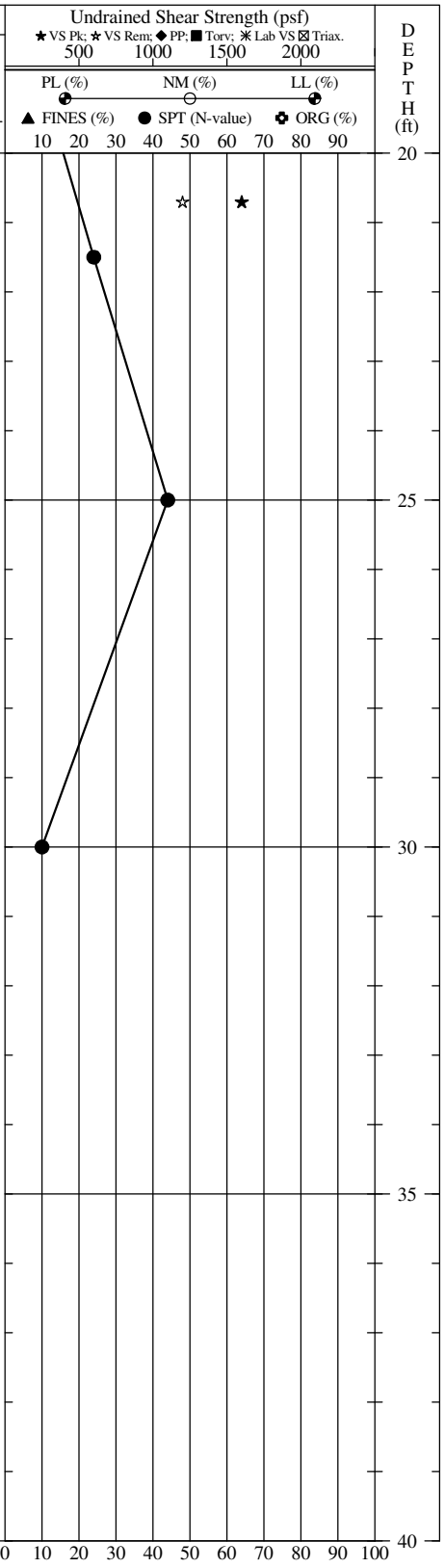
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-05
DRILLED: 6/4/12 - 6/5/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
20	MARSH DEPOSIT (Silt, Sand, Organics/Peat) VS-1 at 20.0' bgs: Su => 1600 psf (sand layer) VS-1 at 20.0' bgs: Sremolded = 1200 psf (sand layer)		-8.8			
	FLUVIAL DEPOSIT (Sand, Gravel, Silt) - 20.5' to 22.0' bgs: Grayish-brown, fine to coarse SAND, little gravel, few silt (SW-SM) - 22.0' to 22.5' bgs: Orange-brown, fine to coarse SAND, some gravel, few silt (SW-SM), medium dense, wet.			SS-11 [0]		10-12-12-10 (N = 24)
	Reddish-brown, fine to coarse SAND, some gravel, trace silt (SW), dense, wet.					
25			-13.8	SS-12 [0]		16-23-21-22 (N = 44)
	Brown, fine to coarse SAND, few gravel, trace silt (SW), loose, wet.					
30			-18.8	SS-13 [0]		4-4-6-6 (N = 10)
	Bottom fo Exploration at 31 feet bgs.					
35			-23.8			
40			-28.8			



BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Truck rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

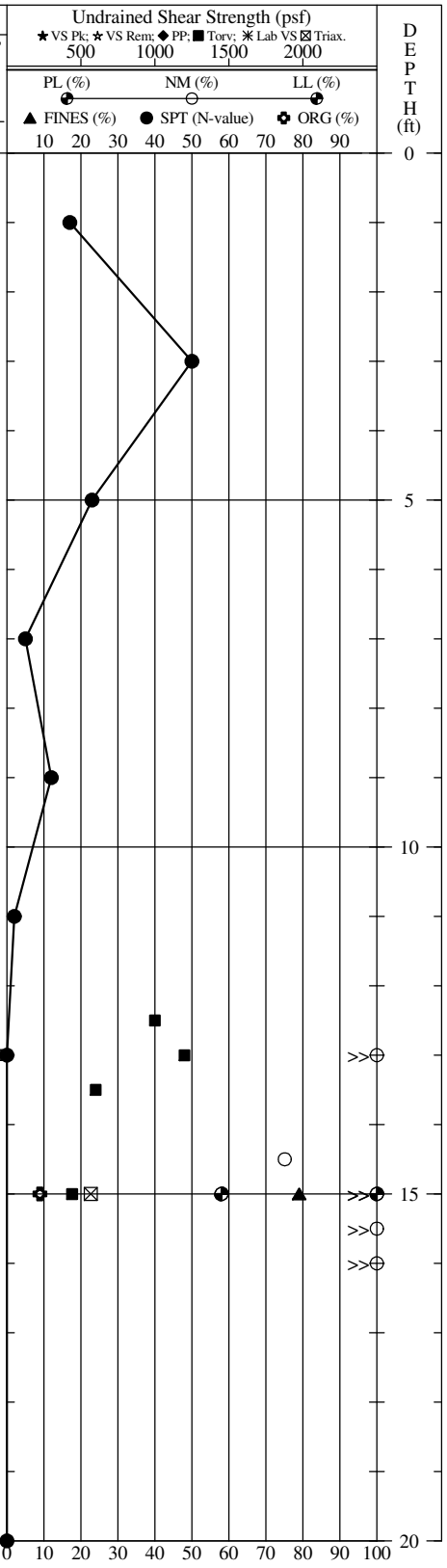
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-05
DRILLED: 6/4/12 - 6/5/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLE IDENT	PID (ppm)	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
0	Topsoil, frequent organics	8.3				
	FILL (Sand, Silt, Gravel, Debris) - 0.8' to 1.1' bgs: fractured cobble Light brown to dark brown, fine to coarse SAND, few to little silt, trace to little gravel (SW-SM/SM), medium dense to dense, dry to moist. - 2.0' to 6.0' bgs: occasional to frequent brick and asphalt fragments, organics - 2.0' to 3.0' bgs: organics		SS-01	[0]		1-9-8-10 (N = 17)
			SS-02	[0]		35-30-20-24 (N = 50)
5		3.3	SS-03	[0.6]		8-13-10-7 (N = 23)
	Gray, fine to coarse SAND, some silt, few gravel, occasional organics (SM), loose to medium dense, wet.		SS-04	[0.1]		5-3-2-2 (N = 5)
	- 8.0' to 10' bgs: frequent asphalt fragments		SS-05	[0.4]		10-7-5-1 (N = 12)
10	MARSH DEPOSIT (Silt, Sand, Organics/Peat)	-1.7				
	No recovery		SS-06	[]		WH-1-1-1 (N = 2)
	Grayish-brown, SILT with organics, trace fine sand (OH), medium plasticity, slow dilatancy, very soft, wet.		SS-07	[0]		WH-WH-WH-WH
	Similar to SS-07					
15		-6.7	ST-08	[0]		
	- sample was difficult to extract; likely disturbed		ST-09	[0]		
	FLUVIAL DEPOSIT (Sand, Gravel, Silt)					
	Dark grayish-brown, fine to coarse SAND, some silt, few gravel, with organic fibers (SM), very loose, wet, slight organic odor.					
20		-11.7				



BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Truck rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/081012

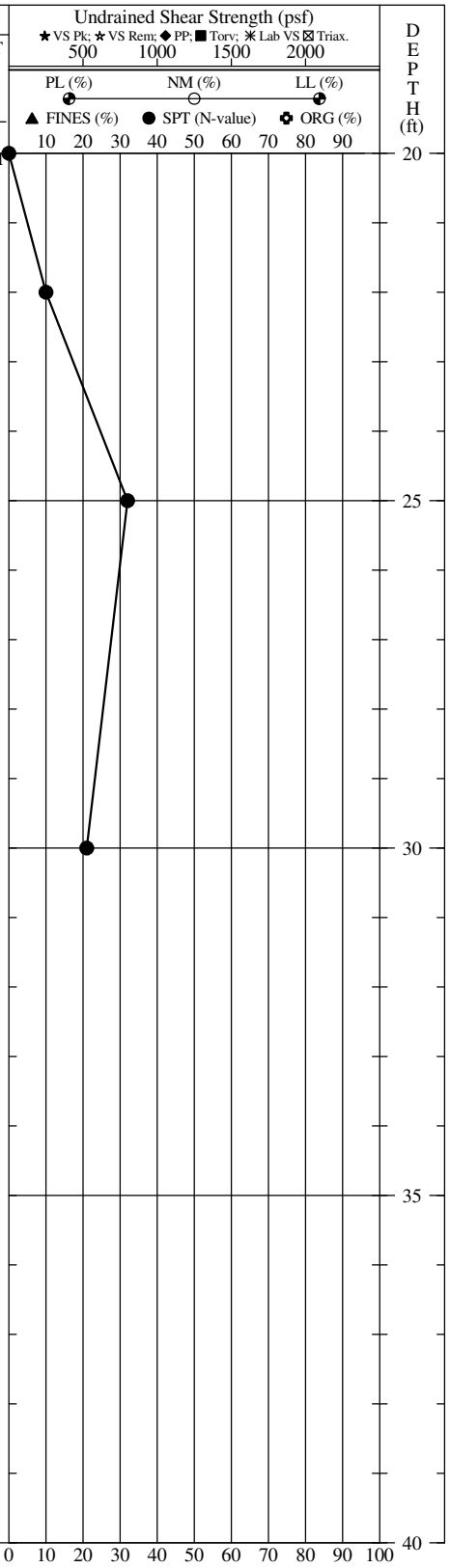
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-06
DRILLED: 6/1/12 - 6/4/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
20	FLUVIAL DEPOSIT (Sand, Gravel, Silt)		-11.7	SS-10 []		1-WH-WH-WH
	Grayish-brown, fine to coarse SAND, little silt, few gravel (SM) changing to brown GRAVEL, some fine to coarse sand, little silt (GM), loose, wet.			SS-11 []		1-5-5-4 (N = 10)
	Orange-brown, fine to coarse SAND, little silt, little to some gravel (SW-SM), dense, wet.					
25			-16.7	SS-12 []		5-16-16-8 (N = 32)
30	Similar to SS-12 changing to Grayish-brown, SILT, some fine sand (ML), non-plastic, medium dense, wet.		-21.7	SS-13 []		15-10-11-7 (N = 21)
	Bottom of Exploration at 31 ft bgs.					
35			-26.7			
40			-31.7			



BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Truck rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

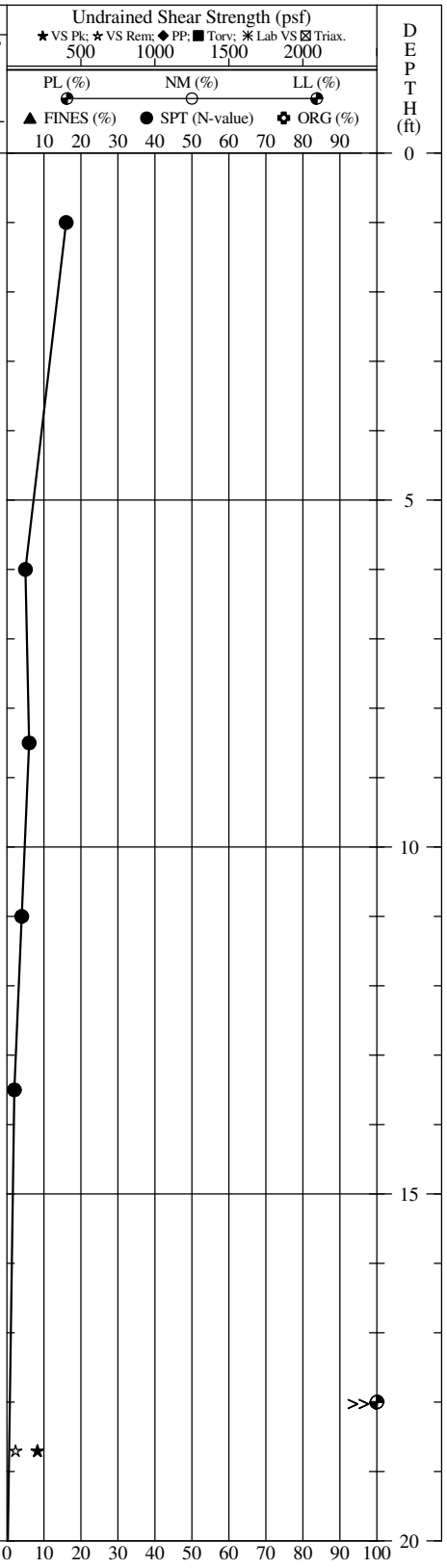
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-06
DRILLED: 6/1/12 - 6/4/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLE IDENT	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
0	Topsoil	7.3			
	FILL Orange brown to dark brown, fine to coarse SAND, little to some silt, few gravel, medium dense, moist (SM)		SS-1		1-4-12-20 (N = 16)
5	Dark gray, fine to coarse SAND, little to some silt, trace to little gravel, loose, wet (SM)	2.3	SS-2		5-2-3-2 (N = 5)
	Similar to SS-2		SS-3		2-3-3-2 (N = 6)
10	Similar to SS-2	-2.7	SS-4		4-3-1-2 (N = 4)
	Grayish brown, SILT/CLAY, some fine sand, medium stiff, wet (ML/CL) Dark gray, fine SAND, some silt, little gravel, loose, (SM)		SS-5		4-1-1-2 (N = 2)
15	MARSH DEPOSIT Grayish brown to dark brown, ORGANIC SILT, few fine sand, very soft to medium stiff, wet, low to moderate plasticity (OH) - occasional to frequent organics	-7.7	ST-6		
			VS-7		
20		-12.7			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	Rotary Wash with Water (Cased) to 30' bgs.
HOLE DIAM.:	4"
SPTs:	Automatic Hammer; NW rods
REMARKS:	Backfilled w/cement-bentonite grout.

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/3-28-13

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-07
DRILLED: 1/31/13 - 2/1/13
PROJECT: Former Raymark Industries (OU6)
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC	Undrained Shear Strength (psf) ★ VS Pk; ☆ VS Rem; ◆ PP; ■ Torv; ✳ Lab VS ⊠ Triax. 500 1000 1500 2000 / PL (%) NM (%) LL (%) / ▲ FINES (%) ● SPT (N-value) ✿ ORG (%) 10 20 30 40 50 60 70 80 90	DEPTH (ft)
20	MARSH DEPOSIT		-12.7					20
	Similar to ST-6			SS-8		WH-WH-1-2		
	Dark brown, ORGANIC SILT			ST-9			>>	
25			-17.7					25
	FLUVIAL SAND Gray to yellow brown, fine to coarse SAND, few to little silt, few gravel, loose to medium dense, wet (SW-SM/SM)			SS-10		3-2-6-11 (N = 8)		
30			-22.7					30
	Similar to SS-10			SS-11		6-3-6-7 (N = 9)		
	End of Exploration at 32' bgs							
35			-27.7					35
40			-32.7					40

0 10 20 30 40 50 60 70 80 90 100

BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER: ADT
RIG TYPE: Tracked CME-55 LC
METHOD: Rotary Wash with Water (Cased) to 30' bgs.
HOLE DIAM.: 4"
SPTs: Automatic Hammer; NW rods
REMARKS: Backfilled w/cement-bentonite grout.

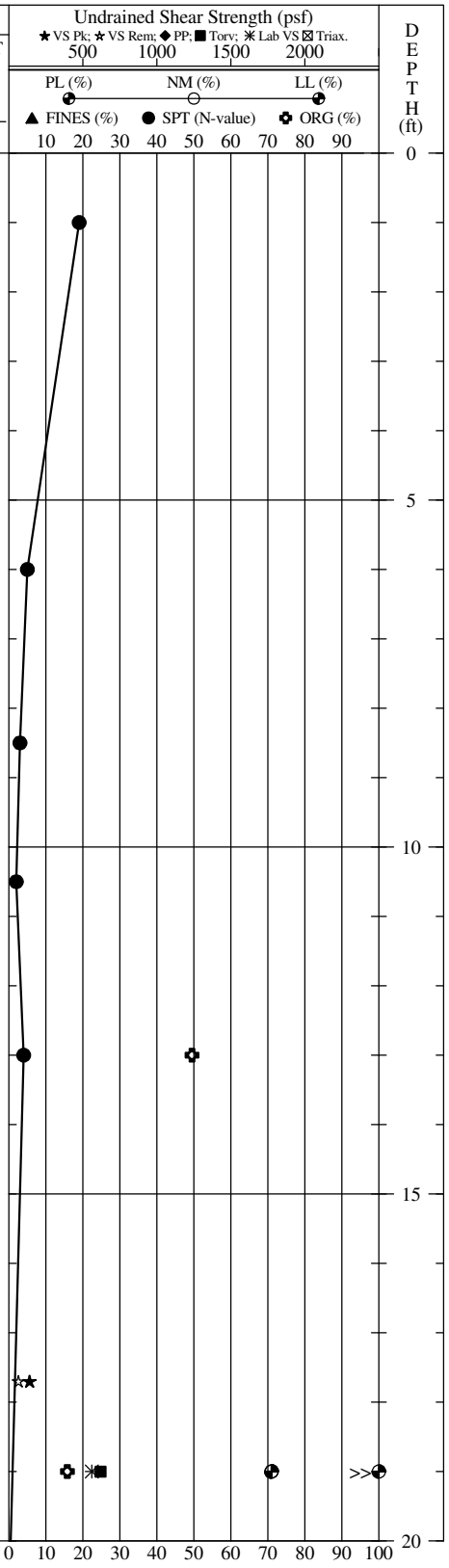
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-07
DRILLED: 1/31/13 - 2/1/13
PROJECT: Former Raymark Industries (OU6)
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLE IDENT	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
0	Topsoil	7.9			
	FILL Gray, GRAVEL, some fine to coarse sand, few silt, medium dense, dry (GP-GM)		SS-1		10-10-9-10 (N = 19)
5	Grayish brown, fine SAND, some silt, little gravel, very loose to loose, wet (SM) - 5.0' to 7.0' bgs: occasional organics	2.9	SS-2		4-3-2-3 (N = 5)
	SS-3: no recovery		SS-3		4-2-1-WH (N = 3)
10		-2.1	SS-4		2-1-1-2 (N = 2)
	Grayish brown, fine to medium SAND, little gravel, few silt, loose, wet (SP-SM)				
	MARSH DEPOSIT Brown, ORGANIC SILT, some fine sand, soft, wet, non-plastic (OH)		SS-5		8-2-2-2 (N = 4)
15		-7.1	ST-6		
	Grayish brown, ORGANIC SILT, few fine sand, very soft to medium stiff, wet, low to moderate plasticity (OH) - 16.0' to 22.0' bgs: occasional to frequent organics		VS-7		
	Similar to VS-7		ST-8		
20		-12.1			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER: ADT
RIG TYPE: Tracked CME-55 LC
METHOD: Rotary Wash with Water (Cased) to 33' bgs.
HOLE DIAM.: 4"
SPTs: Automatic Hammer; NW rods
REMARKS: Backfilled w/cement-bentonite grout.

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/3-28-13

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-08
DRILLED: 1/30/13 - 1/31/13
PROJECT: Former Raymark Industries (OU6)
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC	Undrained Shear Strength (psf) ★ VS Pk; ☆ VS Rem; ◆ PP; ■ Torv; ✳ Lab VS ⊠ Triax. (500, 1000, 1500, 2000)
20	MARSH DEPOSIT		-12.1				
	Similar to ST-8			SS-9		WH-WH-WH-3	
	Similar to SS-9			SS-10		WH-WH-2-2	
25	- 25.0' bgs: becomes brown to dark brown		-17.1				
	Similar to SS-10			SS-11		WH-WH-WH-1	
	FLUVIAL SAND Gray, fine to coarse SAND, fet to little gravel, few silt, loose to dense, wet (SW-SM)			SS-12		20-21-19-22 (N = 40)	
30			-22.1				
	SS-13: no recovery			SS-13		10-5-3-3 (N = 8)	
	Gray, SILT/CLAY, some fine sand, stiff, wet, low plasticity (ML/CL)						
	Gray, fine SAND, some silt, medium dense, wet (SM)			SS-14		7-15-14-6 (N = 29)	
35	End of Exploration at 35' bgs		-27.1				
40			-32.1				

Undrained Shear Strength (psf): 500 1000 1500 2000

PL (%) NM (%) LL (%)

▲ FINES (%) ● SPT (N-value) ✪ ORG (%)

10 20 30 40 50 60 70 80 90

0 10 20 30 40 50 60 70 80 90 100

BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	Rotary Wash with Water (Cased) to 33' bgs.
HOLE DIAM.:	4"
SPTs:	Automatic Hammer; NW rods
REMARKS:	Backfilled w/cement-bentonite grout.

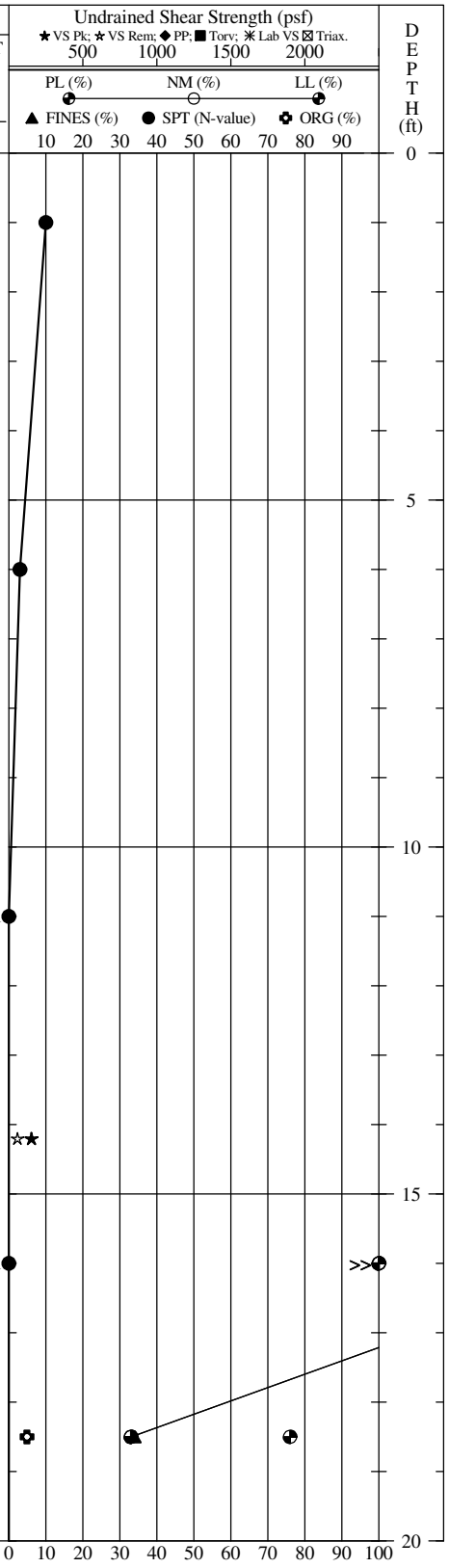
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.:	GB-08
DRILLED:	1/30/13 - 1/31/13
PROJECT:	Former Raymark Industries (OU6)
LOCATION:	Stratford, CT
PROJECT NO.:	3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
0	Topsoil		7.9			
	FILL Light brown, fine to medium SAND, few silt, medium dense, dry (SM) - occasional asphalt and concrete debris			SS-1		20-6-4-9 (N = 10)
	MARSH DEPOSIT					
5	Dark grayish brown, SILT, few fine sand, soft to medium stiff, wet, low plasticity (OH) - occasional to some organics		2.9	SS-2		2-2-1-2 (N = 3)
				ST-3		
10	Grayish brown, ORGANIC SILT/CLAY, few fine sand, very soft to soft, wet, low to moderate plasticity (CH/OH) - some to frequent organics		-2.1	SS-4		WH-WH-WH-1
				VS-5		
15	Similar to SS-4		-7.1	SS-6		WH-WH-WH-1
	Dark brown, ORGANIC CLAY			ST-7		
	FLUVIAL SAND					
20			-12.1			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	Rotary Wash with Water and/or Mud (Cased) to 67' bgs.
HOLE DIAM.:	4"; 3"
SPTs:	Automatic Hammer; NW rods
REMARKS:	Casing advanced to ~ 67' bgs. Abandon hole during roller bitting at ~ 60' bgs due to detached drive shoe/casing. Backfilled w/cement-bentonite grout.

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/3-28-13

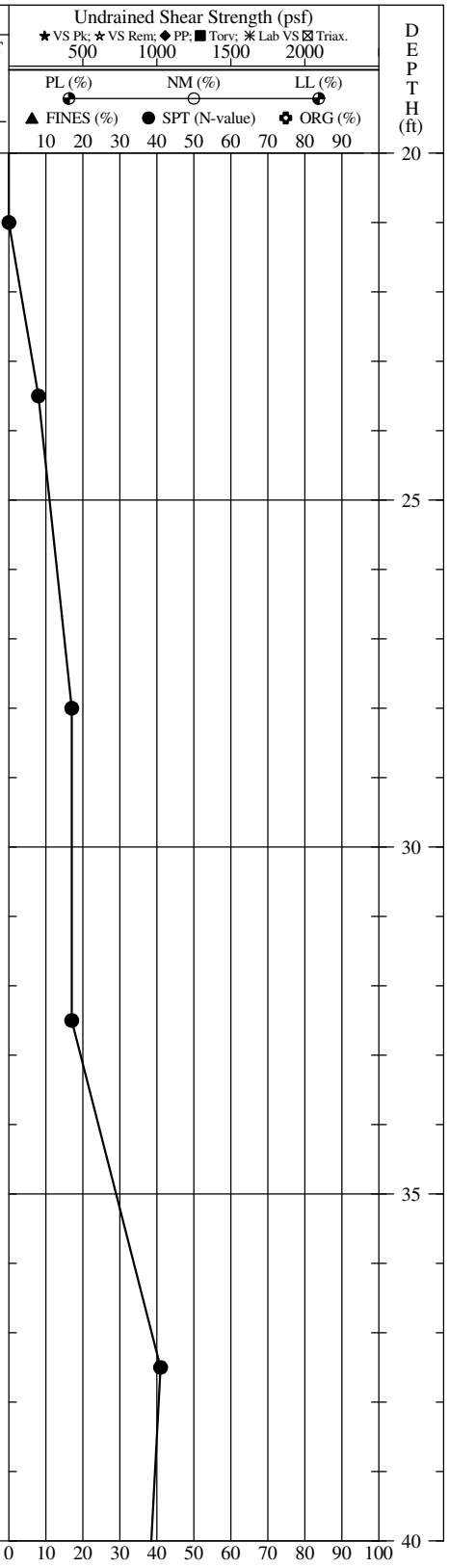
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.:	GB-09
DRILLED:	2/1/13 - 2/5/13
PROJECT:	Former Raymark Industries (OU6)
LOCATION:	Stratford, CT
PROJECT NO.:	3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLE IDENT	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
20	FLUVIAL SAND Gray, fine to coarse SAND, few to little silt, trace gravel, very loose, wet (SW-SM/SM)	-12.1	SS-8		WH-1-WH-1
	- 22.5' bgs: little gravel, becomes loose		SS-9		3-2-6-15 (N = 8)
25		-17.1			
	- 27.0' bgs: becomes grayish brown to orange brown, medium dense (SW-SM)		SS-10		3-7-10-14 (N = 17)
30		-22.1			
	Similar to SS-10		SS-11		7-9-8-6 (N = 17)
35		-27.1			
	- 36.5' bgs: becomes dense		SS-12		35-20-21-20 (N = 41)
40		-32.1			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	Rotary Wash with Water and/or Mud (Cased) to 67' bgs.
HOLE DIAM.:	4"; 3"
SPTs:	Automatic Hammer; NW rods
REMARKS:	Casing advanced to ~ 67' bgs. Abandon hole during roller bitting at ~ 60' bgs due to detached drive shoe/casing. Backfilled w/cement-bentonite grout.

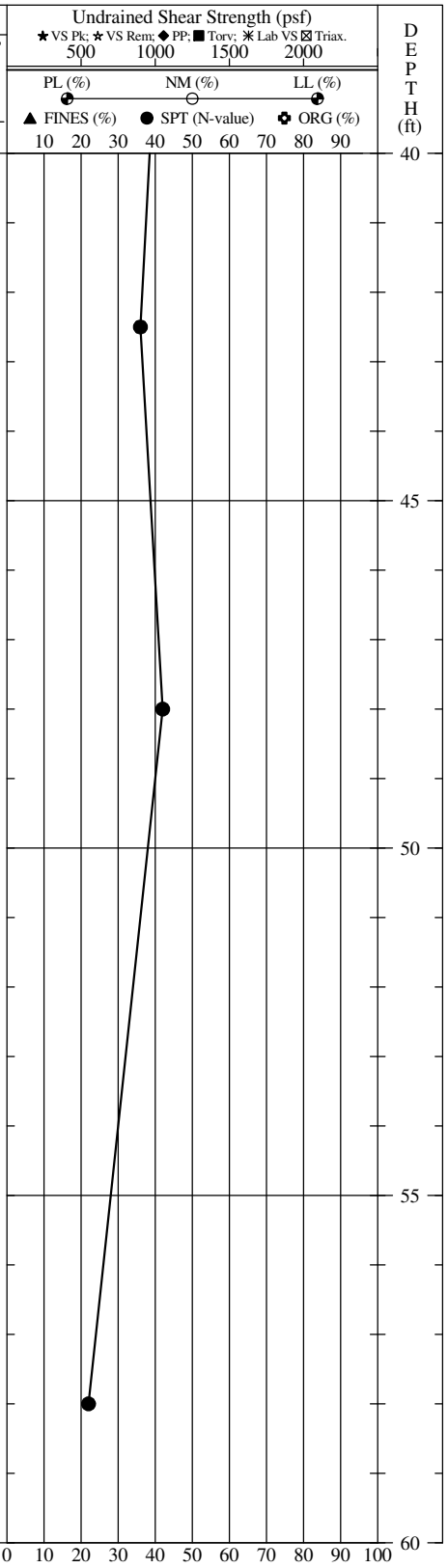
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.:	GB-09
DRILLED:	2/1/13 - 2/5/13
PROJECT:	Former Raymark Industries (OU6)
LOCATION:	Stratford, CT
PROJECT NO.:	3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
40	FLUVIAL SAND	-32.1			
	Similar to SS-12		SS-13		16-16-20-20 (N = 36)
45		-37.1			
	- 47.0' bgs: becomes light brown				
	Similar to SS-13		SS-14		14-23-19-16 (N = 42)
50		-42.1			
55		-47.1			
	Light brown to orange brown, fine to coarse SAND, few gravel, trace silt, medium dense, wet (SW)		SS-15		8-11-11-13 (N = 22)
60		-52.1			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	Rotary Wash with Water and/or Mud (Cased) to 67' bgs.
HOLE DIAM.:	4"; 3"
SPTs:	Automatic Hammer; NW rods
REMARKS:	Casing advanced to ~ 67' bgs. Abandon hole during roller bitting at ~ 60' bgs due to detached drive shoe/casing. Backfilled w/cement-bentonite grout.

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.:	GB-09
DRILLED:	2/1/13 - 2/5/13
PROJECT:	Former Raymark Industries (OU6)
LOCATION:	Stratford, CT
PROJECT NO.:	3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC	Undrained Shear Strength (psf) ★ VS Pk; ☆ VS Rem; ◆ PP; ■ Torv; ✳ Lab VS ⊠ Triax. 500 1000 1500 2000	DEPTH (ft)
60	FLUVIAL SAND		-52.1					60
65			-57.1					65
	End of Exploration at 67' bgs							
70			-62.1					70
75			-67.1					75
80			-72.1					80

PL (%) NM (%) LL (%)
▲ FINES (%) ● SPT (N-value) ✿ ORG (%)
10 20 30 40 50 60 70 80 90
0 10 20 30 40 50 60 70 80 90 100

BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	Rotary Wash with Water and/or Mud (Cased) to 67' bgs.
HOLE DIAM.:	4"; 3"
SPTs:	Automatic Hammer; NW rods
REMARKS:	Casing advanced to ~ 67' bgs. Abandon hole during roller bitting at ~ 60' bgs due to detached drive shoe/casing. Backfilled w/cement-bentonite grout.

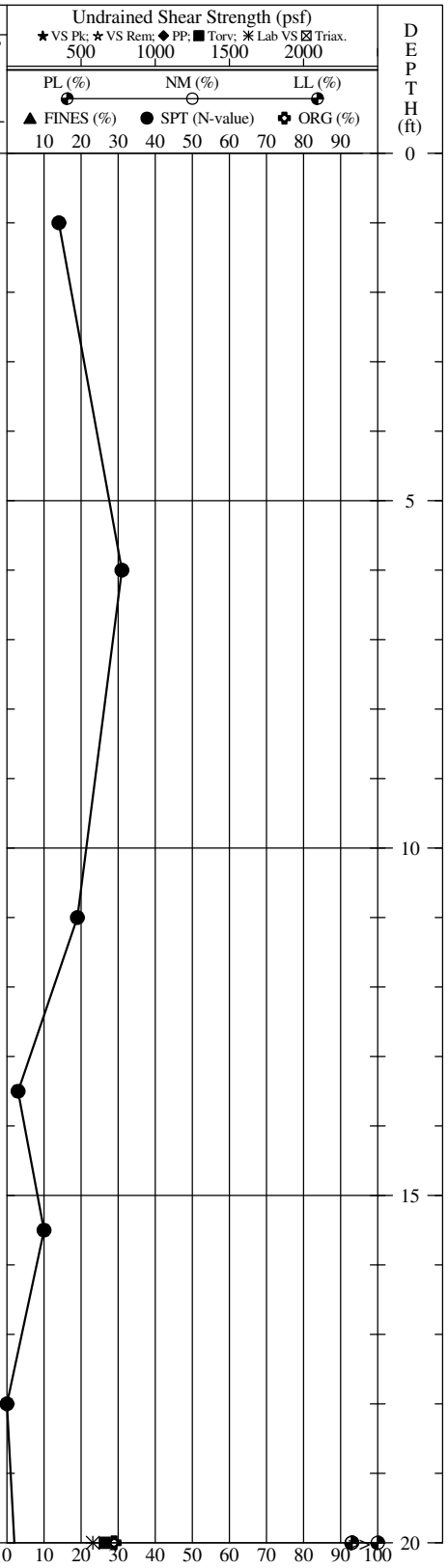
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-09
DRILLED: 2/1/13 - 2/5/13
PROJECT: Former Raymark Industries (OU6)
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLE IDENT	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
0	Topsoil	10.8			
	FILL Light brown, fine to coarse SAND, little silt and gravel, medium dense, dry (SM) - 0.5' to 2.0' bgs: occasional concrete fragments		SS-1		1-5-9-14 (N = 14)
5	Dark gray, fine to coarse SAND, little silt and gravel, dense, wet (SM) - 5.0' to 7.0' bgs: occasional debris	5.8	SS-2		5-13-18-11 (N = 31)
10	Yellowish gray to dark gray, fine to medium SAND, little silt, few gravel, medium dense, wet (SM) - 10.0' to 12.0' bgs: occasional debris - 12.5' to 14.5' bgs: very loose	0.8	SS-3		6-9-10-6 (N = 19)
	SS-4: no recovery		SS-4		6-2-1-2 (N = 3)
15	Dark grayish brown, fine to coarse SAND, little silt, trace fine gravel, medium dense, wet (SM)	-4.2	SS-5		9-7-3-3 (N = 10)
	MARSH DEPOSIT Brownish gray, ORGANIC SILT, little fine sand, very soft to medium stiff, wet, low plasticity (OH) - occasional organics		SS-6		WH-WH-WH-3
	- 19.0' to 21.0' bgs: stiff				
20		-9.2			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER: ADT
RIG TYPE: Tracked CME-55 LC
METHOD: Rotary Wash with Water (Cased) to 25' bgs.
HOLE DIAM.: 4"
SPTs: Automatic Hammer; NW rods
REMARKS: Backfilled w/cement-bentonite grout.

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/3-28-13

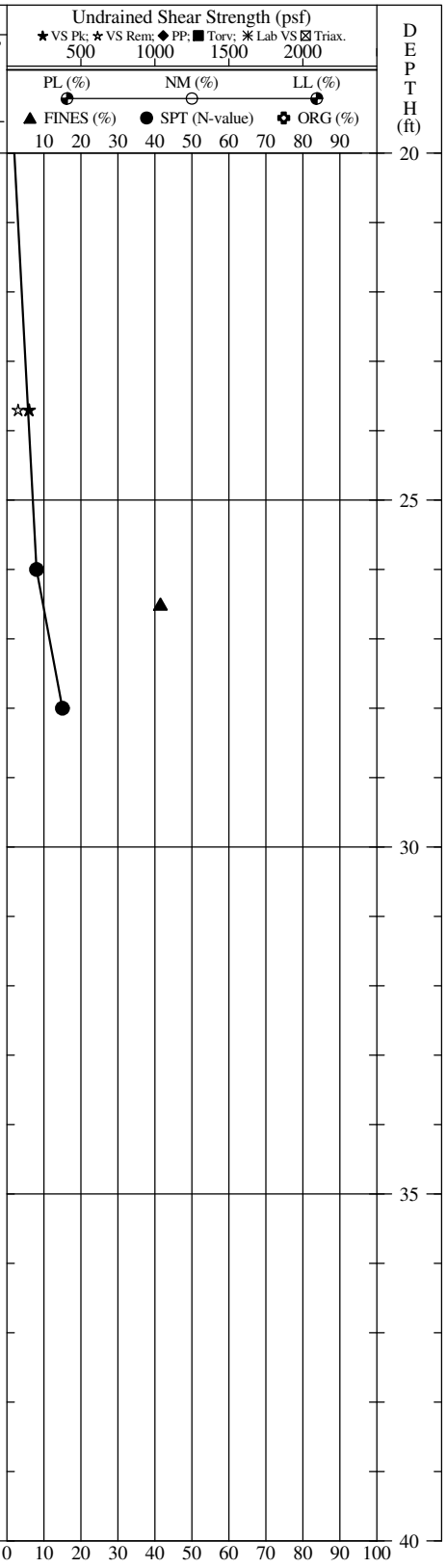
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-10
DRILLED: 1/30/13
PROJECT: Former Raymark Industries (OU6)
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
20	MARSH DEPOSIT Black, ORGANIC SILT		-9.2	ST-7		
	Brownish gray, ORGANIC SILT, few fine sand, very soft, wet, low to moderate plasticity (OH)			VS-8		
25	- 25.0' bgs: soft		-14.2			
	FLUVIAL SAND Grayish brown, fine SAND, some silt, loose, wet (SM)			SS-9		WH-2-6-11 (N = 8)
	Gray, fine to coarse SAND, few silt, little gravel, medium dense, wet (SW-SM)			SS-10		7-8-7-6 (N = 15)
	End of Exploration at 29' bgs					
30			-19.2			
35			-24.2			
40			-29.2			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	Rotary Wash with Water (Cased) to 25' bgs.
HOLE DIAM.:	4"
SPTs:	Automatic Hammer; NW rods
REMARKS:	Backfilled w/cement-bentonite grout.

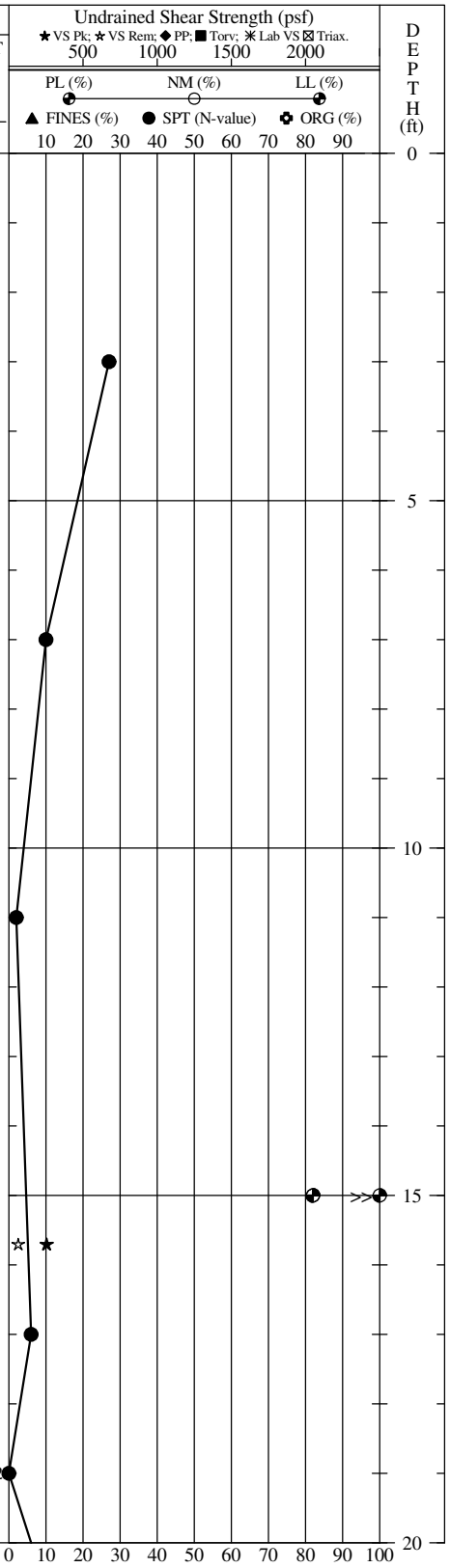
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.:	GB-10
DRILLED:	1/30/13
PROJECT:	Former Raymark Industries (OU6)
LOCATION:	Stratford, CT
PROJECT NO.:	3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLE IDENT [PID (ppm)]	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
0	FILL	7.8			
	Dark brown, fine to medium SAND, few silt and gravel, medium dense, dry to moist (SP-SM) - 2.0' to 4.0' bgs: occasional organics		SS-1 []		6-20-7-10 (N = 27)
5		2.8			
	Dark brown, fine to medium SAND, some gravel, few silt, loose to medium dense, wet (SM) - 6.0' to 8.0' bgs: some wood debris		SS-2 []		12-7-3-6 (N = 10)
	MARSH DEPOSIT				
10	Grayish brown, ORGANIC SILT, few to little fine sand, very soft to medium stiff, wet, moderate plasticity (OH) - some to frequent organics	-2.2	SS-3 [0.3]		1-1-1-1 (N = 2)
	Similar to SS-3		ST-4 []		
15		-7.2	VS-5 []		
	Brown, ORGANIC SILT, few fine to medium sand, soft to medium stiff, wet, low plasticity (OH) - some organics		SS-6 []		4-3-3-3 (N = 6)
	- 18.0' to 19.5' bgs: very soft		SS-7 []		WH-WH-WH-2
	FLUVIAL SAND				
20		-12.2			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	HSA to 5' bgs; Rotary Wash with Water (Cased) to 15'
HOLE DIAM.:	bgs; Rotary Wash with Water (Open-Hole) to 22' bgs.
SPTs:	4"
REMARKS:	Automatic Hammer; NW rods Backfilled w/cement-bentonite grout.

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/3-28-13

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-11
DRILLED: 1/28/13 - 1/29/13
PROJECT: Former Raymark Industries (OU6)
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC	Undrained Shear Strength (psf) ★ VS Pk; ☆ VS Rem; ◆ PP; ■ Torv; ✳ Lab VS ⊠ Triax. 500 1000 1500 2000 / PL (%) NM (%) LL (%) / ▲ FINES (%) ● SPT (N-value) ✿ ORG (%) 10 20 30 40 50 60 70 80 90	DEPTH (ft)
20	Gray, fine to medium SAND, some silt, trace fine gravel, loose, wet (SM) FLUVIAL SAND Gray to orange-brown, fine to coarse SAND, few gravel and silt, medium dense, wet (SW-SM)		-12.2	SS-8 []		3-4-8-9 (N = 12)		20
	End of Exploration at 22' bgs							
25			-17.2					25
30			-22.2					30
35			-27.2					35
40			-32.2				0 10 20 30 40 50 60 70 80 90 100	40

BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	HSA to 5' bgs; Rotary Wash with Water (Cased) to 15'
HOLE DIAM.:	bgs; Rotary Wash with Water (Open-Hole) to 22' bgs.
SPTs:	4"
REMARKS:	Automatic Hammer; NW rods Backfilled w/cement-bentonite grout.

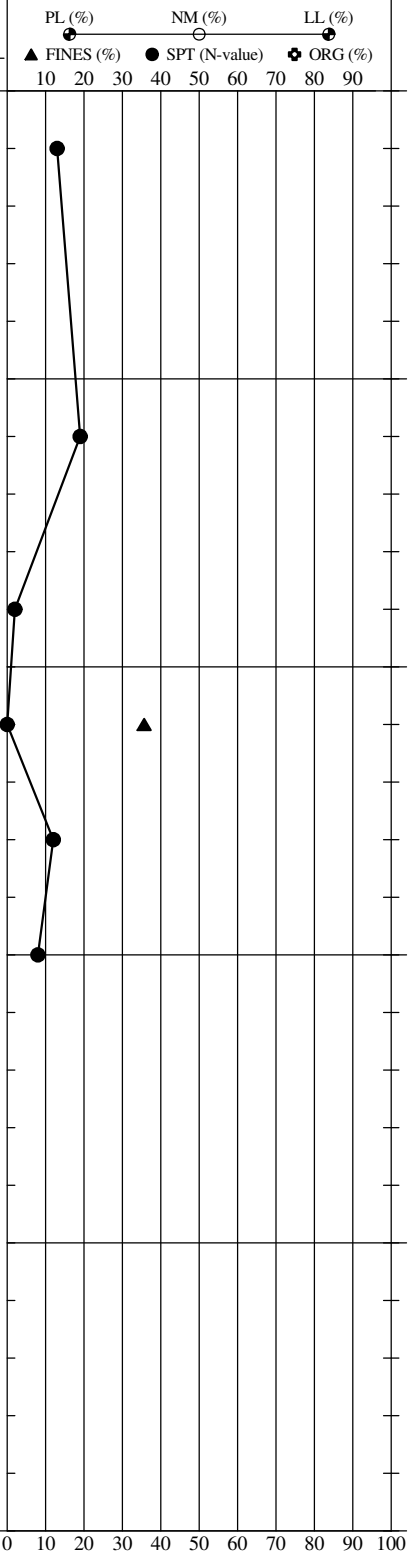
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-11
DRILLED: 1/28/13 - 1/29/13
PROJECT: Former Raymark Industries (OU6)
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
0	Topsoil		7.1			
	FILL Dark grayish brown, fine to medium SAND, some silt, little gravel, medium dense, moist, non-plastic (SM)			SS-1		3-6-7-6 (N = 13)
5	Gray, fine to medium SAND, little silt, trace fine gravel, medium dense, wet, non-plastic (SM) - 5.0' to 7.0' bgs: some concrete		2.1	SS-2		5-6-13-5 (N = 19)
	MARSH DEPOSIT Brownish gray, ORGANIC SILT, few fine sand, soft, wet, low to moderate plasticity (OH) - 8.0' to 11.5' bgs: occasional to frequent organics			SS-3		3-1-1-1 (N = 2)
10	- 10.0' to 11.5' bgs: fine to medium sand, some silt, trace gravel		-2.9	SS-4		WH-WH-1-2
	FLUVIAL SAND Brownish gray, fine to medium SAND, some silt, few gravel, loose, wet (SM) - 11.5' to 12.0' bgs: occasional organics Light brown, fine to coarse SAND, little silt, few gravel, medium dense, wet (SM)			SS-5		5-5-7-7 (N = 12)
15	Brown, fine to coarse SAND, few silt, loose, wet (SW-SM)		-7.9	SS-6		5-4-4-7 (N = 8)
	End of Exploration at 16' bgs					
20			-12.9			
25			-17.9			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER: ADT
RIG TYPE: Tracked CME-55 LC
METHOD: Rotary Wash with Water (Cased) to 14' bgs.
HOLE DIAM.: 4"
SPTs: Automatic Hammer; NW rods
REMARKS: Backfilled w/cement-bentonite grout.

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/3-28-13

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-12
DRILLED: 1/29/13
PROJECT: Former Raymark Industries (OU6)
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4E

amec

ATTACHMENT B

SLOPE/W Output Files

Global Stability Analysis

Section A-A’

Date: 6/27/2013
Title: USACE_Raymark_Global Stability_Section A-A
Name: 2a_Proposed Conditions - Static - 26 deg grid
Method: Spencer
F of S: 3.16

Name: Cover Soil Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Subgrade Fill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 32 ° Piezometric Line: 1
Name: Existing Fill Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Marsh Deposit (Granular) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 26 ° Piezometric Line: 1
Name: Fluvial Sand Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 34 ° Piezometric Line: 1

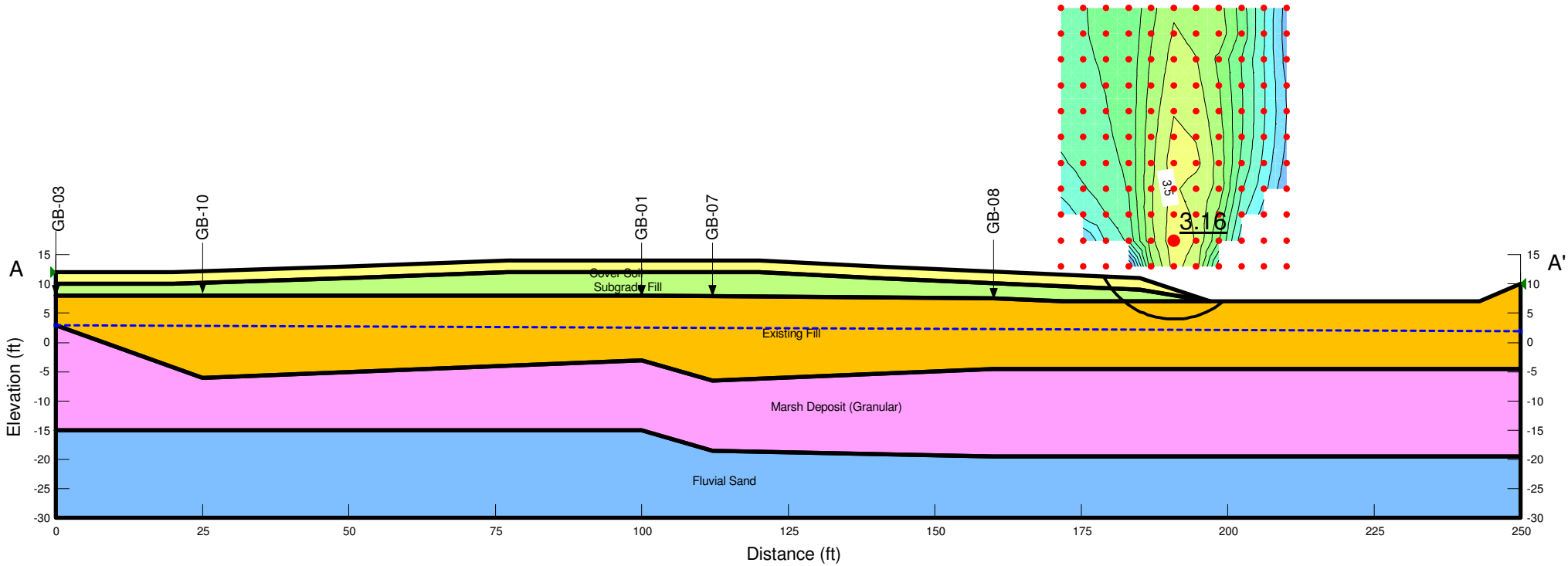


Figure B.1
Section A-A'
Global Stability Evaluation
USACE Raymark - Stratford, CT

Date: 6/27/2013
Title: USACE_Raymark_Global Stability_Section A-A
Name: 2a_Proposed Conditions - Static - 26 deg grid
Method: Spencer
F of S: 4.87

Name: Cover Soil Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Subgrade Fill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 32 ° Piezometric Line: 1
Name: Existing Fill Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Marsh Deposit (Granular) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 26 ° Piezometric Line: 1
Name: Fluvial Sand Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 34 ° Piezometric Line: 1

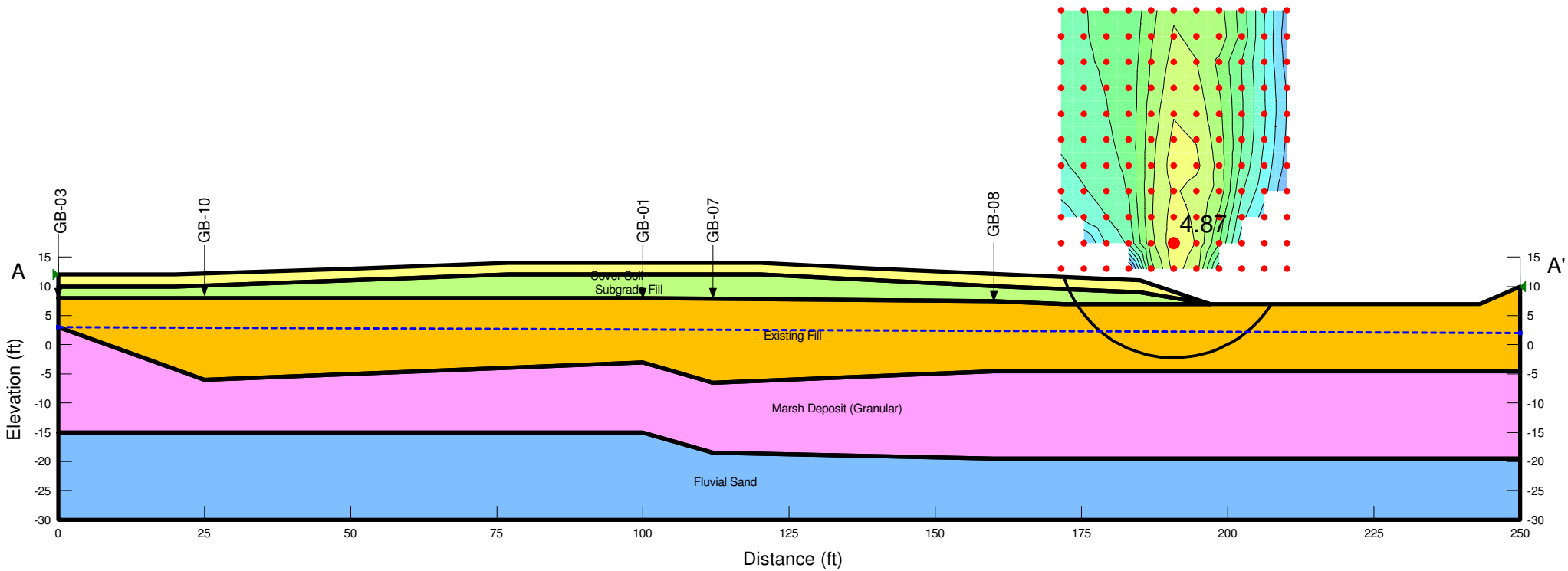


Figure B.2
Section A-A'
Global Stability Evaluation
USACE Raymark - Stratford, CT

Date: 6/27/2013
Title: USACE_Raymark_Global Stability_Section A-A
Name: 2a_Proposed Conditions - Static - 26 deg grid
Method: Spencer
F of S: 5.65

Name: Cover Soil Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Subgrade Fill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 32 ° Piezometric Line: 1
Name: Existing Fill Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Marsh Deposit (Granular) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 26 ° Piezometric Line: 1
Name: Fluvial Sand Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 34 ° Piezometric Line: 1

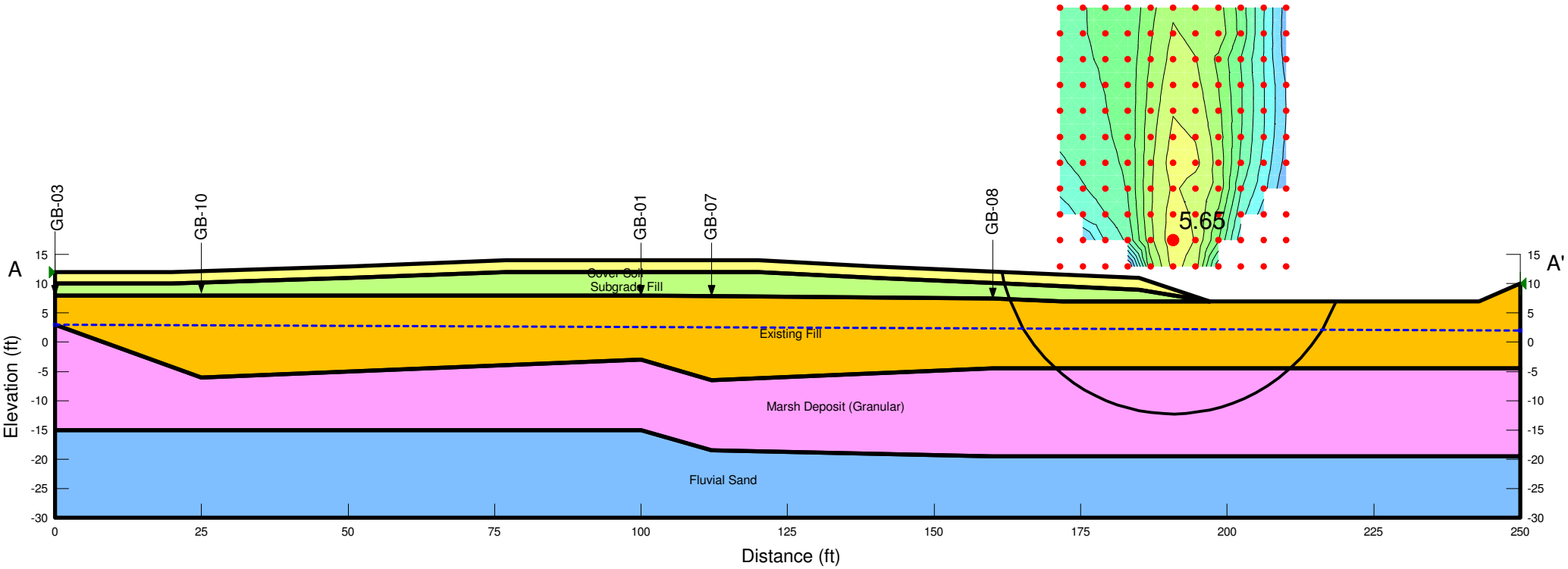


Figure B.3
Section A-A'
Global Stability Evaluation
USACE Raymark - Stratford, CT

Date: 6/27/2013
Title: USACE_Raymark_Global Stability_Section A-A
Name: 2c_Proposed Conditions - Seismic - 26 deg grid
Method: Spencer
F of S: 2.07

Name: Cover Soil Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Subgrade Fill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 32 ° Piezometric Line: 1
Name: Existing Fill Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Marsh Deposit (Granular) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 26 ° Piezometric Line: 1
Name: Fluvial Sand Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 34 ° Piezometric Line: 1

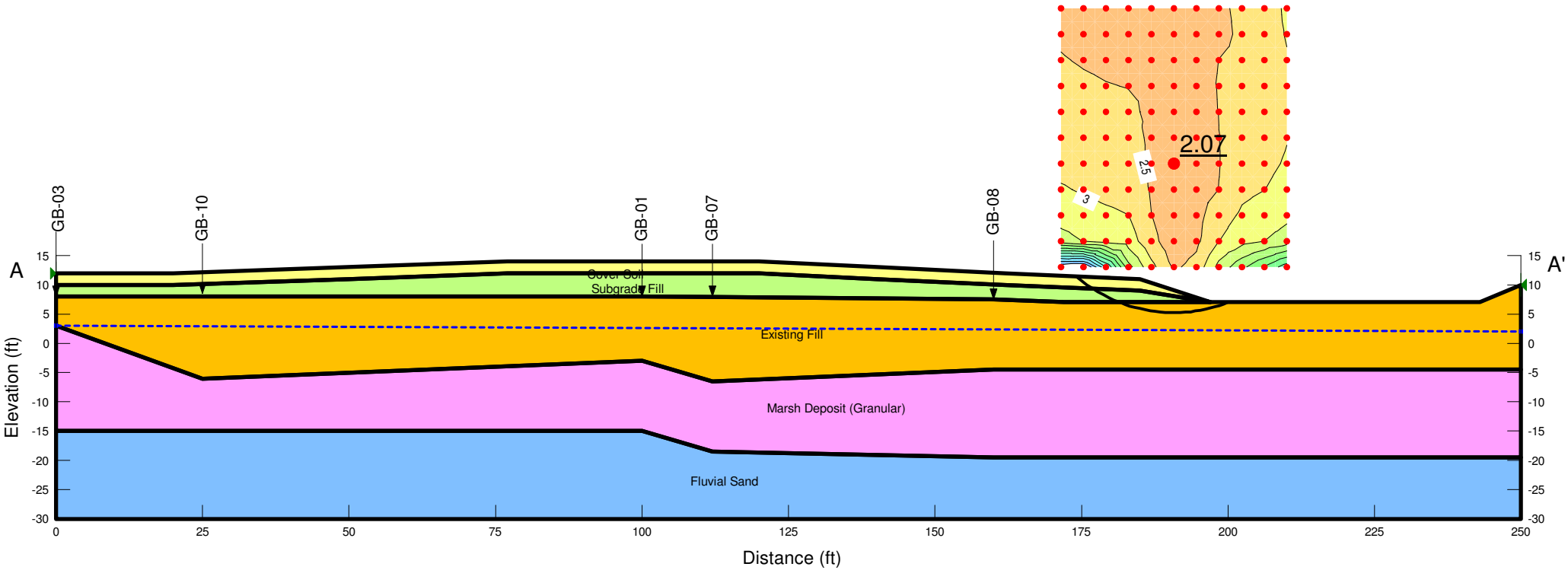


Figure B.4
Section A-A'
Global Stability Evaluation
USACE Raymark - Stratford, CT

Date: 6/27/2013
Title: USACE_Raymark_Global Stability_Section A-A
Name: 3a_Temporary Conditions - Static - 26 deg grid
Method: Spencer
F of S: 1.89

Name: Cover Soil Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Subgrade Fill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 32 ° Piezometric Line: 1
Name: Existing Fill Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Marsh Deposit (Granular) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 26 ° Piezometric Line: 1
Name: Fluvial Sand Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 34 ° Piezometric Line: 1

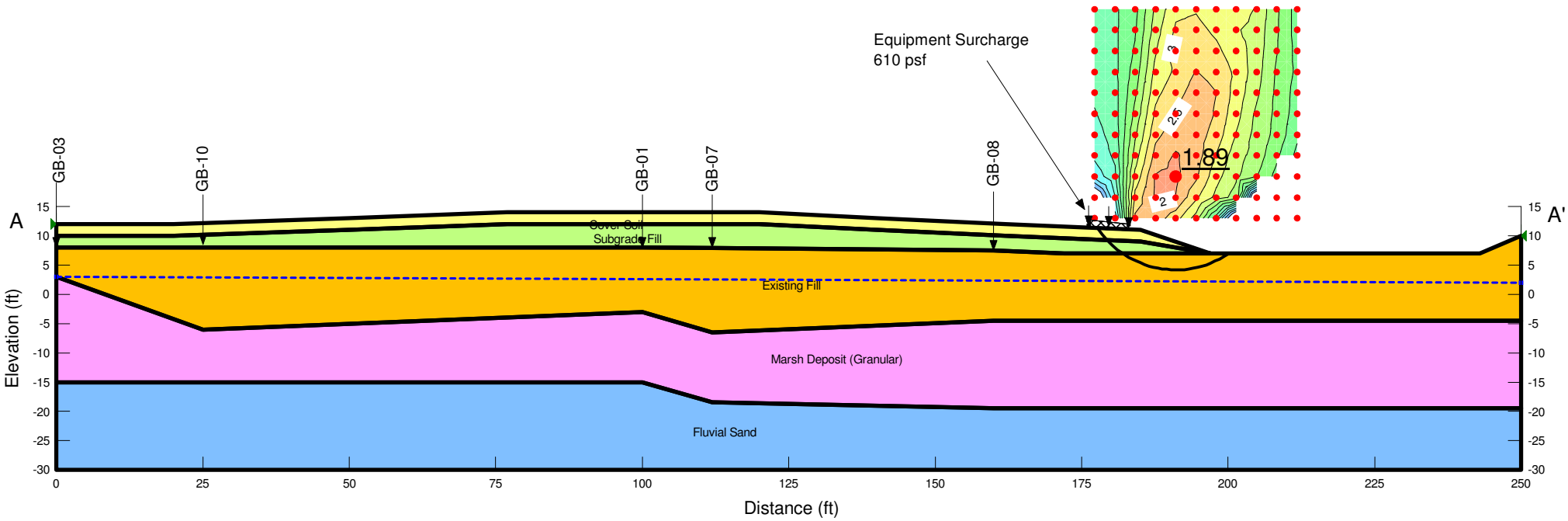


Figure B.5
Section A-A'
Global Stability Evaluation
USACE Raymark - Stratford, CT

ATTACHMENT C

SLOPE/W Output Files

Global Stability Analysis

Section B-B’

Date: 6/27/2013
Title: USACE_Raymark_Global Stability_Section B-B
Name: 2a_Proposed Conditions - Static - 26 deg grid
Method: Spencer
F of S: 2.86

Name: Cover Soil Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Subgrade Fill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 32 ° Piezometric Line: 1
Name: Existing Fill Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Marsh Deposit (Granular) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 26 ° Piezometric Line: 1
Name: Fluvial Sand Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 34 ° Piezometric Line: 1

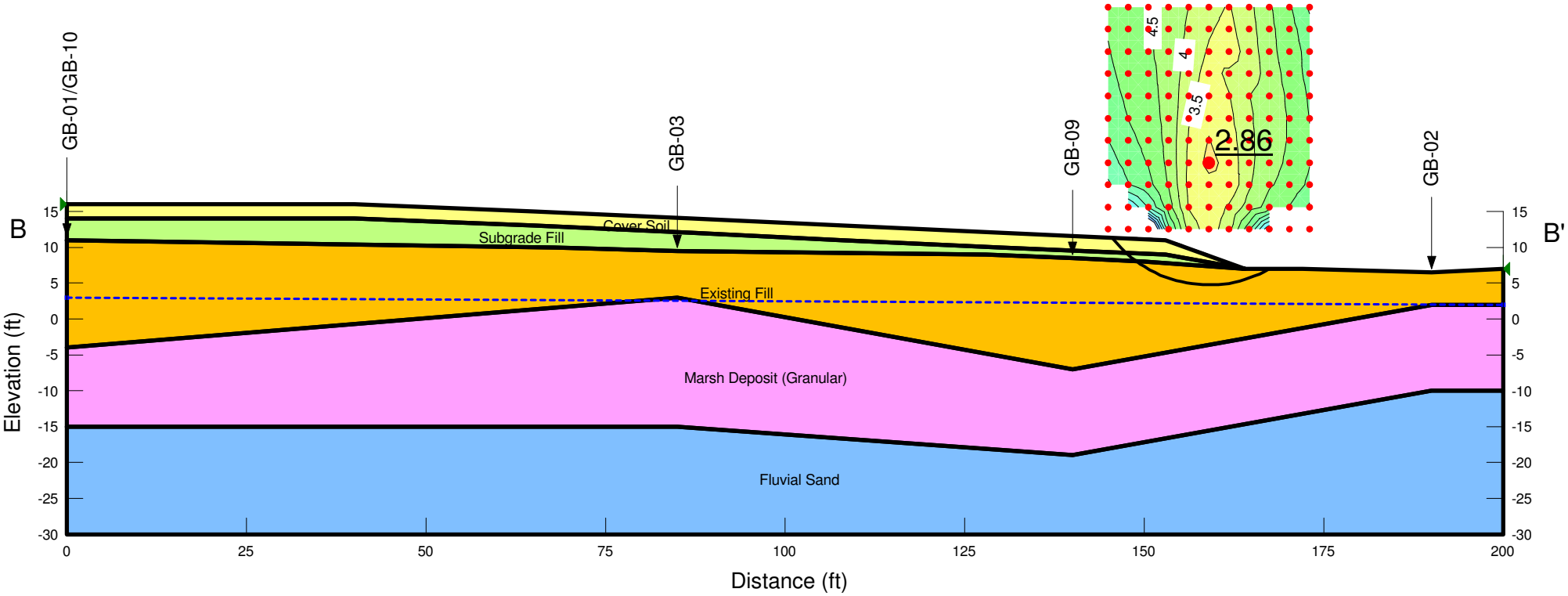


Figure C.1
Section B-B'
Global Stability Evaluation
USACE Raymark - Stratford, CT

Date: 6/27/2013
Title: USACE_Raymark_Global Stability_Section B-B
Name: 2c_Proposed Conditions - Seismic - 26 deg grid
Method: Spencer
F of S: 1.97

Name: Cover Soil Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Subgrade Fill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 32 ° Piezometric Line: 1
Name: Existing Fill Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Marsh Deposit (Granular) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 26 ° Piezometric Line: 1
Name: Fluvial Sand Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 34 ° Piezometric Line: 1

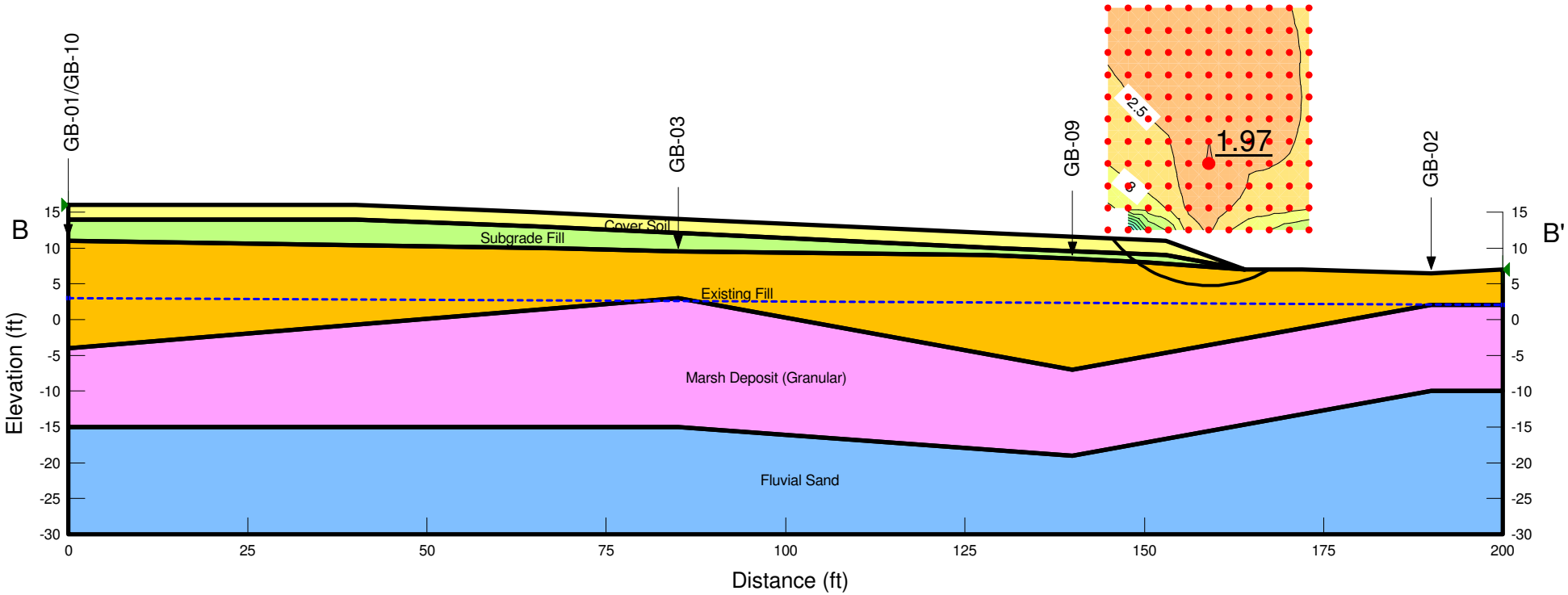


Figure C.2
Section B-B'
Global Stability Evaluation
USACE Raymark - Stratford, CT

Date: 6/27/2013
Title: USACE_Raymark_Global Stability_Section B-B
Name: 3a_Temporary Conditions - Static - 26 deg grid
Method: Spencer
F of S: 1.72

Name: Cover Soil Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Subgrade Fill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 32 ° Piezometric Line: 1
Name: Existing Fill Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Marsh Deposit (Granular) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 26 ° Piezometric Line: 1
Name: Fluvial Sand Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 34 ° Piezometric Line: 1

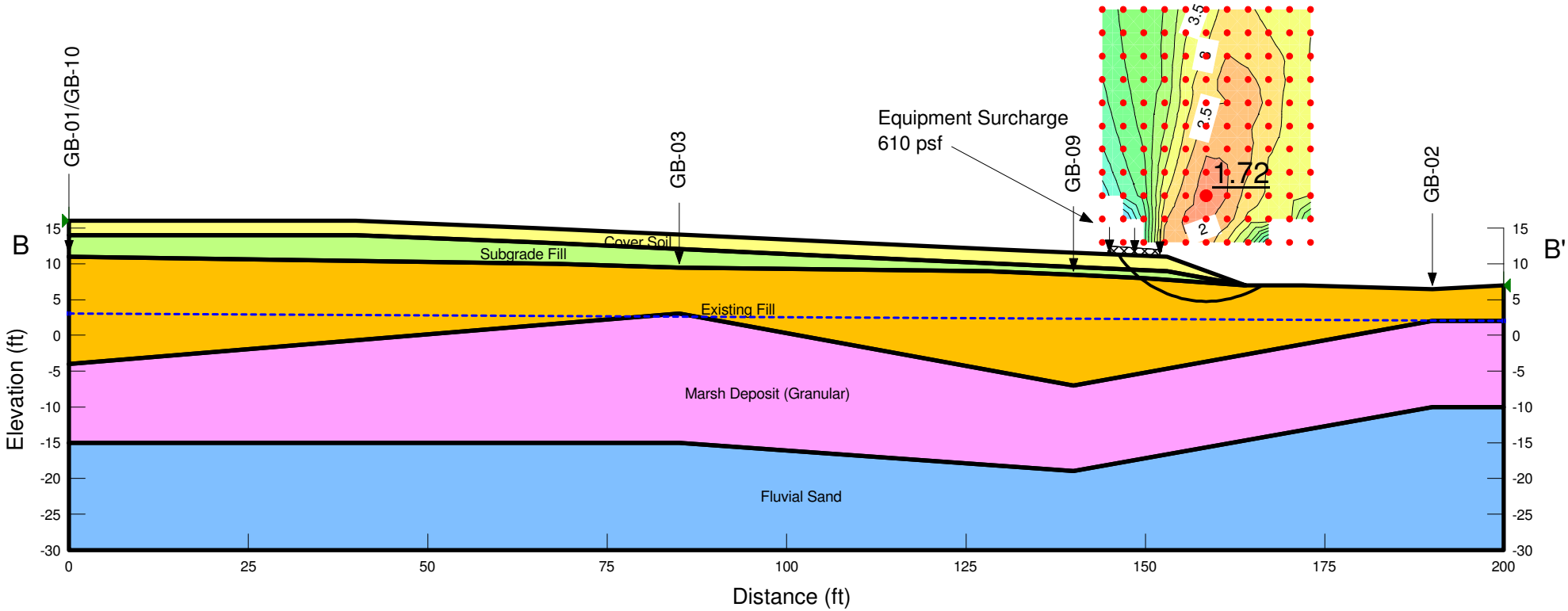


Figure C.3
Section B-B'
Global Stability Evaluation
USACE Raymark - Stratford, CT

ATTACHMENT D

SLOPE/W Output Files

Global Stability Analysis

Section C-C’

Date: 6/27/2013
Title: USACE_Raymark_Global Stability_Section C-C
Name: 2a_Proposed Conditions - Static - 26 deg grid
Method: Spencer
F of S: 3.00

Name: Cover Soil Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Subgrade Fill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 32 ° Piezometric Line: 1
Name: Existing Fill Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Marsh Deposit (Granular) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 26 ° Piezometric Line: 1
Name: Fluvial Sand Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 34 ° Piezometric Line: 1

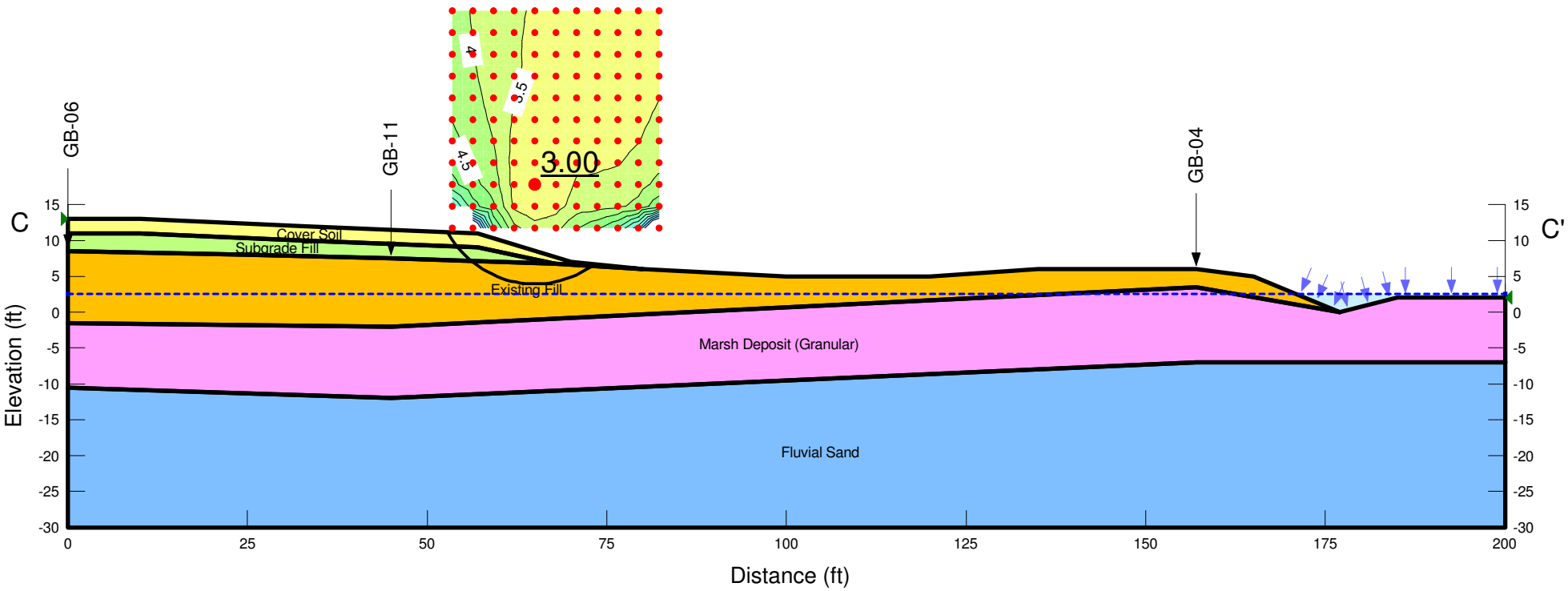


Figure D.1
Section C-C'
Global Stability Evaluation
USACE Raymark - Stratford, CT

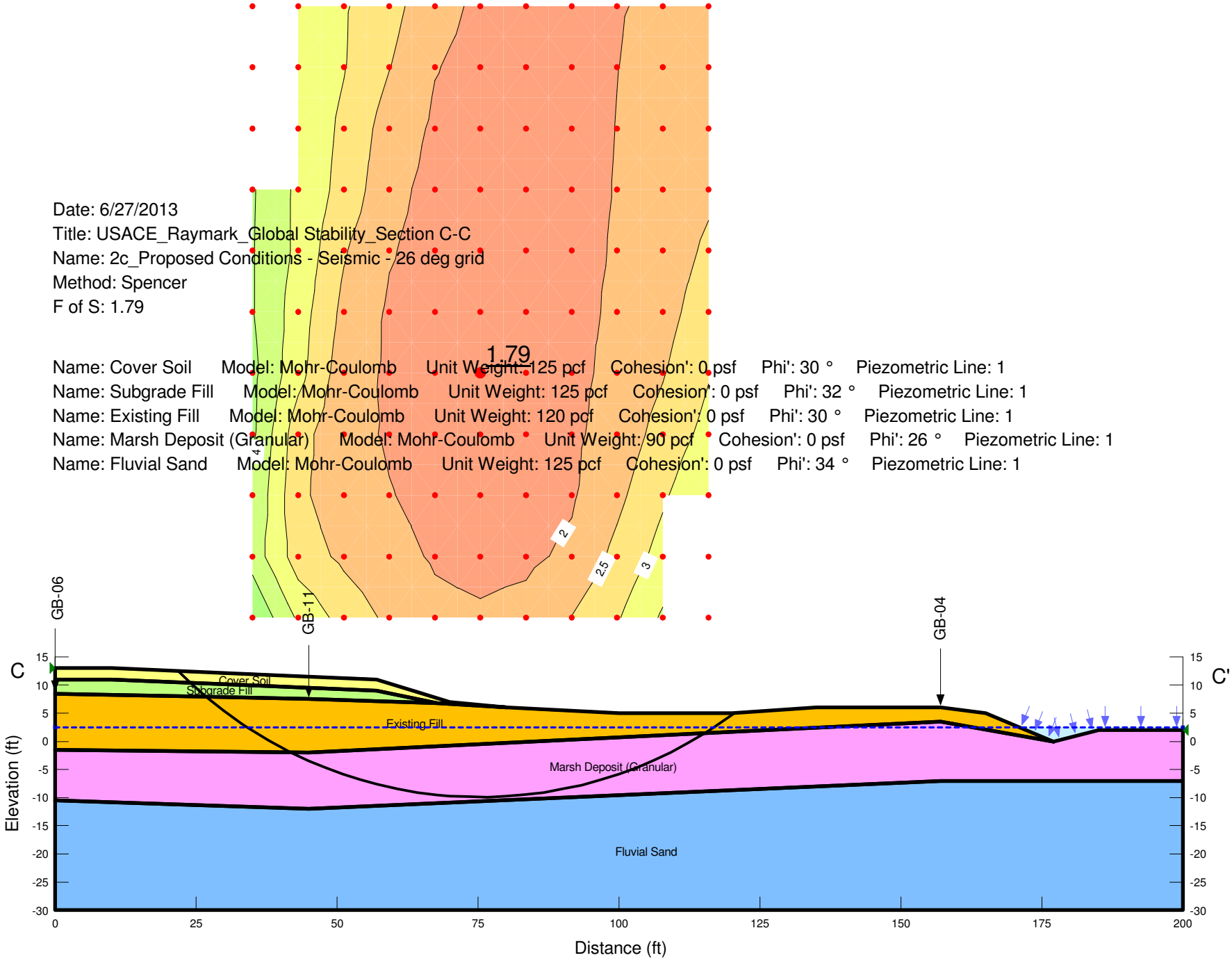


Figure D.2
Section C-C'
Global Stability Evaluation
USACE Raymark - Stratford, CT

Date: 6/27/2013
Title: USACE_Raymark_Global Stability_Section C-C
Name: 2d_Proposed Conditions - Seismic - 750 psf grid
Method: Spencer
F of S: 2.03

Name: Cover Soil Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Subgrade Fill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 32 ° Piezometric Line: 1
Name: Existing Fill Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Marsh Deposit (Cohesive) Model: Undrained (Phi=0) Unit Weight: 90 pcf Cohesion': 750 psf Piezometric Line: 1
Name: Fluvial Sand Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 34 ° Piezometric Line: 1

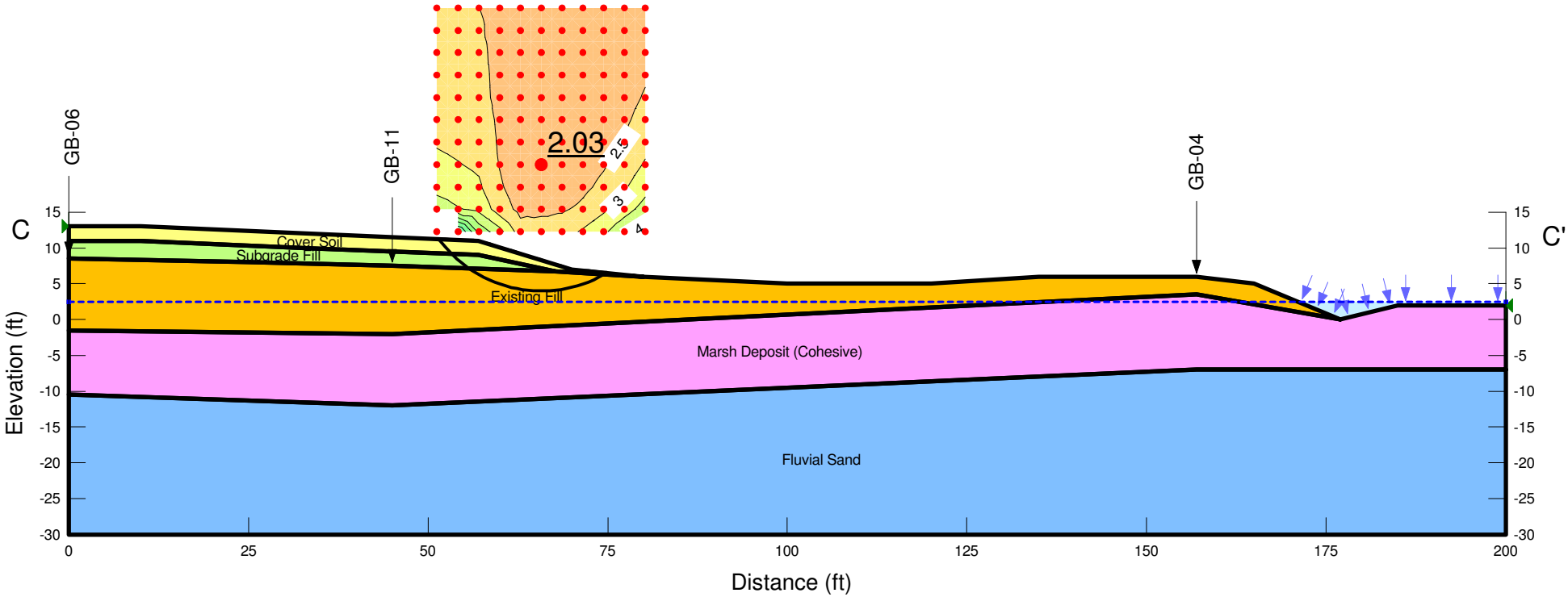


Figure D.3
Section C-C'
Global Stability Evaluation
USACE Raymark - Stratford, CT

Date: 6/27/2013
Title: USACE_Raymark_Global Stability_Section C-C
Name: 3a_Temporary Conditions - Static - 26 deg grid
Method: Spencer
F of S: 1.78

Name: Cover Soil Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Subgrade Fill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 32 ° Piezometric Line: 1
Name: Existing Fill Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Marsh Deposit (Granular) Model: Mohr-Coulomb Unit Weight: 90 pcf Cohesion': 0 psf Phi': 26 ° Piezometric Line: 1
Name: Fluvial Sand Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 34 ° Piezometric Line: 1

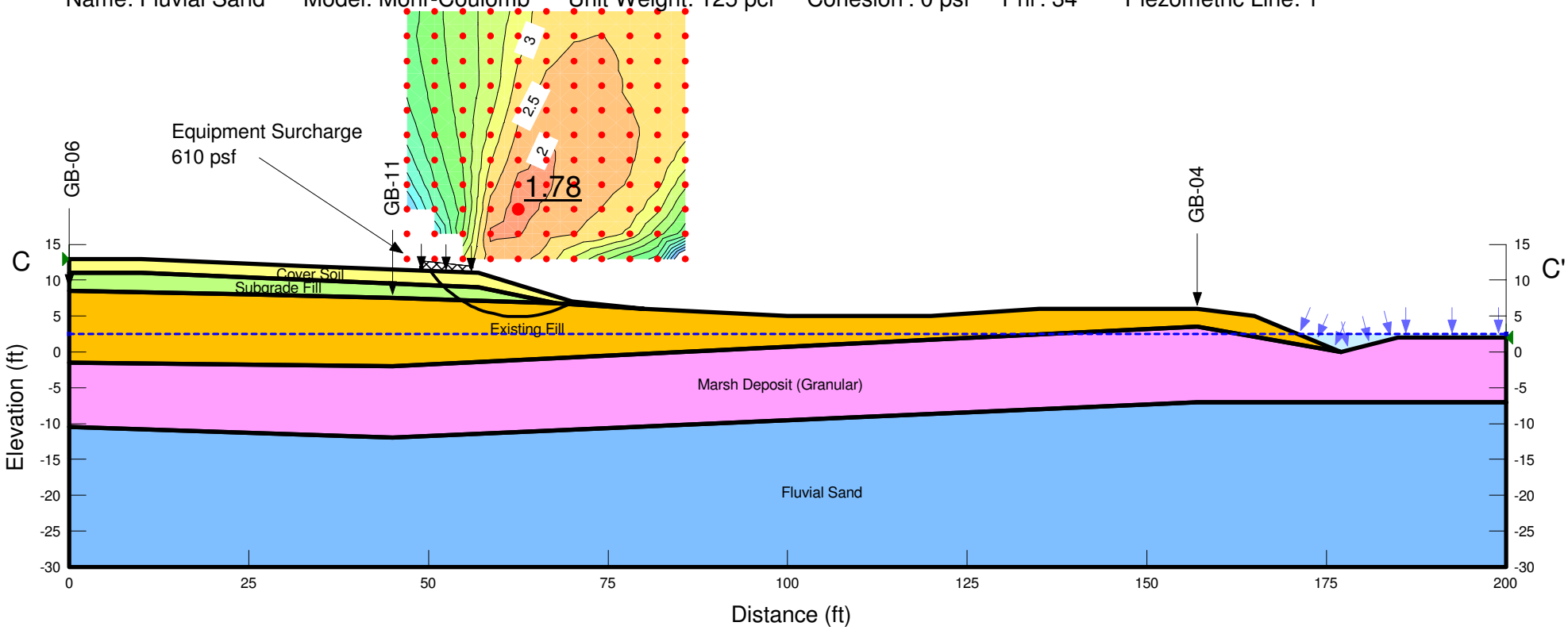


Figure D.4
Section C-C'
Global Stability Evaluation
USACE Raymark - Stratford, CT

ATTACHMENT E

SLOPE/W Output Files

Sensitivity Analysis

Section C-C’

Date: 6/27/2013
Title: USACE_Raymark_Global Stability_Sensitivity_Section C-C
Name: 1a_Proposed Conditions - Static - 500 psf
Method: Spencer
F of S: 3.00

Name: Cover Soil Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Subgrade Fill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 32 ° Piezometric Line: 1
Name: Existing Fill Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Marsh Deposit (500) Model: Undrained (Phi=0) Unit Weight: 90 pcf Cohesion': 500 psf Piezometric Line: 1
Name: Fluvial Sand Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 34 ° Piezometric Line: 1

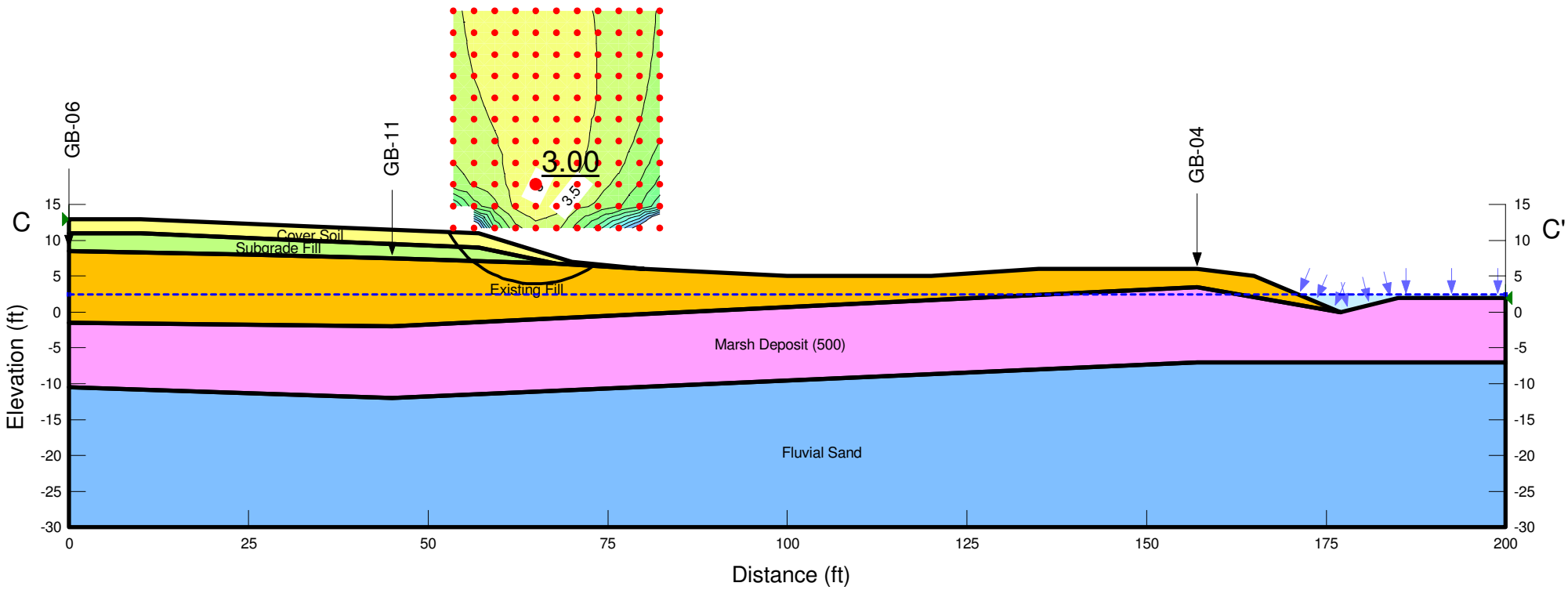


Figure E.1
Section C-C' - Sensitivity
Global Stability Evaluation
USACE Raymark - Stratford, CT

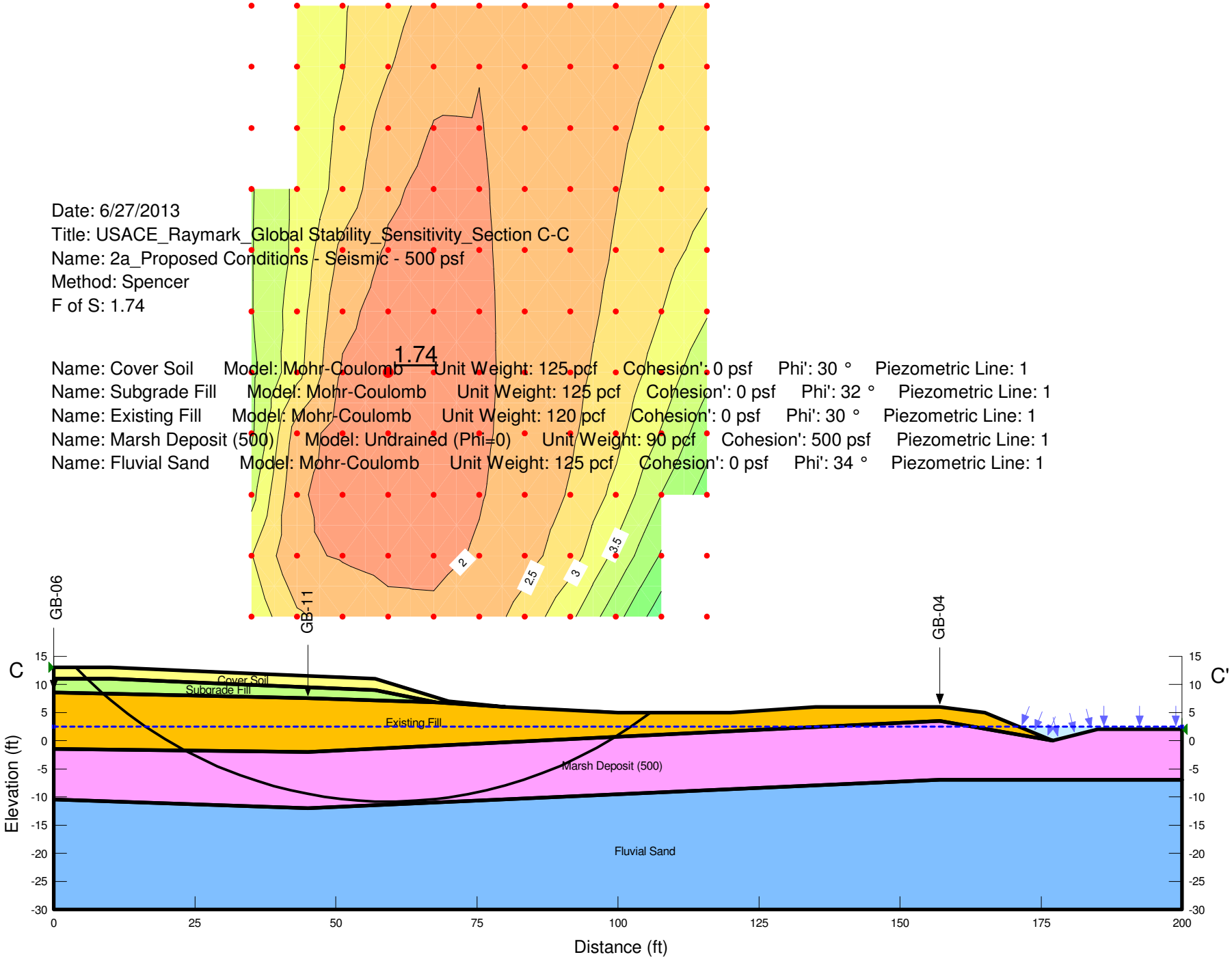


Figure E.2
Section C-C' - Sensitivity
Global Stability Evaluation
USACE Raymark - Stratford, CT

Date: 6/27/2013
Title: USACE_Raymark_Global Stability_Sensitivity_Section C-C
Name: 3a_Temporary Conditions - Static - 500 psf
Method: Spencer
F of S: 1.78

Name: Cover Soil Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Subgrade Fill Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 32 ° Piezometric Line: 1
Name: Existing Fill Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion': 0 psf Phi': 30 ° Piezometric Line: 1
Name: Marsh Deposit (500) Model: Undrained (Phi=0) Unit Weight: 90 pcf Cohesion': 500 psf Piezometric Line: 1
Name: Fluvial Sand Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion': 0 psf Phi': 34 ° Piezometric Line: 1

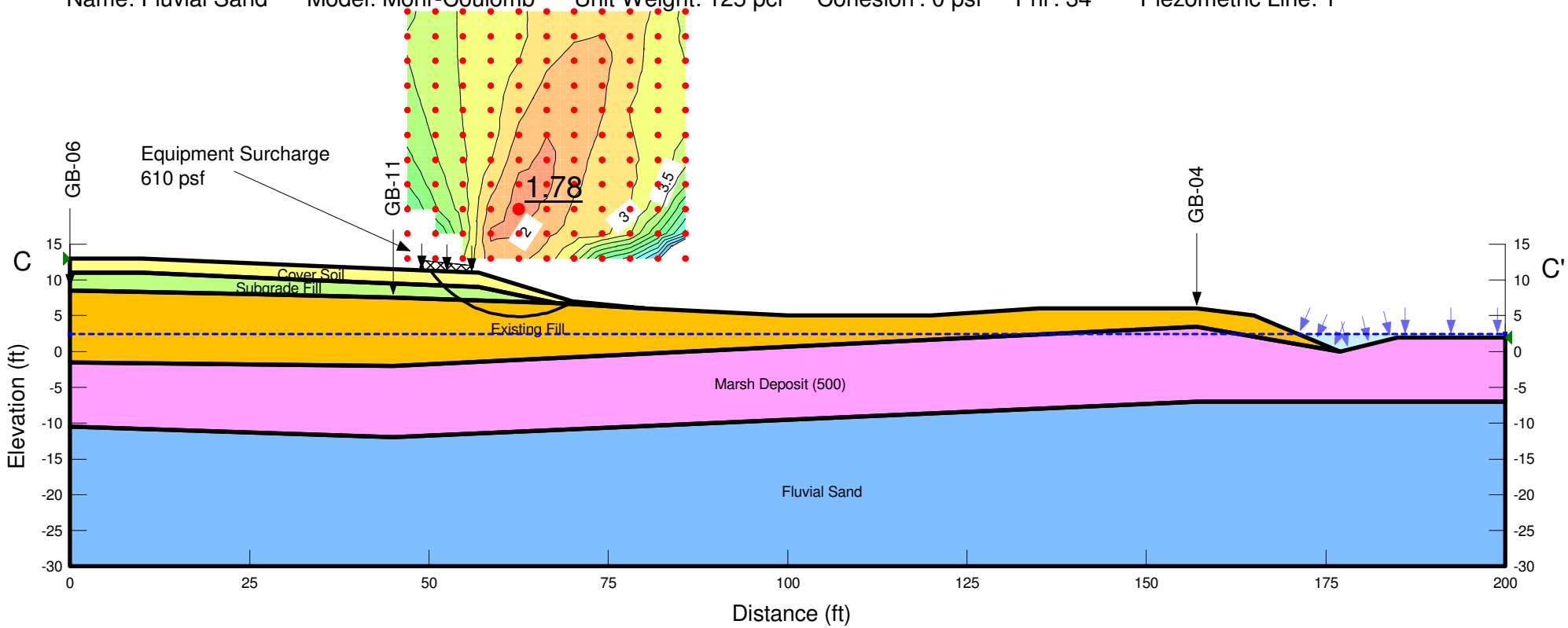


Figure E.3
Section C-C' - Sensitivity
Global Stability Evaluation
USACE Raymark - Stratford, CT

APPENDIX A-3

DRAINAGE LAYER EVALUATION

TECHNICAL MEMORANDUM

DATE: July 12, 2013

TO: Dean Brammer; USACE

COPY TO: Charles Collet, P.E. and Stephen Mitchell, P.E.; AMEC

FROM: Travis Carpenter, P.E. (Maine); AMEC

SUBJECT: Drainage Layer Evaluation, Raymark Industries, Inc. Superfund Site (576/600 East Broadway), Stratford, Connecticut

PROJECT: 3651-12-0004

1.0 INTRODUCTION

AMEC Environment & Infrastructure, Inc. (AMEC) has performed a drainage layer evaluation in support of the Remedial Design (RD) of a low-permeable cap for the Raymark Industries, Inc. Superfund Site, Operable Unit 6 (OU6), at 576/600 East Broadway in Stratford, Connecticut. The purpose of this evaluation was to assess the performance requirements for a geocomposite drainage layer (GDL) and to establish the spacing/location of intermediate drain pipes (if necessary), based on the planned cap configuration, materials, and grading.

This Technical Memorandum (TM) documents the work performed and presents the results of the evaluation. This TM is organized as follows:

- Section 2.0 briefly summarizes relevant project background information;
- Section 3.0 presents the methodology, assumptions, and results; and
- Section 4.0 provides conclusions and recommendations.

2.0 PROJECT BACKGROUND INFORMATION

Elevations reported herein are based on the North American Vertical Datum (NAVD) of 1988. Elevations are reported in units of feet. The horizontal datum is the Connecticut State Plane Coordinate System, based on the North American Datum (NAD) of 1983.

2.1 Site Description

OU6 of the Raymark Industries, Inc. Superfund Site (i.e., the Site) includes properties located at 576/600 East Broadway in Stratford, Connecticut. The two adjacent East Broadway properties encompass approximately 6 acres of commercially-zoned (light industrial) land that is presently overgrown and undeveloped, except for two small buildings and associated pavements situated on the 576 East Broadway parcel. Central portions of the Site are relatively flat and level with existing ground surface elevations generally ranging between +8.0 and +12.5 feet. The Site slopes downward toward the Site perimeter to an elevation of about +4.0 to +5.0 feet in most areas. Existing Site features and topography are depicted in Figure 1.

Beginning in the late 1980s, the Site received waste fill from the former Raymark Industries, Inc. facility. The fill consists of both natural and manmade materials. The manmade materials include presumed asbestos containing material (PACM) (fibrous asbestos mats and pads), asphalt, brake pads, brick, cinders, coal, concrete, gasket material, glass, metal debris, plastic, steel, tiles, shingles, slag, and wood. Raymark waste found in the fill materials at this Site consists of asbestos, lead, copper and/or Aroclor 1268.

Most of the Site was originally a tidal/seasonal floodplain marsh prior to filling. Much of the Site is still presently located within the 100-year floodplain.

2.2 Planned Remedial Action

The remediation of 576/600 East Broadway is being performed as a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Action (RA) under the *Record of Decision for Final Source Control Actions at Four Properties Within Operable Unit 6 (Additional Properties) and Interim Actions at Other Locations Containing Raymark Waste* (USEPA, 2011). As described in the Record of Decision (ROD), the selected RA for this Site is to excavate Raymark waste from the 100-year floodplain, consolidate the waste on the upland portion of the Site, and contain the waste with a low-permeable Resource Conservation and Recovery Act (RCRA) cap.

The planned cap limits/extents and grading are depicted in Figure 1. A final grade/elevation of about +16.5 feet is indicated near the middle of the cap footprint. From this apex, the cap will slope downward gently (4.5% slope) toward the cap perimeter. There will be a grade break near the perimeter, at an elevation of +11.0 feet, where the cap grades will transition from 4.5% slopes to 33.3% slopes [3 horizontal to 1 vertical (3H:1V)]. The 3H:1V perimeter side slopes will be on the order of 3 to 4 feet tall.

The following cap configuration (from the ground surface downward) and materials are planned:

- Topsoil (4 inches, minimum);
- Vegetative support soil (8 inches, minimum);
- Protective cover soil (12 inches, minimum);
- Geocomposite drainage layer (GDL);
- Geomembrane;
- Geosynthetic clay liner (GCL);
- Geocomposite gas venting layer (GVL); and
- Subgrade fill/consolidated waste materials.

The "Final Grading Plan" (Attachment 1) indicates the following cap grading and maximum slope configurations:

- 4.5% upper slopes.
    - 5.5 feet tall (max.) and 125 feet long (max.; along horizontal plane).
- 33.3% side slopes.
    - 4.0 feet tall (max.) and 12 feet long (max.; along horizontal plane).

3.0 DRAINAGE LAYER EVALUATION

AMEC performed this drainage layer evaluation to establish performance requirements for the GDL based on the planned cap configuration, materials, and grading. Given the relatively long upper slopes and the desire to eliminate or minimize the need for intermediate drainage pipes, a tri-planar GDL was evaluated first based on its high hydraulic transmissivity (i.e., flow rate). Subsequently, a bi-planar GDL was assessed.

3.1 Methodology

This evaluation is based on methodology presented in papers entitled "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers Comprising Two Different Slopes" (Giroud, Zornberg, and Beech, 2000) and "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers" (Giroud, Zhao, and Zornberg, 2000). The methodology is summarized in a design calculator (Attachment 2) available at www.landfilldesign.com.

AMEC's utilized the referenced design calculator in conjunction with project-specific input parameters for this evaluation.

3.2 Input Parameters

The liquid impingement rate (i.e., the rate of liquid supply to the GDL per unit horizontal area), q_h, is based on the saturated hydraulic conductivity of the cover soils (consistent with the "unit gradient" method). For this evaluation, the following cover soil permeability is assumed:

- Cover soil permeability, initial = 1.0×10^{-6} meters/second; and
- Cover soil permeability, w/root penetration = 1.5×10^{-6} meters/second.

The lengths of the upper (i.e., upstream), L_{up}, and the lower (i.e, downstream) slopes, L_{down}, are based on the planned cap configuration:

- L_{up} = 125 feet (horizontal), 125.1 feet (along slope) = 38 meters; and
- L_{down} = 12 feet (horizontal), 12.6 feet (along slope) = 4 meters.

Similarly, the slopes of the upstream, β_{up}, and the downstream, β_{down}, sections are based on the planned cap configuration/grading:

- β_{up} = 4.5 percent = 2.6 degrees; and
- β_{down} = 33.3 percent = 18.4 degrees.

3.2.1 Tri-Planar GDL Input Parameters

AMEC selected Syntec's Tenflow 770-2 (Attachment 3) for this evaluation. Syntec provided hydraulic transmissivity testing data (from historical third-party testing) for top plate/soil/GDL/geomembrane/bottom plate configurations tested after 100 hours under a normal load of 1,000 pounds per square foot. The historical data (Attachment 3) indicates that Tenflow 770-2 should be capable of providing the following measured hydraulic transmissivity values, $\theta_{measured}$, used for this analysis:

- $\theta_{measured}$ = 9.0×10^{-3} meters^2/second (at a gradient of 0.05); and
- $\theta_{measured}$ = 4.5×10^{-3} meters^2/second (at a gradient of 0.33).

The long-term in-soil (LTIS) hydraulic transmissivity, θ_{LTIS}, of the GDL is then calculated by applying project- and product-specific reduction factors (RFs) to the laboratory-measured ultimate hydraulic transmissivity. These RFs correspond to mechanisms that can reduce the hydraulic transmissivity of the GDL during its design life. AMEC selected RFs for this analysis based on industry-standard guidance (Attachment 5), product-specific long-term creep testing data (Attachment 3), and engineering judgment. The RFs utilized for the analysis of a tri-planar GDL are listed below:

- RF_{in} = RF for intrusion of geotextile = 1.3;
- RF_{cr} = RF for long-term creep = 1.1;
- RF_{cc} = RF for chemical clogging = 1.1; and
- RF_{bc} = RF for biological clogging (root penetration) = 2.0.

The above RFs are applied to the laboratory-measured ultimate hydraulic transmissivity values to yield the following LTIS hydraulic transmissivity values [$\theta_{LTIS} = \theta_{measured} / (RF_{in} \times RF_{cr} \times RF_{cc} \times RF_{bc})$]:

- θ_{LTIS} = 2.86×10^{-3} meters^2/second (at a gradient of 0.05); and
- θ_{LTIS} = 1.43×10^{-3} meters^2/second (at a gradient of 0.33).

A factor of safety (FS) is also applied to the calculation of the GDL's allowable hydraulic transmissivity, θ_{design}. The FS utilized for this analysis is consistent with industry-standards and is listed below, followed by the associated design transmissivity values ($\theta_{design} = \theta_{LTIS} / (FS_d)$ and the corresponding hydraulic conductivity values ($k = \theta_{design}$ / geonet thickness) :

- FS_d = 2.0;
- θ_{design} = 1.43×10^{-3} meters^2/second (at a gradient of 0.05);
- θ_{design} = 7.15×10^{-4} meters^2/second (at a gradient of 0.33);
- k_{up} = 0.16 meters/second; and
- k_{down} = 0.08 meters/second.

3.2.2 Bi-Planar GDL Input Parameters

AMEC selected Skaps TransNet TN-330-2 (Attachment 4) for this evaluation. Skaps provided hydraulic transmissivity testing data (from historical third-party testing) for top plate/soil/GDL/geomembrane/bottom plate configurations tested after 100 hours under a normal load of 1,000 pounds per square foot. The historical data (Attachment 4) indicates that TN-330-2 should be capable of providing the following measured hydraulic transmissivity values:

- $\theta_{measured}$ = 2.0×10^{-3} meters^2/second (at a gradient of 0.05); and
- $\theta_{measured}$ = 1.2×10^{-3} meters^2/second (at a gradient of 0.33).

To estimate the LTIS hydraulic transmissivity for this GDL, AMEC selected RFs based on industry-standard guidance (Attachment 5) and engineering judgment. The RFs utilized for the analysis of a bi-planar GDL are listed below:

- RF_{in} = RF for intrusion of geotextile = 1.4;
- RF_{cr} = RF for long-term creep = 1.4;
- RF_{cc} = RF for chemical clogging = 1.1; and
- RF_{bc} = RF for biological clogging (root penetration) = 2.0.

The following LTIS hydraulic transmissivity values are estimated using the above RFs:

- θ_{LTIS} = 4.64×10^{-4} meters^2/second (at a gradient of 0.05); and
- θ_{LTIS} = 2.78×10^{-4} meters^2/second (at a gradient of 0.33).

The FS applied, the associated design transmissivity values, and the corresponding hydraulic conductivity values are listed as follows:

- FS_d = 2.0;
- θ_{design} = 2.32×10^{-4} meters^2/second (at a gradient of 0.05);
- θ_{design} = 1.39×10^{-4} meters^2/second (at a gradient of 0.33);
- k_{up} = 0.03 meters/second; and
- k_{down} = 0.02 meters/second.

3.3 RESULTS

Design calculations based on Tenflow 770-2 parameters are provided in Attachment 6. Calculations using Transnet TN-330-2 properties are included as Attachment 7. The calculations indicate that the following transmissivities are required to provide adequate drainage layer capacity for the planned cap configuration, materials, and grading:

- $\theta_{required\text{-}upstream} \geq 1.26 \times 10^{-3}$ meters^2/second; and
- $\theta_{required\text{-}down} \geq 2.00 \times 10^{-4}$ meters^2/second.

To be considered for use, a GDL's laboratory-measured hydraulic transmissivity, $\theta_{measured}$, must be greater than FS_d x RF x $\theta_{required}$. Accordingly, for a tri-planar GDL, the following transmissivity values must be demonstrated via conformance testing, as specified herein:

- $\theta_{measured} \geq 7.91 \times 10^{-3}$ meters^2/second (at a gradient of 0.05); and
- $\theta_{measured} \geq 1.26 \times 10^{-3}$ meters^2/second (at a gradient of 0.33).

For a bi-planar GDL, the following transmissivity values must be demonstrated via conformance testing to be considered for use:

- $\theta_{measured} \geq 1.08 \times 10^{-2}$ meters^2/second (at a gradient of 0.05); and
- $\theta_{measured} \geq 1.72 \times 10^{-3}$ meters^2/second (at a gradient of 0.33).

4.0 CONCLUSIONS AND RECOMMENDATIONS

This evaluation suggests that a tri-planar GDL with high flow capacity will be required for the planned cap configuration, materials, and grading. The historical transmissivity testing data indicate that the tri-planar Tenflow 770-2 can achieve the transmissivity values specified herein, whereas the bi-planar TransNet TN-330-2 cannot achieve the target transmissivity values.

Transmissivity testing of the actual GDL materials to be utilized for construction will be required (i.e., conformance testing in accordance with project specifications). The GDL should be tested using project-specific cap materials consistent with the following conditions:

- Perform transmissivity testing in accordance with ASTM D4716 at a qualified independent laboratory.
- Apply a normal stress of 1,000 psf for a minimum of 100 hours (i.e., seating time) prior to testing.
- Test at gradients of 0.05 and 0.33;
- Test boundary conditions should be steel plate/project-specific soil (protective cover soil)/project-specific GDL/project-specific geomembrane/steel plate.
- Test at a frequency of 1 test per 75,000 square feet of GDL deployed on the project.

GDL materials that meet or exceed the ultimate transmissivity values established herein will be accepted (from a transmissivity standpoint). GDL materials/test data that do not meet the specified transmissivity values may be evaluated for potential use in conjunction with a lower permeability cover soil, as appropriate.

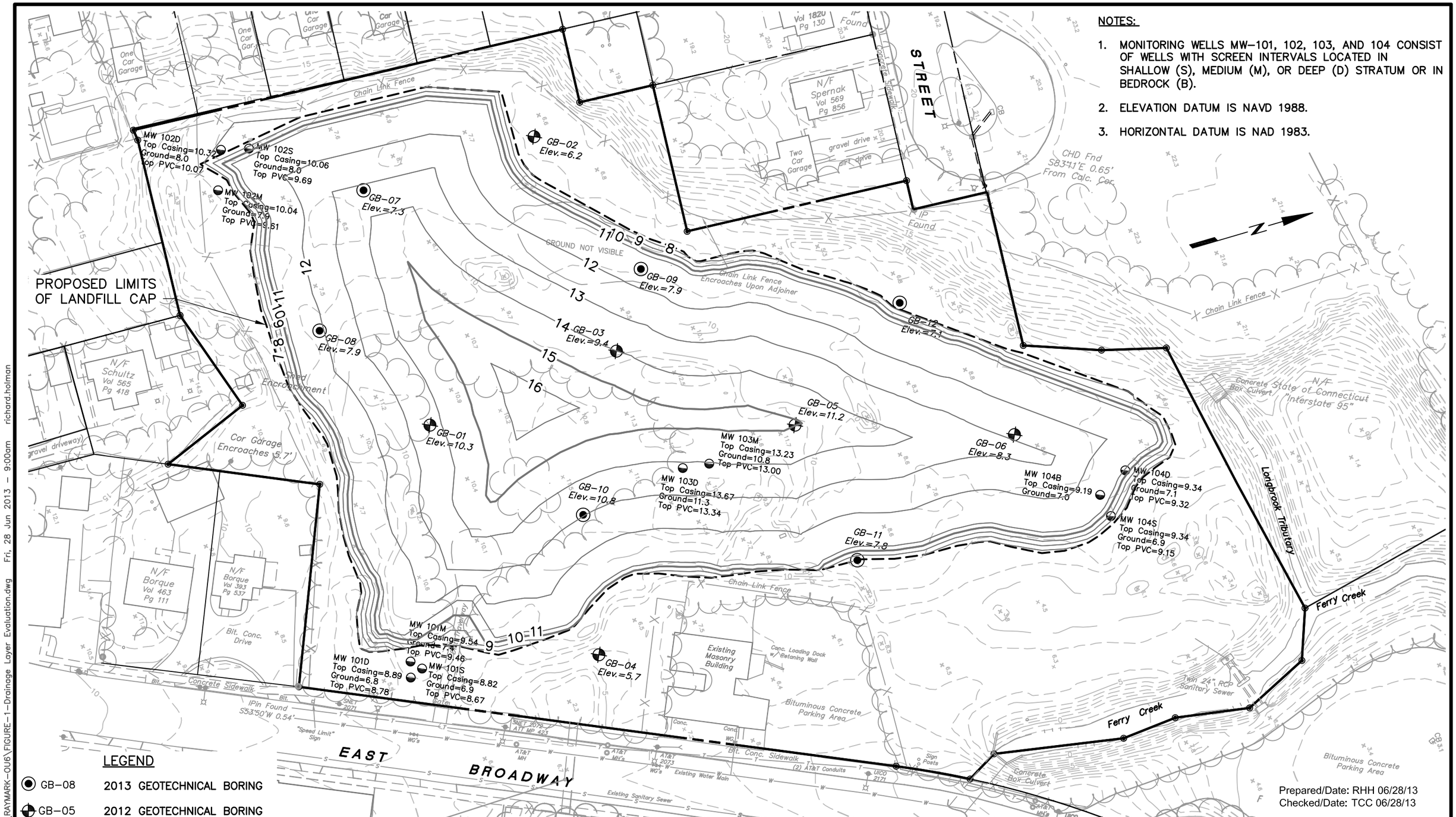
5.0 REFERENCES

Giroud, J.P., Zornberg, J.G., and Beech, J.F. "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers Comprising Two Different Slopes," Geosynthetics International, Special Issue on Liquid Collection Systems, Vol. 7, Nos. 4-6, pp. 453-489.

Giroud, J.P., Zornberg, J.G., and Zhao, A., 2000. "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers", Geosynthetics International, Special Issue on Liquid Collection Systems, Vol. 7, Nos. 4-6, pp. 285-380.

Richardson, G.N., Giroud, J.P., and Zhao, A., 2000. "Design of Lateral Drainage Systems for Landfills".

FIGURES



NOTES:

1. MONITORING WELLS MW-101, 102, 103, AND 104 CONSIST OF WELLS WITH SCREEN INTERVALS LOCATED IN SHALLOW (S), MEDIUM (M), OR DEEP (D) STRATUM OR IN BEDROCK (B).
2. ELEVATION DATUM IS NAVD 1988.
3. HORIZONTAL DATUM IS NAD 1983.

LEGEND

GB-08	2013 GEOTECHNICAL BORING
GB-05	2012 GEOTECHNICAL BORING
MW 103(D)	1994 MONITORING WELL
	EXISTING GROUND SURFACE ELEVATION CONTOUR
	PROPOSED CAP GRADING (95% REMEDIAL DESIGN)

0 30 60 120
SCALE IN FEET HORIZONTAL

Prepared/Date: RHH 06/28/13
Checked/Date: TCC 06/28/13

RAYMARK INDUSTRIES, INC.
576/600 EAST BROADWAY
STRATFORD, CONNECTICUT

amec

DRAINAGE LAYER EVALUATION

Project 3651-12-0004
FIGURE 1

Z:\Projects\USACE\RAYMARK-OU6\FIGURE-1-Drainage Layer Evaluation.dwg Fri, 28 Jun 2013 - 9:00am richard.holman

ATTACHMENT 1

FINAL GRADING PLAN
(June 28, 2013)

NOTE:
1. GRADES SHOWN REPRESENT FINAL GRADING OF TOPSOIL LAYER.
2. FINISH BACKFILLING OF 100–YR FLOODPLAIN RESTORATION WITH 4–INCHES OF TOPSOIL. RESTORE GRADE OF 100–YR FLOODPLAIN TO GRADING SHOWN.

US Army Corps of Engineers® New England District

REV	DESCRIPTION	DATE	APPR.
B	95% PRE-FINAL DESIGN	8/16/12	
A	60% DESIGN FOR REVIEW	7/20/12	

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www.amec.com

DESIGNED BY: SHM | DATE:
DWN BY: RHH | CKD BY: | SOLICITATION NO.:
SUBMITTED BY: | CONTRACT NO.:
PLOT SCALE: | PLOT DATE: | FILE NUMBER:
SIZE: ANSI F | FILE NAME:

REMEDIAL DESIGN OF A LANDFILL CAP
576/600 EAST BROADWAY
STRATFORD, CONNECTICUT

FINAL GRADING PLAN

SHEET IDENTIFICATION
C-104
SHEET 6 OF 10

FILE NAME: Z:\Projects\USACE\RAYMARK-OU6\OU6-C-104.dwg PLOT DATE: Tue, 25 Jun 2013 PLOT TIME: 8:59 AM

ATTACHMENT 2

EVALUATION METHODOLOGY/DESIGN CALCULATOR
(Example/Template from www.landfilldesign.com)

landfilldesign.com

Design of Lateral Drainage Layers Comprising Two Different Slopes - Design Calculator

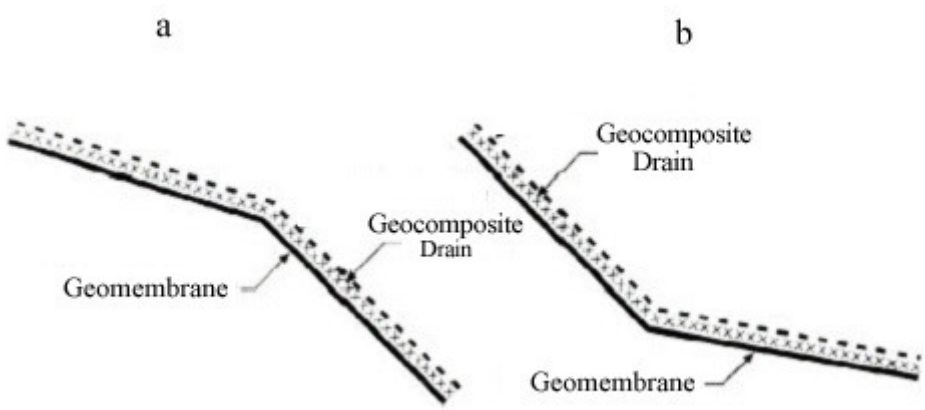
Problem Statement

Lateral drainage layers used in landfills are often comprised of two sections with two different slopes. For instance, in a landfill cover, there is a flat slope typical of 3-8% as an upstream, and a steep slope typical of 4:1 or 3:1 as downstream. In a landfill liner system, however, the upstream is a steep slope and the downstream is a flat slope. Geonet composites can be used for both steep slopes and flat slopes. For liner systems, granular drain is also used at the downstream section. This calculator determines the maximum liquid depth over the liner and required transmissivity for two slopes without an intermediate drainage system.

When an intermediate drainage system is present to separate the two drainage layers, the single slope design calculator should be used.

Problem Solution

Case 1 (a & b): Geocomposite drains are used for both upstream and downstream sections



Maximum Liquid Depth

Upstream section $$t_{upmax} = \frac{q_k L_{up}}{k_{up} \sin \beta_{up}}$$

Downstream section $$t_{downmax} = \frac{q_k (L_{up} + L_{down})}{k_{down} \sin \beta_{down}}$$

Required Transmissivity

Upstream section $$\theta_{upmax} = \frac{q_k L_{up}}{\sin \beta_{up}}$$

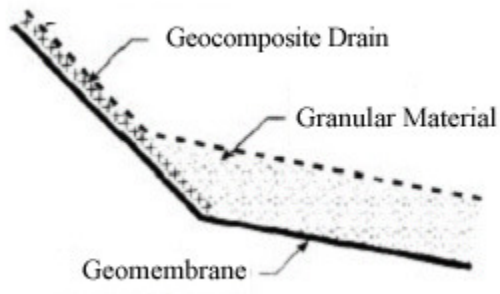
Downstream section $$\theta_{downmax} = \frac{q_k (L_{up} + L_{down})}{\sin \beta_{down}}$$

Ultimate Transmissivity

Upstream section $$\theta_{upultimate} = \theta_{upmax} * FS * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

Downstream section $$\theta_{downultimate} = \theta_{downmax} * FS * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

Case 2: Geocomposite drains at the upstream and granular drain at downstream



Maximum Liquid Depth

Upstream section

$$t_{upmax} = \frac{q_k L_{up}}{k_{up} \sin \beta_{up}}$$

Downstream section

$$t_{downmax} = \left\{ j_{down} \frac{\sqrt{1+4\lambda_{down}} - 1}{2} L_{down} + \lambda_{down} L_{up} \right\} \frac{\tan \beta_{down}}{\cos \beta_{down}}$$

where

$$j_{down} = 1 - 0.12 \exp\left\{ -\left[\log\left(8\lambda_{down} / 5\right)^{5/8} \right]^2 \right\}$$

and

$$\lambda_{down} = \frac{q_k}{k_{down} \tan^2 \beta_{down}}$$

Required Transmissivity

Upstream section

$$\theta_{upmax} = \frac{q_k L_{up}}{\sin \beta_{up}}$$

Downstream section

$$\theta_{downmax} = k_{down} * t_{down}$$

Ultimate Transmissivity

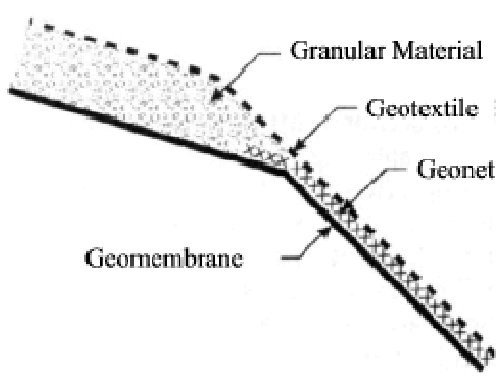
Upstream section

$$\theta_{upultimate} = \theta_{upmax} * FS * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

Downstream section

$$\theta_{downultimate} = \theta_{downmax} * FS * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

Case 3: Granular drains at the upstream and geocomposite drain at downstream



Maximum Liquid Depth

Upstream section

$$t_{upmax} = \left\{ j \frac{\sqrt{1+4\lambda_{up}} - 1}{2} \right\} \frac{\tan \beta_{up}}{\cos \beta_{up}}$$

where

$$j = 1 - 0.12 \exp\left\{ - \left[\log\left(8\lambda_{up} / 5\right)^{5/8} \right]^2 \right\}$$

and

$$\lambda_{up} = \frac{q_h}{k_{up} \tan^2 \beta_{up}}$$

Downstream section

$$t_{downmax} = \frac{q_h (L_{up} + L_{down})}{k_{down} \sin \beta_{down}}$$

Required Transmissivity

Upstream section

$$\theta_{upmax} = k_{up} * t_{up}$$

Downstream section

$$\theta_{downmax} = \frac{q_h L_{down}}{\sin \beta_{down}}$$

Ultimate Transmissivity

Upstream section

$$\theta_{upultimate} = \theta_{upmax} * FS * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

Downstream section

$$\theta_{downultimate} = \theta_{downmax} * FS * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

where:

Symbol	Description	Unit
k_{up}	The hydraulic conductivity of the liquid collection material in the upstream section	m/s
k_{down}	The hydraulic conductivity of the liquid collection material in the downstream section	m/s
L_{up}	The length of the liquid collection layer in the upstream section	m
L_{down}	The length of the liquid collection layer in the downstream section	m
q_h	Impingement rate	m/s
β_{up}	Slope for the upstream section	degrees
β_{down}	Slope for the downstream section	degrees
FS_d	Overall factor of safety for drainage	-
RF_{in}	Intrusion Reduction Factor	-
RF_{cr}	Creep Reduction Factor	-
RF_{cc}	Chemical Clogging Reduction Factor	-
RF_{bc}	Biological Clogging Reduction Factor	-

Input Values

	GC up/GC down		GC up/Granular down		Granular up/GC down	
q_h	1.39e-006	m/s	1.39e-006	m/s	1.39e-006	m/s
L_{up}	25	m	25	m	25	m
L_{down}	40	m	40	m	40	m
k_{up}	0.2	m/s	0.005	m/s	0.005	m/s

k_{down}	0.1	m/s	0.1	m/s	0.1	m/s
β_{up}	4	degrees	4	degrees	4	degrees
β_{down}	25	degrees	25	degrees	25	degrees

	Factor GC up/GC down	GC up/Granular down	Granular up/GC down		SurfaceWater Drains	Leachate Collection and Removal	Leachate Detection Systems
RF_{in}	1.2	1.2	1.2		1.0 - 1.2	1.0 - 1.2	1.0 - 1.2
RF_{cr}	1.4	1.4	1.4	Calculate RF_{CR}			
RF_{cc}	1.2	1.2	1.2		1.0 - 1.2	1.5 - 2.0	1.1 - 1.5
RF_{bc}	1.5	1.5	1.5		1.5 - 3.5	1.1 - 1.3	1.1 - 1.3
FS	2	2	2		2.0 - 10.0	2.0 - 10.0	2.0 - 10.0

Note: The reduction factor values given correspond to the case where the seating time exceeds 100 hours and the boundary conditions due to adjacent materials are simulated in the hydraulic transmissivity test.

Perform Calculations

References

"Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers Comprising Two Different Slopes". Giroud, J.P., Zornberg, J.G., Beech, J.F., Geosynthetics International, Vol. 7, No. 5-6, 2000.

"Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers". Giroud, J.P., Zhao, A., Zornberg, J.G., Geosynthetics International, Vol. 7, No 5-6, 2000.

"Designing with Geosynthetics". Koerner, R.M., Prentice Hall Publishing Co., Englewood Cliffs, NJ, 1998.

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ATTACHMENT 3

GEOCOMPOSITE PRODUCT DATA
(Syntec Tenflow 770-2)

SYNTEC PRODUCT SPECIFICATION
SYNTEC, LLC
4800 Pulaski Highway
Baltimore, Maryland 21224 • USA
Phone: 410-327-1070 • Toll Free: 1-800-874-7437 Fax: 410-327-1078
www.synteccorp.com

SYNTEC
GEOSYNTHETICS EVOLVED

TENFLOW 770-2 Double-Sided Geocomposite

Incorporates a tri-planar geonet manufactured by extruding three sets of HDPE strands forming a three dimensional structure to provide planar water flow. Tenflow 770-2 is capable of providing high transmissivity in a soil environment and will have properties conforming to the values and test methods listed below.

PROPERTY	TEST METHODS	UNITS	VALUE	QUALIFIER	FREQUENCY
TRI-PLANAR GEONET[1]					
Thickness	ASTM D 5199	mil (mm)	350 (8.9)	MAV	100,000 sf
Density	ASTM D 792	g/cm^3	0.94–0.96	Range	100,000 sf
Melt Flow Index	ASTM D 1238	g/10 min	1.0	MAX	100,000 sf
Carbon Black	ASTM D 4218	%	2-3	Range	100,000 sf
Thickness Retained From 10,000 hour creep test under 2,000 psf, and 20°C temperature	GRI-GC8	%	92	-	-
Creep Reduction Factor From 10,000 hour creep test under 2,000 psf, and 20°C temperature	GRI-GC8	-	1.05	-	-
GEOTEXTILE[1]					
U.V. Resistance (500 hrs)	ASTM D 4355	%	70	MARV	Per formula
Grab Tensile	ASTM D 4632	lbs (N)	160 (710)	MARV	100,000 sf
Grab Elongation	ASTM D 4632	%	50	MARV	100,000 sf
Tear Strength	ASTM D 4533	lbs (N)	60 (266)	MARV	100,000 sf
CBR Puncture	ASTM D 6241	lbs (N)	400 (1,776)	MARV	100,000 sf
AOS	ASTM D 4751	US Std Sieve(mm)	70 (0.212)	MaxARV	500,000 sf
Permittivity	ASTM D 4491	sec^{-1}	1.4	MARV	500,000 sf
Water Flow Rate	ASTM D 4491	gpm/ft^2 ($l/min/m^2$)	110 (4481)	MARV	500,000 sf
GEOCOMPOSITE					
Bond Strength (Ply Adhesion) -MD					
Peak	ASTM D 7005	lbs/in	1.0	MAV	100,000 sf
Average			0.5		
Transmissivity[2] – MD					
Plate/Ottawa Sand/Geocomposite/ Geomembrane/Plate, Gradient = 0.1 @ 1,000 psf 24 hour seating period	ASTM D 4716	m^2/sec	$7.0*10^{-3}$	MAV	500,000 sf
Plate/Ottawa Sand/Geocomposite/ Geomembrane/Plate, Gradient = 0.33 @ 1,000 psf 24 hour seating period			$4.0*10^{-3}$		
DIMENSIONS AND DELIVERY					
The geocomposite shall be delivered to the jobsite in roll form with each roll identified and nominally measuring 12.5 feet (3.81 meters) in width and 200 feet (61 meters) in length.					

Qualifiers: MARV=Minimum Average Roll Value (MARV), MAV=Minimum Average Value, MAX=Maximum Value, MaxARV=Maximum average roll value, MD= Machine Direction.

NOTES: 1. Geotextile and geonet properties listed are prior to lamination. 2. The Tenflow geonet has a circular aperture side and a cuspated side, The side with circular apertures should be placed against the soil while the cuspated side should be placed against the geomembrane as indicated with “Top”/”Bottom” labels on the rolls.

GEOCOMPOSITE TEST RESULTS

TRI Client: Syntec Corporation
Project: Glens Falls Landfill, NY

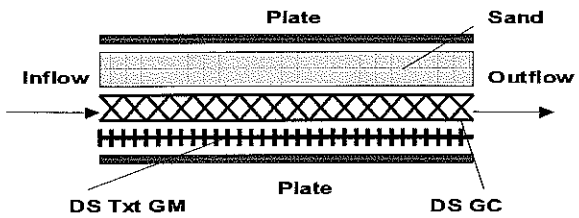
Material: Syntec Tenflow 770-2 Double-Sided Geocomposite
Sample Identification: 161
TRI Log #: E2339-86-07

Hydraulic Transmissivity (ASTM D 4716)

Direction Tested: Machine Direction

Normal Load (psf):	1,000
Seat Time(hrs)	100
Test Length (in)	12
Test Width (in)	12

Plate/ Ottowa Sand/ GC Sample/ 60 mil. TXGM/ Plate

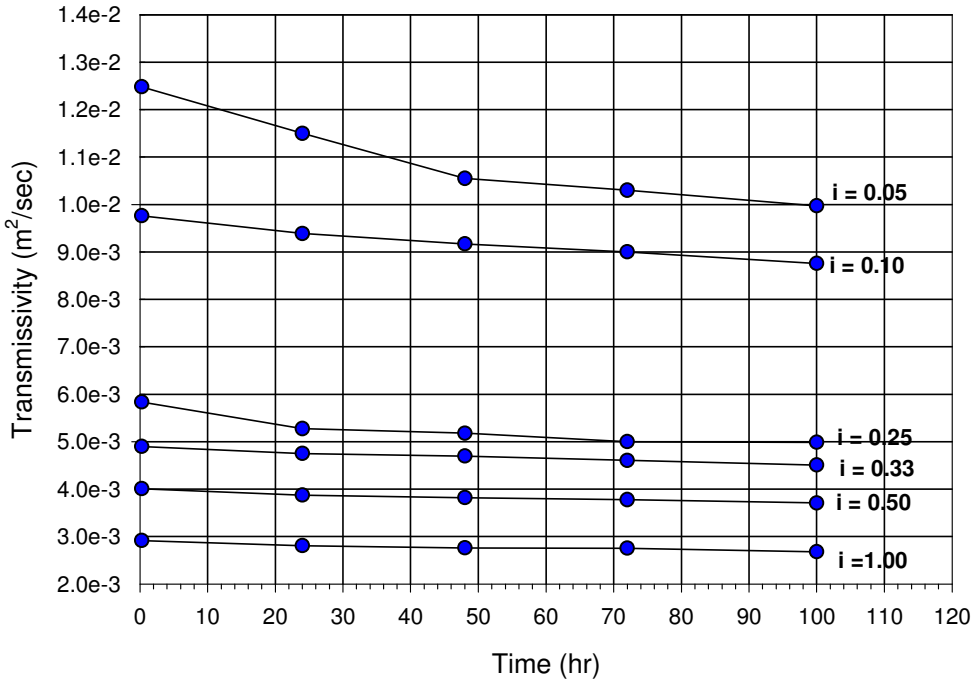


PARAMETER		TEST REPLICATE NUMBER 1	2	3	4	5	6	7	8	9	10	MEAN	STD. DEV.	PROJ. SPEC.
Hydraulic Gradient	Specimen			1										
0.5	Volume (cc)		3377	3312	3355									
	Time (s)		5.06	4.96	5.00									
	Flow Rate (GPM/ft width)		10.58	10.59	10.64							10.60	0.03	
	Transmissivity (m^2/s)		4.38E-03	4.38E-03	4.40E-03							4.39E-03	1.31E-05	
	Test Temp (C)			20.0										
	Temp. Corr. Factor			1.000										
0.33	Volume (cc)		2658	2672	2639									
	Time (s)		4.93	5.04	4.93									
	Flow Rate (GPM/ft width)		8.55	8.40	8.49							8.48	0.07	
	Transmissivity (m^2/s)		5.36E-03	5.27E-03	5.32E-03							5.32E-03	4.48E-05	4.0E-03 min
	Test Temp (C)			20.0										
	Temp. Corr. Factor			1.000										
0.25	Volume (cc)		2334	2335	2331									
	Time (s)		5.06	5.06	5.04									
	Flow Rate (GPM/ft width)		7.31	7.32	7.33							7.32	0.01	
	Transmissivity (m^2/s)		6.05E-03	6.06E-03	6.07E-03							6.06E-03	8.71E-06	
	Test Temp (C)			20.0										
	Temp. Corr. Factor			1.000										
0.1	Volume (cc)		1267	1271	1252									
	Time (s)		5.12	5.12	5.00									
	Flow Rate (GPM/ft width)		3.92	3.94	3.97							3.94	0.02	
	Transmissivity (m^2/s)		8.12E-03	8.14E-03	8.22E-03							8.16E-03	4.99E-05	7.0E-03 min
	Test Temp (C)			20.0										
	Temp. Corr. Factor			1.000										
0.02	Volume (cc)		522	500	512									
	Time (s)		5.15	4.93	5.10									
	Flow Rate (GPM/ft width)		1.61	1.61	1.59							1.60	0.01	
	Transmissivity (m^2/s)		1.66E-02	1.66E-02	1.65E-02							1.66E-02	9.46E-05	
	Test Temp (C)			20.0										
	Temp. Corr. Factor			1.000										

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction: of this report, except in full, without prior approval of TRI.

GeosyntheticTesting.com
9063 Bee Caves Road / Austin, TX 78733 / 512 263 2101 / fax: 512 263 2558

TENFLOW Drainage Geocomposite
Long Term Transmissivity - ASTM D4716

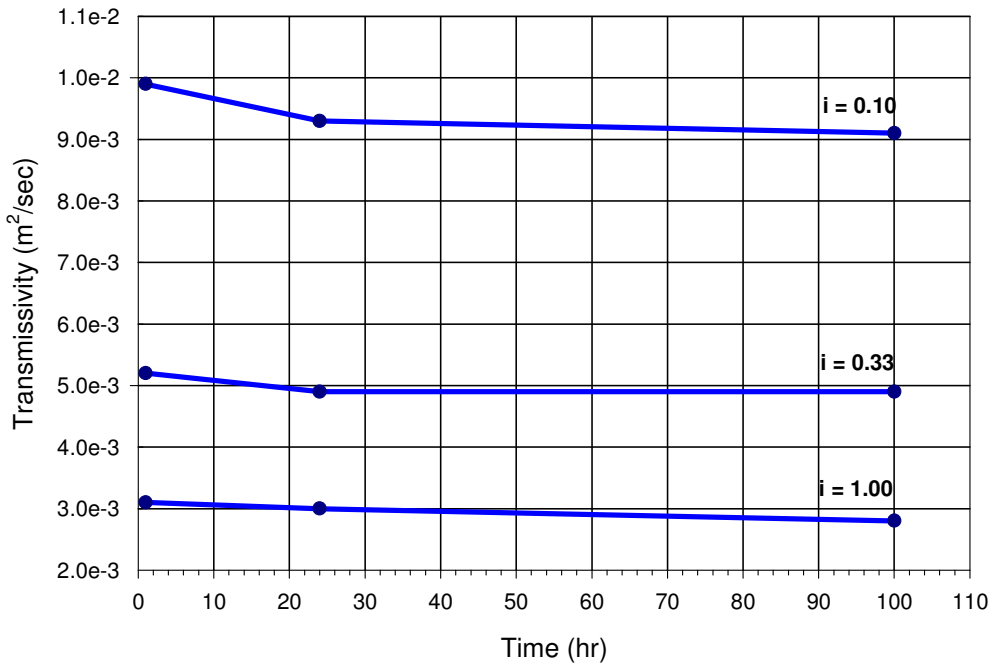


Testing Conditions

Normal Pressure = 1,000 psf

TOP PLATE
SOIL
TENFLOW
GEOMEMBRANE
BOTTOM PLATE

TENFLOW 70-2
Long Term Transmissivity - ASTM D4716*



Testing Conditions

Normal Pressure = 1,000 psf

STEEL PLATE
Ottawa Sand
TENFLOW 70-2
60 mil HD Smooth
STEEL PLATE

* Measured at Precision Geosynthetic Laboratories - Feb, 03

ATTACHMENT 4

GEOCOMPOSITE PRODUCT DATA
(SKAPS TransNet TN-330-2)

SKAPS Industries
571 Industrial Parkway
Commerce, GA 30529 (U.S.A.)
Phone (706) 336-7000 Fax (706) 336-7007
e-mail: info@skaps.com

SKAPS TRANSNET™ (TN)
HDPE GEOCOMPOSITE 330

SKAPS TRANSNET™ geocomposite consists of SKAPS GeoNet made from HDPE resin with non-woven polypropylene geotextile fabric heat bonded on both sides of the the geonet.

Property	Test Method	Unit	Required Value		Qualifier
			With 6 oz.	With 8 oz.	
Geonet					
Thickness	ASTM D 5199	mil.	330±30	330±30	Range
Carbon Black	ASTM D 4218	%	2 to 3	2 to 3	Range
Tensile Strength	ASTM D 5035	lb/in	95	95	Minimum
Melt Flow	ASTM D 1238[3]	g/10 min.	1	1	Maximum
Density	ASTM D 1505	g/cm^3	0.94	0.94	Minimum
Transmissivity[1]	ASTM D 4716	$m^2/sec.$	$8x10^{-3}$	$8x10^{-3}$	MARV[2]
Composite					
Ply Adhesion (Minimum)	ASTM D 7005	lb/in	0.5	0.5	MARV
Ply Adhesion (Average)	ASTM D 7005	lb/in	1	1	MARV
Transmissivity[1]	ASTM D 4716	m^2/sec	$9x10^{-4}$	$9x10^{-4}$	MARV
Geotextile					
Fabric Weight	ASTM D 5261	oz/yd^2	6	8	MARV
Grab Strength	ASTM D 4632	lbs	160	225	MARV
Grab Elongation	ASTM D 4632	%	50	50	MARV
Tear Strength	ASTM D 4533	lbs	65	90	MARV
Puncture Resistance	ASTM D 4833	lbs	95	130	MARV
CBR Puncture	ASTM D 6241	lbs	475	650	MARV
Water Flow Rate	ASTM D 4491	gpm/ft^2	125	100	MARV
Permittivity	ASTM D 4491	sec^{-1}	1.63	1.26	MARV
Permeability	ASTM D 4491	cm/sec	0.3	0.3	MARV
AOS	ASTM D 4751	US Sieve	70	80	MARV

Notes:

1. Transmissivity measured using water at 21 ± 2ºC (70 ± 4ºF) with a gradient of 0.1 and a confining pressure of 10000 psf between stainless steel plates after 15 minutes. Values may vary between individual labs.
2. MARV is statistically defined as mean minus two standard deviations and it is the value which is exceeded by 97.5% of all the test data.
3. Condition 190/2.16

This information is provided for reference purposes only and is not intended as a warranty or guarantee. SKAPS assumes no liability in connection with the use of this information.

SKAPS Industreis
571 Industrial Parkway
Commerce, GA 30529
Phone: 706-336-7000
www.skaps.com

Date: August 28, 2012

Subject: Transmissivity Values for Various SKAPS Products

To whom it may concern:

SKAPS geocomposite materials conforms to following transmissivity values when tested as per ASTM D 4716

Product	Gradient	Duration (hrs)	Transmissivity[1] (m^2/sec)	Qualifier
TN 220-2-6	0.1	100	2.0×10^{-4}	MARV
TN 250-2-6			3.8×10^{-4}	MARV
TN 270-2-6			1.0×10^{-3}	MARV
TN 330-2-6			1.6×10^{-3}	MARV
TN 220-2-6	0.33		1.5×10^{-4}	MARV
TN 250-2-6			3.0×10^{-4}	MARV
TN 270-2-6			7.0×10^{-4}	MARV
TN 330-2-6			1.2×10^{-3}	MARV

Note:

(1) Transmissivity measured using water at 21 $\pm$ 2^{0}C (70 $\pm$ 4^{0}F) with various gradient and a confining pressure of 1,000 psf between sand and liner after 100 hours.

ATTACHMENT 5

GEOCOMPOSITE TRANSMISSIVITY REDUCTION FACTORS

$$\theta_{LTIS} = \frac{\theta_{measured}}{\Pi(RF)} = \frac{\theta_{measured}}{RF_{CR} \times RF_{IN} \times RF_{CD} \times RF_{PC} \times RF_{CC} \times RF_{BC}} \tag{14}$$

The determination of RF_{CR}, RF_{IN}, RF_{CD}, RF_{PC}, RF_{CC}, and RF_{BC} requires long-duration tests. Due to lack of time, such tests cannot be performed for the design of a specific project. Therefore, values obtained from Table 1, from the literature, or from the geosynthetic manufacturer should be used. Table 1 provides guidance regarding the values of the reduction factors for geonets and geocomposites having geonets as the transmissive core (which are the most frequently used geosynthetic liquid collection layers in landfills in the United States). However, the design engineer is cautioned that the values of the reduction factors may vary significantly depending on the type of geocomposite and the exposure conditions (stress, chemical composition of the soil and liquid). Also, as pointed out above, the values of some of the time-dependent reduction factors (e.g. RF_{CR} and RF_{IN}) may significantly vary depending on the conditions under which the hydraulic transmissivity is measured. The values given in Table 1 correspond to the case where the seating time exceeds 100 hours and the boundary conditions due to adjacent materials are simulated in the hydraulic transmissivity test. It is also possible to calculate RF_{CR} from the results of thickness measurements during compressive creep tests (tests that are easy to conduct) without the need for performing long-term hydraulic transmissivity tests (tests that are impractical and expensive), using the method developed by Giroud et al. (2000b).

Table 1. Guidance for the selection of some of the reduction factors on the flow capacity of geonets and geocomposites having a geonet transmissive core.

Examples of application	Normal stress	Liquid	RF_{IN}	RF_{CR}	RF_{CC}	RF_{BC}
Landfill cover drainage layer Low retaining wall drainage	Low	Water	1.0 to 1.2	1.1 to 1.4	1.0 to 1.2	1.2 to 1.5
Embankment, Dams, Landslide repair High retaining wall drainage	High	Water	1.0 to 1.2	1.4 to 2.0	1.0 to 1.2	1.2 to 1.5
Landfill leachate collection layer Landfill leakage collection and detection layer Leachate pond leakage collection and detection layer	High	Leachate	1.0 to 1.2	1.4 to 2.0	1.5 to 2.0	1.5 to 2.0

Notes: The reduction factors, RF_{IN}, RF_{CR}, RF_{CC}, and RF_{BC} are defined in Section 1.7.2. Table 1 was developed for the present paper, using some reduction factor values from Koerner (1998). Design engineers are cautioned that the values of the reduction factors may significantly vary depending on the type of geocomposite and the exposure conditions (stress, chemical composition of the soil and liquid). Also, as discussed in Section 1.7.2, RF_{IN} and RF_{CR} depend on the testing conditions under which the hydraulic transmissivity is measured. The reduction factor values given in Table 1 correspond to the case where the seating time exceeds 100 hours and the boundary conditions due to adjacent materials are simulated in the hydraulic transmissivity test. Finally, due to lack of relevant data, no guidance is provided for RF_{CD} and RF_{PC}. Additional information on reduction factors may be found in a paper by Zanzinger and Gartung (1999).

ATTACHMENT 6

DESIGN CALCULATOR OUTPUT
(Syntec Tenflow 770-2)

go to problem statement input values solution contact help references

landfilldesign.com

Design of Lateral Drainage Layers Comprising Two Different Slopes - Design Calculator

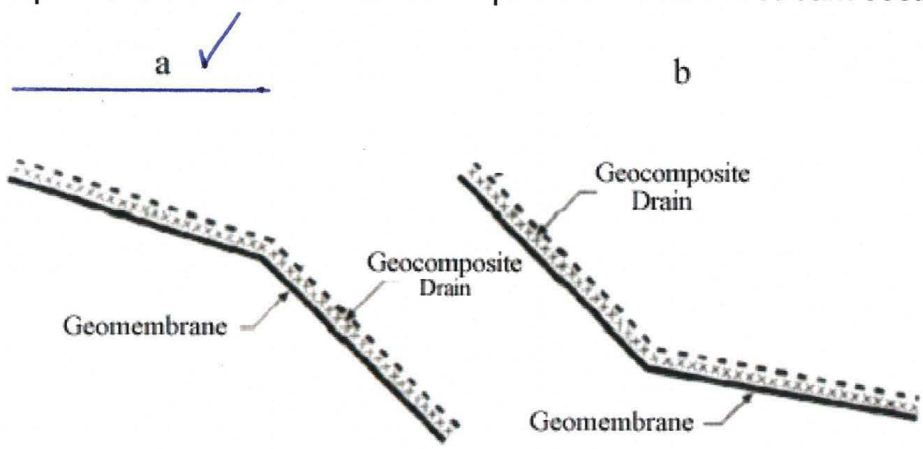
Problem Statement

Lateral drainage layers used in landfills are often comprised of two sections with two different slopes. For instance, in a landfill cover, there is a flat slope typical of 3-8% as an upstream, and a steep slope typical of 4:1 or 3:1 as downstream. In a landfill liner system, however, the upstream is a steep slope and the downstream is a flat slope. Geonet composites can be used for both steep slopes and flat slopes. For liner systems, granular drain is also used at the downstream section. This calculator determines the maximum liquid depth over the liner and required transmissivity for two slopes without an intermediate drainage system.

When an intermediate drainage system is present to separate the two drainage layers, the single slope design calculator should be used.

Problem Solution

Case 1 (a & b): Geocomposite drains are used for both upstream and downstream sections



Maximum Liquid Depth

Upstream section $$t_{upmax} = \frac{q_k L_{up}}{k_{up} \sin \beta_{up}}$$

Downstream section $$t_{downmax} = \frac{q_k (L_{up} + L_{down})}{k_{down} \sin \beta_{down}}$$

Required Transmissivity

Upstream section $$\theta_{upmax} = \frac{q_k L_{up}}{\sin \beta_{up}}$$

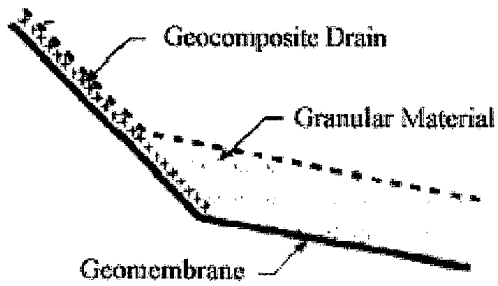
Downstream section $$\theta_{downmax} = \frac{q_k (L_{up} + L_{down})}{\sin \beta_{down}}$$

Ultimate Transmissivity

Upstream section $$\theta_{upultimate} = \theta_{upmax} * FS * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

Downstream section $\theta_{downultimate} = \theta_{downmax} * FS * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$

Case 2: Geocomposite drains at the upstream and granular drain at downstream



Maximum Liquid Depth

Upstream section $$t_{upmax} = \frac{q_h L_{up}}{k_{up} \sin \beta_{up}}$$

Downstream section $$t_{downmax} = \left\{ j_{down} \frac{\sqrt{1+4\lambda_{down}} - 1}{2} L_{down} + \lambda_{down} L_{up} \right\} \frac{\tan \beta_{down}}{\cos \beta_{down}}$$

where

$$j_{down} = 1 - 0.12 \exp\left\{ -\left[\log\left(8\lambda_{down} / 5\right)^{5/8} \right]^2 \right\}$$

and

$$\lambda_{down} = \frac{q_h}{k_{down} \tan^2 \beta_{down}}$$

Required Transmissivity

Upstream section $$\theta_{upmax} = \frac{q_h L_{up}}{\sin \beta_{up}}$$

Downstream section $$\theta_{downmax} = k_{down} * t_{down}$$

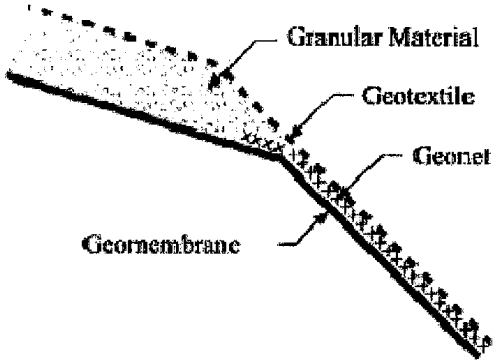
Ultimate Transmissivity

Upstream section $$\theta_{upultimate} = \theta_{upmax} * FS * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

Downstream section $$\theta_{downultimate} = \theta_{downmax} * FS * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

Case 3: Granular drains at the upstream and geocomposite drain at downstream

---



Maximum Liquid Depth

Upstream section

$$t_{up\max} = \left\{ j \frac{\sqrt{1+4\lambda_{up}} - 1}{2} \right\} \frac{\tan \beta_{up}}{\cos \beta_{up}}$$

where

$$j = 1 - 0.12 \exp\left\{ -\left[\log\left(8\lambda_{up} / 5\right)^{5/8} \right]^2 \right\}$$

and

$$\lambda_{up} = \frac{q_h}{k_{up} \tan^2 \beta_{up}}$$

Downstream section

$$t_{down\max} = \frac{q_h (L_{up} + L_{down})}{k_{down} \sin \beta_{down}}$$

Required Transmissivity

Upstream section

$$\theta_{up\max} = k_{up} * t_{up}$$

Downstream section

$$\theta_{down\max} = \frac{q_h L_{down}}{\sin \beta_{down}}$$

Ultimate Transmissivity

Upstream section

$$\theta_{up\,ultimate} = \theta_{up\max} * FS * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

Downstream section

$$\theta_{down\,ultimate} = \theta_{down\max} * FS * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

where:

Symbol	Description	Unit
k_{up}	The hydraulic conductivity of the liquid collection material in the upstream section	m/s
k_{down}	The hydraulic conductivity of the liquid collection material in the downstream section	m/s
L_{up}	The length of the liquid collection layer in the upstream section	m
L_{down}	The length of the liquid collection layer in the downstream section	m
q_h	Impingement rate	m/s
β_{up}	Slope for the upstream section	degrees
β_{down}	Slope for the downstream section	degrees
FS_d	Overall factor of safety for drainage	-
RF_{in}	Intrusion Reduction Factor	-
RF_{cr}	Creep Reduction Factor	-
RF_{cc}	Chemical Clogging Reduction Factor	-

RF_{bc}	Biological Clogging Reduction Factor	-

Input Values

	GC up/GC down		GC up/Granular down		Granular up/GC down	
q_h	1.50e-6	m/s	1.39e-006	m/s	1.39e-006	m/s
L_{up}	38.0	m	25	m	25	m
L_{down}	4.0	m	40	m	40	m
k_{up}	0.16	m/s	0.005	m/s	0.005	m/s
k_{down}	0.08	m/s	0.1	m/s	0.1	m/s
β_{up}	2.6	degrees	4	degrees	4	degrees
β_{down}	18.4	degrees	25	degrees	25	degrees

Factor	GC up/GC down	GC up/Granular down	Granular up/GC down		SurfaceWater Drains	Leachate Collection and Removal	Leachate Detection Systems
RF_{in}	1.3	1.2	1.2		1.0 - 1.2	1.0 - 1.2	1.0 - 1.2
RF_{cr}	1.1	1.4	1.4	Calculate RF_{CR}			
RF_{cc}	1.1	1.2	1.2		1.0 - 1.2	1.5 - 2.0	1.1 - 1.5
RF_{bc}	2.0	1.5	1.5		1.5 - 3.5	1.1 - 1.3	1.1 - 1.3
FS	2.0	2	2		2.0 - 10.0	2.0 - 10.0	2.0 - 10.0

Note: The reduction factor values given correspond to the case where the seating time exceeds 100 hours and the boundary conditions due to adjacent materials are simulated in the hydraulic transmissivity test.

Perform Calculations

Solution

	GC up/GC down	GC up/Granular down	Granular up/GC down
Maximum liquid depth @ upstream	0.0079 m <0.009	0.0996 m	0.0035 m
Maximum liquid depth @ downstream	0.0025 m <0.009	0.0021 m	0.0021 m
Required Transmissivity @ upstream	1.26E-003 m^2/sec	4.98E-004 m^2/sec	1.74E-005 m^2/sec
Required Transmissivity @ downstream	2.00E-004 m^2/sec	2.14E-004 m^2/sec	1.32E-004 m^2/sec
Ultimate Transmissivity @ upstream	7.91E-003 m^2/sec ✓ < 9.00E-003	3.01E-003 m^2/sec	1.05E-004 m^2/sec
Ultimate Transmissivity @ downstream	1.26E-003 m^2/sec ✓ <4.5 e-003	1.29E-003 m^2/sec	7.96E-004 m^2/sec

Additional Assistance

If you would like to have Advanced Geotech Systems provide material specifications that meet your performance criteria, please fill in the following fields and click the submit button. All information is kept strictly confidential.

Name *

Company

Email Address *

Phone

Project Reference

Comments

*required fields

Submit Design Results

References

"Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers Comprising Two Different Slopes". Giroud, J.P., Zornberg, J.G., Beech, J.F., Geosynthetics International, Vol. 7, No. 5-6, 2000.

"Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers". Giroud, J.P., Zhao, A., Zornberg, J.G., Geosynthetics International, Vol. 7, No 5-6, 2000.

"Designing with Geosynthetics". Koerner, R.M., Prentice Hall Publishing Co., Englewood Cliffs, NJ, 1998.

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ATTACHMENT 7

DESIGN CALCULATOR OUTPUT
(SKAPS TransNet TN-330-2)

go to problem statement input values solution contact help references

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Design of Lateral Drainage Layers Comprising Two Different Slopes - Design Calculator

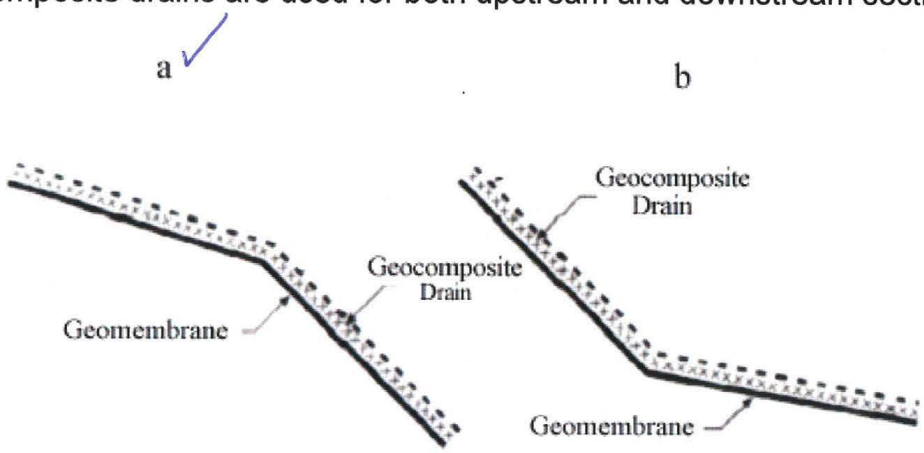
Problem Statement

Lateral drainage layers used in landfills are often comprised of two sections with two different slopes. For instance, in a landfill cover, there is a flat slope typical of 3-8% as an upstream, and a steep slope typical of 4:1 or 3:1 as downstream. In a landfill liner system, however, the upstream is a steep slope and the downstream is a flat slope. Geonet composites can be used for both steep slopes and flat slopes. For liner systems, granular drain is also used at the downstream section. This calculator determines the maximum liquid depth over the liner and required transmissivity for two slopes without an intermediate drainage system.

When an intermediate drainage system is present to separate the two drainage layers, the single slope design calculator should be used.

Problem Solution

Case 1 (a & b): Geocomposite drains are used for both upstream and downstream sections



Maximum Liquid Depth

Upstream section $$t_{upmax} = \frac{q_k L_{up}}{k_{up} \sin \beta_{up}}$$

Downstream section $$t_{downmax} = \frac{q_k (L_{up} + L_{down})}{k_{down} \sin \beta_{down}}$$

Required Transmissivity

Upstream section $$\theta_{upmax} = \frac{q_k L_{up}}{\sin \beta_{up}}$$

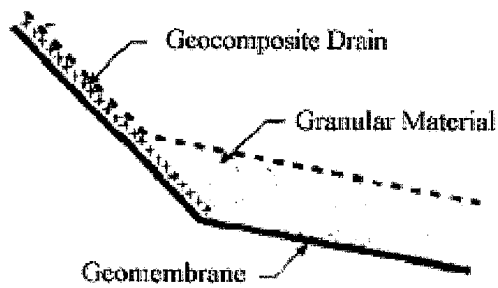
Downstream section $$\theta_{downmax} = \frac{q_k (L_{up} + L_{down})}{\sin \beta_{down}}$$

Ultimate Transmissivity

Upstream section $$\theta_{upultimate} = \theta_{upmax} * FS * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

Downstream section $\theta_{downultimate} = \theta_{downmax} * FS * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$

Case 2: Geocomposite drains at the upstream and granular drain at downstream



Maximum Liquid Depth

Upstream section $$t_{upmax} = \frac{q_k L_{up}}{k_{up} \sin \beta_{up}}$$

Downstream section $$t_{downmax} = \left\{ j_{down} \frac{\sqrt{1+4\lambda_{down}} - 1}{2} L_{down} + \lambda_{down} L_{up} \right\} \frac{\tan \beta_{down}}{\cos \beta_{down}}$$

where

$$j_{down} = 1 - 0.12 \exp\left\{ -\left[\log\left(8\lambda_{down} / 5\right)^{5/8} \right]^2 \right\}$$

and

$$\lambda_{down} = \frac{q_k}{k_{down} \tan^2 \beta_{down}}$$

Required Transmissivity

Upstream section $$\theta_{upmax} = \frac{q_k L_{up}}{\sin \beta_{up}}$$

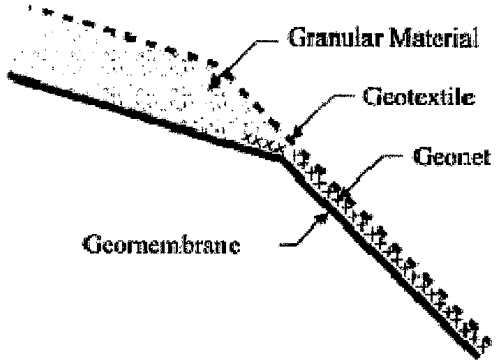
Downstream section $$\theta_{downmax} = k_{down} * t_{down}$$

Ultimate Transmissivity

Upstream section $$\theta_{upultimate} = \theta_{upmax} * FS * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

Downstream section $$\theta_{downultimate} = \theta_{downmax} * FS * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

Case 3: Granular drains at the upstream and geocomposite drain at downstream



Maximum Liquid Depth

Upstream section

$$t_{upmax} = \left\{ j \frac{\sqrt{1+4\lambda_{up}} - 1}{2} \right\} \frac{\tan \beta_{up}}{\cos \beta_{up}}$$

where

$$j = 1 - 0.12 \exp\left\{ - \left[\log\left(8\lambda_{up} / 5\right)^{5/8} \right]^2 \right\}$$

and

$$\lambda_{up} = \frac{q_h}{k_{up} \tan^2 \beta_{up}}$$

Downstream section

$$t_{downmax} = \frac{q_h (L_{up} + L_{down})}{k_{down} \sin \beta_{down}}$$

Required Transmissivity

Upstream section

$$\theta_{up\,max} = k_{up} * t_{up}$$

Downstream section

$$\theta_{downmax} = \frac{q_h L_{down}}{\sin \beta_{down}}$$

Ultimate Transmissivity

Upstream section

$$\theta_{upultimate} = \theta_{upmax} * FS * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

Downstream section

$$\theta_{downultimate} = \theta_{downmax} * FS * RF_{in} * RF_{cr} * RF_{cc} * RF_{bc}$$

where:

Symbol	Description	Unit
k_{up}	The hydraulic conductivity of the liquid collection material in the upstream section	m/s
k_{down}	The hydraulic conductivity of the liquid collection material in the downstream section	m/s
L_{up}	The length of the liquid collection layer in the upstream section	m
L_{down}	The length of the liquid collection layer in the downstream section	m
q_h	Impingement rate	m/s
β_{up}	Slope for the upstream section	degrees
β_{down}	Slope for the downstream section	degrees
FS_d	Overall factor of safety for drainage	-
RF_{in}	Intrusion Reduction Factor	-
RF_{cr}	Creep Reduction Factor	-
RF_{cc}	Chemical Clogging Reduction Factor	-

RF_{bc}	Biological Clogging Reduction Factor	-

Input Values

	GC up/GC down		GC up/Granular down		Granular up/GC down	
q_h	1.50e-6	m/s	1.39e-006	m/s	1.39e-006	m/s
L_{up}	38.0	m	25	m	25	m
L_{down}	4.0	m	40	m	40	m
k_{up}	0.03	m/s	0.005	m/s	0.005	m/s
k_{down}	0.02	m/s	0.1	m/s	0.1	m/s
β_{up}	2.6	degrees	4	degrees	4	degrees
β_{down}	18.4	degrees	25	degrees	25	degrees

Factor	GC up/GC down	GC up/Granular down	Granular up/GC down		SurfaceWater Drains	Leachate Collection and Removal	Leachate Detection Systems
RF_{in}	1.4	1.2	1.2		1.0 - 1.2	1.0 - 1.2	1.0 - 1.2
RF_{cr}	1.4	1.4	1.4	Calculate RF_{CR}			
RF_{cc}	1.1	1.2	1.2		1.0 - 1.2	1.5 - 2.0	1.1 - 1.5
RF_{bc}	2.0	1.5	1.5		1.5 - 3.5	1.1 - 1.3	1.1 - 1.3
FS	2.0	2	2		2.0 - 10.0	2.0 - 10.0	2.0 - 10.0

Note: The reduction factor values given correspond to the case where the seating time exceeds 100 hours and the boundary conditions due to adjacent materials are simulated in the hydraulic transmissivity test.

Perform Calculations

Solution

	GC up/GC down	GC up/Granular down	Granular up/GC down
Maximum liquid depth @ upstream	0.0419 m >0.008 X	0.0996 m	0.0035 m
Maximum liquid depth @ downstream	0.0100 m >0.008 X	0.0021 m	0.0021 m
Required Transmissivity @ upstream	1.26E-003 m^2/sec	4.98E-004 m^2/sec	1.74E-005 m^2/sec
Required Transmissivity @ downstream	2.00E-004 m^2/sec	2.14E-004 m^2/sec	1.32E-004 m^2/sec
Ultimate Transmissivity @ upstream	1.08E-002 m^2/sec >2.0e-3 X	3.01E-003 m^2/sec	1.05E-004 m^2/sec
Ultimate Transmissivity @ downstream	1.72E-003 m^2/sec >1.2e-3 X	1.29E-003 m^2/sec	7.96E-004 m^2/sec

Additional Assistance

If you would like to have Advanced Geotech Systems provide material specifications that meet your performance criteria, please fill in the following fields and click the submit button. All information is kept strictly confidential.

Name *

Company

Email Address *

Phone

Project Reference

Comments

*required fields

Submit Design Results

References

"Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers Comprising Two Different Slopes". Giroud, J.P., Zornberg, J.G., Beech, J.F., Geosynthetics International, Vol. 7, No. 5-6, 2000.

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go to problem statement input values solution contact help references

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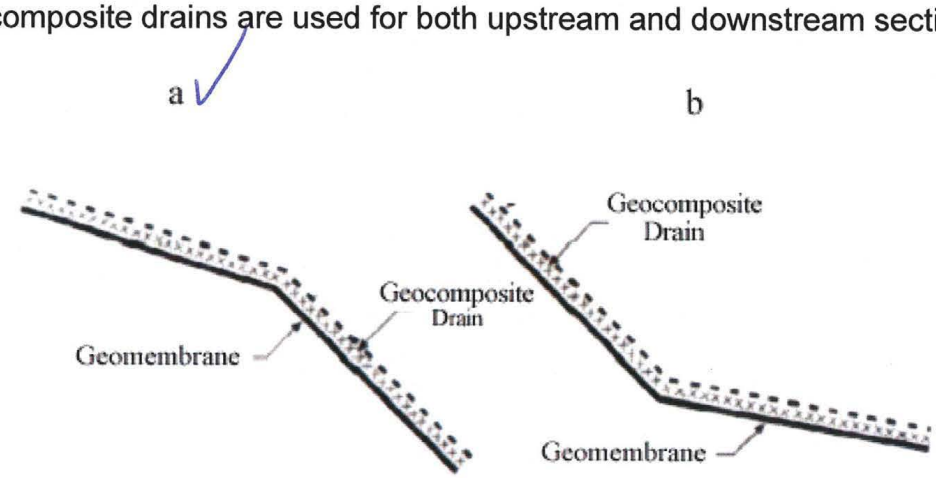

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Required Transmissivity

Upstream section $$\theta_{upmax} = \frac{q_k L_{up}}{\sin \beta_{up}}$$

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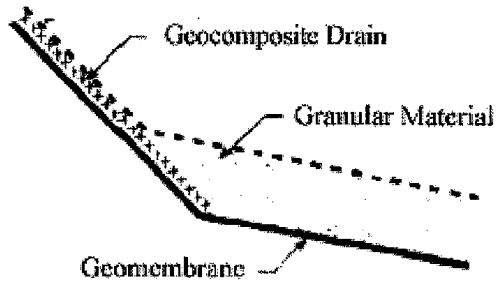

Maximum Liquid Depth

Upstream section $$t_{upmax} = \frac{q_h L_{up}}{k_{up} \sin \beta_{up}}$$

Downstream section $$t_{downmax} = \left\{ j_{down} \frac{\sqrt{1+4\lambda_{down}} - 1}{2} L_{down} + \lambda_{down} L_{up} \right\} \frac{\tan \beta_{down}}{\cos \beta_{down}}$$

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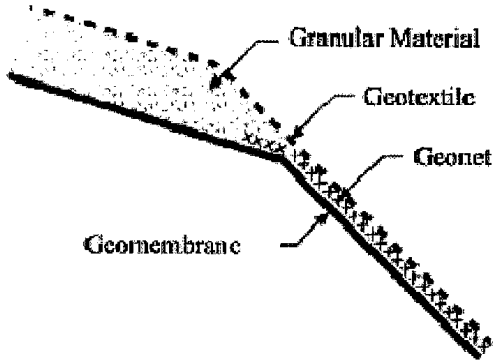

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Required Transmissivity

Upstream section

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Downstream section

$$\theta_{down\max} = \frac{q_h L_{down}}{\sin \beta_{down}}$$

Ultimate Transmissivity

Upstream section

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where:

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RF_{bc}	Biological Clogging Reduction Factor	-

Input Values

	GC up/GC down		GC up/Granular down		Granular up/GC down	
q_h	1.50e-7 *	m/s	1.39e-006	m/s	1.39e-006	m/s
L_{up}	38.0	m	25	m	25	m
L_{down}	4.0	m	40	m	40	m
k_{up}	0.03	m/s	0.005	m/s	0.005	m/s
k_{down}	0.02	m/s	0.1	m/s	0.1	m/s
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RF_{cr}	1.4	1.4	1.4	Calculate RF_{CR}			
RF_{cc}	1.1	1.2	1.2		1.0 - 1.2	1.5 - 2.0	1.1 - 1.5
RF_{bc}	2.0	1.5	1.5		1.5 - 3.5	1.1 - 1.3	1.1 - 1.3
FS	2.0	2	2		2.0 - 10.0	2.0 - 10.0	2.0 - 10.0

Note: The reduction factor values given correspond to the case where the seating time exceeds 100 hours and the boundary conditions due to adjacent materials are simulated in the hydraulic transmissivity test.

Perform Calculations

Solution

	GC up/GC down	GC up/Granular down	Granular up/GC down
Maximum liquid depth @ upstream	0.0042 m <0.008 OK	0.0996 m	0.0035 m
Maximum liquid depth @ downstream	0.0010 m <0.008 OK	0.0021 m	0.0021 m
Required Transmissivity @ upstream	1.26E-004 m^2/sec	4.98E-004 m^2/sec	1.74E-005 m^2/sec
Required Transmissivity @ downstream	2.00E-005 m^2/sec	2.14E-004 m^2/sec	1.32E-004 m^2/sec
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APPENDIX A-4

INTERFACE STABILITY EVALUATION

TECHNICAL MEMORANDUM

DATE: July 12, 2013

TO: Dean Brammer; USACE

COPY TO: Charles Collet, P.E. and Stephen Mitchell, P.E.; AMEC

FROM: Travis Carpenter, P.E. (Maine); AMEC

SUBJECT: Interface Stability Evaluation, Raymark Industries, Inc. Superfund Site (576/600 East Broadway), Stratford, Connecticut

PROJECT: 3651-12-0004

1.0 INTRODUCTION

AMEC Environment & Infrastructure, Inc. (AMEC) has performed an interface stability evaluation in support of the Remedial Design (RD) of a low-permeable cap for the Raymark Industries, Inc. Superfund Site, Operable Unit 6 (OU6), at 576/600 East Broadway in Stratford, Connecticut. The purpose of this evaluation was to establish the interface strength parameters necessary to provide for acceptable interface stability within the cap system.

This Technical Memorandum (TM) documents the work performed and presents the results of the evaluation. This TM is organized as follows:

- Section 2.0 briefly summarizes relevant project background information;
- Section 3.0 presents the methodology, assumptions, and results; and
- Section 4.0 provides conclusions and recommendations.

2.0 PROJECT BACKGROUND INFORMATION

Elevations reported herein are based on the North American Vertical Datum (NAVD) of 1988. Elevations are reported in units of feet. The horizontal datum is the Connecticut State Plane Coordinate System, based on the North American Datum (NAD) of 1983.

2.1 Site Description

OU6 of the Raymark Industries, Inc. Superfund Site (i.e., the Site) includes properties located at 576/600 East Broadway in Stratford, Connecticut. The two adjacent East Broadway properties encompass approximately 6 acres of commercially-zoned (light industrial) land that is presently overgrown and undeveloped, except for two small buildings and associated pavements situated on the 576 East Broadway parcel. Central portions of the Site are relatively flat and level with existing ground surface elevations generally ranging between +8.0 and +12.5 feet. The Site slopes downward toward the Site perimeter to an elevation of about +4.0 to +5.0 feet in most areas. Existing Site features and topography are depicted in Figure 1.

Beginning in the late 1980s, the Site received waste fill from the former Raymark Industries, Inc. facility. The fill consists of both natural and manmade materials. The manmade materials include presumed asbestos containing material (PACM) (fibrous asbestos mats and pads), asphalt, brake pads, brick, cinders, coal, concrete, gasket material, glass, metal debris, plastic, steel, tiles, shingles, slag, and wood. Raymark waste found in the fill materials at this Site consists of asbestos, lead, copper and/or Aroclor 1268.

Most of the Site was originally a tidal/seasonal floodplain marsh prior to filling. Much of the Site is still presently located within the 100-year floodplain.

2.2 Planned Remedial Action

The remediation of 576/600 East Broadway is being performed as a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Action (RA) under the *Record of Decision for Final Source Control Actions at Four Properties Within Operable Unit 6 (Additional Properties) and Interim Actions at Other Locations Containing Raymark Waste* (USEPA, 2011). As described in the Record of Decision (ROD), the selected RA for this Site is to excavate Raymark waste from the 100-year floodplain, consolidate the waste on the upland portion of the Site, and contain the waste with a low-permeable Resource Conservation and Recovery Act (RCRA) cap.

The planned cap limits/extents and grading are depicted in Figure 1. A final grade/elevation of about +16.5 feet is indicated near the middle of the cap footprint. From this apex, the cap will slope downward gently (4.5% slope) toward the cap perimeter. There will be a grade break near the perimeter, at an elevation of +11.0 feet, where the cap grades will transition from 4.5% slopes to 33.3% slopes [3 horizontal to 1 vertical (3H:1V)]. The 3H:1V perimeter side slopes will be on the order of 3 to 4 feet tall.

The following cap configuration (from the ground surface downward) and materials are planned:

- Topsoil (4 inches, minimum);
- Vegetative support soil (8 inches, minimum);
- Protective cover soil (12 inches, minimum);
- Geocomposite drainage layer (GDL);
- Geomembrane [flexible membrane liner (FML)];
- Geosynthetic clay liner (GCL);
- Geocomposite gas venting layer (GVL); and
- Subgrade fill/consolidated waste materials.

The "Final Grading Plan" (Attachment 1) indicates the following cap grading and maximum slope configurations:

- 4.5% upper slopes.
    - 5.5 feet tall (max.) and 125 feet long (max.; along horizontal plane).
- 33.3% side slopes.
    - 4.0 feet tall (max.) and 12 feet long (max.; along horizontal plane).

3.0 INTERFACE STABILITY EVALUATION

AMEC performed this interface stability evaluation to establish interface strength requirements for cap geosynthetics, based on the planned cap configuration, materials, and grading.

3.1 Methodology

This evaluation is based primarily on methodology presented in the "Design of Lining and Cover System Side Slopes" (Druschel and Underwood, 1993), which is included as Attachment 2. AMEC developed and utilized an in-house spreadsheet calculator to calculate an interface stability factor of safety (FS) based on the following force summation equation:

$$FS = \frac{\Sigma \text{ Resisting Forces}}{\Sigma \text{ Driving Forces}}$$

The effects of saturated cover soil conditions were calculated (if applicable) based on methodology presented in "Earth Slides on Geomembrane" (Stamatopoulos and Kotzlas, 1996). Similarly, a seismic coefficient equal to the peak ground acceleration (PGA) was included (if applicable) to represent the anticipated effect of the horizontal acceleration imposed by a seismic event. AMEC's spreadsheet calculator does not include any resistance generated by anchorage/tension in geosynthetic materials.

An infinite slope analysis was also included in this evaluation, given the relatively long (and flat) upper slopes and the relatively thin cap. Infinite slope analyses are considered appropriate for cases in which the slope length is much greater than the thickness of the cap. For infinite slope analyses, the FS is again defined as the resisting forces divided by the driving forces.

3.2 Evaluation Criteria

Table 1 presents the minimum factors of safety for the interface to be considered stable.

Table 1: Minimum Factors of Safety

Condition	Loading	Minimum Factor of Safety	
		Peak Strength	Residual Strength
Long-Term	Static	1.5	1.1
Long-Term	Seismic[1]	1.1	1.0
Construction	Static	1.3	1.1
Construction	Seismic[2]	1.1	1.0
Transient (short-term)	Static	1.3	1.1

Notes:

1. A PGA for a 2% probable exceedance (PE) in 50 years was applied for the long-term condition.
2. A PGA for a 10% PE in 50 years was applied for the construction condition.

3.3 Site-Specific Interfaces and Typical Interface Strength Parameters

Table 2 identifies the site-specific interfaces (based on the planned cap materials) and presents typical strength parameters for each interface (based on literature values, geosynthetic manufacturers' specifications and/or testing databases, and AMEC's experience and engineering judgment).

Table 2: Site-Specific Interfaces and Typical Interface Strength Parameters

Interface			Typical Interface Strength Parameters			
No.	Materials		Peak		Residual	
	General	Specific	δ (degrees)	Cohesion (psf)	δ (degrees)	Cohesion (psf)
1	Cover Soil GDL	Silty Sand NW[1] Geotextile	30	0	28	0
2a	GDL FML	NW Geotextile Smooth	10	0	10	0
2b	GDL FML	NW Geotextile Textured	28	0	22	0
3a	FML GCL[2]	Smooth NW Geotextile	10	0	10	0
3b	FML GCL[2]	Textured NW Geotextile	28	0	22	0
4	GCL[2] GVL	W[1] Geotextile NW Geotextile	26	0	20	0
5	GVL Subgrade Soil	NW Geotextile Silty Sand/Fill	30	0	28	0

Notes:

1. NW = Nonwoven; W = Woven.
2. A reinforced GCL (i.e., needle-punched) is assumed such that the internal shear strength of the GCL is not a critical "interface" to evaluate. Should an unreinforced GCL be considered for use on this Site, it must be evaluated and tested relative to the interface performance requirements established herein.

3.4 Analysis and Results

AMEC performed separate analyses for the upper (4.5%) slopes and the perimeter (33.3%) slopes. General assumptions, slope-specific inputs, and associated results are summarized in the subsections below.

3.4.1 General Assumptions/Input Parameters

The following cover soil thickness, unit weights, strength parameters, and drainage/seepage conditions are assumed, regardless of slope:

- Thickness of cover soils = 2 feet;
- Unit weight of cover soils (moist) = 125 pounds/cubic foot (pcf);
- Unit weight of cover soils (saturated) = 130 pcf;
- Cover soil strength/friction angle = 30 degrees;
- Cover soil cohesion = 0 pounds/square foot (psf); and
- Seepage height above the hydraulic barrier = 0 feet.
    - AMEC completed a site-specific drainage layer evaluation (submitted under separate cover). The results indicate that a tri-planar geocomposite drainage layer has adequate capacity to drain storm water infiltration and prevent down slope flow (i.e., seepage) within the cover soils.

Site-specific seismic coefficients (from USGS) are listed as follows (see Attachment 3):

- PGA for a 2% PE in 50 years = 0.11g; and
- PGA for a 10% PE in 50 years = 0.03g.

3.4.2 Upper (4.5%) Slopes

The following maximum slope configuration is expected for the upper slopes, based on the planned cap grading:

- Slope, β_{up} = 4.5 percent = 2.6 degrees;
- Height, H_{up} = 5.5 feet; and
- Length, $L_{up\text{-}horizontal}$ = 125 feet.

Considering the relatively long slope and relatively thin soil cover, the analysis of the upper (4.5%) slopes conservatively ignored the resistance provided by the "toe" of the soil cover (i.e., the toe buttress per Druschel). This is represented (in the spreadsheet calculator) by inputting a cover soil shear strength, ϕ, of 0 degrees. For the long-term static loading condition, the analysis essentially becomes an infinite slope analysis (Tangent of δ / Tangent of β).

Table 3 presents the estimated factors of safety for each interface, for the long-term static loading condition, based on typical interface strength parameters (Table 2) and the assumptions/inputs described herein. The corresponding spreadsheet calculations are provided in Attachment 4A.

Table 3: Estimated Factors of Safety for Long-Term Static Conditions (4.5% Slopes)

Interface			Estimated Factors of Safety	
No.	Materials		Peak	Residual
	General	Specific	(FS $\geq$ 1.5 Required)	(FS > 1.1 Required)
1	Cover Soil	Silty Sand	12.8	11.8
	GDL	NW[1] Geotextile		
2a	GDL	NW Geotextile	3.9	3.9
	FML	Smooth		
2b	GDL	NW Geotextile	11.8	9.0
	FML	Textured		
3a	FML	Smooth	3.9	3.9
	GCL[2]	NW Geotextile		
3b	FML	Textured	11.8	9.0
	GCL[2]	NW Geotextile		
4	GCL[2]	W[1] Geotextile	10.8	8.1
	GVL	NW Geotextile		
5	GVL	NW Geotextile	12.8	11.8
	Subgrade Soil	Silty Sand/Fill		

Notes:

1. NW = Nonwoven; W = Woven.
2. A reinforced GCL (i.e., needle-punched) is assumed such that the internal shear strength of the GCL is not a critical "interface" to evaluate. Should an unreinforced GCL be considered for use on this Site, it must be evaluated and tested relative to the interface performance requirements established herein.

The results presented in Table 3 indicate that interfaces between a smooth FML and a nonwoven (or woven) geotextile (i.e., Interfaces 2a and 3a) will govern interface stability on the upper 4.5% slopes. As such, these interfaces were analyzed further to consider various site-specific loading conditions/scenarios (e.g., construction equipment, seismic loading, and transient conditions). Table 4 provides a general description of the six scenarios considered. Table 5 summarizes the spreadsheet input parameters and the required factors of safety for each scenario.

Table 4: Description of Site-Specific Scenarios (4.5% Slopes)

Scenario No.	Condition	Evaluation	General Description
1	Long-Term	Static	Simulates the base/long-term condition. Already analyzed. Results are presented in Table 3.
2	Long-Term	Seismic	Simulates base/long-term condition during a seismic event (50-year, 2% PE).
3	Construction	Static	Simulates equipment loading.
4	Construction	Static	Simulates equipment loading on a saturated slope (γ_t=γ_{sat}=130 pcf) but no seepage (for conditions that may occur during spring thaw).
5	Construction	Seismic	Simulates equipment loading during a seismic event (50-year, 10% PE).
6	Transient	Static	Simulates a saturated slope (γ_t=γ_{sat}=130 pcf) but no seepage (for conditions that may occur during a spring thaw).

Table 5: Input Parameters for Site-Specific Scenarios (4.5% Slopes)

Scenario No.	Condition	Evaluation	Seep.	Equip. Loading	Cover Soil Properties			Min. FS Required	
					γ (pcf)	ϕ (deg)	c (psf)	Peak	Resid.
1	Long-Term	Static	No	No	125	30	0	1.5	1.1
2	Long-Term	Seismic	No	No	125	30	0	1.1	1.0
3	Construction	Static	No	Yes	125	30	0	1.3	1.1
4	Construction	Static	No	Yes	130	30	0	1.3	1.1
5	Construction	Seismic	No	Yes	125	30	0	1.1	1.0
6	Transient	Static	No	No	130	30	0	1.3	1.1

Notes:

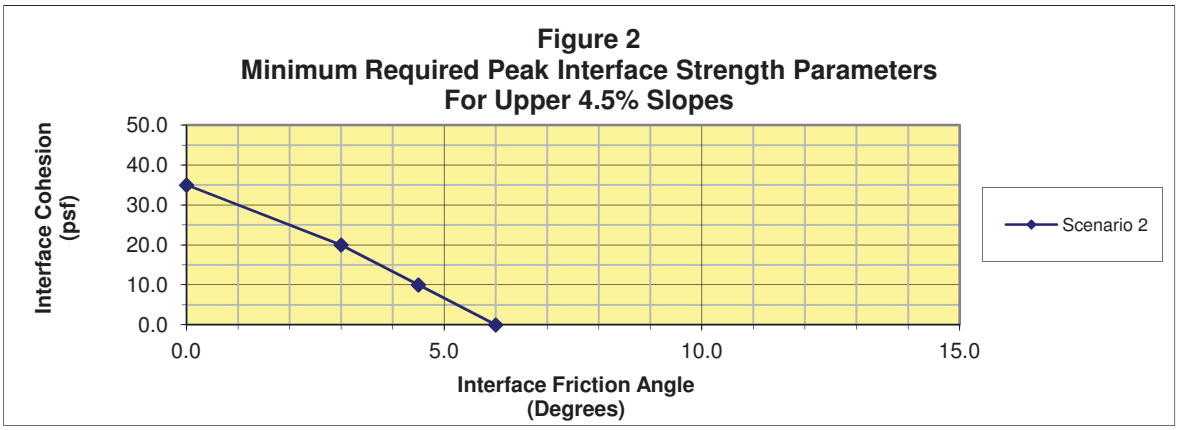
1. Seep. = Seepage represents failure of the GDL. The cover soils become fully saturated and down slope seepage/flow occurs within the cover soils.
2. Equip. Loading = The effect of equipment loading (braking force) is considered. A D7 bulldozer weighing 8,236 pounds with a width of 12.9 feet was utilized.

The interface strength parameters (Table 2) for an interface between a smooth FML and non-woven (or woven) geotextile (i.e., Interfaces 2a and 3a) were utilized for the analysis of the six site-specific scenarios described herein. The results are summarized in Table 6. The corresponding spreadsheet calculations are provided in Attachment 4B.

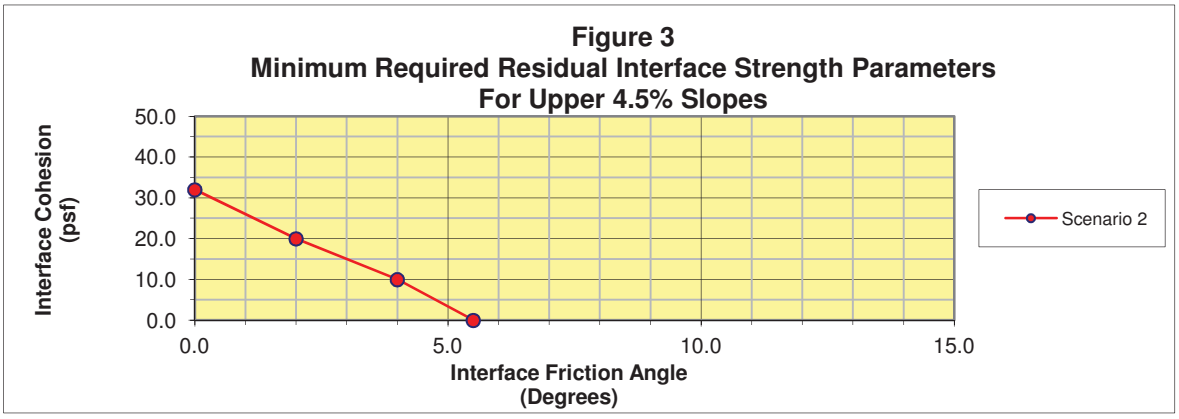
Table 6: Analysis/Results for Site-Specific Scenarios (4.5% Slopes)
Smooth FML/Geotextile Interface

Scenario No.	Condition	Evaluation	Factors of Safety			
			Peak		Residual	
			Required	Estimated	Required	Estimated
1	Long-Term	Static	1.5	3.9	1.1	3.9
2	Long-Term	Seismic	1.1	1.8	1.0	1.8
3	Construction	Static	1.3	3.5	1.1	3.5
4	Construction	Static	1.3	3.5	1.1	3.5
5	Construction	Seismic	1.1	2.7	1.0	2.7
6	Transient	Static	1.3	3.9	1.1	3.9

The analysis/results presented in Table 6 indicate that Scenario No. 2 (long-term seismic) controls the performance requirements for both the peak and residual strengths of a smooth FML/geotextile interface. As such, this scenario was analyzed further to establish the minimum required site-specific peak interface strength parameters (including the effects of interface cohesion) that will provide for acceptable interface stability on the upper 4.5% slopes. An iterative analysis was performed. The results of the peak strength iterations are presented in Figure 2 below. The corresponding spreadsheet calculations are provided in Attachment 4C.



An iterative analysis was also performed to establish the minimum required site-specific residual interface strength parameters (including the effects of interface cohesion), based on Scenario No. 2. The results of the residual strength iterations are presented in Figure 3 below. The corresponding spreadsheet calculations are provided in Attachment 4C.



3.4.3 Perimeter (33.3%) Slopes

The following maximum slope configuration is expected for the perimeter side slopes, based on the planned cap grading:

- Slope, β_{down} = 33.3 percent = 18.4 degrees;
- Height, H_{down} = 4.0 feet; and
- Length, $L_{down\text{-}horizontal}$ = 12 feet.

Table 7 presents the estimated factors of safety for each interface, for the long-term static loading condition, based on typical interface strength parameters (Table 2) and the assumptions/inputs described herein. The corresponding spreadsheet calculations are provided in Attachment 5A.

Table 7: Estimated Factors of Safety for Long-Term Static Conditions (33.3% Slopes)

Interface			Estimated Factors of Safety	
No.	Materials		Peak	Residual
	General	Specific	(FS ≥ 1.5 Required)	(FS > 1.1 Required)
1	Cover Soil GDL	Silty Sand NW[1] Geotextile	2.4	2.2
2a	GDL FML	NW Geotextile Smooth	0.7	0.7
2b	GDL FML	NW Geotextile Textured	2.2	1.7
3a	FML GCL[2]	Smooth NW Geotextile	0.7	0.7
3b	FML GCL[2]	Textured NW Geotextile	2.2	1.7
4	GCL[2] GVL	W[1] Geotextile NW Geotextile	2.0	1.5
5	GVL Subgrade Soil	NW Geotextile Silty Sand/Fill	2.4	2.2

Notes:

1. NW = Nonwoven; W = Woven.
2. A reinforced GCL (i.e., needle-punched) is assumed such that the internal shear strength of the GCL is not a critical "interface" to evaluate. Should an unreinforced GCL be considered for use on this Site, it must be evaluated and tested relative to the interface performance requirements established herein.

The results presented in Table 7 indicate that the FS estimated for interfaces between a smooth FML and a nonwoven (or woven) geotextile (i.e., Interfaces 2a and 3a) are well below the required FS. As such, textured FML will be required for the perimeter 33.3% slopes. Assuming a textured FML, it appears that Interface 4 (GCL/GVL) will govern interface stability on the perimeter 33.3% slopes. As such, this interface was analyzed further to consider various site-specific loading conditions/scenarios (e.g., construction equipment, seismic loading, and transient conditions). Table 8 provides a general description of the six scenarios considered. Table 9 summarizes the spreadsheet input parameters and the required factors of safety for each scenario.

Table 8: Description of Site-Specific Scenarios (33.3% Slopes)

Scenario No.	Condition	Evaluation	General Description
1	Long-Term	Static	Simulates the base/long-term condition. Already analyzed. Results are presented in Table 7.
2	Long-Term	Seismic	Simulates base/long-term condition during a seismic event (50-year, 2% PE).
3	Construction	Static	Simulates equipment loading.
4	Construction	Static	Simulates equipment loading on a saturated slope (γ_t=γ_{sat}=130 pcf) but no seepage (for conditions that may occur during spring thaw).
5	Construction	Seismic	Simulates equipment loading during a seismic event (50-year, 10% PE).
6	Transient	Static	Simulates a saturated slope (γ_t=γ_{sat}=130 pcf) but no seepage (for conditions that may occur during a spring thaw).

Table 9: Input Parameters for Site-Specific Scenarios (33.3% Slopes)

Scenario No.	Condition	Evaluation	Seep.	Equip. Loading	Cover Soil Properties			Min. FS Required	
					γ (pcf)	ϕ (deg)	c (psf)	Peak	Resid.
1	Long-Term	Static	No	No	125	30	0	1.5	1.1
2	Long-Term	Seismic	No	No	125	30	0	1.1	1.0
3	Construction	Static	No	Yes	125	30	0	1.3	1.1
4	Construction	Static	No	Yes	130	30	0	1.3	1.1
5	Construction	Seismic	No	Yes	125	30	0	1.1	1.0
6	Transient	Static	No	No	130	30	0	1.3	1.1

Notes:

1. Seep. = Seepage represents failure of the GDL. The cover soils become fully saturated and down slope seepage/flow occurs within the cover soils.
2. Equip. Loading = The effect of equipment loading (braking force) is considered. A D7 bulldozer weighing 8,236 pounds with a width of 12.9 feet was utilized.

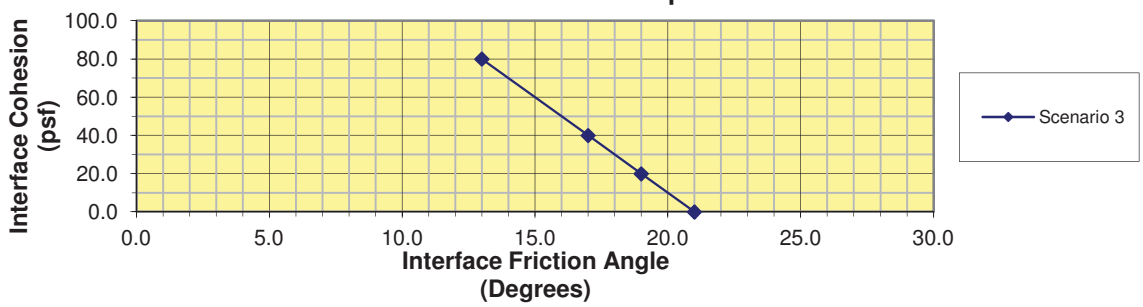
The interface strength parameters (Table 2) for an interface between a GCL and a GVL (i.e., Interface 4) were utilized for the analysis of the six site-specific scenarios described herein. The results are summarized in Table 10. The corresponding spreadsheet calculations are provided in Attachment 5B.

Table 10: Analysis/Results for Site-Specific Scenarios (33.3% Slopes)
GCL/GVL Interface

Scenario No.	Condition	Evaluation	Factors of Safety			
			Peak		Residual	
			Required	Estimated	Required	Estimated
1	Long-Term	Static	1.5	2.0	1.1	1.5
2	Long-Term	Seismic	1.1	1.7	1.0	1.3
3	Construction	Static	1.3	1.7	1.1	1.2
4	Construction	Static	1.3	1.7	1.1	1.2
5	Construction	Seismic	1.1	1.6	1.0	1.2
6	Transient	Static	1.3	2.0	1.1	1.5

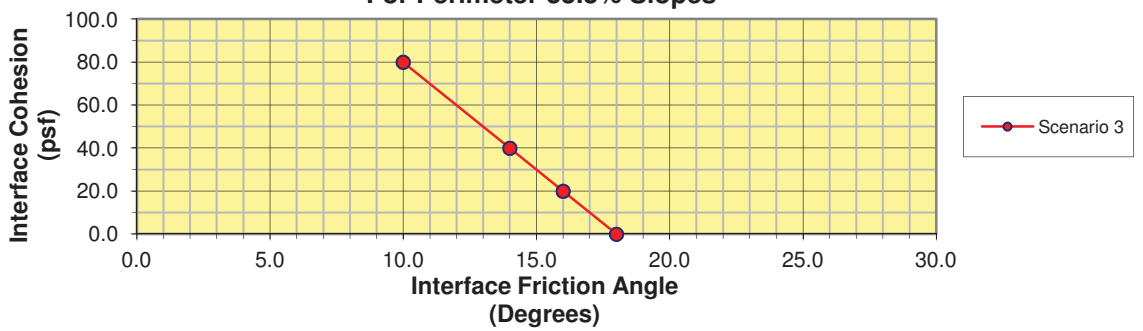
The analysis/results presented in Table 10 indicate that Scenario No. 3 controls the performance requirements for both the peak and residual strengths of the GCL/GVL interface. As such, this scenario was analyzed further to establish the minimum required site-specific peak interface strength parameters (including the effects of interface cohesion) that will provide for acceptable interface stability. An iterative analysis was performed. The results of the peak strength iterations are presented in Figure 4. The corresponding spreadsheet calculations are provided in Attachment 5C.

Figure 4
Minimum Required Peak Interface Strength Parameters
For Perimeter 33.3% Slopes



An iterative analysis was also performed to establish the minimum required site-specific residual interface strength parameters (including the effects of interface cohesion), based on Scenario No. 3. The results of the residual strength iterations are presented in Figure 5. The corresponding spreadsheet calculations are provided in Attachment 5C.

Figure 5
Minimum Required Residual Interface Strength Parameters
For Perimeter 33.3% Slopes



4.0 CONCLUSIONS AND RECOMMENDATIONS

The subsections below summarize conclusions for each slope configuration and outline a recommended project-specific conformance testing program (relative to interface testing).

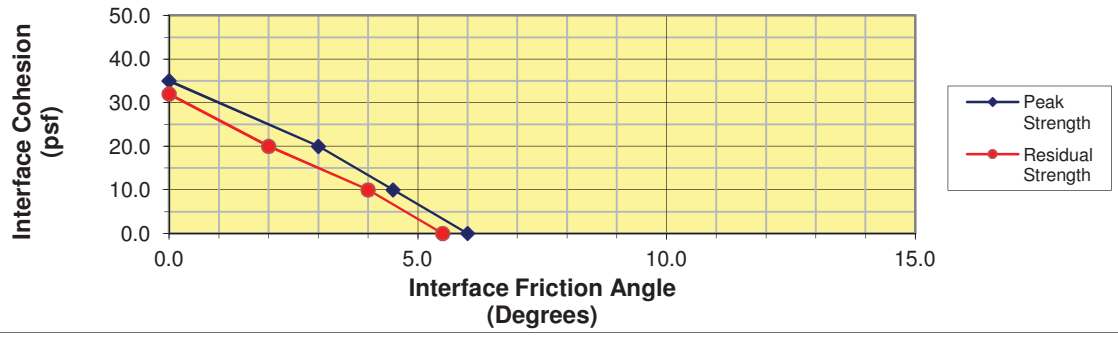
4.1 Upper (4.5%) Slopes

The analyses performed for the upper 4.5% slopes indicate the following minimum required interface strength parameters (assuming no cohesion):

- Peak Strength = 6.0 degrees; and
- Residual Strength = 5.5 degrees.

A reduction in the peak and/or residual friction angles may be justified based on the inclusion of interface cohesion. Figure 6 summarizes the required interface strength parameters (including the effect of interface cohesion). Figure 6 will be used to convey both peak and residual interface strength requirements to the Contractor. Interface friction test results which plot above and to the right the respective peak/residual strength line will provide adequate interface strength to provide for acceptable interface stability on the upper 4.5% slopes.

Figure 6
Minimum Required Interface Strength Parameters
For Upper 4.5% Slopes



The results of this evaluation indicate that a smooth FML is suitable (from an interface friction standpoint) for the upper 4.5% slopes. Literature values and/or historic testing data indicate that interface strengths of 10 degrees or more are typical for smooth FML tested in conjunction with nonwoven and/or woven geotextiles at low normal stresses. Even lower bound interface strengths of 8 degrees (based on literature/historic testing) would exceed the minimum strengths established herein. As such, project-specific testing of smooth FML in conjunction with nonwoven or woven geotextile is not recommended.

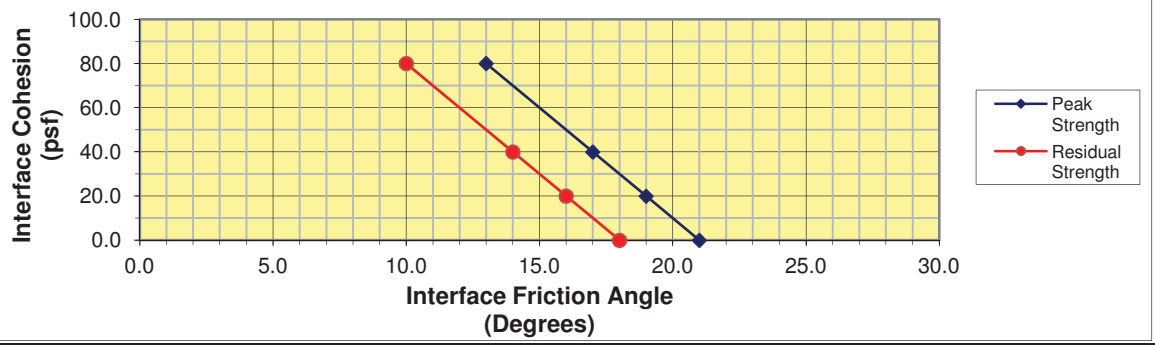
4.2 Perimeter (33.3%) Slopes

The analyses performed for the perimeter 33.3% slopes indicate the following minimum required interface strength parameters (assuming no cohesion):

- Peak Strength = 21.0 degrees; and
- Residual Strength = 18.0 degrees.

A reduction in the peak and/or residual friction angles may be justified based on the inclusion of interface cohesion. Figure 7 summarizes the required interface strength parameters (including the effect of interface cohesion). Figure 7 will be used to convey both peak and residual interface strength requirements to the Contractor. Interface friction test results which plot above and to the right the respective peak/residual strength line will provide adequate interface strength to provide for acceptable interface stability on the perimeter 33.3% slopes.

Figure 7
Minimum Required Interface Strength Parameters
For Perimeter 33.3% Slopes



The results of this evaluation indicate that smooth FML is not suitable (from an interface friction standpoint) for the perimeter 33.3% slopes, based on typical literature values and/or historic testing data. Textured FML will be required for perimeter 33.3% side slopes. Furthermore, project-specific interface testing is recommended for the geosynthetic to geosynthetic interfaces planned for 33.3% slopes.

4.3 Interface Testing Requirements

Site-specific interface friction testing will be required in accordance with the project specifications to satisfy the recommendations developed herein. Furthermore, interface friction testing must be supported by transmissivity testing of the GDL because the drainage requirements represent a critical component of this interface friction evaluation.

Testing procedures, testing frequency, and reporting requirements are detailed in the project specifications. In general, the interface friction testing is to be performed with the following conditions (see project specifications for more details):

1. Interface friction testing must be performed in accordance with ASTM D5321-12 "Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear" and ASTM D6243-13 "Standard Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by Direct Shear", as applicable. Test frequencies should be as listed or at any change in geosynthetic materials.
2. Report all data as required by the referenced testing standard and/or project specifications. In addition, "residual strength values" [i.e., large-displacement strain (minimum of 20%) or maximum displacement of test equipment, as approved by the design engineer] should be provided. Furthermore, the condition of the GDL, FML, and/or GVL must be reported (i.e., did it rip/tear along surfaces or at connections to the shear box). Damage at the connections will constitute an unacceptable test.
3. Testing results obtained during construction will need to be evaluated by the design engineer, using the figures and methods described herein, to make an assessment of all materials (all materials must be evaluated as a system), and to determine acceptability.

4. GDL/Textured FML Interface:

    - Site-specific interface testing should be conducted at the frequency of 1 test/75,000 square feet;
    - The asperity of the textured geomembrane should be measured/recorded prior to testing (based on median value of at least 4 tests completed on the sample);
    - Textured geomembrane should be tested in the cross-machine direction;
    - Site-specific soils taken from samples used for borrow source testing should be used;
    - For testing purposes, three confining stresses of 1, 2, and 3 psi are recommended;
    - A displacement/shearing rate of 0.04 inches/minute under non-inundated conditions is recommended;

- Testing should be performed with the following configuration (top to bottom): top plate, cover soil (compacted to a maximum of 90% of the standard proctor), GDL, textured FML, bottom plate;
- Report both peak and residual/large-displacement values; and
- Acceptance of interface friction testing results should be determined by the design engineer by plotting the project-specific test results on Figure 7.

5. Textured FML/GCL Interface:

- Site-specific interface testing should be conducted at the frequency of 1 test/75,000 square feet. Test frequency should be re-evaluated upon receipt of initial test results;
- The asperity of the textured geomembrane should be measured/recorded prior to testing (based on median value of at least 4 tests completed on the sample);
- Textured geomembrane should be tested in the cross-machine direction;
- The GCL should be hydrated with de-ionized water for a minimum of 48 hours at the target normal stress prior to testing;
- Site-specific soils taken from samples used for borrow source testing should be used, as applicable;
- For testing purposes, three confining stresses of 1, 2, and 3 psi are recommended;
- A displacement/shearing rate of 0.04 inches/minute under non-inundated conditions is recommended;
- Testing should be performed with the following configuration (top to bottom): top plate, textured FML, GCL (nonwoven side up), bottom plate;
- Report both peak and residual/large-displacement values;
- Acceptance of interface friction testing results should be determined by the design engineer by plotting results on Figure 7.

6. GCL/GVL Interface:

- Site-specific interface testing should be conducted at the frequency of 1 test/75,000 square feet. Test frequency should be re-evaluated upon receipt of initial test results;

- The GCL should be hydrated with de-ionized water for a minimum of 48 hours at the target normal stress prior to testing;
- Site-specific soils taken from samples used for borrow source testing should be used, as applicable;
- For testing purposes, three confining stresses of 1, 2, and 3 psi are recommended;
- A displacement/shearing rate of 0.04 inches/minute under non-inundated conditions is recommended;
- Testing should be performed with the following configuration (top to bottom) – top plate, GCL (nonwoven side up), GVL, subgrade soil (compacted to 90% of the standard proctor); bottom plate;
- Report both peak and residual/large-displacement values; and
- Acceptance of interface friction testing results should be determined by the design engineer by plotting results on Figure 7.

5.0 REFERENCES

Druschel, S. J. and Underwood, E. R., 1993. "Design of Lining and Cover System Side Slopes," Geosynthetics, Vancouver, Canada, pp. 1341 – 1355.

Gilbert, R.B., 2001. "Peak Versus Residual Strength for Waste Containment Systems".

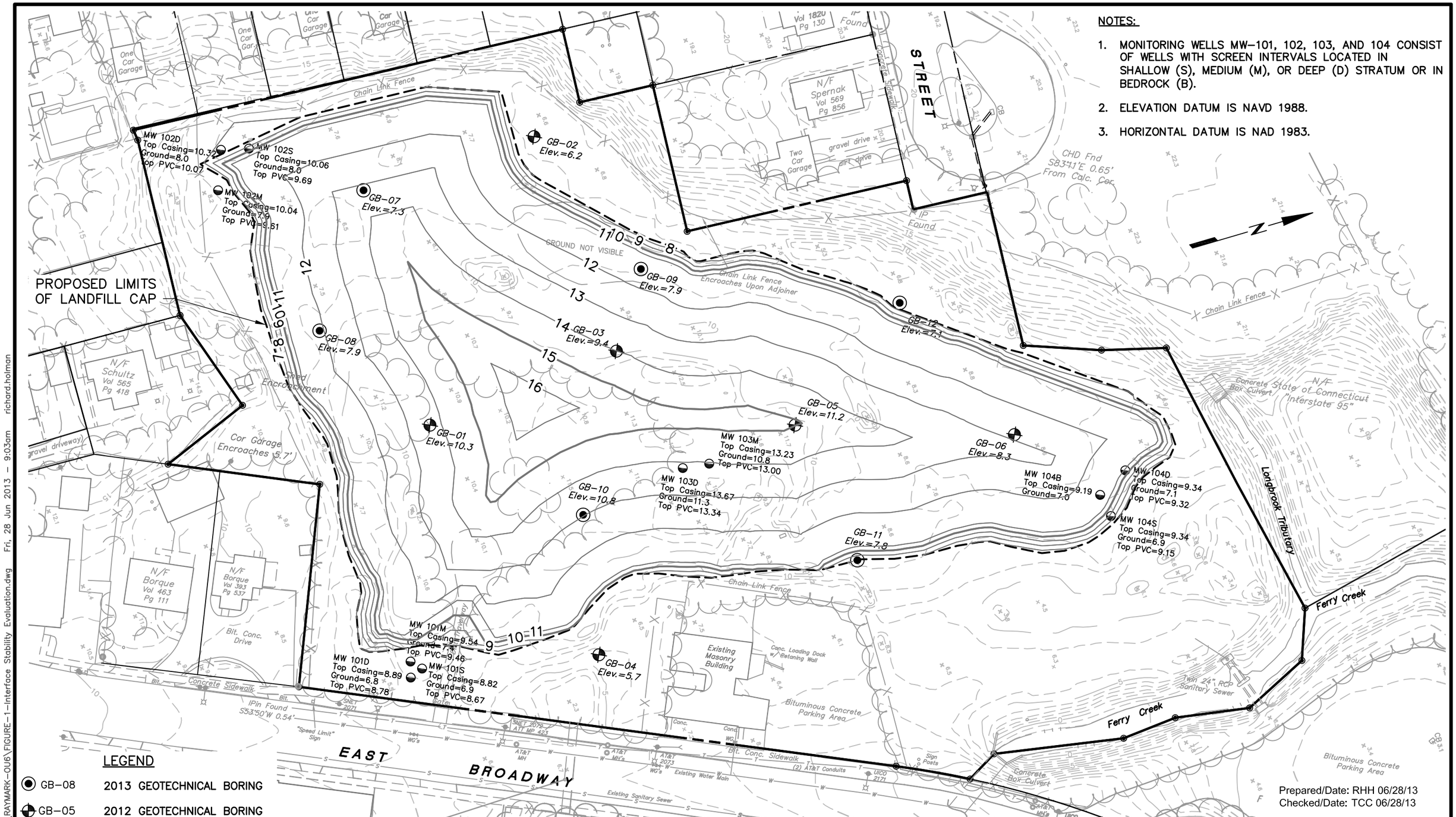
Giroud, J.P., Zornberg, J.G., and Zhao, A., 2000. "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers", Geosynthetics International, Special Issue on Liquid Collection Systems, Vol. 7, Nos. 4-6, pp. 285-380.

Koerner, R., 1994. Designing with Geosynthetics, Prentice Press, 3rd Edition, pp. 492 – 494.

Richardson, G. and Kavazanijian, E., 1995. "RCRA Subtitle D (258): Seismic Design Guidance for Municipal Solid Waste Landfill Facilities", USEPA.

Stamatopoulos, A.C., Kotzlas, P.C., et. all, "Earth Slides on Geomembranes," Journal of Geotechnical Engineering, 1996.

FIGURES



NOTES:

1. MONITORING WELLS MW-101, 102, 103, AND 104 CONSIST OF WELLS WITH SCREEN INTERVALS LOCATED IN SHALLOW (S), MEDIUM (M), OR DEEP (D) STRATUM OR IN BEDROCK (B).
2. ELEVATION DATUM IS NAVD 1988.
3. HORIZONTAL DATUM IS NAD 1983.

LEGEND

GB-08	2013 GEOTECHNICAL BORING
GB-05	2012 GEOTECHNICAL BORING
MW 103(D)	1994 MONITORING WELL
	EXISTING GROUND SURFACE ELEVATION CONTOUR
	PROPOSED CAP GRADING (95% REMEDIAL DESIGN)

0 30 60 120
SCALE IN FEET HORIZONTAL

Prepared/Date: RHH 06/28/13
Checked/Date: TCC 06/28/13

RAYMARK INDUSTRIES, INC.
576/600 EAST BROADWAY
STRATFORD, CONNECTICUT

amec

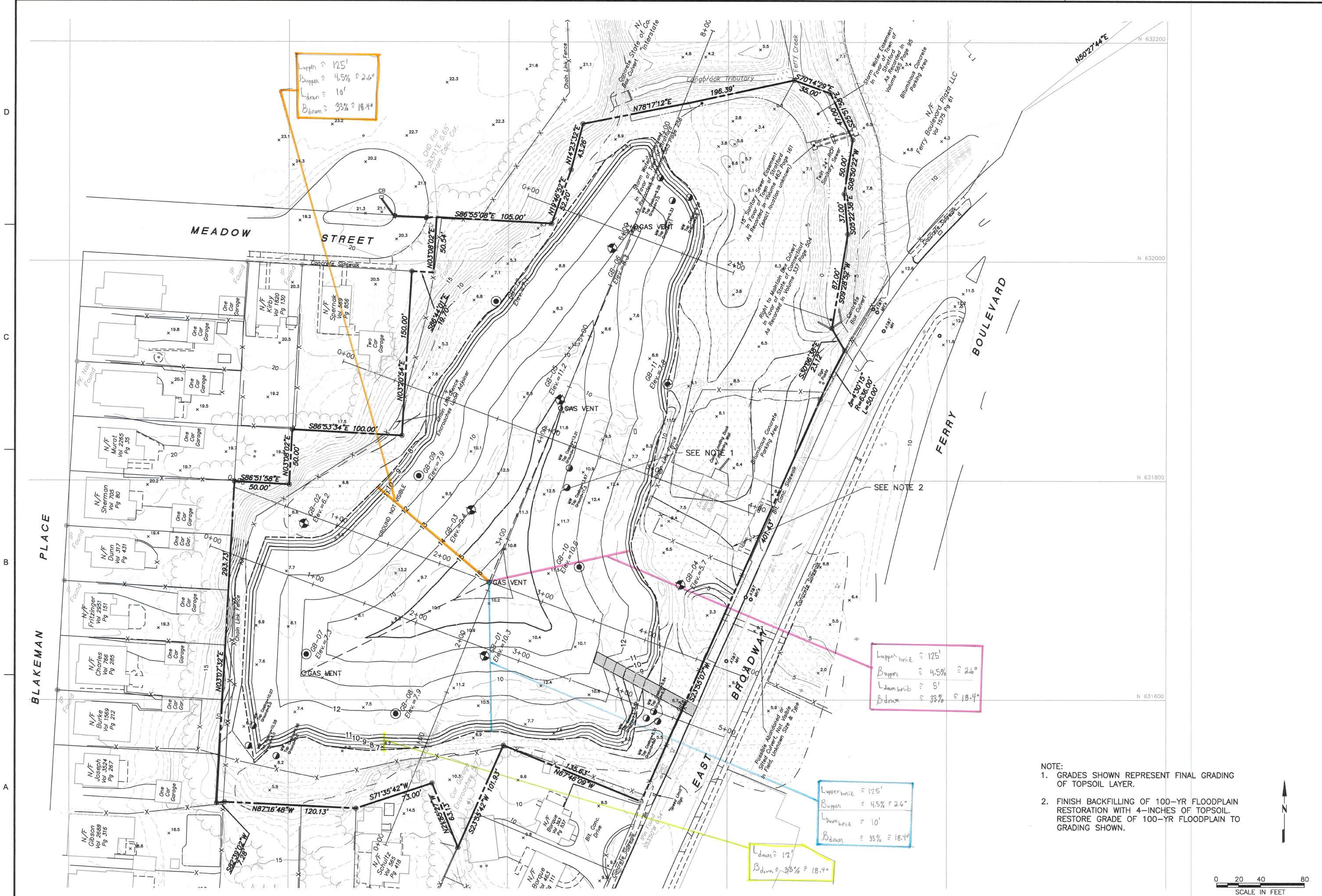
INTERFACE STABILITY EVALUATION

Project 3651-12-0004
FIGURE 1

Z:\Projects\USACE\RAYMARK-OU6\FIGURE-1-Interface Stability Evaluation.dwg Fri, 28 Jun 2013 - 9:03am richard.holman

ATTACHMENT 1

FINAL GRADING PLAN
(June 28, 2013)



NOTE:
1. GRADES SHOWN REPRESENT FINAL GRADING OF TOPSOIL LAYER.
2. FINISH BACKFILLING OF 100-YR FLOODPLAIN RESTORATION WITH 4-INCHES OF TOPSOIL. RESTORE GRADE OF 100-YR FLOODPLAIN TO GRADING SHOWN.

US Army Corps of Engineers® New England District

REV	DESCRIPTION	DATE	APPR.
B	95% PRE-FINAL DESIGN	8/16/12	
A	60% DESIGN FOR REVIEW	7/20/12	

U.S. ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
CONNECTICUT

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WESTFORD, MASSACHUSETTS 01886
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DESIGNED BY: SHM		DATE: DATE
DWN BY: RHH	CKD BY: CHECKED BY	SOLICITATION NO.: SOLICITATION NO.
SUBMITTED BY: SUBMITTED BY		CONTRACT NO.: CONTRACT NO.
PLOT SCALE: PLOT SCALE	PLOT DATE: PLOT DATE	FILE NUMBER: FILE NO.
SIZE: ANSI F	FILE NAME: FILE NAME	

REMEDIAL DESIGN OF A LANDFILL CAP
576/600 EAST BROADWAY
STRATFORD, CONNECTICUT

FINAL GRADING PLAN

SHEET IDENTIFICATION
C-104
SHEET 6 OF 10

FILE NAME: Z:\Projects\USACE\RAYMARK-OU6\OU6-C-104.dwg PLOT DATE: Tue, 25 Jun 2013 PLOT TIME: 8:59 AM

ATTACHMENT 2

DRUSCHEL METHODOLOGY

Design of Lining and Cover System Sideslopes

S.J. Druschel
CH2M Hill Inc., USA

E.R. Underwood
CH2M Hill Inc., USA

ABSTRACT

In this paper, a design methodology is presented for evaluating the stability of various lining and cover sideslope configurations. Traditional sliding-block analysis is the basis of the methodology, but it has been expanded to include seepage forces, equipment loads, geosynthetic anchorage, and factors of safety. As an aid to "real world" application of the methodology, equations are included in this paper to simplify the working analysis of stability and to allow the optimization of factors such as slope geometry, strength, and applied loads. In addition, figures are included that show the maximum slope height attainable for a range of slope angles, interface frictions, soil strengths, soil layer thicknesses, seepage depths, equipment loads, and geosynthetic anchorages. Use of this methodology is demonstrated in a project example in which slope angles are balanced against bench heights, soil characteristics, geosynthetic anchorage, and economics.

GLOSSARY OF SYMBOLS

The symbols used in the text, figures, and equations that appear in this paper are explained in the following list.

H	=	sideslope height
T_c	=	cover soil thickness
β	=	sideslope angle
γ_w	=	unit weight of water (62.4 lbs/ft^3)
γ_c	=	unit weight of cover soil
δ	=	interface friction angle
δ_m	=	interface friction angle (mobilized)
ϕ	=	soil shear strength angle
ϕ_m	=	soil shear strength angle (mobilized)
W_2	=	weight of sideslope soil
W_1	=	weight of toe buttress soil
W_e	=	weight of equipment on the sideslope
F_b	=	equipment braking force

T_w	=	thickness of seepage
W_{w1}	=	weight of seepage water in toe buttress
W_{w2}	=	weight of seepage water in sideslope soil
F_s	=	seepage force
F_a	=	geosynthetic anchorage force
F_1	=	toe buttress reaction force
F_2	=	sideslope reaction force
P	=	sideslope-toe buttress reaction force

INTRODUCTION

The capacity of a waste-containment facility such as a landfill is determined by the facility's area, height, and sideslope angles. Although the area and height are usually determined by property limits and regulations, the sideslope angle is based on engineering judgment and operational performance. Steeper sideslopes provide greater capacity, and greater capacity provides higher profits, so the sideslope angle should be as steep as possible. However, when the sideslope angle is too steep, the protective soil cover can become unstable and slide down slope. At best, such movement increases maintenance costs. At its worst, such movement can destroy a containment facility and cause its premature closure. Designs must balance the need for capacity against the risk of failure.

STABILITY ANALYSIS

Typical modern liner and cover systems consist of both soil and geosynthetic materials in a layered arrangement. When a liner or cover system becomes unstable, stronger overlying layers will tend to remain somewhat intact and slide over the weaker layers. Because the slope length is much greater than the liner or cover system thickness, the system can be modeled by a block sliding on an inclined plane. Figure 1 shows a sideslope with forces that typically act on it.

The sliding-block analysis is a traditional geotechnical technique in which all the forces acting on the sliding block are summed and the resultant must equal zero for the block to be stable. Sliding-block analysis is similar to the infinite slope analysis, another traditional geotechnical technique, but includes the contribution of the slope change at the bottom of the sideslope, described below as the toe buttress force. Factors of safety for sliding block analysis are developed by evaluating the shear strengths required to balance the forces and achieve stability. A full discussion of sliding-block analysis may be found in Lambe & Whitman (1969) or U.S. Navy (1986). Each of the forces that affects sideslope stability is briefly discussed below.

Interface Shear Strength. In any liner or cover system, the weakest interface governs stability. From the many studies of interface friction (for example, Martin, et al. [1984], Saxena and Wong [1984], Williams and Houlihan [1986], Negussey, et al. [1989], O'Rourke, et al. [1990], Mitchell, et al. [1990], and Yegian and Lahlaf [1992]), two classes of commonly encountered interface strengths have emerged: low-strength interfaces and high-strength interfaces.

Low-Strength Interfaces

Geotextile-geomembrane
Geonet-geomembrane
Geotextile-geonet (unless heat-bonded)
Geomembrane-clay(saturated)

δ = 6 to 9 degrees

High-Strength Interfaces

Sand-geomembrane
Sand-geotextile
Clay-geotextile

δ = 15 to 18 degrees

Factors of Safety. Factors of safety are calculated on the basis of the ratio of the actual shear strength to the mobilized shear strength (that is, the shear strength required for stability):

$$\text{Factor of safety} = \frac{\tan \phi}{\tan \phi_m} \text{ or } \frac{\tan \delta}{\tan \delta_m} \qquad \text{(Equation 1)}$$

Alternatively, a factor of safety can be set and maximum values of ϕ_m and δ_m calculated. This value may be used in the sliding block model to determine the maximum conditions (that is, H or β) that can be tolerated while still maintaining the factor of safety.

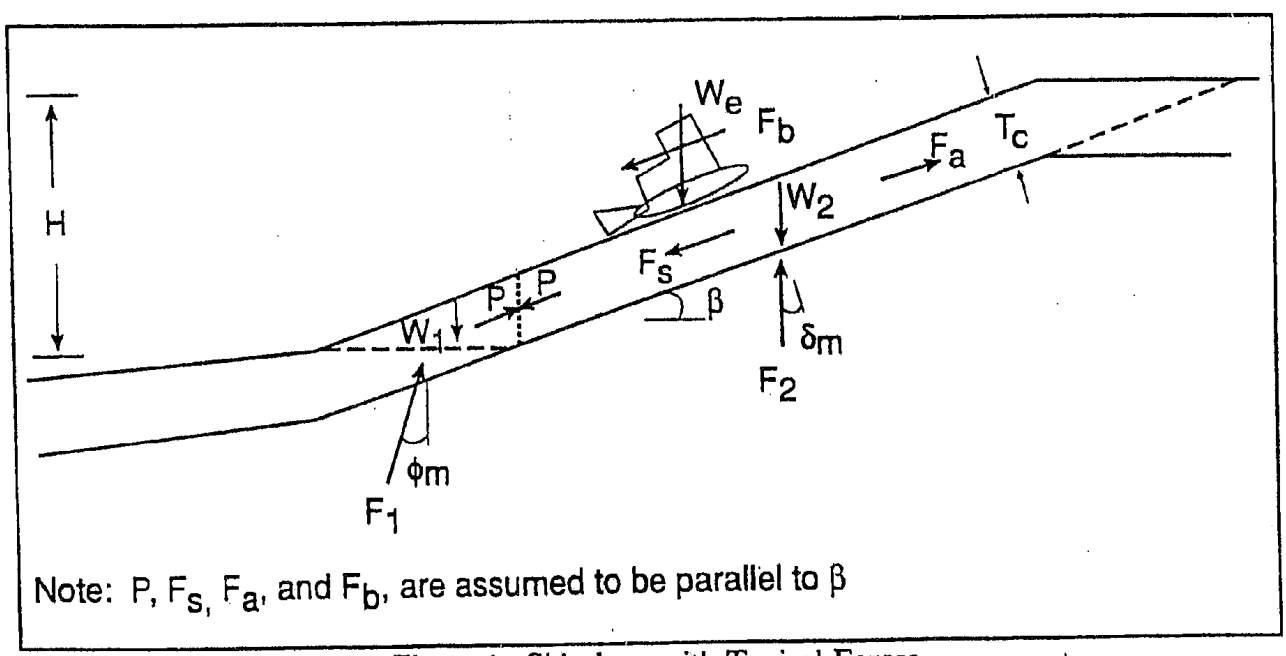


Figure 1. Sideslope with Typical Forces

One important point about shear strength values used for evaluation of cover and liner systems: because each material used in the system has a different shear stress-displacement response, peak or ultimate strengths may occur at different strain levels, or not at all. For this reason, residual shear strengths instead of peak strengths are strongly recommended for use in all slope evaluations.

Toe Buttress. Multilayered geosynthetic or composite liners and covers that have low-strength interfaces (δ values in the range of 6 to 9 degrees) are especially prone to stability problems. What allows liner and cover systems with low-strength interfaces to be stable when $\beta > \delta$? The answer lies with the soil cover at the bottom of the slope, through which any failure surface must propagate. This wedge of soil acts as a toe buttress, holding back the soil cover and increasing its stability. The strength of an effective toe buttress is provided by the friction developed along the failure surface. This friction is a function of ϕ and a combination of W_1 and P (the force of the soil cover acting on the wedge as it tries to slide). While the reaction force is determined graphically, W_1 is given by the following equation:

$$W_1 = \frac{\gamma_c T_c^2}{2 \sin \beta \cos \beta} \qquad \text{(Equation 2)}$$

More detail on the effect of the toe buttress on stability may be found in Beech and Giroud (1989).

Soil Cover. W_2 can be calculated using the following equation:

$$W_2 = \frac{\gamma_c T_c}{\sin \beta}\left(H - \frac{T_c}{2 \cos \beta}\right) \qquad \text{(Equation 3)}$$

This equation addresses soil covers of uniform thickness. It should be noted that this equation also reflects a simplifying assumption in that the upper end of the failure plane passes through the cover soil, but this length is treated as if it has the same strength as the interface. This is a conservative assumption because the actual strength is generally higher.

Equipment Load. Equipment that operates on the sideslope has a static weight, W_e, that acts in the same manner as W_2. However, additional forces are generated by acceleration and braking of the equipment as it moves on the sideslope. Koerner and Richardson (1987) suggest that these forces be treated as a separate braking force, F_b, equal to 30 percent of the equipment's weight and acting downslope, parallel to the interface. While a gross simplification, this approximation is sufficient to allow for the effects of equipment of different sizes. Intuitively, we know there must be a difference in the effects of a D-4 and a D-7 bulldozer, since there is a threefold increase in weight but only a moderately larger footprint.

W_e is calculated using the equipment weight divided by the contact width. The contact width is simply the width over which the load is distributed to the interface of interest. Because soil arching typically will mobilize the zone of soil between the tracks, the contact width may be based on the full width of the equipment.

Seepage Force. F_s is treated as a negative static load on the basis of the buoyancy applied to the cover soil. Simply put, the buoyancy normally reduces frictional shear stress because of the reduction in effective stress normally applied to the sliding plane. Instead of applying the reduction to the strength parameters as is done in most areas of soil mechanics, Lambe and Whitman (1969) suggest using a negative resisting force. A major assumption of this approach is that the seepage is parallel to the slope and of uniform thickness. The seepage force may then be calculated in the same way as the soil loads, changing only T_w.

$$W_{w1} = \frac{\gamma_w T_w^2}{2 \sin\beta \cos\beta} \qquad \text{(Equation 4)}$$

$$W_{w2} = \frac{\gamma_w T_w}{\sin\beta}\left(H - \frac{T_w}{2 \cos\beta}\right) \qquad \text{(Equation 5)}$$

$$F_s = W_{w1} \tan\phi_m + W_{w2} \cos\beta \tan\delta_m \qquad \text{(Equation 6)}$$

It should be noted that no interwedge force exists with seepage because water can sustain no shear stress.

Geosynthetic Anchorage. F_a represents the force provided by geogrids or by high-strength geotextiles anchored at the top of the slope. Strengths typically are taken from the 2 percent strain level of the geosynthetics, a level that generally can be accommodated by the other components of a liner or cover system. The direction of F_a is parallel to the slope and upward. Anchorage trenches or other means of attachment must be sufficiently strong to keep the geogrid or geotextile from pulling out. Geomembranes, geonets, and general-use geotextiles should not be considered for F_a because useful levels of strength would require unacceptable levels of strain.

Earthquake Force. While beyond the scope of this paper, pseudo-static earthquake forces can be applied easily, parallel to the slope. The earthquake force, which is equal to the soil weight multiplied by the acceleration factor (percentage of gravity), is entered into the model as a negative geosynthetic anchorage force. Soil and interface shear strengths should reflect appropriate factors of safety.

Reaction Forces. Reaction forces include P, F_1, and F_2 and are a function of the static equilibrium. These variables drop out of the calculations through some physical and mathematical relationships.

STABILITY CALCULATION

All forces are plotted on a force vector diagram, as shown in Figure 2. The magnitudes of the reaction forces are unknown, but their directions are set by the problem geometry. We can eliminate F_1 and F_2 by using Newton's first law, which states that the sum of the forces in any direction must equal zero for stability to exist. Therefore, the forces perpendicular to F_1 in Polygon 1 and perpendicular to F_2 in Polygon 2 are each summed and set equal to zero. Solving the remaining terms for P sets up the next step.

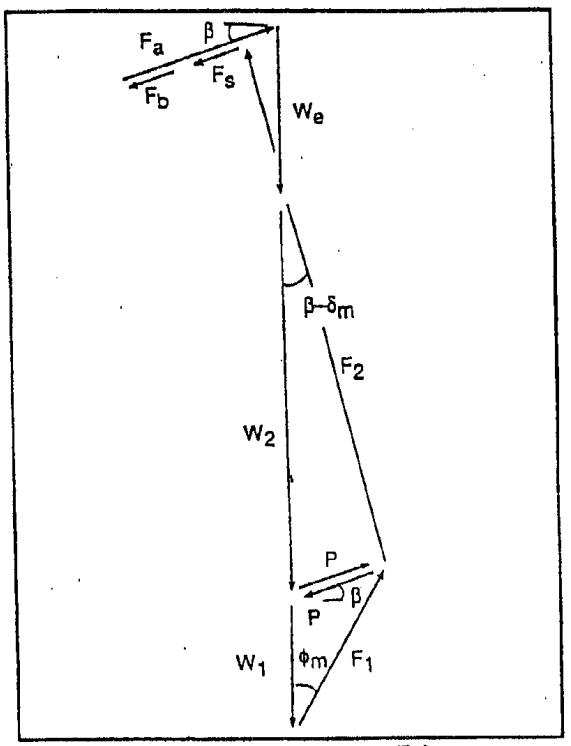


Figure 2. Force Vector Diagram

$$\text{Polygon 1:} \quad P = \frac{W_1 \sin\phi_m}{\cos(\beta + \phi_m)} \qquad \text{(Equation 7)}$$

$$\text{Polygon 2:} \quad P = \frac{(W_e + W_2)\sin(\beta - \delta_m)}{\cos\delta_m} + F_b + F_s - F_a \qquad \text{(Equation 8)}$$

Equations 7 and 8 are now equated, and P drops out:

$$\frac{W_1 \sin\phi_m}{\cos(\beta + \phi_m)} = \frac{(W_e + W_2)\sin(\beta - \delta_m)}{\cos\delta_m} + F_b + F_s - F_a \quad \text{Equation 9)}$$

Equation 9 can be rearranged to solve for F_a:

$$F_a = F_b + F_s + \frac{(W_e + W_2)\sin(\beta - \delta_m)}{\cos\delta_m} - \frac{W_1 \sin\phi_m}{\cos(\beta + \phi_m)} \qquad \text{(Equation 10)}$$

Equation 10 provides the basis for the overall method. Simply stated, if anchorage forces are positive in value, the slope is not stable without them. Solving for F_a to equal zero will give the maximum stable height for a particular set of slope conditions.

To make the calculation, insert the actual values for F_b, F_s, W_1, and W_2:

$$F_a = [\,0.3W_e\,] + \left[\frac{\gamma_w T_w^2 \tan\phi_m}{2\sin\beta\cos\beta} + \frac{\gamma_w T_w \cos\beta \tan\delta_m}{\sin\beta}\left(H - \frac{T_w}{2\cos\beta}\right)\right]$$

$$+ \left[\frac{W_e \sin(\beta-\delta_m)}{\cos\delta_m}\right] + \left[\frac{\gamma_c T_c \sin(\beta-\delta_m)}{\sin\beta\cos\delta_m}\left(H - \frac{T_c}{2\cos\beta}\right)\right] \qquad \text{(Equation 11)}$$

$$- \left[\frac{\gamma_c T_c^2 \sin\phi_m}{2\sin\beta\cos\beta\cos(\beta+\phi_m)}\right]$$

Equation 11 may be expanded as follows:

$$F_a = W_e\left[0.3 + \frac{\sin(\beta-\delta_m)}{\cos\delta_m}\right] + \left[\frac{\gamma_w T_w^2 \tan\phi_m}{2\sin\beta\cos\beta} + \frac{\gamma_w T_w H \cos\beta \tan\delta_m}{\sin\beta} - \frac{\gamma_w T_w^2 \cos\beta \tan\delta_m}{2\sin\beta\cos\beta}\right]$$

$$- \left[\frac{\gamma_c T_c^2 \sin\phi_m}{2\sin\beta\cos\beta\cos(\beta+\phi_m)} + \frac{\gamma_c T_c^2 \sin(\beta-\delta_m)}{2\sin\beta\cos\delta_m\cos\beta} - \frac{\gamma_c T_c H \sin(\beta-\delta_m)}{\sin\beta\cos\delta_m}\right]$$

(Equation 12)

For a slope 6 meters (20 feet) high, two configurations are considered. The first configuration is a 4:1 (β = 14.0 degrees) straight slope. The second configuration has two 3:1 slopes (β = 18.3 degrees), each 3 meters (10 feet) high, separated by a bench 6 meters (20 feet) wide. Constants for this example are:

- ϕ = 35 degrees (maximum residual value)
- δ = 12 degrees (maximum residual value)
- T_w = 76 mm (0.25 feet)
- γ_c = 19.6 kN/m^3 (125 lbs/ft^3)
- W_e = 0

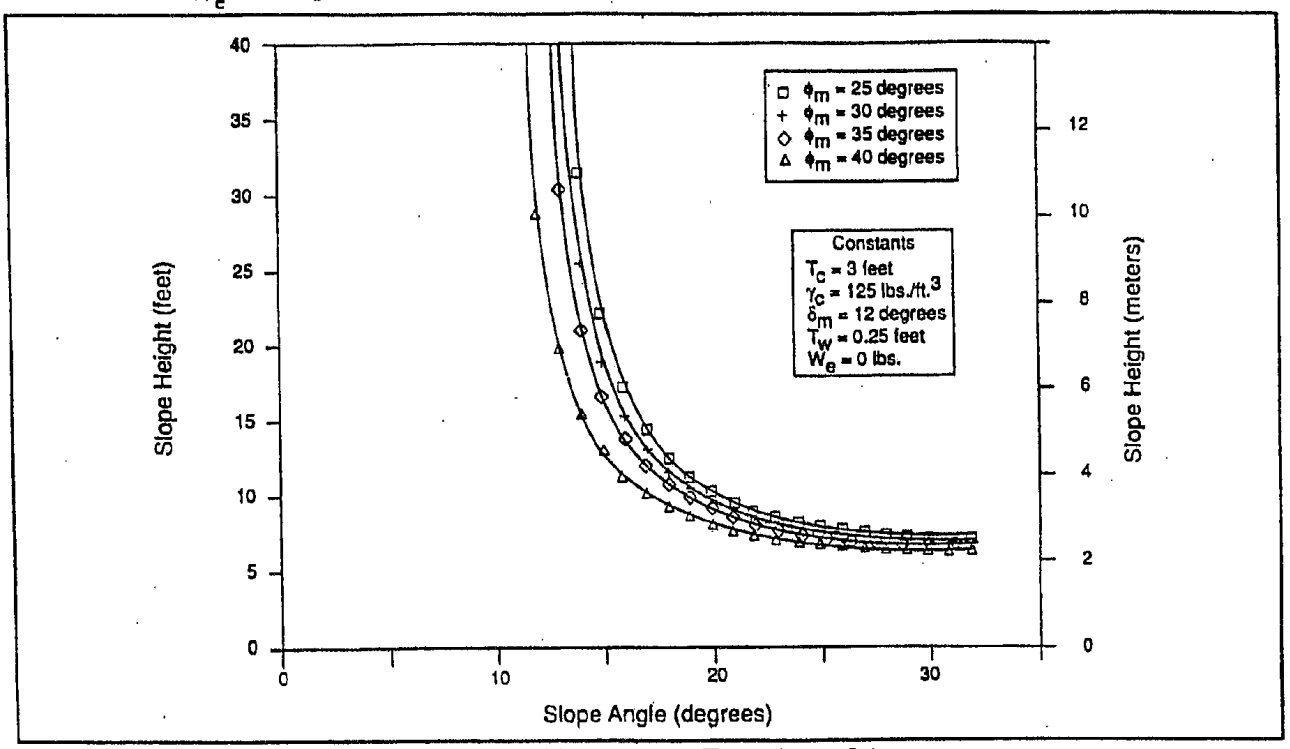


Figure 5. Height as a Function of ϕ_m

In the example, several combinations of T_c and F_a are evaluated to find a design that minimizes costs and maximizes performance while providing a minimum safety factor (FS) of 1.25. The safety factor is determined by finding the highest mobilized strength levels for which F_a equals zero or less. Different combinations of ϕ_m and δ_m, calculated using the same factor of safety for each combination, are inserted into the equation until F_a equals zero.

Table 1 shows the results of the evaluation. Factors of safety for slopes with no geosynthetic anchorage are given, as well as the value of F_a, which is required to provide a factor of safety of at least 1.25 for each of the thinner soil covers. The thinnest T_c to provide a factor of safety of 1.25 without any geosynthetic anchorage is 1.30 meters (4.25 feet) for the 4:1 slope and 1.07 meters (3.5 feet) for the 3:1 slopes with the intermediate bench. These results may be used

in evaluating the relative cost benefit of geosynthetic anchorage and various thicknesses of soil cover in order to optimize the design.

Table 1. Evaluation Results (Example)

Cover Soil Thickness (T_c)	4:1 Slope, H = 6 Meters (20 Feet)		3:1 Slope, H = 3 Meters (10 Feet)	
	FS for $F_a = 0$	F_a Required for FS = 1.25	FS for $F_a = 0$	F_a Required for FS = 1.25
0.61 m (2 ft.)	<1.00	14.83 kN/m (1,009 lbs/ft)	<1.00	7.73 kN/m (526 lbs/ft)
0.91 m (3 ft.)	1.11	11.89 kN/m (809 lbs/ft)	1.16	3.68 kN/m (250 lbs/ft)
1.22 m (4 ft.)	1.22	3.07 kN/m (209 lbs/ft)	1.37	0
1.52 m (5 ft.)	1.34	0	1.60	0

F_a = Geosynthetic anchorage force; FS = Factor of safety;
kN/m = KiloNewtons/meter

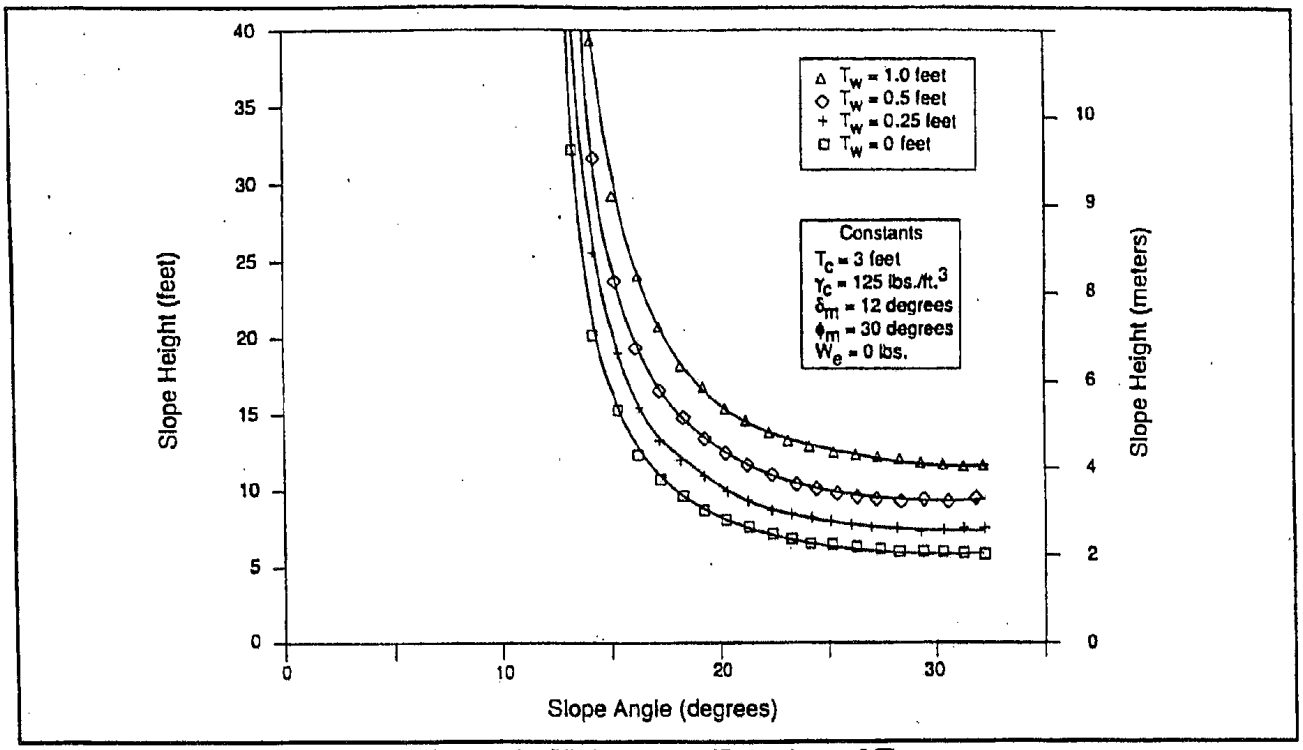


Figure 6. Height as a Function of T_w

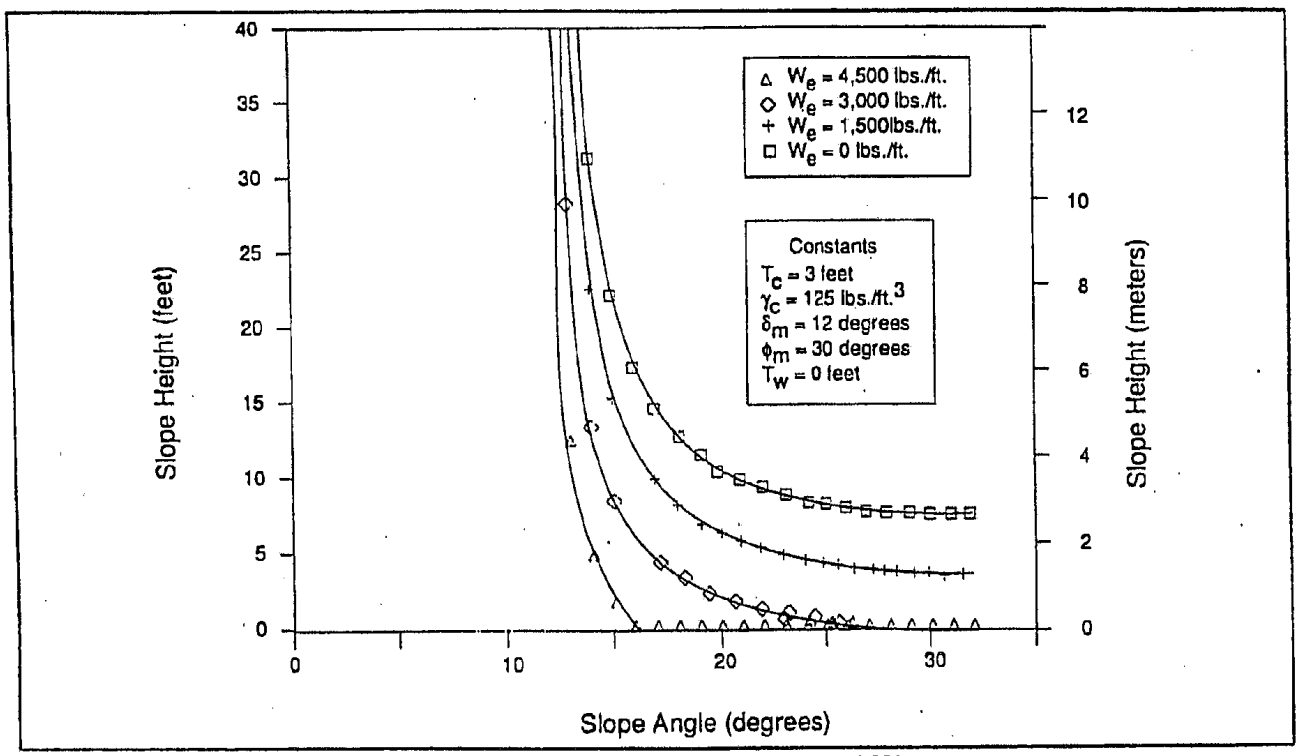


Figure 7. Height as a Function of W_c

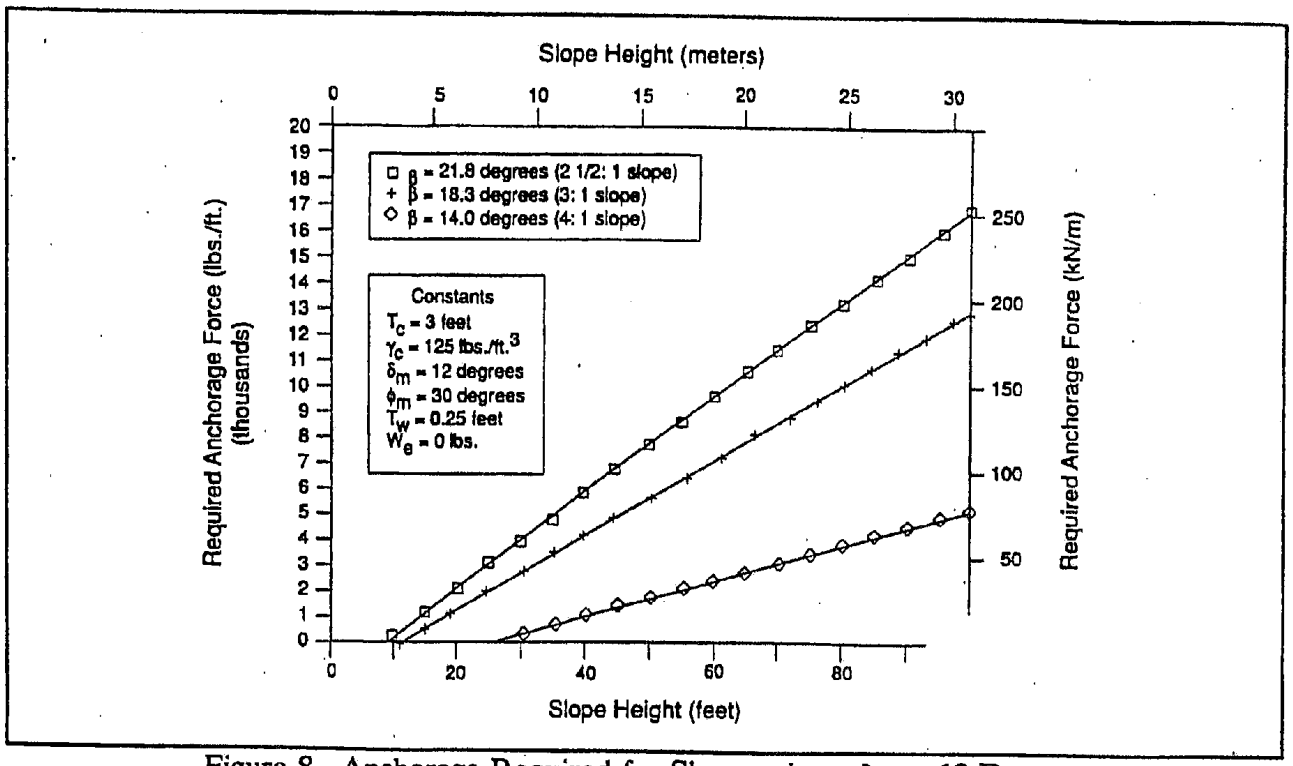


Figure 8. Anchorage Required for Slopes where δ_m = 12 Degrees

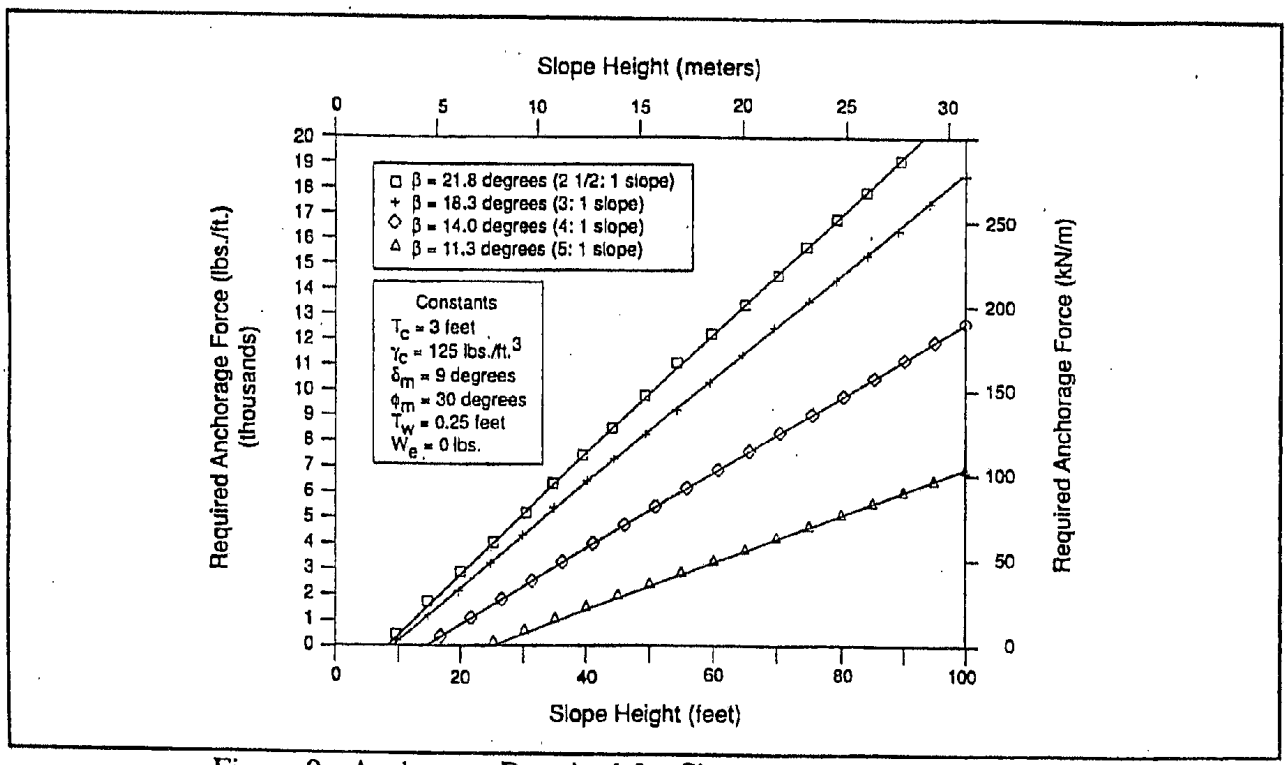


Figure 9. Anchorage Required for Slopes where δ_m = 9 Degrees

SUMMARY

The stability of lining and cover system sideslopes can be evaluated using a design methodology that is described in this paper. This methodology is based on the traditional sliding-block analysis, but has been expanded to include seepage forces, equipment loads, geosynthetic anchorage, and factors of safety. Equations are included in this paper to simplify application of the methodology to "real world" situations and to allow the optimization of factors such as slope geometry, strength, and applied loads.

Figures are presented to show the maximum stable slope height attainable at given slope angles for a range of slope characteristics and external loads. Geosynthetic anchorage can be used to achieve a stable slope, and figures are presented to show the relationship between slope height and required anchorage force (F_a) for various slopes. A project example is included to demonstrate how a landfill sideslope can be designed for best performance.

REFERENCES

Giroud, J.P., and Beech, J.F. (1989) "Stability of soil layers on geosynthetic lining systems," Proceedings, Geosynthetics '89 Conference, IFAI, San Diego, California, pp. 35-46.

Lambe, T.W., and Whitman R.V. (1969) Soil Mechanics, John Wiley and Sons, Inc., New York.

Martin, J.P., Koerner, R.M., and Whitty, J.E. (1984) "Experimental friction evaluation of slippage between geomembranes, geotextiles, and soils," Proc. Int. Conf. on Geomembranes, Industrial Fabrics Association International, Denver, Colorado, pp. 191-196.

Mitchell, J.K., Seed, R.B., and Seed, H.B. (1990) "Kettleman Hills waste landfill slope failure. I: liner-system properties," J. Geotech. Engrg., ASCE 116(4), pp. 647-668.

Negussey, D., Wijewickreme, W.K.D., and Vaid, Y.P. (1989) "Geomembrane interface friction," Canadian Geotech. J., 26 (Feb.), pp. 165-169.

O'Rourke, T.D., Druschel, S.J., and Netravali, A.N. (1990) "Shear strength characteristics of sand-polymer interfaces," J. Geotech. Engrg., ASCE, 116(3), pp. 451-469.

Richardson, G.N., and Koerner, R.M. (1987) Geosynthetic Design Guidance for Hazardous Waste Landfill Cells and Surface Impoundments, Geosynthetic Research Institute, Drexel University, Philadelphia, Pennsylvania.

Saxena, S.K., and Wong, Y.T. (1984) "Frictional characteristics of a geomembrane," Proc. Int. Conf. on Geomembranes, Denver, Colorado, pp. 187-190.

U.S. Navy (1986) "Design manual—soil mechanics, foundations and earth structures," NAVFAC DM-7, Department of the Navy, Washington, D.C.

Williams, N.D., and Houlihan, M. (1986) "Evaluation of friction coefficients between geomembranes, geotextiles, and related products," Proc., 3rd Int. Conf. on Geotextiles, Vienna, Austria, pp. 891-896.

Yegian, M.K., and Lahlaf, A.M. (1992) "Dynamic interface shear strength properties of geomembranes and geotextiles," Journal of Geotechnical Engineering, ASCE, Vol. 118, No. 5, May, pp. 760-779.

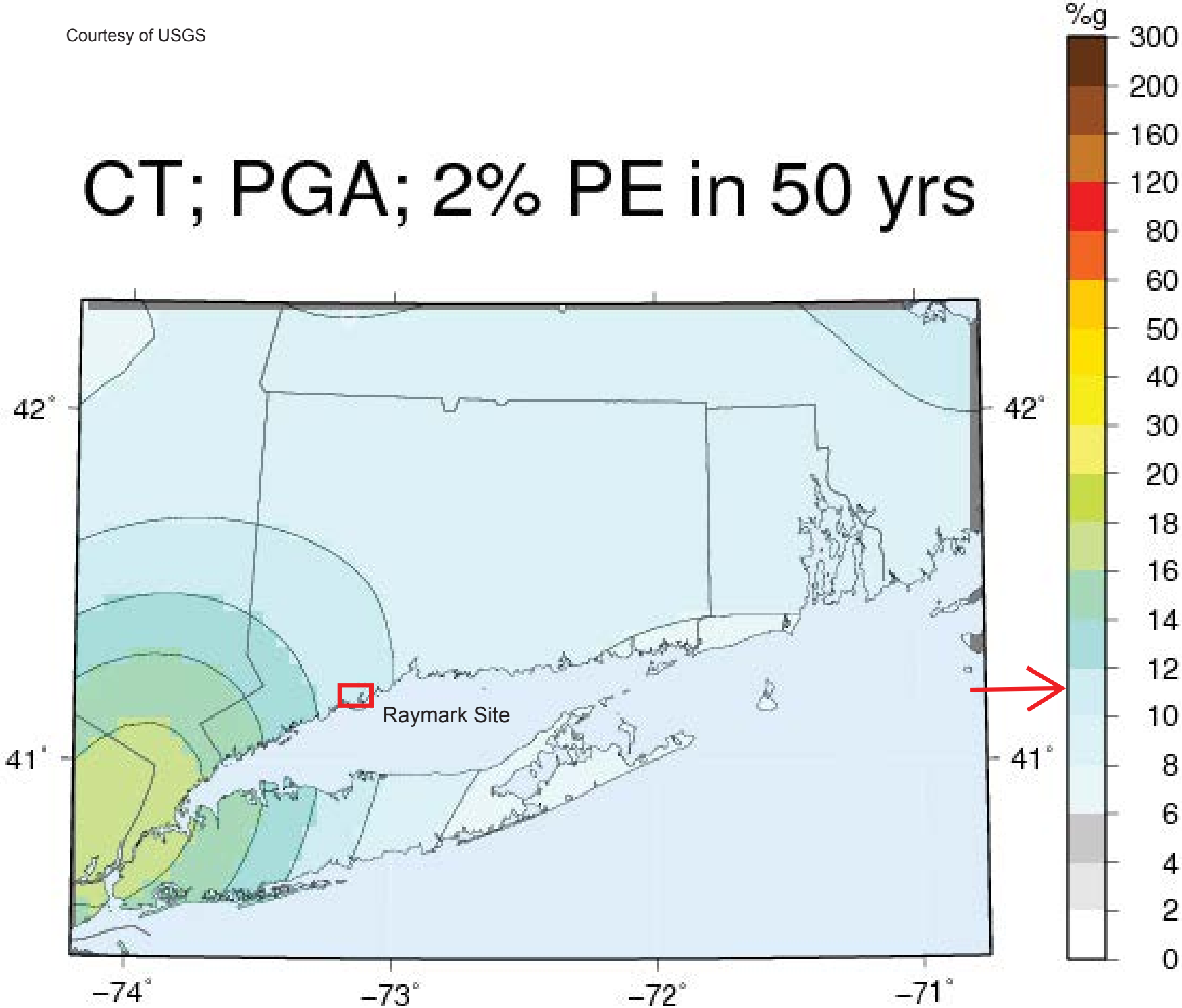
WDCP295/003.51

ATTACHMENT 3

SITE-SPECIFIC SEISMIC HAZARD MAPPING DATA

Courtesy of USGS

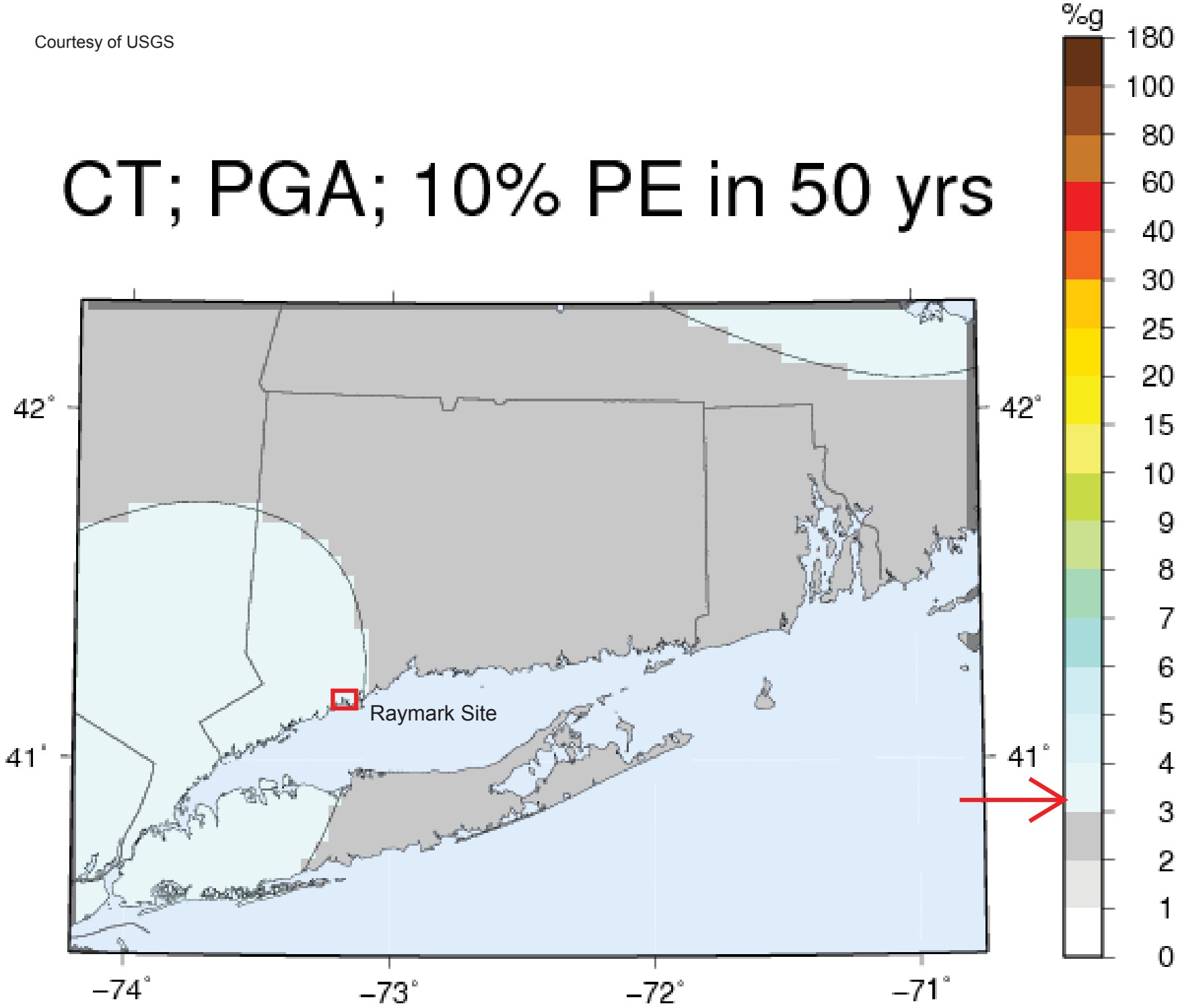
CT; PGA; 2% PE in 50 yrs



Peak Ground Acceleration

Courtesy of USGS

CT; PGA; 10% PE in 50 yrs



Peak Ground Acceleration

ATTACHMENT 4

SPREADSHEET CALCULATOR OUTPUT
UPPER 4.5% SLOPES

ATTACHMENT 4A

SPREADSHEET CALCULATOR OUTPUT
UPPER 4.5% SLOPES

5 Interfaces: Long-Term Static Conditions

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

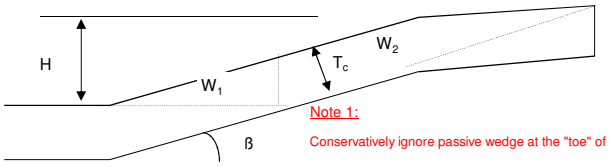
Comments: 4.5% Upper Slopes; Long-Term; Static; Interface No. 1; Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**30.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length = 122 ft	
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.50000	0.86603	0.57735

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**12.8**	**12.8**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**12.8**	**12.8**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	6.2	6.2



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	14,428.11	+	0.00	+	0.00
	Sum of Driving Forces	=	0.00	+	0.00	+	1,124.75	+	0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

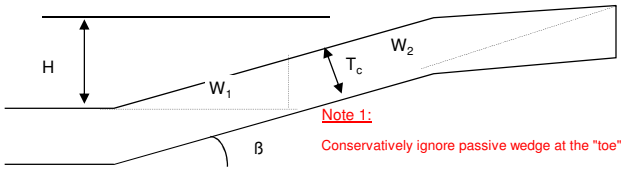
Comments: 4.5% Upper Slopes; Long-Term; Static; Interface No. 1; Residual

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**28.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length =	122 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.46947	0.88295	0.53171

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**11.8**	**11.8**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**11.8**	**11.8**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	5.7	5.7



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Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	13,287.53	+	0.00	+	0.00
	Sum of Driving Forces	=	0.00	+	0.00	+	1,124.75	+	0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

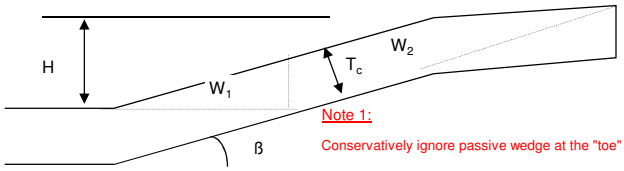
Comments: 4.5% Upper Slopes; Long-Term; Static; Interface No. 2a (Smooth FML); Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**10.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length =	122 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.17365	0.98481	0.17633

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**3.9**	**3.9**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**3.9**	**3.9**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	1.9	1.9



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	4,406.45	+	0.00	+	0.00
	Sum of Driving Forces	=	0.00	+	0.00	+	1,124.75	+	0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

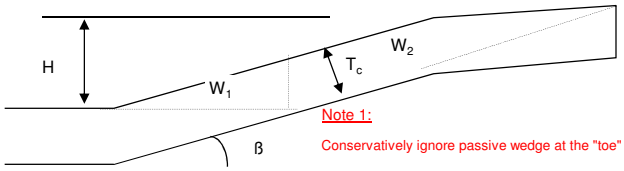
Comments: 4.5% Upper Slopes; Long-Term; Static; Interface No. 2a (Smooth FML); Residual

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**10.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length =	122 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.17365	0.98481	0.17633

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**3.9**	**3.9**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**3.9**	**3.9**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	1.9	1.9



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	4,406.45	+	0.00	+	0.00
	Sum of Driving Forces	=	0.00	+	0.00	+	1,124.75	+	0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

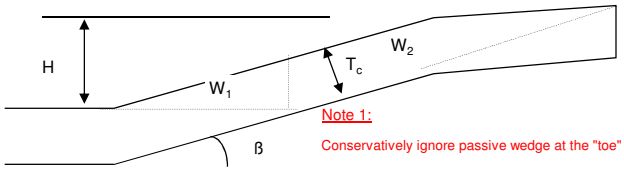
Comments: 4.5% Upper Slopes; Long-Term; Static; Interface No. 2b (Textured FML); Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**28.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length =	122 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.46947	0.88295	0.53171

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**11.8**	**11.8**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**11.8**	**11.8**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	5.7	5.7



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	13,287.53	+	0.00	+	0.00
	Sum of Driving Forces	=	0.00	+	0.00	+	1,124.75	+	0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

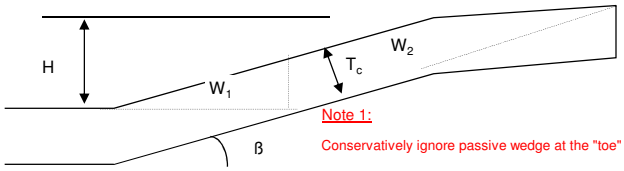
Comments: 4.5% Upper Slopes; Long-Term; Static; Interface No. 2b (Textured FML); Residual

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**22.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length =	122 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.37461	0.92718	0.40403

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**9.0**	**9.0**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**9.0**	**9.0**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	4.3	4.3



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	10,096.70	+	0.00	+	0.00
	Sum of Driving Forces	=	0.00	+	0.00	+	1,124.75	+	0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

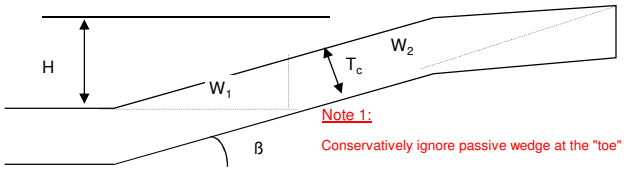
Comments: 4.5% Upper Slopes; Long-Term; Static; Interface No. 3a (Smooth FML); Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**10.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length =	122 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.17365	0.98481	0.17633

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**3.9**	**3.9**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**3.9**	**3.9**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	1.9	1.9



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	4,406.45	+	0.00	+	0.00
	Sum of Driving Forces	=	0.00	+	0.00	+	1,124.75	+	0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

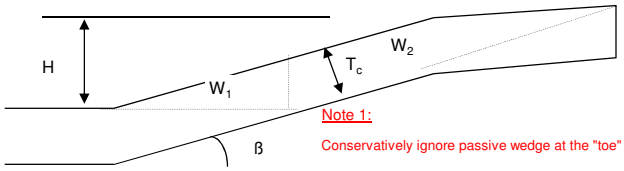
Comments: 4.5% Upper Slopes; Long-Term; Static; Interface No. 3a (Smooth FML); Residual

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**10.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length =	122 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.17365	0.98481	0.17633

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**3.9**	**3.9**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**3.9**	**3.9**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	1.9	1.9



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	4,406.45	+	0.00	+	0.00
	Sum of Driving Forces	=	0.00	+	0.00	+	1,124.75	+	0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

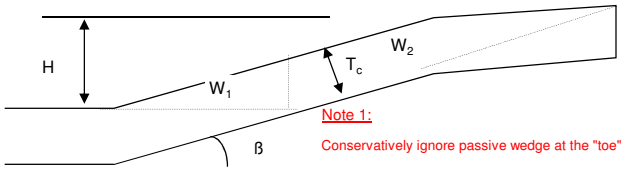
Comments: 4.5% Upper Slopes; Long-Term; Static; Interface No. 3b (Textured FML); Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**28.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length =	122 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.46947	0.88295	0.53171

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**11.8**	**11.8**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**11.8**	**11.8**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	5.7	5.7



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	13,287.53	+	0.00	+	0.00
	Sum of Driving Forces	=	0.00	+	0.00	+	1,124.75	+	0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

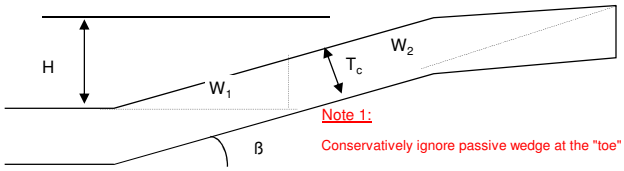
Comments: 4.5% Upper Slopes; Long-Term; Static; Interface No. 3b (Textured FML); Residual

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**22.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length =	122 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.37461	0.92718	0.40403

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**9.0**	**9.0**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**9.0**	**9.0**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	4.3	4.3



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	10,096.70	+	0.00	+	0.00
	Sum of Driving Forces	=	0.00	+	0.00	+	1,124.75	+	0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

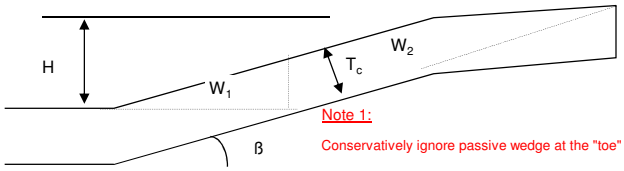
Comments: 4.5% Upper Slopes; Long-Term; Static; Interface No. 4; Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**26.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length =	122 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.43837	0.89879	0.48773

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**10.8**	**10.8**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**10.8**	**10.8**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	5.2	5.2



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	12,188.54	+	0.00	+	0.00
	Sum of Driving Forces	=	0.00	+	0.00	+	1,124.75	+	0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

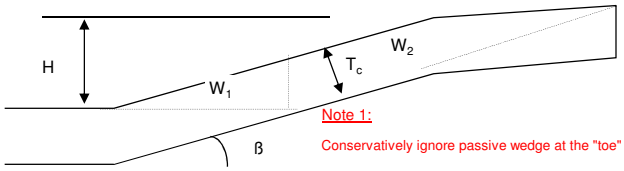
Comments: 4.5% Upper Slopes; Long-Term; Static; Interface No. 4; Residual

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**20.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length =	122 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.34202	0.93969	0.36397

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**8.1**	**8.1**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**8.1**	**8.1**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	3.9	3.9



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	9,095.70	+	0.00	+	0.00
	Sum of Driving Forces	=	0.00	+	0.00	+	1,124.75	+	0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

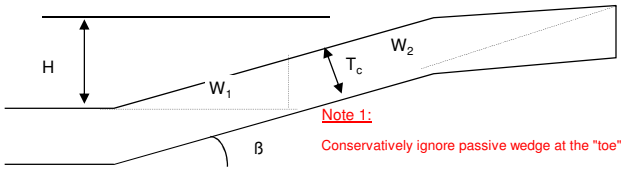
Comments: 4.5% Upper Slopes; Long-Term; Static; Interface No. 5; Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**30.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length =	122 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.50000	0.86603	0.57735

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**12.8**	**12.8**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**12.8**	**12.8**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	6.2	6.2



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	14,428.11	+	0.00	+	0.00
	Sum of Driving Forces	=	0.00	+	0.00	+	1,124.75	+	0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

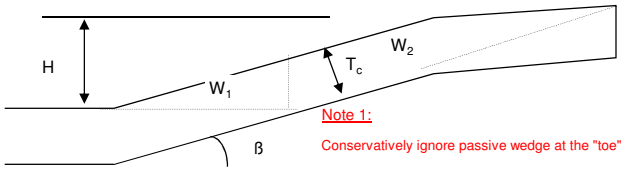
Comments: 4.5% Upper Slopes; Long-Term; Static; Interface No. 5; Residual

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**28.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length =	122 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.46947	0.88295	0.53171

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**11.8**	**11.8**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**11.8**	**11.8**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	5.7	5.7



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	13,287.53	+	0.00	+	0.00
	Sum of Driving Forces	=	0.00	+	0.00	+	1,124.75	+	0.00

ATTACHMENT 4B

SPREADSHEET CALCULATOR OUTPUT
UPPER 4.5% SLOPES

Critical Interface(s): Site-Specific Scenarios

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

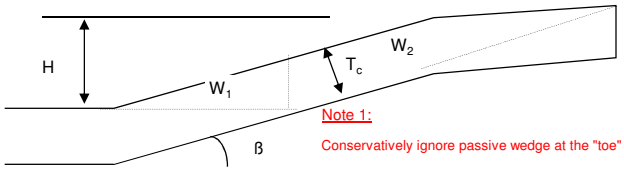
Comments: 4.5% Upper Slopes; Long-Term; Static; Scenario No. 1; Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**10.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length =	122 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.17365	0.98481	0.17633

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**3.9**	**3.9**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**3.9**	**3.9**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	1.9	1.9



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	4,406.45	+	0.00	+	0.00
	Sum of Driving Forces	=	0.00	+	0.00	+	1,124.75	+	0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

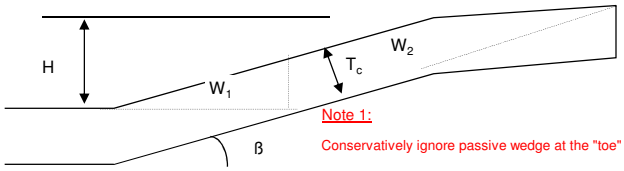
Comments: 4.5% Upper Slopes; Long-Term; Static; Scenario No. 1; Residual

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**10.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length =	122 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.17365	0.98481	0.17633

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**3.9**	**3.9**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**3.9**	**3.9**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	1.9	1.9



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	4,406.45	+	0.00	+	0.00
	Sum of Driving Forces	=	0.00	+	0.00	+	1,124.75	+	0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

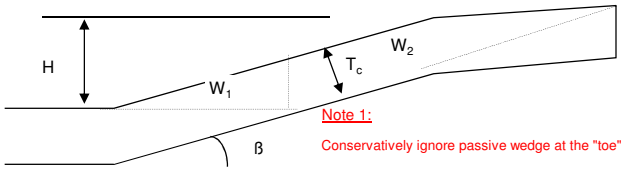
Comments: 4.5% Upper Slopes; Long-Term; Seismic; Scenario No. 2; Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**10.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length =	122 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.17365	0.98481	0.17633

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**1.8**	**1.8**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**3.9**	**3.9**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	1.9	1.9



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.110 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50 from USEPA RCRA Subtitle D (258), Seismic Design Guidance for Municipal Solid Waste Landfill Facilities, 1995
k_s = 0.055 seismic coefficient (a_{max} * K)
$k_s W_2$ = 1375.85

Factor or Safety Methodology Summary:

$$FS = \frac{\text{Sum of Resisting Forces}}{\text{Sum of Driving Forces}} = \frac{\text{passive} + \text{center} + \text{equipment} + \text{cohesion}}{\text{seepage} + \text{equipment} + \text{center} + \text{seismic}}$$

$$FS = \frac{\text{Sum of Resisting Forces}}{\text{Sum of Driving Forces}} = \frac{0.00 + 4{,}406.45 + 0.00 + 0.00}{0.00 + 0.00 + 1{,}124.75 + 1375.85}$$

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

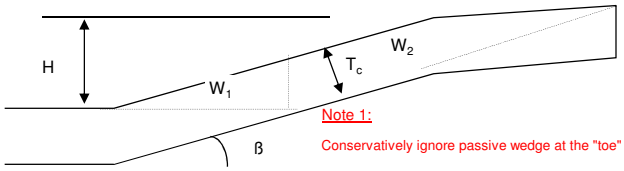
Comments: 4.5% Upper Slopes; Long-Term; Seismic; Scenario No. 2; Residual

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**10.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length =	122 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.17365	0.98481	0.17633

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**1.8**	**1.8**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**3.9**	**3.9**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	1.9	1.9



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.110 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50 from USEPA RCRA Subtitle D (258), Seismic Design Guidance for Municipal Solid Waste Landfill Facilities, 1995
k_s = 0.055 seismic coefficient (a_{max} * K)
$k_s W_2$ = 1375.85

Factor or Safety Methodology Summary:

$$FS = \frac{\text{Sum of Resisting Forces}}{\text{Sum of Driving Forces}} = \frac{\text{passive} + \text{center} + \text{equipment} + \text{cohesion}}{\text{seepage} + \text{equipment} + \text{center} + \text{seismic}}$$

$$FS = \frac{\text{Sum of Resisting Forces}}{\text{Sum of Driving Forces}} = \frac{0.00 + 4{,}406.45 + 0.00 + 0.00}{0.00 + 0.00 + 1{,}124.75 + 1375.85}$$

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

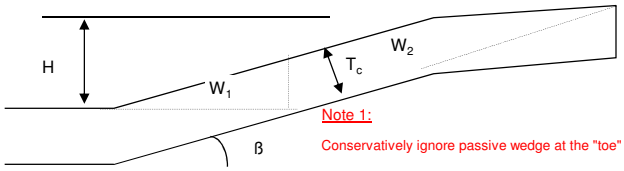
Comments: 4.5% Upper Slopes; Construction; Static; Scenario No. 3; Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**10.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length =	122 ft
W_e	Equipment Weight	8236.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	12.9	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.17365	0.98481	0.17633

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**3.5**	**3.5**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**3.9**	**3.9**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	1.9	1.9



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 16.90 feet (assuming a 1:1 pressure distribution with depth)
W_e = 487.22 pounds per foot of slope width = equipment load/static weight
F_b = 146.17 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	4,406.45	+	85.82	+	0.00
	Sum of Driving Forces	=	0.00	+	168.07	+	1,124.75	+	0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

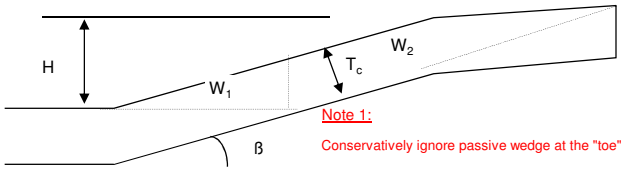
Comments: 4.5% Upper Slopes; Construction; Static; Scenario No. 3; Residual

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**10.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length =	122 ft
W_e	Equipment Weight	8236.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	12.9	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.17365	0.98481	0.17633

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**3.5**	**3.5**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**3.9**	**3.9**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	1.9	1.9



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 16.90 feet (assuming a 1:1 pressure distribution with depth)
W_e = 487.22 pounds per foot of slope width = equipment load/static weight
F_b = 146.17 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

$$FS = \frac{\text{Sum of Resisting Forces}}{\text{Sum of Driving Forces}} = \frac{\text{passive} + \text{center} + \text{equipment} + \text{cohesion}}{\text{seepage} + \text{equipment} + \text{center} + \text{seismic}}$$

$$FS = \frac{\text{Sum of Resisting Forces}}{\text{Sum of Driving Forces}} = \frac{0.00 + 4{,}406.45 + 85.82 + 0.00}{0.00 + 168.07 + 1{,}124.75 + 0.00}$$

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

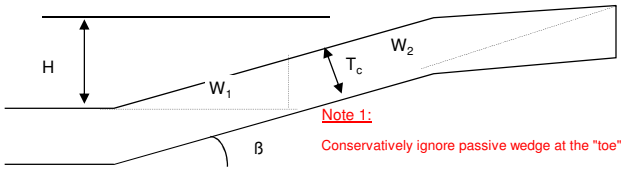
Comments: 4.5% Upper Slopes; Construction (Saturated Cover); Static; Scenario No. 4; Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	130.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**10.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length =	122 ft
W_e	Equipment Weight	8236.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	12.9	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.17365	0.98481	0.17633

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**3.5**	**3.5**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**3.9**	**3.9**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	2.0	2.0



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,788.52 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 26,016.14 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 16.90 feet (assuming a 1:1 pressure distribution with depth)
W_e = 487.22 pounds per foot of slope width = equipment load/static weight
F_b = 146.17 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	4,582.71	+	85.82	+	0.00
	Sum of Driving Forces	=	0.00	+	168.07	+	1,169.74	+	0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

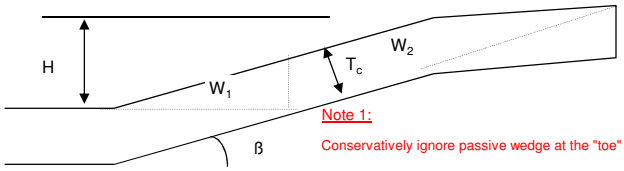
Comments: 4.5% Upper Slopes; Construction (Saturated Cover); Static; Scenario No. 4; Residual

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	130.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**10.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length =	122 ft
W_e	Equipment Weight	8236.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	12.9	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.17365	0.98481	0.17633

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**3.5**	**3.5**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**3.9**	**3.9**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	2.0	2.0



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,788.52 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 26,016.14 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 16.90 feet (assuming a 1:1 pressure distribution with depth)
W_e = 487.22 pounds per foot of slope width = equipment load/static weight
F_b = 146.17 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	4,582.71	+	85.82	+	0.00
	Sum of Driving Forces	=	0.00	+	168.07	+	1,169.74	+	0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

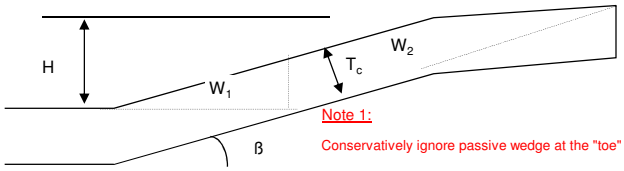
Comments: 4.5% Upper Slopes; Construction; Seismic; Scenario No. 5; Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**10.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length =	122 ft
W_e	Equipment Weight	8236.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	12.9	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.17365	0.98481	0.17633

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**2.7**	**2.7**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**3.9**	**3.9**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	1.9	1.9



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 16.90 feet (assuming a 1:1 pressure distribution with depth)
W_e = 487.22 pounds per foot of slope width = equipment load/static weight
F_b = 146.17 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.030 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.015 seismic coefficient (a_{max} * K)
$k_s W_2$ = 375.23

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	4,406.45	+	85.82	+	0.00
	Sum of Driving Forces	=	0.00	+	168.07	+	1,124.75	+	375.23

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

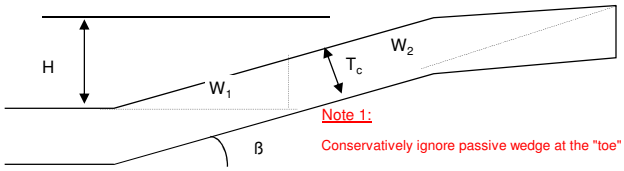
Comments: 4.5% Upper Slopes; Construction; Seismic; Scenario No. 5; Residual

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**10.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length =	122 ft
W_e	Equipment Weight	8236.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	12.9	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.17365	0.98481	0.17633

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**2.7**	**2.7**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**3.9**	**3.9**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	1.9	1.9



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 16.90 feet (assuming a 1:1 pressure distribution with depth)
W_e = 487.22 pounds per foot of slope width = equipment load/static weight
F_b = 146.17 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.030 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.015 seismic coefficient (a_{max} * K)
$k_s W_2$ = 375.23

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	4,406.45	+	85.82	+	0.00
	Sum of Driving Forces	=	0.00	+	168.07	+	1,124.75	+	375.23

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

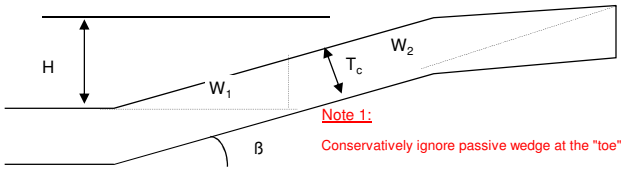
Comments: 4.5% Upper Slopes; Long-Term (Saturated Cover); Static; Scenario No. 6; Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	130.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**10.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length =	122 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.17365	0.98481	0.17633

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**3.9**	**3.9**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**3.9**	**3.9**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	2.0	2.0



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,788.52 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 26,016.14 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	4,582.71	+	0.00	+	0.00
	Sum of Driving Forces	=	0.00	+	0.00	+	1,169.74	+	0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

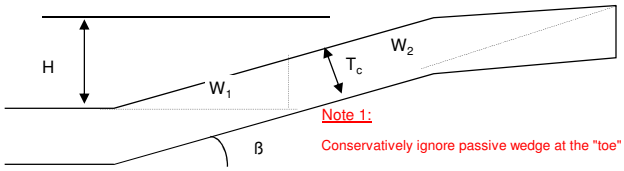
Comments: 4.5% Upper Slopes; Long-Term (Saturated Cover); Static; Scenario No. 6; Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	130.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**10.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length =	122 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.17365	0.98481	0.17633

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**3.9**	**3.9**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**3.9**	**3.9**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	2.0	2.0



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,788.52 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 26,016.14 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	4,582.71	+	0.00	+	0.00
	Sum of Driving Forces	=	0.00	+	0.00	+	1,169.74	+	0.00

ATTACHMENT 4C

SPREADSHEET CALCULATOR OUTPUT
UPPER 4.5% SLOPES

Interface Performance Requirements: Design Iterations

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 07/08/13

Calcs: TCC
Chk'd: RSE

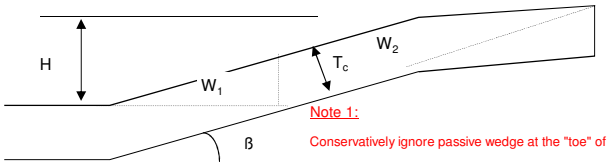
Comments: 4.5% Upper Slopes; Long-Term; Seismic; Establish Design/Performance Requirements; Peak Strength; Iteration 1

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**6.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length = 122 ft	
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.10453	0.99452	0.10510

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**1.1**	**1.1**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**2.3**	**2.3**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	1.1	1.1



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.110 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.055 seismic coefficient (a_{max} * K)
$k_s W_2$ = 1375.85

Factor or Safety Methodology Summary:

$$FS = \frac{\text{Sum of Resisting Forces}}{\text{Sum of Driving Forces}} = \frac{\text{passive} + \text{center} + \text{equipment} + \text{cohesion}}{\text{seepage} + \text{equipment} + \text{center} + \text{seismic}}$$

$$FS = \frac{\text{Sum of Resisting Forces}}{\text{Sum of Driving Forces}} = \frac{0.00 + 2{,}626.58 + 0.00 + 0.00}{0.00 + 0.00 + 1{,}124.75 + 1375.85}$$

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 07/08/13

Calcs: TCC
Chk'd: RSE

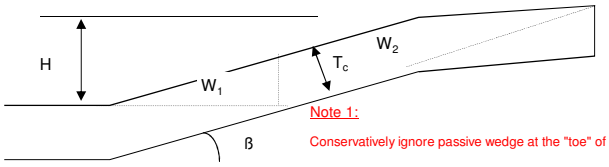
Comments: 4.5% Upper Slopes; Long-Term; Seismic; Establish Design/Performance Requirements; Peak Strength; Iteration 2

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**4.5**	degrees		
	Cohesion @ interface	10.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length = 122 ft	
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.07846	0.99692	0.07870

CALCULATED FACTORS OF SAFETY

			No Interface Cohesion	with Interface Cohesion
Druschel Method			**0.8**	**1.1**
Infinite Slope				
	Static	Infinite slope (soil, based on ϕ)	0.0	0.9
	Static	Infinite slope (interface, based on δ)	**1.7**	**2.6**
	Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.9
	Static	Infinite slope w/seepage (interface, based on δ)	0.8	1.7



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 778.44 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
778.44

Seismic Force

a_{max} = 0.110 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.055 seismic coefficient (a_{max} * K)
$k_s W_2$ = 1375.85

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	1,966.77	+	0.00	+	778.44
	Sum of Driving Forces	=	0.00	+	0.00	+	1,124.75	+	1375.85

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 07/08/13

Calcs: TCC
Chk'd: RSE

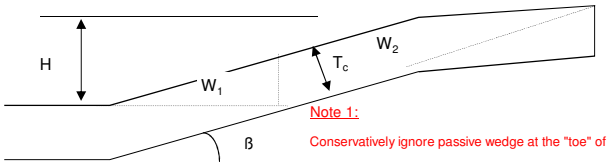
Comments: 4.5% Upper Slopes; Long-Term; Seismic; Establish Design/Performance Requirements; Peak Strength; Iteration 3

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**3.0**	degrees		
	Cohesion @ interface	20.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length = 122 ft	
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.05234	0.99863	0.05241

CALCULATED FACTORS OF SAFETY

			No Interface Cohesion	with Interface Cohesion
Druschel Method			**0.5**	**1.1**
Infinite Slope				
	Static	Infinite slope (soil, based on ϕ)	0.0	1.8
	Static	Infinite slope (interface, based on δ)	**1.2**	**2.9**
	Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	1.7
	Static	Infinite slope w/seepage (interface, based on δ)	0.6	2.3



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 1556.87 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
1556.87

Seismic Force

a_{max} = 0.110 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.055 seismic coefficient (a_{max} * K)
$k_s W_2$ = 1375.85

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	1,309.68	+	0.00	+	1,556.87
	Sum of Driving Forces	=	0.00	+	0.00	+	1,124.75	+	1375.85

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 07/08/13

Calcs: TCC
Chk'd: RSE

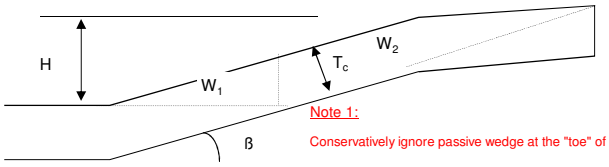
Comments: 4.5% Upper Slopes; Long-Term; Seismic; Establish Design/Performance Requirements; Peak Strength; Iteration 4

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**0.0**	degrees		
	Cohesion @ interface	35.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length = 122 ft	
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.00000	1.00000	0.00000

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**0.0**	**1.1**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	3.1
Static	Infinite slope (interface, based on δ)	**0.0**	**3.1**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	3.0
Static	Infinite slope w/seepage (interface, based on δ)	0.0	3.0



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 2724.52 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
2724.52

Seismic Force

a_{max} = 0.110 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.055 seismic coefficient (a_{max} * K)
$k_s W_2$ = 1375.85

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	0.00	+	0.00	+	2,724.52
	Sum of Driving Forces	=	0.00	+	0.00	+	1,124.75	+	1375.85

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 07/08/13

Calcs: TCC
Chk'd: RSE

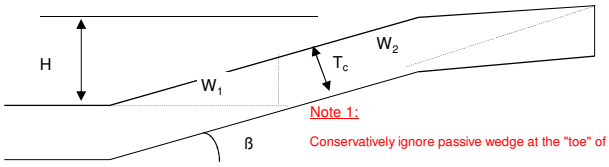
Comments: 4.5% Upper Slopes; Long-Term; Seismic; Establish Design/Performance Requirements; Residual Strength; Iteration 1

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**5.5**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length = 122 ft	
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.09585	0.99540	0.09629

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**1.0**	**1.0**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.0
Static	Infinite slope (interface, based on δ)	**2.1**	**2.1**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.0
Static	Infinite slope w/seepage (interface, based on δ)	1.0	1.0



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.110 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.055 seismic coefficient (a_{max} * K)
$k_s W_2$ = 1375.85

Factor or Safety Methodology Summary:

$$FS = \frac{\text{Sum of Resisting Forces}}{\text{Sum of Driving Forces}} = \frac{\text{passive} + \text{center} + \text{equipment} + \text{cohesion}}{\text{seepage} + \text{equipment} + \text{center} + \text{seismic}}$$

$$FS = \frac{\text{Sum of Resisting Forces}}{\text{Sum of Driving Forces}} = \frac{0.00 + 2{,}406.28 + 0.00 + 0.00}{0.00 + 0.00 + 1{,}124.75 + 1375.85}$$

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 07/08/13

Calcs: TCC
Chk'd: RSE

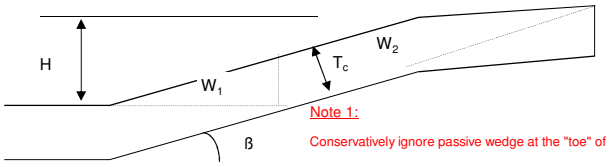
Comments: 4.5% Upper Slopes; Long-Term; Seismic; Establish Design/Performance Requirements; Residual Strength; Iteration 2

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**4.0**	degrees		
	Cohesion @ interface	10.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length = 122 ft	
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.06976	0.99756	0.06993

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**0.7**	**1.0**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	0.9
Static	Infinite slope (interface, based on δ)	**1.6**	**2.4**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	0.9
Static	Infinite slope w/seepage (interface, based on δ)	0.7	1.6



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 778.44 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
778.44

Seismic Force

a_{max} = 0.110 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.055 seismic coefficient (a_{max} * K)
$k_s W_2$ = 1375.85

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	1,747.49	+	0.00	+	778.44
	Sum of Driving Forces	=	0.00	+	0.00	+	1,124.75	+	1375.85

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 07/08/13

Calcs: TCC
Chk'd: RSE

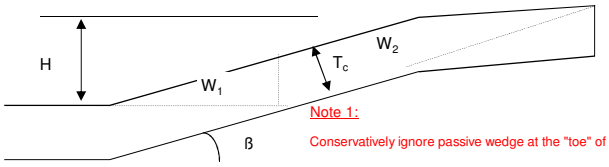
Comments: 4.5% Upper Slopes; Long-Term; Seismic; Establish Design/Performance Requirements; Residual Strength; Iteration 3

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**2.0**	degrees		
	Cohesion @ interface	20.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length = 122 ft	
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.03490	0.99939	0.03492

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**0.3**	**1.0**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	1.8
Static	Infinite slope (interface, based on δ)	**0.8**	**2.6**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	1.7
Static	Infinite slope w/seepage (interface, based on δ)	0.4	2.1



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 1556.87 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
1556.87

Seismic Force

a_{max} = 0.110 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.055 seismic coefficient (a_{max} * K)
$k_s W_2$ = 1375.85

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	872.68	+	0.00	+	1,556.87
	Sum of Driving Forces	=	0.00	+	0.00	+	1,124.75	+	1375.85

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 07/08/13

Calcs: TCC
Chk'd: RSE

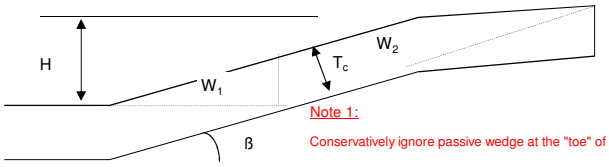
Comments: 4.5% Upper Slopes; Long-Term; Seismic; Establish Design/Performance Requirements; Residual Strength; Iteration 4

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.00 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
ß	slope angle (beta)	2.6	degrees		
ϕ	Soil shear strength	0.0	degrees (See Note 1 below).		
δ	Interface shear strength	**0.0**	degrees		
	Cohesion @ interface	32.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	5.5	feet	Therefore, the slope length = 122 ft	
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.04496	0.99899	0.04501
0.00000	1.00000	0.00000
0.00000	1.00000	0.00000

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**0.0**	**1.0**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.0	2.8
Static	Infinite slope (interface, based on δ)	**0.0**	**2.8**
Static	Infinite slope w/seepage (soil, based on ϕ)	0.0	2.7
Static	Infinite slope w/seepage (interface, based on δ)	0.0	2.7



Note 1:
Conservatively ignore passive wedge at the "toe" of this very long slope (via soil shear strength = 0 degrees).

Weights of wedges (Drushel Methodology):

W_1 = 5,565.88 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 25,015.52 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.00 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 77.84 feet Interface cohesion = 2490.99 pounds per foot of slope width
Ltoe= 44.48 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
2490.99

Seismic Force

a_{max} = 0.110 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.055 seismic coefficient (a_{max} * K)
$k_s W_2$ = 1375.85

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	0.00	+	0.00	+	0.00	+	2,490.99
	Sum of Driving Forces	=	0.00	+	0.00	+	1,124.75	+	1375.85

ATTACHMENT 5

SPREADSHEET CALCULATOR OUTPUT
PERIMETER 33.3% SLOPES

ATTACHMENT 5A

SPREADSHEET CALCULATOR OUTPUT
PERIMETER 33.3% SLOPES

5 Interfaces: Long-Term Static Conditions

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

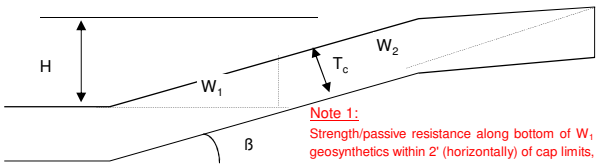
Comments: 33.3% Side Slopes; Long-Term; Static; Interface No. 1; Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	30.0	degrees (See Note 1 below).		
δ	Interface shear strength	**30.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length =	13 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.50000	0.86603	0.57735
0.50000	0.86603	0.57735

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**2.4**	**2.4**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	1.7	1.7
Static	Infinite slope (interface, based on δ)	1.7	1.7
Static	Infinite slope w/seepage (soil, based on ϕ)	0.8	0.8
Static	Infinite slope w/seepage (interface, based on δ)	0.8	0.8



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.22 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	481.12	+	1,275.61	+	0.00	+	0.00
	Sum of Driving Forces	=	0.00	+	0.00	+	736.48	+	0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

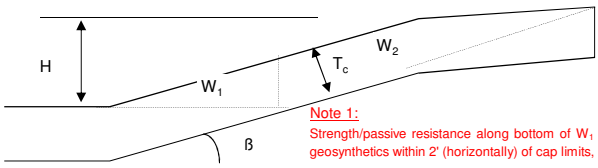
Comments: 33.3% Side Slopes; Long-Term; Static; Interface No. 1; Residual

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	28.0	degrees (See Note 1 below).		
δ	Interface shear strength	**28.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length = 13 ft	
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.46947	0.88295	0.53171
0.46947	0.88295	0.53171

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**2.2**	**2.2**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	1.6	1.6
Static	Infinite slope (interface, based on δ)	1.6	1.6
Static	Infinite slope w/seepage (soil, based on ϕ)	0.8	0.8
Static	Infinite slope w/seepage (interface, based on δ)	0.8	0.8



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.22 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS = Sum of Resisting Forces = passive + center + equipment + cohesion
Sum of Driving Forces = seepage + equipment + center + seismic

FS = Sum of Resisting Forces = 443.09 + 1,174.77 + 0.00 + 0.00
Sum of Driving Forces = 0.00 + 0.00 + 736.48 + 0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

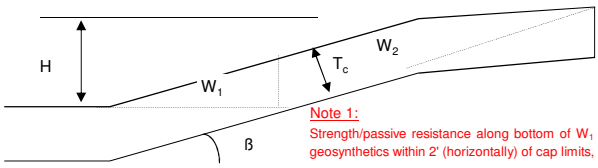
Comments: 33.3% Side Slopes; Long-Term; Static; Interface No. 2a (Smooth FML); Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	10.0	degrees (See Note 1 below).		
δ	Interface shear strength	**10.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length =	13 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.17365	0.98481	0.17633
0.17365	0.98481	0.17633

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**0.7**	**0.7**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.5	0.5
Static	Infinite slope (interface, based on δ)	0.5	0.5
Static	Infinite slope w/seepage (soil, based on ϕ)	0.3	0.3
Static	Infinite slope w/seepage (interface, based on δ)	0.3	0.3



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.22 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS = Sum of Resisting Forces = passive + center + equipment + cohesion
Sum of Driving Forces = seepage + equipment + center + seismic

FS = Sum of Resisting Forces = 146.94 + 389.58 + 0.00 + 0.00
Sum of Driving Forces = 0.00 + 0.00 + 736.48 + 0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

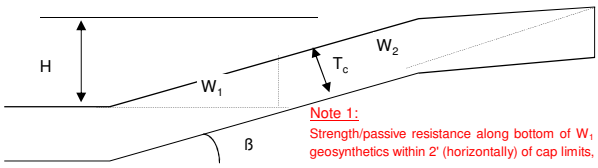
Comments: 33.3% Side Slopes; Long-Term; Static; Interface No. 2a (Smooth FML); Residual

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	10.0	degrees (See Note 1 below).		
δ	Interface shear strength	**10.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length = 13 ft	
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.17365	0.98481	0.17633
0.17365	0.98481	0.17633

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**0.7**	**0.7**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.5	0.5
Static	Infinite slope (interface, based on δ)	0.5	0.5
Static	Infinite slope w/seepage (soil, based on ϕ)	0.3	0.3
Static	Infinite slope w/seepage (interface, based on δ)	0.3	0.3



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.22 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS = Sum of Resisting Forces = passive + center + equipment + cohesion
Sum of Driving Forces = seepage + equipment + center + seismic

FS = Sum of Resisting Forces = 146.94 + 389.58 + 0.00 + 0.00
Sum of Driving Forces = 0.00 + 0.00 + 736.48 + 0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

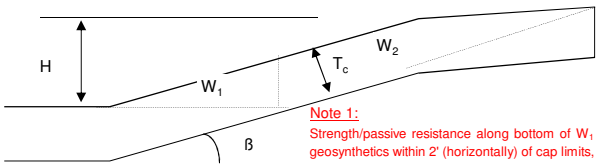
Comments: 33.3% Side Slopes; Long-Term; Static; Interface No. 2b (Textured FML); Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	28.0	degrees (See Note 1 below).		
δ	Interface shear strength	**28.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length =	13 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.46947	0.88295	0.53171
0.46947	0.88295	0.53171

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**2.2**	**2.2**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	1.6	1.6
Static	Infinite slope (interface, based on δ)	1.6	1.6
Static	Infinite slope w/seepage (soil, based on ϕ)	0.8	0.8
Static	Infinite slope w/seepage (interface, based on δ)	0.8	0.8



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.22 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS = Sum of Resisting Forces = passive + center + equipment + cohesion
Sum of Driving Forces = seepage + equipment + center + seismic

FS = Sum of Resisting Forces = 443.09 + 1,174.77 + 0.00 + 0.00
Sum of Driving Forces = 0.00 + 0.00 + 736.48 + 0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

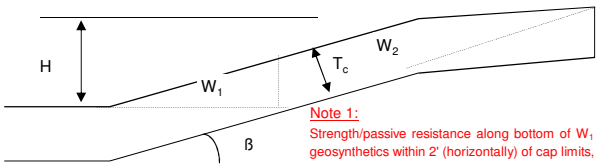
Comments: 33.3% Side Slopes; Long-Term; Static; Interface No. 2b (Textured FML); Residual

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	22.0	degrees (See Note 1 below).		
δ	Interface shear strength	**22.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length =	13 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.37461	0.92718	0.40403
0.37461	0.92718	0.40403

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**1.7**	**1.7**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	1.2	1.2
Static	Infinite slope (interface, based on δ)	1.2	1.2
Static	Infinite slope w/seepage (soil, based on ϕ)	0.6	0.6
Static	Infinite slope w/seepage (interface, based on δ)	0.6	0.6



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.22 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS = Sum of Resisting Forces = passive + center + equipment + cohesion
Sum of Driving Forces = seepage + equipment + center + seismic

FS = Sum of Resisting Forces = 336.69 + 892.67 + 0.00 + 0.00
Sum of Driving Forces = 0.00 + 0.00 + 736.48 + 0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

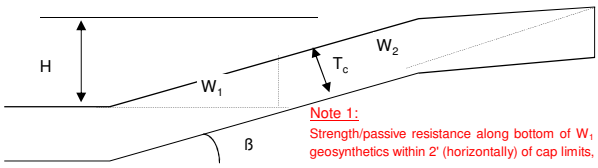
Comments: 33.3% Side Slopes; Long-Term; Static; Interface No. 3a (Smooth FML); Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	10.0	degrees (See Note 1 below).		
δ	Interface shear strength	**10.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length = 13 ft	
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.17365	0.98481	0.17633
0.17365	0.98481	0.17633

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**0.7**	**0.7**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.5	0.5
Static	Infinite slope (interface, based on δ)	0.5	0.5
Static	Infinite slope w/seepage (soil, based on ϕ)	0.3	0.3
Static	Infinite slope w/seepage (interface, based on δ)	0.3	0.3



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.22 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS = Sum of Resisting Forces = passive + center + equipment + cohesion
Sum of Driving Forces = seepage + equipment + center + seismic

FS = Sum of Resisting Forces = 146.94 + 389.58 + 0.00 + 0.00
Sum of Driving Forces = 0.00 + 0.00 + 736.48 + 0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

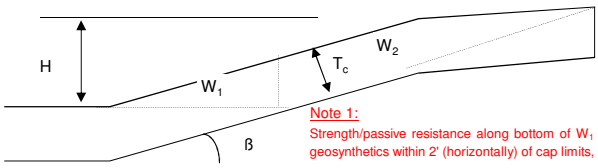
Comments: 33.3% Side Slopes; Long-Term; Static; Interface No. 3a (Smooth FML); Residual

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	10.0	degrees (See Note 1 below).		
δ	Interface shear strength	**10.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length = 13 ft	
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.17365	0.98481	0.17633
0.17365	0.98481	0.17633

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**0.7**	**0.7**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.5	0.5
Static	Infinite slope (interface, based on δ)	0.5	0.5
Static	Infinite slope w/seepage (soil, based on ϕ)	0.3	0.3
Static	Infinite slope w/seepage (interface, based on δ)	0.3	0.3



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

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W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.22 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS = Sum of Resisting Forces = passive + center + equipment + cohesion
Sum of Driving Forces = seepage + equipment + center + seismic

FS = Sum of Resisting Forces = 146.94 + 389.58 + 0.00 + 0.00
Sum of Driving Forces = 0.00 + 0.00 + 736.48 + 0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

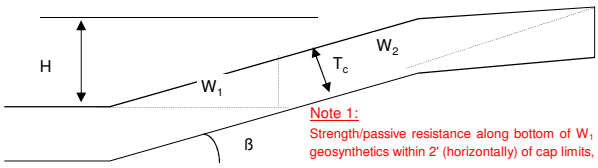
Comments: 33.3% Side Slopes; Long-Term; Static; Interface No. 3b (Textured FML); Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	10.0	degrees (See Note 1 below).		
δ	Interface shear strength	**10.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length =	13 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.17365	0.98481	0.17633
0.17365	0.98481	0.17633

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**0.7**	**0.7**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.5	0.5
Static	Infinite slope (interface, based on δ)	0.5	0.5
Static	Infinite slope w/seepage (soil, based on ϕ)	0.3	0.3
Static	Infinite slope w/seepage (interface, based on δ)	0.3	0.3



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.22 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

$$FS = \frac{\text{Sum of Resisting Forces}}{\text{Sum of Driving Forces}} = \frac{\text{passive} + \text{center} + \text{equipment} + \text{cohesion}}{\text{seepage} + \text{equipment} + \text{center} + \text{seismic}}$$

$$FS = \frac{\text{Sum of Resisting Forces}}{\text{Sum of Driving Forces}} = \frac{146.94 + 389.58 + 0.00 + 0.00}{0.00 + 0.00 + 736.48 + 0.00}$$

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

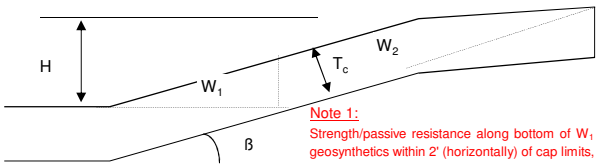
Comments: 33.3% Side Slopes; Long-Term; Static; Interface No. 3b (Textured FML); Residual

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	22.0	degrees (See Note 1 below).		
δ	Interface shear strength	**22.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length =	13 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.37461	0.92718	0.40403
0.37461	0.92718	0.40403

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**1.7**	**1.7**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	1.2	1.2
Static	Infinite slope (interface, based on δ)	1.2	1.2
Static	Infinite slope w/seepage (soil, based on ϕ)	0.6	0.6
Static	Infinite slope w/seepage (interface, based on δ)	0.6	0.6



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.22 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS = Sum of Resisting Forces = passive + center + equipment + cohesion
Sum of Driving Forces = seepage + equipment + center + seismic

FS = Sum of Resisting Forces = 336.69 + 892.67 + 0.00 + 0.00
Sum of Driving Forces = 0.00 + 0.00 + 736.48 + 0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

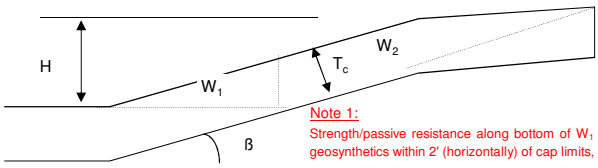
Comments: 33.3% Side Slopes; Long-Term; Static; Interface No. 4; Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	26.0	degrees (See Note 1 below).		
δ	Interface shear strength	**26.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length = 13 ft	
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.43837	0.89879	0.48773
0.43837	0.89879	0.48773

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**2.0**	**2.0**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	1.5	1.5
Static	Infinite slope (interface, based on δ)	1.5	1.5
Static	Infinite slope w/seepage (soil, based on ϕ)	0.7	0.7
Static	Infinite slope w/seepage (interface, based on δ)	0.7	0.7



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.22 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS = Sum of Resisting Forces = passive + center + equipment + cohesion
Sum of Driving Forces = seepage + equipment + center + seismic

FS = Sum of Resisting Forces = 406.44 + 1,077.61 + 0.00 + 0.00
Sum of Driving Forces = 0.00 + 0.00 + 736.48 + 0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

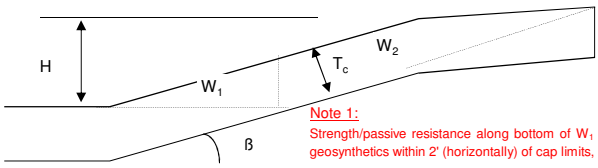
Comments: 33.3% Side Slopes; Long-Term; Static; Interface No. 4; Residual

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	20.0	degrees (See Note 1 below).		
δ	Interface shear strength	**20.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length = 13 ft	
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.34202	0.93969	0.36397
0.34202	0.93969	0.36397

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**1.5**	**1.5**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	1.1	1.1
Static	Infinite slope (interface, based on δ)	1.1	1.1
Static	Infinite slope w/seepage (soil, based on ϕ)	0.5	0.5
Static	Infinite slope w/seepage (interface, based on δ)	0.5	0.5



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.22 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	303.31	+	804.16	+	0.00	+	0.00
	Sum of Driving Forces	=	0.00	+	0.00	+	736.48	+	0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

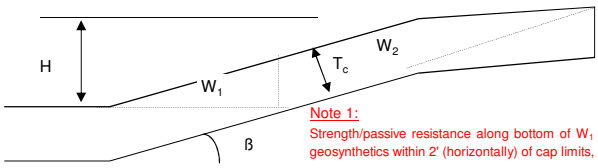
Comments: 33.3% Side Slopes; Long-Term; Static; Interface No. 5; Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	30.0	degrees (See Note 1 below).		
δ	Interface shear strength	**30.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length = 13 ft	
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.50000	0.86603	0.57735
0.50000	0.86603	0.57735

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**2.4**	**2.4**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	1.7	1.7
Static	Infinite slope (interface, based on δ)	1.7	1.7
Static	Infinite slope w/seepage (soil, based on ϕ)	0.8	0.8
Static	Infinite slope w/seepage (interface, based on δ)	0.8	0.8



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.22 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS = Sum of Resisting Forces = passive + center + equipment + cohesion
Sum of Driving Forces = seepage + equipment + center + seismic

FS = Sum of Resisting Forces = 481.12 + 1,275.61 + 0.00 + 0.00
Sum of Driving Forces = 0.00 + 0.00 + 736.48 + 0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

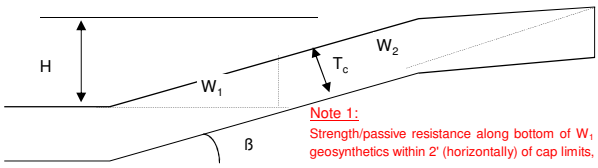
Comments: 33.3% Side Slopes; Long-Term; Static; Interface No. 5; Residual

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	28.0	degrees (See Note 1 below).		
δ	Interface shear strength	**28.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length = 13 ft	
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.46947	0.88295	0.53171
0.46947	0.88295	0.53171

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**2.2**	**2.2**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	1.6	1.6
Static	Infinite slope (interface, based on δ)	1.6	1.6
Static	Infinite slope w/seepage (soil, based on ϕ)	0.8	0.8
Static	Infinite slope w/seepage (interface, based on δ)	0.8	0.8



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.22 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS = Sum of Resisting Forces = passive + center + equipment + cohesion
Sum of Driving Forces = seepage + equipment + center + seismic

FS = Sum of Resisting Forces = 443.09 + 1,174.77 + 0.00 + 0.00
Sum of Driving Forces = 0.00 + 0.00 + 736.48 + 0.00

ATTACHMENT 5B

SPREADSHEET CALCULATOR OUTPUT
PERIMETER 33.3% SLOPES

Critical Interface(s): Site-Specific Scenarios

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

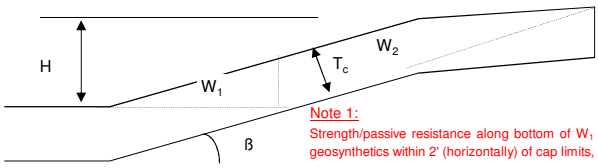
Comments: 33.3% Side Slopes; Long-Term; Static; Scenario No. 1; Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	26.0	degrees (See Note 1 below).		
δ	Interface shear strength	**26.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length =	13 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.43837	0.89879	0.48773
0.43837	0.89879	0.48773

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**2.0**	**2.0**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	1.5	1.5
Static	Infinite slope (interface, based on δ)	1.5	1.5
Static	Infinite slope w/seepage (soil, based on ϕ)	0.7	0.7
Static	Infinite slope w/seepage (interface, based on δ)	0.7	0.7



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.22 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS = Sum of Resisting Forces = passive + center + equipment + cohesion
Sum of Driving Forces = seepage + equipment + center + seismic

FS = Sum of Resisting Forces = 406.44 + 1,077.61 + 0.00 + 0.00
Sum of Driving Forces = 0.00 + 0.00 + 736.48 + 0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

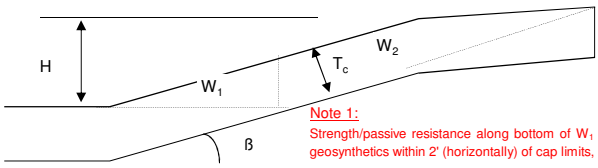
Comments: 33.3% Side Slopes; Long-Term; Static; Scenario No. 1; Residual

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	20.0	degrees (See Note 1 below).		
δ	Interface shear strength	**20.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length = 13 ft	
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.34202	0.93969	0.36397
0.34202	0.93969	0.36397

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**1.5**	**1.5**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	1.1	1.1
Static	Infinite slope (interface, based on δ)	1.1	1.1
Static	Infinite slope w/seepage (soil, based on ϕ)	0.5	0.5
Static	Infinite slope w/seepage (interface, based on δ)	0.5	0.5



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.22 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS = Sum of Resisting Forces = passive + center + equipment + cohesion
Sum of Driving Forces = seepage + equipment + center + seismic

FS = Sum of Resisting Forces = 303.31 + 804.16 + 0.00 + 0.00
Sum of Driving Forces = 0.00 + 0.00 + 736.48 + 0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

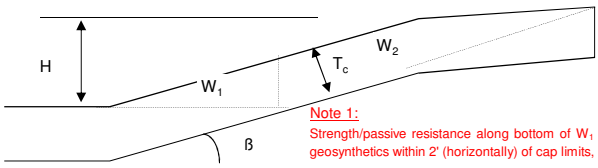
Comments: 33.3% Side Slopes; Long-Term; Seismic; Scenario No. 2; Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	26.0	degrees (See Note 1 below).		
δ	Interface shear strength	**26.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length =	13 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.43837	0.89879	0.48773
0.43837	0.89879	0.48773

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**1.7**	**1.7**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	1.5	1.5
Static	Infinite slope (interface, based on δ)	1.5	1.5
Static	Infinite slope w/seepage (soil, based on ϕ)	0.7	0.7
Static	Infinite slope w/seepage (interface, based on δ)	0.7	0.7



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.22 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.110 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.055 seismic coefficient (a_{max} * K)
$k_s W_2$ = 128.09

Factor or Safety Methodology Summary:

$$FS = \frac{\text{Sum of Resisting Forces}}{\text{Sum of Driving Forces}} = \frac{\text{passive} + \text{center} + \text{equipment} + \text{cohesion}}{\text{seepage} + \text{equipment} + \text{center} + \text{seismic}}$$

$$FS = \frac{\text{Sum of Resisting Forces}}{\text{Sum of Driving Forces}} = \frac{406.44 + 1{,}077.61 + 0.00 + 0.00}{0.00 + 0.00 + 736.48 + 128.09}$$

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

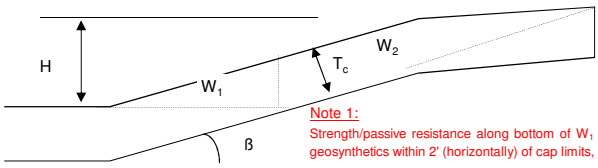
Comments: 33.3% Side Slopes; Long-Term; Seismic; Scenario No. 2; Residual

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	20.0	degrees (See Note 1 below).		
δ	Interface shear strength	**20.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length =	13 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.34202	0.93969	0.36397
0.34202	0.93969	0.36397

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**1.3**	**1.3**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	1.1	1.1
Static	Infinite slope (interface, based on δ)	1.1	1.1
Static	Infinite slope w/seepage (soil, based on ϕ)	0.5	0.5
Static	Infinite slope w/seepage (interface, based on δ)	0.5	0.5



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.22 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.110 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.055 seismic coefficient (a_{max} * K)
$k_s W_2$ = 128.09

Factor or Safety Methodology Summary:

$$FS = \frac{\text{Sum of Resisting Forces}}{\text{Sum of Driving Forces}} = \frac{\text{passive} + \text{center} + \text{equipment} + \text{cohesion}}{\text{seepage} + \text{equipment} + \text{center} + \text{seismic}}$$

$$FS = \frac{\text{Sum of Resisting Forces}}{\text{Sum of Driving Forces}} = \frac{303.31 + 804.16 + 0.00 + 0.00}{0.00 + 0.00 + 736.48 + 128.09}$$

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

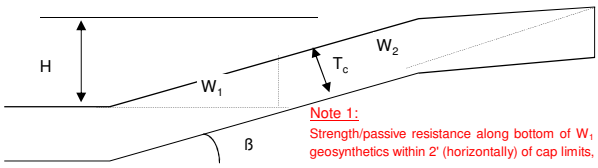
Comments: 33.3% Side Slopes; Construction; Static; Scenario No. 3; Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	26.0	degrees (See Note 1 below).		
δ	Interface shear strength	**26.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length = 13 ft	
W_e	Equipment Weight	8236.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	12.9	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.43837	0.89879	0.48773
0.43837	0.89879	0.48773

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**1.7**	**1.7**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	1.5	1.5
Static	Infinite slope (interface, based on δ)	1.5	1.5
Static	Infinite slope w/seepage (soil, based on ϕ)	0.7	0.7
Static	Infinite slope w/seepage (interface, based on δ)	0.7	0.7



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 17.12 feet (assuming a 1:1 pressure distribution with depth)
W_e = 481.18 pounds per foot of slope width = equipment load/static weight
F_b = 144.35 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS = Sum of Resisting Forces = passive + center + equipment + cohesion
Sum of Driving Forces = seepage + equipment + center + seismic

FS = Sum of Resisting Forces = 406.44 + 1,077.61 + 222.64 + 0.00
Sum of Driving Forces = 0.00 + 296.51 + 736.48 + 0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

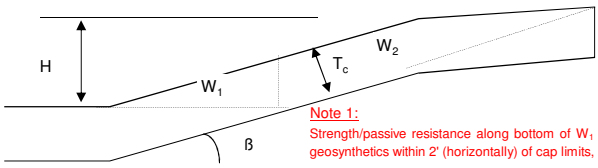
Comments: 33.3% Side Slopes; Construction; Static; Scenario No. 3; Residual

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	20.0	degrees (See Note 1 below).		
δ	Interface shear strength	**20.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length = 13 ft	
W_e	Equipment Weight	8236.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	12.9	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.34202	0.93969	0.36397
0.34202	0.93969	0.36397

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**1.2**	**1.2**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	1.1	1.1
Static	Infinite slope (interface, based on δ)	1.1	1.1
Static	Infinite slope w/seepage (soil, based on ϕ)	0.5	0.5
Static	Infinite slope w/seepage (interface, based on δ)	0.5	0.5



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 17.12 feet (assuming a 1:1 pressure distribution with depth)
W_e = 481.18 pounds per foot of slope width = equipment load/static weight
F_b = 144.35 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS = Sum of Resisting Forces = passive + center + equipment + cohesion
Sum of Driving Forces = seepage + equipment + center + seismic

FS = Sum of Resisting Forces = 303.31 + 804.16 + 166.15 + 0.00
Sum of Driving Forces = 0.00 + 296.51 + 736.48 + 0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

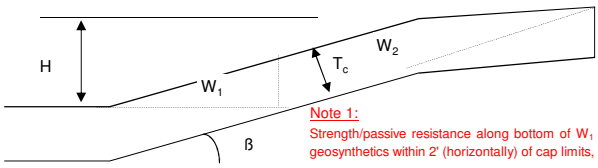
Comments: 33.3% Side Slopes; Construction (Saturated Cover); Static; Scenario No. 4; Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	130.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	26.0	degrees (See Note 1 below).		
δ	Interface shear strength	**26.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length =	13 ft
W_e	Equipment Weight	8236.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	12.9	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.43837	0.89879	0.48773
0.43837	0.89879	0.48773

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**1.7**	**1.7**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	1.5	1.5
Static	Infinite slope (interface, based on δ)	1.5	1.5
Static	Infinite slope w/seepage (soil, based on ϕ)	0.8	0.8
Static	Infinite slope w/seepage (interface, based on δ)	0.8	0.8



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 866.66 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,422.10 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 17.12 feet (assuming a 1:1 pressure distribution with depth)
W_e = 481.18 pounds per foot of slope width = equipment load/static weight
F_b = 144.35 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS = Sum of Resisting Forces = passive + center + equipment + cohesion
Sum of Driving Forces = seepage + equipment + center + seismic

FS = Sum of Resisting Forces = 422.70 + 1,120.71 + 222.64 + 0.00
Sum of Driving Forces = 0.00 + 296.51 + 765.94 + 0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

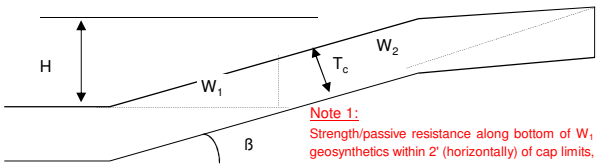
Comments: 33.3% Side Slopes; Construction (Saturated Cover); Static; Scenario No. 4; Residual

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	130.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	20.0	degrees (See Note 1 below).		
δ	Interface shear strength	**20.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length =	13 ft
W_e	Equipment Weight	8236.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	12.9	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.34202	0.93969	0.36397
0.34202	0.93969	0.36397

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**1.2**	**1.2**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	1.1	1.1
Static	Infinite slope (interface, based on δ)	1.1	1.1
Static	Infinite slope w/seepage (soil, based on ϕ)	0.6	0.6
Static	Infinite slope w/seepage (interface, based on δ)	0.6	0.6



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 866.66 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,422.10 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 17.12 feet (assuming a 1:1 pressure distribution with depth)
W_e = 481.18 pounds per foot of slope width = equipment load/static weight
F_b = 144.35 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS = Sum of Resisting Forces = passive + center + equipment + cohesion
Sum of Driving Forces = seepage + equipment + center + seismic

FS = Sum of Resisting Forces = 315.44 + 836.33 + 166.15 + 0.00
Sum of Driving Forces = 0.00 + 296.51 + 765.94 + 0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

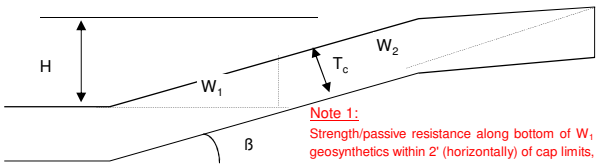
Comments: 33.3% Side Slopes; Construction; Seismic; Scenario No. 5; Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	26.0	degrees (See Note 1 below).		
δ	Interface shear strength	**26.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length = 13 ft	
W_e	Equipment Weight	8236.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	12.9	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.43837	0.89879	0.48773
0.43837	0.89879	0.48773

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**1.6**	**1.6**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	1.5	1.5
Static	Infinite slope (interface, based on δ)	1.5	1.5
Static	Infinite slope w/seepage (soil, based on ϕ)	0.7	0.7
Static	Infinite slope w/seepage (interface, based on δ)	0.7	0.7



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 17.12 feet (assuming a 1:1 pressure distribution with depth)
W_e = 481.18 pounds per foot of slope width = equipment load/static weight
F_b = 144.35 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.030 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.015 seismic coefficient (a_{max} * K)
$k_s W_2$ = 34.93

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	406.44	+	1,077.61	+	222.64	+	0.00
	Sum of Driving Forces	=	0.00	+	296.51	+	736.48	+	34.93

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

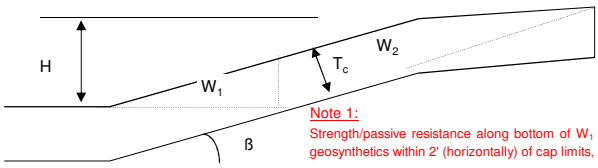
Comments: 33.3% Side Slopes; Construction; Seismic; Scenario No. 5; Residual

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	20.0	degrees (See Note 1 below).		
δ	Interface shear strength	**20.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length =	13 ft
W_e	Equipment Weight	8236.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	12.9	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.34202	0.93969	0.36397
0.34202	0.93969	0.36397

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**1.2**	**1.2**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	1.1	1.1
Static	Infinite slope (interface, based on δ)	1.1	1.1
Static	Infinite slope w/seepage (soil, based on ϕ)	0.5	0.5
Static	Infinite slope w/seepage (interface, based on δ)	0.5	0.5



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 17.12 feet (assuming a 1:1 pressure distribution with depth)
W_e = 481.18 pounds per foot of slope width = equipment load/static weight
F_b = 144.35 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.030 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.015 seismic coefficient (a_{max} * K)
$k_s W_2$ = 34.93

Factor or Safety Methodology Summary:

$$FS = \frac{\text{Sum of Resisting Forces}}{\text{Sum of Driving Forces}} = \frac{\text{passive} + \text{center} + \text{equipment} + \text{cohesion}}{\text{seepage} + \text{equipment} + \text{center} + \text{seismic}}$$

$$FS = \frac{\text{Sum of Resisting Forces}}{\text{Sum of Driving Forces}} = \frac{303.31 + 804.16 + 166.15 + 0.00}{0.00 + 296.51 + 736.48 + 34.93}$$

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

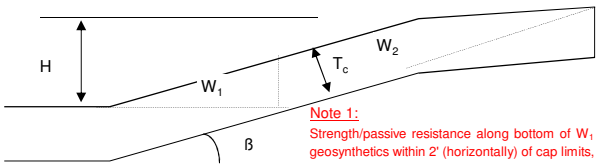
Comments: 33.3% Side Slopes; Transient (Saturated Cover); Static; Scenario No. 6; Peak

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	130.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	26.0	degrees (See Note 1 below).		
δ	Interface shear strength	**26.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length =	13 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.43837	0.89879	0.48773
0.43837	0.89879	0.48773

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**2.0**	**2.0**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	1.5	1.5
Static	Infinite slope (interface, based on δ)	1.5	1.5
Static	Infinite slope w/seepage (soil, based on ϕ)	0.8	0.8
Static	Infinite slope w/seepage (interface, based on δ)	0.8	0.8



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 866.66 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,422.10 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.22 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS = Sum of Resisting Forces = passive + center + equipment + cohesion
Sum of Driving Forces = seepage + equipment + center + seismic

FS = Sum of Resisting Forces = 422.70 + 1,120.71 + 0.00 + 0.00
Sum of Driving Forces = 0.00 + 0.00 + 765.94 + 0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 06/28/13

Calcs: TCC
Chk'd: RSE

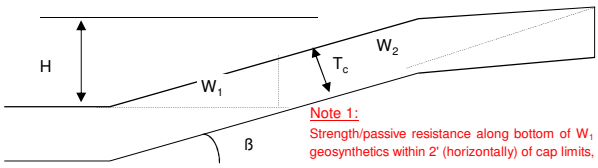
Comments: 33.3% Side Slopes; Transient (Saturated Cover); Static; Scenario No. 6; Residual

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	130.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	20.0	degrees (See Note 1 below).		
δ	Interface shear strength	**20.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length =	13 ft
W_e	Equipment Weight	0.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	0.0	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.34202	0.93969	0.36397
0.34202	0.93969	0.36397

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**1.5**	**1.5**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	1.1	1.1
Static	Infinite slope (interface, based on δ)	1.1	1.1
Static	Infinite slope w/seepage (soil, based on ϕ)	0.6	0.6
Static	Infinite slope w/seepage (interface, based on δ)	0.6	0.6



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 866.66 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,422.10 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 4.22 feet (assuming a 1:1 pressure distribution with depth)
W_e = 0.00 pounds per foot of slope width = equipment load/static weight
F_b = 0.00 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS = Sum of Resisting Forces = passive + center + equipment + cohesion
Sum of Driving Forces = seepage + equipment + center + seismic

FS = Sum of Resisting Forces = 315.44 + 836.33 + 0.00 + 0.00
Sum of Driving Forces = 0.00 + 0.00 + 765.94 + 0.00

ATTACHMENT 5C

SPREADSHEET CALCULATOR OUTPUT
PERIMETER 33.3% SLOPES

Interface Performance Requirements: Design Iterations

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 07/08/13

Calcs: TCC
Chk'd: RSE

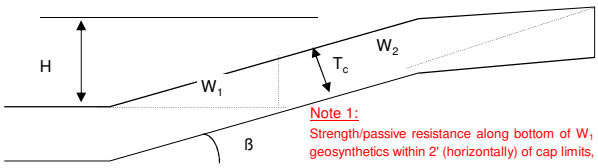
Comments: 33.3% Side Slopes; Construction; Static; Establish Design/Performance Requirements; Peak Strength; Iteration 1

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	21.0	degrees (See Note 1 below).		
δ	Interface shear strength	**21.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length = 13 ft	
W_e	Equipment Weight	8236.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	12.9	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.35837	0.93358	0.38386
0.35837	0.93358	0.38386

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**1.3**	**1.3**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	1.2	1.2
Static	Infinite slope (interface, based on δ)	1.2	1.2
Static	Infinite slope w/seepage (soil, based on ϕ)	0.6	0.6
Static	Infinite slope w/seepage (interface, based on δ)	0.6	0.6



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 17.12 feet (assuming a 1:1 pressure distribution with depth)
W_e = 481.18 pounds per foot of slope width = equipment load/static weight
F_b = 144.35 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS = Sum of Resisting Forces = passive + center + equipment + cohesion
Sum of Driving Forces = seepage + equipment + center + seismic

FS = Sum of Resisting Forces = 319.89 + 848.12 + 175.23 + 0.00
Sum of Driving Forces = 0.00 + 296.51 + 736.48 + 0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 07/08/13

Calcs: TCC
Chk'd: RSE

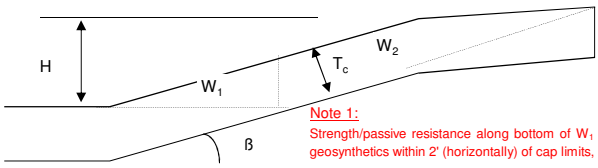
Comments: 33.3% Side Slopes; Construction; Static; Establish Design/Performance Requirements; Peak Strength; Iteration 2

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	19.0	degrees (See Note 1 below).		
δ	Interface shear strength	**19.0**	degrees		
	Cohesion @ interface	20.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length = 13 ft	
W_e	Equipment Weight	8236.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	12.9	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.32557	0.94552	0.34433
0.32557	0.94552	0.34433

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**1.2**	**1.3**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	1.0	1.3
Static	Infinite slope (interface, based on δ)	1.0	1.3
Static	Infinite slope w/seepage (soil, based on ϕ)	0.5	0.7
Static	Infinite slope w/seepage (interface, based on δ)	0.5	0.7



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 17.12 feet (assuming a 1:1 pressure distribution with depth)
W_e = 481.18 pounds per foot of slope width = equipment load/static weight
F_b = 144.35 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 126.49 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
126.49

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

$$FS = \frac{\text{Sum of Resisting Forces}}{\text{Sum of Driving Forces}} = \frac{\text{passive} + \text{center} + \text{equipment} + \text{cohesion}}{\text{seepage} + \text{equipment} + \text{center} + \text{seismic}}$$

$$FS = \frac{\text{Sum of Resisting Forces}}{\text{Sum of Driving Forces}} = \frac{286.94 + 760.77 + 157.18 + 126.49}{0.00 + 296.51 + 736.48 + 0.00}$$

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 07/08/13

Calcs: TCC
Chk'd: RSE

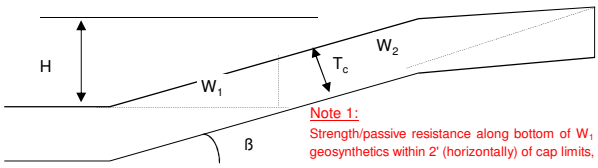
Comments: 33.3% Side Slopes; Construction; Static; Establish Design/Performance Requirements; Peak Strength; Iteration 3

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	17.0	degrees (See Note 1 below).		
δ	Interface shear strength	**17.0**	degrees		
	Cohesion @ interface	40.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length = 13 ft	
W_e	Equipment Weight	8236.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	12.9	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.29237	0.95630	0.30573
0.29237	0.95630	0.30573

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**1.0**	**1.3**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.9	1.4
Static	Infinite slope (interface, based on δ)	0.9	1.4
Static	Infinite slope w/seepage (soil, based on ϕ)	0.4	0.9
Static	Infinite slope w/seepage (interface, based on δ)	0.4	0.9



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 17.12 feet (assuming a 1:1 pressure distribution with depth)
W_e = 481.18 pounds per foot of slope width = equipment load/static weight
F_b = 144.35 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 252.98 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
252.98

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS = Sum of Resisting Forces = passive + center + equipment + cohesion
Sum of Driving Forces = seepage + equipment + center + seismic

FS = Sum of Resisting Forces = 254.77 + 675.49 + 139.56 + 252.98
Sum of Driving Forces = 0.00 + 296.51 + 736.48 + 0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 07/08/13

Calcs: TCC
Chk'd: RSE

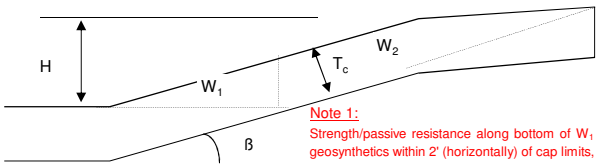
Comments: 33.3% Side Slopes; Construction; Static; Establish Design/Performance Requirements; Peak Strength; Iteration 4

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	13.0	degrees (See Note 1 below).		
δ	Interface shear strength	**13.0**	degrees		
	Cohesion @ interface	80.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length = 13 ft	
W_e	Equipment Weight	8236.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	12.9	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.22495	0.97437	0.23087
0.22495	0.97437	0.23087

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**0.8**	**1.3**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.7	1.7
Static	Infinite slope (interface, based on δ)	0.7	1.7
Static	Infinite slope w/seepage (soil, based on ϕ)	0.3	1.3
Static	Infinite slope w/seepage (interface, based on δ)	0.3	1.3



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 17.12 feet (assuming a 1:1 pressure distribution with depth)
W_e = 481.18 pounds per foot of slope width = equipment load/static weight
F_b = 144.35 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 505.96 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
505.96

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS = Sum of Resisting Forces = passive + center + equipment + cohesion
Sum of Driving Forces = seepage + equipment + center + seismic

FS = Sum of Resisting Forces = 192.39 + 510.09 + 105.39 + 505.96
Sum of Driving Forces = 0.00 + 296.51 + 736.48 + 0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 07/08/13

Calcs: TCC
Chk'd: RSE

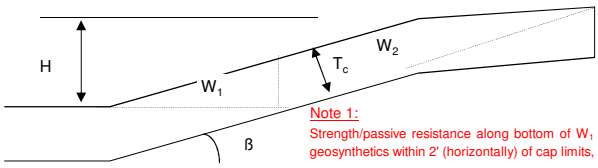
Comments: 33.3% Side Slopes; Construction; Static; Establish Design/Performance Requirements; Residual Strength; Iteration 1

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	18.0	degrees (See Note 1 below).		
δ	Interface shear strength	**18.0**	degrees		
	Cohesion @ interface	0.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length = 13 ft	
W_e	Equipment Weight	8236.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	12.9	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.30902	0.95106	0.32492
0.30902	0.95106	0.32492

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**1.1**	**1.1**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	1.0	1.0
Static	Infinite slope (interface, based on δ)	1.0	1.0
Static	Infinite slope w/seepage (soil, based on ϕ)	0.5	0.5
Static	Infinite slope w/seepage (interface, based on δ)	0.5	0.5



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 17.12 feet (assuming a 1:1 pressure distribution with depth)
W_e = 481.18 pounds per foot of slope width = equipment load/static weight
F_b = 144.35 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 0.00 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
0.00

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS =	Sum of Resisting Forces	=	passive	+	center	+	equipment	+	cohesion
	Sum of Driving Forces	=	seepage	+	equipment	+	center	+	seismic
FS =	Sum of Resisting Forces	=	270.77	+	717.89	+	148.32	+	0.00
	Sum of Driving Forces	=	0.00	+	296.51	+	736.48	+	0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 07/08/13

Calcs: TCC
Chk'd: RSE

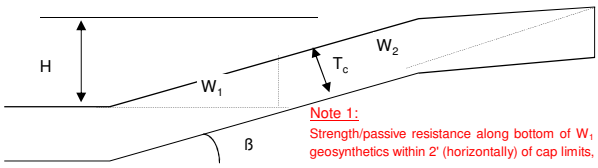
Comments: 33.3% Side Slopes; Construction; Static; Establish Design/Performance Requirements; Residual Strength; Iteration 2

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	16.0	degrees (See Note 1 below).		
δ	Interface shear strength	**16.0**	degrees		
	Cohesion @ interface	20.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length = 13 ft	
W_e	Equipment Weight	8236.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	12.9	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.27564	0.96126	0.28675
0.27564	0.96126	0.28675

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**1.0**	**1.1**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.9	1.1
Static	Infinite slope (interface, based on δ)	0.9	1.1
Static	Infinite slope w/seepage (soil, based on ϕ)	0.4	0.7
Static	Infinite slope w/seepage (interface, based on δ)	0.4	0.7



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 17.12 feet (assuming a 1:1 pressure distribution with depth)
W_e = 481.18 pounds per foot of slope width = equipment load/static weight
F_b = 144.35 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 126.49 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
126.49

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

$$FS = \frac{\text{Sum of Resisting Forces}}{\text{Sum of Driving Forces}} = \frac{\text{passive} + \text{center} + \text{equipment} + \text{cohesion}}{\text{seepage} + \text{equipment} + \text{center} + \text{seismic}}$$

$$FS = \frac{\text{Sum of Resisting Forces}}{\text{Sum of Driving Forces}} = \frac{238.95 + 633.54 + 130.89 + 126.49}{0.00 + 296.51 + 736.48 + 0.00}$$

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 07/08/13

Calcs: TCC
Chk'd: RSE

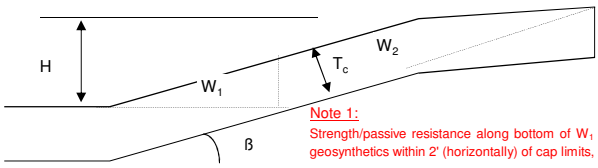
Comments: 33.3% Side Slopes; Construction; Static; Establish Design/Performance Requirements; Residual Strength; Iteration 3

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	14.0	degrees (See Note 1 below).		
δ	Interface shear strength	**14.0**	degrees		
	Cohesion @ interface	40.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length = 13 ft	
W_e	Equipment Weight	8236.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	12.9	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.24192	0.97030	0.24933
0.24192	0.97030	0.24933

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**0.8**	**1.1**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.7	1.3
Static	Infinite slope (interface, based on δ)	0.7	1.3
Static	Infinite slope w/seepage (soil, based on ϕ)	0.4	0.8
Static	Infinite slope w/seepage (interface, based on δ)	0.4	0.8



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 17.12 feet (assuming a 1:1 pressure distribution with depth)
W_e = 481.18 pounds per foot of slope width = equipment load/static weight
F_b = 144.35 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 252.98 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
252.98

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS = Sum of Resisting Forces = passive + center + equipment + cohesion
Sum of Driving Forces = seepage + equipment + center + seismic

FS = Sum of Resisting Forces = 207.77 + 550.87 + 113.81 + 252.98
Sum of Driving Forces = 0.00 + 296.51 + 736.48 + 0.00

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.

INTERFACE FRICTION ANALYSIS

This spreadsheet evaluates the factor of safety for interface stability for landfill cover system design.

Project: Raymark Superfund Site (OU6)
576/600 East Broadway, Stratford, CT

Project Number: 3651120004
Date: 07/08/13

Calcs: TCC
Chk'd: RSE

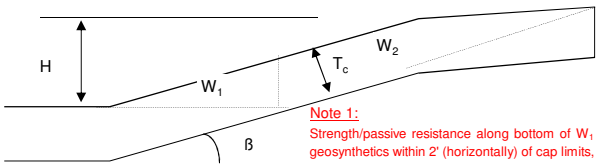
Comments: 33.3% Side Slopes; Construction; Static; Establish Design/Performance Requirements; Residual Strength; Iteration 4

		Inputs			
T_c	Soil Cover Thickness	2.0	feet	(perpendicular to liner)	Therefore = 2.11 feet (vertical)
γ_w	Wt. of Water	62.4	pcf		
γ_c	Weight of cover soil	125.0	pcf		
	Saturated weight of cover	130.0	pcf		
T_w	Thickness of seepage	0.0	feet		
β	slope angle (beta)	18.4	degrees		
ϕ	Soil shear strength	10.0	degrees (See Note 1 below).		
δ	Interface shear strength	**10.0**	degrees		
	Cohesion @ interface	80.0	psf		
	Cohesion of cover soil	0.0	psf		
H	Slope Height	4.0	feet	Therefore, the slope length = 13 ft	
W_e	Equipment Weight	8236.0	pounds	A D7 bulldozer = 8236 lbs	
	Equipment width	12.9	width in feet	A D7 bulldozer = 12.9 ft	

SIN	COS	TAN
0.31623	0.94868	0.33333
0.17365	0.98481	0.17633
0.17365	0.98481	0.17633

CALCULATED FACTORS OF SAFETY

		No Interface Cohesion	with Interface Cohesion
Druschel Method		**0.6**	**1.1**
Infinite Slope			
Static	Infinite slope (soil, based on ϕ)	0.5	1.5
Static	Infinite slope (interface, based on δ)	0.5	1.5
Static	Infinite slope w/seepage (soil, based on ϕ)	0.3	1.2
Static	Infinite slope w/seepage (interface, based on δ)	0.3	1.2



Note 1:
Strength/passive resistance along bottom of W_1 wedge based on interface shear strength (in lieu of soil shear strength) due to geosynthetics within 2' (horizontally) of cap limits, per cap perimeter section detail (Sheet C-302).

Weights of wedges (Drushel Methodology):

W_1 = 833.33 pounds per foot of slope width = weight of passive wedge/toe buttress
W_2 = 2,328.94 pounds per foot of slope width = weight of center wedge/side slope soil

Equipment Loading (Drushel Methodology):

Area of the load at interface = 17.12 feet (assuming a 1:1 pressure distribution with depth)
W_e = 481.18 pounds per foot of slope width = equipment load/static weight
F_b = 144.35 pounds per foot of slope width = equipment braking force (30% of equipment weight)
From Drushel (1993), after Koerner and Richardson (1987)

Seepage Force:

Fs = 0.00 pounds per foot of slope width = seepage force (Stamatopoulos)

Cohesion Force:

Lc = 6.32 feet Interface cohesion = 505.96 pounds per foot of slope width
Ltoe= 6.32 feet Toe/soil cohesion = 0.00 pounds per foot of slope width
505.96

Seismic Force

a_{max} = 0.000 a_{max} = peak horiz. ground acceleration @ Site
K = 0.50
k_s = 0.000 seismic coefficient (a_{max} * K)
$k_s W_2$ = 0.00

Factor or Safety Methodology Summary:

FS = Sum of Resisting Forces = passive + center + equipment + cohesion
Sum of Driving Forces = seepage + equipment + center + seismic

FS = Sum of Resisting Forces = 146.94 + 389.58 + 80.49 + 505.96
Sum of Driving Forces = 0.00 + 296.51 + 736.48 + 0.00

APPENDIX B

STORMWATER EVALUATIONS

TECHNICAL MEMORANDUM

Date: July 12, 2013

Project: Remedial Design of a Landfill Cap, Waste Consolidation, Institutional Controls and Interim Actions, Operable Unit (OU6)
Raymark Industries, Inc. Superfund Site
576/600 East Broadway, Stratford, Connecticut

Contract No. W912WJ-11-D-0005
Delivery Order 0007

Project Number: 36151120004

Subject: Stormwater Analysis

From: AMEC Environment & Infrastructure, Inc.

Prepared By: Tim Michaud Date: July 12, 2013
Tim Michaud

Checked By: Tony Donovan Date: 7/12/13
Tony Donovan, P.E.

Introduction

AMEC Environment & Infrastructure, Inc. (AMEC), under contract with the Army Corps of Engineers New England District, is providing engineering services related to remedial actions at the Raymark Industries, Inc. Superfund Site at 576/600 East Broadway in Stratford, Connecticut (Site). AMEC Is providing the remedial design of a landfill cap for the remedy selected by the New England District Environmental Protection Agency's (EPA's) September 2011 Record of Decision (ROD) for the Site. The EPA established that there shall be no increase in stormwater runoff between pre- and post-remediation conditions from the project site during the 100-year rainfall event. See Appendix A for pre- and post-remediation conditions (Existing and Proposed Conditions Watershed Maps).

This technical memorandum was prepared to summarize the evaluation of pre- and post-remediation peak flow rates during the 100-year rainfall event.

Existing Surface Soils

Surface soil information was obtained from the Natural Resources Conservation Service (NRCS) Web Soil Survey. The attached Existing Conditions Watershed Map identifies surface soil types present at the Site.

The vast majority of Site surface soils are Map Unit Symbol 306 – Udorthents-Urban Land Complex, which is comprised of 50% Udorthents and similar soils, 35% Urban Land, and 15%

minor components. Though Urban Land and minor components are not well defined, information on Udorthents is available. The erodibility factor (Kf) for Udorthents is 0.37, which indicates moderate erodibility.

Udorthents soils belong to Hydrologic Soil Group (HSG) B and have relatively low runoff potential due to moderate infiltration rates. HSG B soils consist primarily of moderately deep or deep, moderately well drained or well drained soils that have a moderately fine to course texture.

Calculations were conducted utilizing the EPA's Hydrologic Evaluation of Landfill Performance (HELP) Model to determine the overall saturated hydraulic conductivity for the Site. Based on Site soil characteristics and the EPA HELP Model, an overall saturated hydraulic conductivity of 3.58 in/hr was determined for the Site. See Appendix B for Calculations.

Existing (Pre-Construction) Drainage

The Site is approximately 5.7-acres (refer to the attached Existing Conditions Watershed Map). Approximately 94% of the Site surface consists of pervious cover. The Site is primarily undeveloped and overgrown with vegetation; consisting mostly of grasses in the central portion surrounded by a mix of grasses and trees. A dirt road providing access to 600 East Broadway encompasses approximately 0.04 acres. A wood shop, warehouse, and associated asphalt parking lot are located in the eastern edge of the Site.

Longbrook Tributary (a tributary to Ferry Creek) abuts the Site to the north. East Broadway borders the site to the southeast. Ferry Creek runs along the northeastern property line. A portion of the Site lies within the 100-year floodplain. Private properties, which border the Site to the west and south, are at higher elevations than the Site. While there are steeper slopes along these property boundaries, the majority of the Site is relatively flat (slopes of 5% or less).

There is no existing stormwater drainage system (e.g., catch basins, storm sewer pipes) on the Site. The majority of stormwater runoff flows towards the north and drains directly to Ferry Creek via overland flow. The remaining runoff from the southern portion of the Site ponds in a series of topographic depressions located within the 100-year floodplain.

This drainage eventually overtops the depressions and flows towards East Broadway where it ponds in a deep depression from what appears to be a former culvert inlet. The deep depression allows for infiltration during storm events approaching the 100-year storm and may ultimately overtop East Broadway for storms exceeding the 100-year storm.

Proposed (Post-Construction) Drainage

Proposed remedial construction activities include:

- Excavate Raymark waste within the 100-year floodplain and consolidate it under the proposed landfill cap. Excavations will be backfilled with clean imported soil to original grade and vegetated with a conservation seed mixture.

- Construct a low permeability landfill cap consisting of the following:

- Gas venting layer to be constructed overlying the subgrade and consisting of a geosynthetic gas venting layer with ¾-inch crushed stone trench, a single perforated gas vent pipe, and four gas vents.

- Hydraulic barrier layer constructed overlying the gas venting layer and consisting of a geosynthetic clay liner and Linear Low Density Polyethylene geomembrane.

- A geocomposite drainage layer to be constructed overlying the hydraulic barrier layer and consisting of geotextile fabric on the top and bottom of a geogrid to collect infiltration and transport it outside the cap to the surrounding environment.

- A 12-inch thick geocomposite protective cover soil layer.

- A top layer of soil comprised of 8-inches of select fill overlain by 4-inches of soil and vegetation meeting the requirements of Connecticut Department of Energy and Environmental Protection (CTDEEP).

The cap will terminate at the edge of the 100-year floodplain. The slope of the cap surface will be approximately 4.5% with 3:1 side slopes around the cap perimeter.

- Construct a gravel road in the same general vicinity as the existing dirt road to provide access to the landfill cap.

The proposed work will not significantly alter the existing drainage paths and flow patterns (refer to the attached Proposed Conditions Watershed Map). Stormwater runoff in the northern portion of the Site will continue to drain directly to Ferry Creek via overland flow. A centrally located high point in the cap will allow runoff from the southern portion of the Site to maintain sheet flow patterns towards topographic depressions located along the perimeter within the 100-year floodplain.

Stormwater Analysis

Peak runoff volumes for the 100-year Type III 24-hour rainfall event (7.0 inches) were evaluated under existing and proposed conditions. Rainfall data was obtained from Soil Conservation Service (SCS) Technical Release 55 (TR-55) revised 1986.

A total of six subcatchments were delineated based on existing and proposed Site topography. The subcatchments as well as their characteristics (e.g., area, curve number, time of concentration) are identified on the attached watershed maps. The total area of the subcatchments is approximately 5.7 acres. A curve number is a hydrologic parameter used to describe the stormwater runoff potential from various surface cover conditions.

These six subcatchment areas convey runoff flows to two discharge locations and include Ferry Creek at the northeastern property line and the deep depression located adjacent to East Broadway. These two discharge locations are identified as Points of Analyses (POAs) No. 1 and No. 2, respectively, for this stormwater analysis.

The average curve number for the Site is 67 (existing) and 63 (proposed), which indicates an improved cover condition and lower runoff volumes. The time of concentration is the time it takes for stormwater to flow from the most hydraulically remote point in a subcatchment, where remoteness relates to the time of travel rather than distance.

Peak runoff volumes resulting from the 100-year rainfall event were calculated for existing and proposed conditions with hydrologic and hydraulic stormwater models developed for the Site using HydroCAD® by HydroCAD Software Solutions LLC. HydroCAD® is a software program that combines key features of TR-20 and TR-55, standard engineering methods used to evaluate runoff conditions and develop stormwater controls, in addition to other accepted hydraulic techniques to evaluate stormwater. See Appendix C for HydroCAD® reports for the pre-remediation and post-remediation conditions.

AMEC applied a factor of safety of 3 to the overall saturated hydraulic conductivity of 3.58 in/hr resulting in an exfiltration value (K) of 1.19 in/hr for the Site. This exfiltration rate was included as a hydrologic parameter for the Site's topographic depressions which were modeled as ponds in the HydroCAD® modeling.

A summary of the rainfall data and the stormwater model results are presented in the tables below:

Table 1: 100-year (7-Inches) Peak Discharge Rates

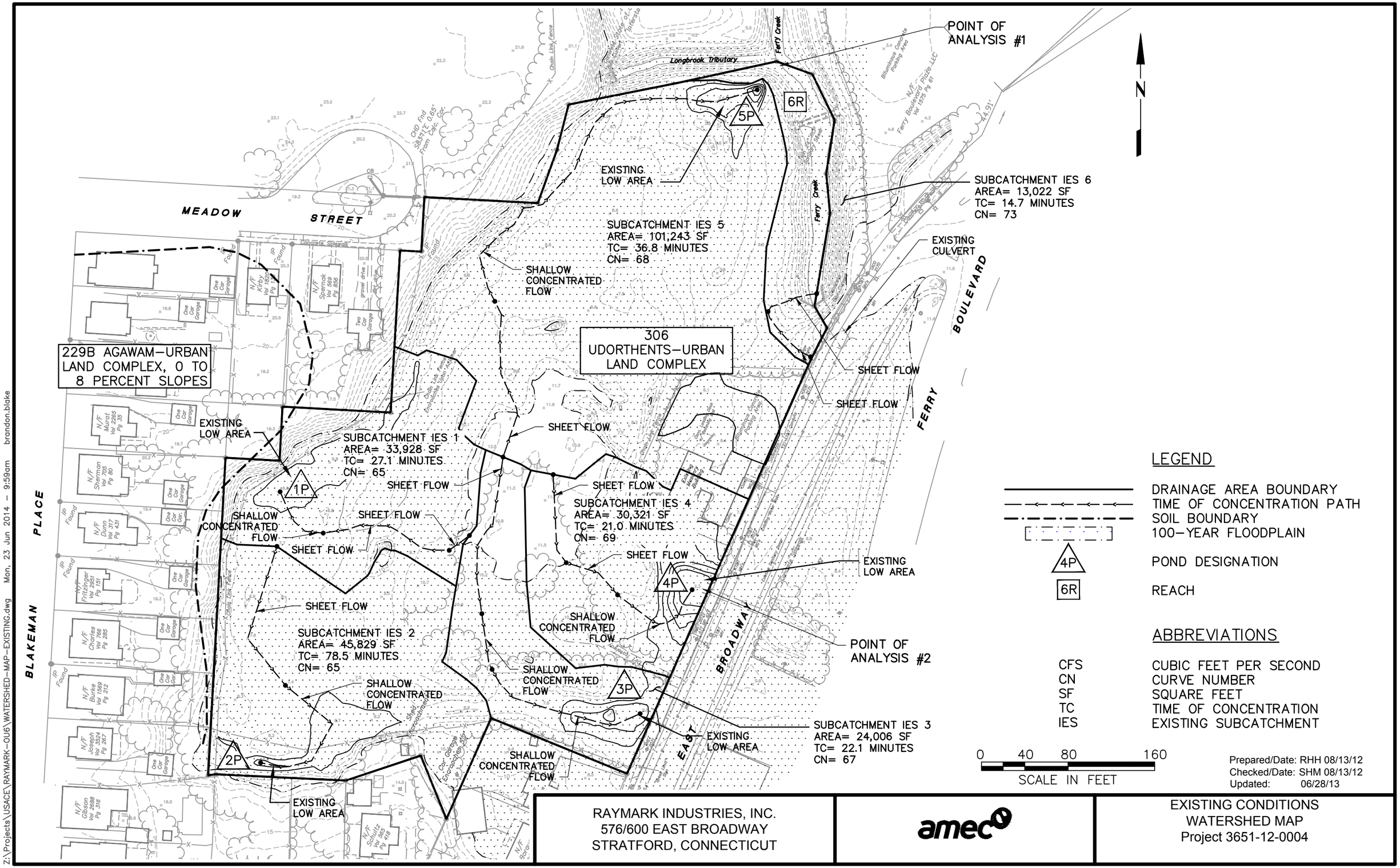
POA	Pre-Remediation Conditions		Post Remediation Conditions		Peak Stormwater Discharge Delta
	Peak Stormwater Discharge	Peak Water Surface Elevation	Peak Stormwater Discharge	Peak Water Surface Elevation	
No. 1	5.20 cfs	(- 2.29) ft	5.12 cfs	(- 2.29) ft	(- 0.08) cfs
No. 2	0.00 cfs	6.20 ft	0.00 cfs	5.78 ft	0.00 cfs
Totals	5.20 cfs		5.12 cfs		(- 0.08) cfs

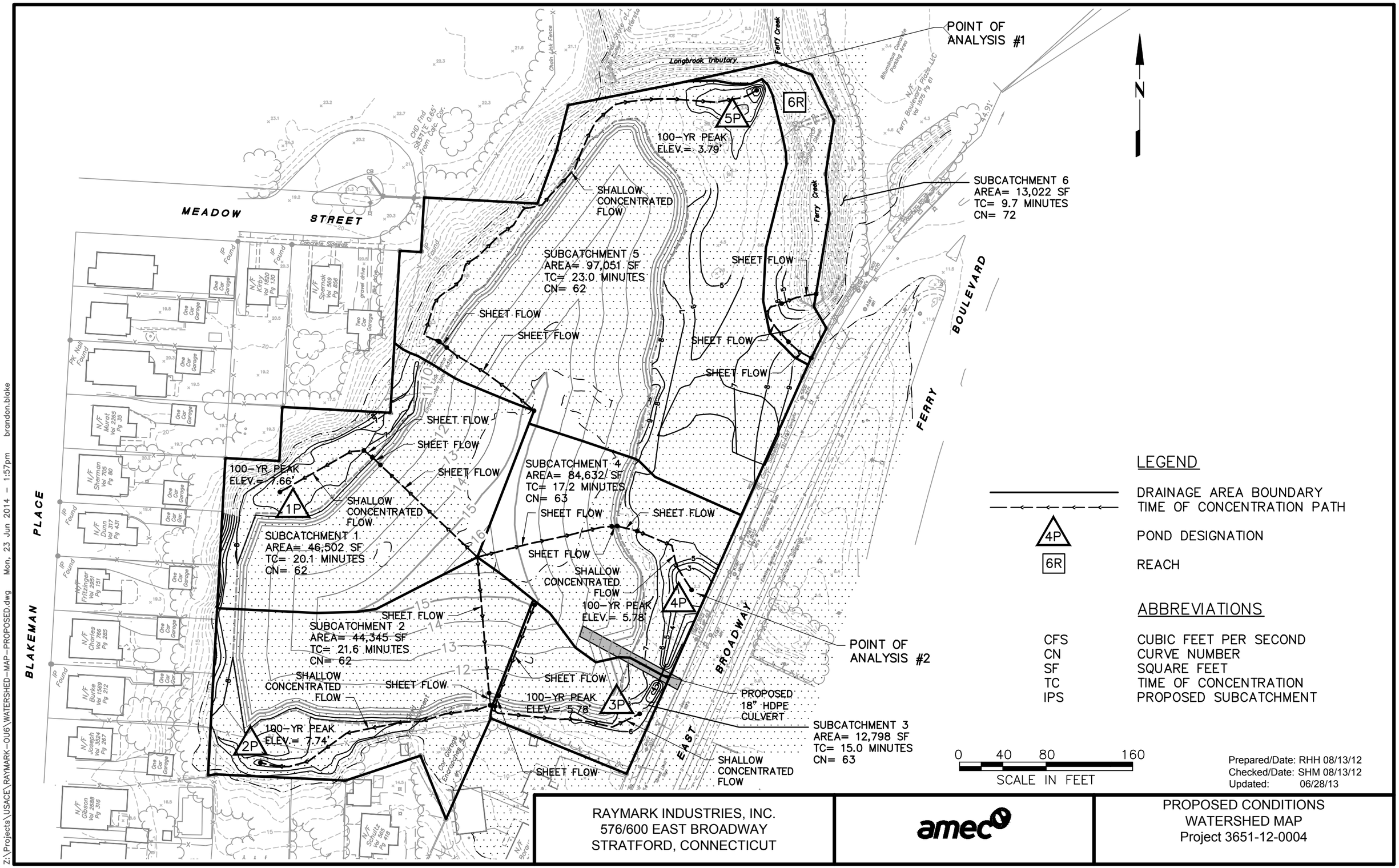
Conclusion

The design requirement set forth by the EPA was that there shall be no increase in stormwater runoff between pre- and post-remediation conditions from the project site during the 100-year rainfall event. As shown in Tables 1, the post-remediation peak flows at POA No.1 and POA No. 2 have been maintained to below pre-remediation rates during the 100-year storm event.

Appendix A

Existing and Proposed Conditions Watershed Maps


POINT OF ANALYSIS #1
Longbrook Tributary
Ferry Creek
6R
5P
EXISTING LOW AREA
SUBCATCHMENT IES 6
AREA= 13,022 SF
TC= 14.7 MINUTES
CN= 73
MEADOW STREET
SUBCATCHMENT IES 5
AREA= 101,243 SF
TC= 36.8 MINUTES
CN= 68
EXISTING CULVERT
SHALLOW CONCENTRATED FLOW
BOULEVARD
306
UDORTHENTS–URBAN LAND COMPLEX
229B AGAWAM–URBAN LAND COMPLEX, 0 TO 8 PERCENT SLOPES
SHEET FLOW
SHEET FLOW
FERRY
EXISTING LOW AREA
SUBCATCHMENT IES 1
AREA= 33,928 SF
TC= 27.1 MINUTES
CN= 65
SHEET FLOW
1P
SHEET FLOW
SHEET FLOW
SUBCATCHMENT IES 4
AREA= 30,321 SF
TC= 21.0 MINUTES
CN= 69
SHALLOW CONCENTRATED FLOW
SHEET FLOW
SHEET FLOW
4P
EXISTING LOW AREA
BLAKEMAN PLACE
SHEET FLOW
SHALLOW CONCENTRATED FLOW
BROADWAY
POINT OF ANALYSIS #2
SUBCATCHMENT IES 2
AREA= 45,829 SF
TC= 78.5 MINUTES
CN= 65
SHALLOW CONCENTRATED FLOW
SHALLOW CONCENTRATED FLOW
3P
SUBCATCHMENT IES 3
AREA= 24,006 SF
TC= 22.1 MINUTES
CN= 67
EAST
EXISTING LOW AREA
SHALLOW CONCENTRATED FLOW
2P
EXISTING LOW AREA
N
LEGEND
DRAINAGE AREA BOUNDARY
TIME OF CONCENTRATION PATH
SOIL BOUNDARY
100–YEAR FLOODPLAIN
4P POND DESIGNATION
6R REACH
ABBREVIATIONS
CFS CUBIC FEET PER SECOND
CN CURVE NUMBER
SF SQUARE FEET
TC TIME OF CONCENTRATION
IES EXISTING SUBCATCHMENT
0 40 80 160
SCALE IN FEET
Prepared/Date: RHH 08/13/12
Checked/Date: SHM 08/13/12
Updated: 06/28/13
RAYMARK INDUSTRIES, INC.
576/600 EAST BROADWAY
STRATFORD, CONNECTICUT
amec
EXISTING CONDITIONS
WATERSHED MAP
Project 3651-12-0004
Z:\Projects\USACE\RAYMARK-OU6\WATERSHED-MAP-EXISTING.dwg Mon, 23 Jun 2014 - 9:59am brandon.blake


POINT OF ANALYSIS #1
Longbrook Tributary
Ferry Creek
6R
5P
100-YR PEAK ELEV.= 3.79'
SHALLOW CONCENTRATED FLOW
SUBCATCHMENT 6
AREA= 13,022 SF
TC= 9.7 MINUTES
CN= 72
MEADOW STREET
SUBCATCHMENT 5
AREA= 97,051 SF
TC= 23.0 MINUTES
CN= 62
SHEET FLOW
BOULEVARD
FERRY
100-YR PEAK ELEV.= 7.66'
1P
SUBCATCHMENT 1
AREA= 46,502 SF
TC= 20.1 MINUTES
CN= 62
SUBCATCHMENT 4
AREA= 84,632 SF
TC= 17.2 MINUTES
CN= 63
BLAKEMAN PLACE
SUBCATCHMENT 2
AREA= 44,345 SF
TC= 21.6 MINUTES
CN= 62
100-YR PEAK ELEV.= 5.78'
4P
BROADWAY
POINT OF ANALYSIS #2
PROPOSED 18" HDPE CULVERT
3P
100-YR PEAK ELEV.= 5.78'
2P
100-YR PEAK ELEV.= 7.74'
SUBCATCHMENT 3
AREA= 12,798 SF
TC= 15.0 MINUTES
CN= 63
EAST
N
LEGEND
DRAINAGE AREA BOUNDARY
TIME OF CONCENTRATION PATH
POND DESIGNATION
REACH
ABBREVIATIONS
CFS CUBIC FEET PER SECOND
CN CURVE NUMBER
SF SQUARE FEET
TC TIME OF CONCENTRATION
IPS PROPOSED SUBCATCHMENT
0 40 80 160
SCALE IN FEET
Prepared/Date: RHH 08/13/12
Checked/Date: SHM 08/13/12
Updated: 06/28/13
RAYMARK INDUSTRIES, INC.
576/600 EAST BROADWAY
STRATFORD, CONNECTICUT
amec
PROPOSED CONDITIONS
WATERSHED MAP
Project 3651-12-0004
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APPENDIX B

Saturated Hydraulic Conductivity Calculations

JOB NO. 36511200004.58 SHEET 1 OF 5
PHASE TASK
JOB NAME Raymark
BY KLS DATE 7/27/12
CHECKED BY MAP DATE 7/31/12

amec
511 Congress Street
Portland, ME 04101
+1 (207) 775-5401 Fax +1 (207) 772-4762

Hydraulic Conductivity of Existing Soils

Per NRCS, site soils are primarily comprised of udorthents - urban land complex. Urban land is not ~~well~~ defined, but udorthents is comprised of 42% sand, 46% silt, and 12% clay at the surface horizon. Soils below are coarser & more well drained.

Description	Fraction	USDA Class	Saturated Hydraulic Conductivity (cm/s)
Sand	42%	S	5.8×10^{-3}
Silt	46%	SiL	1.9×10^{-4}
Clay	12%	C	2.5×10^{-5}

From Table 1 of the HELP model

Overall saturated hydraulic conductivity:

$K = 42\% (5.8 \times 10^{-3}) + 46\% (1.9 \times 10^{-4}) + 12\% (2.5 \times 10^{-5})$

$K = 2.53 \times 10^{-3}$ cm/s = 3.58 in/hr

Apply a factor of safety (FS) = 3

$\boxed{K = 1.19 \text{ in/hr}}$ ← infiltration value in HydroCAD model

Sheet 2 of 5

RUSLE2 Related Attributes

This report summarizes those soil attributes used by the Revised Universal Soil Loss Equation Version 2 (RUSLE2) for the map units in the selected area. The report includes the map unit symbol, the component name, and the percent of the component in the map unit. Soil property data for each map unit component include the hydrologic soil group, erosion factors Kf for the surface horizon, erosion factor T, and the representative percentage of sand, silt, and clay in the surface horizon.

Report—RUSLE2 Related Attributes

RUSLE2 Related Attributes– State of Connecticut								
Map symbol and soil name	Pct. of map unit	Slope length (ft)	Hydrologic group	Kf	T factor	Representative value		
						% Sand	% Silt	% Clay
229B—Agawam-Urban land complex, 0 to 8 percent slopes								
Agawam	40	125	B	.32	3	62.0	31.0	7.0
Urban land	35	—	—	—	—	—	—	0.0
306—Udorthents-Urban land complex								
Udorthents	50	125	B	.37	3	42.0	46.0	12.0
Urban land	35	125	—	—	—	—	—	0.0
307—Urban land								
Urban land	80	125	—	—	—	—	—	0.0

Data Source Information

Soil Survey Area: State of Connecticut
Survey Area Data: Version 10, Mar 31, 2011

Engineering Properties– State of Connecticut												
Map unit symbol and soil name	Depth	USDA texture	Classification		Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
			Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
	In				*Pct*	*Pct*					*Pct*	
306—Udorthents-Urban land complex												
Udorthents	0-5	*Loam	CL-ML, ML, SC-SM, SM	A-4	0	0-10	90-100	80-100	70-100	45-75	15-25	NP-10
	5-21	*Gravelly loam, Extremely gravelly coarse sand, silty clay loam	SM, ML, SC-SM, CL-ML, GC-GM, GM	A-4, A-3, A-2, A-1	0-20	0-25	45-100	30-100	10-100	5-95	15-30	NP-10
	21-80	*Very gravelly sandy loam, Extremely gravelly coarse sand, silty clay loam	CL-ML, GC-GM, ML, GM, SM, SC-SM	A-2, A-4, A-1, A-3	0-20	0-25	45-100	30-100	10-100	5-95	15-30	NP-10
Urban land	0-6	*Material	—	—	—	—	—	—	—	—	—	—
307—Urban land												
Urban land	0-6	*Material	—	—	—	—	—	—	—	—	—	—

Data Source Information

Soil Survey Area: State of Connecticut
Survey Area Data: Version 10, Mar 31, 2011

Sheet 3 of 5

United States
Environmental Protection
Agency

Office of Research and
Development
Washington DC 20460

EPA/600/R-94/168b
September 1994

EPA

Sheet ~~5~~ 4 of ~~6~~ 5

The Hydrologic Evaluation of Landfill Performance (HELP) Model

Engineering Documentation for Version 3

Sheet 6 of 6
5 5

TABLE 1. DEFAULT LOW DENSITY SOIL CHARACTERISTICS

Soil Texture Class			Total Porosity vol/vol	Field Capacity vol/vol	Wilting Point vol/vol	Saturated Hydraulic Conductivity cm/sec
HELP	USDA	USCS				
1	CoS	SP	0.417	0.045	0.018	1.0×10^{-2}
2	S	SW	0.437	0.062	0.024	5.8×10^{-3}
3	FS	SW	0.457	0.083	0.033	3.1×10^{-3}
4	LS	SM	0.437	0.105	0.047	1.7×10^{-3}
5	LFS	SM	0.457	0.131	0.058	1.0×10^{-3}
6	SL	SM	0.453	0.190	0.085	7.2×10^{-4}
7	FSL	SM	0.473	0.222	0.104	5.2×10^{-4}
8	L	ML	0.463	0.232	0.116	3.7×10^{-4}
9	SiL	ML	0.501	0.284	0.135	1.9×10^{-4}
10	SCL	SC	0.398	0.244	0.136	1.2×10^{-4}
11	CL	CL	0.464	0.310	0.187	6.4×10^{-5}
12	SiCL	CL	0.471	0.342	0.210	4.2×10^{-5}
13	SC	SC	0.430	0.321	0.221	3.3×10^{-5}
14	SiC	CH	0.479	0.371	0.251	2.5×10^{-5}
15	C	CH	0.475	0.378	0.251	2.5×10^{-5}
21	G	GP	0.397	0.032	0.013	3.0×10^{-1}

average $7.9 \times 10^{-}$

a = constant representing the effects of various fluid constants and gravity, 21 cm^3/sec

ϕ = total porosity, vol/vol

θ_r = residual volumetric water content, vol/vol

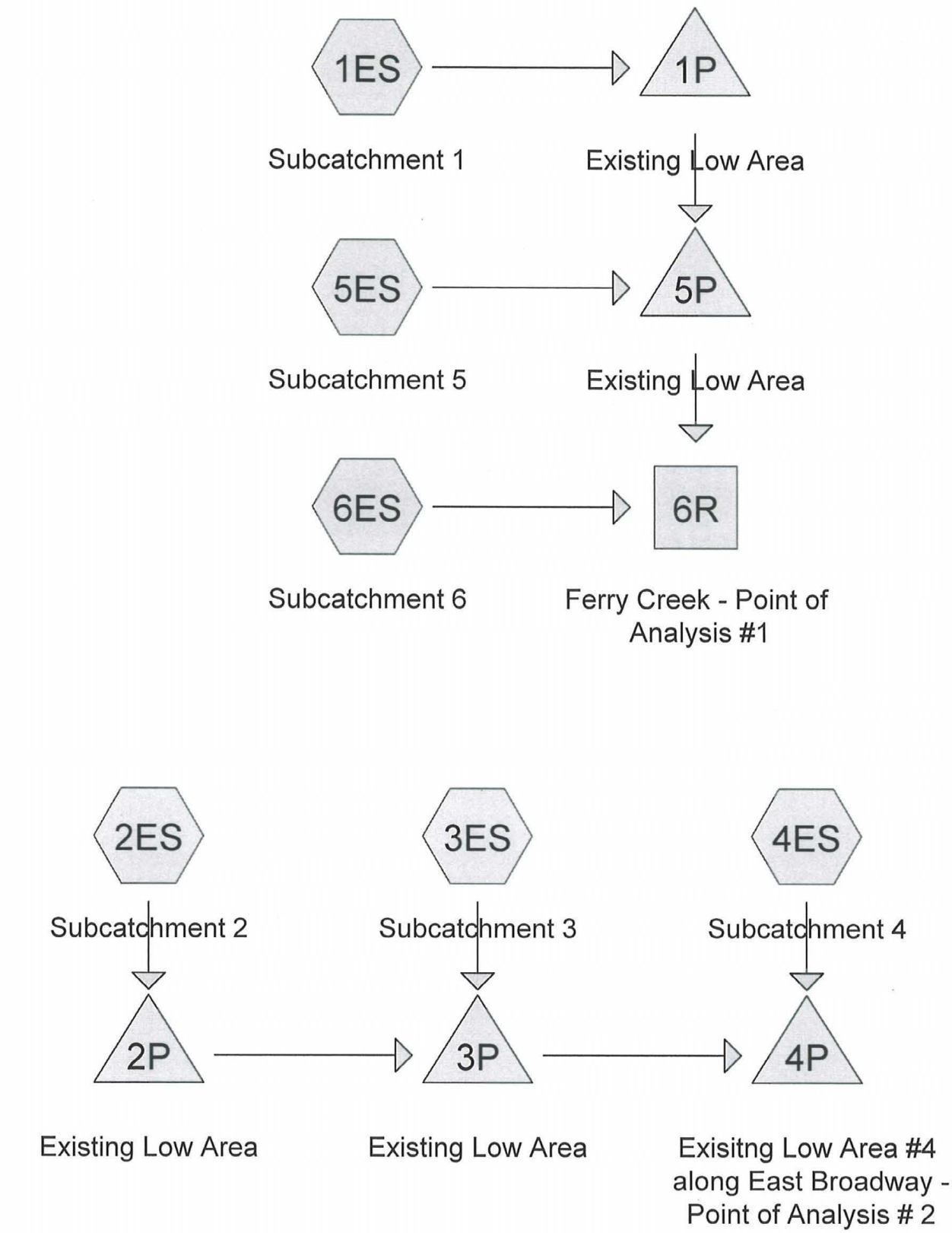
ψ_b = bubbling pressure, cm

λ = pore-size distribution index, dimensionless

A more detailed explanation of Equation 11 can be found in Appendix A of the HELP program Version 3 User's Guide and the cited references.

APPENDIX C

HydroCAD® Reports



Routing Diagram for Existing Conditions
Prepared by AMEC, Printed 7/3/2013
HydroCAD® 10.00 s/n 00677 © 2011 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
4.724	65	Woods/grass comb., Fair, HSG B (1ES, 2ES, 3ES, 4ES, 5ES, 6ES)
0.613	69	50-75% Grass cover, Fair, HSG B (1ES, 2ES, 3ES, 4ES, 5ES, 6ES)
0.043	82	Dirt roads, HSG B (3ES, 4ES)
0.254	98	Paved parking and roofs, HSG B (2ES, 4ES, 5ES)
0.068	98	Water Surface, HSG B (6ES)
5.701	**67**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
5.701	HSG B	1ES, 2ES, 3ES, 4ES, 5ES, 6ES
0.000	HSG C	
0.000	HSG D	
0.000	Other	
5.701		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.613	0.000	0.000	0.000	0.613	50-75% Grass cover, Fair	1ES, 2ES, 3ES, 4ES, 5ES, 6ES
0.000	0.251	0.000	0.000	0.000	0.251	Paved parking and roofs	4ES, 5ES
0.000	0.003	0.000	0.000	0.000	0.003	Paved parking and roofs	2ES
0.000	0.043	0.000	0.000	0.000	0.043	Dirt roads	3ES, 4ES
0.000	4.724	0.000	0.000	0.000	4.724	Woods/grass comb., Fair	1ES, 2ES, 3ES, 4ES, 5ES, 6ES
0.000	0.068	0.000	0.000	0.000	0.068	Water Surface	6ES
0.000	**5.701**	**0.000**	**0.000**	**0.000**	**5.701**	**TOTAL AREA**	

Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1ES: Subcatchment 1 Runoff Area=33,928 sf 0.00% Impervious Runoff Depth=3.10"
Flow Length=208' Tc=27.1 min CN=65 Runoff=1.66 cfs 0.201 af

Subcatchment 2ES: Subcatchment 2 Runoff Area=45,829 sf 0.24% Impervious Runoff Depth=3.10"
Flow Length=288' Tc=78.5 min CN=65 Runoff=1.25 cfs 0.272 af

Subcatchment 3ES: Subcatchment 3 Runoff Area=24,006 sf 0.00% Impervious Runoff Depth=3.31"
Flow Length=359' Tc=22.1 min CN=67 Runoff=1.37 cfs 0.152 af

Subcatchment 4ES: Subcatchment 4 Runoff Area=30,321 sf 5.57% Impervious Runoff Depth=3.51"
Flow Length=237' Tc=21.0 min CN=69 Runoff=1.89 cfs 0.204 af

Subcatchment 5ES: Subcatchment 5 Runoff Area=101,243 sf 9.14% Impervious Runoff Depth=3.41"
Flow Length=524' Slope=0.0220 '/' Tc=36.8 min CN=68 Runoff=4.74 cfs 0.660 af

Subcatchment 6ES: Subcatchment 6 Runoff Area=13,022 sf 22.83% Impervious Runoff Depth=3.94"
Flow Length=110' Tc=14.7 min CN=73 Runoff=1.05 cfs 0.098 af

Reach 6R: Ferry Creek - Point of Avg. Flow Depth=0.21' Max Vel=1.66 fps Inflow=5.20 cfs 0.735 af
n=0.022 L=10.0' S=0.0050 '/' Capacity=3,048.26 cfs Outflow=5.20 cfs 0.735 af

Pond 1P: Existing Low Area Peak Elev=7.63' Storage=3,917 cf Inflow=1.66 cfs 0.201 af
Discarded=0.18 cfs 0.189 af Primary=0.17 cfs 0.013 af Outflow=0.35 cfs 0.201 af

Pond 2P: Existing Low Area Peak Elev=7.72' Storage=5,871 cf Inflow=1.25 cfs 0.272 af
Discarded=0.22 cfs 0.244 af Primary=0.10 cfs 0.009 af Outflow=0.32 cfs 0.253 af

Pond 3P: Existing Low Area Peak Elev=6.79' Storage=1,788 cf Inflow=1.37 cfs 0.160 af
Discarded=0.09 cfs 0.095 af Primary=1.04 cfs 0.063 af Outflow=1.13 cfs 0.159 af

Pond 4P: Exisitng Low Area #4 along East Peak Elev=6.20' Storage=6,205 cf Inflow=2.58 cfs 0.267 af
Discarded=0.29 cfs 0.258 af Primary=0.00 cfs 0.000 af Outflow=0.29 cfs 0.258 af

Pond 5P: Existing Low Area Peak Elev=3.80' Storage=2,187 cf Inflow=4.74 cfs 0.673 af
Discarded=0.00 cfs 0.000 af Primary=4.73 cfs 0.637 af Outflow=4.73 cfs 0.637 af

Total Runoff Area = 5.701 ac Runoff Volume = 1.588 af Average Runoff Depth = 3.34"
94.35% Pervious = 5.379 ac 5.65% Impervious = 0.322 ac

Summary for Subcatchment 1ES: Subcatchment 1

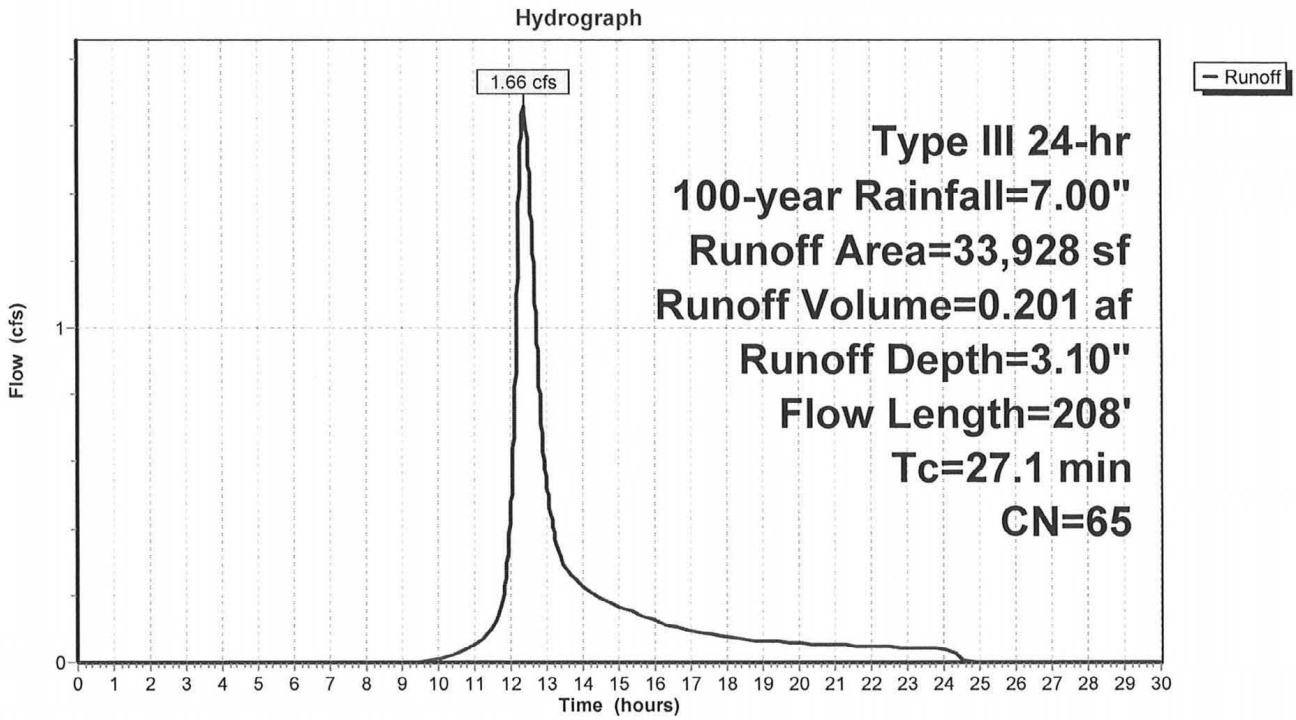
Runoff = 1.66 cfs @ 12.38 hrs, Volume= 0.201 af, Depth= 3.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=7.00"

Area (sf)	CN	Description
482	69	50-75% Grass cover, Fair, HSG B
33,446	65	Woods/grass comb., Fair, HSG B
33,928	65	Weighted Average
33,928		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.3	23	0.0300	0.17		**Sheet Flow,** Range n= 0.130 P2= 3.25"
23.2	127	0.0260	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
1.6	58	0.0140	0.59		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
27.1	208	Total			

Subcatchment 1ES: Subcatchment 1



Summary for Subcatchment 2ES: Subcatchment 2

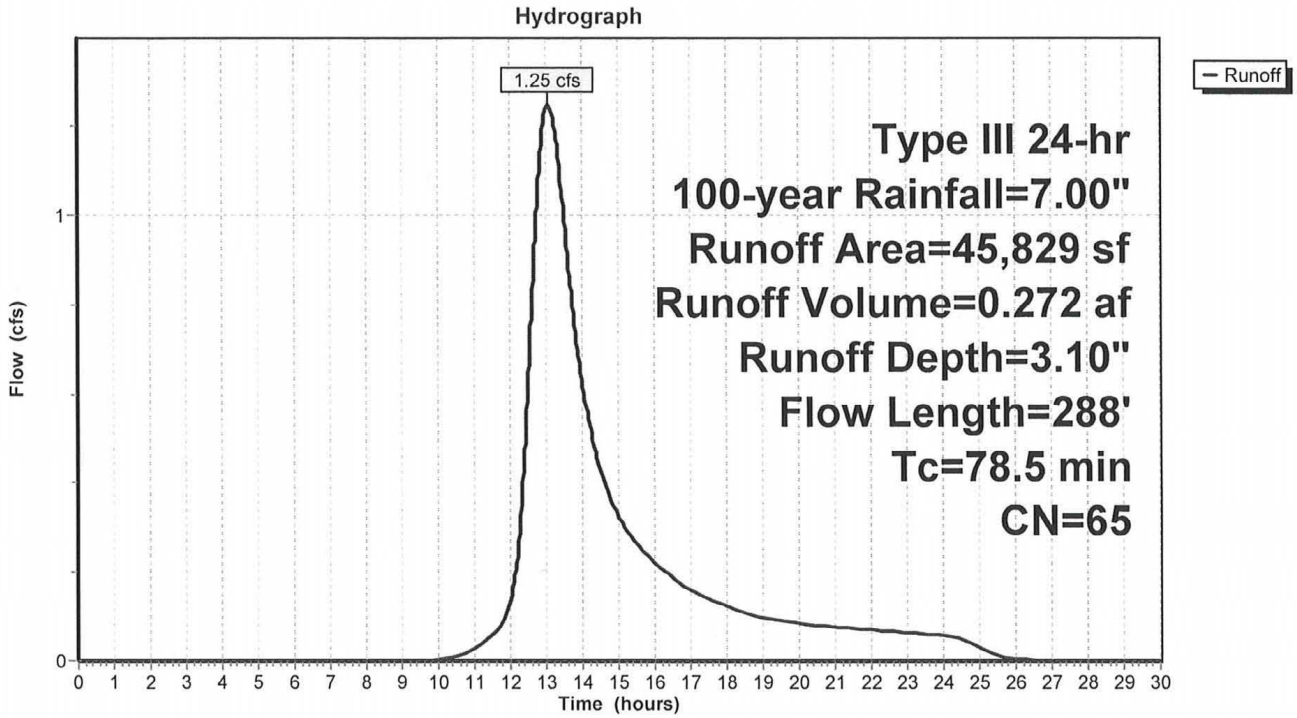
Runoff = 1.25 cfs @ 13.08 hrs, Volume= 0.272 af, Depth= 3.10"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=7.00"

Area (sf)	CN	Description
109	98	Paved parking and roofs, HSG B
3,684	69	50-75% Grass cover, Fair, HSG B
42,036	65	Woods/grass comb., Fair, HSG B
45,829	65	Weighted Average
45,720		99.76% Pervious Area
109		0.24% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
74.0	150	0.0020	0.03		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
4.5	138	0.0105	0.51		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
78.5	288	Total			

Subcatchment 2ES: Subcatchment 2



Summary for Subcatchment 3ES: Subcatchment 3

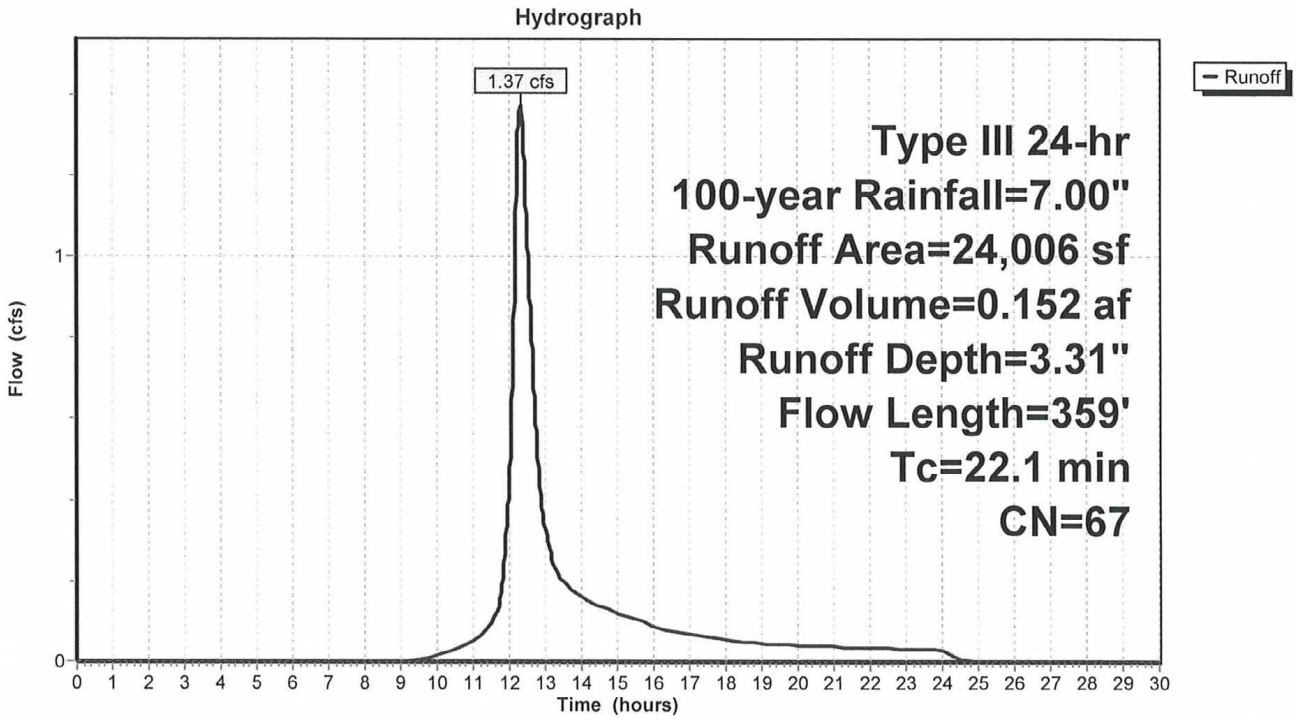
Runoff = 1.37 cfs @ 12.31 hrs, Volume= 0.152 af, Depth= 3.31"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=7.00"

Area (sf)	CN	Description
68	82	Dirt roads, HSG B
11,306	69	50-75% Grass cover, Fair, HSG B
12,632	65	Woods/grass comb., Fair, HSG B
24,006	67	Weighted Average
24,006		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.9	150	0.0073	0.14		**Sheet Flow,** Range n= 0.130 P2= 3.25"
0.8	53	0.0274	1.16		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.4	156	0.0240	0.77		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
22.1	359	Total			

Subcatchment 3ES: Subcatchment 3



Summary for Subcatchment 4ES: Subcatchment 4

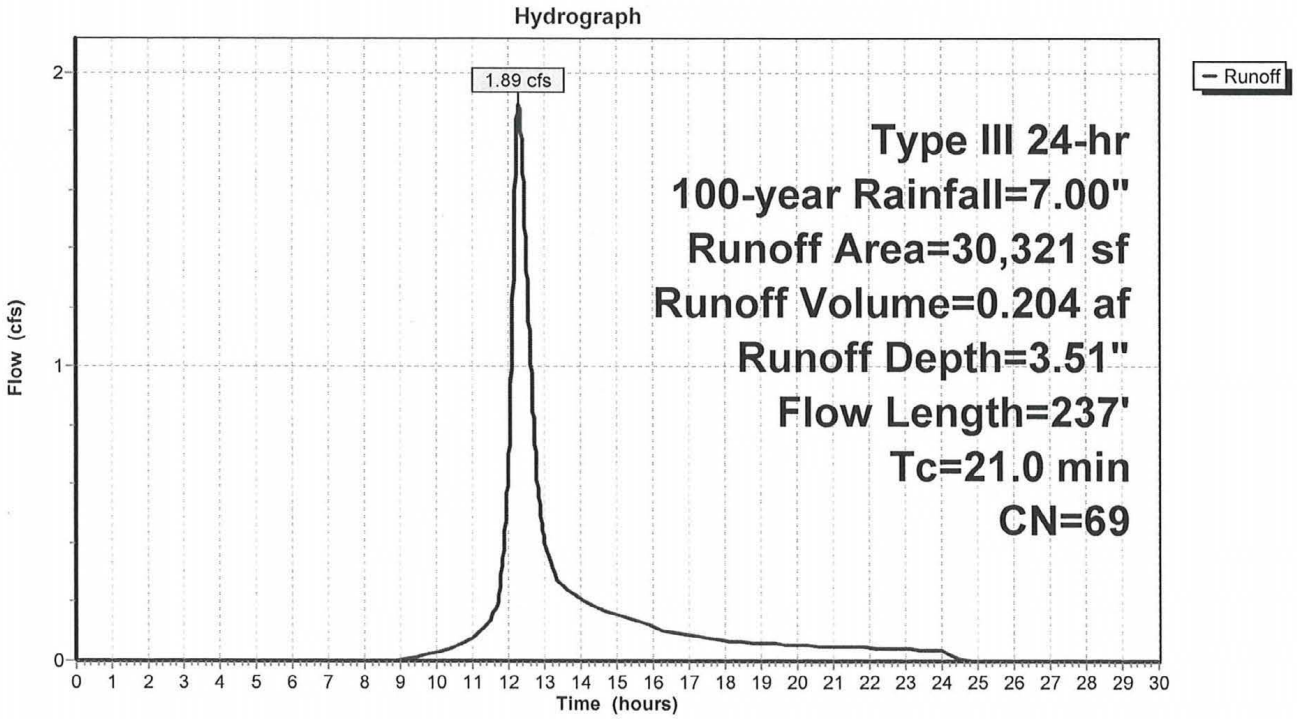
Runoff = 1.89 cfs @ 12.30 hrs, Volume= 0.204 af, Depth= 3.51"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=7.00"

Area (sf)	CN	Description
1,689	98	Paved parking and roofs, HSG B
1,800	82	Dirt roads, HSG B
8,645	69	50-75% Grass cover, Fair, HSG B
18,187	65	Woods/grass comb., Fair, HSG B
30,321	69	Weighted Average
28,632		94.43% Pervious Area
1,689		5.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.6	102	0.0127	0.16		**Sheet Flow,** Range n= 0.130 P2= 3.25"
9.3	48	0.0365	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
1.1	87	0.0740	1.36		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
21.0	237	Total			

Subcatchment 4ES: Subcatchment 4



Summary for Subcatchment 5ES: Subcatchment 5

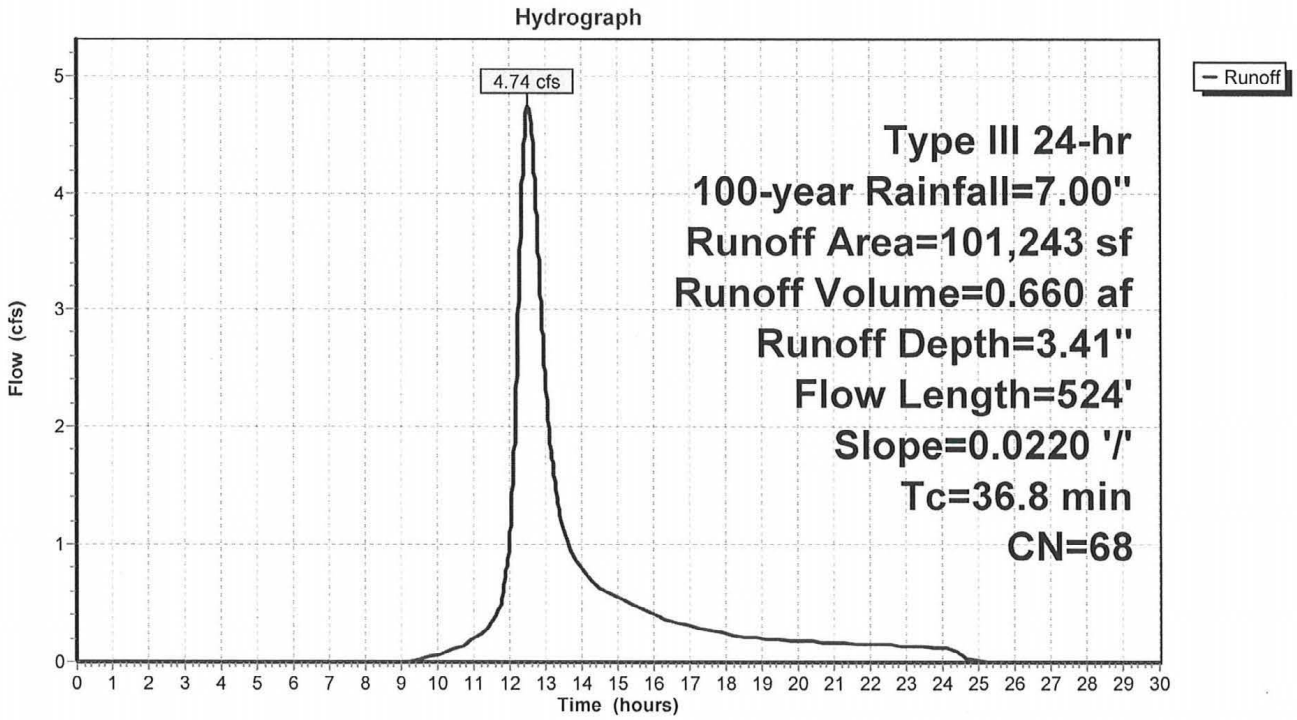
Runoff = 4.74 cfs @ 12.52 hrs, Volume= 0.660 af, Depth= 3.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=7.00"

	Area (sf)	CN	Description
*	9,250	98	Paved parking and roofs, HSG B
	2,547	69	50-75% Grass cover, Fair, HSG B
	89,446	65	Woods/grass comb., Fair, HSG B
	101,243	68	Weighted Average
	91,993		90.86% Pervious Area
	9,250		9.14% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
28.4	150	0.0220	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
8.4	374	0.0220	0.74		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
36.8	524	Total			

Subcatchment 5ES: Subcatchment 5



Summary for Subcatchment 6ES: Subcatchment 6

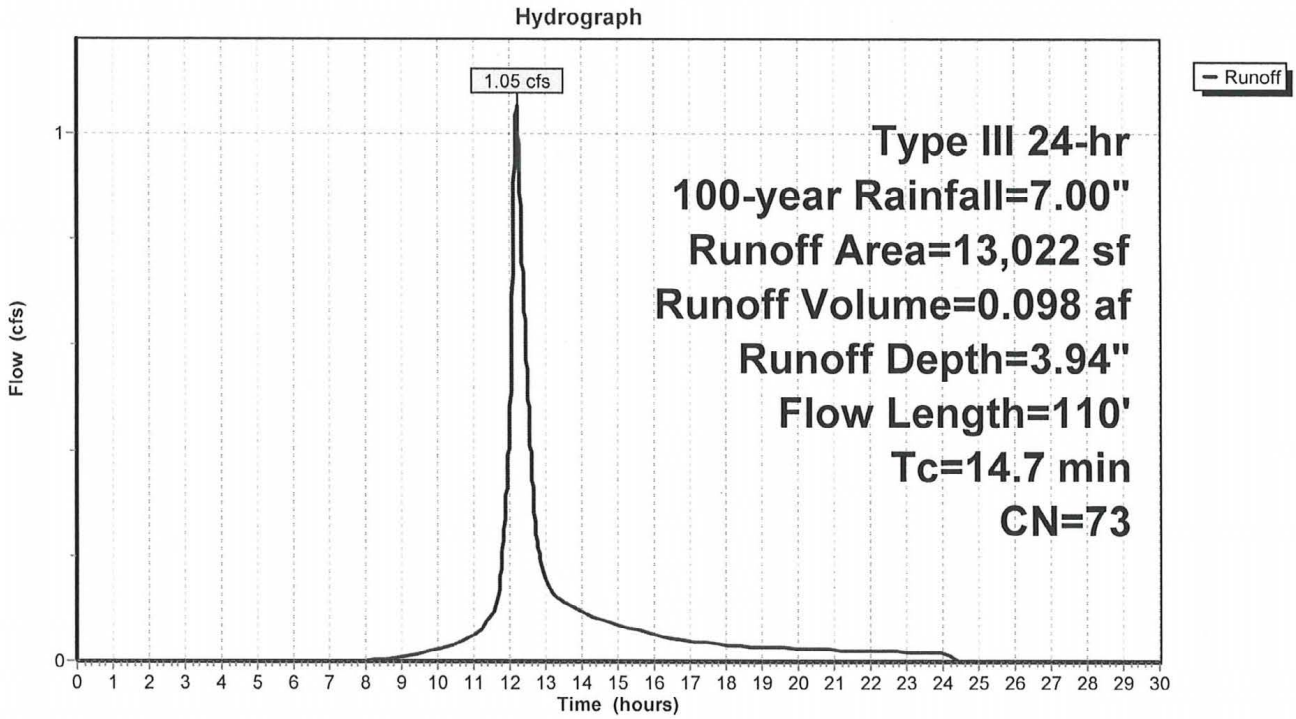
Runoff = 1.05 cfs @ 12.20 hrs, Volume= 0.098 af, Depth= 3.94"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=7.00"

Area (sf)	CN	Description
2,973	98	Water Surface, HSG B
34	69	50-75% Grass cover, Fair, HSG B
10,015	65	Woods/grass comb., Fair, HSG B
13,022	73	Weighted Average
10,049		77.17% Pervious Area
2,973		22.83% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.3	64	0.0500	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
4.4	46	0.2200	0.17		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
14.7	110	Total			

Subcatchment 6ES: Subcatchment 6



Summary for Reach 6R: Ferry Creek - Point of Analysis #1

Inflow Area = 3.402 ac, 8.25% Impervious, Inflow Depth = 2.59" for 100-year event
Inflow = 5.20 cfs @ 12.52 hrs, Volume= 0.735 af
Outflow = 5.20 cfs @ 12.52 hrs, Volume= 0.735 af, Atten= 0%, Lag= 0.0 min

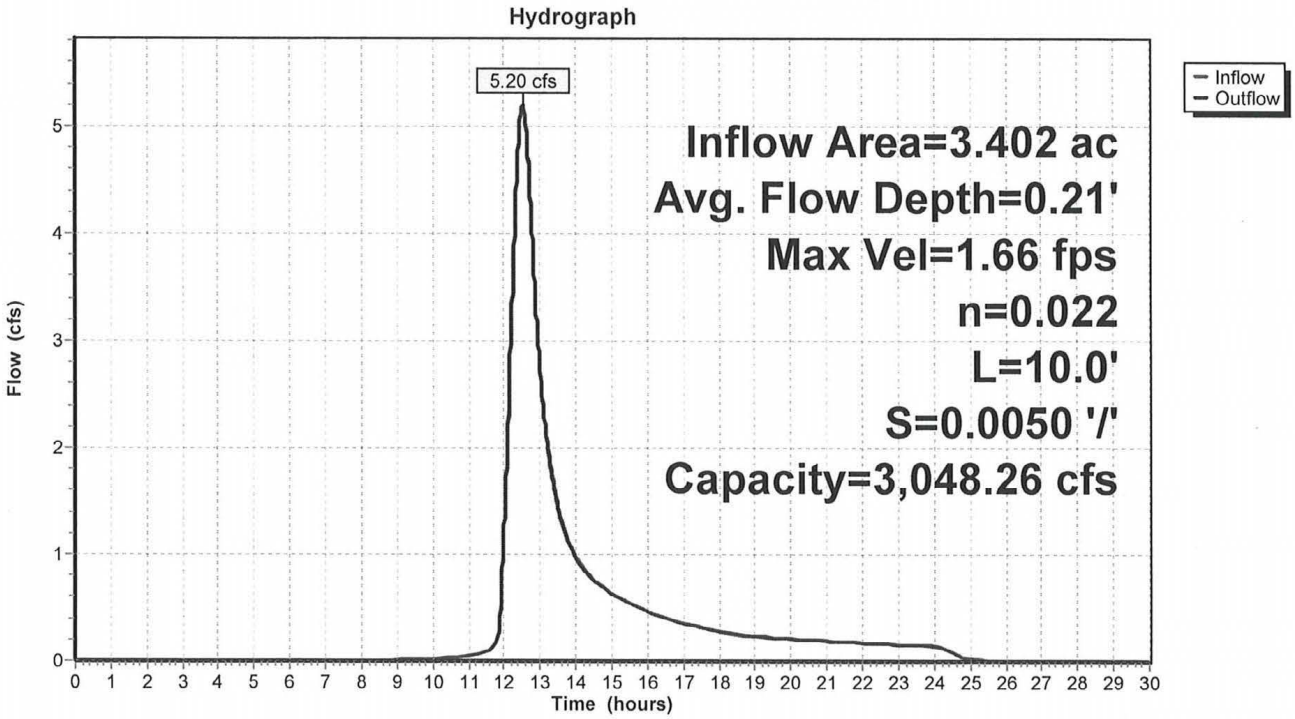
Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.66 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 0.85 fps, Avg. Travel Time= 0.2 min

Peak Storage= 31 cf @ 12.52 hrs
Average Depth at Peak Storage= 0.21'
Defined Flood Depth= 5.00' Flow Area= 145.0 sf, Capacity= 1,497.15 cfs
Bank-Full Depth= 7.00' Flow Area= 245.0 sf, Capacity= 3,048.26 cfs

14.00' x 7.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 '/' Top Width= 56.00'
Length= 10.0' Slope= 0.0050 '/'
Inlet Invert= -2.45', Outlet Invert= -2.50'

‡

Reach 6R: Ferry Creek - Point of Analysis #1



Summary for Pond 1P: Existing Low Area

Inflow Area =	0.779 ac,	0.00% Impervious,	Inflow Depth =	3.10"	for 100-year event
Inflow =	1.66 cfs @	12.38 hrs,	Volume=	0.201 af	
Outflow =	0.35 cfs @	13.28 hrs,	Volume=	0.201 af,	Atten= 79%, Lag= 53.9 min
Discarded =	0.18 cfs @	13.28 hrs,	Volume=	0.189 af	
Primary =	0.17 cfs @	13.28 hrs,	Volume=	0.013 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 7.63' @ 13.28 hrs Surf.Area= 5,801 sf Storage= 3,917 cf
Flood Elev= 7.70' Surf.Area= 6,000 sf Storage= 4,345 cf

Plug-Flow detention time= 239.0 min calculated for 0.201 af (100% of inflow)
Center-of-Mass det. time= 239.0 min (1,100.5 - 861.5)

Volume	Invert	Avail.Storage	Storage Description
#1	6.60'	4,345 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

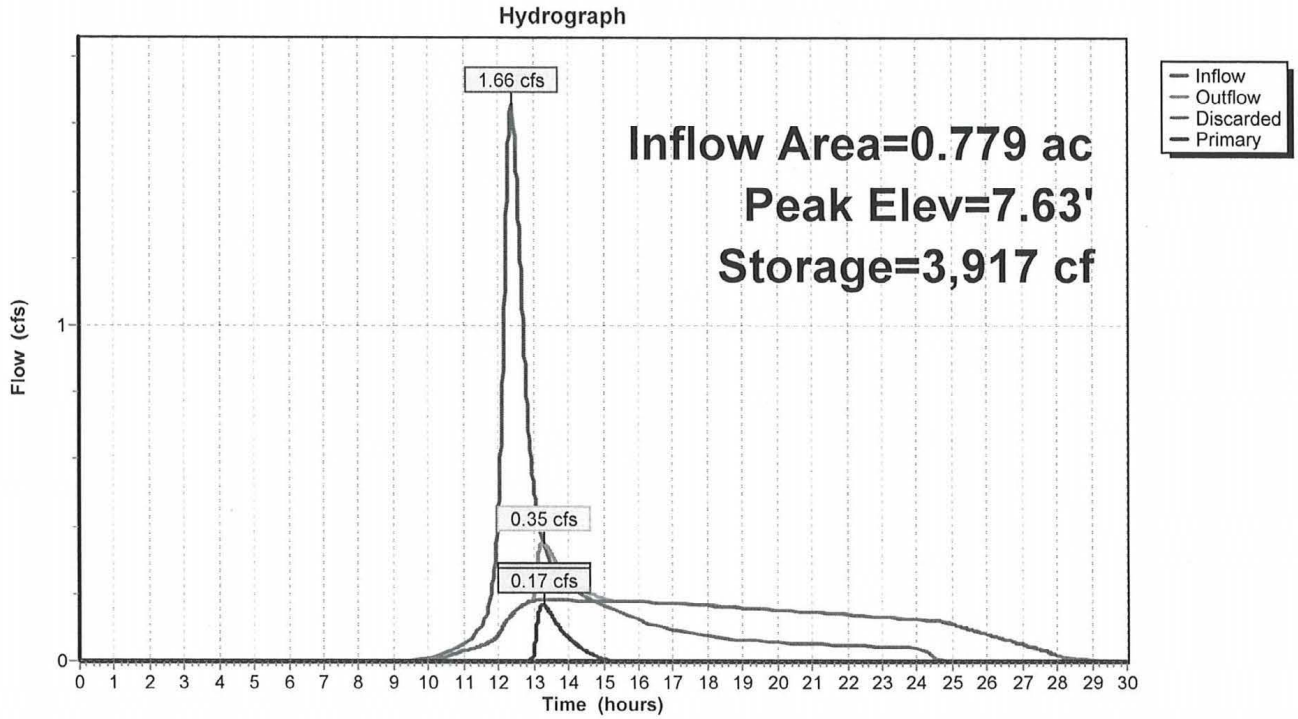
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
6.60	0	0	0
7.00	4,081	816	816
7.70	6,000	3,528	4,345

Device	Routing	Invert	Outlet Devices
#1	Primary	7.60'	**14.0' long x 14.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.64 2.67 2.70 2.65 2.64 2.65 2.65 2.63
#2	Discarded	6.60'	**1.190 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 2.00' Phase-In= 0.10'

Discarded OutFlow Max=0.18 cfs @ 13.28 hrs HW=7.63' (Free Discharge)
└**2=Exfiltration** (Controls 0.18 cfs)

Primary OutFlow Max=0.17 cfs @ 13.28 hrs HW=7.63' TW=3.66' (Dynamic Tailwater)
└**1=Broad-Crested Rectangular Weir** (Weir Controls 0.17 cfs @ 0.44 fps)

Pond 1P: Existing Low Area



Summary for Pond 2P: Existing Low Area

Inflow Area =	1.052 ac,	0.24% Impervious,	Inflow Depth =	3.10"	for 100-year event
Inflow =	1.25 cfs @	13.08 hrs,	Volume=	0.272 af	
Outflow =	0.32 cfs @	15.01 hrs,	Volume=	0.253 af,	Atten= 74%, Lag= 115.9 min
Discarded =	0.22 cfs @	15.01 hrs,	Volume=	0.244 af	
Primary =	0.10 cfs @	15.01 hrs,	Volume=	0.009 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 7.72' @ 15.01 hrs Surf.Area= 6,854 sf Storage= 5,871 cf
Flood Elev= 8.00' Surf.Area= 8,000 sf Storage= 7,942 cf

Plug-Flow detention time= 320.5 min calculated for 0.253 af (93% of inflow)
Center-of-Mass det. time= 283.6 min (1,192.7 - 909.1)

Volume	Invert	Avail.Storage	Storage Description
#1	5.90'	7,942 cf	**Pond (Prismatic)** Listed below (Recalc)

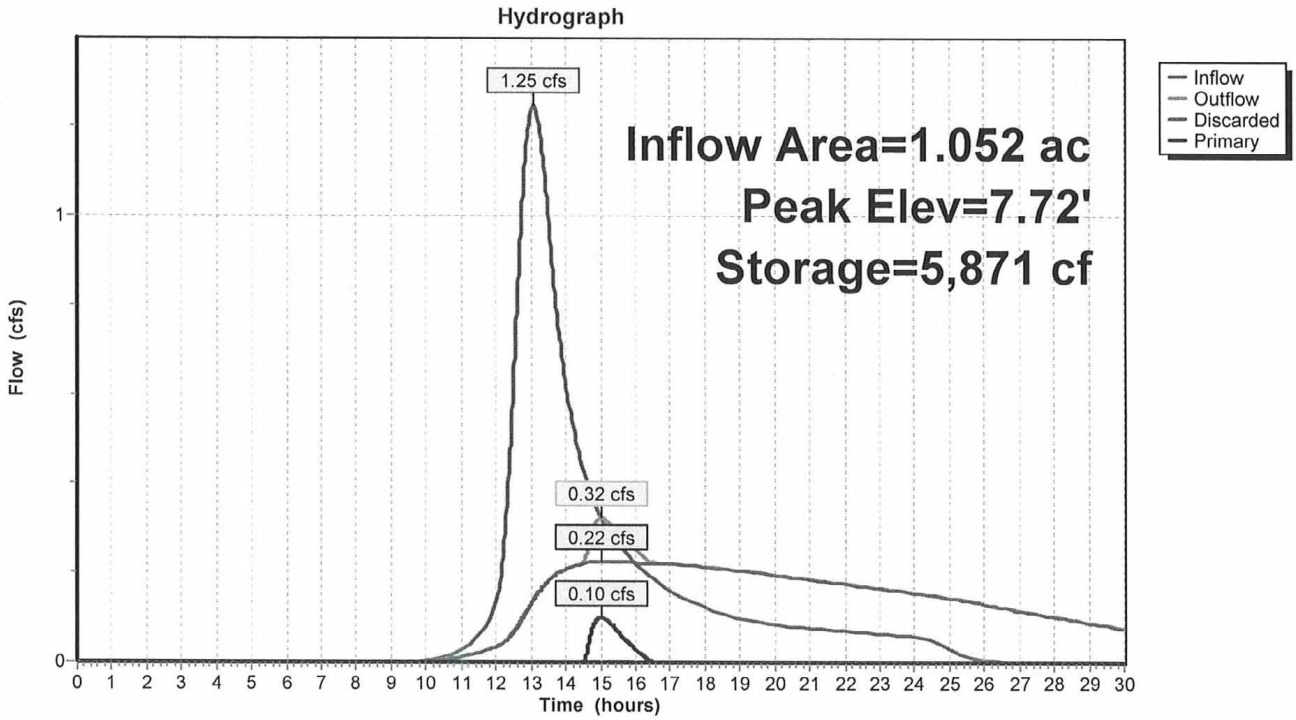
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
5.90	0	0	0
6.00	98	5	5
7.00	3,888	1,993	1,998
8.00	8,000	5,944	7,942

Device	Routing	Invert	Outlet Devices
#1	Primary	7.70'	**12.0' long x 150.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63
#2	Discarded	5.90'	**1.190 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 2.00' Phase-In= 0.10'

Discarded OutFlow Max=0.22 cfs @ 15.01 hrs HW=7.72' (Free Discharge)
└**2=Exfiltration** (Controls 0.22 cfs)

Primary OutFlow Max=0.10 cfs @ 15.01 hrs HW=7.72' TW=6.72' (Dynamic Tailwater)
└**1=Broad-Crested Rectangular Weir** (Weir Controls 0.10 cfs @ 0.39 fps)

Pond 2P: Existing Low Area



Summary for Pond 3P: Existing Low Area

Inflow Area =	1.603 ac,	0.16% Impervious,	Inflow Depth =	1.20"	for 100-year event
Inflow =	1.37 cfs @	12.31 hrs,	Volume=	0.160 af	
Outflow =	1.13 cfs @	12.47 hrs,	Volume=	0.159 af,	Atten= 18%, Lag= 9.8 min
Discarded =	0.09 cfs @	12.47 hrs,	Volume=	0.095 af	
Primary =	1.04 cfs @	12.47 hrs,	Volume=	0.063 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 6.79' @ 12.47 hrs Surf.Area= 2,763 sf Storage= 1,788 cf
Flood Elev= 7.00' Surf.Area= 3,208 sf Storage= 2,411 cf

Plug-Flow detention time= 157.7 min calculated for 0.159 af (99% of inflow)
Center-of-Mass det. time= 152.3 min (1,008.2 - 855.9)

Volume	Invert	Avail.Storage	Storage Description
#1	5.50'	2,411 cf	**Pond (Prismatic)** Listed below (Recalc)

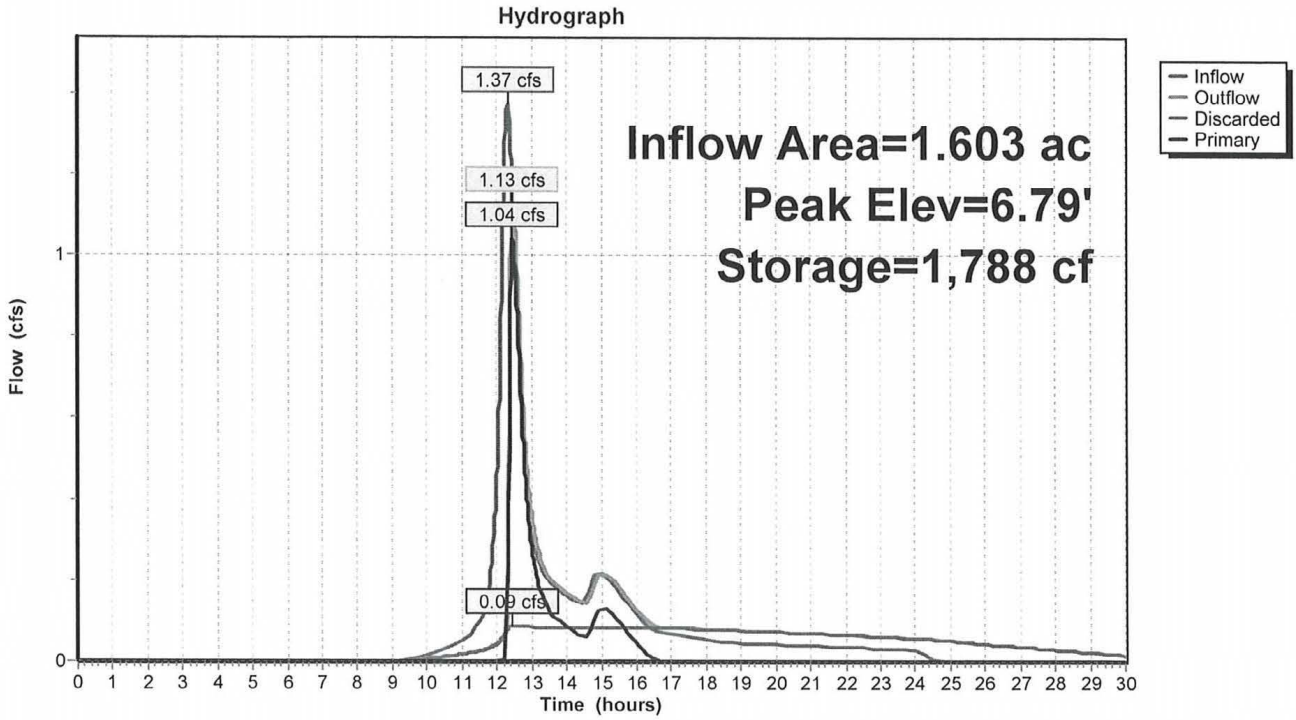
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
5.50	0	0	0
6.00	1,076	269	269
7.00	3,208	2,142	2,411

Device	Routing	Invert	Outlet Devices
#1	Primary	6.70'	**14.0' long x 65.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63
#2	Discarded	5.50'	**1.190 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 2.00' Phase-In= 0.10'

Discarded OutFlow Max=0.09 cfs @ 12.47 hrs HW=6.79' (Free Discharge)
└**2=Exfiltration** (Controls 0.09 cfs)

Primary OutFlow Max=1.04 cfs @ 12.47 hrs HW=6.79' TW=5.23' (Dynamic Tailwater)
└**1=Broad-Crested Rectangular Weir** (Weir Controls 1.04 cfs @ 0.81 fps)

Pond 3P: Existing Low Area



Summary for Pond 4P: Exisitng Low Area #4 along East Broadway - Point of Analysis # 2

Inflow Area =	2.299 ac,	1.80% Impervious,	Inflow Depth =	1.40"	for 100-year event
Inflow =	2.58 cfs @	12.43 hrs,	Volume=	0.267 af	
Outflow =	0.29 cfs @	14.08 hrs,	Volume=	0.258 af,	Atten= 89%, Lag= 99.2 min
Discarded =	0.29 cfs @	14.08 hrs,	Volume=	0.258 af	
Primary =	0.00 cfs @	0.00 hrs,	Volume=	0.000 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 6.20' @ 14.08 hrs Surf.Area= 3,859 sf Storage= 6,205 cf
Flood Elev= 6.25' Surf.Area= 4,000 sf Storage= 6,388 cf

Plug-Flow detention time= 302.7 min calculated for 0.258 af (97% of inflow)
Center-of-Mass det. time= 284.0 min (1,120.5 - 836.5)

Volume	Invert	Avail.Storage	Storage Description
#1	2.30'	6,388 cf	**Pond (Prismatic)** Listed below (Recalc)

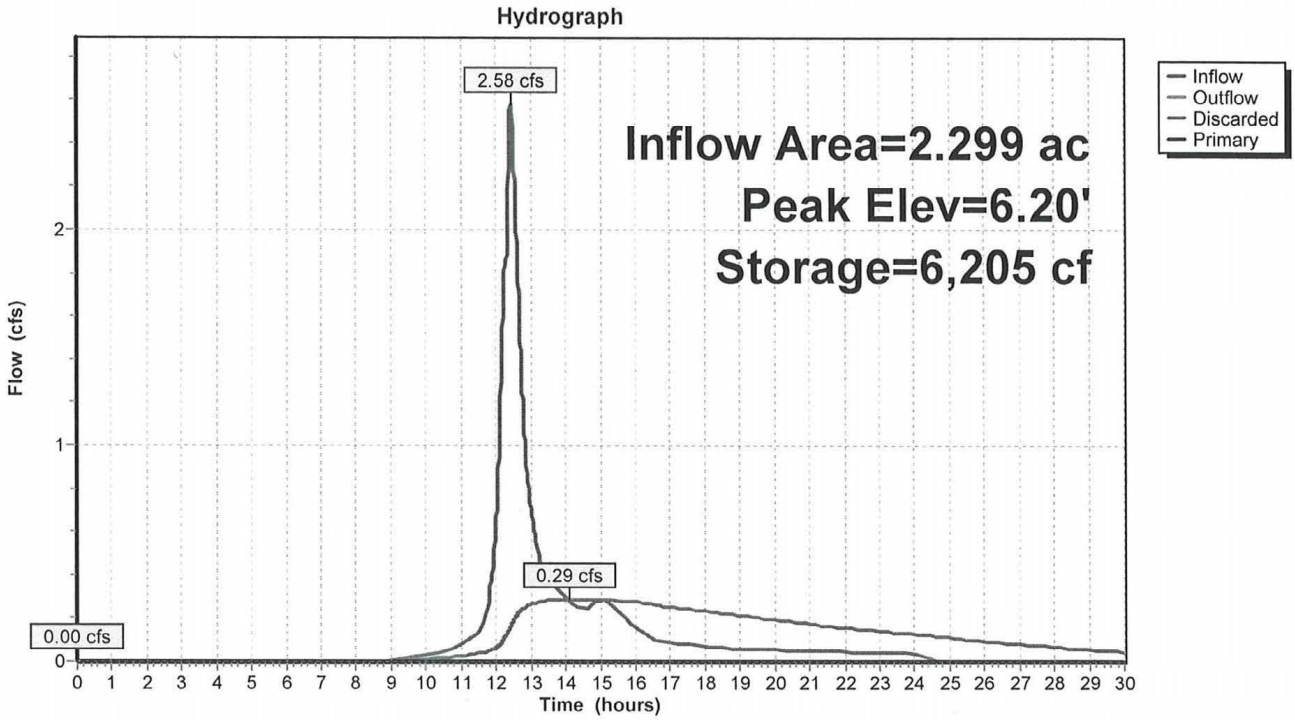
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
2.30	0	0	0
3.00	827	289	289
4.00	1,294	1,061	1,350
5.00	1,866	1,580	2,930
6.00	3,240	2,553	5,483
6.25	4,000	905	6,388

Device	Routing	Invert	Outlet Devices
#1	Primary	6.25'	**25.0' long x 60.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63
#2	Discarded	2.30'	**1.190 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 2.00' Phase-In= 0.10'

Discarded OutFlow Max=0.29 cfs @ 14.08 hrs HW=6.20' (Free Discharge)
└**2=Exfiltration** (Controls 0.29 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=2.30' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 4P: Exisitng Low Area #4 along East Broadway - Point of Analysis # 2



Summary for Pond 5P: Existing Low Area

Inflow Area =	3.103 ac,	6.84% Impervious,	Inflow Depth =	2.60"	for 100-year event
Inflow =	4.74 cfs @	12.52 hrs,	Volume=	0.673 af	
Outflow =	4.73 cfs @	12.55 hrs,	Volume=	0.637 af,	Atten= 0%, Lag= 2.1 min
Discarded =	0.00 cfs @	0.00 hrs,	Volume=	0.000 af	
Primary =	4.73 cfs @	12.55 hrs,	Volume=	0.637 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 3.80' @ 12.55 hrs Surf.Area= 2,256 sf Storage= 2,187 cf
Flood Elev= 4.00' Surf.Area= 2,512 sf Storage= 2,656 cf

Plug-Flow detention time= 43.1 min calculated for 0.637 af (95% of inflow)
Center-of-Mass det. time= 14.4 min (877.4 - 863.0)

Volume	Invert	Avail.Storage	Storage Description
#1	0.30'	2,656 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

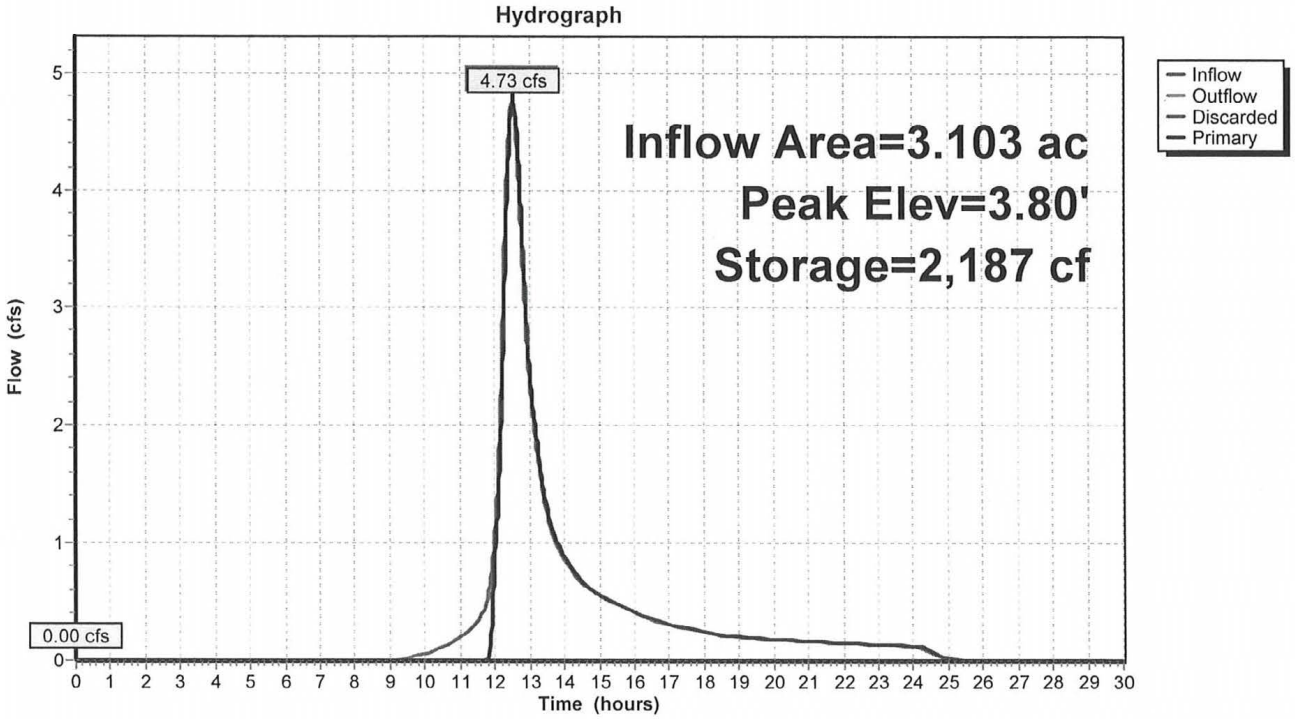
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.30	0	0	0
1.00	47	16	16
2.00	150	99	115
3.00	1,210	680	795
4.00	2,512	1,861	2,656

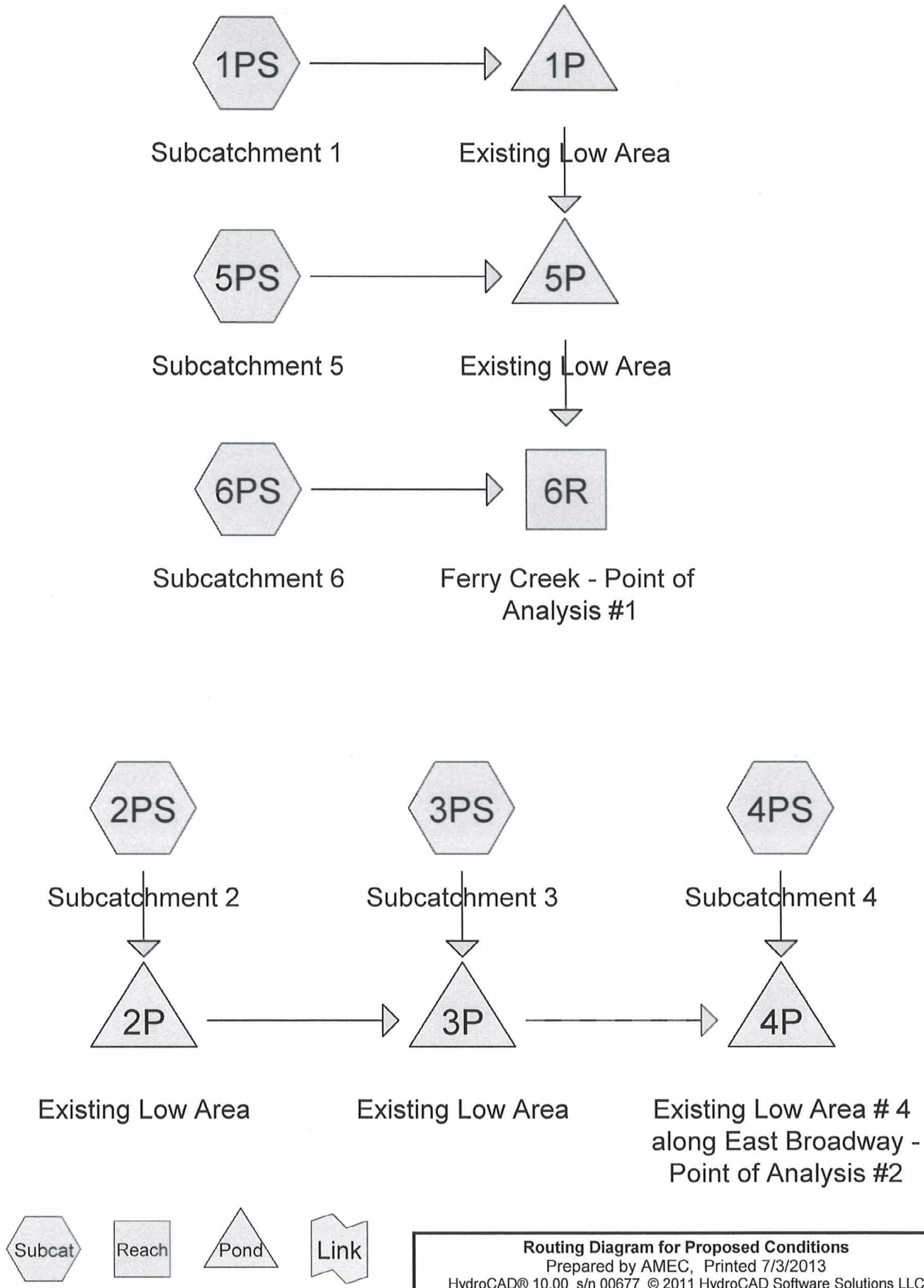
Device	Routing	Invert	Outlet Devices
#1	Primary	3.50'	**11.0' long x 2.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32
#2	Discarded	0.30'	**1.190 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 2.00' Phase-In= 0.10'

Discarded OutFlow Max=0.00 cfs @ 0.00 hrs HW=0.30' (Free Discharge)
└**2=Exfiltration** (Controls 0.00 cfs)

Primary OutFlow Max=4.73 cfs @ 12.55 hrs HW=3.80' TW=-2.24' (Dynamic Tailwater)
└**1=Broad-Crested Rectangular Weir** (Weir Controls 4.73 cfs @ 1.42 fps)

Pond 5P: Existing Low Area





Routing Diagram for Proposed Conditions
Prepared by AMEC, Printed 7/3/2013
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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
3.921	61	>75% Grass cover, Good, HSG B (1PS, 2PS, 3PS, 4PS, 5PS, 6PS)
1.609	65	Woods/grass comb., Fair, HSG B (1PS, 2PS, 3PS, 4PS, 5PS, 6PS)
0.079	69	50-75% Grass cover, Fair, HSG B (2PS, 3PS, 4PS, 6PS)
0.021	96	Gravel surface, HSG B (3PS, 4PS)
0.003	98	Unconnected roofs, HSG B (2PS)
0.068	98	Water Surface, HSG B (6PS)
5.701	**63**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
5.701	HSG B	1PS, 2PS, 3PS, 4PS, 5PS, 6PS
0.000	HSG C	
0.000	HSG D	
0.000	Other	
5.701		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.079	0.000	0.000	0.000	0.079	50-75% Grass cover, Fair	2PS, 3PS, 4PS, 6PS
0.000	3.921	0.000	0.000	0.000	3.921	>75% Grass cover, Good	1PS, 2PS, 3PS, 4PS, 5PS, 6PS
0.000	0.003	0.000	0.000	0.000	0.003	Unconnected roofs	2PS
0.000	0.021	0.000	0.000	0.000	0.021	Gravel surface	3PS, 4PS
0.000	1.609	0.000	0.000	0.000	1.609	Woods/grass comb., Fair	1PS, 2PS, 3PS, 4PS, 5PS, 6PS
0.000	0.068	0.000	0.000	0.000	0.068	Water Surface	6PS
0.000	**5.701**	**0.000**	**0.000**	**0.000**	**5.701**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	3P	4.20	3.80	20.0	0.0200	0.013	18.0	0.0	0.0

Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1PS: Subcatchment 1 Runoff Area=46,502 sf 0.00% Impervious Runoff Depth=2.80"
Flow Length=230' Tc=20.1 min CN=62 Runoff=2.29 cfs 0.249 af

Subcatchment 2PS: Subcatchment 2 Runoff Area=44,345 sf 0.25% Impervious Runoff Depth=2.80"
Flow Length=355' Tc=21.6 min CN=62 Runoff=2.13 cfs 0.238 af

Subcatchment 3PS: Subcatchment 3 Runoff Area=12,798 sf 0.00% Impervious Runoff Depth=2.90"
Flow Length=244' Tc=15.0 min CN=63 Runoff=0.74 cfs 0.071 af

Subcatchment 4PS: Subcatchment 4 Runoff Area=34,632 sf 0.00% Impervious Runoff Depth=2.90"
Flow Length=234' Tc=17.2 min CN=63 Runoff=1.89 cfs 0.192 af

Subcatchment 5PS: Subcatchment 5 Runoff Area=97,051 sf 0.00% Impervious Runoff Depth=2.80"
Flow Length=540' Tc=23.0 min CN=62 Runoff=4.52 cfs 0.520 af

Subcatchment 6PS: Subcatchment 6 Runoff Area=13,022 sf 22.83% Impervious Runoff Depth=3.83"
Flow Length=118' Tc=9.7 min CN=72 Runoff=1.17 cfs 0.095 af

Reach 6R: Ferry Creek - Point of Avg. Flow Depth=0.21' Max Vel=1.65 fps Inflow=5.11 cfs 0.617 af
n=0.022 L=10.0' S=0.0050 '/' Capacity=3,048.26 cfs Outflow=5.12 cfs 0.617 af

Pond 1P: Existing Low Area Peak Elev=7.66' Storage=4,279 cf Inflow=2.29 cfs 0.249 af
Discarded=0.20 cfs 0.211 af Primary=0.55 cfs 0.038 af Outflow=0.75 cfs 0.249 af

Pond 2P: Existing Low Area Peak Elev=7.74' Storage=4,668 cf Inflow=2.13 cfs 0.238 af
Discarded=0.19 cfs 0.203 af Primary=0.26 cfs 0.023 af Outflow=0.45 cfs 0.226 af

Pond 3P: Existing Low Area Peak Elev=5.78' Storage=500 cf Inflow=0.74 cfs 0.094 af
Discarded=0.03 cfs 0.016 af Primary=0.73 cfs 0.078 af Secondary=0.00 cfs 0.000 af Outflow=0.74 cfs 0.094 af

Pond 4P: Existing Low Area # 4 along East Peak Elev=5.78' Storage=5,888 cf Inflow=2.62 cfs 0.270 af
Discarded=0.27 cfs 0.261 af Primary=0.00 cfs 0.000 af Outflow=0.27 cfs 0.261 af

Pond 5P: Existing Low Area Peak Elev=3.79' Storage=2,165 cf Inflow=4.52 cfs 0.558 af
Discarded=0.00 cfs 0.000 af Primary=4.50 cfs 0.522 af Outflow=4.50 cfs 0.522 af

Total Runoff Area = 5.701 ac Runoff Volume = 1.365 af Average Runoff Depth = 2.87"
98.76% Pervious = 5.631 ac 1.24% Impervious = 0.071 ac

Summary for Subcatchment 1PS: Subcatchment 1

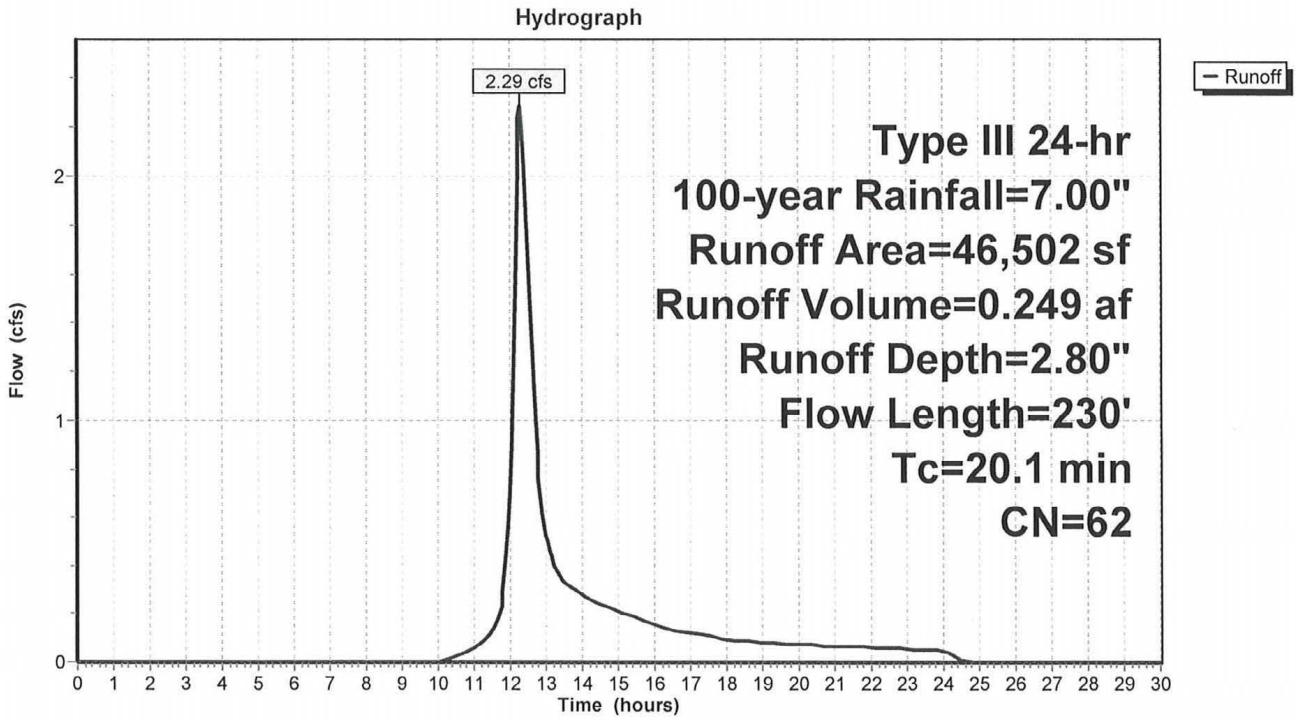
Runoff = 2.29 cfs @ 12.29 hrs, Volume= 0.249 af, Depth= 2.80"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year Rainfall=7.00"

Area (sf)	CN	Description
36,502	61	>75% Grass cover, Good, HSG B
10,000	65	Woods/grass comb., Fair, HSG B
46,502	62	Weighted Average
46,502		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.0	122	0.0450	0.17		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.25"
1.8	10	0.0330	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.25"
1.9	10	0.0870	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
4.4	88	0.0045	0.34		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
20.1	230	Total			

Subcatchment 1PS: Subcatchment 1



Summary for Subcatchment 2PS: Subcatchment 2

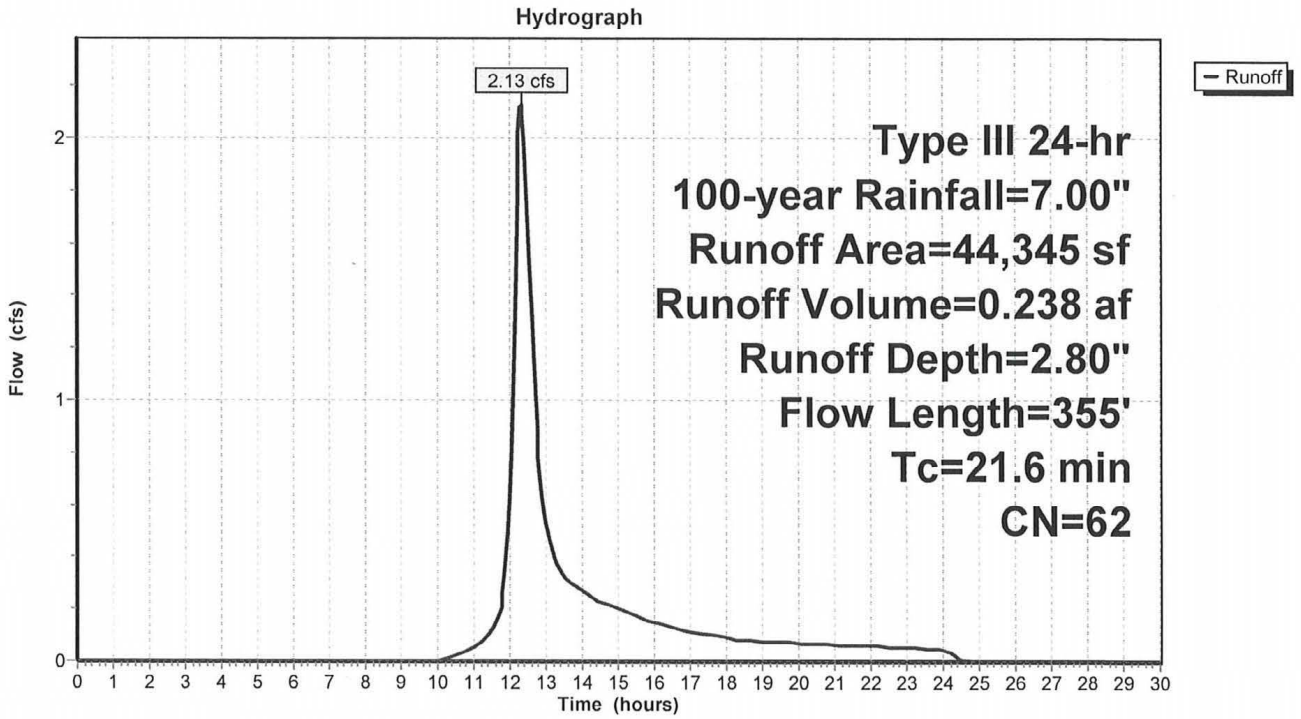
Runoff = 2.13 cfs @ 12.31 hrs, Volume= 0.238 af, Depth= 2.80"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year Rainfall=7.00"

Area (sf)	CN	Description
109	98	Unconnected roofs, HSG B
30,863	61	>75% Grass cover, Good, HSG B
1,912	69	50-75% Grass cover, Fair, HSG B
11,461	65	Woods/grass comb., Fair, HSG B
44,345	62	Weighted Average
44,236		99.75% Pervious Area
109		0.25% Impervious Area
109		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.2	125	0.0450	0.17		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.25"
1.8	10	0.0330	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.25"
7.6	220	0.0093	0.48		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
21.6	355	Total			

Subcatchment 2PS: Subcatchment 2



Summary for Subcatchment 3PS: Subcatchment 3

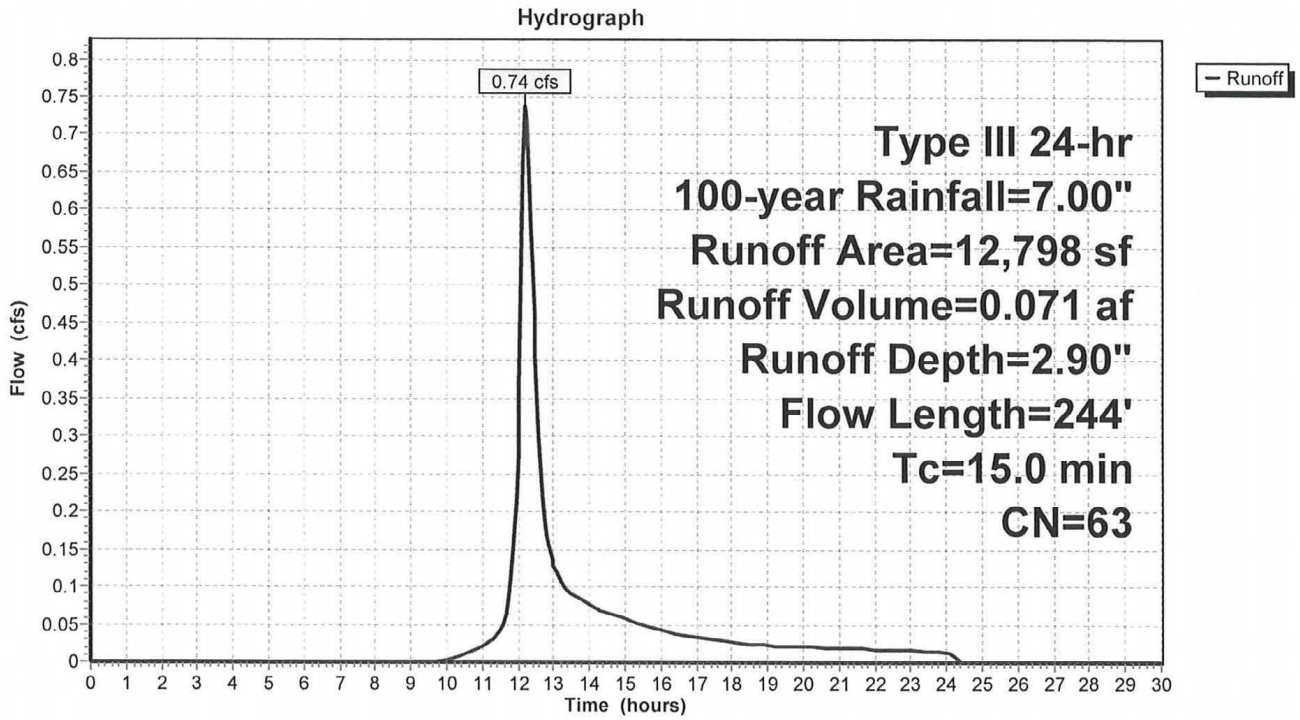
Runoff = 0.74 cfs @ 12.22 hrs, Volume= 0.071 af, Depth= 2.90"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year Rainfall=7.00"

Area (sf)	CN	Description
46	96	Gravel surface, HSG B
8,629	61	>75% Grass cover, Good, HSG B
1,027	69	50-75% Grass cover, Fair, HSG B
3,096	65	Woods/grass comb., Fair, HSG B
12,798	63	Weighted Average
12,798		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	92	0.0450	0.16		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.25"
1.8	10	0.0330	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.25"
3.6	142	0.0170	0.65		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
15.0	244	Total			

Subcatchment 3PS: Subcatchment 3



Summary for Subcatchment 4PS: Subcatchment 4

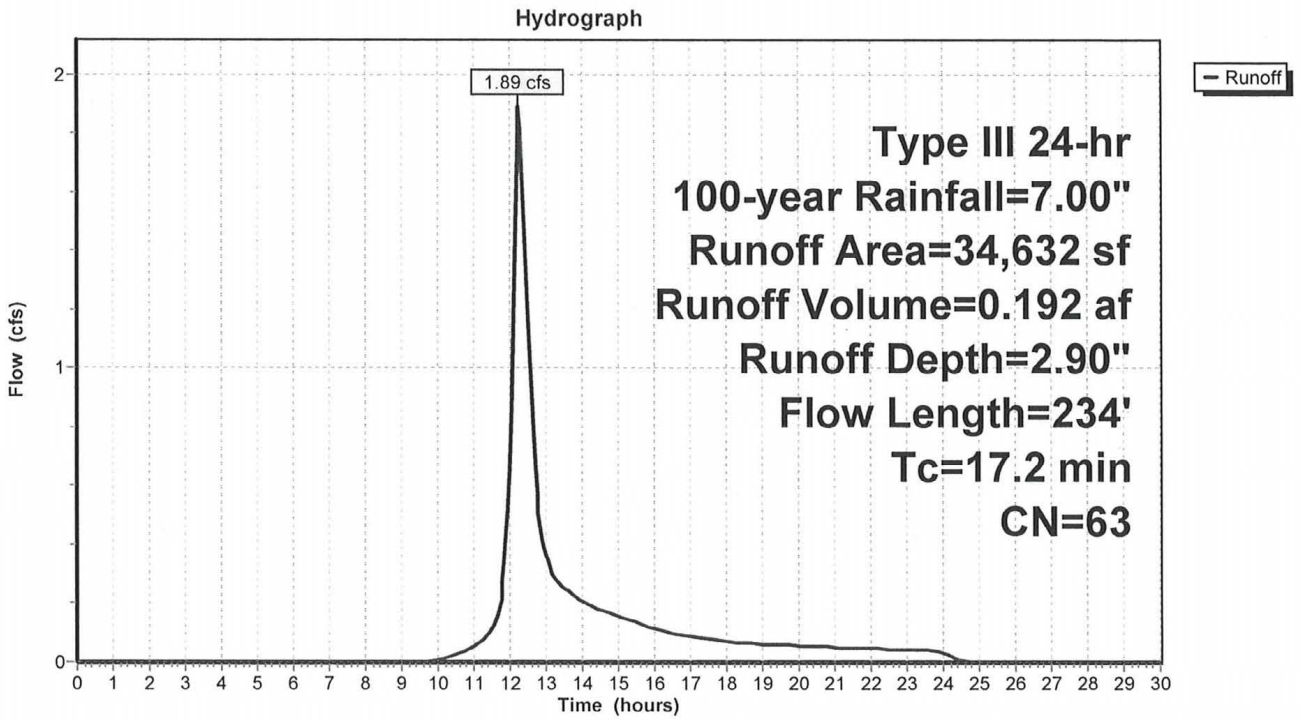
Runoff = 1.89 cfs @ 12.25 hrs, Volume= 0.192 af, Depth= 2.90"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year Rainfall=7.00"

Area (sf)	CN	Description
875	96	Gravel surface, HSG B
26,704	61	>75% Grass cover, Good, HSG B
490	69	50-75% Grass cover, Fair, HSG B
6,563	65	Woods/grass comb., Fair, HSG B
34,632	63	Weighted Average
34,632		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.6	130	0.0450	0.17		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.25"
1.1	5	0.0330	0.08		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.25"
2.4	17	0.1430	0.12		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
1.1	82	0.0585	1.21		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
17.2	234	Total			

Subcatchment 4PS: Subcatchment 4



Summary for Subcatchment 5PS: Subcatchment 5

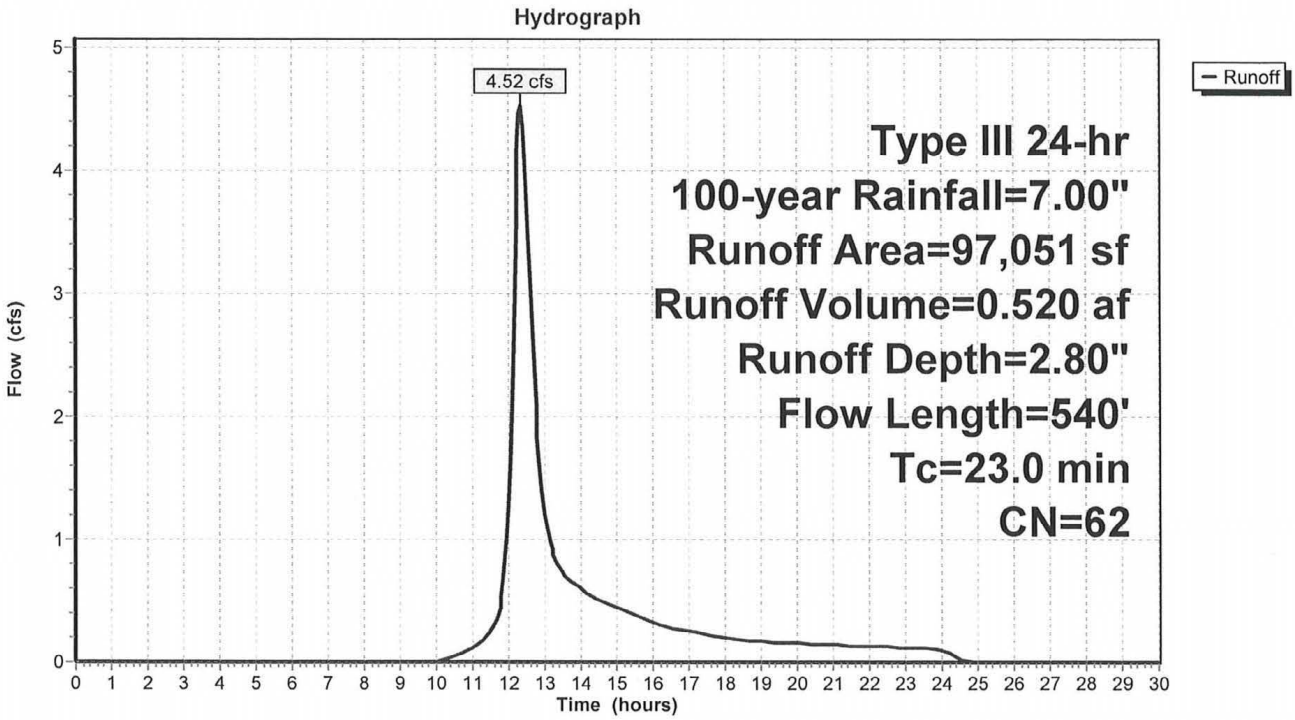
Runoff = 4.52 cfs @ 12.34 hrs, Volume= 0.520 af, Depth= 2.80"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year Rainfall=7.00"

Area (sf)	CN	Description
66,780	61	>75% Grass cover, Good, HSG B
30,271	65	Woods/grass comb., Fair, HSG B
97,051	62	Weighted Average
97,051		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.2	100	0.0450	0.16		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.25"
1.8	10	0.0330	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.25"
11.0	430	0.0170	0.65		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
23.0	540	Total			

Subcatchment 5PS: Subcatchment 5



Summary for Subcatchment 6PS: Subcatchment 6

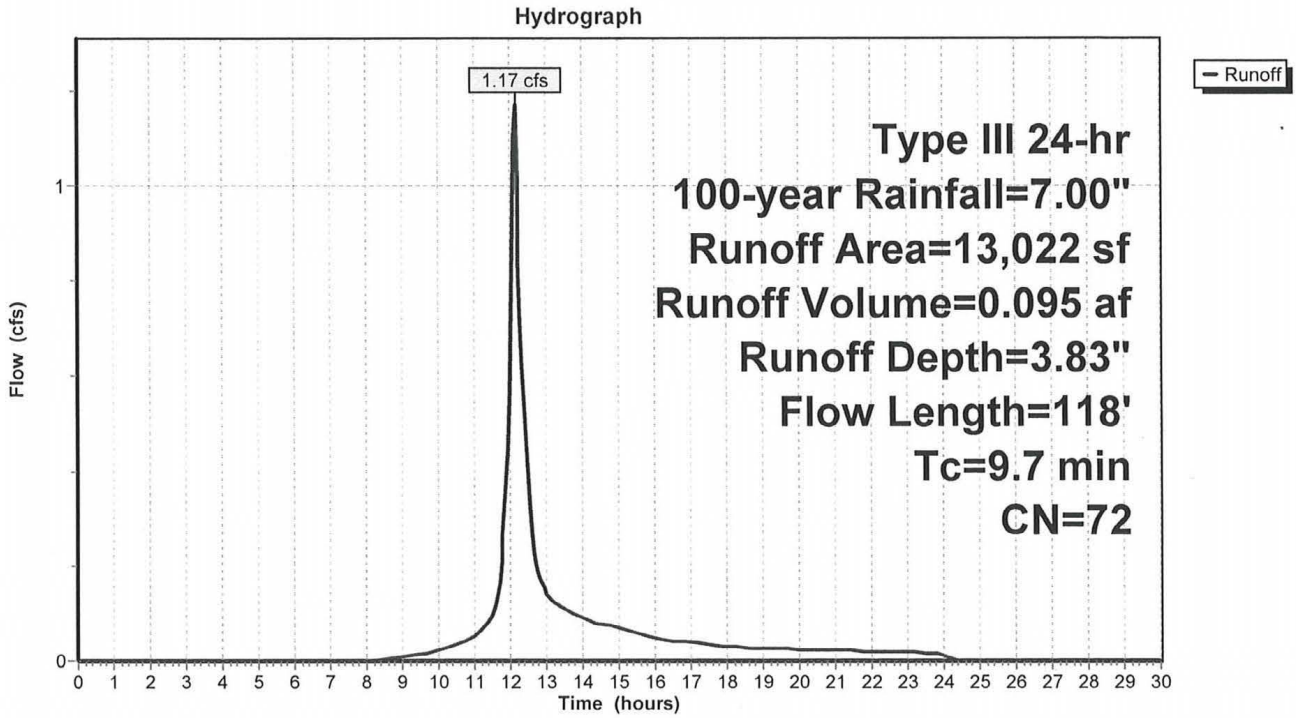
Runoff = 1.17 cfs @ 12.14 hrs, Volume= 0.095 af, Depth= 3.83"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year Rainfall=7.00"

Area (sf)	CN	Description
2,973	98	Water Surface, HSG B
1,301	61	>75% Grass cover, Good, HSG B
34	69	50-75% Grass cover, Fair, HSG B
8,714	65	Woods/grass comb., Fair, HSG B
13,022	72	Weighted Average
10,049		77.17% Pervious Area
2,973		22.83% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	25	0.2000	0.15		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
4.0	60	0.0500	0.25		**Sheet Flow,** Range n= 0.130 P2= 3.25"
2.9	33	0.3145	0.19		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.25"
9.7	118	Total			

Subcatchment 6PS: Subcatchment 6



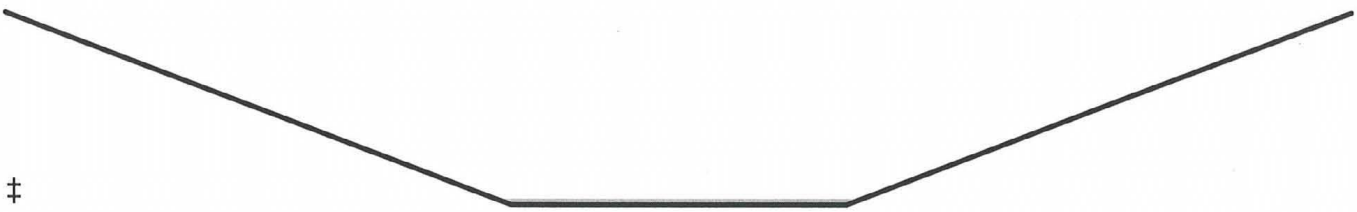
Summary for Reach 6R: Ferry Creek - Point of Analysis #1

Inflow Area = 3.594 ac, 1.90% Impervious, Inflow Depth = 2.06" for 100-year event
Inflow = 5.11 cfs @ 12.35 hrs, Volume= 0.617 af
Outflow = 5.12 cfs @ 12.35 hrs, Volume= 0.617 af, Atten= 0%, Lag= 0.1 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.65 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 0.84 fps, Avg. Travel Time= 0.2 min

Peak Storage= 31 cf @ 12.35 hrs
Average Depth at Peak Storage= 0.21'
Defined Flood Depth= 5.00' Flow Area= 145.0 sf, Capacity= 1,497.15 cfs
Bank-Full Depth= 7.00' Flow Area= 245.0 sf, Capacity= 3,048.26 cfs

14.00' x 7.00' deep channel, n= 0.022 Earth, clean & straight
Side Slope Z-value= 3.0 '/' Top Width= 56.00'
Length= 10.0' Slope= 0.0050 '/'
Inlet Invert= -2.45', Outlet Invert= -2.50'



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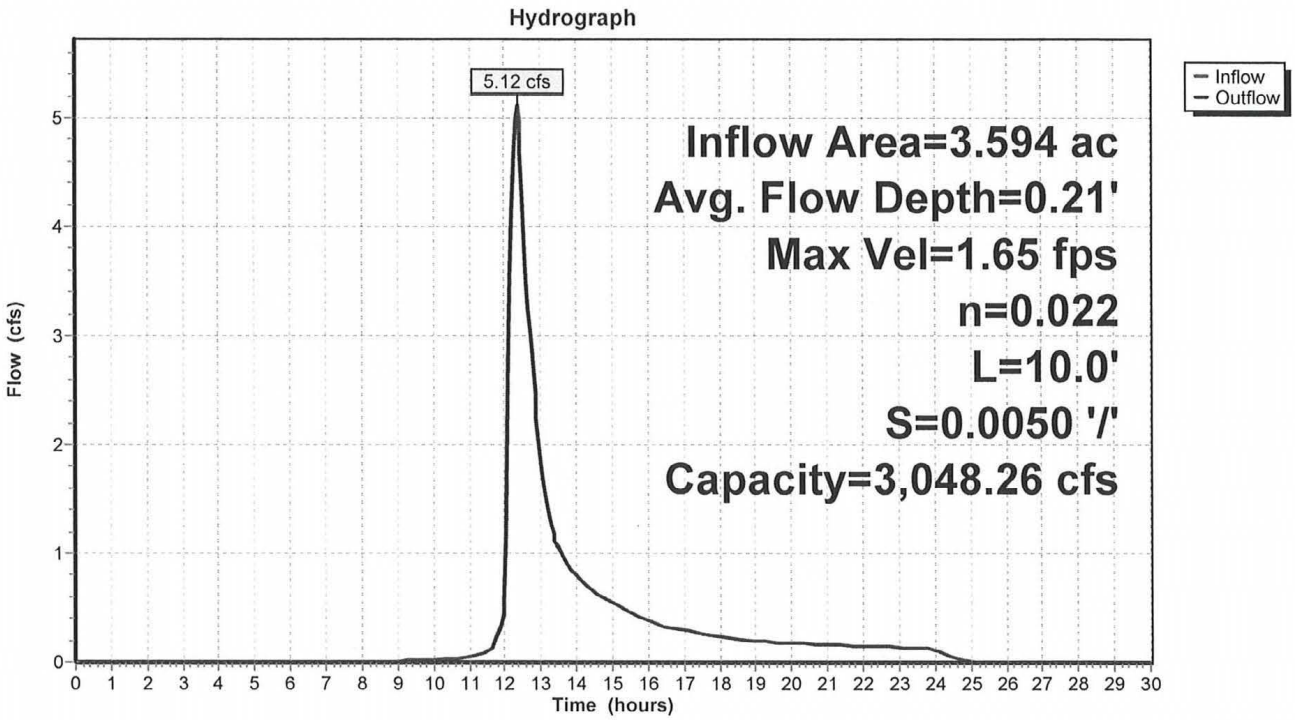
Reach 6R: Ferry Creek - Point of Analysis #1



Summary for Pond 1P: Existing Low Area

Inflow Area =	1.068 ac,	0.00% Impervious,	Inflow Depth =	2.80"	for 100-year event
Inflow =	2.29 cfs @	12.29 hrs,	Volume=	0.249 af	
Outflow =	0.75 cfs @	12.81 hrs,	Volume=	0.249 af,	Atten= 67%, Lag= 31.2 min
Discarded =	0.20 cfs @	12.81 hrs,	Volume=	0.211 af	
Primary =	0.55 cfs @	12.81 hrs,	Volume=	0.038 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 7.66' @ 12.81 hrs Surf.Area= 6,508 sf Storage= 4,279 cf
Flood Elev= 8.00' Surf.Area= 7,789 sf Storage= 6,708 cf

Plug-Flow detention time= 217.3 min calculated for 0.249 af (100% of inflow)
Center-of-Mass det. time= 217.3 min (1,079.2 - 861.9)

Volume	Invert	Avail.Storage	Storage Description
#1	6.60'	6,708 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

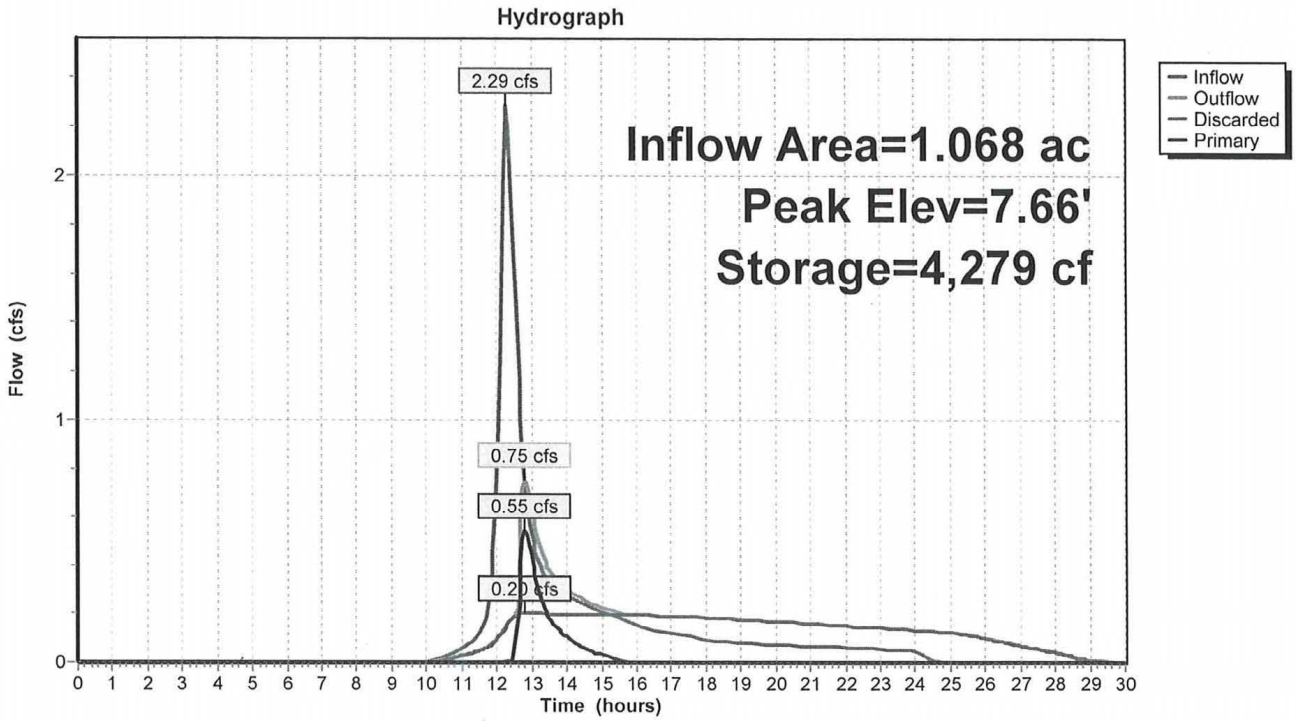
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
6.60	0	0	0
7.00	4,019	804	804
8.00	7,789	5,904	6,708

Device	Routing	Invert	Outlet Devices
#1	Primary	7.60'	**14.0' long x 14.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.64 2.67 2.70 2.65 2.64 2.65 2.65 2.63
#2	Discarded	6.60'	**1.190 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 2.00' Phase-In= 0.10'

Discarded OutFlow Max=0.20 cfs @ 12.81 hrs HW=7.66' (Free Discharge)
↑—**2=Exfiltration** (Controls 0.20 cfs)

Primary OutFlow Max=0.54 cfs @ 12.81 hrs HW=7.66' TW=3.70' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 0.54 cfs @ 0.65 fps)

Pond 1P: Existing Low Area



Summary for Pond 2P: Existing Low Area

Inflow Area =	1.018 ac,	0.25% Impervious,	Inflow Depth =	2.80"	for 100-year event
Inflow =	2.13 cfs @	12.31 hrs,	Volume=	0.238 af	
Outflow =	0.45 cfs @	13.11 hrs,	Volume=	0.226 af,	Atten= 79%, Lag= 47.7 min
Discarded =	0.19 cfs @	13.11 hrs,	Volume=	0.203 af	
Primary =	0.26 cfs @	13.11 hrs,	Volume=	0.023 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 7.74' @ 13.11 hrs Surf.Area= 5,951 sf Storage= 4,668 cf
Flood Elev= 8.00' Surf.Area= 7,066 sf Storage= 6,358 cf

Plug-Flow detention time= 288.7 min calculated for 0.225 af (95% of inflow)
Center-of-Mass det. time= 261.9 min (1,125.2 - 863.3)

Volume	Invert	Avail.Storage	Storage Description
#1	5.90'	6,358 cf	**Pond (Prismatic)** Listed below (Recalc)

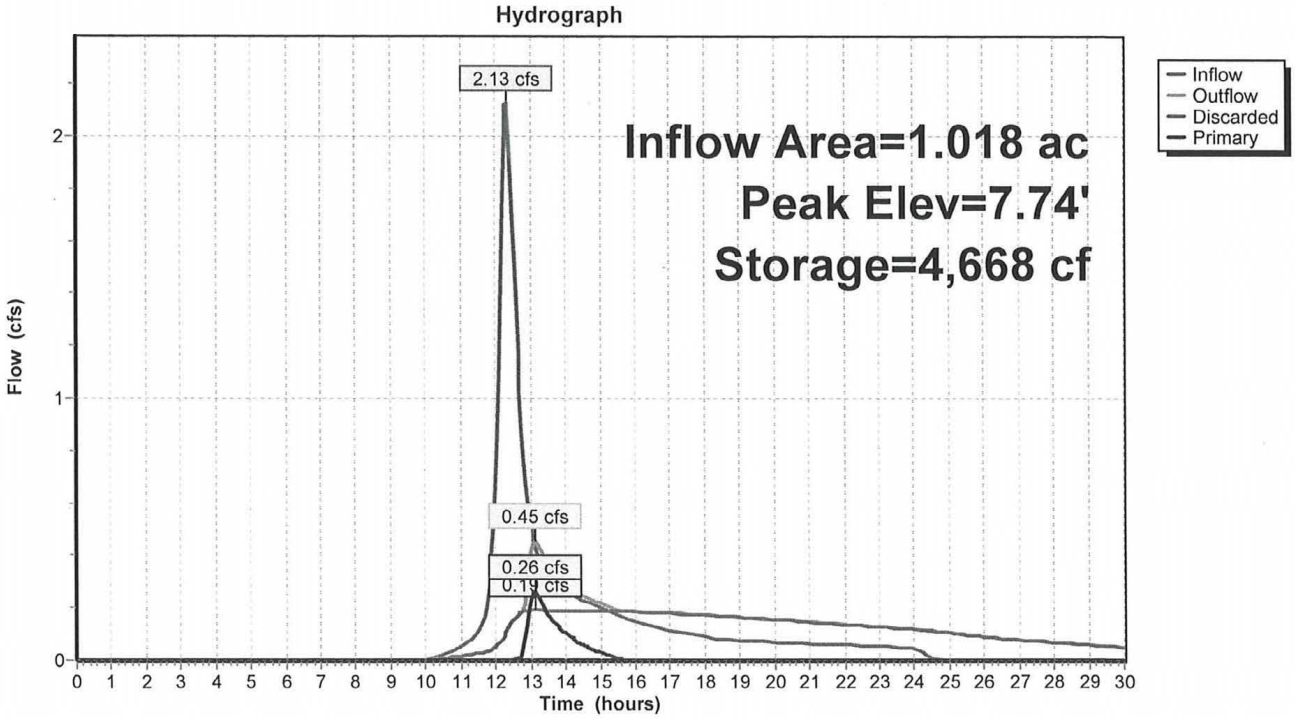
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
5.90	0	0	0
6.00	98	5	5
7.00	2,771	1,435	1,439
8.00	7,066	4,919	6,358

Device	Routing	Invert	Outlet Devices
#1	Primary	7.70'	**12.0' long x 150.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63
#2	Discarded	5.90'	**1.190 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 2.00' Phase-In= 0.10'

Discarded OutFlow Max=0.19 cfs @ 13.11 hrs HW=7.74' (Free Discharge)
└**2=Exfiltration** (Controls 0.19 cfs)

Primary OutFlow Max=0.26 cfs @ 13.11 hrs HW=7.74' TW=5.57' (Dynamic Tailwater)
└**1=Broad-Crested Rectangular Weir** (Weir Controls 0.26 cfs @ 0.54 fps)

Pond 2P: Existing Low Area



Summary for Pond 3P: Existing Low Area

Inflow Area =	1.312 ac,	0.19% Impervious,	Inflow Depth =	0.86"	for 100-year event
Inflow =	0.74 cfs @	12.22 hrs,	Volume=	0.094 af	
Outflow =	0.74 cfs @	12.22 hrs,	Volume=	0.094 af,	Atten= 0%, Lag= 0.5 min
Discarded =	0.03 cfs @	14.56 hrs,	Volume=	0.016 af	
Primary =	0.73 cfs @	12.22 hrs,	Volume=	0.078 af	
Secondary =	0.00 cfs @	0.00 hrs,	Volume=	0.000 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 5.78' @ 14.56 hrs Surf.Area= 941 sf Storage= 500 cf
Flood Elev= 6.25' Surf.Area= 2,000 sf Storage= 1,133 cf

Plug-Flow detention time= 40.1 min calculated for 0.094 af (100% of inflow)
Center-of-Mass det. time= 40.0 min (886.2 - 846.2)

Volume	Invert	Avail.Storage	Storage Description
#1	4.00'	1,133 cf	**Pond (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
4.00	38	0	0
5.00	130	84	84
6.00	1,175	653	737
6.25	2,000	397	1,133

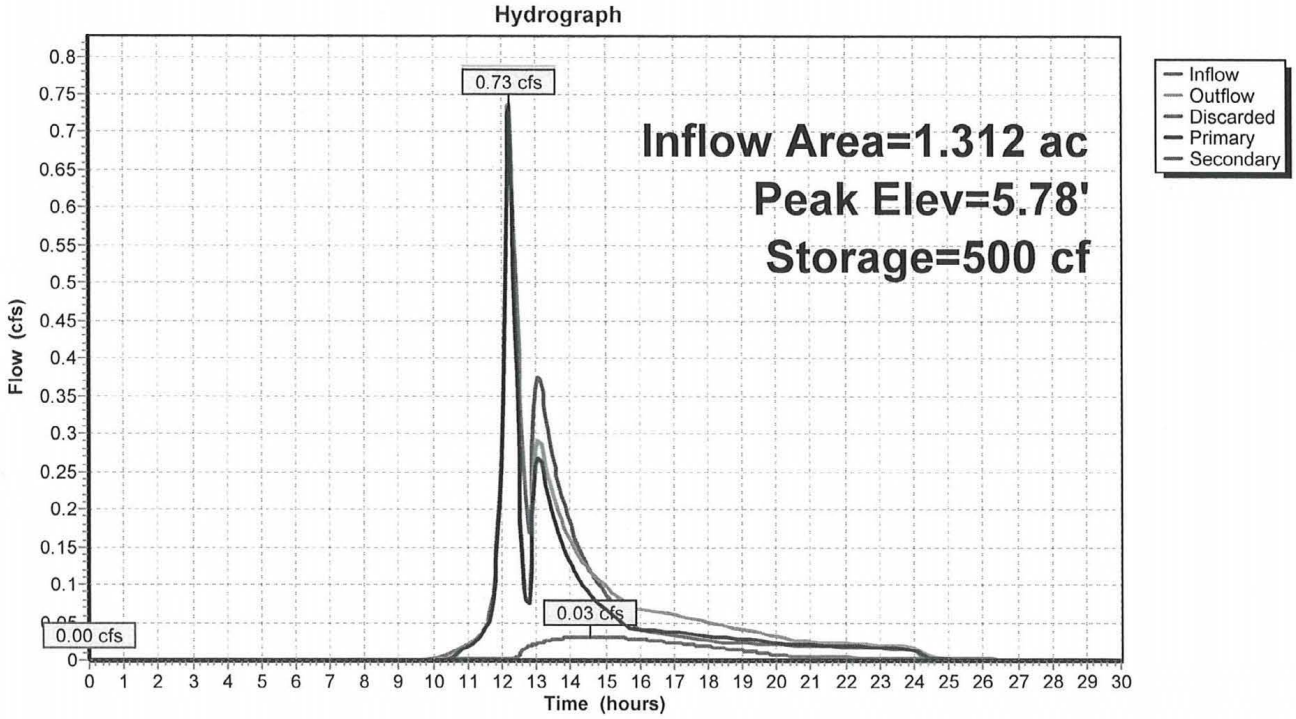
Device	Routing	Invert	Outlet Devices
#1	Primary	4.20'	**18.0" Round CMP_Round 18"** L= 20.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 4.20' / 3.80' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Secondary	6.25'	**14.0' long x 65.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63
#3	Discarded	4.00'	**1.190 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 2.00' Phase-In= 0.10'

Discarded OutFlow Max=0.03 cfs @ 14.56 hrs HW=5.78' (Free Discharge)
└**3=Exfiltration** (Controls 0.03 cfs)

Primary OutFlow Max=0.71 cfs @ 12.22 hrs HW=4.63' TW=4.33' (Dynamic Tailwater)
└**1=CMP_Round 18"** (Outlet Controls 0.71 cfs @ 2.59 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=4.00' TW=2.30' (Dynamic Tailwater)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3P: Existing Low Area



Summary for Pond 4P: Existing Low Area # 4 along East Broadway - Point of Analysis #2

Inflow Area =	2.107 ac,	0.12% Impervious,	Inflow Depth =	1.54"	for 100-year event
Inflow =	2.62 cfs @	12.24 hrs,	Volume=	0.270 af	
Outflow =	0.27 cfs @	14.51 hrs,	Volume=	0.261 af,	Atten= 90%, Lag= 136.2 min
Discarded =	0.27 cfs @	14.51 hrs,	Volume=	0.261 af	
Primary =	0.00 cfs @	0.00 hrs,	Volume=	0.000 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 5.78' @ 14.51 hrs Surf.Area= 3,413 sf Storage= 5,888 cf
Flood Elev= 6.25' Surf.Area= 4,000 sf Storage= 7,647 cf

Plug-Flow detention time= 298.8 min calculated for 0.261 af (96% of inflow)
Center-of-Mass det. time= 279.4 min (1,139.1 - 859.7)

Volume	Invert	Avail.Storage	Storage Description
#1	2.30'	7,647 cf	**Pond (Prismatic)** Listed below (Recalc)

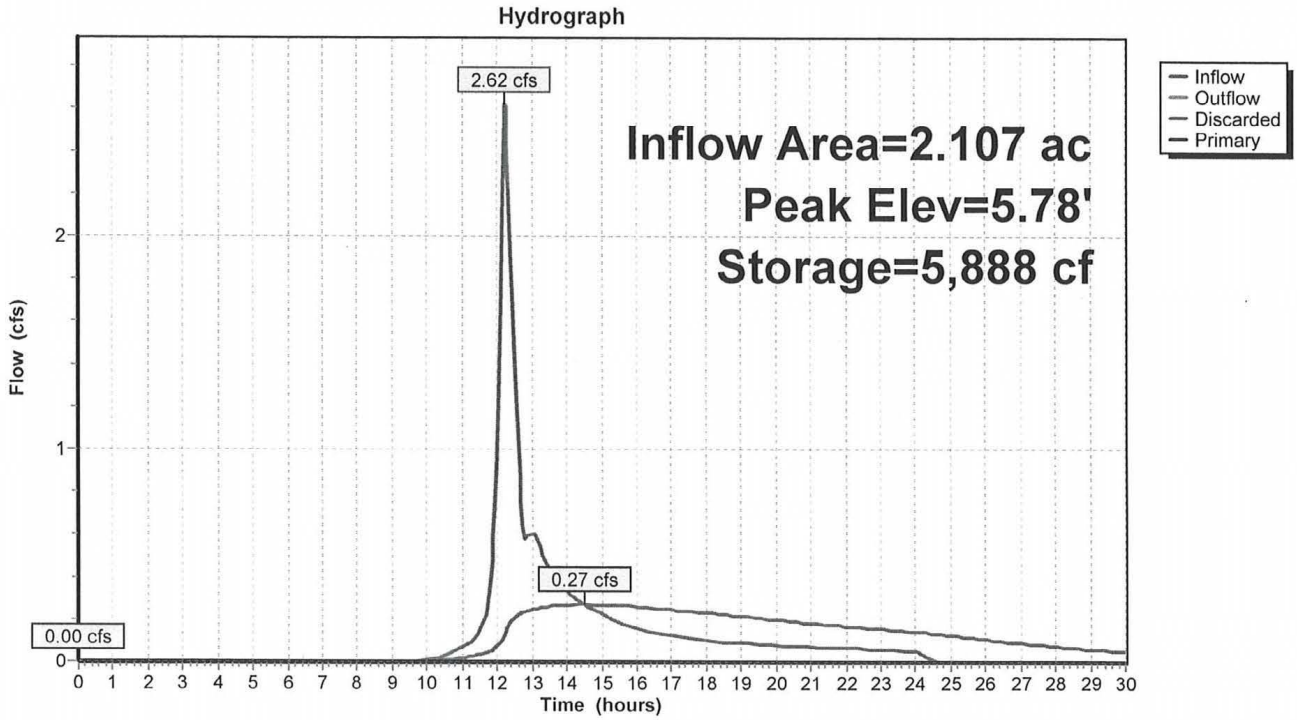
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
2.30	0	0	0
3.00	870	305	305
4.00	1,675	1,273	1,577
5.00	2,420	2,048	3,625
6.00	3,700	3,060	6,685
6.25	4,000	963	7,647

Device	Routing	Invert	Outlet Devices
#1	Primary	6.25'	**25.0' long x 60.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63
#2	Discarded	2.30'	**1.190 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 2.00' Phase-In= 0.10'

Discarded OutFlow Max=0.27 cfs @ 14.51 hrs HW=5.78' (Free Discharge)
└**2=Exfiltration** (Controls 0.27 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=2.30' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 4P: Existing Low Area # 4 along East Broadway - Point of Analysis #2



Summary for Pond 5P: Existing Low Area

Inflow Area =	3.296 ac,	0.00% Impervious,	Inflow Depth =	2.03"	for 100-year event
Inflow =	4.52 cfs @	12.34 hrs,	Volume=	0.558 af	
Outflow =	4.50 cfs @	12.36 hrs,	Volume=	0.522 af,	Atten= 1%, Lag= 1.7 min
Discarded =	0.00 cfs @	0.00 hrs,	Volume=	0.000 af	
Primary =	4.50 cfs @	12.36 hrs,	Volume=	0.522 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Peak Elev= 3.79' @ 12.36 hrs Surf.Area= 2,243 sf Storage= 2,165 cf
Flood Elev= 4.00' Surf.Area= 2,512 sf Storage= 2,656 cf

Plug-Flow detention time= 48.0 min calculated for 0.521 af (93% of inflow)
Center-of-Mass det. time= 15.0 min (875.3 - 860.3)

Volume	Invert	Avail.Storage	Storage Description
#1	0.30'	2,656 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

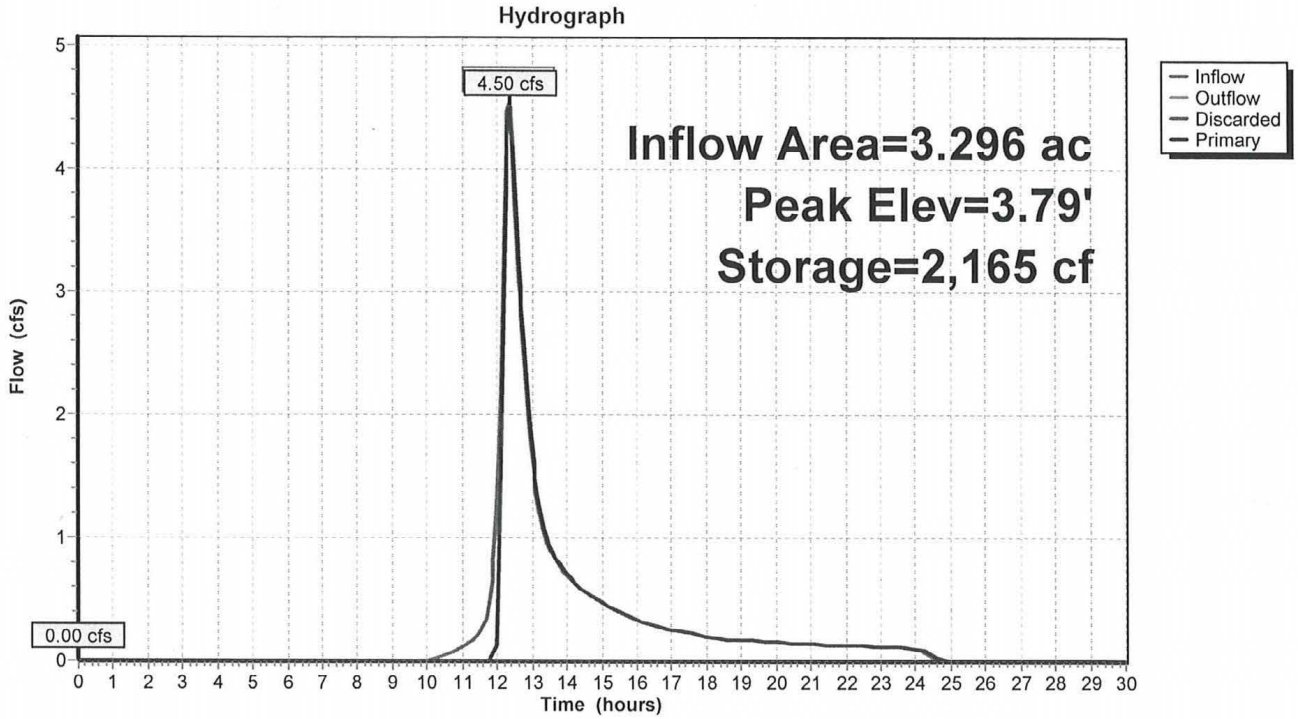
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.30	0	0	0
1.00	47	16	16
2.00	150	99	115
3.00	1,210	680	795
4.00	2,512	1,861	2,656

Device	Routing	Invert	Outlet Devices
#1	Primary	3.50'	**11.0' long x 2.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32
#2	Discarded	0.30'	**1.190 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 2.00' Phase-In= 0.10'

Discarded OutFlow Max=0.00 cfs @ 0.00 hrs HW=0.30' (Free Discharge)
└**2=Exfiltration** (Controls 0.00 cfs)

Primary OutFlow Max=4.47 cfs @ 12.36 hrs HW=3.79' TW=-2.24' (Dynamic Tailwater)
└**1=Broad-Crested Rectangular Weir** (Weir Controls 4.47 cfs @ 1.39 fps)

Pond 5P: Existing Low Area



APPENDIX C

TECHNICAL SPECIFICATIONS

TECHNICAL SPECIFICATIONS
REMEDIAL DESIGN OF A LANDFILL CAP, WASTE CONSOLIDATION, INSTITUTIONAL CONTROLS AND INTERIM ACTIONS, OPERABLE UNIT 6 (OU6)
for
Raymark Industries, Inc. Superfund Site
Stratford, Connecticut

Contract No. W912WJ-11-D-0005
Delivery Order 0007

Prepared for:

New England District
U.S. Army Corps of Engineers
696 Virginia Road
Concord, MA 01742-2751

Prepared by:

AMEC Environment & Infrastructure, Inc.
2 Robbins Road
Westford, Massachusetts 01886

30 June 2014

AMEC Project Number: 3561120004

Charles A. Collet, P.E. | **Stephen H. Mitchell, P.E.**

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-- End of Project Table of Contents --

SECTION 01 11 00

SUMMARY OF WORK
08/11

PART 1 GENERAL

1.1 WORK COVERED BY CONTRACT DOCUMENTS

1.1.1 Project Description

The work includes the excavation of Raymark waste from the 100-year floodplain and consolidation waste under a low-permeable landfill cap and incidental related work.

1.1.2 Location

The work shall be located at the 576/600 East Broadway properties in Stratford, CT, approximately as indicated on the Contract Drawings. The exact location will be shown by the Contracting Officer Representative.

1.2 OCCUPANCY OF PREMISES

The Contractor shall assume that no buildings will be occupied at the time of construction.

Before work is started, the Contractor shall arrange with the Contracting Officer Representative a sequence of procedure, means of access, space for storage of materials and equipment, and use of approaches.

1.3 EXISTING WORK

In addition to "FAR 52.236-9, Protection of Existing Vegetation, Structures, Equipment, Utilities, and Improvements":

a. Remove or alter existing work in such a manner as to prevent injury or damage to any portions of the existing work which remain.

b. Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as approved by the Contracting Officer Representative. At the completion of operations, existing work shall be in a condition equal to or better than that which existed before new work started.

1.4 LOCATION OF UNDERGROUND FACILITIES

The Contractor to locate all underground utilities prior to the start of construction in accordance with General Notes on the Contract Drawings - G-002.

1.5 SALVAGE MATERIAL AND EQUIPMENT

Items designated by the Contracting Officer Representative to be salvaged shall remain the property of the Government.

Contractor shall maintain property control records for material or equipment designated as salvage. Contractor's system of property control

may be used if approved by the Contracting Officer Representative. Contractor shall be responsible for storage and protection of salvaged materials and equipment until disposition by the Contracting Officer Representative.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

SECTION 01 22 00.00 10

MEASUREMENT AND PAYMENT
04/06

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Surveys; G

1.2 LUMP SUM PAYMENT ITEMS

Payment items for the work of this contract for which contract lump sum payments will be made are described below. All costs for items of work, which are not specifically mentioned to be included in a particular lump sum or unit price payment item, shall be included in the listed lump sum item most closely associated with the work involved. The lump sum price and payment made for each item listed shall constitute full compensation for furnishing all plant, labor, materials, and equipment, and performing any associated Contractor quality control, environmental protection, meeting safety requirements, tests and reports, and for performing all work required for which separate payment is not otherwise provided.

1.2.1 Mobilization and Demobilization

Work for this item includes the mobilization and set up of all equipment, materials and personnel to the site, as necessary for the completion of the work, including, but not limited to furnishing and installing temporary facilities and controls as shown on the Contract Drawings, as required for the execution of the work, and/or as approved by the Contracting Officer Representative. Temporary Facilities and Controls are expected to include, but not be limited to, on-site access road/haul route improvements as necessary, construction of a temporary site entrance, stabilized rock construction entrances, fencing and gates (chain-link fencing around entire work area), temporary fencing, equipment/material storage are (i.e. lay-down area), equipment/personnel decontamination area(s), electrical utilities, water utilities, dust control, and other incidental temporary facilities, controls, tasks, and/or items as required to complete the work/Bid Items. This Bid Item also includes furnishing and installing erosion and sedimentation controls as shown on the Contract Drawings in accordance with Best Management Practices. Erosion and sedimentation controls may be installed in phases and relocated as the work progresses as approved by the Contracting Officer Representative and as required for the work.

1.2.1.1 Payment

Payment will be made for costs associated with mobilization and

demobilization, as defined above.

1.2.1.2 Measurement

This Bid Item will be measured on a lump sum basis.

1.2.1.3 Site Setup and Final Surveys

Survey will be conducted in accordance with the Technical Specifications. Work for this item includes establishment of benchmarks and initial control, and a pre-construction topographic survey to establish baseline conditions. The benchmarks and initial control will include establishing a network of permanent monuments on and around the site adequate for reference during the duration of the work and of sufficient quantity that there will be some redundancy in the event that control monuments are damaged or removed. The pre-construction topographic survey shall be completed within the Limits of Disturbance, as shown on the drawings, plus 50 feet beyond the perimeter. The site-wide final/post-construction survey shall be completed for the final disturbed (and restored) footprint, plus 25 feet. Topographic surveys shall be performed by an independent/third-party surveyor licensed in the State of Connecticut.

1.2.1.4 Payment

Payment will be made upon review and acceptance by the Contracting Officer Representative for total value listed for this bid item on the Proposal Form, as applicable. Progress payments will be made as described in Paragraph 1.3.2.2.

1.2.1.5 Measurement

This Bid Item will be measured on a lump sum basis.

1.3 UNIT PRICE PAYMENT ITEMS

Payment items for the work of this contract on which the contract unit price payments will be made are described below. The unit price and payment made for each item listed shall constitute full compensation for furnishing all plant, labor, materials, and equipment, and performing any associated Contractor quality control, environmental protection, meeting safety requirements, tests and reports, and for performing all work required for each of the unit price items.

1.3.1 Cap

Work for this item includes furnishing all labor, equipment, and materials necessary fo the installation of a cap over the limits shown on the Drawings. Cap specialty materials, i.e. the Geocomposite Venting Layer, the LLDPE Geomembranes, the Geocomposite Drainage Layer, Protective Cover Soil, Select Fill, and Topsoil will be supplied by the Contractor. Chain link fencing and gates shall be repaired or replaced as directed by the Contracting Officer Representative. Storm drain culvert with rip-rap inlet/outlet protection shall be installed by the Contractor. The Contractor will be responsible for coordination with material suppliers for proper unloading material shipments and proper material storage on site.

Work for this item shall include, but not be limited to the following:

- Supply and install Gas Venting System;

- Supply and install Geocomposite Venting Layer for Gas Venting;
- Supply and install 40 mil LLDPE Geomembrane (Smooth) and 60 mil LLDPE (Textured) Geomembrane;
- Supply and install Geocomposite Drainage Layer for Cap Drainage;
- Supply and install Protective Cover Soil;
- Supply and install Select Fill;
- Supply and install Topsoil; and
- Supply and install chain link fencing and gates.

All soil materials shall be certified "clean" from the borrow source of origin as per the project requirements.

All materials testing required by the Drawings and Specifications for materials used in capping are included in this pay item, unless specifically required in another pay item.

1.3.1.1 Payment

Payment for this Bid Item will be made for the total value listed for this Bid Item on the Proposal Form when the actual amount of work accepted, based upon document review and/or measurements by the Contracting Officer Representative is within plus or minus 5 percent of the Estimated Bid Quantity. Actual accepted quantities in excess of the 105 percent of the Estimated Bid Quantity tha may result in a higher cost will require the Contractor to request a Construction Change Order before performing such extra work. Actual accepted quantities below 95 percent of the Estimated Bid Quantity shall result in an automatic credit. The Contractor's Unit Rate Costs, as submitted with their Proposal, shall be equally applied to any extra costs (above 105 percent) or credits (below 95 percent).

1.3.1.2 Measurement

This item will be measured on a Unit Rate Basis per square foot of cover system constructed.

1.3.1.3 Unit of Measure

Unit of measurement: square foot.

1.3.2 Construction Surveys

Work for this item includes survey required for daily project implementation and control. The work will include, but not be limited to, monitoring surveys as indicated on the Contract Drawings, post-excavation surveys for each excavation area, at a minimum, for the purposes of quantifying excavation volumes, fill volumes, and restored surface areas. Post-excavation surveys shall be completed within the limits of excavation, plus 25 feet and to capture any other area of disturbance. All surveys shall be performed by an independent/third-party surveyor licensed in the State of Connecticut.

1.3.2.1 Payment

Payment for this Bid Item will be made for the total value listed for this Bid Item on the Proposal Form when the actual amount of work accepted, based upon document review and/or measurements by the Contracting Officer Representative is within plus or minus 5 percent of the Estimated Bid Quantity.

1.3.2.2 Measurement

This Bid Item will be measured on a Monthly Unit Rate Basis.

1.3.3 Excavation

1.3.3.1 Payment

Payment will be made for costs associated with excavation of Raymark Wastes which includes performing required excavation and other operations incidental thereto, Contractor-furnished disposal area(s) and disposition of excess excavated material and unsuitable and frozen materials, including, but not limited to, maintaining excavation stability, transporting waste to the cap area, spreading the waste, and compaction.

1.3.3.2 Measurement

The total quantity of excavated material for which payment will be made will be the theoretical quantity between the ground surface as determined by a survey and the grade and slope of the theoretical cross sections indicated. No allowance will be made for overdepth excavation or for the removal of any material outside the required slope lines unless authorized.

1.3.3.3 Unit of Measure

Unit of measure: cubic yard.

1.3.4 Select Granular Material

Work for this Bid Item includes equipment, labor, and materials required to provide imported Select Granular Material to the site. The Contractor shall provide documentation that the fill is certified "clean" relative to the contract requirements. Work for this Bid Item includes testing of subgrade borrow source(s) and chemical testing, as required to certify material as "clean."

1.3.4.1 Payment

Payment for this Bid Item will be made for the total value listed for this Bid Item on the Proposal Form when the actual amount of work accepted, based upon surveyed measurements, is within plus or minus 5 percent of the Estimated Bid Quantity. Actual accepted quantities in excess of the 105 percent of the Estimated Bid Quantity that may requlT in a higher cost will require the Contractor to reqest a Construction Change Order before performing such extra work. Actual accepted quantites below 95 percent of the Estimated Bid Quantity shall result in an automatic credit. The Contractor's Unit Rate Costs, as submitted with their proposal, shall be equally applied to any extra costs (above 105 percent) or credits (below 95 percent).

1.3.4.2 Measurement

This Bid Item will be measured on a Unit Rate Basis; per cubic yard of material placed and compacted. The measured volume will be based on actual surveyed measurement.

1.3.4.3 Unit of Measure

Unit of measure: cubic yard.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 01 32 01.00 10

PROJECT SCHEDULE
08/08

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. ARMY CORPS OF ENGINEERS (USACE)

ER 1-1-11	(1995) Administration -- Progress, Schedules, and Network Analysis Systems

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Project Schedule; G

1.3 QUALITY ASSURANCE

Designate an authorized representative to be responsible for the preparation of the schedule and all required updating (activity status) and preparation of reports. The authorized representative shall have previously developed, created, and maintained at least 2 electronic schedules for projects similar in nature and complexity to this project and shall be experienced in the use of the scheduling software that meets the requirements of this specification.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

Prepare for approval a Project Schedule, as specified herein, pursuant to the Contract Clause, SCHEDULE FOR CONSTRUCTION CONTRACTS. Show in the schedule the sequence in which the Contractor proposes to perform the work and dates on which the Contractor contemplates starting and completing all schedule activities. The scheduling of the entire project, including the design and construction sequences, is required. The scheduling of construction is the responsibility of the Contractor. Contractor management personnel shall actively participate in its development. Subcontractors and suppliers working on the project shall also contribute

in developing and maintaining an accurate Project Schedule. Provide a schedule that is a forward planning as well as a project monitoring tool.

3.1.1 Approved Project Schedule

Use the approved Project Schedule to measure the progress of the work and to aid in evaluating time extensions. Make the schedule cost loaded and activity coded. The schedule will provide the basis for all progress payments. If the Contractor fails to submit any schedule within the time prescribed, the Contracting Officer Representative may withhold approval of progress payments until the Contractor submits the required schedule.

3.1.2 Schedule Status Reports

Provide a Schedule Status Report on at least a monthly basis. If, in the opinion of the Contracting Officer Representative, the Contractor falls behind the approved schedule, take steps necessary to improve its progress including those that may be required by the Contracting Officer Representative, without additional cost to the Government. In this circumstance, the Contracting Officer Representative may require the Contractor to increase the number of shifts, overtime operations, days of work, and/or the amount of construction plant, and to submit for approval any supplementary schedule or schedules as the Contracting Officer Representative deems necessary to demonstrate how the approved rate of progress will be regained.

3.1.3 Default Terms

Failure of the Contractor to comply with the requirements of the Contracting Officer Representative shall be grounds for a determination, by the Contracting Officer Representative, that the Contractor is not prosecuting the work with sufficient diligence to ensure completion within the time specified in the contract. Upon making this determination, the Contracting Officer Representative may terminate the Contractor's right to proceed with the work, or any separable part of it, in accordance with the default terms of the contract.

3.2 BASIS FOR PAYMENT AND COST LOADING

Use the schedule as the basis for determining contract earnings during each update period and therefore the amount of each progress payment. Lack of an approved schedule update, or qualified scheduling personnel, will result in the inability of the Contracting Officer Representative to evaluate contract earned value for the purposes of payment. Failure of the Contractor to provide all required information will result in the disapproval of the preliminary, initial and subsequent schedule updates. In the event schedule revisions are directed by the Contracting Officer Representative and those revisions have not been included in subsequent revisions or updates, the Contracting Officer Representative may hold retainage up to the maximum allowed by contract, each payment period, until such revisions to the Project Schedule have been made. Activity cost loading shall be reasonable, as determined by the Contracting Officer Representative. The aggregate value of all activities coded to a contract CLIN shall equal the value of the CLIN on the Schedule.

3.3 PROJECT SCHEDULE DETAILED REQUIREMENTS

The computer software system utilized to produce and update the Project Schedule shall be capable of meeting all requirements of this

specification. Failure of the Contractor to meet the requirements of this specification will result in the disapproval of the schedule.

3.3.1 Critical Path Method

Use the Critical Path Method (CPM) of network calculation to generate the Project Schedule. Prepare the Project Schedule using the Precedence Diagram Method (PDM).

3.3.2 Level of Detail Required

Develop the Project Schedule to an appropriate level of detail. Failure to develop the Project Schedule to an appropriate level of detail, as determined by the Contracting Officer Representative, will result in its disapproval. The Contracting Officer Representative will consider, but is not limited to, the following characteristics and requirements to determine appropriate level of detail:

3.3.2.1 Activity Durations

Reasonable activity durations are those that allow the progress of ongoing activities to be accurately determined between update periods. Less than 2 percent of all non-procurement activities shall have Original Durations (OD) greater than 20 work days or 30 calendar days. Procurement activities are defined herein.

3.3.2.2 Procurement Activities

The schedule must include activities associated with the submittal, approval, procurement, fabrication and delivery of long lead materials, equipment, fabricated assemblies and supplies. Long lead procurement activities are those with an anticipated procurement sequence of over 90 calendar days. A typical procurement sequence includes the string of activities: submit, approve, procure, fabricate, and deliver.

3.3.2.3 Mandatory Tasks

The following tasks must be included and properly scheduled:

a. Submission, review and acceptance of design packages.

b. Submission of QC Testing Reports.

c. Materials deliverables.

d. Submission and approval of O & M manuals.

e. Submission and approval of as-built drawings.

f. Air and water balancing.

g. Other systems testing, if required.

h. Contractor's pre-final inspection.

i. Correction of punchlist from Contractor's pre-final inspection.

j. Government's pre-final inspection.

k. Correction of punch list from Government's pre-final inspection.

l. Final inspection.

3.3.2.4 Government Activities

Show Government and other agency activities that could impact progress. These activities include, but are not limited to: inspections, utility tie-in, Government Furnished Equipment (GFE) and Notice to Proceed (NTP) for phasing requirements.

3.3.2.5 Activity Responsibility Coding (RESP)

Assign responsibility Code for all activities to the Prime Contractor, Subcontractor or Government agency responsible for performing the activity. Activities coded with a Government Responsibility code include, but are not limited to: Government approvals, Government design reviews, environmental permit approvals by State regulators, Government Furnished Equipment (GFE) and Notice to Proceed (NTP) for phasing requirements. Code all activities not coded with a Government Responsibility Code to the Prime Contractor or Subcontractor responsible to perform the work. Activities shall not have more than one Responsibility Code. Examples of acceptable activity code values are: DOR (for the designer of record); ELEC (for the electrical subcontractor); MECH (for the mechanical subcontractor); and GOVT (for USACE). Unacceptable code values are abbreviations of the names of subcontractors.

3.3.2.6 Activity Work Area Coding

Assign Work Area code to activities based upon the work area in which the activity occurs. Define work areas based on resource constraints or space constraints that would preclude a resource, such as a particular trade or craft work crew, from working in more than one work area at a time due to restraints on resources or space. Examples of Work Area Coding include different areas within a floor of a building, different floors within a building, and different buildings within a complex of buildings. Activities shall not have more than one Work Area Code. Not all activities are required to be Work Area coded. A lack of Work Area coding will indicate the activity is not resource or space constrained.

3.3.2.7 Contract Changes/Requests for Equitable Adjustment (REA) Coding (MODF)

Assign Activity code to any activity or sequence of activities added to the schedule as a result of a Contract Modification, when approved by the Contracting Officer Representative, with a Contract Changes/REA Code. Key all Code values to the Government's modification numbering system. Any activity or sequence of activities added to the schedule as a result of alleged constructive changes made by the Government may be added to a copy of the current schedule, subject to the approval of the Contracting Officer Representative. Assign Activity codes for these activities with a Contract Changes/REA Code. Key the code values to the Contractor's numbering system. Approval to add these activities does not necessarily mean the Government accepts responsibility and, therefore, liability for such activities and any associated impacts to the schedule, but rather the Government recognizes such activities are appropriately added to the schedule for the purposes of maintaining a realistic and meaningful schedule. Such activities shall not be Responsibility Coded to the Government unless approved. An activity shall not have more than one

Contract Changes/REA Code.

3.3.2.8 Contract Line Item (CLIN) Coding (BIDI)

Code all activities to the CLIN on the Contract Line Item Schedule to which the activity belongs. An activity shall not contain more than one CLIN Item Code. CLIN Item code all activities, even when an activity is not cost loaded.

3.3.2.9 Phase of Work Coding (PHAS)

Assign Phase of Work Code to all activities based upon the phase of work in which the activity occurs. Code activities to a Construction Phase. Code fast track construction phases proposed by the Contractor to allow filtering and organizing the schedule by fast track design and construction packages. If the contract specifies construction phasing with separately defined performance periods, identify a Construction Phase Code to allow filtering and organizing the schedule accordingly. Each activity shall be identified with a single project phase and have only one Phase of Work code.

3.3.2.10 Category of Work Coding (CATW)

Assign Category of Work Code to all Activities based upon the category of work to which the activity belongs. Category of Work Code must include, but is not limited to: construction submittal approvals, Acceptance, Procurement, Fabrication, Delivery, Weather Sensitive Installation, Non-Weather Sensitive Installation, Start-Up, Test and Turnover. Assign a Category of Work Code to each activity. Each activity shall have only one Category of Work Code.

3.3.2.11 Definable Features of Work Coding (FOW1, FOW2, FOW3)

Assign a Definable Feature of Work Code to appropriate activities based on the definable feature of work to which the activity belongs. Definable Feature of Work is defined in Specification Section 01 45 00.10 10 QUALITY CONTROL SYSTEMS (QCS). An activity shall not have more than one Definable Feature of Work Code. Not all activities are required to be Definable Feature of Work Coded.

3.3.3 Scheduled Project Completion and Activity Calendars

The schedule interval shall extend from NTP date to the required contract completion date. The contract completion activity (End Project) shall finish based on the required contract duration in the accepted contract proposal, as adjusted for any approved contract time extensions. The first scheduled work period shall be the day after NTP is received by the Contractor. Schedule activities on a calendar to which the activity logically belongs. Activities may be assigned to a 7 day calendar when the contract assigns calendar day durations for the activity such as a Government Acceptance activity. If the Contractor intends to perform physical work less than seven days per week, schedule the associated activities on a calendar with non-work periods identified including weekends and holidays. Assign the Category of Work Code - Weather Sensitive Installation to those activities that are weather sensitive. Original durations must account for anticipated normal adverse weather. The Government will interpret all work periods not identified as non-work periods on each calendar as meaning the Contractor intends to perform work during those periods.

3.3.3.1 Project Start Date

The schedule shall start no earlier than the date on which the NTP was acknowledged. Include as the first activity in the project schedule an activity called "Start Project"(or NTP). The "Start Project" activity shall have an "ES" constraint date equal to the date that the NTP was acknowledged, and a zero day duration.

3.3.3.2 Schedule Constraints and Open Ended Logic

Constrain completion of the last activity in the schedule by the contract completion date. Schedule calculations shall result in a negative float when the calculated early finish date of the last activity is later than the contract completion date. Include as the last activity in the project schedule an activity called "End Project". The "End Project" activity shall have an "LF" constraint date equal to the contract completion date for the project, and with a zero day duration or by using the "project must finish by" date in the scheduling software. The schedule shall have no constrained dates other than those specified in the contract. The use of artificial float constraints such as "zero fee float" or "zero total float" are typically prohibited. There shall only be 2 open ended activities: Start Project (or NTP) with no predecessor logic and End Project with no successor logic.

3.3.3.3 Early Project Completion

In the event the Preliminary or Initial project schedule calculates an early completion date of the last activity prior to the contract completion date, identify those activities that it intends to accelerate and/or those activities that are scheduled in parallel to support the Contractor's "early" completion. The last activity shall have a late finish constraint equal to the contract completion date and the schedule will calculate positive float. The Government will not approve an early completion schedule with zero float on the longest path. The Government is under no obligation to accelerate activities for which it is responsible to support a proposed early contract completion.

3.3.4 Interim Completion Dates

Constrain contractually specified interim completion dates to show negative float when the calculated early finish date of the last activity in that phase is later than the specified interim completion date.

3.3.4.1 Start Phase

Include as the first activity for a project phase an activity called "Start Phase X" where "X" refers to the phase of work. The "Start Phase X" activity shall have an "ES" constraint date equal to the date on which the NTP was acknowledged, and a zero day duration.

3.3.4.2 End Phase

Include as the last activity for a project phase an activity called "End Phase X" where "X" refers to the phase of work. The "End Phase X" activity shall have an "LF" constraint date equal to the specified completion date for that phase and a zero day duration.

3.3.4.3 Phase "X" Hammock

Include a hammock type activity for each project phase called "Phase X" where "X" refers to the phase of work. The "Phase X" hammock activity shall be logically tied to the earliest and latest activities in the phase.

3.3.5 Default Progress Data Disallowed

Do not automatically update Actual Start and Finish dates with default mechanisms that may be included in the scheduling software. Activity Actual Start (AS) and Actual Finish (AF) dates assigned during the updating process shall match those dates provided from Contractor Quality Control Reports. Failure of the Contractor to document the AS and AF dates on the Daily Quality Control report for every in-progress or completed activity, and failure to ensure that the data contained on the Daily Quality Control reports is the sole basis for schedule updating shall result in the disapproval of the Contractor's updated schedule and the inability of the Contracting Officer Representative to evaluate Contractor progress for payment purposes.

3.3.6 Out-of-Sequence Progress

Activities that have progressed before all preceding logic has been satisfied (Out-of-Sequence Progress) will be allowed only on a case-by-case basis subject to approval by the Contracting Officer Representative. Propose logic corrections to eliminate all out of sequence progress or justify not changing the sequencing for approval prior to submitting an updated project schedule. Correct out of sequence progress that continues for more than two update cycles by logic revision, as approved by the Contracting Officer Representative.

3.3.7 Negative Lags and Start to Finish Relationships

Lag durations contained in the project schedule shall not have a negative value. Do not use Start to Finish (SF) relationships.

3.3.8 Calculation Mode

Schedule calculations shall retain the logic between predecessors and successors even when the successor activity starts and the predecessor activity has not finished. Software features that in effect sever the tie between predecessor and successor activities when the successor has started and the predecessor logic is not satisfied ("progress override") will not be allowed.

3.3.9 Milestones

The schedule must include milestone activities for each significant project event including but not limited to: milestone activities for each fast track design package released for construction; design complete; foundation/substructure construction complete; superstructure construction complete; building dry-in or enclosure complete to allow the initiation of finish activities; permanent power complete; and building systems commissioning complete.

3.4 PROJECT SCHEDULE SUBMISSIONS

Provide the submissions as described below. The data CD, reports, and network diagrams required for each submission are contained in paragraph

SUBMISSION REQUIREMENTS.

3.4.1 Preliminary Project Schedule Submission

Submit the Preliminary Project Schedule, defining the Contractor's planned operations for the first 90 calendar days for approval within 15 calendar days after the NTP is acknowledged. The approved Preliminary Project Schedule will be used for payment purposes not to exceed 90 calendar days after NTP. Completely cost load the Preliminary Project Schedule to balance the contract award CLINS shown on the Price Schedule. Detail it for the first 90 calendar days. It may be summary in nature for the remaining performance period. It must be early start and late finish constrained and logically tied as previously specified. The Preliminary Project Schedule forms the basis for the Initial Project Schedule specified herein and must include all of the required Plan and Program preparations, submissions and approvals identified in the contract (for example, Quality Control Plan, Safety Plan, and Environmental Protection Plan) as well as design activities, the planned submissions of all early design packages, permitting activities, design review conference activities and other non-construction activities intended to occur within the first 90 calendar days. Schedule any construction activities planned for the first 90 calendar days after NTP. Constrain planned construction activities by Government acceptance of the associated design package(s) and all other specified Program and Plan approvals. Activity code any activities that are summary in nature after the first 90 calendar days with Responsibility Code (RESP) and Feature of Work code (FOW1, FOW2, FOW3).

3.4.2 Initial Project Schedule Submission

Submit the Initial Project Schedule for approval within 42 calendar days after NTP. The schedule shall demonstrate a reasonable and realistic sequence of activities which represent all work through the entire contract performance period. The Initial Schedule shall be at a reasonable level of detail as determined by the Contracting Officer Representative.

3.4.3 Periodic Schedule Updates

Based on the result of the meeting, specified in PERIODIC SCHEDULE UPDATE MEETINGS, submit periodic schedule updates. These submissions will enable the Contracting Officer Representative to assess Contractor's progress. If the Contractor fails or refuses to furnish the information and project schedule data, which in the judgment of the Contracting Officer Representative or authorized representative is necessary for verifying the Contractor's progress, the Contractor shall be deemed not to have provided an estimate upon which progress payment may be made.

3.4.4 Standard Activity Coding Dictionary

Use the activity coding structure defined in the Standard Data Exchange Format (SDEF) in ER 1-1-11, Appendix A. This exact structure is mandatory, even if some fields are not used. A template SDEF compatible schedule backup file (sdef.prx) is available on the QCS website: http://rms.usace.army.mil/. The SDEF format is as follows:

SDEF Format			
Field	Activity Code	Length	Description
1	WRKP	3	Workers per Day
2	RESP	4	Responsible Party (e.g. GC, subcontractor, USACE)
3	AREA	4	Area of Work
4	MODF	6	Modification or REA number
5	BIDI	6	Bid Item (CLIN)
6	PHAS	2	Phase of Work
7	CATW	1	Category of Work
8	FOW1	10	Feature of Work (used up to 10 characters in length)
9	FOW2	10	Feature of Work (used up to 20 characters in length)
10	FOW3	10	Feature of Work (used up to 30 characters in length)

3.5 SUBMISSION REQUIREMENTS

Submit the following items for the Preliminary Schedule, Initial Schedule, and every Periodic Schedule Update throughout the life of the project:

3.5.1 Data CD's

Provide two sets of data CD's containing the project schedule in the backup format. Each CD shall also contain all previous update backup files. File medium shall be CD. Label each CD indicating the type of schedule (Preliminary, Initial, Update), full contract number, Data Date and file name. Each schedule shall have a unique file name as determined by the Contractor.

3.5.2 Narrative Report

Provide a Narrative Report with the Preliminary, Initial, and each Periodic Update of the project schedule, as the basis of the progress payment request. The Narrative Report shall include: a description of activities along the 2 most critical paths where the total float is less than or equal to 20 work days, a description of current and anticipated problem areas or delaying factors and their impact, and an explanation of corrective actions taken or required to be taken. The narrative report is expected to communicate to the Government, the Contractor's thorough analysis of the schedule output and its plans to compensate for any problems, either current or potential, which are revealed through that analysis. Identify and explain why any activities that, based their calculated late dates, should have either started or finished during the update period but did not.

3.5.3 Approved Changes Verification

Include only those project schedule changes in the schedule submission that

have been previously approved by the Contracting Officer Representative. The Narrative Report shall specifically reference, on an activity by activity basis, all changes made since the previous period and relate each change to documented, approved schedule changes.

3.5.4 Schedule Reports

The format, filtering, organizing and sorting for each schedule report shall be as directed by the Contracting Officer Representative. Typically reports shall contain: Activity Numbers, Activity Description, Original Duration, Remaining Duration, Early Start Date, Early Finish Date, Late Start Date, Late Finish Date, Total Float, Actual Start Date, Actual Finish Date, and Percent Complete. The following lists typical reports that will be requested. One or all of these reports may be requested for each schedule submission.

3.5.4.1 Activity Report

A list of all activities sorted according to activity number.

3.5.4.2 Logic Report

A list of detailed predecessor and successor activities for every activity in ascending order by activity number.

3.5.4.3 Total Float Report

A list of all incomplete activities sorted in ascending order of total float. List activities which have the same amount of total float in ascending order of Early Start Dates. Do not show completed activities on this report.

3.5.4.4 Earnings Report by CLIN

A compilation of the Contractor's Total Earnings on the project from the NTP to the data date. This report shall reflect the earnings of specific activities based on the agreements made in the schedule update meeting defined herein. Provided that the Contractor has furnished a complete schedule update, this report shall serve as the basis of determining progress payments. Group activities by CLIN item number and sort by activity number. This report shall: sum all activities coded to a particular CLIN and provide a CLIN item percent earned value; and complete and sum CLIN items to provide a total project percent complete. The printed report shall contain, for each activity: the Activity Number, Activity Description, Original Budgeted Amount, Total Quantity, Quantity to Date, Percent Complete (based on cost), and Earnings to Date.

3.5.5 Network Diagram

The network diagram is required for the Preliminary, Initial and Periodic Updates. The network diagram shall depict and display the order and interdependence of activities and the sequence in which the work is to be accomplished. The Contracting Officer Representative will use, but is not limited to, the following conditions to review compliance with this paragraph:

3.5.5.1 Continuous Flow

Diagrams shall show a continuous flow from left to right with no arrows

from right to left. Show the activity number, description, duration, and estimated earned value on the diagram.

3.5.5.2 Project Milestone Dates

Show dates on the diagram for start of project, any contract required interim completion dates, and contract completion dates.

3.5.5.3 Critical Path

Clearly show the critical path.

3.5.5.4 Banding

Organize activities as directed to assist in the understanding of the activity sequence. Typically, this flow will group activities by category of work, work area and/or responsibility.

3.5.5.5 S-Curves

Earnings curves showing projected early and late earnings and earnings to date.

3.6 PERIODIC SCHEDULE UPDATE MEETINGS

Conduct periodic schedule update meetings for the purposes of reviewing the Contractor's proposed out of sequence corrections, determining causes for delay, correcting logic, maintaining schedule accuracy and determining earned value. Meetings shall occur at least monthly within five days of the proposed schedule data date and after the Contractor has updated the schedule with Government concurrence respecting actual start dates, actual finish dates, remaining durations and percent complete for each activity it intend to status. Provide a computer with the scheduling software loaded and a projector during the meeting which allows all meeting participants to view the proposed schedule update during the meeting. The meeting and resultant approvable schedule update shall be a condition precedent to a formal submission of the update as described in SUBMISSION REQUIREMENTS and to the submission of an invoice for payment. The meeting will be a working interactive exchange which will allow the Government and the Contractor the opportunity to review the updated schedule on a real time and interactive basis. The Contractor's authorized scheduling representative will organize, sort, filter and schedule the update as requested by the Government. The meeting will last no longer than 8 hours. A rough draft of the proposed activity logic corrections and narrative report shall be provided to the Government 48 hours in advance of the meeting. The Contractor's Project Manager and Authorized Scheduler shall attend the meeting with the Authorized Representative of the Contracting Officer Representative.

3.6.1 Update Submission Following Progress Meeting

Submit a complete update of the project schedule containing all approved progress, revisions, and adjustments, pursuant to paragraph SUBMISSION REQUIREMENTS not later than 4 working days after the periodic schedule update meeting, reflecting only those changes made during the previous update meeting.

3.6.2 Status of Activities

Update information, including Actual Start Dates (AS), Actual Finish Dates (AF), Remaining Durations (RD), and Percent Complete shall be subject to the approval of the Government prior to the meeting. As a minimum, address the following items on an activity by activity basis during each progress meeting.

3.6.2.1 Start and Finish Dates

Accurately show the status of the AS and/or AF dates for each activity currently in-progress or completed since the last update. The Government may allow an AF date to be assigned with the percent complete less than 100% to account for the value of work remaining but not restraining successor activities. Only assign AS dates when actual progress occurs on an activity.

3.6.2.2 Remaining Duration

Update the estimated RD for all incomplete activities independent of Percent Complete. Remaining Durations may exceed the activity OD or may exceed the activity's prior update RD if the Government considers the current OD or RD to be understated based on current progress, insufficient work crews actually manning the job, unrealistic OD or deficiencies that must be corrected that restrain successor activities.

3.6.2.3 Percent Complete

Update the percent complete for each activity started, based on the realistic assessment of earned value. Activities which are complete but for remaining minor punch list work and which do not restrain the initiation of successor activities may be declared 100 percent complete. To allow for proper schedule management, cost load the correction of punch list from Government pre-final inspection activity(ies) not less than 1 percent of the total contract value, which activity(ies) may be declared 100 percent complete upon completion and correction of all punch list work identified during Government pre-final inspection(s).

3.6.2.4 Logic Changes

Specifically identify and discuss all logic changes pertaining to NTP on change orders, change orders to be incorporated into the schedule, Contractor proposed changes in work sequence, corrections to schedule logic for out-of-sequence progress, and other changes that have been made pursuant to contract provisions. The Government will only approve logic revisions for the purpose of keeping the schedule valid in terms of its usefulness in calculating a realistic completion date, correcting erroneous logic ties, and accurately sequencing the work.

3.6.2.5 Other Changes

Other changes required due to delays in completion of any activity or group of activities include: 1) delays beyond the Contractor's control, such as strikes and unusual weather. 2) delays encountered due to submittals, Government Activities, deliveries or work stoppages which make re-planning the work necessary. 3) Changes required to correct a schedule that does not represent the actual or planned prosecution and progress of the work.

3.7 REQUESTS FOR TIME EXTENSIONS

In the event the Contractor believes it is entitled to an extension of the contract performance period, completion date, or any interim milestone date, furnish the following for a determination by the Contracting Officer Representative: justification, project schedule data, and supporting evidence as the Contracting Officer Representative may deem necessary. Submission of proof of excusable delay, based on revised activity logic, duration, and costs (updated to the specific date that the delay occurred) is a condition precedent to any approvals by the Government. In response to each Request For Proposal issued by the Government, submit a schedule impact analysis demonstrating whether or not the change contemplated by the Government impacts the critical path.

3.7.1 Justification of Delay

The project schedule shall clearly display that the Contractor has used, in full, all the float time available for the work involved with this request. The Contracting Officer Representative's determination as to the number of allowable days of contract extension shall be based upon the project schedule updates in effect for the time period in question, and other factual information. Actual delays that are found to be caused by the Contractor's own actions, which result in a calculated schedule delay, will not be a cause for an extension to the performance period, completion date, or any interim milestone date.

3.7.2 Submission Requirements

Submit a justification for each request for a change in the contract completion date of less than 2 weeks based upon the most recent schedule update at the time of the NTP or constructive direction issued for the change. Such a request shall be in accordance with the requirements of other appropriate Contract Clauses and shall include, as a minimum:

a. A list of affected activities, with their associated project schedule activity number.

b. A brief explanation of the causes of the change.

c. An analysis of the overall impact of the changes proposed.

d. A sub-network of the affected area.

Identify activities impacted in each justification for change by a unique activity code contained in the required data file.

3.7.3 Additional Submission Requirements

The Contracting Officer Representative may request an interim update with revised activities for any requested time extension of over 2 weeks. Provide this disk within 4 days of the Contracting Officer Representative's request.

3.8 DIRECTED CHANGES

If the NTP is issued for changes prior to settlement of price and/or time, submit proposed schedule revisions to the Contracting Officer Representative within 2 weeks of the NTP being issued. The Contracting Officer Representative will approve proposed revisions to the schedule

prior to inclusion of those changes within the project schedule. If the Contractor fails to submit the proposed revisions, the Contracting Officer Representative may furnish the Contractor with suggested revisions to the project schedule. Include these revisions in the project schedule until revisions are submitted, and final changes and impacts have been negotiated. If the Contractor has any objections to the revisions furnished by the Contracting Officer Representative, advise the Contracting Officer Representative within 2 weeks of receipt of the revisions. Regardless of the objections, continue to update the schedule with the Contracting Officer Representative's revisions until a mutual agreement in the revisions is reached. If the Contractor fails to submit alternative revisions within 2 weeks of receipt of the Contracting Officer Representative's proposed revisions, the Contractor will be deemed to have concurred with the Contracting Officer Representative's proposed revisions. The proposed revisions will then be the basis for an equitable adjustment for performance of the work.

3.9 WEEKLY PROGRESS MEETINGS

a. Meet weekly with the Government (or as otherwise mutually agreed to) between the meetings described in paragraph PERIODIC SCHEDULE UPDATE MEETINGS for the purpose of jointly reviewing the actual progress of the project as compared to the as planned progress and to review planned activities for the upcoming two weeks. The then current and approved schedule update shall be used for the purposes of this meeting and for the production and review of reports. The Contractor's Project Manager and the Authorized Representative of the Contracting Officer Representative shall attend. The weekly progress meeting will address the status of RFI's, RFP's and Submittals.

b. Provide a bar chart produced by the scheduling software, organized by Total Float and Sorted by Early Start Date, and a two week "look-ahead" schedule by filtering all schedule activities to show only current ongoing activities and activities schedule to start during the upcoming two weeks, organized by Work Area Code (AREA) and sorted by Early Start Date.

c. The Government and the Contractor shall jointly review the reports. If it appears that activities on the longest path(s) which are currently driving the calculated completion date (driving activities), are not progressing satisfactorily and therefore could jeopardize timely project completion, corrective action must be taken immediately. Corrective action includes but is not limited to: increasing the number of work crews; increasing the number of work shifts; increasing the number of hours worked per shift; and determining if Government responsibility coded activities require Government corrective action.

3.10 OWNERSHIP OF FLOAT

Float available in the schedule, at any time, shall not be considered for the exclusive use of either the Government or the Contractor.

3.11 TRANSFER OF SCHEDULE DATA INTO RMS/QCS

Download and upload the schedule data into the Resident Management System (RMS) prior to RMS databases being transferred to the Government and is considered to be additional supporting data in a form and detail required by the Contracting Officer Representative pursuant to FAR 52.232-5 - Payments under Fixed-Price Construction Contracts. The receipt of a proper

payment request pursuant to FAR 52.232-27 - Prompt Payment for Construction Contracts is contingent upon the Government receiving both acceptable and approvable hard copies and electronic export from QCS of the application for progress payment.

-- End of Section --

SECTION 01 33 00

SUBMITTAL PROCEDURES
05/11

PART 1 GENERAL

1.1 SUMMARY

The Contracting Officer Representative may request submittals in addition to those specified when deemed necessary to adequately describe the work covered in the respective sections.

Units of weights and measures used on all submittals are to be the same as those used in the contract drawings.

Each submittal is to be complete and in sufficient detail to allow ready determination of compliance with contract requirements.

Contractor's Quality Control (CQC) System Manager to check and approve all items prior to submittal and stamp, sign, and date indicating action taken. Proposed deviations from the contract requirements are to be clearly identified. Include within submittals items such as: Contractor's, manufacturer's, or fabricator's drawings; descriptive literature including (but not limited to) catalog cuts, diagrams, operating charts or curves; test reports; test cylinders; samples; O&M manuals (including parts list); certifications; warranties; and other such required submittals.

Submittals requiring Government approval are to be scheduled and made prior to the acquisition of the material or equipment covered thereby. Pick up and dispose of samples not incorporated into the work in accordance with manufacturer's Material Safety Data Sheets (MSDS) and in compliance with existing laws and regulations.

1.2 DEFINITIONS

1.2.1 Submittal Descriptions (SD)

Submittals requirements are specified in the technical sections. Submittals are identified by Submittal Description (SD) numbers and titles as follows:

SD-01 Preconstruction Submittals

Submittals which are required prior to start of construction (work) or the start of the next major phase of the construction on a multi-phase contract, includes schedules, tabular list of data, or tabular list including location, features, or other pertinent information regarding products, materials, equipment, or components to be used in the work.

Certificates of insurance

Surety bonds

List of proposed Subcontractors

Construction Progress Schedule

Network Analysis Schedule (NAS)

Submittal register

Schedule of prices

Health and safety plan

Work plan

Quality Control(QC) plan

Environmental protection plan

SD-02 Shop Drawings

Drawings, diagrams and schedules specifically prepared to illustrate some portion of the work.

Diagrams and instructions from a manufacturer or fabricator for use in producing the product and as aids to the Contractor for integrating the product or system into the project.

Drawings prepared by or for the Contractor to show how multiple systems and interdisciplinary work will be coordinated.

SD-03 Product Data

Catalog cuts, illustrations, schedules, diagrams, performance charts, instructions and brochures illustrating size, physical appearance and other characteristics of materials, systems or equipment for some portion of the work.

Samples of warranty language when the contract requires extended product warranties.

SD-04 Samples

Fabricated or unfabricated physical examples of materials, equipment or workmanship that illustrate functional and aesthetic characteristics of a material or product and establish standards by which the work can be judged.

Color samples from the manufacturer's standard line (or custom color samples if specified) to be used in selecting or approving colors for the project.

Field samples and mock-ups constructed on the project site establish standards by which the ensuring work can be judged. Includes assemblies or portions of assemblies which are to be incorporated into the project and those which will be removed at conclusion of the work.

SD-05 Design Data

Design calculations, mix designs, analyses or other data pertaining to a part of work.

SD-06 Test Reports

Report signed by authorized official of testing laboratory that a material, product or system identical to the material, product or system to be provided has been tested in accord with specified requirements. (Testing must have been within three years of date of contract award for the project.)

Report which includes findings of a test required to be performed by the Contractor on an actual portion of the work or prototype prepared for the project before shipment to job site.

Report which includes finding of a test made at the job site or on sample taken from the job site, on portion of work during or after installation.

Investigation reports.

Daily logs and checklists.

Final acceptance test and operational test procedure.

SD-07 Certificates

Statements printed on the manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements. Must be dated after award of project contract and clearly name the project.

Document required of Contractor, or of a manufacturer, supplier, installer or Subcontractor through Contractor, the purpose of which is to further quality of orderly progression of a portion of the work by documenting procedures, acceptability of methods or personnel qualifications.

Confined space entry permits, if required.

Text of posted operating instructions, if required.

SD-08 Manufacturer's Instructions

Preprinted material describing installation of a product, system or material, including special notices and (MSDS)concerning impedances, hazards and safety precautions.

SD-11 Closeout Submittals

Documentation to record compliance with technical or administrative requirements or to establish an administrative mechanism.

Special requirements necessary to properly close out a construction contract. For example, Record Drawings and as-built drawings. Also, submittal requirements necessary to properly close out a major phase of construction on a multi-phase contract.

Interim "DD Form 1354" with cost breakout for all assets 30 days prior to facility turnover.

1.2.2 Approving Authority

Contracting Officer or designated person authorized to approve submittal.

1.2.3 Work

As used in this section, on- and off-site construction required by contract documents, including labor necessary to produce submittals, except those SD-01 Pre-Construction Submittals noted above, construction, materials, products, equipment, and systems incorporated or to be incorporated in such construction.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with this section.

SD-01 Preconstruction Submittals

Submittal Register; G

1.4 SUBMITTAL CLASSIFICATION

Submittals are classified as follows:

1.4.1 Government Approved (G)

Government approval is required for extensions of design, critical materials, deviations, equipment whose compatibility with the entire system must be checked, and other items as designated by the Contracting Officer Representative. Within the terms of the Contract Clause entitled, "Specifications and Drawings for Construction," they are considered to be "shop drawings."

1.4.2 Information Only

Submittals not requiring Government approval will be for information only. They are not considered to be "shop drawings" within the terms of the Contract Clause referred to above.

1.5 PREPARATION

1.6 QUANTITY OF SUBMITTALS

1.6.1 Number of Copies of SD-02 Shop Drawings

Submit six copies of submittals of shop drawings requiring review and approval only by QC organization and seven copies of shop drawings requiring review and approval by Contracting Officer Representative.

1.6.2 Number of Copies of SD-03 Product Data and SD-08 Manufacturer's Instructions

Submit in compliance with quantity requirements specified for shop drawings.

1.6.3 Number of Samples SD-04 Samples

a. Submit two samples, or two sets of samples showing range of variation, of each required item. One approved sample or set of samples will be retained by approving authority and one will be returned to Contractor.

b. Submit one sample panel or provide one sample installation where directed. Include components listed in technical section or as directed.

c. Submit one sample installation, where directed.

d. Submit one sample of non-solid materials.

1.6.4 Number of Copies SD-05 Design Data and SD-07 Certificates

Submit in compliance with quantity requirements specified for shop drawings.

1.6.5 Number of Copies SD-06 Test Reports and SD-09 Manufacturer's Field Reports

Submit in compliance with quantity and quality requirements specified for shop drawings other than field test results that will be submitted with QC reports.

1.6.6 Number of Copies of SD-10 Operation and Maintenance Data

Submit three copies of O&M Data to the Contracting Officer Representative for review and approval.

1.6.7 Number of Copies of SD-01 Preconstruction Submittals and SD-11 Closeout Submittals

Unless otherwise specified, submit three sets of administrative submittals.

1.7 INFORMATION ONLY SUBMITTALS

Normally submittals for information only will not be returned. Approval of the Contracting Officer Representative is not required on information only submittals. The Government reserves the right to require the Contractor to resubmit any item found not to comply with the contract. This does not relieve the Contractor from the obligation to furnish material conforming to the plans and specifications; will not prevent the Contracting Officer Representative from requiring removal and replacement of nonconforming material incorporated in the work; and does not relieve the Contractor of the requirement to furnish samples for testing by the Government laboratory or for check testing by the Government in those instances where the technical specifications so prescribe.

1.8 VARIATIONS

Variations from contract requirements require both Designer of Record (DOR) and Government approval pursuant to contract Clause FAR 52.236-21 and will be considered where advantageous to Government.

1.8.1 Considering Variations

Discussion with Contracting Officer Representative prior to submission, after consulting with the DOR, will help ensure functional and quality

requirements are met and minimize rejections and re-submittals. When contemplating a variation which results in lower cost, consider submission of the variation as a Value Engineering Change Proposal (VECP).

Specifically point out variations from contract requirements in transmittal letters. Failure to point out deviations may result in the Government requiring rejection and removal of such work at no additional cost to the Government.

1.8.2 Proposing Variations

When proposing variation, deliver written request to the Contracting Officer Representative, with documentation of the nature and features of the variation and why the variation is desirable and beneficial to Government, including the DOR's written analysis and approval. If lower cost is a benefit, also include an estimate of the cost savings. In addition to documentation required for variation, include the submittals required for the item. Clearly mark the proposed variation in all documentation.

Check the column "variation" of ENG Form 4025 for submittals which include proposed deviations requested by the Contractor. Set forth in writing the reason for any deviations and annotate such deviations on the submittal. The Government reserves the right to rescind inadvertent approval of submittals containing unnoted deviations.

1.8.3 Warranting That Variations Are Compatible

When delivering a variation for approval, Contractor, including its Designer(s) of Record, warrants that this contract has been reviewed to establish that the variation, if incorporated, will be compatible with other elements of work.

1.8.4 Review Schedule Is Modified

In addition to normal submittal review period, a period of 10 working days will be allowed for consideration by the Government of submittals with variations.

1.9 SUBMITTAL REGISTER

Prepare and maintain submittal register, as the work progresses. Do not change data which is output in columns (c), (d), (e), and (f) as delivered by Government; retain data which is output in columns (a), (g), (h), and (i) as approved. A submittal register showing items of equipment and materials for which submittals are required by the specifications is provided as an attachment. This list may not be all inclusive and additional submittals may be required. Maintain a submittal register for the project in accordance with Section 01 45 00.10 10 QUALITY CONTROL SYSTEMS (QCS). The Government will provide the initial submittal register with the following fields completed, to the extent that will be required by the Government during subsequent usage.

Column (c): Lists specification section in which submittal is required.

Column (d): Lists each submittal description (SD No. and type, e.g. SD-02 Shop Drawings) required in each specification section.

Column (e): Lists one principal paragraph in specification section where a material or product is specified. This listing is only to facilitate locating submitted requirements. Do not consider entries in column (e) as limiting project requirements.

Thereafter, the Contractor is to track all submittals by maintaining a complete list, including completion of all data columns, including dates on which submittals are received and returned by the Government.

1.9.1 Use of Submittal Register

Submit submittal register. Submit with QC plan and project schedule. Verify that all submittals required for project are listed and add missing submittals. Coordinate and complete the following fields on the register submitted with the QC plan and the project schedule:

Column (a) Activity Number: Activity number from the project schedule.

Column (g) Contractor Submit Date: Scheduled date for approving authority to receive submittals.

Column (h) Contractor Approval Date: Date Contractor needs approval of submittal.

Column (i) Contractor Material: Date that Contractor needs material delivered to Contractor control.

1.9.2 Contractor Use of Submittal Register

Update the following fields in the Government-furnished submittal register program or equivalent fields in program utilized by Contractor with each submittal throughout contract.

Column (b) Transmittal Number: Contractor assigned list of consecutive numbers.

Column (j) Action Code (k): Date of action used to record Contractor's review when forwarding submittals to QC.

Column (l) List date of submittal transmission.

Column (q) List date approval received.

1.9.3 Approving Authority Use of Submittal Register

Update the following fields in the Government-furnished submittal register program or equivalent fields in program utilized by Contractor.

Column (b) Transmittal Number: Contractor assigned list of consecutive numbers.

Column (l) List date of submittal receipt.

Column (m) through (p) List Date related to review actions.

Column (q) List date returned to Contractor.

1.10 SCHEDULING

Schedule and submit concurrently submittals covering component items forming a system or items that are interrelated. Include certifications to be submitted with the pertinent drawings at the same time. No delay damages or time extensions will be allowed for time lost in late submittals.

a. Coordinate scheduling, sequencing, preparing and processing of submittals with performance of work so that work will not be delayed by submittal processing. Allow for potential resubmittal of requirements.

b. Submittals called for by the contract documents will be listed on the register. If a submittal is called for but does not pertain to the contract work, the Contractor is to include the submittal in the register and annotate it "N/A" with a brief explanation. Approval by the Contracting Officer Representative does not relieve the Contractor of supplying submittals required by the contract documents but which have been omitted from the register or marked "N/A."

c. Re-submit register and annotate monthly by the Contractor with actual submission and approval dates. When all items on the register have been fully approved, no further re-submittal is required.

d. Carefully control procurement operations to ensure that each individual submittal is made on or before the Contractor scheduled submittal date shown on the approved "Submittal Register."

1.11 GOVERNMENT APPROVING AUTHORITY

When approving authority is Contracting Officer Representative, the Government will:

a. Note date on which submittal was received.

b. Review submittals for approval within scheduling period specified and only for conformance with project design concepts and compliance with contract documents.

c. Identify returned submittals with one of the actions defined in paragraph entitled, "Review Notations," of this section and with markings appropriate for action indicated.

Upon completion of review of submittals requiring Government approval, stamp and date approved submittals. Three copies of the approved submittal will be retained by the Contracting Officer Representative and one copy of the submittal will be returned to the Contractor. If the Government performs a conformance review of other Designer of Record approved submittals, the submittals will be so identified and returned, as described above.

1.11.1 Review Notations

Contracting Officer Representative review will be completed within 15 calendar days after date of submission. Submittals will be returned to the Contractor with the following notations:

a. Submittals marked "approved" or "accepted" authorize the Contractor to proceed with the work covered.

b. Submittals marked "approved as noted" "or approved except as noted, resubmittal not required," authorize the Contractor to proceed with the work covered provided he takes no exception to the corrections.

c. Submittals marked "not approved" or "disapproved," or "revise and resubmit," indicate noncompliance with the contract requirements or design concept, or that submittal is incomplete. Resubmit with appropriate changes. No work shall proceed for this item until resubmittal is approved.

d. Submittals marked "not reviewed" will indicate submittal has been previously reviewed and approved, is not required, does not have evidence of being reviewed and approved by Contractor, or is not complete. A submittal marked "not reviewed" will be returned with an explanation of the reason it is not reviewed. Resubmit submittals returned for lack of review by Contractor or for being incomplete, with appropriate action, coordination, or change.

1.12 DISAPPROVED OR REJECTED SUBMITTALS

Contractor shall make corrections required by the Contracting Officer Representative. If the Contractor considers any correction or notation on the returned submittals to constitute a change to the contract drawings or specifications; notice as required under the clause entitled, "Changes," is to be given to the Contracting Officer Representative. Contractor is responsible for the dimensions and design of connection details and construction of work. Failure to point out deviations may result in the Government requiring rejection and removal of such work at the Contractor's expense.

If changes are necessary to submittals, the Contractor shall make such revisions and submission of the submittals in accordance with the procedures above. No item of work requiring a submittal change is to be accomplished until the changed submittals are approved.

1.13 APPROVED/ACCEPTED SUBMITTALS

The Contracting Officer Representative's approval or acceptance of submittals is not to be construed as a complete check, and indicates only that the general method of construction, materials, detailing and other information are satisfactory.

Approval or acceptance will not relieve the Contractor of the responsibility for any error which may exist, as the Contractor under the Contractor Quality Control (CQC) requirements of this contract is responsible for dimensions, the design of adequate connections and details, and the satisfactory construction of all work.

After submittals have been approved or accepted by the Contracting Officer Representative, no resubmittal for the purpose of substituting materials or equipment will be considered unless accompanied by an explanation of why a substitution is necessary.

1.14 APPROVED SAMPLES

Approval of a sample is only for the characteristics or use named in such approval and is not be construed to change or modify any contract requirements. Before submitting samples, the Contractor to assure that the

materials or equipment will be available in quantities required in the project. No change or substitution will be permitted after a sample has been approved.

Match the approved samples for materials and equipment incorporated in the work. If requested, approved samples, including those which may be damaged in testing, will be returned to the Contractor, at his expense, upon completion of the contract. Samples not approved will also be returned to the Contractor at its expense, if so requested.

Failure of any materials to pass the specified tests will be sufficient cause for refusal to consider, under this contract, any further samples of the same brand or make of that material. Government reserves the right to disapprove any material or equipment which previously has proved unsatisfactory in service.

Samples of various materials or equipment delivered on the site or in place may be taken by the Contracting Officer Representative for testing. Samples failing to meet contract requirements will automatically void previous approvals. Contractor to replace such materials or equipment to meet contract requirements.

Approval of the Contractor's samples by the Contracting Officer Representative does not relieve the Contractor of his responsibilities under the contract.

1.15 WITHHOLDING OF PAYMENT

Payment for materials incorporated in the work will not be made if required approvals have not been obtained.

1.16 STAMPS

Stamps used by the Contractor on the submittal data to certify that the submittal meets contract requirements is to be similar to the following:

CONTRACTOR
(Firm Name)
_____ Approved
_____ Approved with corrections as noted on submittal data and/or attached sheets(s)
SIGNATURE: _____
TITLE: _____
DATE: _____

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SUBMITTAL REGISTER

CONTRACT NO.

TITLE AND LOCATION
Raymark Industries, Inc. Superfund Site, Stratford, CT

CONTRACTOR

ACTIVITY NO	TRANSMITTAL NO	SPEC SECT	DESCRIPTION ITEM SUBMITTED	PARAGRAPH #	CLASSIFICATION	GOVT OR A/E REVWR	CONTRACTOR: SCHEDULE DATES			CONTRACTOR ACTION			APPROVING AUTHORITY					MAILED TO CONTR/ DATE RCD FRM APPR AUTH	REMARKS
							SUBMIT	APPROVAL NEEDED BY	MATERIAL NEEDED BY	ACTION CODE	DATE OF ACTION	DATE FWD TO APPR AUTH/ DATE RCD FROM CONTR	DATE FWD TO OTHER REVIEWER	DATE RCD FROM OTH REVIEWER	ACTION CODE	DATE OF ACTION			
(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)		(q)	(r)
		01 22 00.00 10	SD-03 Product Data																
			Surveys	1.2.1.3	G														
		01 32 01.00 10	SD-01 Preconstruction Submittals																
			Project Schedule	3.4	G														
		01 33 00	SD-01 Preconstruction Submittals																
			Submittal Register	1.9	G														
		01 35 29.13	SD-02 Shop Drawings																
			Work Zones	1.16.1	G														
			Decontamination Facilities	1.17.1	G														
			SD-03 Product Data																
			Exposure Monitoring/Air	1.13	G														
			Sampling Program																
			Site Control Log	1.16.2	G														
			Employee Certificates	1.12.4	G														
			Respiratory Protection Program		G														
			Qualifications		G														
			Training Program		G														
			Licenses, Permits and		G														
			Notifications																
			Accident Prevention Plan and EM		G														
			385-1-1 Activity Hazard Analysis																
			Plans																
			CIH or CSP Stampled Health and		G														
			Safety Plan																
			SD-06 Test Reports																

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(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		01 35 29.13	Exposure Assessment and Air		G													
			Monitoring															
			Daily Logs of Activities		G													
			SD-07 Certificates															
			Medical Surveillance															
			Requirements															
		01 35 45.00 10	SD-03 Product Data															
			Sampling and Analysis Plan	3.3	G													
			SD-06 Test Reports															
			QA Sample Collection and	1.6.2	G													
			Analysis															
			Chemistry Data Package	3.4	G													
			Chemical Data Final Report	3.7	G													
		01 45 00.00 20	SD-01 Preconstruction Submittals															
			Construction Quality Control (QC)	1.6.1	G													
			Plan															
		01 50 00	SD-01 Preconstruction Submittals															
			Construction site plan	1.3	G													
			Traffic control plan	3.3.1	G													
		01 57 19.00 20	SD-01 Preconstruction Submittals															
			Preconstruction Survey	1.5.1	G													
			Solid Waste Management Plan	3.4	G													
			and Permit															
			Regulatory Notifications	1.5.2	G													
			Environmental Management Plan	3.1	G													

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(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		01 57 19.00 20	Storm Water Pollution Prevention	3.2.2.1	G													
			Plan															
			Storm Water Notice of Intent (for	3.2.2.1	G													
			NPDES coverage under the															
			general permit for construction															
			activities)															
			Dust Control Plan	3.14.1														
			Contractor Hazardous Material	3.6	G													
			Inventory Log															
			Traffic Control Plan	3.16	G													
			SD-06 Test Reports															
			Erosion and Sediment Control	3.2.2														
			Inspection Reports															
			Storm Water Pollution Prevention															
			Plan Inspection Reports															
			Contractor 40 CFR employee	1.5.4														
			training records															
			Solid Waste Management Report	3.4.1	G													
			SD-11 Closeout Submittals															
			Storm Water Pollution Prevention	3.2.2.2	G													
			Plan compliance notebook															
			Waste Determination	3.5														
			Documentation															
			Disposal Documentation for	3.6.1														
			Hazardous and Regulated Waste															

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(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		01 57 19.00 20	Contractor 40 CFR Employee	1.5.4														
			Training Records															
			Solid Waste Management Permit	3.4														
			Solid Waste Management Report	3.4.1														
			Contractor Hazardous Material	3.6	G													
			Inventory Log															
			Hazardous Waste/Debris	3.13.2														
			Management															
			Regulatory Notifications	1.5.2														
		01 57 23	SD-01 Preconstruction Submittals															
			Storm Water Pollution Prevention	1.3.2														
			Plan															
			Storm Water Notice of Intent	1.3.2														
			SD-06 Test Reports															
			Storm Water Inspection Reports	1.3.2														
			for General Permit															
			Erosion and Sediment Controls	1.3														
			SD-07 Certificates															
			Mill Certificate or Affidavit	2.1.3														
		01 62 35	SD-01 Preconstruction Submittals															
			Biobased Products	1.7	G													
		01 68 00	SD-01 Preconstruction Submittals															
			Detailed Work Plan	1.1.2	G													
			SD-06 Test Reports															
			Treatment System Performance	2.2.1	G													
			Monitoring Reports															

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		01 68 00	Treatment System Start-Up	2.2.2	G													
			SD-11 Closeout Submittals															
			Operator's Field Notebooks		G													
		01 71 23	SD-01 Preconstruction Submittals															
			Qualifications	1.4.1	G													
			Accuracy of Survey Work	1.4.2	G													
			SD-05 Design Data															
			Field Verification Survey	1.7	G													
			SD-11 Closeout Submittals															
			Log of Control and Survey Work	3.1.1	G													
		01 74 19	SD-01 Preconstruction Submittals															
			Waste Management Plan	1.6	G													
			SD-11 Closeout Submittals															
			Records	1.7	G													
		01 78 00	SD-03 Product Data															
			As-Built Record of Equipment	1.2.2	G													
			and Materials															
			Warranty Management Plan	1.5.1														
			Warranty Tags	1.5.5														
			SD-08 Manufacturer’s Instructions															
			Instructions	1.5.1	G													
			SD-11 Closeout Submittals															
			Record Drawings	1.2.1														
			Quality Control Testing Reports	1.2.6	G													
		02 14 00	SD-01 Preconstruction Submittals															

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(a)	(b)	(c)	(d)	(e)	(f)		(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
		02 14 00	Qualifications and Relevant	1.4.1	G													
			Project Experience of Proposed															
			Dewatering															
			Personnel/Subcontractor															
			Excavation Dewatering Plan	1.4.2	G													
			Water Management Plan	1.4.3	G													
			SD-03 Product Data															
			Materials	2.2	G													
		02 56 13	SD-02 Shop Drawings															
			Geomembrane Panel Layout		G													
			QC Manuals		G													
			Penetrations	3.6	G													
			As-Built Drawings	1.3	G													
			SD-03 Product Data															
			Tests, Inspections, and	2.2	G													
			Verifications															
			Field Seaming	3.3	G													
			Qualifications	1.5	G													
			SD-06 Test Reports															
			Materials	2.1	G													
			Surface Preparation	3.1.1	G													
			Non-Destructive Field Seam		G													
			Continuity Testing															
			Destructive Field Seam Testing		G													
			Destructive Seam Test Repairs	3.5.4.7	G													
			Tests	3.5	G													

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		02 56 13	SD-07 Certificates															
			Materials	2.1	G													
			Destructive Field Seam Testing		G													
			Destructive Seam Test Repairs	3.5.4.7	G													
			Tests	3.5	G													
		02 56 15	SD-02 Shop Drawings															
			Layout and Detail Drawings	1.3	G													
			SD-03 Product Data															
			GCL Properties	2.1	G													
			Warranty	1.7	G													
			Tests, Inspections, and	2.2	G													
			Verifications															
			Qualifications	1.5	G													
			SD-06 Test Reports															
			Tests, Inspections, and	2.2	G													
			Verifications															
			Conformance Tests	3.1.2	G													
			Subgrade Preparation	3.2.1	G													
		02 61 13	SD-02 Shop Drawings															
			Surveys	3.1	G													
			SD-03 Product Data															
			Work Plan	1.3	G													
			Closure Report	3.9	G													
			SD-06 Test Reports															
			Confirmation Test Results		G													
			Surveys	3.1	G													

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		02 61 13	Compaction	3.7.2	G													
		02 66 00	SD-03 Product Data															
			Materials Handling Plan	2.5	G													
			Borrow Source Assessment	3.1	G													
			Report															
			SD-04 Samples															
			Protective Cover Soil	2.1	G													
			Select Fill	2.2	G													
			Topsoil	2.3	G													
			SD-06 Test Reports															
			Material Tests	3.4.1	G													
			Protective Cover Soil, Select Fill		G													
			and Topsoil Material Tests															
			Moisture Content and Density	3.4.2	G													
			Tests of Protective Cover and															
			Select Fill In-Place															
		02 81 00	SD-03 Product Data															
			Onsite Hazardous Waste	3.1	G													
			Management															
			Notices of Non-Compliance and															
			Notices of Violation															
			Packaging Notifications	2.1.1														
			SD-06 Test Reports															
			Recordkeeping	3.6	G													
			Spill Response	3.7														
			Exception Report	3.6	G													

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		02 81 00	SD-07 Certificates															
			Certification	1.4.3														
			Security Plan	3.2.3														
			Transportation and Disposal	1.4.1	G													
			Coordinator															
			Training	1.4.2	G													
			EPA Offsite Policy	3.2.1														
			Certificates of Disposal	3.2.4														
			Shipping Documents and	3.2.2	G													
			Packagings Certification															
		02 82 14.00 10	SD-03 Product Data															
			Asbestos Waste Shipment	3.6.3.1	G													
			Records															
			Weight Bills and Delivery Tickets	1.1	G													
			Encapsulants	2.1	G													
			Respiratory Protection Program	1.9.1	G													
			Cleanup and Disposal	3.6	G													
			Qualifications	1.6.1	G													
			Training Program	1.10	G													
			Licenses, Permits and	1.8.1	G													
			Notifications															
			Asbestos Management Plan	3.6.3.2	G													
			Alternative Work Practice	1.3.1	G													
			Asbestos Hazard Abatement		G													
			Plan and EM 385-1-1 Activity															
			Hazard Analysis Plans															

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		02 82 14.00 10	Qualifications and Organization		G													
			Report															
			Specific Requirements in Section		G													
			1.6															
			SD-06 Test Reports															
			Exposure Assessment and Air	3.4	G													
			Monitoring															
			Documentation of AWP		G													
			Compliance															
			Daily Logs and ACM Activities		G													
			SD-07 Certificates															
			Encapsulants	2.1	G													
			Medical Surveillance	1.9														
			Requirements															
		31 00 00	SD-01 Preconstruction Submittals															
			Shoring	3.7	G													
			SD-03 Product Data															
			Utilization of Excavated Materials	3.10	G													
			Opening of any Excavation or	3.6														
			Borrow Pit															
			SD-06 Test Reports															
			Testing	3.15	G													
			Borrow Site Testing	2.1	G													
			SD-07 Certificates															
			Testing	3.15	G													
		31 05 19	SD-03 Product Data															

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		31 05 19	Thread	2.1.2	G													
			Manufacturing Quality Control	2.2	G													
			Sampling and Testing															
			SD-04 Samples															
			Quality Assurance Samples and															
			Tests															
			SD-07 Certificates															
			Geotextile	2.1.1	G													
		31 05 20	SD-01 Preconstruction Submittals															
			Manufacturer's Quality Control															
			Manual															
			Manufacturer's Product		G													
			Datasheet															
			Project Reference List for		G													
			geocomposite															
			SD-03 Product Data															
			Sampling and Testing	2.3	G													
			Penetrations	3.1.5	G													
			Construction Quality Control (QC)	1.4	G													
			Laboratory															
			SD-04 Samples															
			Geocomposite Drainage Layer		G													
			Geocomposite Venting Layer		G													
			SD-06 Test Reports															
			Sampling and Testing	2.3	G													
			Geosynthetic Drainage Layer		G													

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		31 21 00	SD-02 Shop Drawings															
			Off-gas Piping System	1.3	G													
			SD-03 Product Data															
			Materials and Equipment	2.1	G													
			Statement of Satisfactory	3.7.1														
			Installation															
			SD-07 Certificates															
			Off-gas Piping System	1.3														
		32 31 13	SD-02 Shop Drawings															
			Erection/Installation Drawings	1.3														
			Fence Assembly	1.3														
			Location of Gate, Corner, End,	3.17.1														
			and Posts															
			Gate Assembly	1.3														
			Gate Hardware and Accessories	2.17														
			SD-03 Product Data															
			Fence Assembly	1.3														
			Gate Assembly	1.3														
			Gate Hardware and Accessories	2.17														
			Recycled material content	2.1														
			SD-07 Certificates															
			Zinc Coating	1.5.1														
			Zinc Coating	2.2														
			Zinc Coating	2.11														
			PVC coating	1.5.1														
			Fabric	2.3														

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		32 31 13	Fabric	2.4														
			Fabric	3.9														
			Stretcher Bars	2.12														
			Gate Hardware and Accessories	2.17														
		32 92 19	SD-03 Product Data															
			Fertilizer	2.1.2	G													
			Fertilizer	2.4	G													
			Lime	2.1.3	G													
			Seed	2.1.4	G													
			Seed	2.2	G													
			Wood Cellulose Fiber Mulch	2.5.3	G													
			Binders for Mulch	2.1.6	G													
			Erosion Control Blankets	2.1.7	G													
			SD-07 Certificates															
			seed	2.1.4	G													
			seed	2.2	G													
			Hydraulic Seeding Method		G													
		33 40 00	SD-03 Product Data															
			Placing Pipe	3.3														
			SD-07 Certificates															
			Pipeline Testing	3.5														
			Hydrostatic Test on Watertight	2.4														
			Joints															
			Determination of Density	3.4.5														

SECTION 01 35 29.13

HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES
01/08

PART 1 GENERAL

1.1 DESCRIPTION OF WORK AND PAYMENT

Work at the site will include site preparation activities, excavation and consolidation of historic fill materials, placement, grading, capping, and compaction of site soils, and establishment of vegetative cover in areas of disturbance associated with the work. A variety of these activities will impact hazardous materials identified in the documents referenced in Section 1.7. The Contractor shall develop a Health and Safety Plan (HASP) to protect workers and the general public specifically for these hazardous materials, as well as any unknowns that may be encountered during the work. Employees involved in these material handling activities will be required to meet the training and health monitoring requirements of OSHA 29 CFR 1910 and 29 CFR 1926. In addition, safety procedures and measures will be required for protection of the public. Contractor employees shall, in addition to the requirements of its HASP, comply with the Owner's hazardous waste protection requirements at all times when conducting work in posted hazardous areas.

The Contractor shall retain the services of an independent environmental consulting firm's Certified Industrial Hygienist (CIH) or Certified Safety Professional (CSP) to:

a. Develop a HASP for the site stamped by a CIH or CSP.

b. Provide daily monitoring of site contaminants during all fill disburbances.

In the event a safety concern or concerns are identified during the performance of the Work, the Owner and Owner's Representative have the absolute authority to halt the Contractor's work, at no additional cost to the Owner, until the identified safety concern(s) are addressed by the Contractor.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)

ANSI/ISEA Z358.1	(2009) American National Standard for Emergency Eyewash and Shower Equipment

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

NIOSH 85-115	(1985) Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2008; Errata 1-2010; Changes 1-3 2010; Changes 4-6 2011) Safety and Health Requirements Manual

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1904	Recording and Reporting Occupational Injuries and Illnesses
29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1910.120	Hazardous Waste Operations and Emergency Response
29 CFR 1910.134	Respiratory Protection
29 CFR 1926	Safety and Health Regulations for Construction
29 CFR 1926.1101	Asbestos
29 CFR 1926.32	Safety and Health Regulations for Construction - Definition
29 CFR 1926.65	Hazardous Waste Operations and Emergency Response
40 CFR 61	National Emission Standards for Hazardous Air Pollutants
40 CFR 763	Asbestos
42 CFR 84	Approval of Respiratory Protective Devices
49 CFR 107	Hazardous Materials Program Procedures
49 CFR 171	General Information, Regulations, and Definitions
49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements
49 CFR 173	Shippers - General Requirements for Shipments and Packagings

STATE OF CONNECTICUT

19a-14	CT General Statutes Related to Asbestos
19a-17	CT General Statutes Related to Asbestos
19a-332 to 19a-333	CT General Statutes Related to Asbestos
20-435 to 20-442	CT General Statutes Related to Asbestos

19a-332a-1 to 19a-332a-16	DPH Standards for Asbestos Abatement
20-440-1 to 20-440-9	DPH Licensing and Training Requirements
20-441	DPH Licensing and Training Requirements
22a-208a-1	DEP Disposal Requirements
22a-209-1	DEP Disposal Requirements
22a-209-8	DEP Disposal Requirements

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Work Zones; G
Decontamination Facilities; G

SD-03 Product Data

Exposure Monitoring/Air Sampling Program; G
Site Control Log; G
Employee Certificates; G
Respiratory Protection Program; G
Qualifications; G
Training Program; G
Licenses, Permits and Notifications; G
Accident Prevention Plan and EM 385-1-1 Activity Hazard Analysis Plans; G
CIH or CSP Stampled Health and Safety Plan; G

SD-06 Test Reports

Exposure Assessment and Air Monitoring; G
Copies of Daily Logs of Activities; G

SD-07 Certificates

Medical Surveillance Requirements

1.4 REGULATORY REQUIREMENTS

Comply with EM 385-1-1, OSHA requirements in 29 CFR 1910 and 29 CFR 1926 with work performed under this contract, especially OSHA's Standards 29 CFR 1926.65 and 29 CFR 1910.120 and state specific OSHA requirements where applicable. Submit to the Contracting Officer Representative for resolution matters of interpretation of standards before starting work. The most stringent requirements apply where the requirements of this specification, applicable laws, criteria, ordinances, regulations, and referenced documents vary.

All work shall be performed in accordance with State of Connecticut 19a-14,

19a-17, 19a-332 to 19a-333, 20-435 to 20-442, 19a-332a-1 to 19a-332a-16, 20-440-1 to 20-440-9, 20-441, 22a-208a-1, 22a-209-1, and 22a-209-8 as well as 29 CFR 1910.134, 29 CFR 1926.1101, 29 CFR 1926.32, 40 CFR 61, 40 CFR 763, 42 CFR 84, 49 CFR 107, 49 CFR 171, 49 CFR 172, and 49 CFR 173.

Section 02 82 14.00 10 ASBESTOS HAZARD CONTROL ACTIVITIES addresses asbestos requirements for the site. The Connecticut Department of Public Health (DPH) determines work practice requirements for Asbestos Containing Materials (ACM) fill materials on a case by case basis through the development and review of Alternative Work Practices under 19a-332a-11 (AWP) of the Standards for Asbestos Abatement. The Contractor shall retain the services of an independent Connecticut Licensed Asbestos firm to:

a. Develop and AWP for the site.

b. Obtain AWP approval from the DPH.

c. Provide continuous daily monitoring and on-site asbestos analysis during all ACM fill disturbance.

d. Perform soil sampling to document the effectiveness of the remediation.

All work shall be performed in accordance with the approved AWP. The requirements of the AWP shall be incorporated into the HASP.

The following specification provides detailed requirements for ACM work practices. In instances where the specification varies from the approved AWP, the DPH approved AWP shall govern the work practices as determined by the Contracting Officer Representative.

1.5 PRECONSTRUCTION SAFETY CONFERENCE

Conduct a preconstruction safety conference prior to the start of site activities and after submission of the Contractor's APP/SSHP. The objective of the meeting will be to discuss health and safety concerns related to the impending work, discuss project health and safety organization and expectations, review and answer comments and concerns regarding the APP/SSHP or other health and safety concerns the Contractor may have. Ensure that those individuals responsible for health and safety at the project level are available and attend this meeting.

1.6 ACCIDENT PREVENTION PLAN/SITE SAFETY AND HEALTH PLAN (APP/SSHP)

Develop and implement a Site Safety and Health Plan and attach to the Accident Prevention Plan (APP) as an appendix (APP/SSHP). Address all occupational safety and health hazards (traditional construction as well as contaminant-related hazards) associated with cleanup operations within the APP/SSHP. Cover each SSHP element in section 28.A.01 of EM 385-1-1 and each APP element in Appendix A of EM 385-1-1. There are overlapping elements in Section 28.A.01 and Appendix A of EM 385-1-1. SSHP appendix elements that overlap with APP elements need not be duplicated in the APP/SSHP provided each SOH issue receives adequate attention and is documented in the APP/SSHP. The APP/SSHP is a dynamic document, subject to change as project operations/execution change. The APP/SSHP will require modification to address changing and previously unidentified health and safety conditions. It is the Contractor's responsibility to ensure that the APP/SSHP is updated accordingly. Submit amendments to the APP/SSHP to the COR as the APP/SSHP is updated. For long duration projects resubmit

the APP/SSHP to the COR annually for review. The APP/SSHP must contain all updates.

1.6.1 Acceptance and Modifications

Prior to submittal, the APP/SSHP must be signed and dated by the Safety and Health Manager and the Site Superintendent. Submit for review 15 days prior to the Preconstruction Safety Conference. Deficiencies in the APP/SSHP will be discussed at the preconstruction safety conference, and be revised to correct the deficiencies and resubmitted for acceptance. Onsite work must not begin until the plan has been accepted. Maintain a copy of the written APP/SSHP onsite. Changes and modifications to must be made with the knowledge and concurrence of the Safety and Health Manager, the Site Superintendent, and the Contracting Officer Representative. Bring to the attention of the Safety and Health Manager, the Site Superintendent, and the Contracting Officer Representative any unforeseen hazard that becomes evident during the performance of the work, through the Site Safety and Health Officer (SSHO) for resolution as soon as possible. In the interim, take necessary action to re-establish and maintain safe working conditions in order to safeguard onsite personnel, visitors, the public, and the environment. Disregard for the provisions of this specification or the accepted APP/SSHP will be cause for stopping work until the matter has been rectified.

1.6.2 Availability

Make available the APP/SSHP in accordance with 29 CFR 1910.120, (b)(1)(v) and 29 CFR 1926.65, (b)(1)(v).

1.7 SITE DESCRIPTION AND CONTAMINATION CHARACTERIZATION

1.7.1 Project/Site Conditions

Refer to the Remedial Design Report for the site description and contamination characterization.

1.7.1.1 CERCLA Documents

CTDEP Guidelines for Soil Erosion and Sediment Control (CTDEP, 2002).

EPA New England, Region 1, July 2011. "Record of Decision for Final Source Control Actions at Four Properties Within Operable Unit 6 (Additional Properties) and Interim Actions at Other Locations Containing Raymark Waste." Stratford, Connecticut.

Nobis Engineering, Inc., August 2010. Remedial Investigation/Feasibility Study. Operable Unit 6 - Additional Properties. Raymark Industries, Inc. Superfund Site. 576/600 East Broadway, Stratford, Connecticut. July.

Tetra Tech Nus, Inc., June 2005. Final Remedial Investigation, Raymark Industries, Inc. Superfund Site. 576/600 East Broadway, Stratford, Connecticut. July.

1.8 TASK SPECIFIC HAZARDS, INITIAL PPE, HAZWOPER MEDICAL SURVEILLANCE AND TRAINING APPLICABILITY

Task specific occupational hazards, task specific HAZWOPER medical surveillance and training applicability and task specific initial PPE requirements for the project are listed on the Task Hazard and Control

Sheets at the end of this section. It is the Contractor's responsibility to reevaluate occupational safety and health hazards as the work progresses and to adjust the PPE and onsite operations, if necessary, so that the work is performed safely and in compliance with occupational safety and health regulations.

1.9 STAFF ORGANIZATION, QUALIFICATION AND RESPONSIBILITIES

1.9.1 Safety and Health Manager

Safety and Health Manager must be an Industrial Hygienist certified by the American Board of Industrial Hygiene or Certified Safety Professional certified by the Board of Certified Safety Professionals.

1.9.1.1 Additional Qualifications

The Safety and Health Manager must have the following additional qualifications:

a. A minimum of 3 years experience in developing and implementing safety and health programs at hazardous waste sites.

b. Documented experience in supervising professional and technician level personnel.

c. Documented experience in developing worker exposure assessment programs and air monitoring programs and techniques.

d. Documented experience in managing personal protective equipment programs and conducting PPE hazard evaluations for the types of activities and hazards likely to be encountered on the project.

e. Working knowledge of state and Federal occupational safety and health regulations.

1.9.1.2 Responsibilities and Duties

The Safety and Health Manager shall:

a. Be responsible for the development, implementation, oversight, and enforcement of the APP/SSHP.

b. Sign and date the APP/SSHP prior to submittal.

c. Conduct initial site-specific training.

d. Be present onsite during the first 3 days of remedial activities and at the startup of each new major phase of work.

e. Visit the site as needed and at least once per week for the duration of activities, to audit the effectiveness of the APP/SSHP.

f. Be available for emergencies.

g. Provide onsite consultation as needed to ensure the APP/SSHP is fully implemented.

h. Coordinate any modifications to the APP/SSHP with the Site Superintendent, the SSHO, and the Contracting Officer Representative.

i. Provide continued support for upgrading/downgrading of the level of personal protection.

j. Be responsible for evaluating air monitoring data and recommending changes to engineering controls, work practices, and PPE.

k. Review accident reports and results of daily inspections.

l. Serve as a member of the Contractor's quality control staff.

1.9.2 Additional Certified Health and Safety Support Personnel

Retain safety support from a safety professional certified by the Board of Certified Safety professionals to develop written occupational safety procedures for the APP/SSHP and, when necessary, visit the site to help implement APP/SSHP requirements.

1.9.3 Site Safety and Health Officer

Designate an individual and one alternate as the Site Safety and Health Officer (SSHO). The name, qualifications (education and training summary and documentation), and include work experience of the Site Safety and Health Officer and alternate in the APP/SSHP.

1.9.3.1 Qualifications

The SSHO shall meet the following qualifications:

a. A minimum of 1 year experience in implementing safety and health programs at hazardous waste sites where Level C personal protective equipment was required.

b. Documented experience in construction techniques and construction safety procedures.

c. Working knowledge of Federal and state occupational safety and health regulations.

d. Specific training in personal and respiratory protective equipment, confined space entry and in the proper use of air monitoring instruments and air sampling methods including monitoring for asbestos.

1.9.3.2 Responsibilities and Duties

The Site Safety and Health Officer shall:

a. Assist and represent the Safety and Health Manager in onsite training and the day to day onsite implementation and enforcement of the accepted APP/SSHP.

b. Be assigned to the site on a full time basis for the duration of field activities. The SSHO can have collateral duties in addition to Safety and Health related duties. If operations are performed during more than 1 work shift per day, a site Safety and Health Officer must be present for each shift.

c. Have authority to ensure site compliance with specified safety and health requirements, Federal, state and OSHA regulations and all

aspects of the APP/SSHP including, but not limited to, activity hazard analyses, air monitoring, use of PPE, decontamination, site control, standard operating procedures used to minimize hazards, safe use of engineering controls, the emergency response plan, confined space entry procedures, spill containment program, and preparation of records by performing a daily safety and health inspection and documenting results on the Daily Safety Inspection Log in accordance with 29 CFR 1904.

d. Have authority to stop work if unacceptable health or safety conditions exist, and take necessary action to re-establish and maintain safe working conditions.

e. Consult with and coordinate any modifications to the APP/SSHP with the Safety and Health Manager, the Site Superintendent, and the Contracting Officer Representative.

f. Serve as a member of the Contractor's quality control staff on matters relating to safety and health.

g. Conduct accident investigations and prepare accident reports.

h. Conduct daily safety inspection and document safety and health findings into the Daily Safety Inspection Log. Track noted safety and health deficiencies to ensure that they are corrected.

i. In coordination with site management and the Safety and Health Manager, recommend corrective actions for identified deficiencies and oversee the corrective actions.

1.9.4 Occupational Physician

Utilize the services of a licensed physician, who is certified in occupational medicine by the American Board of Preventative Medicine, or who, by necessary training and experience is Board eligible. The physician must be familiar with this site's hazards and the scope of this project. Include the medical consultant's name, qualifications, and knowledge of the site's conditions and proposed activities in the APP/SSHP. The physician will be responsible for the determination of medical surveillance protocols and for review of examination/test results performed in compliance with 29 CFR 1910.120, (f) and 29 CFR 1926.65, (f) and paragraph MEDICAL SURVEILLANCE.

1.9.5 Persons Certified in First Aid and CPR

At least two persons who are currently certified in first aid and CPR by the American Red Cross or other approved agency must be onsite at all times during site operations. They must be trained in universal precautions and the use of PPE as described in the Bloodborne Pathogens Standard of 29 CFR 1910, Section .1030. These persons may perform other duties but will be immediately available to render first aid when needed.

1.9.6 Safety and Health Technicians

For each work crew in the exclusion zone, one person, designated as a Safety and Health technician, must perform activities such as air monitoring, decontamination, and safety oversight on behalf of the SSHO. They must have appropriate training equivalent to the SSHO in each specific area for which they have responsibility and report to and be under the supervision of the SSHO.

1.10 TRAINING

Meet the following requirements in the Contractor's training program for workers performing cleanup operations and who will be exposed to contaminants.

1.10.1 General Hazardous Waste Operations Training

All Personnel performing duties with potential for exposure to onsite contaminants must meet and maintain the following 29 CFR 1910.120/ 29 CFR 1926.65 (e) training requirements:

a. 40 hours of off site hazardous waste instruction.

b. 3 days actual field experience under the direct supervision of a trained, experienced supervisor.

c. 8 hours refresher training annually.

Onsite supervisors must have an additional 8 hours management and supervisor training specified in 29 CFR 1910.120/29 CFR 1926.65 (e) (4).

1.10.2 Pre-entry Briefing

Prior to commencement of onsite field activities, all site employees, including those assigned only to the Support Zone, must attend a site-specific safety and health training session. This session will be conducted by the Safety and Health Manager and the Site Safety and Health Officer to ensure that all personnel are familiar with requirements and responsibilities for maintaining a safe and healthful work environment. Thoroughly discuss procedures and contents of the accepted APP/SSHP and Sections 01.B.02 and 28.D.03 of EM 385-1-1. Each employee must sign a training log to acknowledge attendance and understanding of the training. Notify the Contracting Officer Representative at least 5 days prior to the initial site-specific training session so government personnel involved in the project may attend.

1.10.3 Periodic Sessions

Conduct periodic onsite training by the SSHO at least daily for personnel assigned to work at the site during the following day. Address safety and health procedures, work practices, any changes in the APP/SSHP, activity hazard analyses, work tasks, or schedule; results of previous week's air monitoring, review of safety discrepancies and accidents. Convene a meeting prior to implementation of the change must be convened should an operational change affecting onsite field work be made, to explain safety and health procedures. Conduct a site-specific training sessions for new personnel, visitors, and suppliers by the SSHO using the training curriculum outlines developed by the Safety and Health Manager. Each employee must sign a training log to acknowledge attendance and understanding of the training.

1.10.4 Other Training

Two hour asbestos worker traiing, where required, will be provided by the Owner's Representative. Such training will be required of all personnel who are not licensed asbestos workers.

1.11 PERSONAL PROTECTIVE EQUIPMENT

1.11.1 Site Specific PPE Program

Provide onsite personnel exposed to contaminants with appropriate personal protective equipment. Components of levels of protection (B, C, D and modifications) must be relevant to site-specific conditions, including heat and cold stress potential and safety hazards. Use only respirators approved by NIOSH. Commercially available PPE, used to protect against chemical agent, must be approved by the director of Army Safety through the Chemical Agent Safety and Health Policy Action Committee (CASHPAC). Keep protective equipment and clothing clean and well maintained. Include site-specific procedures to determine PPE program effectiveness and for onsite fit-testing of respirators, cleaning, maintenance, inspection, and storage of PPE within the PPE section of the APP/SSHP.

1.11.2 Levels of Protection

The Safety and Health Manager must establish and evaluate as the work progresses the levels of protection for each work activity. Also establish action levels for upgrade or downgrade in levels of PPE. Describe in the SSHP the protocols and the communication network for changing the level of protection. Address air monitoring results, potential for exposure, changes in site conditions, work phases, job tasks, weather, temperature extremes, individual medical considerations, etc. within the PPE evaluation protocol.

1.11.2.1 Initial PPE Components

The following items constitute initial minimum protective clothing and equipment ensembles.

a. Level D. Hard hats, steel-toed boots, safety glasses, and reflective safety vest.

b. Level D plus Tyvek.

c. Modified Level D plus respirators.

1.11.3 PPE for Government Personnel

Three clean sets of personal protective equipment and clothing (excluding air-purifying negative-pressure respirators and safety shoes, which will be provided by individual visitors), as required for entry into the Exclusion Zone and/or Contamination Reduction Zone, must be available for use by the Contracting Officer Representative or official visitors. The items must be cleaned and maintained by the Contractor and stored appropriately and clearly marked: "FOR USE BY GOVERNMENT ONLY." Provide basic training in the use and limitations of the PPE provided.

1.12 MEDICAL SURVEILLANCE PROGRAM

Meet 29 CFR 1910.120/29 CFR 1926.65 (f) and the following requirements for medical surveillance program for workers performing cleanup operations and who will be exposed to contaminants. Assure the Occupational Physician or the physician's designee performs the physical examinations and reviews examination results. Participation in the medical surveillance program will be without cost to the employee, without loss of pay and at a reasonable time and place.

1.12.1 Frequency of Examinations

Medical surveillance program participants must receive medical examinations and consultations on the following schedule:

a. Every 12 months

b. If and when the participant develops signs and symptoms indicating a possible overexposure due to an uncontrolled release of a hazardous substance on the project.

c. Upon termination or reassignment to a job where medical surveillance program participation is not required, unless his/her previous annual examination/consultation was less than 6 months prior to reassignment or termination.

d. On a schedule specified by the occupational physician.

1.12.2 Content of Physical Examinations/Consultation

Verify the following information about medical surveillance program participants:

a. Baseline health conditions and exposure history.

b. Allergies/sensitivity/susceptibility to hazardous substances exposure.

c. Ability to wear personal protective equipment inclusive of NIOSH certified respirators under extreme temperature conditions.

d. Fitness to perform assigned duties.

Provide the occupational physician with the following information for each medical surveillance program participant:

a. Information on the employee's anticipated or measured exposure.

b. A description of any PPE used or to be used.

c. A description of the employee's duties as they relate to the employee's exposures (including physical demands on the employee and heat/cold stress).

d. A copy of 29 CFR 1910.120, or 29 CFR 1926.65.

e. Information from previous examinations not readily available to the examining physician.

f. A copy of Section 5.0 of NIOSH 85-115.

g. Information required by 29 CFR 1910 Section .134.

1.12.3 Physician's Written Opinion

Obtain and furnish to the Safety and Health Manager; and the employee before work begins, a copy of the physician's written opinion for each employee. Address the employee's ability to perform hazardous waste site remediation work and containing the following:

a. The physician's verification of the employee's fitness to perform duties as well as recommended limitations upon the employee's assigned work and/or PPE usage.

b. The physician's opinion about increased risk to the employee's health resulting from work; and

c. A statement that the employee has been informed and advised about the results of the examination.

1.12.4 Employee Certificates

Provided on employee certificates for each worker performing cleanup operations with potential for contaminant-related occupational exposure signed by the safety and health manager and the occupational physician indicating the workers meet the training and medical surveillance requirements of this contract.

1.13 EXPOSURE MONITORING/AIR SAMPLING PROGRAM

Prepare and implement by the Safety and Health Manager an exposure monitoring/air sampling program to identify and quantify safety and health hazards and airborne levels of hazardous substances in order to assure proper selection of engineering controls, work practices and personal protective equipment for affected site personnel. Include action levels for upgrading/downgrading PPE in the program. Submit personnel exposure monitoring/sampling results.

1.14 HEAT STRESS MONITORING AND MANAGEMENT

Document in the APP/SSHP and implement the procedures and practices in section 06.J. in EM 385-1-1 to monitor and manage heat stress.

1.15 SPILL AND DISCHARGE CONTROL

Develop and implement written spill and discharge containment/control procedures. Address material handling equipment, as well as drum and container handling, opening, sampling, shipping and transport. Describe prevention measures, such as building berms or dikes; spill control measures and material to be used (e.g. booms, vermiculite); location of the spill control material; personal protective equipment required to cleanup spills; disposal of contaminated material; and who is responsible to report the spill. Storage of contaminated material or hazardous materials must be appropriately bermed, diked and/or contained to prevent any spillage of material on uncontaminated soil. If the spill or discharge is reportable, and/or human health or the environment are threatened, the National Response Center, the state, and the Contracting Officer Representative must be notified as soon as possible.

1.16 SITE CONTROL MEASURES

1.16.1 Work Zones

Initial anticipated work zone boundaries (exclusion zone, contamination reduction zone, support zone, all access points and decontamination areas) are to be clearly delineated on the site drawings. Base delineation of work zone boundaries on the contamination characterization data and the hazard/risk analysis to be performed as described in paragraph: HAZARD/RISK

ANALYSIS. As work progresses and field conditions are monitored, work zone boundaries may be modified (and site drawings modified) with approval of the Contracting Officer Representative. Clearly identify work zones and marked in the field (using fences, tape, signs, etc.). Submit and post a site map, showing work zone boundaries and locations of decontamination facilities in the onsite office. Work zones must consist of the following:

a. Exclusion Zone (EZ): The exclusion zone is the area where hazardous contamination is either known or expected to occur and the greatest potential for exposure exists. Control entry into this area and exit may only be made through the CRZ.

b. Contamination Reduction Zone (CRZ): The CRZ is the transition area between the Exclusion Zone and the Support Zone. The personnel and equipment decontamination areas must be separate and unique areas located in the CRZ.

c. Support Zone (SZ): The Support Zone is defined as areas of the site, other than exclusion zones and contamination reduction zones, where workers do not have the potential to be exposed to hazardous substances or dangerous conditions resulting from hazardous waste operations. Secure the Support Zone against active or passive contamination. Site offices, parking areas, and other support facilities must be located in the Support Zone.

1.16.2 Site Control Log

A log of personnel visiting, entering, or working on the site must be maintained. Include the following: date, name, agency or company, time entering and exiting site, time entering and exiting the exclusion zone (if applicable). Before visitors are allowed to enter the Contamination Reduction Zone or Exclusion Zone, they must show proof of current training, medical surveillance and respirator fit testing (if respirators are required for the tasks to be performed) and fill out a Certificate of Worker or Visitor Acknowledgment. Record this visitor information, including date, in the log.

1.16.3 Communication

Provide and install an employee alarm system that has adequate means of on and off site communication in accordance with 29 CFR 1910 Section .165. The means of communication must be able to be perceived above ambient noise or light levels by employees in the affected portions of the workplace. The signals must be distinctive and recognizable as messages to evacuate or to perform critical operations.

1.16.4 Site Security

Provide the following site security: Print signs in bold large letters on contrasting backgrounds. Signs must be visible from all points where entry might occur and at such distances from the restricted area that employees may read the signs and take necessary protective steps before entering.

1.17 PERSONAL HYGIENE AND DECONTAMINATION

Personnel entering the Exclusion or Contamination Reduction Zones or otherwise exposed to hazardous chemical vapors, gases, liquids, or contaminated solids must decontaminate themselves and their equipment prior to exiting the contamination reduction zone (CRZ) and entering the support

zone. Consult Chapter 10.0 of NIOSH 85-115 when preparing decontamination procedures. Submit a detailed discussion of personal hygiene and decontamination facilities and procedures to be followed by site workers as part of the APP/SSHP. Train employees in the procedures and enforce the procedures throughout site operations.

1.17.1 Decontamination Facilities

Submit drawings showing the layout of the personnel and equipment decontamination areas.

1.17.2 Personnel Decontamination

Initially set up a decontamination line in the CRZ. Employees must exit the exclusion zone through the CRZ and implement the following decontamination procedures and techniques: Remove all outer garments, hand and face wash. It is the Site Safety and Health Officer's responsibility to recommend techniques to improve personnel decontamination procedures, if necessary.

1.17.3 Equipment Decontamination

Decontaminate the vehicles and equipment used in the EZ shall be decontaminated in the CRZ prior to leaving the site.

1.17.3.1 Facilities for Equipment and Personnel

Provide a vehicle/equipment decontamination station within the CRZ for decontaminating vehicles and equipment leaving the EZ. Construct a decontamination station pad, which meets the site decontamination needs for all vehicles and larger equipment decontamination. Construct the pad to capture decontamination water, including overspray, and allow for collection and removal of the decontamination water using sumps, dikes and ditches as required. High pressure, low volume, water wash area for equipment and vehicles.

1.17.3.2 Procedures

Procedures for equipment decontamination must be developed and utilized to prevent the spread of contamination into the SZ and offsite areas. These procedures must address disposal of contaminated products and spent materials used on the site, including containers, fluids, oils, etc. Assume any item taken into the EZ to be contaminated and perform an inspection and decontaminate. Vehicles, equipment, and materials must be cleaned and decontaminated prior to leaving the site. Handle construction material in such a way as to minimize the potential for contaminants being spread and/or carried offsite. Prior to exiting the site, vehicles and equipment must be monitored to ensure the adequacy of decontamination.

1.18 EMERGENCY EQUIPMENT AND FIRST AID REQUIREMENTS

Maintain, as a minimum, the following items onsite and available for immediate use:

a. First aid equipment and supplies approved by the consulting physician.

b. Emergency eyewashes and showers that comply with ANSI/ISEA Z358.1.

c. Provide fire extinguishers of sufficient size and type at site

facilities and in all vehicles and at any other site locations where flammable or combustible materials present a fire risk.

1.19 EMERGENCY RESPONSE AND CONTINGENCY PROCEDURES

An Emergency Response Plan, that meets the requirements of 29 CFR 1910.120 (l) and 29 CFR 1926.65 (l), must be developed and implemented as a section of the APP/SSHP. In the event of any emergency associated with remedial action, without delay, alert all onsite employees and as necessary offsite emergency responders that there is an emergency situation; take action to remove or otherwise minimize the cause of the emergency; alert the Contracting Officer Representative; and institute measures necessary to prevent repetition of the conditions or actions leading to, or resulting in, the emergency. Train employees that are required to respond to hazardous emergency situations to their level of responsibility according to 29 CFR 1910.120 (q) and 29 CFR 1926.65 (q) requirements. Rehearse the plan regularly as part of the overall training program for site operations. Review the plan periodically and revised as necessary to reflect new or changing site conditions or information. Provide copies of the Emergency Response Portion of the accepted APP/SSHP to the affected local emergency response agencies. Address, as a minimum, the following elements in the plan:

a. Pre-emergency planning. Coordinate with local emergency response providers during preparation of the Emergency Response Plan. At a minimum, coordinate with local fire, rescue, hazardous materials response teams, police and emergency medical providers to assure all organizations are capable and willing to respond to and provide services for on-site emergencies. Ensure the Emergency Response Plan for the site is compatible and integrated with the local fire, rescue, medical and police security services available from local emergency response planning agencies.

b. Personnel roles, lines of authority, communications for emergencies.

c. Emergency recognition and prevention.

d. Site topography, layout, and prevailing weather conditions.

e. Criteria and procedures for site evacuation (emergency alerting procedures, employee alarm system, emergency PPE and equipment, safe distances, places of refuge, evacuation routes, site security and control).

f. Specific procedures for decontamination and medical treatment of injured personnel.

g. Route maps to nearest prenotified medical facility. Site-support vehicles must be equipped with maps. At the beginning of project operations, drivers of the support vehicles must become familiar with the emergency route and the travel time required.

h. Emergency alerting and response procedures including posted instructions and a list of names and telephone numbers of emergency contacts (physician, nearby medical facility, fire and police departments, ambulance service, Federal, state, and local environmental agencies; as well as Safety and Health Manager, the Site Superintendent, the Contracting Officer Representative and/or their alternates).

i. Criteria for initiating community alert program, contacts, and responsibilities.

j. Procedures for reporting incidents to appropriate government agencies. In the event that an incident such as an explosion or fire, or a spill or release of toxic materials occurs during the course of the project, the appropriate government agencies must be immediately notified. In addition, verbally notify the Contracting Officer Representative and the local district safety office immediately and receive a written notification within 24 hours. Include within the report the following items:

(1) Name, organization, telephone number, and location of the Contractor.

(2) Name and title of the person(s) reporting.

(3) Date and time of the incident.

(4) Location of the incident, i.e., site location, facility name.

(5) Brief summary of the incident giving pertinent details including type of operation ongoing at the time of the incident.

(6) Cause of the incident, if known.

(7) Casualties (fatalities, disabling injuries).

(8) Details of any existing chemical hazard or contamination.

(9) Estimated property damage, if applicable.

(10) Nature of damage, effect on contract schedule.

(11) Action taken to ensure safety and security.

(12) Other damage or injuries sustained, public or private.

k. Procedures for critique of emergency responses and follow-up.

1.20 CERTIFICATE OF WORKER/VISITOR ACKNOWLEDGEMENT

A copy of a Contractor-generated certificate of worker/visitor acknowledgement must be completed and submitted for each visitor allowed to enter contamination reduction or exclusion zones, and for each employee, following the example certificate at the end of this section.

1.21 INSPECTIONS

Attach to and submit with the Daily Quality Control reports the SSHO's Daily Inspection Logs. Include with each entry the following: date, work area checked, employees present in work area, PPE and work equipment being used in each area, special safety and health issues and notes, and signature of preparer.

1.22 SAFETY AND HEALTH PHASE-OUT REPORT

Submit a Safety and Health Phase-Out Report in conjunction with the project

close out report and will be received prior to final acceptance of the work. Include the following minimum information :

a. Summary of the overall performance of safety and health (accidents or incidents including near misses, unusual events, lessons learned, etc.).

b. Final decontamination documentation including procedures and techniques used to decontaminate equipment, vehicles, and on site facilities.

c. Summary of exposure monitoring and air sampling accomplished during the project.

d. Signatures of Safety and Health Manager and SSHO.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 01 35 45.00 10

CHEMICAL DATA QUALITY CONTROL
04/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. ARMY CORPS OF ENGINEERS (USACE)

UFP QAPP	(2004) Uniform Federal Policy for Quality Assurance Project Plans, July 2004, OSWER Directive 9272.0-17
EM 200-1-6	(1997) Environmental Quality -- Chemical Quality Assurance for HTRW Projects
ER 1110-1-263	(1998) Engineering and Design -- Chemical Data Quality Management for Hazardous, Toxic, Radioactive Waste Remedial Activities

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 540/R 94-008	(1999) USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review
EPA SW-846.3-3	(1999, Third Edition, Update III-A) Test Methods for Evaluating Solid Waste: Physical/Chemical Methods

1.2 ACRONYMS

The definition of acronyms used by the Contractor that pertain to chemical data quality control shall be clearly defined for all contract related products and communications.

1.3 MEASUREMENT AND PAYMENT

Separate payment will not be made for providing and maintaining the chemical data quality requirements including the chemical data quality management, chemical data validation, minimum chemical data reporting requirements, and chemical data quality submittal requirements; these costs shall be included in the applicable unit prices or lump sum prices contained in the bidding schedule.

1.4 CHEMISTRY REQUIREMENTS

Chemical Data Quality Control (CDQC) shall be as defined in ER 1110-1-263; this ER, which integrates USACE guidance on the subject, shall be supplemented by EM 200-1-6 for detail technical guidance on CDQC. Tables

and charts defining Design Analysis (DA), ROD, and remedial technology specific chemistry shall be according to or consistent with UFP QAPP.

1.4.1 Data Quality Objectives (DQO)

Sample acquisition, chemical analysis and chemical parameter measurements shall be performed so that the resulting data meet and support data use requirements. The chemical data shall be acquired, documented, verified and reported to ensure that the specified precision, accuracy, representativeness, comparability, completeness and sensitivity requirements are achieved.

1.4.2 Sampling, Analysis and Measurement

In accordance with Technical Specifications.

1.4.2.1 Borrow or Fill Material Samples

Borrow or fill material samples shall be collected and analyzed in accordance with Section 31 00 00 EARTHWORK.

1.4.2.2 Perimeter Air Monitoring Samples

Perimeter air monitoring samples shall be analyzed in accordance with Section 02 82 14.00 10 ASBESTOS HAZARD CONTROL ACTIVITIES.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Sampling and Analysis Plan; G

Submit no later than 14 days after receipt of notice to proceed.

SD-06 Test Reports

QA Sample Collection and Analysis; G
Chemistry Data Package; G

Chemical Data Final Report; G

Each report shall be labeled with the contract number, project name and location.

1.6 QUALITY ASSURANCE ELEMENTS

Follow the QA elements necessary to monitor and ensure the quality of chemical data produced.

1.6.1 Laboratory Validation Requirements

Laboratories completing the soil and air testing will have obtained approval under the Department of Defense Environmental Laboratories

Accreditation Program (DoD ELAP). Surveys of environmental testing conducted in support of the Department of Defense (DoD) estimate that at least 90 percent of the testing is performed by contract laboraties. The DoD unified minimum quality systems requirements for environmental laboratories that intend to perform work for the Department of Defense across the Components by publishing the DoD Quality Systems Manual for Environmental Laboratories (DoD QSM). The DoD QSM is based on the National Environmental Laboratory Accreditation Conference (NELAC) certificaton process.

1.6.2 QA Sample Collection and Analysis

Collect and transport QA samples to the QA laboratory. Samples for all analyses (except volatiles) shall be taken as splits of homogenized samples. Samples for volatiles shall be collected as discrete duplicates/triplicates.

a. Submit the QA Laboratory Advance Notification (QALAN) to the QA laboratory at least 10 business days before the initial shipment of samples. The QALAN shall include a list of laboratory-related DQO. The DQO shall include, but shall not be limited to, identification of extraction and analysis method numbers, a list of analytes with required limits, estimated number of tests, approximate sampling dates, and requested completion date for QA testing. Notify the Contracting Officer Representative (CO) and the QA laboratory immediately of any changes.

b. Provide all labor and field supplies, including sample containers and shipping coolers, for collecting and shipping samples for QA testing. In the presence of the Contracting Officer Representative, properly collect, label, and package the QA samples, fill out all chain-of-custody forms, and ship the samples by one-day delivery service to the designated QA laboratory for analysis. Notify the laboratory when all sampling is completed and shall clearly mark the chain-of-custody form accompanying the final shipment "FINAL" in 1 inch high lettering.

c. Allow 60 calendar days for laboratory analysis of QA samples, data review, and submission of the Government chemical quality assurance report. The elapsed time shall begin when the Contractor's last sample arrives at the QA laboratory, provided that the Contractor's completed chemistry data package is received within 30 calendar days thereafter. Otherwise, allow 30 calendar days from the date the completed chemistry data package is received at the laboratory. The Contractor may, as an option, continue activities based on initial sampling and QC results, before receipt of QA test results. Where QA results are unacceptable due to Contractor negligence (e.g. improper sample collection and/or handling by the Contractor), or where QA sample results conflict with the Contractor's primary sample results, further sampling and testing shall be performed as directed by the CO. All costs for such additional sampling and testing due to Contractor negligence, including both QC and QA testing and analysis, and for any required remedial actions in the work, shall be borne by the Contractor. USACE acceptance of final disposition of any excavated soil shall not occur until the Contractor's sampling and QC results have been confirmed by QA results. This includes all final stockpiling, wasting, backfilling, and related construction. No payment will be made for laboratory sampling and testing before receipt and acceptance by the Government of the QA samples and the completed Chemical Data Final Report (CDFR),

properly formulated according to these specifications.

1.6.3 Single or Double Blind Performance Evaluation Samples

Submit certified soil Performance Evaluation (PE) samples. The PE samples shall contain the site specific contaminants of concern. The analytes shall be contained in the PE samples at the site specific action levels for each target analyte. At the beginning of the projectone PE sample per analysis type shall be submitted for analysis. If the laboratory does not meet the certified PE sample acceptance limits, project sample analysis shall be terminated until corrective actions have been implemented. Supply the PE sample results and the vendor's acceptance limit documentation to the CO within 48 hours following reporting of the results by the laboratory.

1.6.4 Review of Primary Laboratory Data

Secure independent data review of the entire primary data set.

1.6.5 Validation of Data

One hundred percent of the soil data will be validated using USEPA Region I guidelines Tier II procedures (USEPA, 1996). In addition, aalidate 10 percent of the data in accordance with EPA 540/R 94-008 (National Functional Guidelines). Samples chosen for 10 percent full validation will be selected from the first groups of samples generated at the beginning of the field program. Additional samples in the 10 percent will be selected later in the sampling program to cover the full time span of the remedial action. The data validation strategy shall be established at the beginning of the project to be consistent with project DQO.

1.7 QUALIFICATIONS

1.7.1 Chemical Quality Control Officer

As a minimum, the Contractor's Chemical Quality Control Officer shall have: a bachelors degree in Chemistry or related science; five years of experience related to investigations, studies, design and remedial actions at HTRW sites; and five field seasons (or one continuous calendar year experience) in calibration and operation of various field monitoring devices as well as standard analytical chemistry methods common for analyzing soil, water, air and other materials for chemical contamination assessment, including hazardous waste manifesting. The Chemical Quality Control Officer shall ensure that all chemistry related objectives including responsibilities for DQO definitions, sampling and analysis, project requirements for data documentation and validation, and final project reports are attained. The Chemical Quality Control officer need not be present onsite during routine sampling, but shall be available for consultation with Government and Contractor personnel.

1.7.2 Project Chemist

As a minimum, the Contractor's Senior Chemist shall have: a bachelors degree in Chemistry or related science; three years of experience related to investigations, studies, design and remedial actions at HTRW sites; three field seasons experience in calibrating and operating various field monitoring devices; and three years of experience in the operation of an HTRW commercial laboratory with standard analytical chemistry methods common for analyzing soil, water, air and other materials for chemical contamination assessment, including data for hazardous waste manifesting.

The project chemist shall ensure that all chemistry related goals of the program are attained. The project chemist shall be onsite during all sampling events and shall also be available for consultation with Government personnel.

1.7.3 Environmental Sampler

As a minimum, the Contractor's Environmental Sampler shall have: a bachelors degree in Chemistry, Environmental Science, Engineering, Geology, Hydrology, or a related field; one year of experience in and knowledge of EPA methods for collecting environmental and hazardous waste samples; one year of experience in operation of field screening equipment (e.g. PID, FID, infrared spectrometer, immunoassay, etc.); and one field seasons of experience with the particular field screening techniques for use on this project. The Environmental Sampler shall collect all onsite samples and perform all field screening tests. The Environmental Sampler shall review the sampling results, and provide recommendations for the Contractor's sampling program. The Environmental Sampler shall be onsite during excavation and stockpiling operations involving contaminated soil or soil to be checked for contamination.

1.8 COORDINATION MEETING

After the preconstruction conference, before any sampling or testing, the Contractor and the Contracting Officer Representative will meet at the construction site to discuss the CQC Plan and the SAP. The coordination meeting will be simultaneous to any CQC coordination meeting required in Section 01 45 00.10 10 QUALITY CONTROL SYSTEMS (QCS) unless otherwise indicated or directed. A list of definable features that involve chemical measurements shall be agreed upon. At a minimum, each matrix (soil, water, air, containerized wastes, radioactive wastes, instrumental chemical parameter measurement, etc.) shall be a definable work feature. Management of the chemical data quality system including project DQO, project submittals, chemical data documentation, chemical data assessment, required sampling and analysis protocols, and minimum data reporting requirements shall be agreed upon. The meeting will serve to establish an interrelationship between the Contractor's chemical data quality management and Government chemical quality assurance requirements. Minutes of the meeting will be documented by the Government and shall be signed by both the Contractor and the Contracting Officer Representative. The minutes will include any or all unresolved chemical issues along with the conditions for resolution and will become a part of the contract file.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

Provide chemical sample acquisition, sample analysis, instrumental measurements of chemical parameters for chemical data quality control. An effective chemical data quality control system shall be established that meets the requirements for the chemical measurement DQO applicable to the project. The system shall cover chemical measurements pertaining to and required for Contractor and subcontractor produced chemical data. Control field screening, sampling, and testing in conjunction with remedial activities to meet all DQO; minimize the amount of excavated material

requiring temporary storage; prevent dilution of contaminated soils with clean soils; and ensure completion of work within the required time.

3.2 QUALITY CONTROL PLAN

The project quality control plan will be prepared in accordance with the UFP QAPP guidelines. Because this is a remedial action, it is anticipated that some of the worksheets will not be included. During the development of the UFP QAPP a list of relevant worksheets will be determined. Ratinal for exculsion of worksheets (if applicable) wil lbe documented in the UFP QAPP.

3.2.1 Additional Requirements

In addition to the quality control requirements specified in Section 01 45 00.10 10 QUALITY CONTROL SYHSTEMS (QCS), the CQC Plan shall incorporate the qualifications, authority and responsibilities of all chemical quality management and support personnel. Chemical measurements including sampling and/or chemical parameter measurement will not be permitted to begin until after production and acceptance of the CQC Plan, and Government approval of the SAP.

3.2.2 Chemistry Elements of the CQC Plan

To cover contract related chemical measurements by the Contractor and all subContractors, the CQC Plan shall include the following as a minimum.

3.2.2.1 Qualifications

Names, education, experience qualifications, authorities, and decision-making responsibilities of all chemical quality management and support personnel. The CQC Plan shall contain a copy of a letter from the project QC manager designating and authorizing a Chemical Quality Control Officer and chemical quality control organization staff.

3.2.2.2 Authority and Responsibility

A diagram, flow chart, or figure clearly depicting the chemical data quality management and support staff and the authority and responsibility of each for chemical sampling and analysis, procedures for corrective actions, deliverables and submittals, deviations and changes, chemical quality documentation, data validation, minimum data reporting requirements, and DQO for chemical parameter measurement by the Contractor and subContractors. The contents of this section of the CQC Plan shall be included in the applicable "Project Organization" elements of the FSP and the QAPP.

3.3 SAMPLING AND ANALYSIS PLAN

Sampling and analysis procedures shall be prepared in accordance with DOD requirements in the UFP. The UFP document will contain all elements of an FSP and QAPP. Sections of the QAPP shall be cross referenced to additional documents when applicable. The UFP QAPP shall confirm the Contractor's understanding of the contract requirements for chemical data quality control, and shall describe procedures for field sampling and sample submittal for analysis, field chemical parameter measurement, data documentation, data assessment and data reporting requirements. The UFP QAPP shall delineate the methods the Contractor intends to use to accomplish the chemical quality control items to assure accurate, precise, representative, complete, legally defensible and comparable data. The SAP

shall describe all chemical parameter measurements for all matrices for all phases of the remediation contract. As a single interrelated document, the SAP shall be provided to field and laboratory personnel. The Contractor may propose original/innovative approaches to chemical parameter measurements for cost reduction and remediation efficiency by abbreviated sampling, contingency sampling and/or contingency analysis, indicator or tracer analysis, onsite analytical services, equivalency or screening methods. The SAP shall clearly identify the Contractor obtained laboratories. Furnish copies of the Government approved SAP to all laboratories and the Contractor's field sampling crew. The SAP shall address all levels of the investigation with enough detail to become a document which may be used as an audit guide for field and laboratory work.

3.3.1 Field Sampling Plan

The UFP QAPP shall contain necessary technical detail and direction for the field personnel to understand sampling and field measurement requirements. The FSP shall provide a comprehensive description and full detail for personnel to perform all onsite activities required to attain project DQO, including: locations of samples, sampling procedures for onsite and offsite chemical analysis, summaries of analyses to be performed on samples, shipment of samples for offsite analyses, performance of onsite and offsite instrumental parameter measurements, data documentation and reporting requirements.

3.3.2 Quality Assurance Project Plan

The UFP QAPP shall contain necessary technical detail and direction for field and laboratory personnel to understand project sample analysis, quality control and data reporting requirements, analytical methods, required detection limits, QC requirements, and data validation and reporting requirements.

3.4 CHEMISTRY DATA PACKAGE

The chemistry data package shall be produced and provided through USACE CO every 7 days of the project.

The chemistry data package shall contain information to demonstrate that the project's DQO have been fulfilled. The QA function will compare QA sample results to corresponding primary sample results, will assess the Contractor's compliance with the SAP, and will recommend corrective action as necessary.

3.5 CONTROL OF CHEMICAL DATA QUALITY

Contractor chemical data quality control shall ensure that a quality control program is in place that assures sampling and analytical activities and the resulting chemical parameter measurement data comply with the DQO and the requirements of the UFP QAPP.

3.6 ANALYTICAL TESTING LABORATORIES

Propose the analytical laboratories to be used for the primary samples analyses. Laboratory validation requirements shall be in accordance with the DoD ELAP. The Contractor may utilize its own laboratory or utilize subcontract laboratories to achieve the primary required sample analyses.

3.6.1 Laboratory Analytical Requirements

Provide the specified chemical analyses by the Contractor's laboratory. Provide chemical analyses to achieve the project DQO for all parameters specified by the methods. To give the USACE programs the greatest flexibility in the execution of its projects, the EPA SW-846.3-3 methods are generally the methods employed for the analytical testing of environmental samples. These methods are flexible and shall be adapted to individual project-specific requirements.

3.6.2 Laboratory Performance

Provide continued acceptable analytical performance and shall establish a procedure to address data deficiencies noted by review and/or quality assurance sample results. Provide and implement a mechanism for providing analytical labs with the UFP QAPP, for monitoring the lab's performance and for performing corrective action procedures. Acquire analytical services with additional DoD ELAP validated laboratories in the event a project lab loses its validation status during the project.

3.7 CHEMICAL DATA FINAL REPORT

The CDFR shall be produced including a summary of quality control practices employed and all chemical parameter measurement activities after project completion. As a minimum, the CDFR shall contain the following:

a. Summary of project scope and description.

b. Summary of any deviations from the design chemical parameter measurement specifications.

c. Summary of chemical parameter measurements performed as contingent measurements.

d. Summary discussion of resulting data including achieving data reporting requirements.

e. Summary of achieving project specific DQO.

f. Presentation and evaluation of the data to include an overall assessment on the quality of the data for each method and matrix.

g. Internal QC data generated during the project, including tabular summaries correlating sample identifiers with all blank, matrix spikes, surrogates, duplicates, laboratory control samples, and batch identifiers.

h. A list of the affected sample results for each analyte (indexed by method and matrix) including the appropriate data qualifier flag (J, B, R, etc.), where sample results are negatively impacted by adverse quality control criteria.

i. Summary of field and laboratory oversight activities, providing a discussion of the reliability of the data, QC problems encountered, and a summary of the evaluation of data quality for each analysis and matrix as indicated by the laboratory QC data and any other relevant findings.

j. Conclusions and recommendations.

k. Appendices containing: (1) Chemistry data package, and (2) Results of the Chemical Quality Assurance Report (CQAR). The CQAR is a Government produced document achieved through the inspection and analysis of QA samples and corresponding project sample data. The CQAR will include review of all QC parameters such as holding times, detection limits, method blanks, surrogate recoveries, matrix spikes and duplicates, and inter-laboratory and intra-laboratory data comparisons.

3.8 DOCUMENTATION

Documentation records shall be provided as factual evidence that required chemical data has been produced and chemical data quality has been achieved. The documentation shall comply with the requirements specified in paragraphs SAMPLING AND ANALYSIS PLAN, CHEMISTRY DATA PACKAGE, and CHEMICAL DATA FINAL REPORT.

3.9 NOTIFICATION OF NON-COMPLIANCE

The Contracting Officer Representative will notify the Contractor of any detected noncompliance with the foregoing requirements. Take immediate corrective action after receipt of such notice.

-- End of Section --

SECTION 01 45 00.00 20

QUALITY CONTROL
11/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2008; Errata 1-2010; Changes 1-3 2010; Changes 4-6 2011) Safety and Health Requirements Manual

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES

SD-01 Preconstruction Submittals

Construction Quality Control (QC) Plan; G

Submit a Construction QC Plan prior to start of construction.

1.3 INFORMATION FOR THE CONTRACTING OFFICER REPRESENTATIVE

Prior to commencing work on construction, the Contractor can obtain a single copy set of the current report forms from the Contracting Officer Representative. The report forms will consist of the Contractor Production Report, Contractor Production Report (Continuation Sheet), Contractor Quality Control (CQC) Report, (CQC) Report (Continuation Sheet), Preparatory Phase Checklist, Initial Phase Checklist, Rework Items List, and Testing Plan and Log.

Deliver the following to the Contracting Officer Representative during Construction:

a. CQC Report: Mail or hand-carry the original (wet signatures) and 2 copies by 10:00 AM the next working day after each day that work is performed and for every seven consecutive calendar days of no-work.

b. Contractor Production Report: Submit the report electronically by 10:00 AM the next working day after each day that work is performed and for every seven consecutive calendar days of no-work.

c. Preparatory Phase Checklist: Original attached to the original CQC Report and one copy attached to each QC Report copy.

d. Initial Phase Checklist: Submit the report electronically in the same

manner as the CQC Report for each Initial Phase held.

e. Field Test Reports: Within two working days after the test is performed, submit the report as an electronic attachment to the CQC Report.

f. Monthly Summary Report of Tests: Submit the report as an electronic attachment to the CQC Report at the end of each month.

g. Testing Plan and Log: Submit the report as an electronic attachment to the CQC Report, at the end of each month. A copy of the final Testing Plan and Log shall be provided to the OMSI preparer for inclusion into the OMSI documentation.

h. Rework Items List: Submit lists containing new entries daily, in the same manner as the CQC Report.

i. CQC Meeting Minutes: Within two working days after the meeting is held, submit the report as an electronic attachment to the CQC Report.

j. QC Certifications: As required by the paragraph entitled "QC Certifications."

1.4 QC PROGRAM REQUIREMENTS

Establish and maintain a QC program as described in this section. This QC program is a key element in meeting the objectives of NAVFAC Commissioning. The QC program consists of a QC Organization, QC Plan, QC Plan Meeting(s), a Coordination and Mutual Understanding Meeting, QC meetings, three phases of control, submittal review and approval, testing, completion inspections, and QC certifications and documentation necessary to provide materials, equipment, workmanship, fabrication, construction and operations which comply with the requirements of this Contract. The QC program must cover on-site and off-site work and be keyed to the work sequence. No construction work or testing may be performed unless the QC Manager is on the work site. The QC Manager must report to an officer of the firm and not be subordinate to the Project Superintendent or the Project Manager. The QC Manager, Project Superintendent and Project Manager must work together effectively. Although the QC Manager is the primary individual responsible for quality control, all individuals will be held responsible for the quality of work on the job.

1.4.1 Acceptance of the Construction Quality Control (QC) Plan

Acceptance of the QC Plan is required prior to the start of construction. The Contracting Officer Representative reserves the right to require changes in the QC Plan and operations as necessary, including removal of personnel, to ensure the specified quality of work. The Contracting Officer Representative reserves the right to interview any member of the QC organization at any time in order to verify the submitted qualifications. All QC organization personnel are subject to acceptance by the Contracting Officer Representative. The Contracting Officer Representative may require the removal of any individual for non-compliance with quality requirements specified in the Contract.

1.4.2 Preliminary Construction Work Authorized Prior to Acceptance

The only construction work that is authorized to proceed prior to the acceptance of the QC Plan is mobilization of storage and office trailers,

temporary utilities, and surveying.

1.4.3 Notification of Changes

Notify the Contracting Officer Representative, in writing, of any proposed changes in the QC Plan or changes to the QC organization personnel, a minimum of 10 work days prior to a proposed change. Proposed changes are subject to acceptance by the Contracting Officer Representative.

1.5 QC ORGANIZATION

1.5.1 QC Manager

1.5.1.1 Duties

Provide a QC Manager at the work site to implement and manage the QC program. The only duties and responsibilities of the QC Manager are to manage and implement the QC program on this Contract. The QC Manager is required to attend the partnering meetings, QC Plan Meetings, Coordination and Mutual Understanding Meeting, conduct the QC meetings, perform the three phases of control, perform submittal review and approval, ensure testing is performed and provide QC certifications and documentation required in this Contract. The QC Manager is responsible for managing and coordinating the three phases of control and documentation performed by testing laboratory personnel and any other inspection and testing personnel required by this Contract. The QC Manager is the manager of all QC activities.

1.5.1.2 Qualifications

An individual with a minimum of 5 years combined experience in the following positions: Project Superintendent, QC Manager, Project Manager, Project Engineer or Construction Manager on similar size and type construction contracts which included the major trades that are part of this Contract. The individual must have at least two years experience as a QC Manager. The individual must be familiar with the requirements of EM 385-1-1, and have experience in the areas of hazard identification, safety compliance, and sustainability.

A graduate of a four year accredited college or university program in one of the following disciplines: Engineering, Architecture, Construction Management, Engineering Technology, Building Construction, or Building Science, with a minimum of 10 years experience as a Project Superintendent, QC Manager, Project Manager, Project Engineer or Construction Manager on similar size and type construction contracts which included the major trades that are part of this Contract. The individual must have at least two years experience as a QC Manager. The individual must be familiar with the requirements of EM 385-1-1, and have experience in the areas of hazard identification, safety compliance, and sustainability.

1.5.2 Construction Quality Management Training

In addition to the above experience and education requirements, the QC Manager must have completed the course entitled "Construction Quality Management (CQM) for Contractors." If the QC Manager does not have a current certification, they must obtain the CQM for Contractors course certification within 90 days of award. This course is periodically offered by the Naval Facilities Engineering Command and the Army Corps of Engineers. Contact the Contracting Officer Representative for information

on the next scheduled class.

1.5.3 Alternate QC Manager Duties and Qualifications

Designate an alternate for the QC Manager at the work site to serve in the event of the designated QC Manager's absence. The period of absence may not exceed two weeks at one time, and not more than 30 workdays during a calendar year. The qualification requirements for the Alternate QC Manager must be the same as for the QC Manager.

1.6 QUALITY CONTROL (QC) PLAN

1.6.1 Construction Quality Control (QC) Plan

1.6.1.1 Requirements

Provide, for acceptance by the Contracting Officer Representative, a Construction QC Plan submitted in a three-ring binder that includes a table of contents, with major sections identified with tabs, with pages numbered sequentially, and that documents the proposed methods and responsibilities for accomplishing commissioning activities during the construction of the project:

a. QC ORGANIZATION: A chart showing the QC organizational structure.

b. NAMES AND QUALIFICATIONS: Names and qualifications, in resume format, for each person in the QC organization. Include the CQM for Contractors course certifications for the QC Manager and Alternate QC Manager as required by the paragraphs entitled "Construction Quality Management Training" and "Alternate QC Manager Duties and Qualifications".

c. DUTIES, RESPONSIBILITY AND AUTHORITY OF QC PERSONNEL: Duties, responsibilities, and authorities of each person in the QC organization.

d. OUTSIDE ORGANIZATIONS: A listing of outside organizations, such as architectural and consulting engineering firms, that will be employed by the Contractor and a description of the services these firms will provide.

e. APPOINTMENT LETTERS: Letters signed by an officer of the firm appointing the QC Manager and Alternate QC Manager and stating that they are responsible for implementing and managing the QC program as described in this Contract. Include in this letter the responsibility of the QC Manager and Alternate QC Manager to implement and manage the three phases of control, and their authority to stop work which is not in compliance with the Contract. Letters of direction are to be issued by the QC Manager to all other QC Specialists outlining their duties, authorities, and responsibilities. Include copies of the letters in the QC Plan.

f. SUBMITTAL PROCEDURES AND INITIAL SUBMITTAL REGISTER: Procedures for reviewing, approving, and managing submittals. Provide the name(s) of the person(s) in the QC organization authorized to review and certify submittals prior to approval. Provide the initial submittal of the Submittal Register as specified in Section 01 33 00 SUBMITTAL PROCEDURES.

g. TESTING LABORATORY INFORMATION: Testing laboratory information

required by the paragraphs entitled "Accreditation Requirements", as applicable.

h. TESTING PLAN AND LOG: A Testing Plan and Log that includes the tests required, referenced by the specification paragraph number requiring the test, the frequency, and the person responsible for each test. Use Government forms to log and track tests.

i. PROCEDURES TO COMPLETE REWORK ITEMS: Procedures to identify, record, track, and complete rework items. Use Government forms to record and track rework items.

j. DOCUMENTATION PROCEDURES: Use Government form.

k. LIST OF DEFINABLE FEATURES: A Definable Feature of Work (DFOW) is a task that is separate and distinct from other tasks and has control requirements and work crews unique to that task. A DFOW is identified by different trades or disciplines and is an item or activity on the construction schedule. Include in the list of DFOWs, but not be limited to, all critical path activities on the NAS. Include all activities for which this specification requires QC Specialists or specialty inspection personnel. Provide separate DFOWs in the Network Analysis Schedule for each design development stage and submittal package.

l. PROCEDURES FOR PERFORMING THE THREE PHASES OF CONTROL: Identify procedures used to ensure the three phases of control to manage the quality on this project. For each DFOW, a Preparatory and Initial phase checklist will be filled out during the Preparatory and Initial phase meetings. Conduct the Preparatory and Initial Phases and meetings with a view towards obtaining quality construction by planning ahead and identifying potential problems for each DFOW.

m. PERSONNEL MATRIX: Not Applicable

n. PROCEDURES FOR COMPLETION INSPECTION: Procedures for identifying and documenting the completion inspection process. Include in these procedures the responsible party for punch out inspection, pre-final inspection, and final acceptance inspection.

o. TRAINING PROCEDURES AND TRAINING LOG: Not Applicable

p. ORGANIZATION AND PERSONNEL CERTIFICATIONS LOG: Procedures for coordinating, tracking and documenting all certifications on subcontractors, testing laboratories, suppliers, personnel, etc. QC Manager will ensure that certifications are current, appropriate for the work being performed, and will not lapse during any period of the contract that the work is being performed.

1.7 QC PLAN MEETINGS

Prior to submission of the QC Plan, the QC Manager will meet with the Contracting Officer Representative to discuss the QC Plan requirements of this Contract. The purpose of this meeting is to develop a mutual understanding of the QC Plan requirements prior to plan development and submission and to agree on the Contractor's list of DFOWs.

1.8 COORDINATION AND MUTUAL UNDERSTANDING MEETING

After submission of the QC Plan, and prior to the start of construction, the QC Manager will meet with the Contracting Officer Representative to present the QC program required by this Contract. When a new QC Manager is appointed, the coordination and mutual understanding meeting shall be repeated.

1.8.1 Purpose

The purpose of this meeting is to develop a mutual understanding of the QC details, including documentation, administration for on-site and off-site work, design intent, Cx, environmental requirements and procedures, coordination of activities to be performed, and the coordination of the Contractor's management, production, and QC personnel. At the meeting, the Contractor will be required to explain in detail how three phases of control will be implemented for each DFOW, as well as how each DFOW will be affected by each management plan or requirement as listed below:

a. Waste Management Plan.

b. IAQ Management Plan.

c. Procedures for noise and acoustics management.

d. Environmental Protection Plan.

e. Environmental regulatory requirements.

f. Cx Plan.

1.8.2 Coordination of Activities

Coordinate activities included in various sections to assure efficient and orderly installation of each component. Coordinate operations included under different sections that are dependent on each other for proper installation and operation. Schedule construction operations with consideration for indoor air quality as specified in the IAQ Management Plan. Coordinate prefunctional tests and startup testing with Cx.

1.8.3 Attendees

As a minimum, the Contractor's personnel required to attend include an officer of the firm, the Project Manager, Project Superintendent, QC Manager, Alternate QC Manager, A/E, CA, Environmental Manager, and subcontractor representatives. Each subcontractor who will be assigned QC responsibilities shall have a principal of the firm at the meeting. Minutes of the meeting will be prepared by the QC Manager and signed by the Contractor, the A/E and the Contracting Officer Representative. Provide a copy of the signed minutes to all attendees and shall be included in the QC Plan.

1.9 QC MEETINGS

After the start of construction, conduct weekly QC meetings by the QC Manager at the work site with the Project Superintendent, the CA, and the foremen who are performing the work of the DFOWs. The QC Manager is to prepare the minutes of the meeting and provide a copy to the Contracting Officer Representative within two working days after the meeting. The

Contracting Officer Representative may attend these meetings. As a minimum, accomplish the following at each meeting:

a. Review the minutes of the previous meeting.

b. Review the schedule and the status of work and rework.

c. Review the status of submittals.

d. Review the work to be accomplished in the next two weeks and documentation required.

e. Resolve QC and production problems (RFI, etc.).

f. Address items that may require revising the QC Plan.

g. Review Accident Prevention Plan (APP).

h. Review environmental requirements and procedures.

i. Review Waste Management Plan.

j. Review IAQ Management Plan.

k. Review Environmental Management Plan.

l. Review the status of training completion.

m. Review Cx Plan and progress.

1.10 DESIGN REVIEW AND DOCUMENTATION

Review the basis of design received from the Contracting Officer Representative.

1.11 THREE PHASES OF CONTROL

Adequately cover both on-site and off-site work with the Three Phases of Control and include the following for each DFOW.

1.11.1 Preparatory Phase

Notify the Contracting Officer Representative at least two work days in advance of each preparatory phase meeting. The meeting will be conducted by the QC Manager and attended by the Project Superintendent, the CA, and the foreman responsible for the DFOW. When the DFOW will be accomplished by a subcontractor, that subcontractor's foreman shall attend the preparatory phase meeting. Document the results of the preparatory phase actions in the daily Contractor Quality Control Report and in the Preparatory Phase Checklist. Perform the following prior to beginning work on each DFOW:

a. Review each paragraph of the applicable specification sections.

b. Review the Contract drawings.

c. Verify that field measurements are as indicated on construction and/or shop drawings before confirming product orders, in order to minimize waste due to excessive materials.

d. Verify that appropriate shop drawings and submittals for materials and equipment have been submitted and approved. Verify receipt of approved factory test results, when required.

e. Review the testing plan and ensure that provisions have been made to provide the required QC testing.

f. Examine the work area to ensure that the required preliminary work has been completed.

g. Coordinate the schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.

h. Arrange for the return of shipping/packaging materials, such as wood pallets, where economically feasible.

i. Examine the required materials, equipment and sample work to ensure that they are on hand and conform to the approved shop drawings and submitted data.

j. Discuss specific controls used and construction methods, construction tolerances, workmanship standards, and the approach that will be used to provide quality construction by planning ahead and identifying potential problems for each DFOW.

k. Review the APP and appropriate Activity Hazard Analysis (AHA) to ensure that applicable safety requirements are met, and that required Material Safety Data Sheets (MSDS) are submitted.

l. Review the Cx Plan and ensure all preliminary work items have been completed and documented.

1.11.2 Initial Phase

Notify the Contracting Officer Representative at least two work days in advance of each initial phase. When construction crews are ready to start work on a DFOW, conduct the initial phase with the Project Superintendent, and the foreman responsible for that DFOW. Observe the initial segment of the DFOW to ensure that the work complies with Contract requirements. Document the results of the initial phase in the daily CQC Report and in the Initial Phase Checklist. Repeat the initial phase for each new crew to work on-site, or when acceptable levels of specified quality are not being met. Perform the following for each DFOW:

a. Establish the quality of workmanship required.

b. Resolve conflicts.

c. Ensure that testing is performed by the approved laboratory.

d. Check work procedures for compliance with the APP and the appropriate AHA to ensure that applicable safety requirements are met.

e. Review the Cx Plan and ensure all preparatory work items have been completed and documented.

1.11.3 Follow-Up Phase

Perform the following for on-going work daily, or more frequently as necessary, until the completion of each DFOW and document in the daily CQC Report:

a. Ensure the work is in compliance with Contract requirements.

b. Maintain the quality of workmanship required.

c. Ensure that testing is performed by the approved laboratory.

d. Ensure that rework items are being corrected.

e. Assure manufacturers representatives have performed necessary inspections if required and perform safety inspections.

f. Review the Cx Plan and ensure all work items, testing, and documentation has been completed.

1.11.4 Additional Preparatory and Initial Phases

Conduct additional preparatory and initial phases on the same DFOW if the quality of on-going work is unacceptable, if there are changes in the applicable QC organization, if there are changes in the on-site production supervision or work crew, if work on a DFOW is resumed after substantial period of inactivity, or if other problems develop.

1.11.5 Notification of Three Phases of Control for Off-Site Work

Notify the Contracting Officer Representative at least two weeks prior to the start of the preparatory and initial phases.

1.12 SUBMITTAL REVIEW AND APPROVAL

Procedures for submission, review and approval of submittals are described in Section 01 33 00 SUBMITTAL PROCEDURES.

1.13 TESTING

Except as stated otherwise in the specification sections, perform sampling and testing required under this Contract.

1.13.1 Accreditation Requirements

Construction materials testing laboratories must be accredited by a laboratory accreditation authority and will be required to submit a copy of the Certificate of Accreditation and Scope of Accreditation. The laboratory's scope of accreditation must include the appropriate ASTM standards (E 329, C 1077, D 3666, D 3740, A 880, E 543) listed in the technical sections of the specifications. Laboratories engaged in Hazardous Materials Testing shall meet the requirements of OSHA and EPA. The policy applies to the specific laboratory performing the actual testing, not just the Corporate Office.

1.13.2 Laboratory Accreditation Authorities

Laboratory Accreditation Authorities include the National Voluntary Laboratory Accreditation Program (NVLAP) administered by the National

Institute of Standards and Technology at http://ts.nist.gov/ts/htdocs/210/214/214.htm , the American Association of State Highway and Transportation Officials (AASHTO) program at http://www.transportation.org/aashto/home.nsf/frontpage , International Accreditation Services, Inc. (IAS) at http://www.iasonline.org, U. S. Army Corps of Engineers Materials Testing Center (MTC)at http://www.wes.army.mil/SL/MTC/, the American Association for Laboratory Accreditation (A2LA) program at http://www.a2la.org/, the Washington Association of Building Officials (WABO) at http://www.wabo.org/ (Approval authority for WABO is limited to projects within Washington State), and the Washington Area Council of Engineering Laboratories (WACEL) at http://www.wacel.org/labaccred.html (Approval authority by WACEL is limited to projects within Facilities Engineering Command (FEC) Washington geographical area).

1.13.3 Capability Check

The Contracting Officer Representative retains the right to check laboratory equipment in the proposed laboratory and the laboratory technician's testing procedures, techniques, and other items pertinent to testing, for compliance with the standards set forth in this Contract.

1.13.4 Test Results

Cite applicable Contract requirements, tests or analytical procedures used. Provide actual results and include a statement that the item tested or analyzed conforms or fails to conform to specified requirements. If the item fails to conform, notify the Contracting Officer Representative immediately. Conspicuously stamp the cover sheet for each report in large red letters "CONFORMS" or "DOES NOT CONFORM" to the specification requirements, whichever is applicable. Test results must be signed by a testing laboratory representative authorized to sign certified test reports. Furnish the signed reports, certifications, and other documentation to the Contracting Officer Representative via the QC Manager. Furnish a summary report of field tests at the end of each month, per the paragraph entitled "INFORMATION FOR THE Contracting Officer Representative".

1.13.5 Test Reports and Monthly Summary Report of Tests

Furnish the signed reports, certifications, and a summary report of field tests at the end of each month to the Contracting Officer Representative. Attach a copy of the summary report to the last daily Contractor Quality Control Report of each month. Provide a copy of the signed test reports and certifications to the OMSI preparer for inclusion into the OMSI documentation.

1.14 QC CERTIFICATIONS

1.14.1 CQC Report Certification

Contain the following statement within the CQC Report: "On behalf of the Contractor, I certify that this report is complete and correct and equipment and material used and work performed during this reporting period is in compliance with the contract drawings and specifications to the best of my knowledge, except as noted in this report."

1.14.2 Invoice Certification

Furnish a certificate to the Contracting Officer Representative with each payment request, signed by the QC Manager, attesting that as-built drawings are current, coordinated and attesting that the work for which payment is requested, including stored material, is in compliance with Contract requirements.

1.14.3 Completion Certification

Upon completion of work under this Contract, the QC Manager shall furnish a certificate to the Contracting Officer Representative attesting that "the work has been completed, inspected, tested and is in compliance with the Contract." Provide a copy of this final QC Certification for completion to the OMSI preparer for inclusion into the OMSI documentation.

1.15 COMPLETION INSPECTIONS

1.15.1 Punch-Out Inspection

Near the completion of all work or any increment thereof, established by a completion time stated in the Contract Clause entitled "Commencement, Prosecution, and Completion of Work," or stated elsewhere in the specifications, the QC Manager and the CA must conduct an inspection of the work and develop a "punch list" of items which do not conform to the approved drawings, specifications and Contract. Include in the punch list any remaining items on the "Rework Items List", which were not corrected prior to the Punch-Out Inspection. Include within the punch list the estimated date by which the deficiencies will be corrected. Provide a copy of the punch list to the Contracting Officer Representative. The QC Manager, or staff, must make follow-on inspections to ascertain that all deficiencies have been corrected. Once this is accomplished, notify the Government that the facility is ready for the Government "Pre-Final Inspection".

1.15.2 Pre-Final Inspection

The Government and QCM will perform this inspection to verify that the facility is complete and ready to be occupied. A Government "Pre-Final Punch List" will be documented by the CQM as a result of this inspection. The QC Manager will ensure that all items on this list are corrected prior to notifying the Government that a "Final" inspection with the Client can be scheduled. Any items noted on the "Pre-Final" inspection must be corrected in a timely manner and be accomplished before the contract completion date for the work,or any particular increment thereof, if the project is divided into increments by separate completion dates.

1.15.3 Final Acceptance Inspection

Notify the Contracting Officer Representative at least 14 calendar days prior to the date a final acceptance inspection can be held. State within the notice that all items previously identified on the pre-final punch list will be corrected and acceptable, along with any other unfinished Contract work, by the date of the final acceptance inspection. The Contractor must be represented by the QC Manager, the Project Superintendent, the CA, and others deemed necessary. Attendees for the Government will include the Contracting Officer Representative, other FEAD/ROICC personnel, and personnel representing the Client. Failure of the Contractor to have all contract work acceptably complete for this inspection will be cause for the

Contracting Officer Representative to bill the Contractor for the Government's additional inspection cost in accordance with the Contract Clause entitled "Inspection of Construction."

1.16 DOCUMENTATION

Maintain current and complete records of on-site and off-site QC program operations and activities.

1.16.1 Construction Documentation

Reports are required for each day that work is performed and must be attached to the Contractor Quality Control Report prepared for the same day. Maintain current and complete records of on-site and off-site QC program operations and activities. The forms identified under the paragraph "INFORMATION FOR THE CONTRACTING OFFIDER REPRESENTATIVE" will be used. Reports are required for each day work is performed. Account for each calendar day throughout the life of the Contract. Every space on the forms must be filled in. Use N/A if nothing can be reported in one of the spaces. The Project Superintendent and the QC Manager must prepare and sign the Contractor Production and CQC Reports, respectively. The reporting of work must be identified by terminology consistent with the construction schedule. In the "remarks" sections of the reports, enter pertinent information including directions received, problems encountered during construction, work progress and delays, conflicts or errors in the drawings or specifications, field changes, safety hazards encountered, instructions given and corrective actions taken, delays encountered and a record of visitors to the work site, quality control problem areas, deviations from the QC Plan, construction deficiencies encountered, meetings held. For each entry in the report(s), identify the Schedule Activity No. that is associated with the entered remark.

1.16.2 Quality Control Validation

Establish and maintain the following in a series of three ring binders. Binders shall be divided and tabbed as shown below. These binders must be readily available to the Contracting Officer Representative during all business hours.

a. All completed Preparatory and Initial Phase Checklists, arranged by specification section.

b. All milestone inspections, arranged by Activity Number.

c. An up-to-date copy of the Testing Plan and Log with supporting field test reports, arranged by specification section.

d. Copies of all contract modifications, arranged in numerical order. Also include documentation that modified work was accomplished.

e. An up-to-date copy of the Rework Items List.

f. Maintain up-to-date copies of all punch lists issued by the QC staff to the Contractor and Sub-Contractors and all punch lists issued by the Government.

g. Commissioning documentation including Cx checklists, schedules, tests, and reports.

1.16.3 Testing Plan and Log

As tests are performed, the CA and the QC Manager will record on the "Testing Plan and Log" the date the test was performed and the date the test results were forwarded to the Contracting Officer Representative. Attach a copy of the updated "Testing Plan and Log" to the last daily CQC Report of each month, per the paragraph "INFORMATION FOR THE CONTRACTING OFFICER REPRESENTATIVE". Provide a copy of the final "Testing Plan and Log" to the OMSI preparer for inclusion into the OMSI documentation.

1.16.4 Rework Items List

The QC Manager must maintain a list of work that does not comply with the Contract, identifying what items need to be reworked, the date the item was originally discovered, the date the item will be corrected by, and the date the item was corrected. There is no requirement to report a rework item that is corrected the same day it is discovered. Attach a copy of the "Rework Items List" to the last daily CQC Report of each month. The Contractor is responsible for including those items identified by the Contracting Officer Representative.

1.16.5 As-Built Drawings

The QC Manager is required to ensure the as-built drawings, required by Section 01 78 00 CLOSEOUT SUBMITTALS are kept current on a daily basis and marked to show deviations which have been made from the Contract drawings. Ensure each deviation has been identified with the appropriate modifying documentation (e.g. PC No., Modification No., Request for Information No., etc.). The QC Manager must initial each revision. Upon completion of work, the QC Manager will furnish a certificate attesting to the accuracy of the as-built drawings prior to submission to the Contracting Officer Representative.

1.17 NOTIFICATION ON NON-COMPLIANCE

The Contracting Officer Representative will notify the Contractor of any detected non-compliance with the Contract. Take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the work site, shall be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the Contracting Officer Representative may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders will be made the subject of claim for extension of time for excess costs or damages by the Contractor.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 PREPARATION

Designate receiving/storage areas for incoming material to be delivered according to installation schedule and to be placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication. Store and handle materials in a manner as to prevent loss

from weather and other damage. Keep materials, products, and accessories covered and off the ground, and store in a dry, secure area. Prevent contact with material that may cause corrosion, discoloration, or staining. Protect all materials and installations from damage by the activities of other trades.

-- End of Section --

SECTION 01 45 00.10 10

QUALITY CONTROL SYSTEM (QCS)
02/10

PART 1 GENERAL

1.1 Contract Administration

The Government will use the Resident Management System for Windows (RMS) to assist in its monitoring and administration of this contract. The Contractor must use the Government-furnished Construction Contractor Module of RMS, referred to as QCS, to record, maintain, and submit various information throughout the contract period. The Contractor module, user manuals, updates, and training information can be downloaded from the RMS web site (http://rms.usace.army.mil). This joint Government-Contractor use of RMS and QCS will facilitate electronic exchange of information and overall management of the contract. QCS provides the means for the Contractor to input, track, and electronically share information with the Government in the following areas:

Administration
Finances
Quality Control
Submittal Monitoring
Scheduling
Import/Export of Data

1.1.1 Correspondence and Electronic Communications

For ease and speed of communications, both Government and Contractor will, to the maximum extent feasible, exchange correspondence and other documents in electronic format. Correspondence, pay requests and other documents comprising the official contract record will also be provided in paper format, with signatures and dates where necessary. Paper documents will govern, in the event of discrepancy with the electronic version.

1.1.2 Other Factors

Particular attention is directed to Contract Clause, "Schedules for Construction Contracts", Contract Clause, "Payments", Section 01 32 01.00 10 PROJECT SCHEDULE, and Section 01 33 00 SUBMITTAL PROCEDURES, which have a direct relationship to the reporting to be accomplished through QCS. Also, there is no separate payment for establishing and maintaining the QCS database; all costs associated therewith will be included in the contract pricing for the work.

1.2 QCS SOFTWARE

QCS is a Windows-based program that can be run on a stand-alone personal computer or on a network. The Government will make available the QCS software to the Contractor after award of the construction contract. Prior to the Pre-Construction Conference, the Contractor will be responsible to download, install and use the latest version of the QCS software from the Government's RMS Internet Website. Upon specific justification and request by the Contractor, the Government can provide QCS on optical disk. Any program updates of QCS will be made available to the Contractor via the

Government RMS Website as they become available.

1.3 SYSTEM REQUIREMENTS

The following is the minimum system configuration required to run QCS:

Minimum QCSSystem Requirements	
Hardware	
Windows-based PC	1000 MHz Pentium or higher processor
RAM	256+ MB for workstation / 512+ MB for server
Hard drive disk	1 GB space for sole use by the QCS system
Optical Disk (CD or DVD) Reader	8x speed or higher
Monitor	SVGA or higher resolution (1024x768, 256 colors)
Mouse or other pointing device	
Windows compatible printer	Laser printer must have 4 MB+ of RAM
Connection to the Internet	minimum 56k BPS
Software	
MS Windows	2000, XP, Vista or Windows 7
Word Processing software	MS Word 2000 or newer
Internet browser	Netscape Navigator, Microsoft Internet Explorer, or other browser that supports HTML 4.0 or higher
Email	MAPI compatible
Virus protection software	regularly upgraded with all issued manufacturer's updates

1.4 RELATED INFORMATION

1.4.1 QCS User Guide

After contract award, download instructions for the installation and use of QCS from the Government RMS Internet Website. In case of justifiable difficulties, the Government will provide an optical disk (CD/DVD) containing these instructions.

1.4.2 Contractor Quality Control (CQC) Training

The use of QCS will be discussed with the QC System Manager during the mandatory CQC Training class.

1.5 CONTRACT DATABASE

Prior to the pre-construction conference, the Government will provide the Contractor with basic contract award data to use for QCS. The Government will provide data updates to the Contractor as needed, generally by using the Government's SFTP repository built into QCS import/export function. These updates will generally consist of submittal reviews, correspondence status, QA comments, and other administrative and QA data.

1.6 DATABASE MAINTENANCE

Establish, maintain, and update data in the QCS database throughout the duration of the contract at the Contractor's site office. Submit data updates to the Government (e.g., daily reports, submittals, RFI's, schedule updates, payment requests, etc.) using the Government's SFTP repository built into QCS export function. If permitted by the Contracting Officer, email or optical disk may be used instead of QCS (see Paragraph DATA SUBMISSION VIA OPTICAL DISK). The QCS database typically includes current data on the following items:

1.6.1 Administration

1.6.1.1 Contractor Information

Contain within the database the Contractor's name, address, telephone numbers, management staff, and other required items. Within 14 calendar days of receipt of QCS software from the Government, deliver Contractor administrative data in electronic format.

1.6.1.2 Subcontractor Information

Contain within the database the name, trade, address, phone numbers, and other required information for all subcontractors. A subcontractor must be listed separately for each trade to be performed. Assign each subcontractor/trade a unique Responsibility Code, provided in QCS. Within 14 calendar days of receipt of QCS software from the Government, deliver subcontractor administrative data in electronic format.

1.6.1.3 Correspondence

Identify all Contractor correspondence to the Government with a serial number. Prefix correspondence initiated by the Contractor's site office with "S". Prefix letters initiated by the Contractor's home (main) office with "H". Letters must be numbered starting from 0001. (e.g., H-0001 or S-0001). The Government's letters to the Contractor will be prefixed with "C".

1.6.1.4 Equipment

Contain within the Contractor's QCS database a current list of equipment planned for use or being used on the jobsite, including the most recent and planned equipment inspection dates.

1.6.1.5 Management Reporting

QCS includes a number of reports that Contractor management can use to track the status of the project. The value of these reports is reflective of the quality of the data input, and is maintained in the various sections of QCS. Among these reports are: Progress Payment Request worksheet,

QA/QC comments, Submittal Register Status, Three-Phase Control checklists.

1.6.1.6 Request For Information (RFI)

Exchange all Requests For Information (RFI) using the Built-in RFI generator and tracker in QCS.

1.6.2 Finances

1.6.2.1 Pay Activity Data

Include within the QCS database a list of pay activities that the Contractor must develop in conjunction with the construction schedule. The sum of all pay activities must be equal to the total contract amount, including modifications. Group pay activities Contract Line Item Number (CLIN); the sum of the activities must equal the amount of each CLIN. The total of all CLINs equals the Contract Amount.

1.6.2.2 Payment Requests

Prepare all progress payment requests using QCS. Complete the payment request worksheet, prompt payment certification, and payment invoice in QCS. Update the work completed under the contract, measured as percent or as specific quantities, at least monthly. After the update, generate a payment request report using QCS. Submit the payment request, prompt payment certification, and payment invoice with supporting data using the Government's SFTP repository built into QCS export function. If permitted by the Contracting Officer, email or a optical disk may be used. A signed paper copy of the approved payment request is also required, which will govern in the event of discrepancy with the electronic version.

1.6.3 Quality Control (QC)

QCS provides a means to track implementation of the 3-phase QC Control System, prepare daily reports, identify and track deficiencies, document progress of work, and support other Contractor QC requirements. Maintain this data on a daily basis. Entered data will automatically output to the QCS generated daily report. Within seven calendar days of Government acceptance, submit a QCS update reflecting the information contained in the accepted CQC Plan: schedule, pay activities, features of work, submittal register, QC requirements, and equipment list.

1.6.3.1 Daily Contractor Quality Control (CQC) Reports.

QCS includes the means to produce the Daily CQC Report. The Contractor may use other formats to record basic QC data. However, the Daily CQC Report generated by QCS must be the Contractor's official report. Summarize data from any supplemental reports by the Contractor and consolidate onto the QCS-generated Daily CQC Report. Electronically submit reports to the Government within 24 hours after the date covered by the report. Also provide the Government a signed, printed copy of the daily CQC report.

1.6.3.2 Deficiency Tracking.

Use QCS to track deficiencies. Deficiencies identified by the Contractor will be numerically tracked using QC punch list items. Maintain a current log of its QC punch list items in the QCS database. The Government will log the deficiencies it has identified using its QA punch list items. The Government's QA punch list items will be included in its export file to the

Contractor. Regularly update the correction status of both QC and QA punch list items.

1.6.3.3 QC Requirements

Develop and maintain a complete list of QC testing and required structural and life safety special inspections required by the International Code Council (ICC), transferred and installed property, and user training requirements in QCS. Update all data on these QC requirements as work progresses, and promptly provide this information to the Government via QCS.

1.6.3.4 Three-Phase Control Meetings

Maintain scheduled and actual dates and times of preparatory and initial control meetings in QCS.

1.6.3.5 Labor and Equipment Hours

Log labor and equipment exposure hours on a daily basis. This data will be rolled up into a monthly exposure report.

1.6.3.6 Accident/Safety Reporting

The Government will issue safety comments, directions, or guidance whenever safety deficiencies are observed. The Government's safety comments will be included in its export file to the Contractor. Regularly update the correction status of the safety comments. In addition, utilize QCS to advise the Government of any accidents occurring on the jobsite. This brief supplemental entry is not to be considered as a substitute for completion of mandatory reports, e.g., ENG Form 3394 and OSHA Form 300.

1.6.3.7 Features of Work

Include a complete list of the features of work in the QCS database. A feature of work may be associated with multiple pay activities. However, each pay activity (see subparagraph "Pay Activity Data" of paragraph "Finances") will only be linked to a single feature of work.

1.6.3.8 Hazard Analysis

Use QCS to develop a hazard analysis for each feature of work included in the CQC Plan. Address any hazards, or potential hazards, that may be associated with the work.

1.6.4 Submittal Management

The Government will provide the initial submittal register in electronic format. Thereafter, maintain a complete list of all submittals, including completion of all data columns. Dates on which submittals are received and returned by the Government will be included in its export file to the Contractor. Use QCS to track and transmit all submittals. ENG Form 4025, submittal transmittal form, and the submittal register update must be produced using QCS. QCS and RMS will be used to update, store and exchange submittal registers and transmittals, but will not be used for storage of actual submittals.

1.6.5 Schedule

Develop a construction schedule consisting of pay activities, in accordance

with Section 01 32 01.00 10 PROJECT SCHEDULE. Input and maintain in the QCS database this schedule either manually or by using the Standard Data Exchange Format (SDEF). Include with each pay request the updated schedule.

1.6.6 Import/Export of Data

QCS includes the ability to export Contractor data to the Government and to import submittal register and other Government-provided data from RMS, and schedule data using SDEF.

1.7 IMPLEMENTATION

Contractor use of QCS as described in the preceding paragraphs is mandatory. Ensure that sufficient resources are available to maintain its QCS database, and to provide the Government with regular database updates. QCS shall be an integral part of the Contractor's management of quality control.

1.8 DATA SUBMISSION VIA OPTICAL DISK

The Government-preferred method for Contractor's submission of QCS data is by using the Government's SFTP repository built into QCS export function. Other data should be submitted using email with file attachment(s). For locations where this is not feasible, the Contracting Officer may permit use of optical disk for data transfer. Export data onto optical disks using the QCS built-in export function. If used, submit optical disks in accordance with the following:

1.8.1 File Medium

Submit in English required data on optical disk conforming to industry standards used in the United States.

1.8.2 Optical Disk Labels

Affix a permanent exterior label to each optical disk submitted. Indicate on the label in English, the QCS file name, full contract number, contract name, project location, data date, name and telephone number of person responsible for the data.

1.8.3 File Names

The files will be automatically named by the QCS software. The naming convention established by the QCS software must not be altered.

1.9 MONTHLY COORDINATION MEETING

Update the QCS database each workday. At least monthly, generate and submit an export file to the Government with schedule update and progress payment request. As required in Contract Clause "Payments", at least one week prior to submittal, meet with the Government representative to review the planned progress payment data submission for errors and omissions.

Make all required corrections prior to Government acceptance of the export file and progress payment request. Payment requests accompanied by incomplete or incorrect data submittals will be returned. The Government will not process progress payments until an acceptable QCS export file is received.

1.10 NOTIFICATION OF NONCOMPLIANCE

The Contracting Officer will notify the Contractor of any detected noncompliance with the requirements of this specification. Take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the work site, will be deemed sufficient for the purpose of notification.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 01 50 00

TEMPORARY CONSTRUCTION FACILITIES AND CONTROLS
08/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 241	(2013) Standard for Safeguarding Construction,Alteration, and Demolition Operations
NFPA 70	(2014; AMD 1 2013; Errata 1 2013; AMD 2 2013; Errata 2 2013) National Electrical Code

U.S. FEDERAL AVIATION ADMINISTRATION (FAA)

FAA AC 70/7460-1	(2007; Rev K) Obstruction Marking and Lighting

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

MUTCD	(2009) Manual on Uniform Traffic Control Devices

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Construction site plan; G
Traffic control plan; G

1.3 CONSTRUCTION SITE PLAN

Prior to the start of work, submit a site plan showing the locations and dimensions of temporary facilities (including layouts and details, equipment and material storage area (onsite and offsite), and access and haul routes, avenues of ingress/egress to the fenced area and details of the fence installation. Identify any areas which may have to be graveled to prevent the tracking of mud. Indicate if the use of a supplemental or other staging area is desired. Show locations of safety and construction fences, site trailers, construction entrances, trash dumpsters, temporary sanitary facilities, and worker parking areas.

1.4 HURRICANE CONDITION OF READINESS

Unless directed otherwise, comply with:

a. Condition FOUR (Sustained winds of 50 knots or greater expected within 72 hours): Normal daily jobsite cleanup and good housekeeping practices. Collect and store in piles or containers scrap lumber, waste material, and rubbish for removal and disposal at the close of each work day. Maintain the construction site including storage areas, free of accumulation of debris. Stack form lumber in neat piles less than 4 feet high. Remove all debris, trash, or objects that could become missile hazards. Contact Contracting Officer for Condition of Readiness (COR) updates and completion of required actions.

b. Condition THREE (Sustained winds of 50 knots or greater expected within 48 hours): Maintain "Condition FOUR" requirements and commence securing operations necessary for "Condition ONE" which cannot be completed within 18 hours. Cease all routine activities which might interfere with securing operations. Commence securing and stow all gear and portable equipment. Make preparations for securing buildings. Review requirements pertaining to "Condition TWO" and continue action as necessary to attain "Condition THREE" readiness. Contact Contracting Officer for weather and COR updates and completion of required actions.

c. Condition TWO (Sustained winds of 50 knots or greater expected within 24 hours): Curtail or cease routine activities until securing operation is complete. Reinforce or remove form work and scaffolding. Secure machinery, tools, equipment, materials, or remove from the jobsite. Expend every effort to clear all missile hazards and loose equipment from general base areas. Contact Contracting Officer for weather and Condition of Readiness (COR) updates and completion of required actions.

d. Condition ONE. (Sustained winds of 50 knots or greater expected within 12 hours): Secure the jobsite, and leave Government premises.

PART 2 PRODUCTS

2.1 TEMPORARY SIGNAGE

2.1.1 Bulletin Board

Immediately upon beginning of work, provide a weatherproof glass-covered bulletin board not less than 36 by 48 inches in size for displaying the Equal Employment Opportunity poster, a copy of the wage decision contained in the contract, Wage Rate Information poster, and other information approved by the Contracting Officer. Locate the bulletin board at the project site in a conspicuous place easily accessible to all employees, as approved by the Contracting Officer.

2.1.2 Project and Safety Signs

Project and safety signs shall be approved by the Contracting Officer. Erect signs within 15 days after receipt of the notice to proceed. Correct the data required by the safety sign daily, with light colored metallic or non-metallic numerals.

2.2 TEMPORARY TRAFFIC CONTROL

2.2.1 Haul Roads

Construct access and haul roads necessary for proper prosecution of the work under this contract. Construct with suitable grades and widths; sharp curves, blind corners, and dangerous cross traffic are be avoided. Provide necessary lighting, signs, barricades, and distinctive markings for the safe movement of traffic. The method of dust control, although optional, must be adequate to ensure safe operation at all times. Location, grade, width, and alignment of construction and hauling roads are subject to approval by the Contracting Officer. Lighting must be adequate to assure full and clear visibility for full width of haul road and work areas during any night work operations.

2.2.2 Barricades

Erect and maintain temporary barricades to limit public access to hazardous areas. Whenever safe public access to paved areas such as roads, parking areas or sidewalks is prevented by construction activities or as otherwise necessary to ensure the safety of both pedestrian and vehicular traffic barricades will be required. Securely place barricades clearly visible with adequate illumination to provide sufficient visual warning of the hazard during both day and night.

2.2.3 Fencing

Provide fencing along the construction site at all open excavations and tunnels to control access by unauthorized people.

a. The safety fencing must be a high visibility orange colored, high density polyethylene grid or approved equal, a minimum of 42 inches high, supported and tightly secured to steel posts located on maximum 10 foot centers, constructed at the approved location. Install fencing to be able to restrain a force of at least 250 pounds against it.

2.2.4 Temporary Wiring

Provide temporary wiring in accordance with NFPA 241 and NFPA 70. Include frequent inspection of all equipment and apparatus.

PART 3 EXECUTION

3.1 EMPLOYEE PARKING

Contractor employees will park privately owned vehicles in an area designated by the Contracting Officer. This area will be within reasonable walking distance of the construction site. Contractor employee parking must not interfere with existing and established parking requirements of the government installation.

3.2 AVAILABILITY AND USE OF UTILITY SERVICES

3.2.1 Temporary Utilities

Provide temporary utilities required for construction. Materials may be new or used, must be adequate for the required usage, not create unsafe conditions, and not violate applicable codes and standards.

3.2.2 Payment for Utility Services

a. The Government will make all reasonably required utilities available to the Contractor from existing outlets and supplies, as specified in the contract. Unless otherwise provided in the contract, the amount of each utility service consumed will be charged to or paid for by the Contractor at prevailing rates charged to the Government or, where the utility is produced by the Government, at reasonable rates determined by the Contracting Officer. Carefully conserve any utilities furnished without charge.

b. Reasonable amounts of the following utilities will be made available to the Contractor at the prevailing rates.

c. The point at which the Government will deliver such utilities or services and the quantity available is as indicated. Pay all costs incurred in connecting, converting, and transferring the utilities to the work. Make connections and disconnections as required.

3.2.3 Meters and Temporary Connections

At the Contractors expense and in a manner satisfactory to the Contracting Officer, provide and maintain necessary temporary connections, distribution lines, and meter bases (Government will provide meters) required to measure the amount of each utility used for the purpose of determining charges. Notify the Contracting Officer, in writing, 5 working days before final electrical connection is desired so that a utilities contract can be established. The Government will provide a meter and make the final hot connection after inspection and approval of the Contractor's temporary wiring installation. The Contractor will not make the final electrical connection.

3.2.4 Advance Deposit

An advance deposit for utilities consisting of an estimated month's usage or a minimum of $50.00 will be required. The last monthly bills for the fiscal year will normally be offset by the deposit and adjustments will be billed or returned as appropriate. Services to be rendered for the next fiscal year, beginning 1 October, will require a new deposit. Notification of the due date for this deposit will be mailed to the Contractor prior to the end of the current fiscal year.

3.2.5 Final Meter Reading

Before completion of the work and final acceptance of the work by the Government, notify the Contracting Officer, in writing, 5 working days before termination is desired. The Government will take a final meter reading, disconnect service, and remove the meters. Then remove all the temporary distribution lines, meter bases, and associated paraphernalia. Pay all outstanding utility bills before final acceptance of the work by the Government.

3.2.6 Sanitation

a. Provide and maintain within the construction area minimum field-type sanitary facilities approved by the Contracting Officer and periodically empty wastes into a municipal, district, or station sanitary sewage system, or remove waste to a commercial facility. Obtain approval from the system owner prior to discharge into any

municipal, district, or commercial sanitary sewer system. Any penalties and / or fines associated with improper discharge will be the responsibility of the Contractor. Coordinate with the Contracting Officer and follow station regulations and procedures when discharging into the station sanitary sewer system. Maintain these conveniences at all times without nuisance. Include provisions for pest control and elimination of odors. Government toilet facilities will not be available to Contractor's personnel.

3.2.7 Telephone

Make arrangements and pay all costs for telephone facilities desired.

3.2.8 Obstruction Lighting of Cranes

Provide a minimum of 2 aviation red or high intensity white obstruction lights on temporary structures (including cranes) over 100 feet above ground level. Light construction and installation must comply with FAA AC 70/7460-1. Lights must be operational during periods of reduced visibility, darkness, and as directed by the Contracting Officer.

3.2.9 Fire Protection

Provide temporary fire protection equipment for the protection of personnel and property during construction. Remove debris and flammable materials daily to minimize potential hazards.

3.3 TRAFFIC PROVISIONS

3.3.1 Maintenance of Traffic

a. Conduct operations in a manner that will not close any thoroughfare or interfere in any way with traffic on railways or highways except with written permission of the Contracting Officer at least 15 calendar days prior to the proposed modification date, and provide a Traffic Control Plan detailing the proposed controls to traffic movement for approval. The plan must be in accordance with State and local regulations and the MUTCD, Part VI. Make all notifications and obtain any permits required for modification to traffic movements outside Station's jurisdiction.. Contractor may move oversized and slow-moving vehicles to the worksite provided requirements of the highway authority have been met.

b. Conduct work so as to minimize obstruction of traffic, and maintain traffic on at least half of the roadway width at all times. Obtain approval from the Contracting Officer prior to starting any activity that will obstruct traffic.

c. Provide, erect, and maintain, at contractors expense, lights, barriers, signals, passageways, detours, and other items, that may be required by the Life Safety Signage, overhead protection authority having jurisdiction.

3.3.2 Protection of Traffic

Maintain and protect traffic on all affected roads during the construction period except as otherwise specifically directed by the Contracting Officer. Measures for the protection and diversion of traffic, including the provision of watchmen and flagmen, erection of barricades, placing of lights around and in front of equipment the work, and the erection and

maintenance of adequate warning, danger, and direction signs, will be as required by the State and local authorities having jurisdiction. Protect the traveling public from damage to person and property. Minimize the interference with public traffic on roads selected for hauling material to and from the site. Investigate the adequacy of existing roads and their allowable load limit. Contractor is responsible for the repair of any damage to roads caused by construction operations.

3.3.3 Rush Hour Restrictions

Do not interfere with the peak traffic flows preceding and during normal operations without notification to and approval by the Contracting Officer.

3.3.4 Dust Control

Dust control methods and procedures must be approved by the Contracting Officer. Treat dust abatement on access roads with applications of calcium chloride, water sprinklers, or similar methods or treatment.

3.4 CONTRACTOR'S TEMPORARY FACILITIES

Contractor-owned or -leased trailers must be identified by Government assigned numbers. Size and location of the number will be provided by the Government. Apply the number to the trailer within 14 calendar days of notification, or sooner, if directed by the Government.

3.4.1 Safety

Protect the integrity of any installed safety systems or personnel safety devices. If entrance into systems serving safety devices is required, the Contractor must obtain prior approval from the Contracting Officer. If it is temporarily necessary to remove or disable personnel safety devices in order to accomplish contract requirements, provide alternative means of protection prior to removing or disabling any permanently installed safety devices or equipment and obtain approval from the Contracting Officer.

3.4.2 Administrative Field Offices

Provide and maintain administrative field office facilities within the construction area at the designated site. Government office and warehouse facilities will not be available to the Contractor's personnel.

3.4.3 Storage Area

Construct a temporary 6 foot high chain link fence around trailers and materials. Include plastic strip inserts, colored green, so that visibility through the fence is obstructed. Fence posts may be driven, in lieu of concrete bases, where soil conditions permit. Do not place or store Trailers, materials, or equipment outside the fenced area unless such trailers, materials, or equipment are assigned a separate and distinct storage area by the Contracting Officer away from the vicinity of the construction site but within the installation boundaries. Trailers, equipment, or materials must not be open to public view with the exception of those items which are in support of ongoing work on any given day. Do not stockpile materials outside the fence in preparation for the next day's work. Park mobile equipment, such as tractors, wheeled lifting equipment, cranes, trucks, and like equipment within the fenced area at the end of each work day.

3.4.4 Supplemental Storage Area

Upon Contractor's request, the Contracting Officer will designate another or supplemental area for the Contractor's use and storage of trailers, equipment, and materials. This area may not be in close proximity of the construction site but will be within the installation boundaries. Fencing of materials or equipment will not be required at this site; however, the Contractor is responsible for cleanliness and orderliness of the area used and for the security of any material or equipment stored in this area. Utilities will not be provided to this area by the Government.

3.4.5 Appearance of Trailers

a. Trailers utilized by the Contractor for administrative or material storage purposes must present a clean and neat exterior appearance and be in a state of good repair. Trailers which, in the opinion of the Contracting Officer, require exterior painting or maintenance will not be allowed on installation property.

b. Paint using suitable paint and maintain the temporary facilities. Failure to do so will be sufficient reason to require their removal.

3.4.6 Maintenance of Storage Area

a. Keep fencing in a state of good repair and proper alignment. Grassed or unpaved areas, which are not established roadways, will be covered with a layer of gravel as necessary to prevent rutting and the tracking of mud onto paved or established roadways, should the Contractor elect to traverse them with construction equipment or other vehicles; gravel gradation will be at the Contractor's discretion. Mow and maintain grass located within the boundaries of the construction site for the duration of the project. Grass and vegetation along fences, buildings, under trailers, and in areas not accessible to mowers will be edged or trimmed neatly.

3.4.7 New Building

In the event a new building is constructed for the temporary project field office, it will be a minimum 12 feet in width, 16 feet in length and have a minimum of 7 feet headroom. Equip the building with approved electrical wiring, at least one double convenience outlet and the required switches and fuses to provide 110-120 volt power. Provide a work table with stool, desk with chair, two additional chairs, and one legal size file cabinet that can be locked. The building must be waterproof, supplied with a heater, have a minimum of two doors, electric lights, a telephone, a battery operated smoke detector alarm, a sufficient number of adjustable windows for adequate light and ventilation, and a supply of approved drinking water. Approved sanitary facilities must be furnished. Screen the windows and doors and provide the doors with dead bolt type locking devices or a padlock and heavy duty hasp bolted to the door. Door hinge pins will be non-removable. Arrange the windows to open and to be securely fastened from the inside. Protect glass panels in windows by bars or heavy mesh screens to prevent easy access. In warm weather, furnish air conditioning capable of maintaining the office at 50 percent relative humidity and a room temperature 20 degrees F below the outside temperature when the outside temperature is 95 degrees F. Any new building erected for a temporary field office must be maintained by the Contractor during the life of the contract and upon completion and acceptance of the work become the property of the Contractor and removed from the site.

3.4.8 Security Provisions

Provide adequate outside security lighting at the Contractor's temporary facilities. The Contractor will be responsible for the security of its own equipment; in addition, the Contractor will notify the appropriate law enforcement agency requesting periodic security checks of the temporary project field office.

3.4.9 Weather Protection of Temporary Facilities and Stored Materials

Take necessary precautions to ensure that roof openings and other critical openings in the building are monitored carefully. Take immediate actions required to seal off such openings when rain or other detrimental weather is imminent, and at the end of each workday. Ensure that the openings are completely sealed off to protect materials and equipment in the building from damage.

3.4.9.1 Building and Site Storm Protection

When a warning of gale force winds is issued, take precautions to minimize danger to persons, and protect the work and nearby Government property. Precautions must include, but are not limited to, closing openings; removing loose materials, tools and equipment from exposed locations; and removing or securing scaffolding and other temporary work. Close openings in the work when storms of lesser intensity pose a threat to the work or any nearby Government property.

3.5 GOVERNMENT FIELD OFFICE

3.5.1 Resident Engineer's Office

Provide the Government Resident Engineer with an office, approximately 200 square feet in floor area, located where directed and providing space heat, electric light and power, and toilet facilities consisting of one lavatory and one water closet complete with connections to water and sewer mains. Provide a mail slot in the door or a lockable mail box mounted on the surface of the door. Include a 4 by 8 foot plan table, computer work space a standard size office desk and chair, and telephone. At completion of the project, the office will remain the property of the Contractor and be removed from the site. Utilities willbe connected and disconnected in accordance with local codes and to the satisfaction of the Contracting Officer.

3.5.2 Quality Control Manager Records and Field Office

Provide on the jobsite an office with approximately 100 square feet of useful floor area for the exclusive use of the QC Manager. Provide a weathertight structure with adequate heating and cooling, toilet facilities, lighting, ventilation, a 4 by 8 foot plan table, a standard size office desk and chair, computer station, and working communications facilities. Provide either a 1,500 watt radiant heater and a window-mounted air conditioner rated at 9,000 Btus minimum or a window-mounted heat pump of the same minimum heating and cooling ratings. Provide a door with a cylinder lock and windows with locking hardware. Make utility connections. Locate as directed. File quality control records in the office and make available at all times to the Government. After completion of the work, remove the entire structure from the site.

3.5.3 Trailer-Type Mobile Office

The Contractor may, at its option, furnish and maintain a trailer-type mobile office acceptable to the Contracting Officer and providing as a minimum the facilities specified above. Securely anchor the trailer to the ground at all four corners to guard against movement during high winds.

3.6 PLANT COMMUNICATION

Whenever the Contractor has the individual elements of its plant so located that operation by normal voice between these elements is not satisfactory, the Contractor must install a satisfactory means of communication, such as telephone or other suitable devices and made available for use by Government personnel.

3.7 TEMPORARY PROJECT SAFETY FENCING

As soon as practicable, but not later than 15 days after the date established for commencement of work, furnish and erect temporary project safety fencing at the work site. Maintain the safety fencing during the life of the contract and, upon completion and acceptance of the work, will become the property of the Contractor and be removed from the work site.

3.8 CLEANUP

Remove construction debris, waste materials, packaging material and the like from the work site daily. Any dirt or mud which is tracked onto paved or surfaced roadways must be cleaned away. Store any salvageable materials resulting from demolition activities within the fenced area described above or at the supplemental storage area. Neatly stack stored materials not in trailers, whether new or salvaged.

3.9 RESTORATION OF STORAGE AREA

Upon completion of the project remove the bulletin board, signs, barricades, haul roads, and any other temporary products from the site. After removal of trailers, materials, and equipment from within the fenced area, remove the fence that will become the property of the Contractor. Restore areas used by the Contractor for the storage of equipment or material, or other use to the original or better condition. Remove gravel used to traverse grassed areas and restore the area to its original condition, including top soil and seeding as necessary.

-- End of Section --

SECTION 01 57 19.00 20

TEMPORARY ENVIRONMENTAL CONTROLS
11/11

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 833-R-060-04	(2000) Developing Your Storm Water Pollution Prevention Plan, a Guide for Construction Sites

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.120	Hazardous Waste Operations and Emergency Response
40 CFR 112	Oil Pollution Prevention
40 CFR 122.26	Storm Water Discharges (Applicable to State NPDES Programs, see section 123.25)
40 CFR 241	Guidelines for Disposal of Solid Waste
40 CFR 243	Guidelines for the Storage and Collection of Residential, Commercial, and Institutional Solid Waste
40 CFR 258	Subtitle D Landfill Requirements
40 CFR 260	Hazardous Waste Management System: General
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 263	Standards Applicable to Transporters of Hazardous Waste
40 CFR 264	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 265	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 266	Standards for the Management of Specific

	Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities
40 CFR 268	Land Disposal Restrictions
40 CFR 270	EPA Administered Permit Programs: The Hazardous Waste Permit Program
40 CFR 271	Requirements for Authorization of State Hazardous Waste Programs
40 CFR 272	Approved State Hazardous Waste Management Programs
40 CFR 273	Standards For Universal Waste Management
40 CFR 279	Standards for the Management of Used Oil
40 CFR 280	Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST)
40 CFR 300	National Oil and Hazardous Substances Pollution Contingency Plan
40 CFR 355	Emergency Planning and Notification
40 CFR 372-SUBPART D	Specific Toxic Chemical Listings
40 CFR 82	Protection of Stratospheric Ozone
49 CFR 171	General Information, Regulations, and Definitions
49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements
49 CFR 173	Shippers - General Requirements for Shipments and Packagings
49 CFR 178	Specifications for Packagings

1.2 DEFINITIONS

1.2.1 Sediment

Soil and other debris that have eroded and have been transported by runoff water or wind.

1.2.2 Solid Waste

Garbage, refuse, debris, sludge, or other discharged material, including solid, liquid, semisolid, or contained gaseous materials resulting from domestic, industrial, commercial, mining, or agricultural operations. Types of solid waste typically generated at construction sites may include:

a. Green waste: The vegetative matter from landscaping, land clearing and

grubbing, including, but not limited to, grass, bushes, scrubs, small trees and saplings, tree stumps and plant roots. Marketable trees, grasses and plants that are indicated to remain, be re-located, or be re-used are not included.

b. Surplus soil: Existing soil that is in excess of what is required for this work, including aggregates intended, but not used, for on-site mixing of concrete, mortars and paving. Contaminated soil meeting the definition of hazardous material or hazardous waste is not included.

c. Debris: Non-hazardous solid material generated during the construction, demolition, or renovation of a structure which exceeds 2.5 inch particle size that is: a manufactured object; plant or animal matter; or natural geologic material (e.g. cobbles and boulders), broken or removed concrete, masonry, and rock asphalt paving; ceramics; roofing paper and shingles. Inert materials may be reinforced with or contain ferrous wire, rods, accessories and weldments. A mixture of debris and other material such as soil or sludge is also subject to regulation as debris if the mixture is comprised primarily of debris by volume, based on visual inspection.

d. Wood: Dimension and non-dimension lumber, plywood, chipboard, hardboard. Treated and/or painted wood that meets the definition of lead contaminated or lead based contaminated paint is not included.

e. Scrap metal: Scrap and excess ferrous and non-ferrous metals such as reinforcing steel, structural shapes, pipe and wire that are recovered or collected and disposed of as scrap. Scrap metal meeting the definition of hazardous material or hazardous waste is not included.

f. Paint cans: Metal cans that are empty of paints, solvents, thinners and adhesives. If permitted by the paint can label, a thin dry film may remain in the can.

g. Recyclables: Materials, equipment and assemblies such as doors, windows, door and window frames, plumbing fixtures, glazing and mirrors that are recovered and sold as recyclable. Metal meeting the definition of lead contaminated or lead based paint contaminated may not be included as recyclable if sold to a scrap metal company. Paint cans may not be included as recyclable if sold to a scrap metal company.

h. Hazardous Waste: By definition, to be a hazardous waste a material must first meet the definition of a solid waste. Hazardous waste and hazardous debris are special cases of solid waste. They have additional regulatory controls and must be handled separately. They are thus defined separately in this document.

Material not regulated as solid waste are: nuclear source or byproduct materials regulated under the Federal Atomic Energy Act of 1954 as amended; suspended or dissolved materials in domestic sewage effluent or irrigation return flows, or other regulated point source discharges; regulated air emissions; and fluids or wastes associated with natural gas or crude oil exploration or production.

1.2.3 Hazardous Debris

As defined in Solid Waste paragraph, debris that contains listed hazardous waste (either on the debris surface, or in its interstices, such as pore structure) per 40 CFR 261; or debris that exhibits a characteristic of

hazardous waste per 40 CFR 261.

1.2.4 Chemical Wastes

This includes salts, acids, alkalizes, herbicides, pesticides, and organic chemicals.

1.2.5 Garbage

Refuse and scraps resulting from preparation, cooking, dispensing, and consumption of food.

1.2.6 Hazardous Waste

Any discarded material, liquid, solid, or gas, which meets the definition of hazardous material or is designated hazardous waste by the Environmental Protection Agency or State Hazardous Control Authority as defined in 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, 40 CFR 265, 40 CFR 266, 40 CFR 268, 40 CFR 270, 40 CFR 271, 40 CFR 272, 40 CFR 273, 40 CFR 279, and 40 CFR 280.

1.2.7 Hazardous Materials

Hazardous materials as defined in 49 CFR 171 and listed in 49 CFR 172.

Hazardous material is any material that:

a. Is regulated as a hazardous material per 49 CFR 173, or

b. Requires a Material Safety Data Sheet (MSDS) per 29 CFR 1910.120, or

c. During end use, treatment, handling, packaging, storage, transpiration, or disposal meets or has components that meet or have potential to meet the definition of a hazardous waste as defined by 40 CFR 261 Subparts A, B, C, or D.

Designation of a material by this definition, when separately regulated or controlled by other instructions or directives, does not eliminate the need for adherence to that hazard-specific guidance which takes precedence over this instruction for "control" purposes. Such material include ammunition, weapons, explosive actuated devices, propellants, pyrotechnics, chemical and biological warfare materials, medical and pharmaceutical supplies, medical waste and infectious materials, bulk fuels, radioactive materials, and other materials such as asbestos, mercury, and polychlorinated biphenyls (PCBs). Nonetheless, the exposure may occur incident to manufacture, storage, use and demilitarization of these items.

1.2.8 Waste Hazardous Material (WHM)

Any waste material which because of its quantity, concentration, or physical, chemical, or infectious characteristics may pose a substantial hazard to human health or the environment and which has been so designated. Used oil not containing any hazardous waste, as defined above, falls under this definition.

1.2.9 Oily Waste

Those materials which are, or were, mixed with used oil and have become separated from that used oil. Oily wastes also means materials, including

wastewaters, centrifuge solids, filter residues or sludges, bottom sediments, tank bottoms, and sorbents which have come into contact with and have been contaminated by, used oil and may be appropriately tested and discarded in a manner which is in compliance with other State and local requirements.

This definition includes materials such as oily rags, "kitty litter" sorbent clay and organic sorbent material. These materials may be land filled provided that:

a. It is not prohibited in other State regulations or local ordinances

b. The amount generated is "de minimus" (a small amount)

c. It is the result of minor leaks or spills resulting from normal process operations

d. All free-flowing oil has been removed to the practical extent possible

Large quantities of this material, generated as a result of a major spill or in lieu of proper maintenance of the processing equipment, are a solid waste. As a solid waste, a hazardous waste determination must be performed prior to disposal. As this can be an expensive process, it is recommended that this type of waste be minimized through good housekeeping practices and employee education.

1.2.10 Regulated Waste

Those solid waste that have specific additional Federal, state, or local controls for handling, storage, or disposal.

1.2.11 Class I Ozone Depleting Substance (ODS)

Class I ODS is defined in Section 602(a) of The Clean Air Act and includes the following chemicals:

chlorofluorocarbon-11 (CFC-11)
chlorofluorocarbon-12 (CFC-12)
chlorofluorocarbon-13 (CFC-13)
chlorofluorocarbon-111 (CFC-111)
chlorofluorocarbon-112 (CFC-112)
chlorofluorocarbon-113 (CFC-113)
chlorofluorocarbon-114 (CFC-114)
chlorofluorocarbon-115 (CFC-115)
chlorofluorocarbon-211 (CFC-211)
chlorofluorocarbon-212 (CFC-212)

chlorofluorocarbon-213 (CFC-213)
chlorofluorocarbon-214 (CFC-214)
chlorofluorocarbon-215 (CFC-215)
chlorofluorocarbon-216 (CFC-216)
chlorofluorocarbon-217 (CFC-217)
chlorofluorocarbon-500 (CFC-500)
chlorofluorocarbon-502 (CFC-502)
chlorofluorocarbon-503 (CFC-503)
halon-1211
halon-1301
halon-2402
carbon tetrachloride
methyl bromide
methyl chloroform

Class II ODS is defined in Section 602(s) of The Clean Air Act and includes the following chemicals:

hydrochlorofluorocarbon-21 (HCFC-21)
hydrochlorofluorocarbon-22 (HCFC-22)
hydrochlorofluorocarbon-31 (HCFC-31)
hydrochlorofluorocarbon-121 (HCFC-121)
hydrochlorofluorocarbon-122 (HCFC-122)
hydrochlorofluorocarbon-123 (HCFC-123)
hydrochlorofluorocarbon-124 (HCFC-124)
hydrochlorofluorocarbon-131 (HCFC-131)
hydrochlorofluorocarbon-132 (HCFC-132)
hydrochlorofluorocarbon-133 (HCFC-133)
hydrochlorofluorocarbon-141 (HCFC-141)

hydrochlorofluorocarbon-142 (HCFC-142)
hydrochlorofluorocarbon-221 (HCFC-221)
hydrochlorofluorocarbon-222 (HCFC-222)
hydrochlorofluorocarbon-223 (HCFC-223)
hydrochlorofluorocarbon-224 (HCFC-224)
hydrochlorofluorocarbon-225 (HCFC-225)
hydrochlorofluorocarbon-226 (HCFC-226)
hydrochlorofluorocarbon-231 (HCFC-231)
hydrochlorofluorocarbon-232 (HCFC-232)
hydrochlorofluorocarbon-233 (HCFC-233)
hydrochlorofluorocarbon-234 (HCFC-234)
hydrochlorofluorocarbon-235 (HCFC-235)
hydrochlorofluorocarbon-251 (HCFC-251)
hydrochlorofluorocarbon-252 (HCFC-252)
hydrochlorofluorocarbon-253 (HCFC-253)
hydrochlorofluorocarbon-261 (HCFC-261)
hydrochlorofluorocarbon-262 (HCFC-262)
hydrochlorofluorocarbon-271 (HCFC-271)

1.2.11.1 Universal Waste

The universal waste regulations streamline collection requirements for certain hazardous wastes in the following categories: batteries, pesticides, mercury-containing equipment (e.g., thermostats) and lamps (e.g., fluorescent bulbs). The rule is designed to reduce hazardous waste in the municipal solid waste (MSW) stream by making it easier for universal waste handlers to collect these items and send them for recycling or proper disposal. These regulations can be found at 40 CFR 273.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Preconstruction Survey; G

Solid Waste Management Plan and Permit; G

Regulatory Notifications; G

Environmental Management Plan; G

Storm Water Pollution Prevention Plan; G

Storm Water Notice of Intent (for NPDES coverage under the general permit for construction activities); G

Dust Control Plan

Contractor Hazardous Material Inventory Log; G

Traffic Control Plan; G

SD-06 Test Reports

Erosion and Sediment Control Inspection Reports

Storm Water Pollution Prevention Plan Inspection Reports

Contractor 40 CFR employee training records

Solid Waste Management Report; G

SD-11 Closeout Submittals

Some of the records listed below are also required as part of other submittals. For the "Records" submittal, maintain on-site a separate three-ring Environmental Records binder and submit at the completion of the project. Make separate parts to the binder corresponding to each of the applicable sub items listed below.

Storm Water Pollution Prevention Plan compliance notebook; G

Waste Determination Documentation

Disposal Documentation for Hazardous and Regulated Waste

Contractor 40 CFR Employee Training Records

Solid Waste Management Permit

Solid Waste Management Report

Contractor Hazardous Material Inventory Log; G

Hazardous Waste/Debris Management

Regulatory Notifications

1.4 ENVIRONMENTAL PROTECTION REQUIREMENTS

Provide and maintain, during the life of the contract, environmental protection as defined. Plan for and provide environmental protective

measures to control pollution that develops during normal construction practice. Plan for and provide environmental protective measures required to correct conditions that develop during the construction of permanent or temporary environmental features associated with the project. Comply with Federal, State, and local regulations pertaining to the environment, including water, air, solid waste, hazardous waste and substances, oily substances, and noise pollution.

The Contractor may be required to promptly conduct tests and procedures for the purpose of assessing whether construction operations are in compliance with Applicable Environmental Laws. Analytical work shall be done by qualified laboratories; and where required by law, the laboratories shall be certified.

1.4.1 Conformance with the Environmental Management System

The Contractor shall perform work under this contract consistent with the policy and objectives identified in the installation's Environmental Management System (EMS). The Contractor shall perform work in a manner that conforms to objectives and targets, environmental programs and operational controls identified by the EMS. The Contractor will provide monitoring and measurement information as necessary to address environmental performance relative to environmental, energy, and transportation management goals. In the event an EMS nonconformance or environmental noncompliance associated with the contracted services, tasks, or actions occurs, the Contractor shall take corrective and/or preventative actions. In addition, the Contractor shall ensure that its employees are aware of their roles and responsibilities under the EMS and how these EMS roles and responsibilities affect work performed under the contract.

The Contractor is responsible for ensuring that their employees receive applicable environmental and occupational health and safety training, and keep up to date on regulatory required specific training for the type of work to be conducted onsite. All on-site Contractor personnel, and their subcontractor personnel, performing tasks that have the potential to cause a significant environmental impact shall be competent on the basis of appropriate education, training or experience. Upon contract award, the Contracting Officer Representative's Representative will notify the installation's EMS coordinator to arrange EMS training. The installation's EMS coordinator shall identify training needs associated with environmental aspects and the EMS, and arrange training or take other action to meet these needs. The Contractor shall provide training documentation to the Contracting Officer Representative. The EMS coordinator shall retain associated records.

1.5 QUALITY ASSURANCE

1.5.1 Preconstruction Survey

Perform a Preconstruction Survey of the project site with the Contracting Officer Representative, and take photographs showing existing environmental conditions in and adjacent to the site. Submit a report for the record.

1.5.2 Regulatory Notifications

The Contractor is responsible for all regulatory notification requirements in accordance with Federal, State and local regulations. In cases where public notification must also be provided (such as stormwater permitting), the Contractor must coordinate with the Contracting Officer

Representative. The Contractor shall submit copies of all regulatory notifications to the Contracting Officer Representative prior to commencement of work activities. Typically, regulatory notifications must be provided for the following (this listing is not all inclusive): demolition, renovation, NPDES defined site work, remediation of controlled substances (asbestos, hazardous waste, lead paint).

1.5.3 Environmental Brief

Attend an environmental brief to be included in the preconstruction meeting. Provide the following information: types, quantities, and use of hazardous materials that will be brought onto the activity; types and quantities of wastes/wastewater that may be generated during the contract. Discuss the results of the Preconstruction Survey at this time.

Prior to initiating any work on site, meet with the Contracting Officer Representative and activity environmental staff to discuss the proposed Environmental Management Plan. Develop a mutual understanding relative to the details of environmental protection, including measures for protecting natural resources, required reports, required permits, permit requirements, and other measures to be taken.

1.5.4 Contractor 40 CFR Employee Training Records

Prepare and maintain employee training records throughout the term of the contract meeting applicable 40 CFR requirements. Submit these training records to the Contracting Officer Representative at the conclusion of the project, unless otherwise directed.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 ENVIRONMENTAL MANAGEMENT PLAN

Prior to initiating any work on site, the Contractor will meet with the Contracting Officer Representative to discuss the proposed Environmental Protection Plan and develop a mutual understanding relative to the details of environmental protection, including measures for protecting natural resources, required reports, and other measures to be taken. The Contractor's Environmental Plan shall incorporate construction related objectives and targets from the installation's Environmental Management System. The Environmental Management Plan will be submitted in the following format and shall include the elements specified below.

a. Description of the Environmental Management Plan

(1) General overview and purpose

(a) A brief description of each specific plan required by environmental permit or elsewhere in this contract.

(b) The duties and level of authority assigned to the person(s) on the job site that oversee environmental compliance.

(c) A copy of any standard or project specific operating procedures that will be used to effectively manage and protect the

environment on the project site.

(d) Communication and training procedures that will be used to convey environmental management requirements to contractor employees and subcontractors.

(e) Emergency contact information contact information (office phone number, cell phone number, and e-mail address).

(2) General site information

b. Management of Natural Resources

(1) Land resources

(2) Tree protection

(3) Replacement of damaged landscape features

(4) Temporary construction

(5) Stream crossings

(6) Fish and wildlife resources

(7) Wetland areas

c. Protection of Historical and Archaeological Resources

(1) Objectives

(2) Methods

d. Storm Water Management and Control

(1) Ground cover

(2) Erodible soils

(3) Temporary measures

(a) Mechanical retardation and control of runoff

(b) Vegetation and mulch

(4) Effective selection, implementation and maintenance of Best Management Practices (BMPs).

e. Protection of the Environment from Waste Derived from Contractor Operations

(1) Control and disposal of solid and sanitary waste. If Section 01 74 19.05 20 is included in the contract, submit the plan required by that section as part of the Environmental Management Plan.

(2) Control and disposal of hazardous waste (Hazardous Waste Management Section)

This item will consist of the management procedures for all

hazardous waste to be generated. The elements of those procedures will coincide with the Activity Hazardous Waste Management Plan. A copy of the Activity Hazardous Waste Management Plan will be provided by the Contracting Officer Representative. As a minimum, include the following:

(a) Procedures to be employed to ensure a written waste determination is made for appropriate wastes which are to be generated;

(b) Sampling/analysis plan;

(c) Methods of hazardous waste accumulation/storage (i.e., in tanks and/or containers);

(d) Management procedures for storage, labeling, transportation, and disposal of waste (treatment of waste is not allowed unless specifically noted);

(e) Management procedures and regulatory documentation ensuring disposal of hazardous waste complies with Land Disposal Restrictions (40 CFR 268);

(f) Management procedures for recyclable hazardous materials such as lead-acid batteries, used oil, and the like;

(g) Used oil management procedures in accordance with 40 CFR 279;

(h) Pollution prevention\hazardous waste minimization procedures;

(i) Plans for the disposal of hazardous waste by permitted facilities;

(j) Procedures to be employed to ensure all required employee training records are maintained.

f. Prevention of Releases to the Environment

(1) Procedures to prevent releases to the environment

(2) Notifications in the event of a release to the environment

g. Regulatory Notification and Permits

List what notifications and permit applications must be made. Demonstrate that those permits have been obtained by including copies of all applicable, environmental permits.

3.1.1 Environmental Protection Plan Review

Within thirty days after the Contract award date, submit the proposed Environmental Management Plan for further discussion, review, and approval. Commencement of work will not begin until the environmental management plan has been approved.

3.1.2 Licenses and Permits

No permits will be obtained by the Contracting Officer Representative. The project is not required to obtain permits under the CERCLA Permit

Exemption. Any substantive elements that would be required by the permit, however, must still be attained. Therfore, the Contractor shall prepare the permit documents required herein and submit them to the Contracting Officer Representative.

3.2 PROTECTION OF NATURAL RESOURCES

Preserve the natural resources within the project boundaries and outside the limits of permanent work. Restore to an equivalent or improved condition upon completion of work. Confine construction activities to within the limits of the work indicated or specified. If the work is near streams, lakes, or other waterways, conform to the national permitting requirements of the Clean Water Act.

Do not disturb fish and wildlife. Do not alter water flows or otherwise significantly disturb the native habitat adjacent to the project and critical to the survival of fish and wildlife, except as indicated or specified.

Except in areas to be cleared, do not remove, cut, deface, injure, or destroy trees or shrubs without the Contracting Officer Representative's permission. Do not fasten or attach ropes, cables, or guys to existing nearby trees for anchorages unless authorized by the Contracting Officer Representative. Where such use of attached ropes, cables, or guys is authorized, the Contractor will be responsible for any resultant damage.

Protect existing trees which are to remain and which may be injured, bruised, defaced, or otherwise damaged by construction operations. Remove displaced rocks from uncleared areas. By approved excavation, remove trees with 30 percent or more of their root systems destroyed. Remove trees and other landscape features scarred or damaged by equipment operations, and replace with equivalent, undamaged trees and landscape features. Obtain Contracting Officer Representative's approval before replacement.

The Contracting Officer Representative's approval is required before any equipment will be permitted to ford live streams. In areas where frequent crossings are required, install temporary culverts or bridges. Obtain Contracting Officer Representative's approval prior to installation. Remove temporary culverts or bridges upon completion of work, and repair the area to its original condition.

3.2.1 Erosion and Sediment Control Measures

3.2.1.1 Burnoff

Burnoff of the ground cover is not permitted.

3.2.1.2 Protection of Erodible Soils

Immediately finish the earthwork brought to a final grade, as indicated or specified. Immediately protect the side slopes and back slopes upon completion of rough grading. Plan and conduct earthwork to minimize the duration of exposure of unprotected soils.

3.2.1.3 Temporary Protection of Erodible Soils

Use the following methods to prevent erosion and control sedimentation:

a. Mechanical Retardation and Control of Runoff

Mechanically retard and control the rate of runoff from the construction site. This includes construction of diversion ditches, benches, berms, and use of silt fences and straw bales to retard and divert runoff to protected drainage courses.

b. Sediment Basins

(1) Trap sediment in temporary sediment basins. Select a basin size to accommodate the runoff of a local 10-year storm. Pump dry and remove the accumulated sediment, after each storm. Use a paved weir or vertical overflow pipe for overflow. Remove collected sediment from the site. Institute effluent quality monitoring programs.

(2) Install, inspect, and maintain best management practices (BMPs) as required by the general permit. Prepare BMP Inspection Reports as required by the general permit. If required by the permit, include those inspection reports.

c. Vegetation and Mulch

(1) Provide temporary protection on sides and back slopes as soon as rough grading is completed or sufficient soil is exposed to require erosion protection. Protect slopes by accelerated growth of permanent vegetation, temporary vegetation, mulching, or netting. Stabilize slopes by hydroseeding, anchoring mulch in place, covering with anchored netting, sodding, or such combination of these and other methods necessary for effective erosion control.

(2) Seeding: Provide new seeding where ground is disturbed. Include topsoil or nutriment during the seeding operation necessary to establish or reestablish a suitable stand of grass. The seeding operation will be as specified in Section 32 92 19 SEEDING.

3.2.2 Erosion and Sediment Control Inspection Reports

Submit "Erosion and Sediment Control Inspection Reports" (E&S) (form provided at the pre-construction conference) to the Contracting Officer Representative once every 7 calendar days and within 24 hours of a storm event that produces 0.5 inch or more of rain.

Note erosion control inspection reports may be compiled as part of a stormwater pollution prevention plan inspection reports if applicable.

3.2.2.1 Storm Water Notice of Intent for Construction Activities and Storm Water Pollution Prevention Plan

The Contractor shall submit a Storm Water Notice of Intent (for NPDES coverage under the general permit for construction activities) and a Storm Water Pollution Prevention Plan (SWPPP) for the project to the Contracting Officer Representative prior and gain approval prior to the commencement of work. The SWPPP will meet the requirements of the EPA or State general permit for storm water discharges from construction sites. Submit the SWPPP along with any required Notice of Intents, and Notice of Termination to the Contracting Officer Representative, a minimum of 14 calendar days prior to the start of any land disturbing activities. The Contractor shall maintain an approved copy of the SWPPP at the construction on-site office,

and continually update as regulations require, reflecting current site conditions.

Under CERCLA, permits are not required, however, the substantive elements that would be required by the permit must be attained. The Contractor may be required to install, inspect, maintain best management practices (BMPs), and submit stormwater BMP inspection reports and stormwater pollution prevention plan inspection reports. The Contractor shall ensure construction operations and management are constantly in compliance with the terms and conditions of the general permit for storm water discharges from construction activities.

a. The SWPPP shall:

(1) Identify potential sources of pollution which may be reasonably expected to affect the quality of storm water discharge from the site.

(2) Describe and ensure implementation of practices which will be used to reduce the pollutants in storm water discharge from the site.

(3) Ensure compliance with terms of the EPA or State general permit for storm water discharge.

(4) Select applicable best management practices from EPA 833-R-060-04.

(5) Include a completed copy of the Registration Statement, BMP Inspection Report Template and Notice of Termination except for the effective date.

(6) Storm Water Pollution Prevention Measures and Notice of Intent 40 CFR 122.26, EPA 833-R-060-04. Provide a "Storm Water Pollution Prevention Plan" (SWPPP) for the project. The SWPPP will meet the requirements of the EPA or State general permit for storm water discharges from construction sites. Submit the SWPPP along with any required Notice of Intents, Notice of Termination, and appropriate permit fees, via the Contracting Officer Representative, to the appropriate Federal or State agency for approval, a minimum of 14 calendar days prior to the start of construction. A copy of the approved SWPPP will be kept at the construction on-site office, and continually updated as regulations require reflecting current site conditions.

3.2.2.2 Storm Water Pollution Prevention Plan Compliance Notebook

The contractor shall create and maintain a three binder of documents that demonstrate compliance with the Stormwater Construction Activity permit. The binder shall include a copy of the permit Registration Statement, proof of permit fee payment, SWPPP and SWPPP update amendments, SWPPP, inspection reports, copies of correspondence with the EPA and State of Connecticut and a copy of the permit Notice of Termination. At the completion of the project the folder shall become the property of the Government. The compliance notebook shall be provided to Contracting Officer Representative. An advance copy of the Registration Statement shall be provided to the Contracting Officer Representative immediately after the form is presented to the permitting agency.

3.2.3 Stormwater Drainage and Construction Dewatering

There will be no discharge of excavation ground water to the sanitary sewer, storm drains, or to the river without prior specific authorization of the Environmental Division in writing. Discharge of hazardous substances will not be permitted under any circumstances.

Construction site runoff will be prevented from entering any storm drain or the river directly by the use of straw bales or other method suitable to the Environmental Division. Contractor will provide erosion protection of the surrounding soils.

Construction Dewatering shall not be discharged to the sanitary sewer. If the construction dewatering is noted or suspected of being contaminated, it may only be released to the storm drain system if the discharge is specifically permitted. Authorization for any contaminated groundwater release shall be obtained in advance from the base Environmental Officer. Discharge of hazardous substances will not be permitted under any circumstances.

3.3 HISTORICAL AND ARCHAEOLOGICAL RESOURCES

Carefully protect in-place and report immediately to the Contracting Officer Representative historical and archaeological items or human skeletal remains discovered in the course of work. Upon discovery, notify the Contracting Officer Representative. Stop work in the immediate area of the discovery until directed by the Contracting Officer Representative to resume work. The Government retains ownership and control over historical and archaeological resources.

3.4 SOLID WASTE MANAGEMENT PLAN and PERMIT

Provide to the Contracting Officer Representative written notification of the quantity of solid waste/debris that is anticipated to be generated by construction. Include in the report the locations where various types of waste will be disposed or recycled. Include letters of acceptance or as applicable, submit one copy of a State and local Solid Waste Management Permit or license showing such agency's approval of the disposal plan before transporting wastes off Government property.

3.4.1 Solid Waste Management Report

Monthly, submit a solid waste disposal report to the Contracting Officer Representative. For each waste, the report will state the classification (using the definitions provided in this section), amount, location, and name of the business receiving the solid waste.

The Contractor will include copies of the waste handling facilities' weight tickets, receipts, bills of sale, and other sales documentation. In lieu of sales documentation, the Contractor may submit a statement indicating the disposal location for the solid waste which is signed by an officer of the Contractor firm authorized to legally obligate or bind the firm. The sales documentation or Contractor certification will include the receiver's tax identification number and business, EPA or State registration number, along with the receiver's delivery and business addresses and telephone numbers. For each solid waste retained by the Contractor for his own use, the Contractor will submit on the solid waste disposal report the information previously described in this paragraph. Prices paid or received will not be reported to the Contracting Officer Representative

unless required by other provisions or specifications of this Contract or public law.

3.4.2 Control and Management of Solid Wastes

Pick up solid wastes, and place in covered containers which are regularly emptied. Do not prepare or cook food on the project site. Prevent contamination of the site or other areas when handling and disposing of wastes. At project completion, leave the areas clean. Recycling is encouraged and can be coordinated with the Contracting Officer Representative and the activity recycling coordinator. Remove all solid waste (including non-hazardous debris) from Government property and dispose off-site at an approved landfill. Solid waste disposal off-site must comply with most stringent local, State, and Federal requirements including 40 CFR 241, 40 CFR 243, and 40 CFR 258.

Manage spent hazardous material used in construction, including but not limited to, aerosol cans, waste paint, cleaning solvents, contaminated brushes, and used rags, as per environmental law.

3.5 WASTE DETERMINATION DOCUMENTATION

Complete a Waste Determination form (provided at the pre-construction conference) for all contractor derived wastes to be generated. Base the waste determination upon either a constituent listing from the manufacturer used in conjunction with consideration of the process by which the waste was generated, EPA approved analytical data, or laboratory analysis (Material Safety Data Sheets (MSDS) by themselves are not adequate). Attach all support documentation to the Waste Determination form. As a minimum, a Waste Determination form must be provided for the following wastes (this listing is not all inclusive): oil and latex based painting and caulking products, solvents, adhesives, aerosols, petroleum products, and all containers of the original materials.

3.6 CONTRACTOR HAZARDOUS MATERIAL INVENTORY LOG

Submit the "Contractor Hazardous Material Inventory Log"(found at: http://www.wbdg.org/ccb/NAVGRAPH/graphtoc.pdf), which provides information required by (EPCRA Sections 312 and 313) along with corresponding Material Safety Data Sheets (MSDS) to the Contracting Officer Representative at the start and at the end of construction (30 days from final acceptance), and update no later than January 31 of each calendar year during the life of the contract. Documentation for any spills/releases, environmental reports or off-site transfers may be requested by the Contracting Officer Representative.

3.6.1 Disposal Documentation for Hazardous and Regulated Waste

Manifest, pack, ship and dispose of hazardous or toxic waste and universal waste that is generated as a result of construction in accordance with the generating facilities generator status under the Recourse Conservation and Recovery Act. Contact the Contracting Officer Representative for the facility RCRA identification number that is to be used on each manifest.

Submit a copy of the applicable EPA and or State permit(s), manifest(s), or license(s) for transportation, treatment, storage, and disposal of hazardous and regulated waste by permitted facilities. Hazardous or toxic waste manifest must be reviewed, signed, and approved by the Navy before the Contractor may ship waste. To obtain specific disposal instructions

the Contractor must coordinate with the Activity environmental office.

3.7 POLLUTION PREVENTION/HAZARDOUS WASTE MINIMIZATION

Minimize the use of hazardous materials and the generation of hazardous waste. Include procedures for pollution prevention/ hazardous waste minimization in the Hazardous Waste Management Section of the Environmental Management Plan. Consult with the activity Environmental Office for suggestions and to obtain a copy of the installation's pollution prevention/hazardous waste minimization plan for reference material when preparing this part of the plan. If no written plan exists, obtain information by contacting the Contracting Officer Representative. Describe the types of the hazardous materials expected to be used in the construction when requesting information.

3.8 WHM/HW MATERIALS PROHIBITION

No waste hazardous material or hazardous waste shall be disposed of on government property. No hazardous material shall be brought onto government property that does not directly relate to requirements for the performance of this contract. The government is not responsible for disposal of Contractor's waste material brought on the job site and not required in the performance of this contract. The intent of this provision is to dispose of that waste identified as waste hazardous material/hazardous waste as defined herein that was generated as part of this contract and existed within the boundary of the Contract limits and not brought in from offsite by the Contractor. Incidental materials used to support the contract including, but not limited to aerosol cans, waste paint, cleaning solvents, contaminated brushes, rags, clothing, etc. are the responsibility of the Contractor. The list is illustrative rather than inclusive. The Contractor is not authorized to discharge any materials to sanitary sewer, storm drain, or to the river or conduct waste treatment or disposal on government property without written approval of the Contracting Officer Representative.

3.9 HAZARDOUS MATERIAL MANAGEMENT

No hazardous material shall be brought onto government property that does not directly relate to requirements for the performance of this contract.

Include hazardous material control procedures in the Safety Plan. Address procedures and proper handling of hazardous materials, including the appropriate transportation requirements. Submit a MSDS and estimated quantities to be used for each hazardous material to the Contracting Officer Representative prior to bringing the material on base. Typical materials requiring MSDS and quantity reporting include, but are not limited to, oil and latex based painting and caulking products, solvents, adhesives, aerosol, and petroleum products. At the end of the project, provide the Contracting Officer Representative with the maximum quantity of each material that was present at the site at any one time, the dates the material was present, the amount of each material that was used during the project, and how the material was used. Ensure that hazardous materials are utilized in a manner that will minimize the amount of hazardous waste that is generated. Ensure that all containers of hazardous materials have NFPA labels or their equivalent. Keep copies of the MSDS for hazardous materials on site at all times and provide them to the Contracting Officer Representative at the end of the project. Certify that all hazardous materials removed from the site are hazardous materials and do not meet the definition of hazardous waste per 40 CFR 261.

3.10 PETROLEUM PRODUCTS AND REFUELING

Conduct the fueling and lubricating of equipment and motor vehicles in a manner that protects against spills and evaporation. Manage all used oil generated on site in accordance with 40 CFR 279. Determine if any used oil generated while on-site exhibits a characteristic of hazardous waste. Used oil containing 1000 parts per million of solvents will be considered a hazardous waste and disposed of at Contractor's expense. Used oil mixed with a hazardous waste will also be considered a hazardous waste.

3.10.1 Oily and Hazardous Substances

Prevent oil or hazardous substances from entering the ground, drainage areas, or navigable waters. In accordance with 40 CFR 112, surround all temporary fuel oil or petroleum storage tanks with a temporary berm or containment of sufficient size and strength to contain the contents of the tanks, plus 10 percent freeboard for precipitation. The berm will be impervious to oil for 72 hours and be constructed so that any discharge will not permeate, drain, infiltrate, or otherwise escape before cleanup occurs.

3.10.2 Inadvertent Discovery of Petroleum Contaminated Soil or Hazardous Wastes

If petroleum contaminated soil or suspected hazardous waste is found during construction that was not identified in the contract documents, the contractor shall immediately notify the Contracting Officer Representative. The contractor shall not disturb this material until authorized by the Contracting Officer Representative.

3.11 FUEL TANKS

Petroleum products and lubricants required to sustain up to 30 days of construction activity may be kept on site. Storage and refilling practices shall comply with 40 CFR Part 112. Secondary containment shall be provided and be no less than 110 percent of the tank volume plus five inches of free-board. If a secondary berm is used for containment then the berm shall be impervious to oil for 72 hours and be constructed so that any discharge will not permeate, drain, infiltrate, or otherwise escape before cleanup occurs. Drips pans are required and the tanks must be covered during inclement weather.

3.12 RELEASES/SPILLS OF OIL AND HAZARDOUS SUBSTANCES

Exercise due diligence to prevent, contain, and respond to spills of hazardous material, hazardous substances, hazardous waste, sewage, regulated gas, petroleum, lubrication oil, and other substances regulated by environmental law. Maintain spill cleanup equipment and materials at the work site. In the event of a spill, take prompt, effective action to stop, contain, curtail, or otherwise limit the amount, duration, and severity of the spill/release. In the event of any releases of oil and hazardous substances, chemicals, or gases; immediately (within 15 minutes) notify the Base or Activity Fire Department, the activity's Command Duty Officer, and the Contracting Officer Representative. If the contractor's response is inadequate, the Navy may respond. If this should occur, the contractor will be required to reimburse the government for spill response assistance and analysis.

The Contractor is responsible for verbal and written notifications as required by the federal 40 CFR 355, State, local regulations and Navy Instructions. Spill response will be in accordance with 40 CFR 300 and applicable State and local regulations. Contain and clean up these spills without cost to the Government. If Government assistance is requested or required, the Contractor will reimburse the Government for such assistance. Provide copies of the written notification and documentation that a verbal notification was made within 20 days.

Maintain spill cleanup equipment and materials at the work site. Clean up all hazardous and non-hazardous (WHM) waste spills. The Contractor shall reimburse the government for all material, equipment, and clothing generated during any spill cleanup. The Contractor shall reimburse the government for all costs incurred including sample analysis materials, equipment, and labor if the government must initiate its own spill cleanup procedures, for Contractor responsible spills, when:

a. The Contractor has not begun spill cleanup procedure within one hour of spill discovery/occurrence, or

b. If, in the government's judgment, the Contractor's spill cleanup is not adequately abating life threatening situation and/or is a threat to any body of water or environmentally sensitive areas.

3.13 CONTROL AND MANAGEMENT OF HAZARDOUS WASTES

3.13.1 Facility Hazardous Waste Generator Status

Not applicable.

3.13.2 Hazardous Waste/Debris Management

Identify all construction activities which will generate hazardous waste/debris. Provide a documented waste determination for all resultant waste streams. Hazardous waste/debris will be identified, labeled, handled, stored, and disposed of in accordance with all Federal, State, and local regulations including 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, 40 CFR 265, 40 CFR 266, and 40 CFR 268.

Hazardous waste will also be managed in accordance with the approved Hazardous Waste Management Section of the Environmental Protection Plan. Store hazardous wastes in approved containers in accordance with 49 CFR 173 and 49 CFR 178. Hazardous waste generated within the confines of Government facilities will be identified as being generated by the Government.

Prior to removal of any hazardous waste from Government property, all hazardous waste manifests must be signed by activity personnel from the Station Environmental Office. No hazardous waste will be brought onto Government property. Provide to the Contracting Officer Representative a copy of waste determination documentation for any solid waste streams that have any potential to be hazardous waste or contain any chemical constituents listed in 40 CFR 372-SUBPART D. For hazardous wastes spills, verbally notify the Contracting Officer Representative immediately.

3.13.2.1 Regulated Waste Storage/Satellite Accumulation/90 Day Storage Areas

If the work requires the temporary storage/collection of regulated or hazardous wastes, the Contractor will request the establishment of a

Regulated Waste Storage Area, a Satellite Accumulation Area, or a 90 Day Storage Area at the point of generation. The Contractor must submit a request in writing to the Contracting Officer Representative providing the following information:

Contract Number	
Contractor	
Haz/Waste or Regulated Waste POC	
Phone Number	
Type of Waste	
Source of Waste	
Emergency POC	
Phone Number	
Location of the Site	

(Attach Site Plan to the Request)

Attach a waste determination form. Allow ten working days for processing this request. The designated area where waste is being stored shall be barricaded and a sign identifying as follows:

"DANGER - UNAUTHORIZED PERSONNEL KEEP OUT"

3.13.2.2 Asbestos Certification

Items, components, or materials disturbed by or included in work under this contract do involve asbestos. Other materials in the general area around where work will be performed may contain asbestos. All thermal insulation, in all work areas, should be considered to be asbestos unless positively identified by conspicuous tags or previous laboratory analysis certifying them as asbestos free.

Inadvertent discovery of non-disclosed asbestos that will result in an abatement action requires a change in scope before proceeding. Upon discovery of asbestos containing material not identified in the contract documents, the Contractor shall immediately stop all work that would generate further damage to the material, evacuate the asbestos exposed area, and notify the Contracting Officer Representative for resolution of the situation prior to resuming normal work activities in the affected area. The Contractor will not remove or perform work on any asbestos containing materials without the prior approval of the Contracting Officer Representative. The Contractor will not engage in any activity, which would remove or damage such materials or cause the generation of fibers from such materials.

Asbestos containing waste shall be managed and disposed of in accordance with applicable environmental law. Asbestos containing waste shall be manifested and the manifest provided to the Contracting Officer

Representative.

3.13.3 Class I and II ODS Prohibition

Class I and II ODS as defined and identified herein will not be used in the performance of this contract, nor be provided as part of the equipment. This prohibition will be considered to prevail over any other provision, specification, drawing, or referenced documents. Regulations related to the protection of stratosphere ozone may be found in 40 CFR 82.

Heating and air conditioning technicians must be certified through an EPA-approved program. Copies of certifications shall be maintained at the employees' place of business and be carried as a wallet card by the technician, as provided by environmental law. Accidental venting of a refrigerant is a release and shall be reported to the Contracting Officer Representative.

3.13.3.1 Universal Waste/e-Waste Management

Universal waste including but not limited to some mercury containing building products such florescent lamps, mercury vapor lamps, high pressure sodium lamps, CRTs, batteries, aerosol paint containers, electrical equipment containing PCBs, and consumed electronic devices, shall be managed in accordance with applicable environmental law and installation instructions.

3.14 DUST CONTROL

Keep dust down at all times, including during nonworking periods. Sprinkle or treat, with dust suppressants, the soil at the site, haul roads, and other areas disturbed by operations. Dry power brooming will not be permitted. Instead, use vacuuming, wet mopping, wet sweeping, or wet power brooming. Air blowing will be permitted only for cleaning nonparticulate debris such as steel reinforcing bars. Only wet cutting will be permitted for cutting concrete blocks, concrete, and bituminous concrete. Do not unnecessarily shake bags of cement, concrete mortar, or plaster.

3.14.1 Dust Control Plan

Submit truck and material haul routes along with a plan for controlling dirt, debris, and dust on base roadways. As a minimum, identify in the plan the subcontractor and equipment for cleaning along the haul route and measures to reduce dirt, dust, and debris from roadways.

3.15 NOISE

Make the maximum use of low-noise emission products, as certified by the EPA. Blasting or use of explosives will not be permitted without written permission from the Contracting Officer Representative, and then only during the designated times. Confine pile-driving operations to the period between 8 a.m. and 4 p.m., Monday through Friday, exclusive of holidays, unless otherwise specified.

3.16 TRAFFIC CONTROL PLAN

Traffic control plans includng measures to reduce erosion of temporary roadbeds by construction traffic, especially during wet weather. Plan shall include measures to minimize the amount of mud transported onto paved public roads by vehicles or runoff.

-- End of Section --

SECTION 01 57 23

TEMPORARY STORM WATER POLLUTION CONTROL
04/08

PART 1 GENERAL

1.1 SUMMARY

The work consists of implementing the storm water pollution prevention measures to prevent sediment from entering streams or water bodies as specified in this Section in conformance with the requirements of Section 01 57 19.00 20 TEMPORARY ENVIRONMENTAL CONTROLS, and the requirements of the National Pollutant Discharge Elimination System (NPDES).

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D4439	(2011) Geosynthetics
ASTM D4491	(1999a; R 2014; E 2014) Water Permeability of Geotextiles by Permittivity
ASTM D4533	(2011) Trapezoid Tearing Strength of Geotextiles
ASTM D4632/D4632M	(2008; E 2013; R 2013) Grab Breaking Load and Elongation of Geotextiles
ASTM D4751	(2012) Determining Apparent Opening Size of a Geotextile
ASTM D4873	(2002; R 2009) Identification, Storage, and Handling of Geosynthetic Rolls and Samples

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 832-R-92-005	(1992) Storm Water Management for Construction Activities Developing Pollution Preventions and Plans and Best Management Practices

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 122.26	Storm Water Discharges (Applicable to State NPDES Programs, see section 123.25)

1.3 EROSION AND SEDIMENT CONTROLS

The controls and measures required of the Contractor are described below.

1.3.1 Stabilization Practices

The stabilization practices to be implemented include temporary seeding, mulching, geotextiles, sod stabilization, vegetative buffer strips, erosion control matts, protection of trees, preservation of mature vegetation, etc. On the daily CQC Report, record the dates when the major grading activities occur, (e.g., clearing and grubbing, excavation, embankment, and grading); when construction activities temporarily or permanently cease on a portion of the site; and when stabilization practices are initiated. Except as provided in paragraphs UNSUITABLE CONDITIONS and NO ACTIVITY FOR LESS THAN 21 DAYS, initiate stabilization practices as soon as practicable, but no more than 14 days, in any portion of the site where construction activities have temporarily or permanently ceased.

1.3.1.1 Unsuitable Conditions

Where the initiation of stabilization measures by the fourteenth day after construction activity temporarily or permanently ceases or is precluded by unsuitable conditions caused by the weather, initiate stabilization practices as soon as practicable after conditions become suitable.

1.3.1.2 No Activity for Less Than 21 Days

When the total time period in which construction activity is temporarily ceased on a portion of the site is 21 days minimum, stabilization practices do not have to be initiated on that portion of the site until 14 days have elapsed after construction activity temporarily ceased.

1.3.1.3 Burnoff

Burnoff of the ground cover is not permitted.

1.3.1.4 Protection of Erodible Soils

Immediately finish the earthwork brought to a final grade, as indicated or specified, and protect the side slopes and back slopes upon completion of rough grading. Plan and conduct earthwork to minimize the duration of exposure of unprotected soils.

1.3.2 Erosion, Sediment and Stormwater Control

a. Submit "Erosion and Sediment Controls" (E&S) (form provided at the pre-construction conference) and Storm Water Inspection Reports for General Permit to the Contracting Officer once every 7 calendar days and within 24 hours of a storm event that produces 0.5 inch or more of rain.

b. Comply with CT DEEP Permit to Discharge Storm Water under the National Pollutant Discharge Elimination System. The existing permit may be obtained from: http://h20.enr.state.nc.us/su/PDF_Files/SW_General_Permits/NCG01_Inspect_log.pdf.

c. Storm Water Notice of Intent for Construction Activities

d. Submit a Storm Water Notice of Intent for NPDES coverage under the general permit for construction activities and a Storm Water Pollution Prevention Plan (SWPPP) for the project to the Contracting Officer prior to the commencement of work. The SWPPP shall meet the requirements of the State of Connecticut general permit for storm water

discharges from construction sites. Submit the SWPPP along with any required Notice of Intents, Notice of Termination, and appropriate permit fees, via the Contracting Officer, to the appropriate State agency for approval, a minimum of 14 calendar days prior to the start of any land disturbing activities. Maintain an approved copy of the SWPPP at the construction on-site office, and continually update as regulations require, to reflect current site conditions. Include within the SWPPP:

(1) Identify potential sources of pollution which may be reasonably expected to affect the quality of storm water discharge from the site.

(2) Describe and ensure implementation of practices which will be used to reduce the pollutants in storm water discharge from the site.

(3) Ensure compliance with terms of the State of Connecticut general permit for storm water discharge.

(4) Select applicable best management practices from EPA 832-R-92-005.

(5) Include a completed copy of the Registration Statement, BMP Inspection Report Template and Notice of Termination except for the effective date.

(6) Storm Water Pollution Prevention Measures and Notice of Intent 40 CFR 122.26, EPA 832-R-92-005. Provide a "Storm Water Pollution Prevention Plan" (SWPPP) for the project. The SWPPP will meet the requirements of the State of Connecticut general permit for storm water discharges from construction sites. Submit the SWPPP along with any required Notice of Intents, Notice of Termination, and appropriate permit fees, via the Contracting Officer, to the appropriate State agency for approval, a minimum of 14 calendar days prior to the start of construction. A copy of the approved SWPPP will be kept at the construction on-site office, and continually updated as regulations require to reflect current site conditions.

(7) Following SWPPP approval, submit Registration Statement and appropriate permit fees to the Connecticut Department of Energy and Environmental Protection (CT DEEP) before any land disturbing activities begin. Coverage under the permit begins on the day the Registration Statement and fee are: (1) post marked by mail, (2) registered online at the DCR's website, or (3) hand delivered to the CT DEEP office. The Contractor is responsible for all associated fees; contact CT DEEP to determine applicable fees.

(8) Install, inspect, and maintain best management practices (BMPs) as required by the general permit. Prepare and submit to CT DEEP, BMP Inspection Reports as required by the general permit.

(9) Once construction is complete and the site has been stabilized with a final, sustainable cover, submit the Notice of Termination to CT DEEP within 30 days after all land disturbing activities end.

(10) Information on the permit application, SWPPP requirements, Registration Statement, BMP Inspection Reports, and Notice of Termination can be found on the CT DEEP website

http://www.ct.gov/deep/cwp/view.asp?a=2721&q=325702&deepNav_GID=1654%20. This website also contains the permit regulations and information on how to obtain coverage online.

(11) Once construction is complete and the site has been stabilized with a final, sustainable cover, submit the Notice of Termination to CT DEEP within 30 days after all land disturbing activities end.

1.3.3 Structural Practices

Implement structural practices to divert flows from exposed soils, temporarily store flows, or otherwise limit runoff and the discharge of pollutants from exposed areas of the site. Implement structural practices in a timely manner, during the construction process, to minimize erosion and sediment runoff. Include the following devices; Location and details of installation and construction are shown on the drawings.

1.3.3.1 Silt Fences

Provide silt fences as a temporary structural practice to minimize erosion and sediment runoff. Properly install silt fences to effectively retain sediment immediately after completing each phase of work where erosion would occur in the form of sheet and rill erosion (e.g. clearing and grubbing, excavation, embankment, and grading). Install silt fences in the locations indicated on the drawings. Obtain approval from the Contracting Officer prior to final removal of silt fence barriers.

1.3.3.2 Straw Bales

Provide bales of straw as a temporary structural practice to minimize erosion and sediment runoff. If bales are used, properly place the bales to effectively retain sediment immediately after completing each phase of work (e.g., clearing and grubbing, excavation, embankment, and grading) in each independent runoff area (e.g., after clearing and grubbing in a area between a ridge and drain, place the bales as work progresses, remove/replace/relocate the bales as needed for work to progress in the drainage area). Show on the drawings areas where straw bales are to be used. The Contracting Officer will approve the final removal of straw bale barriers. Provide rows of bales of straw as follows:

a. Along the downhill perimeter edge of all areas disturbed.

b. Along the top of the slope or top bank of drainage ditches, channels, swales, etc. that traverse disturbed areas.

c. Along the toe of all cut slopes and fill slopes of the construction areas.

d. Perpendicular to the flow in the bottom of existing drainage ditches, channels, swales, etc. that traverse disturbed areas or carry runoff from disturbed areas. Space the rows as shown on the drawings.

e. Perpendicular to the flow in the bottom of new drainage ditches, channels, and swales. Space the rows as shown on the drawings.

f. At the entrance to culverts that receive runoff from disturbed areas.

1.3.3.3 Diversion Dikes

Build diversion dikes with a maximum channel slope of 2 percent and adequately compacted to prevent failure. The minimum height measured from the top of the dike to the bottom of the channel shall be 18 inches. The minimum base width shall be 6 feet and the minimum top width shall be 2 feet. Ensure that the diversion dikes are not damaged by construction operations or traffic. Locate diversion dikes where shown on the drawings.

1.3.4 Sediment Basins

Trap sediment in temporary sediment basins. Select a basin size to accommodate the runoff of a local 2-year storm. Pump dry and remove the accumulated sediment, after each storm. Use a paved weir or vertical overflow pipe for overflow. Remove collected sediment from the site. Institute effluent quality monitoring programs. Install, inspect, and maintain best management practices (BMPs) as required by the general permit. Prepare BMP Inspection Reports as required by the general permit. If required by the permit, include those inspection reports.

1.3.5 Vegetation and Mulch

a. Provide temporary protection on sides and back slopes as soon as rough grading is completed or sufficient soil is exposed to require erosion protection. Protect slopes by accelerated growth of permanent vegetation, temporary vegetation, mulching, or netting. Stabilize slopes by hydroseeding, anchoring mulch in place, covering with anchored netting, sodding, or such combination of these and other methods necessary for effective erosion control.

b. Seeding: Provide new seeding where ground is disturbed. Include topsoil or nutriment during the seeding operation necessary to establish a suitable stand of grass. The seeding operation will be as specified in Section 32 92 19 SEEDING.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Storm Water Pollution Prevention Plan
Storm Water Notice of Intent

SD-06 Test Reports

Storm Water Inspection Reports for General Permit
Erosion and Sediment Controls

SD-07 Certificates

Mill Certificate or Affidavit

1.5 DELIVERY, STORAGE, AND HANDLING

Identify, store and handle filter fabric in accordance with ASTM D4873.

PART 2 PRODUCTS

2.1 COMPONENTS FOR SILT FENCES

2.1.1 Filter Fabric

Provide geotextile that complies with the requirements of ASTM D4439, and consists of polymeric filaments which are formed into a stable network such that filaments retain their relative positions. The filament shall consist of a long-chain synthetic polymer composed of at least 85 percent by weight of ester, propylene, or amide, and contains stabilizers and/or inhibitors added to the base plastic to make the filaments resistant to deterioration due to ultraviolet and heat exposure. Provide synthetic filter fabric that contains ultraviolet ray inhibitors and stabilizers to assure a minimum of six months of expected usable construction life at a temperature range of 0 to 120 degrees F. The filter fabric shall meet the following requirements:

FILTER FABRIC FOR SILT SCREEN FENCE		
PHYSICAL PROPERTY	TEST PROCEDURE	STRENGTH REQUIREMENT
Grab Tensile Elongation (percent)	ASTM D4632/D4632M	100 lbs. min. 30 percent max.
Trapezoid Tear	ASTM D4533	55 lbs. min.
Permittivity	ASTM D4491	0.2 sec-1
AOS (U.S. Std Sieve)	ASTM D4751	20-100

2.1.2 Silt Fence Stakes and Posts

Use either wooden stakes or steel posts for fence construction. Wooden stakes utilized for silt fence construction, shall have a minimum cross section of 2 by 2 inches when oak is used and 4 by 4 inches when pine is used, and have a minimum length of 5 feet. Steel posts (standard "U" or "T" section) utilized for silt fence construction, shall have a minimum weight of 1.33 pounds/linear foot and a minimum length of 5 feet.

2.1.3 Mill Certificate or Affidavit

Provide a mill certificate or affidavit attesting that the fabric and factory seams meet chemical, physical, and manufacturing requirements specified above. Specify in the mill certificate or affidavit the actual Minimum Average Roll Values and identify the fabric supplied by roll identification numbers. Submit a mill certificate or affidavit signed by a legally authorized official from the company manufacturing the filter fabric.

2.2 COMPONENTS FOR STRAW BALES

The straw in the bales shall be stalks from oats, wheat, rye, barley, rice, or from grasses such as byhalia, bermuda, etc., furnished in air dry condition. Provide bales with a standard cross section of 14 by 18 inches. Wire-bound or string-tie all bales. Use either wooden stakes or steel posts to secure the straw bales to the ground. Wooden stakes utilized for this purpose, shall have a minimum dimensions of 2 by 2 inches in cross section and have a minimum length of 3 feet. Steel posts (standard "U" or "T" section) utilized for securing straw bales, shall have a minimum weight of 1.33 pounds/linear foot and a minimum length of 3 feet.

PART 3 EXECUTION

3.1 INSTALLATION OF SILT FENCES

Extend silt fences a minimum of 16 inches above the ground surface without exceeding 34 inches above the ground surface. Provide filter fabric from a continuous roll cut to the length of the barrier to avoid the use of joints. When joints are unavoidable, splice together filter fabric at a support post, with a minimum 6 inch overlap, and securely sealed. Excavate trench approximately 4 inches wide and 4 inches deep on the upslope side of the location of the silt fence. The 4 by 4 inch trench shall be backfilled and the soil compacted over the filter fabric. Remove silt fences upon approval by the Contracting Officer.

3.2 INSTALLATION OF STRAW BALES

Place the straw bales in a single row, lengthwise on the contour, with ends of adjacent bales tightly abutting one another. Install straw bales so that bindings are oriented around the sides rather than along the tops and bottoms of the bales in order to prevent deterioration of the bindings. Entrench and backfill the barrier. Excavate a trench the width of a bale and the length of the proposed barrier to a minimum depth of 4 inches. After the bales are staked and chinked (gaps filled by wedging with straw), backfill the excavated soil against the barrier. Conform the backfill soil with the ground level on the downhill side and build up to 4 inches against the uphill side of the barrier. Scatter loose straw over the area immediately uphill from a straw bale barrier to increase barrier efficiency. Securely anchor each bale by at least two stakes driven through the bale. Drive the first stake or steel post in each bale toward the previously laid bale to force the bales together. Drive stakes or steel pickets a minimum 18 inches deep into the ground to securely anchor the bales.

3.3 FIELD QUALITY CONTROL

Maintain the temporary and permanent vegetation, erosion and sediment control measures, and other protective measures in good and effective operating condition by performing routine inspections to determine condition and effectiveness, by restoration of destroyed vegetative cover, and by repair of erosion and sediment control measures and other protective measures. Use the following procedures to maintain the protective measures.

3.3.1 Silt Fence Maintenance

Inspect the silt fences in accordance with paragraph, titled "Inspections," of this section. Any required repairs shall be made promptly. Pay close attention to the repair of damaged silt fence resulting from end runs and

undercutting. Should the fabric on a silt fence decompose or become ineffective, and the barrier is still necessary, replace the fabric promptly. Remove sediment deposits when deposits reach one-third of the height of the barrier. Remove a silt fence when it is no longer required. The immediate area occupied by the fence and any sediment deposits shall be shaped to an acceptable grade. The areas disturbed by this shaping shall be seeded in accordance with Section 32 92 19 SEEDING.

3.3.2 Straw Bale Maintenance

Inspect straw bale barriers in accordance with paragraph, titled "Inspections". Pay close attention to the repair of damaged bales, end runs and undercutting beneath bales. Accomplish necessary repairs to barriers or replacement of bales in a promptly manner. Remove sediment deposits when deposits reach one-half of the height of the barrier. At the each end of each row turn bales uphill when used to retain sediment. Remove a straw bale barrier when it is no longer required. The immediate area occupied by the bales and any sediment deposits shall be shaped to an acceptable grade. Seed the areas disturbed by this shaping in accordance with Section 32 92 19 SEEDING.

3.3.3 Diversion Dike Maintenance

Inspect diversion dikes in accordance with paragraph, titled "Inspections," of this section. Pay close attention to the repair of damaged diversion dikes and accomplish necessary repairs promptly. When diversion dikes are no longer required, shape to an acceptable grade. Seed the areas disturbed by this shaping in accordance with Section 32 92 19 SEEDING.

3.4 INSPECTIONS

3.4.1 General

Inspect disturbed areas of the construction site, areas that have not been finally stabilized used for storage of materials exposed to precipitation, stabilization practices, structural practices, other controls, and area where vehicles exit the site at least once every seven (7) calendar days and within 24 hours of the end of any storm that produces 0.5 inches or more rainfall at the site. Conduct inspections at least once every month where sites have been finally stabilized.

3.4.2 Inspections Details

Inspect disturbed areas and areas used for material storage that are exposed to precipitation for evidence of, or the potential for, pollutants entering the drainage system. Observe erosion and sediment control measures identified in the Storm Water Pollution Prevention Plan to ensure that they are operating correctly. Inspect discharge locations or points to ascertain whether erosion control measures are effective in preventing significant impacts to receiving waters. Inspect locations where vehicles exit the site for evidence of offsite sediment tracking.

3.4.3 Inspection Reports

For each inspection conducted, prepare a report summarizing the scope of the inspection, name(s) and qualifications of personnel making the inspection, the date(s) of the inspection, major observations relating to the implementation of the Storm Water Pollution Prevention Plan, maintenance performed, and actions taken. Furnish the report to the

Contracting Officer within 24 hours of the inspection as a part of the Contractor's daily CQC REPORT. A copy of the inspection report shall be maintained on the job site.

3.4.4 Monthly Inspection Report and Certification Form

Complete, sign, and submit the original form, on the first working day of each month, to the Fairfield County Soil and Water Conservation District at the following address:

69-B Stony Hill Road
Bethel, CT 06801
TEL: 203-744-6108

Also furnish, on the first working day of each month, one copy of the form submitted to the Contracting Officer as part of the Contractor's daily CQC Report and attach a copy of the completed form to the Plan. Unless otherwise notified by the Fairfield County Soil and Water Conservation District, submit the Monthly Inspection Report and Certification Forms for an additional two months after the final completion of all storm water pollution prevention measures required in this contract have been implemented.

-- End of Section --

SECTION 01 62 35

RECYCLED/RECOVERED/BIOBASED MATERIALS

05/13

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 247	Comprehensive Procurement Guideline for Products Containing Recovered Materials
48 CFR 23	Environment, Energy and Water Efficiency, Renewable Energy Technologies, Occupational Safety, and Drug-Free Workplace

1.2 OBJECTIVES

Government procurement policy is to acquire, in a cost effective manner, items containing the highest percentage of recycled, recovered and biobased materials practicable consistent with maintaining a satisfactory level of competition without adversely affecting performance requirements or exposing suppliers' employees to undue hazards from the recovered materials. The Environmental Protection Agency (EPA) and the United States Department of Agriculture (USDA) has designated certain items which must contain a specified percent range of recovered or recycled materials. EPA and USDA designated products specified in this contract comply with the stated policy and with the EPA and USDA guidelines. Make all reasonable efforts to use recycled, recovered and biobased materials in providing the EPA and USDA designated products and in otherwise utilizing recycled, recovered and biobased materials in the execution of the work.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Biobased Products; G

1.4 DESIGNATED ITEMS INCORPORATED IN THE WORK

Various sections of the specifications contain requirements for materials that have been designated by EPA and USDA as being products which are or can be made with recovered or recycled, recovered and biobased materials.

These items, when incorporated into the work under this contract, shall contain at least the specified percentage of recycled or recovered materials or biobased unless adequate justification (non-availability) for non-use is provided. When a designated item is specified as an option to a non-designated item, the designated item requirements apply only if the designated item is used in the work.

1.5 PROPOSED ITEMS INCORPORATED IN THE WORK

Products other than those designated by EPA and USDA are still being researched and are being considered for future Comprehensive Procurement Guideline (CPG) and USDA's Federal Procument Preferences (FPP) designations. It is recommended that these items, when incorporated in the work under this contract, contain the highest practicable percentage of recycled, recovered and biobased materials, provided specified requirements are also met.

1.6 LISTED ITEMS USED IN CONDUCT OF THE WORK BUT NOT INCORPORATED IN THE WORK

Many products listed in 40 CFR 247 and 48 CFR 23 have been designated or proposed by EPA and USDA to include recycled, recovered and biobased materials that may be used by the Contractor in performing the work but will not be incorporated into the work. These products include office products, temporary traffic control products, and pallets. It is recommended that these non-construction products, when used in the conduct of the work, contain the highest practicable percentage of recycled, recovered and biobased materials and that these products be recycled when no longer needed.

1.7 BIOPREFERRED FPP

Utilize products and material made from biobased materials to the maximum extent possible without jeopardizing the intended end use or detracting from the overall quality delivered to the end user. All supplies and materials shall be of a type and quality that conform to applicable specifications and standards.

Biobased products that are designated for preferred procurement under USDA’s BioPreferred program must meet the required minimum biobased content. Refer to http://www.biopreferred.gov/ProductCategories.aspx for the product categories and http://www.biopreferred.gov/bioPreferredCatalog/faces/jsp/catalogLanding.jsp for the BioPreferred Catalog. Submit data for the biobased products to include biobased content and source of biobased material; indicating the name of the manufacturer, cost of each material, and the intended use of each of the materials that are to be used in carrying out the requirements of the contract.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 01 68 00

DEWATERING TREATMENT FACILITY
06/14

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

1.1.1 General

The dewatering treatment facility will treat all potentially contaminated water collected by the remedial construction activities at the Site. Potentially contaminated water includes, but is not limited to: stormwater runoff from contamination reduction zones, vehicle cleaning operations, decontamination operations, excavation dewatering, groundwater extaction activities, and any other water that is collected for treatment and discharge to the POTW.

1.1.2 Work Included

a. Preparation of a detailed work plan for on-site treatment of dewatering liquids from the proposed excavations. The work plan shall be submitted for review and approval by the Engineer prior to startup of the treatment plant. The work plan shall include as a minimum a process flow diagram, site layout of the proposed facilities, unit sizing, a description of solids handling and off-site disposal method, operating schedule, storage requirements, and sampling and analysis schedule. The analysis schedule shall indicate which compounds are to be analyzed for each sample taken. The method of secondary containment shall be provided in the work plan.

b. Procurement or rental and installation of the required treatment plant components, including storage on the influent and effluent sides of the plant, extraction of the dewatering liquids, transportation to the treatment site, and the treated effluent discharge system.

c. Procurement and installation of the secondary containment system for the dewatering treatment facility site.

d. All sampling, testing, and reporting required for start-up and operation of the dewatering treatment system for excavation areas.

e. Cleanup and removal of all solids generated during dewatering liquid treatment as well as the treatment plant components are included along with the secondary containment structure and the dewatering fluid extraction and transportation system.

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Detailed Work Plan; G

SD-06 Test Reports

Treatment System Performance Monitoring Reports; G

Treatment System Start-Up; G

SD-11 Closeout Submittals

Operator's Field Notebooks; G

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

2.1.1 Description of the Dewatering Treatment Facility Operation

Discharge Limit Requirements: The Contractor is responsible for insuring that the extracted water treatment facility effluent discharge limits for the POTW are met at all times.

2.1.2 Commissioning Step

After installation of the dewatering treatment facility is complete, the treatment facility shall be run using clean, potable water to test piping, pumps, and tanks for leaks. Once the treatment system is determined to have no leaks, the extraction system may be started.

2.1.3 Start-Up Step

a. Provide enough water volume necessary to operate the treatment system for at least a 4-hour period at the design flow rate.

b. Start the dewtaering extraction system and fill the influent storage tank(s).

c. Start the dewatering treatment facility.

d. Operate the treatment system for a minimum 4-hour period, store the treated effluent in the effluent storage tank(s) provided, and test the treated effluent for conformance with the discharge limitations set by the POTW.

e. If the discharge limits are met, the treated effluent can be discharged to the POTW. If not, modifications and/or additions to the treatment system will have to be made and the treated effluent will be retreated, until it meets the discharge criteria. This volume of treated effluent can be discharged to the POTW. The start-up procedure will be repeated until the dewatered water can be treated in one pass and meet the discharge criteria.

f. Run the dewatering treatment facility as required to treat the water extracted during the dewatering of the sites to be excavated. Test the effluent from the dewatering treatment facility at least once per operating day to determine conformance with the treatment objectives and effluent limitations.

2.2 TESTS, INSPECTIONS, AND VERIFICATIONS

2.2.1 Treatment System Performance Monitoring Reports

Including sample dates, time, record of laboratory results, and reports of an excedances of the discharge limits.

2.2.2 Treatment System Start-Up

Written report of treatement system start-up including discussion of any mechanical problems, treatment problems, and number of treatment recycles utilized. Include discussion on any modifications or additions required to be made to the treatment facility during this period. If additional equipment is added to the treatment system, provide a modified process flow diagram, site layout sketch, and a description of the changes made.

PART 3 EXECUTION

3.1 OPERATION

The Contractor shall supply the equipment, manpower, power, chemicals, solids disposal, and anything else required for proper operation of the dewatering treatment facility to handle the extracted water from excavation areas.

The Contractor is responsible for extracting the water at the excavation sites, transporting it to the treatment facility, treating the dewatering fluid to meet the discharge requirements, and transporting the treated effluent to the discharge point into the POTW.

The Contractor is responsible for payment of any fines or fees levied due to the proposed discharge and for any financial penalty imposed for not meeting the discharge limitations stated in this specification section.

-- End of Section --

SECTION 01 71 23

FIELD ENGINEERING AND SURVEY CONTROL
06/14

PART 1 GENERAL

1.1 DESCRIPTION

Establish survey control points on-site for construction purposes. The Contractor shall verify locations of survey control points prior to starting Work. The Contractor shall safeguard all survey control points. Should any of these points be destroyed, the Contractor shall replace the control point at no cost to the Owner. The Contractor shall assume the entire expense of rectifying work improperly constructed due to failure to maintain and protect such established survey control points.

The Contractor shall be responsible for the layout of any additional survey control points, grid coordinate locations, lines, grades, and levels necessary for the proper construction and testing of the Work required in the Contract Documents. Survey control shall include, but not be limited to, maintaining appropriate slopes and specified thickness.

The Contractor shall employ a surveyor using standard practices and datum for the State of New Jersey to provide the surveying functions necessary for the proper execution of the Work, and to document and record the completed work.

The Contractor is responsible for scheduling the surveys to coincide with his construction activities. If the survey documentation shows improper slopes, elevations, locations, or layer thickness, the Contractor shall correct the deficiency and re-survey the re-work. Phases for survey layout and documentation may include, but not be limited to:

a. Initial field verification survey, see Paragraph 1.05.

b. Completed excavation elevations, limits and slopes.

c. Location and elevations of storm sewer features including piping, catch basins manholes (including pipe inverts and top of cover) and appurtenances.

d. Final grade elevations including fill and roadway areas.

e. Utility and storm drain features installed, encountered or relocated as part of the work.

f. Location of cap limits, well vaults, wells, force mains, sheeting, warning layers, individual cap layers.

1.2 RELATED REQUIREMENTS

a. Section 01 11 00 SUMMARY OF WORK.

b. Section 01 33 00 SUBMITTAL PROCEDURES.

c. Section 01 45 00.10 10 QUALITY CONTROL SYSTEMS (QCS).

d. Section 01 78 00 CLOSEOUT SUBMITTALS.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualifications; G

Accuracy of Survey Work; G

SD-05 Design Data

Field Verification Survey; G

SD-11 Closeout Submittals

Log of Control and Survey Work; G

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

On request, submit data demonstrating qualificaions of persons providing field engineering and survey services.

1.4.2 Accuracy of Survey Work

On request, submit documentation verifying accuracy of survey work.

1.4.3 Field Verification Survey

The Contractor shall perform a field verification survey as part of the Work prior to the start of construction activities, to verify/establish current conditions. The Contractor shall then compare the existing condition information shown on the Contract Drawings, to the current conditions determined during the field verification activities. Where discrepancies exist, the Contractor shall submit to the Engineer the results of the field verification survey and results of the comparison with the Contract Drawings. All discrepancies shall be resolved, by the Engineer prior to initiation of construction activities affected by discrepancies.

1.5 FIELD ENGINEERING AND SURVEY REQUIREMENTS

Provide field engineering and survey services using appropriate construction practices. Use skilled persons, trained and experienced in the necessary tasks and techniques for the proper execution of the Work. Locate and layout the Work by survey instrumentation and similar appropriate means.

The Contractor shall perform layout and document completed construction on Record Drawings of the features list contained in this Specification.

The Contractor shall establish a grid system (Construction Control Grid) with a maximum spacing of 25 feet with additional grid points as required for grade breaks (toe, top of slopes) over the entire limits of Work. The grid system shall be established for the purpose of determining required excavation and fill thickness, cut and fill quantities as well as locating work and testing by the Contractor or independent construction quality assurance personnel. Periodically re-establish or verify layout and grid points as required as work progresses.

The Contractor shall sufficiently establish the existing ground elevations before earthwork is started. Survey constructed grades (subgrade and final) subsequent to excavation and filling existing grades. The Contractor shall sufficiently survey to verify quantities included in requests for payment.

Vertical and horizontal control shall be sufficient to assure work is constructed within 0.1 foot of proposed fill thickness requirements (or proposed grades as indicated where settlement is not a concern) and location.

Verification surveys, surveys for measurement and payment, and Project Record Documentation shall be provided in electronic file format using the current version of AutoCAD at the time of the survey work.

1.6 TECHNICAL REQUIREMENTS OF SURVEY

Horizontal ground control shall originate and terminate on New Jersey State Plane NAVD 83. Vertical control shall be tied to New Jersey State Plane NGVD 29.

Map Accuracy - Ninety percent of the elevations determined from the solid-line contours for the topographic maps shall have accuracy with respect to true elevation of 0.5 contour interval (0.5 foot) or better, and the remaining 10 percent of such elevations shall not be in error by more than one contour interval (1 foot). This accuracy shall apply only to the contours which are on each map. Thus, in each particular area where the intermediate contours have had to be omitted due to the steepness of the ground slopes and only the index contours are not omitted, the accuracies are applicable to the contour interval specified for the topographic maps. In densely wooded areas where the heavy brush or tree cover fully obscures the ground the surveyor shall verify elevations in the field.

Coordinate Grid Lines - The plotted position of each plane-coordinated grid line shall not vary by more than one one-hundredth inch (0.01") on each map manuscript.

Establish a permanent project benchmark for vertical control.

Horizontal Control - Each horizontal control point shall be plotted on the map manuscript within the coordinate grid in which it should lie to an accuracy of one one-hundredth in (0.01") of its true position as expressed by the plane coordinates computed for this point.

Spot Elevations - Survey shall be constructed to provide an accuracy of 0.1 feet vertically. No shots exceeding 25 feet shall be taken. Ninety percent of all spot elevations placed on the maps shall have an accuracy of at least 0.1 feet, and the remaining 10 percent shall not be in error by more than one-half (1/2) the contour interval (0.5 feet).

Accuracy - Accuracies and accuracy tests apply to the stereo compilation scale of the original manuscript (i.e., if the manuscript is compiled at a scale of 1 inch = 100 feet and then reduced to 1 inch = 200 feet, then the accuracies will apply to the original 1 inch = 100 feet scale). This is also true if the manuscript is enlarged to 1 inch = 50 feet or some larger scale.

1.7 FIELD VERIFICATION SURVEY

The existing conditions depicted on the Drawings were interpreted from various sources including: "ALTA / ACSM Land Title Survey, Block 1290.1 ~ Lots 2D, 2E, & 16A.99" by CMX, 20 Waterview Boulevard, P.O. Box 5245, Parsippany, NJ 07054, Dated 05/23/08.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 CLOSEOUT ACTIVITIES

3.1.1 Log of Control and Survey Work

Maintain complete, accurate log of control and survey work as it progresses. Submit Record Documents specified in Section 01 78 00 CLOSEOUT SUBMITTALS.

-- End of Section --

SECTION 01 74 19

CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT
01/07

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED NC	(2009) Leadership in Energy and Environmental Design(tm) New Construction Rating System

1.2 GOVERNMENT POLICY

Government policy is to apply sound environmental principles in the design, construction and use of facilities. As part of the implementation of that policy: (1) practice efficient waste management when sizing, cutting, and installing products and materials and (2) use all reasonable means to divert construction and demolition waste from landfills and incinerators and to facilitate their recycling or reuse.

1.3 MANAGEMENT

Develop and implement a waste management program. Take a pro-active, responsible role in the management of construction and demolition waste and require all subcontractors, vendors, and suppliers to participate in the effort. Construction and demolition waste includes products of demolition or removal, excess or unusable construction materials, packaging materials for construction products, and other materials generated during the construction process but not incorporated into the work. In the management of waste consideration shall be given to the availability of viable markets, the condition of the material, the ability to provide the material in suitable condition and in a quantity acceptable to available markets, and time constraints imposed by internal project completion mandates. The Contractor is responsible for implementation of any special programs involving rebates or similar incentives related to recycling of waste. Revenues or other savings obtained for salvage, or recycling accrue to the Contractor. Appropriately permit firms and facilities used for recycling, reuse, and disposal for the intended use to the extent required by federal, state, and local regulations. Also, provide on-site instruction of appropriate separation, handling, recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Waste Management Plan; G; (LEED NC)

SD-11 Closeout Submittals

Records; G

1.5 MEETINGS

Conduct Construction Waste Management meetings. After award of the Contract and prior to commencement of work, schedule and conduct a meeting with the Contracting Officer to discuss the proposed Waste Management Plan and to develop a mutual understanding relative to the details of waste management. The requirements for this meeting may be fulfilled during the coordination and mutual understanding meeting outlined in Section 01 45 00.10 10 QUALITY CONTROL SYSTEMS (QCS). At a minimum, environmental and waste management goals and issues shall be discussed at the following additional meetings:

a. Pre-bid meeting.

b. Preconstruction meeting.

c. Regular site QC meetings.

d. Work safety meetings.

1.6 WASTE MANAGEMENT PLAN

A waste management plan shall be submitted within 15 days after contract award and not less than 10 days before the preconstruction meeting. The plan shall demonstrate how the project waste diversion goal shall be met and shall include the following:

a. Name of individuals on the Contractor's staff responsible for waste prevention and management.

b. Actions that will be taken to reduce solid waste generation, including coordination with subcontractors to ensure awareness and participation.

c. Description of the regular meetings to be held to address waste management.

d. Description of the specific approaches to be used in recycling/reuse of the various materials generated, including the areas on site and equipment to be used for processing, sorting, and temporary storage of wastes.

e. Characterization, including estimated types and quantities, of the waste to be generated.

f. Name of landfill and/or incinerator to be used and the estimated costs for use, assuming that there would be no salvage or recycling on the project.

g. Identification of local and regional reuse programs, including non-profit organizations such as schools, local housing agencies, and

organizations that accept used materials such as materials exchange networks and Habitat for Humanity. Include the name, location, and phone number for each reuse facility to be used, and provide a copy of the permit or license for each facility.

h. List of specific waste materials that will be salvaged for resale, salvaged and reused on the current project, salvaged and stored for reuse on a future project, or recycled. Recycling facilities that will be used shall be identified by name, location, and phone number, including a copy of the permit or license for each facility.

i. Identification of materials that cannot be recycled/reused with an explanation or justification, to be approved by the Contracting Officer.

j. Description of the means by which any waste materials identified in item (h) above will be protected from contamination.

k. Description of the means of transportation of the recyclable materials (whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler and removed from the site).

l. Anticipated net cost savings determined by subtracting Contractor program management costs and the cost of disposal from the revenue generated by sale of the materials and the incineration and/or landfill cost avoidance.

Revise and resubmit Plan as required by the Contracting Officer. Approval of Contractor's Plan will not relieve the Contractor of responsibility for compliance with applicable environmental regulations or meeting project cumulative waste diversion requirement. Distribute copies of the Waste Management Plan to each subcontractor, the Quality Control Manager, and the Contracting Officer.

1.7 RECORDS

Records shall be maintained to document the quantity of waste generated; the quantity of waste diverted through sale, reuse, or recycling; and the quantity of waste disposed by landfill or incineration. The records shall be made available to the Contracting Officer during construction, and a copy of the records shall be delivered to the Contracting Officer upon completion of the construction.

Demolition accomplished by other parties on this project site count toward the project's total waste diversion cumulative score for LEED NC. Information on the quantity and disposition of these materials will be provided by the Contracting Officer. Include this data in records, annotated to indicate that it was accomplished by another party.

1.8 COLLECTION

Separate, store, protect, and handle at the site identified recyclable and salvageable waste products in a manner that maximizes recyclability and salvagability of identified materials. Provide the necessary containers, bins and storage areas to facilitate effective waste management and clearly and appropriately identify them. Provide materials for barriers and enclosures around recyclable material storage areas which are nonhazardous and recyclable or reusable. Locate out of the way of construction traffic. Provide adequate space for pick-up and delivery and convenience to

subcontractors. Recycling and waste bin areas are to be kept neat and clean, and recyclable materials shall be handled to prevent contamination of materials from incompatible products and materials. Clean contaminated materials prior to placing in collection containers. Use cleaning materials that are nonhazardous and biodegradable. Handle hazardous waste and hazardous materials in accordance with applicable regulations. Separate materials by one of the following methods:

1.8.1 Source Separated Method.

Waste products and materials that are recyclable shall be separated from trash and sorted as described below into appropriately marked separate containers and then transported to the respective recycling facility for further processing. Deliver materials in accordance with recycling or reuse facility requirements (e.g., free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process). Separate materials into the following category types as appropriate to the project waste and to the available recycling and reuse programs in the project area:

a. Land clearing debris.

b. Asphalt.

c. Concrete and masonry.

d. Metal (e.g. banding, stud trim, ductwork, piping, rebar, roofing, other trim, steel, iron, galvanized, stainless steel, aluminum, copper, zinc, lead brass, bronze).

(1) Ferrous.

(2) Non-ferrous.

e. Wood (nails and staples allowed).

f. Debris.

g. Glass (colored glass allowed).

h. Paper.

(1) Bond.

(2) Newsprint.

(3) Cardboard and paper packaging materials.

i. Plastic.

Type	
1	Polyethylene Terephthalate (PET, PETE)
2	High Density Polyethylene (HDPE)
3	Vinyl (Polyvinyl Chloride or PVC)

Type	
4	Low Density Polyethylene (LDPE)
5	Polypropylene (PP)
6	Polystyrene (PS)
7.	Other. Use of this code indicates that the package in question is made with a resin other than the six listed above, or is made of more than one resin listed above, and used in a multi-layer combination.

j. Gypsum.

k. Non-hazardous paint and paint cans.

l. Carpet.

m. Ceiling tiles.

n. Insulation.

o. Beverage containers.

1.8.2 Co-Mingled Method.

Waste products and recyclable materials shall be placed into a single container and then transported to a recycling facility where the recyclable materials are sorted and processed.

1.8.3 Other Methods.

Other methods proposed by the Contractor may be used when approved by the Contracting Officer.

1.9 DISPOSAL

Control accumulation of waste materials and trash. Recycle or dispose of collected materials off-site at intervals approved by the Contracting Officer and in compliance with waste management procedures. Except as otherwise specified in other sections of the specifications, disposal shall be in accordance with the following:

1.9.1 Reuse.

First consideration shall be given to salvage for reuse since little or no re-processing is necessary for this method, and less pollution is created when items are reused in their original form. Coordinate reuse with the Contracting Officer. Sale or donation of waste suitable for reuse shall be considered.

1.9.2 Recycle.

Waste materials not suitable for reuse, but having value as being recyclable, shall be made available for recycling. All fluorescent lamps, HID lamps, and mercury-containing thermostats removed from the site shall

be recycled. Arrange for timely pickups from the site or deliveries to recycling facilities in order to prevent contamination of recyclable materials.

1.9.3 Compost

Consider composting on site if a reasonable amount of compostable material will be available. Compostable materials include plant material, sawdust, and certain food scraps.

1.9.4 Waste.

Materials with no practical use or economic benefit shall be disposed at a landfill or incinerator.

1.9.5 Return

Set aside and protect misdelivered and substandard products and materials and return to supplier for credit.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used. -- End of Section --

SECTION 01 78 00

CLOSEOUT SUBMITTALS
08/11

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

As-Built Record of Equipment and Materials; G
Warranty Management Plan
Warranty Tags

SD-08 Manufacturer's Instructions

Instructions; G

SD-11 Closeout Submittals

Record Drawings
Quality Control Testing Reports; G

1.2 PROJECT RECORD DOCUMENTS

1.2.1 Record Drawings

Drawings showing final as-built conditions of the project. This paragraph covers record drawings complete, as a requirement of the contract. The terms "drawings," "contract drawings," "drawing files," "working record drawings" and "final record drawings" refer to contract drawings which are revised to be used for final record drawings showing as-built conditions. The final CAD record drawings must consist of one set of electronic CAD drawing files in the specified format, 2 sets of prints, and one set of the approved working Record drawings.

1.2.1.1 Government Furnished Materials

One set of electronic CADD files in the specified software and format revised to reflect all bid amendments will be provided by the Government at the preconstruction conference for projects requiring CADD file record drawings.

1.2.1.2 Working Record and Final Record Drawings

Revise 2 sets of paper drawings by red-line process to show the as-built conditions during the prosecution of the project. Keep these working as-built marked drawings current on a weekly basis and at least one set available on the jobsite at all times. Changes from the contract plans which are made in the work or additional information which might be

uncovered in the course of construction must be accurately and neatly recorded as they occur by means of details and notes. Prepare final record (as-built) drawings after the completion of each definable feature of work as listed in the Contractor Quality Control Plan (Foundations, Utilities, Structural Steel, etc., as appropriate for the project). The working as-built marked prints and final record (as-built) drawings will be jointly reviewed for accuracy and completeness by the Contracting Officer Representative and the Contractor prior to submission of each monthly pay estimate. If the Contractor fails to maintain the working and final record drawings as specified herein, the Contracting Officer Representative will deduct from the monthly progress payment an amount representing the estimated cost of maintaining the record drawings. This monthly deduction will continue until an agreement can be reached between the Contracting Officer Representative and the Contractor regarding the accuracy and completeness of updated drawings. Show on the working and final record drawings , but not limited to, the following information:

a. The actual location, kinds and sizes of all sub-surface utility lines. In order that the location of these lines and appurtenances may be determined in the event the surface openings or indicators become covered over or obscured, show by offset dimensions to two permanently fixed surface features the end of each run including each change in direction on the record drawings. Locate valves, splice boxes and similar appurtenances by dimensioning along the utility run from a reference point. Also record the average depth below the surface of each run.

b. The location and dimensions of any changes within the building structure.

c. Correct grade, elevations, cross section, or alignment of roads, earthwork, structures or utilities if any changes were made from contract plans.

d. Changes in details of design or additional information obtained from working drawings specified to be prepared and/or furnished by the Contractor; including but not limited to fabrication, erection, installation plans and placing details, pipe sizes, insulation material, dimensions of equipment foundations, etc.

e. The topography, invert elevations and grades of drainage installed or affected as part of the project construction.

f. Changes or modifications which result from the final inspection.

g. Where contract drawings or specifications present options, show only the option selected for construction on the final as-built prints.

h. If borrow material for this project is from sources on Government property, or if Government property is used as a spoil area, furnish a contour map of the final borrow pit/spoil area elevations.

i. Systems designed or enhanced by the Contractor, such as HVAC controls, fire alarm, fire sprinkler, and irrigation systems.

j. Modifications (include within change order price the cost to change working and final record drawings to reflect modifications) and compliance with the following procedures.

(1) Follow directions in the modification for posting descriptive changes.

(2) Place a Modification Circle at the location of each deletion.

(3) For new details or sections which are added to a drawing, place a Modification Circle by the detail or section title.

(4) For minor changes, place a Modification Circle by the area changed on the drawing (each location).

(5) For major changes to a drawing, place a Modification Circle by the title of the affected plan, section, or detail at each location.

(6) For changes to schedules or drawings, place a Modification Circle either by the schedule heading or by the change in the schedule.

(7) The Modification Circle size shall be 1/2 inch diameter unless the area where the circle is to be placed is crowded. Smaller size circle shall be used for crowded areas.

1.2.1.3 Drawing Preparation

Modify the record drawings as may be necessary to correctly show the features of the project as it has been constructed by bringing the contract set into agreement with approved working as-built prints, and adding such additional drawings as may be necessary. These working as-built marked prints must be neat, legible and accurate. These drawings are part of the permanent records of this project and must be returned to the Contracting Officer Representative after approval by the Government. Any drawings damaged or lost by the Contractor must be satisfactorily replaced by the Contractor at no expense to the Government.

1.2.1.4 Computer Aided Design and Drafting (CADD) Drawings

Only employ personnel proficient in the preparation of CADD drawings to modify the contract drawings or prepare additional new drawings. Additions and corrections to the contract drawings must be equal in quality and detail to that of the originals. Line colors, line weights, lettering, layering conventions, and symbols must be the same as the original line colors, line weights, lettering, layering conventions, and symbols. If additional drawings are required, prepare them using the specified electronic file format applying the same graphics standards specified for original drawings. The title block and drawing border to be used for any new final record drawings must be identical to that used on the contract drawings. Accomplish additions and corrections to the contract drawings using CADD files. The Contractor will be furnished "as-designed" drawings in AutoCad 2010 format compatible with a Windows XP operating system. The electronic files will be supplied on compact disc, read-only memory (CD-ROM). Provide all program files and hardware necessary to prepare final record drawings. The Contracting Officer Representative will review final record drawings for accuracy and return them to the Contractor for required corrections, changes, additions, and deletions.

a. Provide CADD "base" colors of red, green, and blue. Color code for changes as follows:

(1) Deletions (Red) - Over-strike deleted graphic items (lines),

lettering in notes and leaders.

(2) Additions (Green) - Added items, lettering in notes and leaders.

(3) Special (Blue) - Items requiring special information, coordination, or special detailing or detailing notes.

b. Rename the Contract Drawing files in a manner related to the contract number (i.e., 98-C-10.DGN) as instructed in the Pre-Construction conference. Use only those renamed files for the Marked-up changes. All changes shall be made on the layer/level as the original item.

c. When final revisions have been completed, show the wording "RECORD DRAWINGS / AS-BUILT CONDITIONS" followed by the name of the Contractor in letters at least 3/16 inch high on the cover sheet drawing. Mark all other contract drawings either "Record" drawing denoting no revisions on the sheet or "Revised Record" denoting one or more revisions. Date original contract drawings in the revision block.

d. Within 10 days for contracts less than $5 million after Government approval of all of the working record drawings for a phase of work, prepare the final CADD record drawings for that phase of work and submit two sets of blue-lined prints of these drawings for Government review and approval. The Government will promptly return one set of prints annotated with any necessary corrections. Within 7 days for contracts less than $5 million revise the CADD files accordingly at no additional cost and submit one set of final prints for the completed phase of work to the Government. Within 10 days for contracts less than $5 million of substantial completion of all phases of work, submit the final record drawing package for the entire project. Submit one set of electronic files on compact disc, read-only memory (CD-ROM), one set of mylars, two sets of blue-line prints and one set of the approved working record drawings. They must be complete in all details and identical in form and function to the contract drawing files supplied by the Government. Any transactions or adjustments necessary to accomplish this is the responsibility of the Contractor. The Government reserves the right to reject any drawing files it deems incompatible with the customer's CADD system. Paper prints, drawing files and storage media submitted will become the property of the Government upon final approval. Failure to submit final record drawing files and marked prints as specified will be cause for withholding any payment due the Contractor under this contract. Approval and acceptance of final record drawings must be accomplished before final payment is made to the Contractor.

1.2.1.5 Payment

No separate payment will be made for record drawings required under this contract, and all costs accrued in connection with such drawings are considered a subsidiary obligation of the Contractor.

1.2.2 As-Built Record of Equipment and Materials

Furnish 2 copies of preliminary record of equipment and materials used on the project 15 days prior to final inspection. This preliminary submittal will be reviewed and returned 2 days after final inspection with Government comments. Submit 2 sets of final record of equipment and materials 10 days after final inspection. Key the designations to the related area depicted on the contract drawings. List the following data:

RECORD OF DESIGNATED EQUIPMENT AND MATERIALS DATA				
Description	Specification Section	Manufacturer and Catalog, Model, and Serial Number	Composition and Size	Where Used
Waste Containment Geomembrane	02 56 13			
Geosynthetic Clay Liner	02 56 15			
Geocomposite	31 05 20			

1.2.3 Final Approved Shop Drawings

Furnish final approved project shop drawings 30 days after transfer of the completed facility.

1.2.4 Construction Contract Specifications

Furnish final record (as-built) construction contract specifications, including modifications thereto, 30 days after transfer of the completed facility.

1.2.5 Real Property Equipment

Furnish a list of installed equipment furnished under this contract. Include all information usually listed on manufacturer's name plate. In the "EQUIPMENT-IN-PLACE LIST" include, as applicable, the following for each piece of equipment installed: description of item, location (by room number), model number, serial number, capacity, name and address of manufacturer, name and address of equipment supplier, condition, spare parts list, manufacturer's catalog, and warranty. Furnish a draft list at time of transfer. Furnish the final list 30 days after transfer of the completed facility.

1.2.6 Quality Control Testing

Furnish Quality Control Testing Reports in accordance with the Contract Documents.

1.3 SPARE PARTS DATA

Not applicable.

1.4 PREVENTATIVE MAINTENANCE

Not applicable.

1.5 WARRANTY MANAGEMENT

1.5.1 Warranty Management Plan

Develop a warranty management plan which contains information relevant to the clause Warranty of Construction. At least 30 days before the planned pre-warranty conference, submit 2 sets of the warranty management plan. Include within the warranty management plan all required actions and documents to assure that the Government receives all warranties to which it is entitled. The plan must be in narrative form and contain sufficient detail to render it suitable for use by future maintenance and repair personnel, whether tradesmen, or of engineering background, not necessarily familiar with this contract. The term "status" as indicated below must include due date and whether item has been submitted or was accomplished. Warranty information made available during the construction phase must be submitted to the Contracting Officer Representative for approval prior to each monthly pay estimate. Assemble approved information in a binder and turn over to the Government upon acceptance of the work. The construction warranty period will begin on the date of project acceptance and continue for the full product warranty period. A joint 4 month and 9 month warranty inspection will be conducted, measured from time of acceptance, by the Contractor, Contracting Officer Representative and the Customer Representative. Include within the warranty management plan , but not limited to, the following:

a. Roles and responsibilities of all personnel associated with the warranty process, including points of contact and telephone numbers within the organizations of the Contractors, subContractors, manufacturers or suppliers involved.

b. Furnish with each warranty the name, address, and telephone number of each of the guarantor's representatives nearest to the project location.

c. Listing and status of delivery of all Certificates of Warranty for extended warranty items, to include roofs, HVAC balancing, pumps, motors, transformers, and for all commissioned systems such as fire protection and alarm systems, sprinkler systems, lightning protection systems, etc.

d. A list for each warranted equipment, item, feature of construction or system indicating:

(1) Name of item.
(2) Model and serial numbers.
(3) Location where installed.
(4) Name and phone numbers of manufacturers or suppliers.
(5) Names, addresses and telephone numbers of sources of spare parts.
(6) Warranties and terms of warranty. Include one-year overall warranty of construction, including the starting date of warranty of construction. Items which have extended warranties must be indicated with separate warranty expiration dates.
(7) Cross-reference to warranty certificates as applicable.
(8) Starting point and duration of warranty period.
(9) Summary of maintenance procedures required to continue the warranty in force.
(10) Cross-reference to specific pertinent Operation and Maintenance manuals.
(11) Organization, names and phone numbers of persons to call for warranty service.

(12) Typical response time and repair time expected for various warranted equipment.

e. The Contractor's plans for attendance at the 4 and 9 month post-construction warranty inspections conducted by the Government.

f. Procedure and status of tagging of all equipment covered by extended warranties.

g. Copies of instructions to be posted near selected pieces of equipment where operation is critical for warranty and/or safety reasons.

1.5.2 Performance Bond

The Contractor's Performance Bond must remain effective throughout the construction period.

a. In the event the Contractor fails to commence and diligently pursue any construction warranty work required, the Contracting Officer Representative will have the work performed by others, and after completion of the work, will charge the remaining construction warranty funds of expenses incurred by the Government while performing the work, including, but not limited to administrative expenses.

b. In the event sufficient funds are not available to cover the construction warranty work performed by the Government at the Contractor's expense, the Contracting Officer Representative will have the right to recoup expenses from the bonding company.

c. Following oral or written notification of required construction warranty repair work, respond in a timely manner. Written verification will follow oral instructions. Failure of the Contractor to respond will be cause for the Contracting Officer Representative to proceed against the Contractor.

1.5.3 Pre-Warranty Conference

Prior to contract completion, and at a time designated by the Contracting Officer Representative, meet with the Contracting Officer Representative to develop a mutual understanding with respect to the requirements of this section. Communication procedures for Contractor notification of construction warranty defects, priorities with respect to the type of defect, reasonable time required for Contractor response, and other details deemed necessary by the Contracting Officer Representative for the execution of the construction warranty will be established/reviewed at this meeting. In connection with these requirements and at the time of the Contractor's quality control completion inspection, furnish the name, telephone number and address of a licensed and bonded company which is authorized to initiate and pursue construction warranty work action on behalf of the Contractor. This point of contact will be located within the local service area of the warranted construction, be continuously available, and be responsive to Government inquiry on warranty work action and status. This requirement does not relieve the Contractor of any of its responsibilities in connection with other portions of this provision.

1.5.4 Contractor's Response to Construction Warranty Service Requirements

Following oral or written notification by the Contracting Officer Representative, respond to construction warranty service requirements in

accordance with the "Construction Warranty Service Priority List" and the three categories of priorities listed below. Submit a report on any warranty item that has been repaired during the warranty period. Include within the report the cause of the problem, date reported, corrective action taken, and when the repair was completed. If the Contractor does not perform the construction warranty within the timeframes specified, the Government will perform the work and backcharge the construction warranty payment item established.

a. First Priority Code 1. Perform onsite inspection to evaluate situation, and determine course of action within 4 hours, initiate work within 6 hours and work continuously to completion or relief.

b. Second Priority Code 2. Perform onsite inspection to evaluate situation, and determine course of action within 8 hours, initiate work within 24 hours and work continuously to completion or relief.

c. Third Priority Code 3. All other work to be initiated within 3 work days and work continuously to completion or relief.

d. The "Construction Warranty Service Priority List" is as follows:

Code 1-Life Safety Systems
(1) Fire suppression systems.
(2) Fire alarm system(s) in place in the building.

Code 1-Air Conditioning Systems
(1) Recreational support.
(2) Air conditioning leak in part of building, if causing damage.
(3) Air conditioning system not cooling properly.

Code 1-Doors
(1) Overhead doors not operational, causing a security, fire, or safety problem.
(2) Interior, exterior personnel doors or hardware, not functioning properly, causing a security, fire, or safety problem.

Code 3-Doors
(1) Overhead doors not operational.
(2) Interior/exterior personnel doors or hardware not functioning properly.

Code 1-Electrical
(1) Power failure (entire area or any building operational after 1600 hours).
(2) Security lights
(3) Smoke detectors

Code 2-Electrical
(1) Power failure (no power to a room or part of building).
(2) Receptacle and lights (in a room or part of building).

Code 3-Electrical
Street lights.

Code 1-Gas
(1) Leaks and breaks.
(2) No gas to family housing unit or cantonment area.

Code 1-Heat
(1) Area power failure affecting heat.
(2) Heater in unit not working.

Code 2-Kitchen Equipment
(1) Dishwasher not operating properly.
(2) All other equipment hampering preparation of a meal.

Code 1-Plumbing
(1) Hot water heater failure.
(2) Leaking water supply pipes.

Code 2-Plumbing
(1) Flush valves not operating properly.
(2) Fixture drain, supply line to commode, or any water pipe leaking.
(3) Commode leaking at base.

Code 3 -Plumbing
Leaky faucets.

Code 3-Interior
(1) Floors damaged.
(2) Paint chipping or peeling.
(3) Casework.

Code 1-Roof Leaks
Temporary repairs will be made where major damage to property is occurring.

Code 2-Roof Leaks
Where major damage to property is not occurring, check for location of leak during rain and complete repairs on a Code 2 basis.

Code 2-Water (Exterior)
No water to facility.

Code 2-Water (Hot)
No hot water in portion of building listed.

Code 3-All other work not listed above.

1.5.5 Warranty Tags

At the time of installation, tag each warranted item with a durable, oil and water resistant tag approved by the Contracting Officer Representative. Attach each tag with a copper wire and spray with a silicone waterproof coating. Also, submit two record copies of the warranty tags showing the layout and design. The date of acceptance and the QC signature must remain blank until the project is accepted for beneficial occupancy. Show the following information on the tag.

Type of product/material	
Model number	
Serial number	
Contract number	

Warranty period from/to	
Inspector's signature	
Construction Contractor	
Address	
Telephone number	
Warranty contact	
Address	
Telephone number	
Warranty response time priority code	
WARNING - PROJECT PERSONNEL TO PERFORM ONLY OPERATIONAL MAINTENANCE DURING THE WARRANTY PERIOD.	

1.6 CLEANUP

Sweep paved areas and rake clean landscaped areas. Remove waste and surplus materials, rubbish and construction facilities from the site.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

SECTION 02 14 00

DEWATERING
06/14

PART 1 GENERAL

1.1 DESCRIPTION

Work for this item includes dewatering wells, well point systems and/or sumps piping, valves, and appurtenances. The Contractor may elect to supplement the dewatering systems with sumps to accelerate dewatering. The Contractor should allow for placement of a limited number of sumps in localized areas. The objective is to maintain the groundwater at a minimum of 2 feet beow the base of the excavations and subgrade layer to allow for placement and compaction of the backfill in adequately dry conditions.

The dewatering system will discharge to a Dewatering Treatment Facility that provides for detention purposes of settlement followed by bag filters to remove solids prior to discharge to the POTW. Dewatering, treatment, and discharge will be conducted in accordance with the requirements of the POTW and applicable permits.

The dewatering system will operate as required. Dewatering is to be conducted during the backfilling process to allow for backfilling in dry conditions.

Work for this item includes all labor, materials, and equipment to operate and maintain the Dewatering System.

The Contractor shall furnish all labor, equipment, and materials necessary for the control and collection of ground surface water: entering trenches and/or excavations; Contamination Reduction Zones; control of groundwater levels within all fill areas, the cap area, and demolitions. Work includes, but is not limited to, the following:

a. Design dewatering system required to perform the work;

b. Furnishing, operating, and maintaining dewatering equipment;

c. Temporary on-site storage and containment of all water collected from dewatering operations; and

d. Removal of temporary works.

On-site treatment of all water collected from dewatering operations that has potentially contacted Raymark waste will be required prior to discharge to the sanitary sewer.

1.2 RELATED WORK SPECIFIED ELSEWHERE

a. Section 01 11 00 SUMMARY OF WORK.

b. Section 01 33 00 SUBMITTAL PROCEDURES.

c. Section 01 68 00 DEWATERING TREATMENT FACILITY.

d. Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL.

e. Section 31 00 00 EARTHWORK.

f. Section 31 32 11 SOIL SURFACE EROSION CONTROL.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES, at least 10 days prior to beginning excavation in areas where dewatering may be required of where req:quired by the Engineer due to changed or unforeseen conditions:

SD-01 Preconstruction Submittals

Qualifications and Relevant Project Experience of Proposed Dewatering Personnel/Subcontractor; G

Excavation Dewatering Plan; G

Water Management Plan; G

SD-03 Product Data

Materials; G

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

Submit Qualifications and Relevant Project Experience of Proposed Dewatering Personnel/Subcontractor, as applicable.

1.4.2 Excavation Dewatering Plan

Submit Excavation Dewatering Plan, including means, methods, equipment, layout plan, discharge location, expected daily volumes, and schedule.

1.4.3 Water Management Plan

Submit Water Management Plan, including means/methods of storage and treatment, details of the discharge method(s), and proposed schedule.

PART 2 PRODUCTS

2.1 GENERAL

If needed for construction, the Contractor will provide, operate, and maintain a dewatering system to remove water from excavations and trenches using pumps, drains, well points, piping, and any other facilities necessary to keep excavations and trenches free of water to the extent that is required to facilitate and complete construction.

a. Have spare units available for immediate use in the event of equipment breakdowns.

2.2 MATERIALS

2.2.1 Dewatering Equipment and Supplies

As necessary, best adapted to site-specific design requirements.

2.2.2 Storage Containers

As necessary, best adapted to site-specific design requirements. In accordance with applicable Federal and State regulations.

2.2.3 Water Treatment Equipment and Plant Operation

Minimum requirements specified on Drawings and in permits. Contractor shall independently verify and design all system components.

PART 3 EXECUTION

3.1 PERFORMANCE

3.1.1 General

a. Mechanical retard and control the rate of run-on and runoff at the construction site. This includes construction of diversion ditches, benches, and berms to retard and divert run-on away from the area of work and runoff to protected drainage courses. Stormwater from the site shall be diverted, to the extent practicable, to minimize infiltration into the open excavations and to avoid contact with contaminated materials.

b. Keep excavations and trenches dry until the structures, pipes, and appurtenances to be built therein have been completed to such an extent that they will not be damaged.

c. Perform dewatering work when necessary to keep excavations dry and/or to provide for stability of excavations, including but not limited to the stability of excavation sidewalls; the stability of excavation sheeting, shoring, and/or bracing; the stability of the excavation bottom relative to pumping, heaving, boiling, and/or rutting; and the stability of embankment slopes.

3.1.2 Damage

a. All damage resulting from the dewatering operations or the failure of the Contractor to maintain the work in a suitable dry condition shall be repaired by the Contractor, at no addition cost to the Owner.

b. Take all necessary precautions to protect new work and non-work areas from flooding during storms or from other causes.

c. Thoroughly brace or otherwise protect all pipelines and structures which are not stable, against flotation, when necessary.

3.2 CONSTRUCTION DEWATERING

3.2.1 General

a. Dewater excavations and other parts of the construction site and

keep free of standing water or excessively muddy conditions as needed for proper execution of the Work.

b. Furnish, install, operate, and maintain all drains, sumps, pumps, and other equipment needed to perform the dewatering as specified.

c. Dewatering methods that cause a loss of fines from foundation areas will not be permitted.

3.2.2 Diversion Berms

a. Design, construct, maintain, and remove diversion berms where necessary for diverting runoff away from open excavations and trenches to minimize the generation of waste water.

b. Design and construct diversion berms to withstand all imposed loads to prevent injury to adjacent structures or property.

c. Maintain berms to minimize water ponding, through re-routing or pumping surface water away from bermed areas.

3.2.3 Temporary Underdrains

a. When necessary, lay temporary underdrain in the excavation.

b. Excavate trenches to suitable dimensions to provide space for the underdrains and surrounding gravel.

c. Install underdrains a distance of at least 3 inches below the bottom of any pipe or structure.

d. Temporary underdrain pipe shall be vitrified clay, concrete, ADS, PE, or PVC pipe of standard thickness with open joints wrapped in geotextile fabric to prevent the admission of sand and other soil.

e. Entirely surround the underdrain pipe and fill the space between the underdrain and the pipe or structure with crushed stone.

f. Compact the crushed stone and leave the surface suitable for laying the pipe or building the structure.

3.2.4 Cofferdams

a. Design, construct, maintain, and remove cofferdams where necessary for the dewatering, control, and diversion of water to keep excavations and trenches free of water.

b. Construct cofferdams to depths to permit a reasonable change in depths of the work, of sufficient height to prevent flooding, and of such dimensions to give sufficient clearance for construction and inspection.

c. Remove cofferdams after the completion of permanent construction.

3.2.5 Well Points

a. If required, dewater the excavations via a well point system.

b. Use well points designed for dewatering work.

c. Use pumping units design to be used with well points, capable of maintaining high vacuums, and capable of handling large volumes of air and water at the same time.

3.3 TEMPORARY ON-SITE STORAGE/CONTAINMENT

Excavation dewatering waste shall be collected and stored on-site until treatment and discharge can occur. Storage shall be in a suitable enclosed tank such as a Frac, Baker Tank, modutank or equal.

a. On-site storage shall be capable of handling the capacity of the anticipated construction dewatering liquid in addition to other collected liquid wastes including decontamination water, well development water, and contaminated stormwater.

b. Store water in an area as approved by the Contracting Officer.

c. On-site storage/containment shall be in accordance with Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL.

d. Contractor shall verify storage requirements based on information provided in permit applications.

3.4 ON-SITE TREATMENT

All water that potentially comes in contact with Raymark waste material shall be treated on-site prior to discharge and disposal to JCMUA. Means/Methods of treatment shall be as specified in Section 01 68 00 DEWATERING TREATMENT FACILITY.

3.5 SAMPLING AND ANALYSIS

Water from dewatering/treatment operations shall be sampled, analyzed, and characterized as necessary to comply with the discharge permit. The Contractor shall consider a 3-day turnaround time (TAT) for water sample results.

3.6 TRANSPORTATION AND DISPOSAL

If sample results meet local POTW requirements, dewatering fluids can be discharged to the sanitary sewer.

3.7 REMOVAL OF TEMPORARY WORKS

a. The Contractor shall removal all temporary works following completion of the specified activities.

b. Except as otherwise specified, remove pipes and casings from well points and fill to ground level with gravel or other material as specified.

-- End of Section --

SECTION 02 56 13

WASTE CONTAINMENT GEOMEMBRANE
02/10

PART 1 GENERAL

1.1 MEASUREMENT AND PAYMENT

Measurement shall be made of the total surface area in square feet covered by geomembrane. Final quantities will be based on as-built conditions. Allowance will be made for geomembrane in anchor and drainage trenches; however, no allowance will be made for waste, overlap, repairs, or materials used for the convenience of the Contractor. Geomembrane installed and accepted by the Contracting Officer Representative will be paid for at the respective contract unit price in the bidding schedule.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1004	(2009) Initial Tear Resistance of Plastic Film and Sheeting
ASTM D1238	(2010) Standard Test for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D1505	(2010) Density of Plastics by the Density-Gradient Technique
ASTM D1557	(2009) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D1603	(2011) Carbon Black Content in Olefin Plastics
ASTM D3895	(2007) Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
ASTM D4218	(1996; R 2008) Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
ASTM D4833	(2007) Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
ASTM D5321	(2008) Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear

	Method
ASTM D5323	(2011) Standard Practice for Determination of 2% Secant Modulus for Polyethylene Geomembranes
ASTM D5596	(2003; R 2009) Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
ASTM D5617	(2010) Standard Test Method for Multi-Axial Tension Test for Geosynthetics
ASTM D5885	(2006) Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry
ASTM D5994	(2010) Measuring Core Thickness of Textured Geomembrane
ASTM D6392	(2008) Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
ASTM D6497	(2002; R 2010) Mechanical Attachment of Geomembrane to Penetrations or Structures
ASTM D6693	(2010) Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flaxible Polypropylene Geomembranes

GEOSYNTHETIC INSTITUTE (GSI)

GSI GRI GM7	(1995) Accelerated Curing of Geomembrane Test Strip Seams Made by Chemical Fusion Methods
GSI GRI GM9	(1995) Cold Weather Seaming of Geomembranes

1.3 SUBMITTAL REQUIREMENTS

Submit manufacturer's, and fabricator's qualification statements, including resumes of key personnel involved in the project, a minimum of 7 days prior to geomembrane shipment. Also submit installer's, QC inspector's, and QC laboratory's qualification statements including resumes of key personnel involved in the project a minimum of 7 days prior to geomembrane placement. The submittal from the QC laboratory shall include verification that the laboratory is accredited via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests the QC laboratory will be required to perform. The following shall also be submitted:

a. Furnish geomembrane panel layout and penetration detail drawings, a minimum of 7 days prior to geomembrane placement.

b. Manufacturer's and fabricator's QC manuals, a minimum of 7 days prior to geomembrane shipment. Installer's QC manual, a minimum of 7 days prior to geomembrane placement.

c. Manufacturer's certified raw and sheet material test reports and a copy of the Manufacturer Quality Control (MQC) certificates, a minimum of 7 days prior to shipment of geomembrane to the site.

d. Certification from the QC inspector and installer of the acceptability of the surface on which the geomembrane is to be placed, immediately prior to geomembrane placement.

e. QC inspector certified test results on all field seams. Installer and certified QC laboratory test results on all destructively tested field seams. QC inspector certified test results on all repaired seams. Certified QC test results.

f. Certified laboratory interface friction test results including description of equipment and test method, a minimum of 7 days prior to geomembrane shipment.

g. Final as-built drawings of the geomembrane installation shall be prepared. These drawings shall include panel numbers, seam numbers, location of repairs, destructive seam samples, and penetrations.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Geomembrane Panel Layout; G
QC Manuals; G
Penetrations; G
As-Built Drawings; G

SD-03 Product Data

Tests, Inspections, and Verifications; G
Field Seaming; G
Qualifications; G

SD-06 Test Reports

Materials; G
Surface Preparation; G
Non-Destructive Field Seam Continuity Testing; G
Destructive Field Seam Testing; G
Destructive Seam Test Repairs; G
Tests; G

SD-07 Certificates

Materials; G
Destructive Field Seam Testing; G
Destructive Seam Test Repairs; G
Tests; G

1.5 QUALIFICATIONS

1.5.1 Manufacturer

Manufacturer shall have produced the proposed geomembrane sheets for at least 10 completed projects having a total minimum area of 10 million square feet.

1.5.2 Installer

The installer is responsible for field handling, deploying, seaming, anchoring, and field Quality Control (QC) testing of the geomembrane. The installer shall be the manufacturer or a manufacturer approved installer trained to install the manufacturer's geomembrane. Installation shall be performed under the constant direction of a single installation supervisor who shall remain on site and be in responsible charge, through the subgrade approval, geomembrane installation, for geomembrane layout, seaming, patching, testing, repairs, and other site activities required by the installer. The installer shall also provide a master seamer (who may also be the installation supervisor). The installation supervisor/master seamer shall have installed or supervised the installation and seaming of a minimum of 2 million square feet of linear low density polyethylene (LLDPE) geomembrane liner.The installer shall have installed the proposed geomembrane material for at least 5 completed projects having a total minimum area of 2 million square feet. At least one seamer shall have experience seaming a minimum of 500,000 square feet of the proposed geomembrane using the same type of seaming equipment and geomembrane thickness specified for this project.

1.5.3 QC Inspector

The QC inspector is the person or corporation hired by the Contractor, who is responsible for monitoring and documenting activities related to the QC of the geomembrane from manufacturing through installation. The QC inspector shall have provided QC inspection during installation of the proposed geomembrane material for at least 5 completed projects having a total minimum area of 2 million square feet.

1.5.4 QC Laboratory

The QC laboratory shall have provided QC and/or Quality Assurance (QA) testing of the proposed geomembrane and geomembrane seams for at least five completed projects having a total minimum area of 2 million square feet. The QC laboratory shall be accredited via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests the QC laboratory will be required to perform.

1.6 DELIVERY, STORAGE AND HANDLING

1.6.1 Delivery

The geomembrane rolls shall be packaged and shipped by appropriate means to prevent damage of the geomembrane rolls. Off-loading, handling, and storage of the geomembrane is the responsibility of the installer. The installer shall be responsible for replacing any damaged or unacceptable material at no additional cost to the Contractor. The QC inspector shall be present during delivery and unloading of the geomembrane. Each geomembrane roll/panel shall be labeled with the manufacturer's name, product identification number, roll/panel number, roll dimensions, and date of

manufacture.

1.6.2 Storage

Temporary storage at the project site shall be on a level surface, free of sharp objects where water cannot accumulate. The geomembrane shall be protected from puncture, abrasion, excessive heat or cold, material degradation, or other damaging circumstances. Storage shall not result in crushing the core of roll goods or flattening of the rolls. The rolls shall be stored on a prepared surface (not wooden pallets or hard abrasive surfaces) and shall not be stacked more than two rolls high. Ultraviolet sensitive materials (i.e., PVC) shall be covered with a sacrificial opaque and waterproof covering or placed in a temporary shelter. Damaged geomembrane shall be removed from the site and replaced with geomembrane that meets the specified requirements.

1.6.3 Handling

Rolls/panels shall not be dragged, lifted by one end, or dropped. A pipe or solid bar, of sufficient strength to support the full weight of a roll without significant bending, shall be used for all handling activities. The diameter of the pipe or solid bar shall be small enough to be easily inserted through the core of the roll. Chains shall be used to link the ends of the pipe or bar to the ends of a spreader bar. The spreader bar shall be wide enough to prevent the chains from rubbing against the ends of the roll. Alternatively, a stinger bar protruding from the end of a forklift or other equipment may be used. The stinger bar shall be at least three-fourths the length of the core and also must be capable of supporting the full weight of the roll without significant bending. If recommended by the manufacturer, a sling handling method utilizing appropriate loading straps may be used.

1.7 MATERIAL WARRANTY

The LLDPE geomembrane manufacturer shall warrant the geomembrane against manufacturing defects and material degradation under outdoor exposure for a period of 5 years on a prorated basis from the date of final payment and acceptance. The manufacturer shall repair or replace, including material and labor, at no expense to the Government, any material which fails from the above causes within the warranty period. The manufacturer shall furnish a written warranty covering the requirements of this paragraph.

1.8 GUARANTEE

The installer shall guarantee the LLDPE geomembrane against defects in installation and workmanship for the period of 1 year commencing with the date of final payment and acceptance by the Contractor. The guarantee shall include the services of qualified personnel, all materials required for the repairs and testing at no expense to the Contractor.

1.9 AMBIENT CONDITIONS

Geomembrane shall not be deployed or field-seamed in the presence of excess moisture (i.e., rain, fog, dew), in areas of ponded water, or in the presence of excess wind. Unless authorized by the Contracting Officer Representative, no placement or seaming shall be attempted at ambient temperatures below 32 degrees F or above 104 degrees F. Ambient temperature shall be measured at a height no greater than 6 inches above the ground or geomembrane surface. If seaming is allowed below 32 degrees F,

the procedures outlined in GSI GRI GM9 shall be followed. In marginal conditions, seaming shall cease unless destructive field seam tests, conducted by the QC laboratory, confirm that seam properties meet the requirements listed in Table 2. Tests shall be conducted in accordance with paragraph Destructive Field Seam Testing.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 General

The resin from which the geomembrane is made shall generally be in the density range of 0.926 g/cc or lower, and have a melt index value per ASTM D1238 of less than 1.0 g/10 min. Formulated sheet density shall be 0.939 g/cc or lower.

The blended resin shall contain two to three percent carbon black, anti-oxidants and heat stabilizer, but no fillers or extenders. The resin shall be virgin material, with no more than ten (10) percent rework. If rework is used, it must be of the same formulation as the parent material. No post-consumer resin of any type shall be added to the formulation.

The geomembrane material shall be so produced as to be free of holes, blisters, thin areas, inconsistent texturing, undispersed raw materials, or any sign of contamination by foreign matter.

The sheets shall be manufactured in a minimum 22 ft seamless width.

2.1.2 Properties

The geomembrane rolls shall be textured or smooth LLDPE, as required, and shall meet the specified physical, mechanical, and chemical property requirements listed in attached Table 1. Manufacturing Quality Control testing shall be conducted at the frequencies recommended in GRI GM 17 unless otherwise noted.

Interface Strength Requirements: In addition to the general material properties requirements, the Manufacturer shall provide geomembrane material meeting the following minimum project-specific interface strength requirements when required:

Interface	Peak Shear Strength	Residual Shear Strength
Geocomposite Drainage Layer/Geomembrane (textured)	21 degrees	18 degrees
Geomembrane (textured) Geosynthetic Clay Liner (GCL)	21 degrees	18 degrees

TABLE 1 - LLDPE GEOMEMBRANE PROPERTIES (TEXTURED AND SMOOTH)			
PROPERTY	TEST VALUE (TEXTURED)	TEST VALUE (SMOOTH)	TEST METHOD
Thickness - Specified	60 mils	40 mils	ASTM D5994
Thickness (min ave)	57 mils	40 mils	ASTM D5994
Lowest individual for 8 out of 10 values	54 mils	-	ASTM D5994
Lowest individual of 10 values	51 mils	36 mils	ASTM D5994
Asperity Height (min ave) (1, 2)	10 mils	-	ASTM D7466
Tensile Properties(3)(min ave)			ASTM D6693 Type IV
Break Strength	90 lb/in	152 lb/in	
Break Elongation	250 percent	800 percent	
Tear Resistance (min ave)	33 lb	22 lb	ASTM D1004
Puncture Resistance(min ave)	66 lb	56 lb	ASTM D4833
Density (max)	0.939 g/cc	0.939 g/cc	ASTM D1505 ASTM D792
Carbon Black Content (range)	2.0-3.0 percent	2.0-3.0 percent	ASTM D1603 (4)
Carbon Black Dispersion	Note (5)	Note (5)	ASTM D5596
2 percent Modulus (max)	3600 lb/in	2400 lb/in	ASTM D5323
Oxidative Induction Time (OIT)(min ave)(6)			
Std OIT	100	100	ASTM D3895
or High Pres OIT	400	400	ASTM D5885

TABLE 1 - LLDPE GEOMEMBRANE PROPERTIES (TEXTURED AND SMOOTH)			
PROPERTY	TEST VALUE (TEXTURED)	TEST VALUE (SMOOTH)	TEST METHOD
Axi-Symmetric Break Resistance Strain (min)	30 percent	30 percent	ASTM D5617
Oven Aging at 185 deg F - retained after 90 days (min ave) (9)			
Std OIT	35 percent	35 percent	ASTM D3895
or High Pres OIT	60 percent	60 percent	ASTM D5885
UV Resistance - High Pressure			
High Pres OIT(7)(8)	35 percent	35 percent	ASTM D5885

TABLE 1 NOTES	
Note (1)	Of 10 readings, 8 of 10 must be greater than or equal to 7 mils and the lowest individual reading must be greater than or equal to 5 mils.
Note (2)	Alternate the measurement side for double textured sheet.
Note (3)	Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction. Break elongation is calculated using a gage length of 2 inches at 2 inches/min.
Note (4)	Other methods such as ASTM D4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to ASTM D1603 (tube furnace) can be established.
Note (5)	Carbon black dispersion (only near sperical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3.
Note (6)	The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

TABLE 1 NOTES	
Note (7)	The condition of the test shall be a 20 hour UV cycle at 167 degrees F followed by a 4 hour condensation cycle at 140 degrees F.
Note (8)	UV resistance is based on percent retained value regardless of the original HP-OIT value.
Note (9)	It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.
	The above tests shall be performed by the LLDPE geomembrane manufacturer for identification of the manufacturer's product. The above test results shall be submitted to the Contractor for approval of the product. The geomembrane to be supplied for the project shall meet these properties.

TABLE 2 - LLDPE SEAM PROPERTIES (TEXTURED AND SMOOTH)			
PROPERTY	TEST VALUE (TEXTURED)	TEST VALUE (SMOOTH)	TEST METHOD
Shear Strength (min 4 of 5, min 1 of 5)	40-mil: 60 lb/in 60-mil: 90 lb/in	40-mil: 48 lb/in 60-mil: 72 lb/in	ASTM D6392
Peel Strength (min 4 of 5, min 1 of 5)	40-mil: 50 lb/in & FTB 60-mil: 75 lb/in & FTB	40-mil: 48 lb/in & FTB 60-mil: 60 lb/in in FTB	ASTM D6392
Note 1: Where applicable, both tracks of a double hot wedge seam shall be tested for peel adhesion.			

2.1.3 Other Materials

Extrudate welding rods (for fusion welds) shall be compatible and similar to the geomembrane and supplied by the Manufacturer and shall be delivered in the original sealed containers. Each container shall have a label bearing the brand name, Manufacturer's lot number and complete directions as to proper storage.

Boots and shrouds for pipe penetration shall fit snugly around the pipe. Prefabricated material shall be designed to fit site specific conditions for the intended slope and size of pipe and be made of compatible and identical materials as the geomembrane.

2.2 TESTS, INSPECTIONS, AND VERIFICATIONS

2.2.1 Conformance Testing

2.2.1.1 Tests

Conformance testing shall be performed by the independent Quality Assurance Laboratory (QAL) provided and paid for by the Contracting Officer Representative. The Manufacturer shall obtain the samples from the roll, mark the machine direction and identification number and ship the samples to the QAL. The following conformance tests shall be conducted at the laboratory prior to shipment to the site:

1. Thickness
2. Density
3. Tensile properties
4. Tear resistance
5. Puncture resistance
6. Carbon black content
7. Carbon black dispersion
8. Asperity height

2.2.1.2 Frequency

These conformance tests shall be performed in accordance with Table 1 at a frequency of one sample per per 100,000 square feet unless otherwise noted or approved by the Contracting Officer Representative.

2.2.1.3 Acceptance or Rejection

Conformance test results shall be reviewed by the Contracting Officer Representative and accepted or rejected, prior to shipment of the geomembrane. Test results shall meet, or exceed, the property values listed in Table 1. The course of action implemented for retesting failing tests shall be approved by the Contracting Officer Representative. In case of failing test results, the Manufacturer may request that another sample be retested by the independent laboratory with Manufacturer's technical representative present during the testing procedures. This retesting shall be paid for by the Manufacturer. The Manufacturer may also have the sample retested at two different laboratories approved by the Contracting Officer Representative, paid for by the Manufacturer. If both laboratories report passing results, the material shall be accepted. If both laboratories do not report passing results, geomembrane material from the lot or bracketed square footage representing the failing sample will be considered out of specification and rejected.

2.2.2 Manufacturing, Sampling, and Testing

2.2.2.1 Raw Materials

Raw materials shall be tested in accordance with the approved MQC manual. Any raw material which fails to meet the geomembrane manufacturer's

specified physical properties shall not be used in manufacturing the sheet. Seaming rods and pellets shall be manufactured of materials which are essentially identical to that used in the geomembrane sheet. Seaming rods and pellets shall be tested for density, melt index and carbon black content in accordance with the approved MQC manual. Seaming rods and pellets which fail to meet the corresponding property values required for the sheet material, shall not be used for seaming. Submit QC certificates that the geomembrane and extrudate produced for this project have compatible properties.

2.2.2.2 Sheet Material

Geomembrane sheets shall be tested in accordance with the approved MQC manual. As a minimum, MQC testing shall be conducted at the frequencies shown in Table 1. Sheets not meeting the minimum requirements specified in Table 1 shall not be sent to the site.

2.3 EQUIPMENT

Equipment used in performance of the work shall be in accordance with the geomembrane manufacturer's recommendations and shall be maintained in satisfactory working condition.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Surface Preparation

Surface preparation shall be performed in accordance with Section 31 00 00 EARTHWORK. Rocks larger than 1/2 inch in diameter and any other material which could damage the geomembrane shall be removed from the surface to be covered with the geomembrane. Construction equipment tire or track deformations beneath the geomembrane shall not be greater than 1.0 inch in depth. Each day during placement of geomembrane, the Contracting Officer Representative and installer shall inspect the surface on which geomembrane is to be placed and certify in writing that the surface is acceptable. Repairs to the subgrade shall be performed at no additional cost to the Government.

3.1.2 Anchor Trenches

Where an anchor trench is required, it shall be constructed as shown on the Drawings and/or as specified herein. If the anchor trench is excavated in cohesive soil susceptible to desiccation, only the amount of anchor trench required for placement of geomembrane in a single day shall be excavated. Ponded water shall be removed from the anchor trench while the trench is open. Trench corners shall be slightly rounded to avoid sharp bends in the geomembrane. Loose soil, rocks larger than 1/2 inch in diameter, and any other material which could damage the geomembrane shall be removed from the surfaces of the trench. The geomembrane shall extend down the front wall and across the bottom of the anchor trench. Backfilling and compaction of the anchor trench shall be in accordance with Section 31 00 00 EARTHWORK.

3.2 GEOMEMBRANE DEPLOYMENT

Each panel of the geomembrane shall be rolled out and installed in accordance with the approved shop drawings prepared by the Installer. The layout shall be designed to keep field seams of the LLDPE geomembrane to a

minimum and consistent with proper methods of LLDPE geomembrane installation. Panel layout and deployment shall be such that seams run down slope (i.e., perpendicular to top of slope). End seams across slopes greater than 25 percent shall be avoided except as necessary to install textured geomembrane as described below. See additional seam requirements in Section 3.3.2.

Textured geomembrane is to be installed from the edge of cap, upslope to the flatter (approximately 4.5 percent) slope. The length of textured from the edge of the cap upslope is to be approximately 21 linear feet (one full roll width less overlap). The actual length of textured material will depend on the Installer's approved panel layout and the desgn reqirement where textured material is necessary to achieve interface stability on the 33 percent edge slope condition. Smooth 40-mil geomembrane is to be installed on the flatter (approximately 4.5 percent) slope.

The procedures and equipment used shall not elongate, wrinkle, scratch, or otherwise damage the geomembrane, other geosynthetic layers, or the underlying subgrade. The Installer shall avoid dragging the geomembrane sheets on rough soil subgrade. Personnel working on the geomembrane shall not smoke, wear damaging shoes or involve themselves in any activity that may damage the geomembrane. Geomembrane damaged during installation shall be replaced or repaired, at the QC or QA inspector's discretion. The Contractor's QC Representative shall inspect each panel, after placement and prior to seaming, for damage and/or defects. Also, inspect geomembrane for defects prior to geocomposite drainage layer installation. Repaired areas and destructive sample locations shall be recorded and indicated on the as-built drawings. Only geomembrane panels that can be anchored and seamed together the same day shall be deployed. Adequate ballast (i.e., sand bags) shall be placed on the geomembrane, without damaging the geomembrane, to prevent uplift by wind. Equipment necessary to perform the installation (generators, compressors, etc.) at a minimum shall have a scrap geomembrane sheet placed underneath to protect the installed geomembrane from possible damage. No welder or testing equipment shall be allowed to remain on top of the installed geomembrane overnight. Equipment must be removed and stored off the installed geomembrane. No fueling of equipment will be allowed on top of the installed geomembrane. No fuel containers shall be allowed on the geomembrane. No other equipment shall be operated on the top surface of the geomembrane without permission from the Contracting Officer Representative. Seams shall be oriented parallel to the line of maximum slope. Where seams can only be oriented across the slope, the upper panel shall be lapped over the lower panel. When tying into previously installed geomembrane, excavation, if required, adjacent to installed liner shall be performed by hand to prevent damage. The methods used to deploy and backfill over the geomembrane shall minimize wrinkles and tensile stresses in the geomembrane. The geomembrane shall have adequate slack to prevent the creation of tensile stress. The wrinkle height to width ratio for installed geomembrane shall not exceed 0.5. In addition, geomembrane wrinkles shall not exceed 6 inches in height. Wrinkles that do not meet the above criteria shall be cut out and repaired in accordance with the installer's approved QC manual. Personnel working on the geomembrane shall not smoke, wear damaging shoes or involve themselves in any activity that may damage the geomembrane.

3.2.1 Liner Boots (Penetrations)

LLDPE boots or shrouds for liner penetrations shall be furnished and installed where indicated on the Drawings. Prefabricated material shall be designed to fit site specific conditions for the intended slope and size of

pipe and be made of compatible and similar materials as the geomembrane. The geomembrane end of the boots shall terminate in a skirt section suitable for welding to the geomembrane liner. The overlap between the boot and the geomembrane shall be approximately 18 inches. The boot shall be welded to the geomembrane as specified herein. Boots and shrouds shall fit snugly around the pipe, pole, wells, or vaults. A neoprene rubber gasket and/or silicone caulking shall be used between the boot or shroud and the penetration structure and secured with a 1 inch wide stainless steel clamp. An LLDPE sacrificial sheet shall be used between the boot or shroud and the clamp for protection. For pipes, poles, wells, vaults larger than 4-inch diameter, a second clamp shall be used. The fastener of the second clamp shall be located on the opposite side from the first clamp to compensate for uneven pressue and elongation.

3.3 FIELD SEAMING

3.3.1 Trial Seams

Trial seams shall be made under field conditions on strips of excess geomembrane. Trial seams shall be made each day prior to production seaming, whenever there is a change in seaming personnel or seaming equipment, and at least once every four hours, by each seamer and each piece of seaming equipment used that day. Trial seam samples shall be collected and tested in accordance with ASTM D6392. One sample shall be obtained from each trial seam. This sample shall be at least 36 inches long by 12 inches wide with the seam centered lengthwise. Ten random specimens 1 inch wide shall be cut from the sample. Five seam specimens shall be field tested for shear strength and 5 seam specimens shall be field tested for peel adhesion using an approved quantitative tensiometer. Installer shall provide a calibrated tensiometer, on-site before and during geomembrane installation for the purpose of testing samples. Where necessary, accelerated curing of trial seams made by chemical methods shall be conducted in accordance with GSI GRI GM7. To be acceptable, 4 out of 5 replicate test specimens shall meet seam strength requirements specified in Table 2. If the field tests fail to meet these requirements, the entire operation shall be repeated. If the additional trial seam fails, the seaming apparatus or seamer shall not be used until the deficiencies are corrected by the installer and 2 consecutive successful trial seams are achieved.

3.3.2 Field Seams

Panels shall be seamed in accordance with the geomembrane manufacturer's recommendations. The following shall apply:

a. Individual panels of geomembrane shall be laid out and overlapped by a minimum of 4 inches prior to welding. The area to be welded shall be cleaned and prepared in accordance with the quality control welding procedures approved by the Contractor's QC representative.

b. Double track hot wedge fusion welds shall be used for straight long seams to the maximum extent possible.

c. Extrusion welds shall be used in areas inaccessible for double track hot wedge fusion welding, including patches, repairs, and penetration boots.

d. The welding equipment used shall be capable of continuously

monitoring and controlling the temperatures in the zone of contact where the machine is actually fusing the geomembrane material so as to ensure that changes in environmental conditions will not affect the integrity of the weld.

e. No "fish mouths" or wrinkles will be allowed within the seam area. Where "fish mouths" or wrinkles occur, the material shall be cut, overlapped, and an extrusion weld patch shall be applied. Welds upon completion of the work shall be tightly bonded. Any geomembrane area showing injury due to excessive scuffing, puncture, or distress from any cause shall be replaced or repaired with an additional piece of geomembane. The number of patches per 100-foot length of seam length shall not exceed five. If more than five patches per 100-foot length are necessary, then the entire 100-foot length of seam shall be removed. Further welding will cease at this time and the Contractor's QC representative shall be notified.

f. Seams shall have a seam number that corresponds with the panel layout numbers. The numbering system shall be used in the development of the as-built drawings. Seam numbers shall be derived from the combination of the two panel numbers that are to be welded together. Patches, boots, and repairs shall be numbered using a system that includes the panel number where the patch, boot or repair is located.

g. Fusion welded "T" seams (i.e., the result of the geomembrane panels placed perpendicular to each other) shall be double welded where possible. The extrusion process shall be used for the second weld.

h. Extrudate shall be free of dirt, dry and protected from damage.

i. If an extrusion welder is stopped for longer than one minute, it shall be purged to remove heat degraded extrudate. Purged extudate shall not be placed on the installed geomembrane.

j. Seams constructed on sloped surfaces shall be perpendicular to the top and toe of the slope (vertical seams).

k. Panels placed on sloped surfaces (steeper than 25 percent) shall extend a minimum of 5 feet inward (on the flat) from the top of slope or edge of trench.

l. End seams shall be staggered a minimum of 5 feet in length between contiguous panels. No end seams are allowed on slopes 25 percent (4 horizontal and 1 vertical) or greater, unless otherwise approved by the Contractor.

m. To prevent moisture build-up during fusion welding, it may be necessary to place a movable protective layer of plastic (skid sheet) directly below each overlap of geomembrane that is to be seamed.

n. Seam welds shall extend the full extent into the anchor trench.

o. Factory seams, field seams and repair welds shall meet seam strength requirements specified in Table 2.

3.4 SEAMING WEATHER CONDITIONS

3.4.1 Normal Weather Conditions

The normal weather conditions for seaming are:

a. Ambient temperature higher than 32 degrees F and lower than 104 degrees F.

b. No precipitation or other excessive moisture, such as fog or dew.

c. No excessive winds.

3.4.2 Cold Weather Conditions

If the ambient air temperature is below 32 degrees F, the following procedures shall be implemented:

a. Preheating the surface of the geomembrane to achieve normal temperature range.

b. Preheating may be waived by the Contracting Officer Representative if the Installer demonstrates that satisfactory welds of equivalent quality may be obtained without preheating at the expected temperature of installation.

c. Preheating devices shall be approved by the Manufacturer.

d. Care shall be taken to assure that surface temperatures are not lowered below the minimum required surface temperature for welding due to winds.

e. Additional destructive test samples shall be taken at the discretion of the Contracting Officer Representative.

f. Test seams, as described in Section 3.5, shall be performed under similar ambient temperature conditions as the actual seams.

3.4.3 Warm Weather Conditions

a. If the ambient air temperature is above 104 degrees F, no seaming of geomembrane shall be permitted unless the installer can deomonstrate, to the satisfaction of the Contracting Officer Representative, that geomembrane seam quality is not adversely impacted.

b. Test seams shall be performed under similar ambient air temperature conditions as the actual seams.

c. Additional destructive tests shall be taken at the discretion of the Contracting Officer Representative

3.5 TESTS

3.5.1 Conformance Testing

Conformance testing shall be performed by the independent Quality Control Laboratory (QCL) provided and paid for by the Contractor. The Manufacturer shall obtain the samples from the roll, mark the machine direction and

identification number and ship the samples to the QCL. The following conformance tests shall be conducted at the laboratory prior to shipment to the site:

a. Thickness

b. Density

c. Tensile properties

d. Tear resistance

e. Puncture resistence

f. Carbon black content

g. Carbon black dispersion

h. Asperity height

Conformance test results shall be reviewed by the Contracting Officer Representative and accepted or rejected, prior to shipment of the geomembrane. Test results shall meet, or exceed, the property values listed in Table 1. The course of action implemented for retesting failing tests shall be approved by the Contracting Officer Representative. In case of failing test results, the Manufacturer may request that another sample be retested by the independent laboratory with Manufacturer's technical representative present during the testing procedures. This retesting shall be paid for by the Manufacturer. The Manufacturer may also have the sample retested at two different laboratories approved by the Contracting Officer Representative, paid for by the Manufacturer. If both laboratories report passing results, the material shall be accepted. If both laboratories do not report passing results, geomembrane material from the lot or bracketed square footage representing the failing sample will be considered out of specification and rejected.

These conformance tests shall be performed in accordance with Table 1.

3.5.2 Site-Specific Quality Control Testing

Site-specific interface strength shall meet the following requirements:

Interface	Peak Shear Strength(1)	Residual Shear Strength (1)
Geocomposite Drainage Layer (GDL)/Geomembrane (Textured) (3)(4)(6)(8)	21 degrees	18 degrees
Geomembrane (Textured)/Geosynthetic Clay Liner (GCL) (3)(4)(5)(7)(9)	21 degrees	18 degrees

NOTES:

1. Conducted in accordance with ASTM D5321. Cohesion = 0 conditions.
2. Site-specific testing shall be conducted at the frequency of 1

test/75,000 square feet of installed geomembrane.

3. Perform test at confining normal stresses of 1, 2, and 3 psi with a displacement rate of at least 0.04 in/min, under non-inundated conditions, report peak and residual large displacement values.
4. Textured geomembrane shall be tested in the cross-machine direction.
5. Hydrate GCL with de-ionized water for a minimum of 48 hours at the target normal stress prior to testing.
6. Test shear box configuration (top to bottom): top plate, protective cover soil, GDL, textured geomembrane, bottom plate.
7. Test shear box configuration (top to bottom): top plate, textured geomembrane, GCL, bottom plate.
8. Protective cover soil shall be compacted to 90 percent of the maximum dry density, as determined by ASTM D1557 with the moisture content of a maximum of 3 percent wet of optimum.
9. GCL shall be tested in the orientation it will be installed. The upper and lower geotextiles shall be in contact with adjacent interfaces to match field conditions.

Report all data as required by the referenced testing standard and/or project specifications. Include the following:

a. Residual strength (i.e., large-displacement strain) values shall be reported for a minimum 20 percent strain or the maximum allowable displacement of the test equipment.

b. The final condition of the tested soil and geosynthetics (i.e., did it rip/tear along surfaces or at connections to the shear box).

c. The measured asperity height of the textured geomembrane test sample prior to testing. Measure in accordance with ASTM D7466.

The Contracting Officer Representative shall review and accept site-specific QC testing completed and submitted by the Contractor for compliance with the project requirements.

3.5.3 Non-Destructive Seam Testing

The Installer shall perform a nondestructive test on field seams over their full length. The purpose of this test is to assure continuity and integrity of the seams. Vacuum and air pressure tests shall be used for nondestructive testing. The vacuum test shall be used for extrusion welds. The air pressure test shall be used for double track fusion welds.

3.5.3.1 Vacuum Testing

a. Equipment for testing single wedge fusion seams and extrusion seams shall be comprised of the following:

(1) A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft rubber gasket attached to the bottom, port hole or valve assembly and a vacuum gauge.

(2) A vacuum tank and pump assembly equipped with a pressure controller and pipe connections.

(3) A rubber pressure/vacuum hose with fittings and connections.

(4) A plastic bucket and wide paint brush or mop.

(5) A soapy solution.

b. The following procedures shall be followed by the Installer:

(1) Excess sheet overlap shall be trimmed away.

(2) Clean the window, gasket surfaces and check for leaks.

(3) Energize the vacuum pump and reduce the tank pressure to approximately 5 psi.

(4) Wet a strip of geomembrane approximately 12 inches by 48 inches (length of box) with the soapy solution.

(5) Place the box over the wetted area and compress.

(6) Close the bleed valve and open the vacuum valve.

(7) Ensure that a leak tight seal is created.

(8) For a minimum period of 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.

(9) If no bubbles appear after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum of 3 inch overlap and repeat the process.

(10) Areas where soap bubbles appear shall be marked and repaired in accordance with Section 3.5.2.6 and then retested.

3.5.3.2 Air Pressure Testing (for double track fusion seams only)

The following procedures are applicable to those processes which produce a double seam with an enclosed space.

a. Equipment for testing double fusion seams shall be comprised of the following:

(1) An air pump equipped with pressure gauge capable of generating and sustaining a pressure between 25 and 30 psi and mounted on a cushion to protect the geomembrane.

(2) A manometer equipped with a sharp hollow needle, or other approved pressure feed device.

b. The following procedures shall be followed by the Installer:

(1) Seal both ends of the seam to be tested. The length of seam shall not exceed 500 ft without approval by Contracting Officer Representative.

(2) Insert needle or other approved pressure feed device into the tunnel created by the double wedge fusion weld.

(3) Energize the air pump to a pressure between 25 and 30 psi. After allowing two minutes for relaxation, the pressure shall be monitored over a test period not less than five minutes.

(4) If the loss of pressure exceeds 4 psi or the pressure does not stabilize, the weld shall be considered faulty (unless the Installer can demonstrate that monitoring for an additional five minutes does not cause an additional loss in pressure in excess of 1 psi, and that the pressure stabilizes within the second monitoring period). Locate the faulty area, repair in accordance with Section 3.5.2.6 and retest.

(5) If the pressure loss is less than 4 psi after five minutes, cut the air channel on the opposite end the pressure device to confirm there is no blockage and verify the length of the seam tested. Remove needle of other approved pressured feed device and seal both ends with an extrusion weld. Remove needle or other approved pressure feed device and seal.

3.5.4 Destructive Seam Testing

The purpose of the desctuctive testing is to evaluate seam strength properties. An initial minimum sampling interval of one test per 500 feet of performed seam length shall be used for a minimum start-up batch of 50 samples. With 0 to 1 failure out of 50 samples, the sampling interval may be increased to a maximum of one test per 1000 feet of seam length with the approval of the Contracting Officer Representative. With more than 4 failures out of 50 samples, the sampling interval may be decreased as deterimined by the Contracting Officer Representative. The location of samples shall be determined by the Contracting Officer Representative. Selection of such locations may be prompted by suspicion of overheating, contamination, or other potential cause that may adversely impact the welds. Location of samples shall not be revealed to Installer in advance. Sampling shall be performed by the Installer. Testing of field samples shall be performed by the Contractor's QCL.

3.5.4.1 Sampling Procedures

a. Samples shall be cut by the Installer at locations chosen by the Contracting Officer Representative as the seaming progresses.

b. The seams shall not be covered by another material before they have been tested and accepted by the Contracting Officer Representative.

c. Upon obtaining each sample, assign a number to the sample and mark it accordingly.

d. Record sample location on layout drawing.

e. Record purpose of the sample - statistical routine or suspicious weld area.

f. Holes in the geomembrane resulting from destructive seam testing shall be immediately repaired in accordance with Paragraph 3.5.1.6.

3.5.4.2 Size and Disposition of Samples

a. Two samples, 12-inch wide by 6-inch shall be taken for field testing. Each of these samples shall be cut with a 1-inch wide die, with the seam centered parallel to the width. The distance between these two samples shall be 36 inches. If all samples pass

the field test described in Paragraph 3.5.1.3, a sample for laboratory testing shall be taken from the 36-inch portion.

b. The laboratory sample shall be cut into three parts and distributed as follows:

(1) One portion to the Installer for optional laboratory testing, 12 inches by 12 inches.

(2) One portion for QCL testing, 12 inches by 12 inches.

(3) One portion to the Contractor for archive storage, 12 inches by 12 inches.

3.5.4.3 Field Testing

The following shall be performed by the Installer in the presence of the Contracting Officer Representative:

a. The Installer shall cut six 1-inch wide replicate specimens from the field testing samples to be tested for shear and peel strength, in accordance with the criterial set in Table 1.

b. The Installer shall test three specimens for shear seam strength and three for peel strength. Replicate test specimens shall pass for the seam to be acceptable.

c. Samples shall be tested with a tensiometer equipped with a drive/pull apparatus adjusted to a pull rate of 20 inches per minute for both peel and shear testing in accordance with ASTM D6392. Each sample shall be tested until film tearing bond (FTB) is achieved. At a minimum, the required pass criteri for peel shall be as specified in Table 2. (Note: The machine shall be capable of pulling the geomembrane seams at both 2 or 20 inches per minute. At the start of the first production work day. If the results are similar, both numerically and visually, the specified test speed shall be 20 inches per minute for all field and laboratory destructive seam tests. If it appears that the faster speed may be affecting the testing results, then the specified speed shall be 2 inches per minute for all field and laboratory destructive seam testing.)

d. Any specimen that fails through the weld or through the fusion at the weld sheet interface is a non-FTB break and shall be considered a failure even if it achieves the acceptable strengths.

e. A specimen that does not break at the full extent of the test apparatus will be considered a passing test.

f. Alternate testing to evaluate both sides of dual wedge welds.

3.5.4.4 Quality Control Laboratory Testing

a. The Installer shall package and ship destructive test samples to the Contractor's independent Quality Control Laboratory (QCL) as directed by the Contracting Officer Representative by overnight delivery service. Shipping costs and destructive tests are to be paid by the Contractor.

b. Laboratory testing shall include shear and peel strength tests performed in accordance with ASTM D6392. The minimum acceptable values obtained in these tests shall be in accordance with Table 1.

c. At least five specimens shall be tested each for shear and peel strength. A passing test shall meet the minimum required values in the five specimens tested for each method.

d. The QCL shall provide verbal test results to the Contract no more than 24 hours after they receive the samples. The Contracting Officer Representative shall review the laboratory results as soon as they become available.

3.5.4.5 Procedures for Destructive Test Failure

a. The following procedures shall apply whenever a sample fails a destructive test, whether that test is conducted in the field or by the QCL. The Installer has two options:

(1) The Installer can repair the seam between (1/2 the distance or as directed by the Contracting Officer Representative any two passing test locations in accordance with Paragraph 3.5.1.6.

(2) The Installer can retrace the welding path to an intermediate location a minimum of 10 feet on each side of the failed sample. The sample shall be tested in the field. Subsequent failure of test samples shall cause the testing to move further down the seam until the extent of faulty seam has been determined.

b. Acceptable repaired seams shall be bound by two passing locations on each side of the original sample. In cases where repaired seam exceeds 150 feet, a sample taken from the zone in which the seam has been repaired must pass destructive testing. Repairs shall be made in accordance with Paragraph 3.5.1.6.

c. The Contractor shall document all actions taken in conjunction with destructive test failures.

3.5.4.6 Repair Procedures

a. Any portion of the geomembrane exhibiting signs of any kind of defect, or failing a destructive or a nondestructive test, shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be made by the Contracting Officer Representative.

b. The repair procedures available include:

(1) Patching, used to repair large holes, tears, undispersed raw materials and contamination by foreign matter.

(2) Spot welding or seaming, used to repair small tears, pinholes, or other minor, localized defects.

(3) Capping is used to repair large lengths of failed seams.

(4) Removing bad seam and replacing with a strip of new materials welded in place.

c. For any repair method, the following provisions shall be satisfied:

(1) Surfaces of the geomembrane which are to be required using extrusion methods shall be abraded no more than one hour prior to the repair.

(2) Surfaces shall be clean and dry at the time of the repair.

(3) Seaming equipment used in repairing procedures shall be qualified.

(4) Patches and caps shall extend at least 4 inches beyond the edge of the defect.

(5) Patches shall have rounded corners.

3.5.4.7 Repair Verification

Each of the destructive seam test repairs shall be numbered and logged by the Installer. Each repair shall be nondestructively tested using the methods described in Paragraph 3.5.1 as appropriate. Repairs which pass the nondestructive test shall be taken as an indication of an adequate repair. Repairs more than 150 feet long may be of sufficient length to require destructive test sampling, at the discretion of the Contracting Officer Representative. A failed test of the repaired section indicates that the repair shall be redone and retested until passing test results are achieved. The Contracting Officer Representative shall observe nondestructive testing of repairs. The installer shall record the number of each repair, date and test outcome.

3.5.4.8 Wrinkles

Large wrinkles that remain in the sheet as a result of temperature expansion or uneven surface preparation may need removal as determined by the Contracting Officer Representative in consideration of applied loads on the wrinkle. Should the wrinkle need removing, the lower down-slope edge of the wrinkle shall be cut, overlapped, and repaired as described in 3.5.1.6. Both ends of the wrinkle repair shall be patched. Caution must be taken in removing any wrinkles. Wrinkles are needed to allow for future contraction of the geomembrane liner, especially in cold weather.

3.6 PENETRATIONS

Geomembrane penetration details shall be in accordance with ASTM D6497 or as recommended by the geomembrane manufacturer. Factory fabricated boots shall be used wherever possible. Field seams for penetrations shall be non-destructively tested in accordance with the Installer's approved QC manual. Seams that fail non-destructive testing shall be repaired in accordance with the installer's approved QC manual and non-destructively tested prior to acceptance.

3.7 PROTECTION AND BACKFILLING

The deployed and seamed geomembrane shall be covered with geocomposite drainage layer within 3 calendar days of acceptance. Wrinkles in the geomembrane shall be prevented from folding over during placement of overlying materials. Cover soil shall not be dropped onto the geomembrane or overlying geosynthetics from a height greater than 3 feet. The soil shall be pushed out over the geomembrane or overlying geosynthetics in an

upward tumbling motion. Soil shall be placed from the bottom of the slope upward. The initial loose soil lift thickness shall be 12 inches. Equipment with ground pressures less than 7 psi shall be used to place soil on the cap. Cover soil compaction and testing requirements are described in Section 31 00 00 EARTHWORK. Equipment placing cover soil shall not stop abruptly, make sharp turns, spin their wheels, or travel at speeds exceeding 5 mph.

3.8 DISPOSAL OF WASTE MATERIAL

Upon completion of installation, the Installer shall properly remove and dispose of all trash, waste material, tools, and equipment used in connection with the performed work and shall leave the premises in a neat and acceptable condition.

3.9 AS-BUILT DRAWINGS AND INSTALLATION DOCUMENTATION

The Installer shall prepare and submit to the Contractor an as-built drawing reflecting the actual installation of geomembrane liner, including the location of seams, the location of destructive samples, and the location of repair work. The as-built drawing shall be submitted to the Contractor within 7 days of the completion of the geomembrane. In addition, a copy of the complete installation documentation package will accompany the as-built drawing.

-- End of Section --

SECTION 02 56 15

GEOSYNTHETIC CLAY LINER (GCL)
02/10

PART 1 GENERAL

1.1 UNIT PRICES

Measurement will be made of the total surface area covered by GCL in square feet as shown on the contract drawings. Final quantities will be based on as-built conditions. Allowance will be made for GCL in anchor and drainage trenches; however, no allowance will be made for waste, overlap, repairs, or materials used for the convenience of the Contractor. GCL installed and accepted will be paid for at the respective contract unit price in the bidding schedule.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D4632	(2008) Grab Breaking Load and Elongation of Geotextiles
ASTM D4643	(2008) Determination of Water (Moisture) Content of Soil by the Microwave Oven Method
ASTM D5261	(2010) Measuring Mass Per Unit Area of Geotextiles
ASTM D5887	(2009) Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter
ASTM D5888	(2006; R 2011) Storage and Handling of Geosynthetic Clay Liners
ASTM D5889	(2011) Quality Control of Geosynthetic Clay Liners
ASTM D5890	(2011) Swell Index of Clay Mineral Component of Geosynthetic Clay Liners
ASTM D5891	(2002; R 2009) Fluid Loss of Clay Component of Geosynthetic Clay Liners
ASTM D5993	(1999; R 2009) Measuring Mass Per Unit of Geosynthetic Clay Liners
ASTM D6072/D6072M	(2009) Obtaining Samples of Geosynthetic Clay Liners

ASTM D6243	(2009) Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method
ASTM D6496	(2004a; R 2009) Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners
ASTM D6768	(2004; R 2009) Tensile Strength of Geosynthetic Clay Liners

1.3 SUBMITTAL REQUIREMENTS

Submit manufacturer's certified raw and roll material data sheets. If needle punching or stitch bonding is used in construction of GCL, the certification shall indicate that the GCL has been continuously inspected for broken needles using an in-line metal detector and all broken needles have been removed. The certified data sheets shall be attested to by a person having legal authority to bind the GCL manufacturing company. Certified test results shall be submitted at least 14 working days prior to delivery of the GCL. Submit GCL panel layout and detail drawings, for approval, a minimum of 14 days prior to deployment. The following shall also be submitted as specified:

a. GCL panel layout and penetration detail drawings.

b. Manufacturer's warranty statement.

c. Manufacturer's quality control (QC) manual which describes testing procedures, frequency of testing and acceptance/rejection criteria for QC testing at least 14 days prior to delivery of the GCL. QC samples shall be delivered at the specified frequencies.

d. Manufacturer's, Installer's, QC inspector's, and QC laboratory's qualification statements including resumes of key personnel involved in this project.

e. Manufacturer's quality control (MQC) test results.

f. Iterface shear strength test results at least 14 days prior to deployment.

g. Independent QC laboratory test results including description of equipment and test methods.

h. Certificate of subgrade inspection.

1.3.1 Prior to Shipping Material to Site

a. Certification of manufacturer quality control tests on GCL product.

b. Certification of manufacturer quality control tests on Bentonite.

1.3.2 Prior to Installing GCL

a. Certification signed by the Installer and QC Inspector of subrade acceptance.

1.3.3 Upon Completion of GCL Installation

a. Certification by Installer that the GCL was installed per project specifications.

b. Material and Installation Warranties.

c. As-built drawings showing actual GCL placement.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Layout and Detail Drawings; G

SD-03 Product Data

GCL Properties; G
Warranty; G
Tests, Inspections, and Verifications; G
Qualifications; G

SD-06 Test Reports

Tests, Inspections, and Verifications; G
Conformance Tests; G
Subgrade Preparation; G

1.5 QUALIFICATIONS

1.5.1 Manufacturer

Geosynthetic clay liner shall be the product of a GCL Manufacturer who has produced the proposed GCL using the same bentonite, geotextiles, and sewing thread for at least 5 completed projects and shall have produced a minimum of 2,000,000 square feet of the proposed GCL.

1.5.2 Installer

The installer shall have installed GCL at a minimum of 5 projects of comparable scope and complexity and shall have installed a minimum of 2,000,000 square feet of the proposed GCL.

1.5.3 QC Inspector

The independent QC inspector is responsible for monitoring and documenting activities related to the QC of the GCL from manufacturing through installation. The QC inspector shall have provided QC and/or QA inspection during installation of GCL material for at least 5 projects and shall have performed QC and/or QA inspection on a minimum of 2 million square feet of GCL.

1.5.4 QC Laboratory

An independent QC laboratory is responsible for QC GCL testing. The QC laboratory shall have provided QC and/or QA testing of GCL for at least 10 completed projects and shall have performed QC and or QA testing for a minimum of 10 million square feet of GCL. The QC laboratory shall be accredited via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP).

1.6 DELIVERY, STORAGE, AND HANDLING

Delivery, storage, and handling of GCL shall be in accordance with ASTM D5888.

1.6.1 Delivery

Deliver material to the site only after the Contracting Officer Representative accepts required submittals. The Contracting Officer Representative shall be present during unloading of the GCL. Rolls shall be packaged in an opaque, waterproof, protective covering and wrapped around a central core. Tears in the packaging shall be repaired to restore a waterproof protective barrier around the GCL. Unloading of rolls from the delivery vehicles shall be done in a manner that prevents damage to the GCL and its packaging. Ship less than one month prior to scheduled installation unless otherwise approved by Contracting Officer Representative. Each roll shall be marked with the following information:

a. Manufacturer's name.

b. Product identification.

c. Roll number.

1.6.2 Storage

Field storage shall be in flat dry areas where water cannot accumulate and the GCL rolls can be protected from damage. Storage of the rolls on blocks or pallets will not be allowed unless the GCL rolls are fully supported as approved by the Contracting Officer Representative. Stacks of GCL rolls shall be no greater than three high. Rolls shall be covered with a water proof tarpaulin or plastic sheet if stored outdoors.

1.6.3 Handling

The QCA Inspector shall verify that proper handling equipment exists which does not pose any danger to installation personnel or risk of damage or deformation to the liner material itself. During handling, rolls shall not be dragged, lifted by one end, dropped to the ground, or otherwise damaged. Suitable handling equipment is described below:

a. Spreader Bar Assembly: A spreader bar assembly shall include both a core pipe or bar and a spreader bar beam. The core pipe shall be used to uniformly support the roll when inserted through the GCL core while the spreader bar beam will prevent chains or straps from chafing the roll edges.

b. Stinger: A stinger is a rigid pipe or rod with one end directly connected to a forklift or other handling equipment. If a stinger is used, it should be fully inserted to its full length into the

roll to prevent excessive bending of the roll when lifted.

c. Roller Cradles: Roller cradles consist of two large diameter rollers spaced approximately 3 inches apart, which both support the GCL roll and allows it to freely unroll. The use of roller cradles shall be permitted if the rollers support the entire width of the GCL roll.

d. Straps: A properly structured and supported pole or "carpet puller" can be used to unload GCL rolls onsite. As an alternative, straps that are appropriately rated can be used as an approved lifting method to unload GCL rolls.

1.6.4 GCL Inspection upon Delivery

Each roll shall be visually inspected when unloaded to determine if any packaging or material has been damaged during transit.

Repairs to damaged GCL shall be performed in accordance with Section 3.3 of this specification.

a. Rolls exhibiting damage shall be marked and set aside for closer examination during deployment.

b. Minor rips or tears in the plastic packaging shall be repaired with moisture resistant tape prior to being placed in storage to prevent moisture damage.

c. GCL rolls delivered to the project site shall be only those indicated on GCL manufacturing quality control certificates.

d. For needlepunched GCLs, the presence of free-flowing water within the packaging shall require that roll to be set aside for further examination to ascertain the extent of damage, if any. Free-flowing water within the packaging of unreinforced GCLs shall be cause for rejection of that roll.

1.7 WARRANTY

The manufacturer's warranty shall state that the GCL materials meet all requirements of the contract documents and that for the intended use, the GCL is warranted for 5 years against deterioration. The installer's warranty shall state that the GCL shall not fail due to improper installation within 1 year from the date of geomembrane completion.

PART 2 PRODUCTS

2.1 GCL PROPERTIES

The reinforced GCL shall be a manufactured product consisting of a sodium montmorillonite clay (bentonite) layer evenly distributed between two geotextiles. GCL shall conform to the property requirements listed in Table 1 and shall be free of tears, holes, or other defects that may affect its serviceability. Encapsulating geotextiles shall be mechanically bonded together using a needle punch or stitch bonding process. Needle punched and stitch bonded GCLs shall be continuously inspected for broken needles using an in-line metal detector and broken needles shall be removed. The minimum manufactured GCL sheet width shall be 10 feet and the minimum manufactured GCL sheet length shall be 125 feet.

TABLE 1 - GCL PROPERTIES			
	TEST METHOD	TEST VALUE	FREQUENCY
BENTONITE			
Swell Index Test, minimum	ASTM D5890	24 mL / 2 g min	1/100,000 lb
Fluid Loss, maximum	ASTM D5891	18 mL max	1/100,000 lb
Moisture Content	ASTM D4643	35 percent max	1/100,000 lb
UPPER GEOTEXTILE PROPERTIES			
Material Type		Nonwoven	
Mass per Unit Area, min.	ASTM D5261	3.0 ounces/square yard	1/200,000 sq.yd.
LOWER GEOTEXTILE PROPERTIES			
Material Type		Nonwoven	
Mass per Unit Area, min.	ASTM D5261	3.1 ounces/square yard MARV, Note 1	1/200,00 sq.yd.
FINISHED GCL PROPERTIES			
Bentonite Mass/Unit Area, minimum, Note 3	ASTM D5993	0.75 lbs/sq foot MARV	1/40,000 SF
Tensile Strength, minimum, (MD), Note 4	ASTM D6768	50 lbs/in MARV, Note 1	1,40,000 SF
Peak Internal Mid-Plane Shear Strength (hydrated), minimum at a normal stress of 200 psf, Note 8	ASTM D6243	500 psf typical	Periodically
Index Flux, maximum, Note 5	ASTM D5887	0.00000001 cubic m/sq m-sec	1/week
Peel Strength, MARV MDNote 6	ASTM D4632 ASTM D6496, Note 7	12 lb/in MARV 60 lbs MARV	1/40,000 SF

TABLE 1 - GCL PROPERTIES			
	TEST METHOD	TEST VALUE	FREQUENCY
Hydraulic Conductivity, Note 5	ASTM D5887	$5x10^{-11}$ m/sec max	1/week
Note 1: Minimum average roll value. Note 2: Roll widths and lengths have a tolerance of +/- 1 percent. Note 3: Bentonite mass/unit area shall be computed at 0 percent moisure content. Bentonite mass/unit area is exclusive of glues added to the bentonite. Note 4: Tested in machine direction. Note 5: Deaired, deionized water @ 5 psi (34.5 kPa) maximum effective confining stress and 2 psi (13.8 kPa) head pressure. Note 6: The peel test applies to geotextile backed GCL products only. Note 7: Modified ASTM D4632 to use a 4-inch wide grip. The maximum peak of five specimens averaged in machine direction. Note 8: Typical peak value for specimen hydrated for 24 hours and sheared under 200 psf (9.6 kPa) normal stress.			

Interface Strength Requirements: In addition to the general material properties, the manufacturer shall provide GCL material meeting the minimum project-specific interface strength requirements specified in Section 31 05 20 GEOCOMPOSITE.

2.1.1 Acceptable GCL Products

a. CETCO Bentomat DN

b. GSE BentoLiner NWL60

c. Owner's Representative approved alternative.

2.1.2 Alternative Materials

Prior to considering an alternative GCL material, the Contractor shall submit certified test results and statements of quality from the proposed GCL supplier to the Contracting Officer Representative, indicating without exception that the proposed GCL meets the requirements of this specification. Submittals shall be delivered to the Contracting Officer Representative.

2.2 TESTS, INSPECTIONS, AND VERIFICATIONS

2.2.1 Manufacturing Sampling and Testing

GCL and its components shall be sampled and tested in accordance with the manufacturer's approved QC manual. The manufacturer's QC procedures shall be in accordance with ASTM D5889. Test results not meeting the requirements specified in Table 1 shall result in the rejection of

applicable rolls. The manufacturer's QC manual shall describe procedures used to determine rejection of applicable rolls. As a minimum, rolls produced immediately prior to and immediately after the failed roll shall be tested for the same failed parameter. Testing shall continue until a minimum of three successive rolls on both sides of the original failing roll pass the failed parameter. The minimum manufacturer's testing frequency shall be as specified in Table 1.

PART 3 EXECUTION

3.1 SAMPLES AND TESTS

3.1.1 Samples

Collect QC samples at approved locations upon delivery to the site at the request of the Contracting Officer Representative a frequency of one test sample per 50,000 square feet. Samples shall be collected, packaged, and transported in accordance with ASTM D6072/D6072M. Samples shall be identified with a waterproof marker by manufacturer's name, product identification, lot and roll number. The date, a unique sample number, the machine direction, and the top surface of the GCL shall also be noted on the sample. The outer layer of the GCL roll shall be discarded prior to sampling a roll. Samples shall then be collected by cutting the full-width of the GCL sheet a minimum of 3 feet wide in the machine direction. An additional 24 by 24 inch QA sample shall be collected, labeled, and submitted to the Contracting Officer Representative each time QC samples are collected.

3.1.2 Conformance Tests

Provide QA samples to the Contracting Officer Representative to determine bentonite mass per unit area (ASTM D5993) peel strength (ASTM D6496), flux (ASTM D5887) and tensile strength (ASTM D6768) at the request of the Contracting Officer Representative at a frequency of once per 50,000 square feet of GCL placed. Tests not meeting the requirements specified in Table 1 shall result in the rejection of applicable rolls. Determination of applicable rolls shall be as described in paragraph Tests, Inspections and Verifications.

3.2 INSTALLATION

3.2.1 Subgrade Preparation

The subgrade shall be compacted in accordance with Section 31 00 00 EARTHWORK. The subgrade surface or overlying geocomposite venting layer shall be smooth and free of vegetation, standing water, and angular stones or other foreign matter that could damage the GCL. At a minimum, the subgrade surface shall be rolled with a smooth-drum compactor of sufficient weight to remove any wheel ruts, footprints, or other abrupt grade changes. All protrusions extending more than 0.5 inches from the subgrade surface (or less if recommended by the manufacturer) shall either be removed, crushed, or pushed into the surface with the smooth-drum compactor. Each day during placement, the Contracting Officer Representative and Installer shall inspect the surface on which GCL is to be placed and certify in writing that the surface is acceptable.

3.2.2 Placement

GCL shall be installed as soon as practical after completion and approval

of the subgrade or overlying geocomposite venting layer. Rolls shall be delivered to the work area in their original packaging. Immediately prior to deployment, the packaging shall be carefully removed without damaging the GCL. GCL which has been hydrated prior to being covered by an overlying geomembrane or a minimum of 12 inches of cover soil shall be removed and replaced. Hydrated GCL is defined as having become soft as determined by squeezing the material with finger pressure or material which has exhibited swelling. If the subgrade is soil, construction equipment may be used to deploy GCL. If the subgrade is a geosynthetic, GCL shall be deployed by hand or by use of approved light weight equipment with pneumatic tires which will not damage the underlying geosynthetic. GCL material shall be placed in general accordance with the procedures specified below or modified to account for site specific conditions.

3.2.2.1 GCL Orientation

GCL panels are typically placed with the nonwoven side up (heat burnished side down) to maximize the shear strength characteristics. However, the heat burnished side may be placed up if it maximizes the shear strength characteristics of a site specific interface. In base or flat areas, the GCL is not required to be installed in any particular orientation. Orientation of installed material shall be as recommended by the manufacturer to maximize shear strength characteristics.

3.2.2.2 GCL Panel Position

Where possible, all slope panels shall be installed parallel to the maximum slope while panels installed in flat areas require no particular orientation.

3.2.2.3 Panel Deployment

GCL materials shall be installed in general accordance with the procedures set forth in this section, subject to site specific conditions which would necessitate modifications.

a. Deployment should proceed form the highest elevation to the lowest to facilitate drainage in the event of precipitation.

b. The GCL may be deployed on slopes by pulling the material from a suspended roll, or securing a roll end into an anchor trench and unrolling each panel as the handling equipment slowly moves backwards.

c. Deployment on flat areas shall be conducted in the same manner as that for the slopes, however, care should be taken to minimize "dragging" the GCL. Slipsheet may be used to facilitate positioning of the liner while ensuring the GCL is not damaged from underlying sources.

d. The GCL will have seam overlaps a minimum of 6 inches for all woven/nonwoven GCLs. GCLs comprised of a nonwoven/nonwoven geotextiles will have a minimum seam overlap of 6 inches for scrim reinforced and 12 inches minimum for all non-scrim reinforced nonwoven GCLs. End of panel or butt end seams shall be a minimum of 12 inches for all woven/nonwoven GCLs, 12 inches for all scrim-reinforced double nonwoven GCLs, 24 inches for non-scrim reinforced double nonwoven GCLs, and be free of wrinkles, folds, or "fish-mouths."

e. The Contractor shall only install as much GCL that can be covered at the end of the day. No GCL shall be left exposed overnight. The exposed edge of the GCL shall be covered by a temporary tarpaulin or other such water resistant sheeting until the next working day.

3.2.3 Anchor Trench

Where anchor trenches are required, they shall be placed a minimum of 24 inches back from the edge of slopes to be covered. Anchor trenches shall be a minimum of 24 inches deep and 18 inches wide. The front edge of the trench shall be rounded so as to eliminate sharp corners that could damage the GCL. The GCL shall extend down the front wall and across the bottom of the anchor trench. Soils used for backfill shall have a maximum particle size of 1.0 inch and shall be placed in two lifts. Compaction and testing requirements are described in Section 31 00 00 EARTHWORK.

3.2.4 Seams

On side slopes, GCL shall be placed with seams oriented parallel to the line of maximum slope and shall be free of tension or stress upon completion of installation. Panels shall be positioned with the overlap recommended by the manufacturer, but not less than 6 inches for panel sides or 18 inches for panel ends. Soil or other foreign matter shall be removed from the overlap area immediately prior to seaming. If recommended by the manufacturer, granular bentonite of the same type as the bentonite used for the GCL shall be placed along the entire overlap width at a minimum rate of 0.25 lbs/linear foot or as recommended by the manufacturer. Construction adhesive or other approved seaming methods recommended by the manufacturer shall be used for horizontal seams on slopes. Overlaps which occur on slopes shall be constructed with the up slope GCL shingled over the down slope GCL. Alternate seaming methods may be approved if recommended by the manufacturer.

3.2.5 Protection

Only those GCL panels which can be anchored and covered in the same day shall be unpackaged and installed. If exposed GCL cannot be permanently covered before the end of a working day, it shall be temporarily covered with plastic or other waterproof material to prevent hydration.

3.3 REPAIRS

Holes or tears in GCL shall be repaired by placing a patch of GCL extending a minimum of 12 inches beyond the edges of the hole or tear on all sides. If recommended by the manufacturer, granular bentonite or bentonite mastic shall be applied in the overlap area. Patches shall be secured with a construction adhesive or other approved methods as recommended by the manufacturer.

3.4 PENETRATIONS

Penetration details shall be as recommended by the GCL manufacturer. As a minimum, pipe penetrations shall incorporate a collar of GCL wrapped around the pipe and securely fastened. Dry bentonite or bentonite paste shall be placed around the penetration as recommended by the GCL manufacturer.

3.5 COVERING

The cover material shall be geomembrane. The uncovered edge of GCL panels shall be protected at the end of the working day with either geomembrane or a waterproof sheet which is secured adequatly with ballast.

Precautions shall be taken to prevent damage to the GCL by restricting the use of heavy equipment over the GCL. Installation of the overlying geosynthetic component can be accomplished through the use of lightweight, rubber-tired equipment such as a 4-wheel all-terrain vehicle (ATV). This vehicle can be driven directly on the GCL, provided the ATV makes no sudden stops, starts, or turns.

-- End of Section --

SECTION 02 61 13

EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL
02/10

PART 1 GENERAL

1.1 MEASUREMENT AND PAYMENT

1.1.1 Measurement

Measurement for excavation and onsite transportation shall be based on the actual number of cubic yards of contaminated material in-place prior to excavation. Determination of the volume of contaminated material excavated shall be based on cross-sectional volume determination reflecting the differential between the original elevations of the top of the contaminated material and the final elevations after removal of the contaminated material. Measurement for backfilling of excavated areas shall be based on in-place cubic yards of compacted fill. Measurement for construction of stockpile areas shall be based on the number of square yards of stockpile liner constructed.

1.1.2 Payment

1.1.2.1 Excavation and Transportation

Compensation for excavation and onsite transportation of contaminated material will be paid as a unit cost. This unit cost shall include any other items incidental to excavation and handling not defined as having a specific unit cost.

1.1.2.2 Backfilling

Compensation for backfill soil, transportation of backfill, backfill soil conditioning, backfilling, compaction, and geotechnical testing will be paid as a single unit cost.

1.1.2.3 Stockpiling

Compensation for construction of stockpile areas will be paid for as a unit cost. This unit cost shall include all aspects of grading, preparation, handling, placement, maintenance, removal, treatment, and disposal of stockpile cover materials and liner materials and all other items incidental to construction of stockpiles. Stockpiling inside the 100-year floodplain will not be permitted.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1556	(2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method

ASTM D1557	(2009) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D2167	(2008) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D5434	(2009) Field Logging of Subsurface Explorations of Soil and Rock
ASTM D6938	(2010) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2008; Errata 1-2010; Changes 1-3 2010; Changes 4-6 2011) Safety and Health Requirements Manual

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1926	Safety and Health Regulations for Construction
40 CFR 302	Designation, Reportable Quantities, and Notification

1.3 DESCRIPTION OF WORK

The work consists of excavation, on-site transportation, placement, grading and compaction of approximately 5,333 cubic yards of contaminated material. Approximate locations of contaminated material are shown on the drawings. Characterization data on the nature and extent of the contaminated material is available in the Final Remediation Investigation, Raymark Industries, Inc. Superfund Site, 576/600 East Broadway, Stratford, CT. Tetra Tech NUS, Inc., June 2005. Subsurface conditions are shown in the Remedial Design Report, AMEC 2012. Submit a Work Plan as specified below. Notify the Contracting Officer Representative within 24 hours, and before excavation, if contaminated material is discovered that has not been previously identified or if other discrepancies between data provided and actual field conditions are discovered. Backfill material is not available onsite. Ground water is approximately 6 feet below pre-excavation ground surface. Required sampling and chemical analysis shall be conducted in accordance with Section 01 35 45.00 10 CHEMICAL DATA QUALITY CONTROL.

1.3.1 Scheduling

Notify the Contracting Officer Representative 14 calendar days prior to the start of excavation of contaminated material. The Contracting Officer Representative will be responsible for contacting regulatory agencies in accordance with the applicable reporting requirements.

1.3.2 Work Plan

Submit a Work Plan within 30 calendar days after notice to proceed. No work at the site, with the exception of site inspections and surveys, shall

be performed until the Work Plan is approved. Allow 30 calendar days in the schedule for the Government's review. No adjustment for time or money will be made if resubmittals of the Work Plan are required due to deficiencies in the plan. At a minimum, the Work Plan shall include:

a. Schedule of activities.

b. Method of excavation and equipment to be used.

c. Shoring or side-wall slopes proposed.

d. Dewatering plan.

e. Storage methods and locations for liquid and solid contaminated material.

f. Borrow sources and haul routes.

g. Decontamination procedures.

h. Spill contingency plan.

1.3.3 Other Submittal Requirements

Submit separate cross-sections of each area before and after excavation and after backfilling, test results, and 12 copies of the Closure Report within 14 calendar days of work completion at the site.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Surveys; G

SD-03 Product Data

Work Plan; G
Closure Report; G

SD-06 Test Reports

Confirmation Test Results; G
Surveys; G
Compaction; G

1.5 REGULATORY REQUIREMENTS

1.5.1 Permits and Licenses

Under CERCLA, permits are not required for work performed on the site, however, the substantive elements that would be required by the permit must be attained.

1.5.2 Air Emissions

Air emissions shall be monitored and controlled in accordance with Section 01 57 19.00 20 TEMPORARY ENVIRONMENTAL CONTROLS.

PART 2 PRODUCTS

2.1 SPILL RESPONSE MATERIALS

Provide appropriate spill response materials including, but not limited to the following: containers, adsorbents, shovels, and personal protective equipment. Spill response materials shall be available at all times when contaminated materials/wastes are being handled or transported. Spill response materials shall be compatible with the type of materials and contaminants being handled.

PART 3 EXECUTION

3.1 SURVEYS

Surveys shall be performed immediately prior to and after excavation of contaminated material to determine the volume of contaminated material removed. Surveys shall also be performed immediately after backfill of each excavation. Provide cross-sections on 25 foot intervals and at break points for all excavated areas. Locations of any confirmation samples shall also be surveyed and shown on the drawings.

3.1.1 Surveyor

The name, qualifications, and proposed survey means/methods of an independent/third-party Land Surveyor to complete site topographic surveys as required for measurement and payment shall be submitted within 7 days following notice to proceed.

The Land Surveyor shall be registered in the State of Connecticut.

3.2 EXISTING STRUCTURES AND UTILITIES

No excavation shall be performed until site utilities have been field located. Take the necessary precautions to ensure no damage occurs to existing structures and utilities. Damage to existing structures and utilities resulting from the Contractor's operations shall be repaired at no additional cost to the Government. Utilities encountered that were not previously shown or otherwise located shall not be disturbed without approval from the Contracting Officer Representative.

3.3 CLEARING

Clearing shall be performed to the limits shown on the drawings in accordance with Section 31 11 00 CLEARING AND GRUBBING.

3.4 CONTAMINATED MATERIAL REMOVAL

3.4.1 Excavation

Areas of contamination shall be excavated to the depth and extent shown on the drawings and not more than 0.2 ft beyond the depth and extent shown on the drawings unless directed by the Contracting Officer Representative. Excavation shall be performed in a manner that will limit spills and the

potential for contaminated material to be mixed with uncontaminated material. An excavation log describing visible signs of contamination encountered shall be maintained for each area of excavation. Excavation logs shall be prepared in accordance with ASTM D5434.

3.4.2 Shoring

If workers must enter the excavation, it shall be evaluated, shored, sloped or braced as required by EM 385-1-1 and 29 CFR 1926 section 650.

3.4.3 Dewatering

Surface water shall be diverted to prevent entry into the excavation. Dewatering shall be limited to that necessary to assure adequate access, a safe excavation, prevent the spread of contamination, and to ensure that compaction requirements can be met. No dewatering shall be performed without prior approval of the Contracting Officer Representative.

3.5 CONTAMINATED MATERIAL STORAGE

Material shall be placed in temporary storage immediately after excavation only if the material cannot be immediately transported and placed. Contaminated material storage will only be allowed if approved by the Contracting Officer Representative. The following paragraphs describe acceptable methods of material storage. Storage units shall be in good condition and constructed of materials that are compatible with the material or liquid to be stored. If multiple storage units are required, each unit shall be clearly labeled with an identification number and a written log shall be kept to track the source of contaminated material in each temporary storage unit.

3.5.1 Stockpiles

Stockpiles shall be constructed to isolate stored contaminated material from the environment. The maximum stockpile size shall be 100 cubic yards. Stockpiles shall not be constructed within the 100-year floodplain. Stockpiles shall be constructed to include:

a. A chemically resistant geomembrane liner free of holes and other damage. Non-reinforced geomembrane liners shall have a minimum thickness of 20 mils. Scrim reinforced geomembrane liners shall have a minimum weight of 40 lbs/1000 square feet. The ground surface on which the geomembrane is to be placed shall be free of rocks greater than 0.5 inches in diameter and any other object which could damage the membrane.

b. Geomembrane cover free of holes or other damage to prevent precipitation from entering the stockpile. Non-reinforced geomembrane covers shall have a minimum thickness of 10 mils. Scrim reinforced geomembrane covers shall have a minimum weight of 26 lbs/1000 square feet. The cover material shall be extended over the berms and anchored or ballasted to prevent it from being removed or damaged by wind.

c. Berms surrounding the stockpile, a minimum of 12 inches in height. Vehicle access points shall also be bermed.

d. The liner system shall be sloped to allow collection of leachate. Storage and removal of liquid which collects in the stockpile, in accordance with paragraph Liquid Storage.

3.5.2 Roll-Off Units

Roll-off units used to temporarily store contaminated material shall be water tight. A cover shall be placed over the units to prevent precipitation from contacting the stored material. The units shall be located as shown on the drawings. Liquid which collects inside the units shall be removed and stored in accordance with paragraph Liquid Storage.

3.5.3 Liquid Storage

Liquid collected from excavations and stockpiles shall be temporarily stored in 55 gallon barrels. Liquid storage containers shall be water-tight and shall be located as shown on the drawings.

3.6 SPILLS

In the event of a spill or release of a hazardous substance (as designated in 40 CFR 302), pollutant, contaminant, or oil (as governed by the Oil Pollution Act (OPA), 33 U.S.C. 2701 et seq.), notify the Contracting Officer Representative immediately. If the spill exceeds the reporting threshold, follow the pre-established procedures as described in the RCRA Contingency Plan for immediate reporting and containment. Immediate containment actions shall be taken to minimize the effect of any spill or leak. Cleanup shall be in accordance with applicable federal, state, and local regulations. As directed by the Contracting Officer Representative, additional sampling and testing shall be performed to verify spills have been cleaned up. Spill cleanup and testing shall be done at no additional cost to the Government.

3.7 BACKFILLING

3.7.1 Confirmation Test Results

Excavations shall be backfilled immediately after all contaminated materials have been removed and confirmation test results (if required) have been approved. Backfill shall be placed and compacted to the lines and grades shown on the drawings.

3.7.2 Compaction

Approved backfill shall be placed in lifts with a maximum loose thickness of 8 inches. Soil shall be compacted to 90 percent of ASTM D1557 maximum dry density. Density tests shall be performed at a frequency of once per 10,000 square feet per lift. A minimum of one density test shall be performed on each lift of backfill placed. Field in-place dry density shall be determined in accordance with ASTM D1556, ASTM D2167, or ASTM D6938. If ASTM D6938 is used, a minimum of one in ten tests shall be checked using ASTM D1556 or ASTM D2167. Test results from ASTM D1556 or ASTM D2167 shall govern if there is a discrepancy with the ASTM D6938 test results.

3.8 DISPOSAL REQUIREMENTS

Offsite disposal of contaminated material shall be in accordance with Section 02 81 00 TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS.

3.9 CLOSURE REPORT

Twelve (12) copies of a Closure Report shall be prepared and submitted within 14 calendar days of completing work at the site. The report shall

be labeled with the contract number, project name, location, date, name of general Contractor, and the Corps of Engineers District contracting for the work. The Closure Report shall include the following information as a minimum:

a. A cover letter signed by a responsible company official certifying that all services involved have been performed in accordance with the terms and conditions of the contract documents and regulatory requirements.

b. A narrative report including, but not limited to, the following:

(1) site conditions, ground water elevation, and cleanup criteria;

(2) excavation logs;

(3) field screening readings;

(4) quantity of materials removed from each area of contamination;

(5) quantity of water/product removed during dewatering;

(6) sampling locations and sampling methods;

(7) sample collection data such as time of collection and method of preservation;

(8) sample chain-of-custody forms; and

(9) source of backfill.

c. Copies of all chemical and physical test results.

d. Copies of all manifests and land disposal restriction notifications.

e. Copies of all certifications of final disposal signed by the responsible disposal facility official.

f. Waste profile sheets.

g. Scale drawings showing limits of each excavation, limits of contamination, known underground utilities within 50 feet of excavation, sample locations, and sample identification numbers. On-site stockpile, storage, treatment, loading, and disposal areas shall also be shown on the drawings.

h. Progress Photographs. Color photographs shall be used to document progress of the work. A minimum of four views of the site showing the location of the area of contamination, entrance/exit road, and any other notable site conditions shall be taken before work begins. After work has been started, activities at each work location shall be photographically recorded daily. Photographs shall be a minimum of 3 by 5 inches and shall include:

(1) Soil removal and sampling.

(2) Dewatering operations.

(3) Unanticipated events such as spills and the discovery of additional contaminated material.

(4) Contaminated material/water storage, handling, treatment, and transport.

(5) Site or task-specific employee respiratory and personal protection.

(6) Fill placement and grading.

(7) Post-construction photographs. After completion of work at each site, take a minimum of four views of each excavation site.

A digital version of all photos shown in the report shall be included with the Closure Report. Photographs shall be a minimum of 3 inches by 5 inches and shall be mounted back-to-back in double face plastic sleeves punched to fit standard three ring binders. Each print shall have an information box attached. The box shall be typewritten and arranged as follows:

Project Name:	Direction of View:
Location:	Date/Time:
Photograph No.:	Description of View:

-- End of Section --

SECTION 02 66 00

PROTECTIVE COVER SOIL, SELECT FILL AND TOPSOIL FOR LANDFILL COVER
02/10

PART 1 GENERAL

1.1 UNIT PRICES

Measurement and payment for "protective cover soil", "select fill" and "topsoil" shall be based on the respective unit prices for each cubic yard of "protective cover soil", "select fill" and "topsoil" in place. This unit price shall include the cost for development of borrow sources, cost of materials, excavation, hauling, equipment, placement, testing, and other work required to construct the "protective cover soil", "select fill" or "topsoil" layers.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1556	(2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1557	(2009) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D2167	(2008) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D2216	(2010) Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D2487	(2011) Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2974	(2007a) Moisture, Ash, and Organic Matter of Peat and Other Organic Soils
ASTM D422	(1963; R 2007) Particle-Size Analysis of Soils
ASTM D4318	(2010) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4972	(2001; R 2007) pH of Soils
ASTM D5101	(2012) Standard Test Method for Measuring the Filtration Compatibility of Soil-Geotextile Systems

ASTM D5084	(2010) Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
ASTM D5567	(2011) Standard Test Method for Hydraulic Conductivity Ratio (HCR) Testing of Soil/Geotextile Systems
ASTM D6938	(2010) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D698	(2007e1) Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/cu. ft. (600 kN-m/cu. m.))

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Materials Handling Plan; G
Borrow Source Assessment Report; G

SD-04 Samples

Protective Cover Soil; G
Select Fill; G
Topsoil; G

SD-06 Test Reports

Material Tests; G
Protective Cover Soil, Select Fill and Topsoil Material Tests; G
Moisture Content and Density Tests of Protective Cover and Select Fill In-Place; G

PART 2 PRODUCTS

2.1 PROTECTIVE COVER SOIL

Protective cover soil shall be placed above the geocomposite drainage layer. The cover soil will be placed in a single lift with a minimum compacted thickness of 12 inches. If temporary haul roads are utilized over the cap for truck delivery of cover soil the roads will be constructed to a minimum depth of 36 inches. The soil placed over the geocomposite will be spread using low ground pressure equipment (or equivalent low load method) while maintaining a 1 foot minimum of cover between the equipment and the geocomposite. Small equipment such as ATV's or golf carts will be permitted to operate directly on the surface of the geocomposite subject to the approval of the Contracting Officer. Such equipment will be subject to inspection to verify that the tires are of a type and condition that will

not damage the geocomposite drainage layer and that there are no fuel or hydraulic leaks.

The protective cover soil shall be free of trash, ice, snow, tree stumps, and other unsuitable and deleterious materials. The maximum particle size shall be 3/8 inch or less. It shall be of such a nature and character that it can be compacted to the specified dry density of 90 percent (measured as a percentage of the maximum dry density as determined by ASTM D1557) with a reasonable compaction effort. The protective cover soil will have a compacted (90 percent of the maximum dry density as determined by ASTM D1557) in-place hydraulic conductivity not less than $1x10^{-4}$ cm/sec as determined by ASTM D5084.

Protective cover soil will meet one of the two requirements shown below:

a. The materials may be analyzed directly for hydraulic performance with the geocomposite drainage layer by the gradient ratio test (ASTM D5101) and/or the hydraulic conductivity ratio test (ASTM D5567), as applicable. Materials will be subject to Contracting Officer Representative approval after results from the gradient ratio test are reviewed.

b. The following gradation, retention, and clogging requirements for contact with the drainage geocomposite:

(1) Gradation/Stability: For soil to be classified as both well graded and stable, it must meet the following criteria:

Well Graded: $20 > D_{60}/D_{10}>4$ and
Stable: $D_{30}^2/(D_{10}xD_{60})<3$
Where:
D_{10}=the diameter at which 10 percent of the soil is finer
D_{30}=the diameter at which 30 percent of the soil is finer
D_{60}=the diameter at which 60 percent of the soil is finer

(2) Retention: The ability of the geocomposite drainage geotextile to retain the cover soil can be verified using the following criteria:

O95/D85<B

Where: B is a function of coefficient of uniformity (D_{60}/D_{10})

B=1 $D_{60}/D_{10}<2$ or >8
B=0.5 x D_{60}/D_{10} $2<D_{60}/D_{10}<4$
B=8/D_{60}/D_{10} $4<D_{60}/D_{10}<8$
B=1.8 for silts and clays
O95=the 95 percent opening size of the geotextile (in)
D85=the diameter at which 85 percent of the soil is finer

(3) Clogging: To minimize particulate clogging:

O95>$3D_{15}$ or PI > 15
Where:
O95=the 95 percent opening size of the geotextile (in)
D_{15}=the diameter at which 15 percent of the soil is finer
PI = Plasticity Index

2.2 Select Fill

Select fill shall be clean imported soil free of debris, frozen materials, angular rocks, roots, and organics. The maximum particle size shall be 4 inches. Submit test results for representative select fill samples from each proposed borrow source to the Contracting Officer Representative at least 15 days prior to delivery.

2.3 TOPSOIL

Topsoil shall consist of natural, friable soil that is representative of soils in the vicinity which produce heavy growths of crops, grass, or other vegetation and is reasonably free from underlying subsoil, clay lumps, objectionable weeds, litter, brush, matted roots, toxic substances, or any material that might be harmful to plant growth or be a hindrance to grading, planting, or maintenance operations. Submit test results for representative topsoil samples obtained from each proposed borrow source to the Contracting Officer Representative at least 15 days prior to delivery. Topsoil shall also comply with the criteria listed in Table 1 and the CTDEEP Guidelines for Soil Erosion and Sediment Control.

TABLE 1
REQUIRED PHYSICAL PROPERTIES OF SELECT FILL AND TOPSOIL

Property	Test Value	Test Method
USDA Soil Textural Class	Loamy Sand, Silty Loam	-
Max. particle size (inches)	2.0	ASTM D422
pH	5-7	ASTM D4972
Organic content (percent)	5-20	ASTM D2974

2.4 1-INCH MINUS STONE

Placement for Access Road surfaces, toe drain stone, gas collection trench stone, and storm drain culvert bedding.

1-inch minus stone shall be free from clay, loam, organic matter, and shall meet the minimum requirements of Connecticut Department of Transportation (CONNDOT) No. 67 Aggregate specified in Section M.01 of the CONNDOT Standard Specifications for Roads, Bridges, and Incidental Construction, Form 815 with the gradation provided below:

Square Mesh Sieves	No. 67
2-1/2-inch	-
2-inch	-

Square Mesh Sieves	No. 67
1-1/2-inch	-
1-inch	100
3/4-inch	90-100
1/2-inch	-
3/8-inch	20-55
No. 4	0-10
No. 8	0-5
No. 16	-

2.5 EQUIPMENT

Equipment used to place the select fill, protective soil, and topsoil layers shall be as described in the approved Materials Handling Plan, including ground pressures. Equipment shall not accelerate or brake suddenly, turn sharply, or be operated at speeds exceeding 5.0 miles per hour.

PART 3 EXECUTION

3.1 BORROW SOURCE ASSESSMENT REPORT

Submit a Borrow Source Assessment Report at least 15 days prior to select fill and topsoil placement. No select fill or topsoil shall be placed until the Borrow Source Assessment Report is approved. The report shall include the following: location of each borrow source; estimated quantity of borrow available; logs of subsurface explorations; and laboratory test results.

3.1.1 Select Fill

3.1.1.1 Classification Testing

Borrow source assessment tests shall be performed on each principal type or combination of materials proposed for use in the select fill layer to ensure compliance with specified requirements. At least one set of borrow assessment tests shall be performed on each borrow source proposed for use. A set of borrow source assessment tests shall consist of Atterberg limits (ASTM D4318), particle size analysis (ASTM D422), and moisture content (ASTM D2216). Based on borrow source assessment testing, soils shall be classified in accordance with ASTM D2487.

3.1.1.2 Moisture-Density (Compaction) Testing

A representative sample from each principal type or combination of borrow materials shall be tested to establish compaction curves using ASTM D698. At least one compaction test shall be performed on each borrow source proposed. A minimum of 5 points shall be used to develop each compaction curve. During construction, placement of select fill shall conform to the following requirements:

a. The minimum allowable dry density shall be no less than 90 percent of maximum dry density (ASTM D1557).

b. The allowable moisture content range shall be +/- 3 percent of optimum.

3.1.2 Topsoil

Testing shall be performed on representative samples of each principal type or combination of topsoil materials. At least one set of tests shall be performed on each borrow source proposed. Testing shall consist of the determination of maximum particle size in accordance with ASTM D422, pH in accordance with ASTM D4972, and organic content in accordance with ASTM D2974.

3.1.3 Protective Cover Soil

3.1.3.1 Classification Testing

Borrow source assessment tests shall be performed on each principal type or combination of materials proposed for use in the protective cover soil layer to ensure compliance with specified requirements. At least one set of borrow assessment tests shall be performed on each borrow source proposed for use. A set of borrow source assessment tests shall consist of Atterberg limits (ASTM D4318), particle size analysis (ASTM D422), and moisture content (ASTM D2216). Based on borrow source assessment testing, soils shall be classified in accordance with ASTM D2487.

3.1.3.2 Moisture-Density (Compaction) Testing

Representative samples from each principal type or combination of borrow materials shall be tested to establish compaction curves using ASTM D1557. At least three compaction tests shall be performed on each borrow source proposed. A minimum of 5 points shall be used to develop each compaction curve. During construction, placement of protective cover soil shall conform to the following requirements:

a. The minimum allowable dry density shall be no less than 90 percent of maximum dry density (ASTM D1557).

b. The allowable moisture content range shall be +/- 3 percent of optimum.

3.1.3.3 Additional Requirements

Protective cover soil shall also meet the requirements of Paragraph 2.1 of this Specification.

3.1.4 Chemical Contamination Testing

Borrow used for this project shall be free of contamination. Each proposed borrow source shall be sampled and analyzed for chemical contamination.

Analytical testing shall be performed for protective soil, select fill, and topsoil used for this Project to verify that the material is clean (free of contamination).

The Contractor shall provide certification that the soil materials used are clean (free of contamination). Laboratory analytical results shall be attached to the certification to verify that the results are below applicable CTDEEP RSR Criteria. Laboratory analyses shall be performed on a

minimum of one sample per borrow source/material and shall include volatile organic compounds, semivolatile organic compounds, inorganics, pesticides, and polychlorinated biphenyls. The certification and analytical results must be submitted to the Contracting Officer for approval. Only approved backfill material will be allowed to be used.

3.2 INSTALLATION

3.2.1 Protective Cover Soil Placement

No equipment shall be operated directly on the top surface of geosynthetics without permission from the Contracting Officer. Protective cover soil shall be pushed out over geosynthetics in an upward tumbling motion so that wrinkles in geosynthetics do not fold over. Soil shall not be dropped directly onto geosynthetics from a height greater than 3 feet. On slopes, protective cover soil shall be placed from the bottom of the slope upward.

3.2.1.1 Initial Lift of Protective Cover Soil Placed Over Geosynthetics

The first lift of soil placed over geosynthetics shall be a minimum of 15 inches in loose thickness. Equipment with ground pressures less than 7 psi shall be used to place and traffic compact fill. Traffic compaction shall consist of a minimum of 2 passes over all areas.

3.2.1.2 Subsequent Lifts of Fill Soils

The loose lift thickness of each subsequent lift shall be no greater than 12 inches.

3.2.2 Topsoil Placement

Topsoil shall not be placed when the subgrade is frozen, excessively wet, extremely dry, or in a condition otherwise detrimental to proper grading. Topsoil shall be placed in one lift and shall be evenly spread to the final compacted thickness as shown on the Drawings. Topsoil shall be traffic compacted using approved placement equipment. On slopes, topsoil shall be placed from the bottom of the slope upward.

3.3 CONSTRUCTION TOLERANCES

Finished surfaces shall be uniformly graded and shall be free from depressions, mounds, or windrows. The top surface of the protective cover soil layer, select fill layer and topsoil layer shall be no greater than 3 inches above the lines and grades shown on the drawings. No minus tolerance will be permitted. Rigid grade stakes shall not be driven into the select fill layer to control placement.

3.4 CONSTRUCTION TESTS

3.4.1 Material Tests

No materials shall be placed until the Borrow Source Assessment Reports are approved. During construction of each soil layer, representative samples shall be taken for testing at the frequencies listed in Table 2 from the borrow sources prior to placement. Test results must comply with the requirements listed in this Section or the material will be rejected for use. Submit test results as specified.

TABLE 2 MATERIAL TESTING FREQUENCIES		
Property	Frequency	Test Method
Select Fill and Protective Cover Soil		
Grain size analysis	2,000 cubic yards	ASTM D422
Atterberg limits	2,000 cubic yards	ASTM D4318
Moisture/Density (Note 1)	2,000 cubic yards	ASTM D1557
Topsoil		
Grain size analysis for maximum particle size	2,000 cubic yards	ASTM D422
pH	2,000 cubic yards	ASTM D4972
Organic content	2,000 cubic yards	ASTM D2974
1" Minus Stone		
Particle Sieve Analysis	500 cubic yards	ASTM D5519
Note 1: Moisture/Density results shall be compared with the results obtained during the borrow source assessment. When there are significant differences, adjustments to the acceptable moisture content or density ranges shall be proposed by the Contractor for approval.		

3.4.2 Moisture Content and Density Tests of Protective Cover and Select Fill In-Place

Moisture content and density tests shall be performed in accordance with Table 3. Submit test results as specified.

TABLE 3 MOISTURE CONTENT AND DENSITY TESTS OF IN-PLACE PROTECTIVE COVER SOIL AND SELECT FILL		
Property	Frequency per Lift	Test Method
Nuclear moisture content	10,000 square feet	ASTM D6938
Standard moisture content	1 for every 20 nuclear tests	ASTM D2216

TABLE 3 MOISTURE CONTENT AND DENSITY TESTS OF IN-PLACE PROTECTIVE COVER SOIL AND SELECT FILL		
Nuclear density	10,000 square feet (1 per day min.)	ASTM D6938
Standard density	1 for every 20 nuclear tests	ASTM D1556 or ASTM D2167

3.4.2.1 Test Frequencies and Locations

Each day that fill is placed, a minimum of one set of standard moisture content and density tests shall be performed. Nuclear density and moisture content tests shall be checked at the frequencies shown in Table 3. Standard tests shall be performed at locations which are as close as possible to the locations of the nuclear tests being checked.

3.4.2.2 Nuclear Density and Moisture Content Tests

Nuclear density readings shall be taken in the direct transmission mode. When ASTM D6938 is used, the calibration curves shall be checked and adjusted using only the sand cone method as described in ASTM D1556. ASTM D6938 results in a wet unit weight of soil and when using this method ASTM D6938 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D6938; the calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed by the Contracting Officer.

3.4.2.3 Test Results

Field moisture content and density test results shall be compared to the compaction curve for the appropriate material type being tested. If test results are not within the acceptable range for moisture content or density, as described in subparagraph Moisture-Density (Compaction) Testing, 3 additional tests shall be performed near the location of the failed parameter. If all retests pass, no additional action shall be taken. If any of the retests fail, the lift of soil shall be repaired out to the limits defined by passing tests for that parameter. The area shall then be retested as directed.

3.5 PROTECTION

3.5.1 Damage

Erosion rills or other damage that occurs shall be repaired and grades re-established. Repairs to the select fill layer or topsoil layer shall be documented including location and volume of soil affected, corrective action taken, and results of retests.

3.5.2 Stockpiles

Storage or stockpiling of material on the completed surface of the select fill or topsoil layers will not be permitted.

-- End of Section --

SECTION 02 81 00

TRANSPORTATION AND DISPOSAL OF HAZARDOUS MATERIALS
02/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

INTERNATIONAL AIR TRANSPORT ASSOCIATION (IATA)

IATA DGR	(2004) Dangerous Goods Regulations

U.S. DEPARTMENT OF TRANSPORTATION (DOT)

DOT 4500.9R	Defense Transportation Regulation, Part 2, Cargo Movement, Chapter 204, Hazardous Material

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 263	Standards Applicable to Transporters of Hazardous Waste
40 CFR 264	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 265	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 268	Land Disposal Restrictions
40 CFR 270	EPA Administered Permit Programs: The Hazardous Waste Permit Program
40 CFR 279	Standards for the Management of Used Oil
40 CFR 300	National Oil and Hazardous Substances Pollution Contingency Plan
40 CFR 302	Designation, Reportable Quantities, and Notification
40 CFR 61	National Emission Standards for Hazardous Air Pollutants

40 CFR 761	Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions
49 CFR 107	Hazardous Materials Program Procedures
49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements
49 CFR 173	Shippers - General Requirements for Shipments and Packagings
49 CFR 178	Specifications for Packagings

1.2 DEFINITIONS

1.2.1 Hazardous Material

A substance or material which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and which has been so designated pursuant to the Hazardous Materials Transportation Act, 49 U.S.C. Appendix Section 1801 et seq. The term includes materials designated as hazardous materials under the provisions of 49 CFR 172, Sections .101 and .102 and materials which meet the defining criteria for hazard classes and divisions in 49 CFR 173. EPA designated hazardous wastes are also hazardous materials.

1.2.2 Hazardous Waste

A waste which meets criteria established in RCRA or specified by the EPA in 40 CFR 261 or which has been designated as hazardous by a RCRA authorized state program.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Onsite Hazardous Waste Management; G
Notices of Non-Compliance and Notices of Violation
Packaging Notifications

SD-06 Test Reports

Recordkeeping; G
Spill Response
Exception Report; G

SD-07 Certificates

Certification
Security Plan
Transportation and Disposal Coordinator; G
Training; G
EPA Offsite Policy
Certificates of Disposal
Shipping Documents and Packagings Certification; G

1.4 QUALITY ASSURANCE

1.4.1 Transportation and Disposal Coordinator

Designate, by position and title, one person to act as the Transportation and Disposal Coordinator (TDC) for this contract. The TDC shall serve as the single point of contact for all environmental regulatory matters and shall have overall responsibility for total environmental compliance at the site including, but not limited to, accurate identification and classification of hazardous waste and hazardous materials; determination of proper shipping names; identification of marking, labeling, packaging and placarding requirements; completion of waste profiles, hazardous waste manifests, asbestos waste shipment records, PCB manifests, bill of ladings, exception and discrepancy reports; and all other environmental documentation. The TDC shall have, at a minimum, one year of specialized experience in the management and transportation of hazardous waste and have been Department of Transportation certified under 49 CFR 172, Subpart H.

1.4.2 Training

The Contractor's hazardous materials employees shall be trained, tested, and certified to safely and effectively carry out their assigned duties in accordance with Section 01 35 29.13 HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES FOR CONTAMINATED SITES. The Contractor's employees transporting hazardous materials or preparing hazardous materials for transportation, including samples, shall be trained, tested, and certified in accordance with 49 CFR 172, Subpart H, including security awareness and any applicable security plans. Where shipment of hazardous materials by air may be occurring, such as for sample shipments, the Contractor's hazardous material employees shall also be trained on IATA DGR. Contractor employees making determinations that shipments do not constitute DOT regulated hazardous materials shall also be trained, tested, and certified in accordance with 49 CFR 172, Subpart H.

1.4.3 Certification

The Contractor and/or subContractors transporting hazardous materials shall possess a current certificate of registration issued by the Research and Special Programs Administration (RSPA), U.S. Department of Transportation, when required by 49 CFR 107, Subpart G. Submit copies of the certificates or written statements certifying exemption from these requirements.

1.4.4 Laws and Regulations Requirements

Work shall meet or exceed the minimum requirements established by Federal, state, and local laws and regulations which are applicable. These requirements are amended frequently and compliance with amendments is required as they become effective. In the event that compliance exceeds the scope of work or conflicts with specific requirements of the contract, notify the Contracting Officer Representative immediately.

PART 2 PRODUCTS

2.1 MATERIALS

Provide all the materials required for the packaging, labeling, marking, placarding and transportation of hazardous wastes and hazardous materials in conformance with Department of Transportation standards and IATA DGR. Details in this specification shall not be construed as establishing the limits of the Contractor's responsibility.

2.1.1 Packagings

Provide bulk and non-bulk containers for packaging hazardous materials/wastes consistent with the authorizations referenced in the Hazardous Materials Table in 49 CFR 172, Section.101, Column 8. Bulk and non-bulk packaging shall meet the corresponding specifications in 49 CFR 173 referenced in the Hazardous Materials Table, 49 CFR 172, Section .101. Each packaging shall conform to the general packaging requirements of Subpart B of 49 CFR 173, to the requirements of 49 CFR 178 at the specified packing group performance level, to the requirements of special provisions of column 7 of the Hazardous Materials Table in 49 CFR 172, Section .101, and shall be compatible with the material to be packaged as required by 40 CFR 262. The Contractor shall provide portable, temporary storage tanks (FRAC tanks, etc.) for the storage/treatment of collected liquids (i.e. decontamination fluids and dewatering waste liquids). The Contractor shall also provide spill containment for 110 percent of the tank volume. The Contractor is responsible for the rental, deliver, removal, and decontamination of FRAC tanks. Radiological screening of FRAC tanks prior to leaving the site will be provided by the Owner's Representative. The Contractor shall provide DOT-approved steel drums (55 gallon capacity) for possible storage of residual contaminated material and/or water.Also provide other packaging related materials such as materials used to cushion or fill voids in overpacked containers, etc. Sorbent materials shall not be capable of reacting dangerously with, being decomposed by, or being ignited by the hazardous materials being packaged. Additionally, sorbents used to treat free liquids to be disposed of in landfills shall be non-biodegradable as specified in 40 CFR 264, Section .314. In addition, packaging notifications will be provided to the Government in accordance with 49 CFR 172, Section .178.2(c) regarding type and dimensions of closures, including gaskets, needed to satisfy performance test requirements.

2.1.2 Markings

Provide markings for each hazardous material/waste package, freight container, and transport vehicle consistent with the requirements of 49 CFR 172, Subpart D and 40 CFR 262, Section .32 (for hazardous waste), 40 CFR 761, Section .45 (for PCBs), and 40 CFR 61, Section .149(d) (for asbestos). Markings shall be capable of withstanding, without deterioration or substantial color change, a 180 day exposure to conditions reasonably expected to be encountered during container storage and transportation.

2.1.3 Labeling

Provide primary and subsidiary labels for hazardous materials/wastes consistent with the requirements in the Hazardous Materials Table in 49 CFR 172, Section .101, Column 6. Labels shall meet design specifications required by 49 CFR 172, Subpart E including size, shape,

color, printing, and symbol requirements. Labels shall be durable and weather resistant and capable of withstanding, without deterioration or substantial color change, a 180 day exposure to conditions reasonably expected to be encountered during container storage and transportation.

2.1.4 Placards

For each offsite shipment of hazardous material/waste, provide primary and subsidiary placards consistent with the requirements of 49 CFR 172, Subpart F. Placards shall be provided for each side and each end of bulk packaging, freight containers, transport vehicles, and rail cars requiring such placarding. Placards may be plastic, metal, or other material capable of withstanding, without deterioration, a 30 day exposure to open weather conditions and shall meet design requirements specified in 49 CFR 172, Subpart F.

2.1.5 Spill Response Materials

Provide spill response materials including, but not limited to, containers, adsorbent, shovels, and personal protective equipment. Spill response materials shall be available at all times in which hazardous materials/wastes are being handled or transported. Spill response materials shall be compatible with the type of material being handled.

2.2 EQUIPMENT AND TOOLS

Provide miscellaneous equipment and tools necessary to handle hazardous materials and hazardous wastes in a safe and environmentally sound manner.

PART 3 EXECUTION

3.1 ONSITE HAZARDOUS WASTE MANAGEMENT

These paragraphs apply to Government owned waste only. Contractors are prohibited by 10 U.S.C. 2692 from storing Contractor owned waste onsite for any length of time. The Contractor is responsible for ensuring compliance with all Federal, state, and local hazardous waste laws and regulations and shall verify those requirements when preparing reports, waste shipment records, hazardous waste manifests, or other documents. Identify hazardous wastes using criteria set forth in 40 CFR 261 or all applicable state and local laws, regulations, and ordinances. When accumulating hazardous waste onsite, comply with generator requirements in 40 CFR 262 and any applicable state or local law or regulations. Onsite accumulation times shall be restricted to applicable time frames referenced in 40 CFR 262, Section .34 and any applicable state or local law or regulation. Accumulation start dates shall commence when waste is first generated (i.e. containerized or otherwise collected for discard). The Contractor shall furnish all labor, equipment, and materials necessary to provide for the proper on-site handling and management of materials including, but not limited to, materials identified as radiologically contaminated and RCRA hazardous waste materials (soil, steel, concrete/masonry, wood, asphalt pavement, and other miscellaneous debris); contaminated liquid waste (decontamination water, etc.); and contaminated remediation waste (disposable PPE, plastic sheeting, and sampling equipment). Only use containers in good condition and compatible with the waste to be stored. Ensure containers are closed except when adding or removing waste, and immediately mark all hazardous waste containers with the words "hazardous waste" and other information required by 40 CFR 262, Section .32 and any applicable state or local law or regulation as soon as the waste is containerized. An additional marking

shall be placed on containers of "unknowns" designating the date sampled, and the suspected hazard. Inspect containers for signs of deterioration and for responding to any spills or leaks. Inspect all hazardous waste areas weekly and provide written documentation of the inspection. Include date and time of inspection, name of individual conducting the inspection, problems noted, and corrective actions taken on the inspection logs.

3.1.1 Hazardous Waste Classification

Identify, in consultation with the Contracting Officer Representative, all waste codes applicable to each hazardous waste stream based on requirements in 40 CFR 261 or any applicable state or local law or regulation. Also identify all applicable treatment standards in 40 CFR 268 and state land disposal restrictions and make a determination as to whether or not the waste meets or exceeds the standards. Waste profiles, analyses, classification and treatment standards information shall be submitted to Contracting Officer Representative for review and approval.

3.1.2 Management Plan

Prepare a plan detailing the manner in which hazardous wastes will be managed and describing the types and volumes of hazardous wastes anticipated to be managed as well as the management practices to be utilized. The plan shall identify the method to be used to ensure accurate piece counts and/or weights of shipments; shall identify waste minimization methods; shall propose facilities to be utilized for treatment, storage, and/or disposal; shall identify areas onsite where hazardous wastes are to be handled; and shall identify whether transfer facilities are to be utilized; and if so, how the wastes will be tracked to ultimate disposal. Submit the plan prior to start of work. Written documentation of weekly hazardous waste inspections shall be submitted on a monthly basis.

3.2 OFFSITE HAZARDOUS WASTE MANAGEMENT

3.2.1 Status of the Facility

Facilities receiving hazardous waste shall be permitted in accordance with 40 CFR 270 or operating under interim status in accordance with 40 CFR 265 requirements, or permitted by a state authorized by the Environmental Protection Agency to administer the RCRA permit program. Additionally, prior to using a TSD Facility, contact the EPA Regional Offsite Coordinator specified in 40 CFR 300, Section .440, to determine the facility's status, and document all information necessary to satisfy the requirements of the EPA Offsite policy and submit this information to the Contracting Officer Representative.

3.2.2 Shipping Documents and Packagings Certification

Prior to shipment of any hazardous material offsite and a minimum of 14 days prior to anticipated pickup, the Contractor's TDC shall provide for review written certification to the Contracting Officer Representative that hazardous materials have been properly packaged, labeled, and marked in accordance with Department of Transportation and EPA requirements. Packaging assurances shall be furnished by the designated disposal facility not later than 35 days after acceptance of the shipment. The Contractor's TDC shall also provide written certification regarding waste minimization efforts documenting that efforts have been taken to reduce the volume and toxicity of waste to the degree economically practicable and that the method of treatment, storage, or disposal selected minimizes threats to

human health and the environment.

3.2.3 Transportation

Prior to conducting hazardous materials activities, the Contractor responsible for pre-transportation activities shall either certify to the Government that a Security Plan is in place which meets the requirements of 49 CFR 172, Subpart I or in the event that the types or amounts of hazardous materials are excluded from the security planning requirements, a written statement to that effect detailing the basis for the exception. Use manifests for transporting hazardous wastes as required by 40 CFR 263 or any applicable state or local law or regulation. Transportation shall comply with all requirements in the Department of Transportation referenced regulations in the 49 CFR series. Prepare hazardous waste manifests for each shipment of hazardous waste shipped offsite. Manifests shall be completed using instructions in 40 CFR 262, Subpart B and any applicable state or local law or regulation. Submit manifests and waste profiles to Contracting Officer Representative for review and approval. Prepare land disposal restriction notifications as required by 40 CFR 268 or any applicable state or local law or regulation for each shipment of hazardous waste. Submit notifications with the manifest to the Contracting Officer Representative for review and approval. In accordance with DOT 4500.9R, inspect motor vehicles used to transport hazardous materials in accordance the 49 CFR and DOT safety regulations and complete DDForm 626, Motor Vehicle Inspection.

3.2.4 Treatment and Disposal of Hazardous Wastes

The hazardous waste shall be transported to an approved hazardous waste treatment, storage, or disposal facility within 90 days of the accumulation start date on each container. Ship hazardous wastes only to facilities which are properly permitted to accept the hazardous waste or operating under interim status. Ensure wastes are treated to meet land disposal treatment standards in 40 CFR 268 prior to land disposal. Propose TSD facilities via submission of the Hazardous Waste Management Plan, subject to the approval of the Contracting Officer Representative. Submit Certificates of Disposal documenting the ultimate disposal, destruction or placement of hazardous wastes, CERCLA remediation waste, polychlorinated biphenyls (PCBs), Raymark wastes, and asbestos within 180 days of initial shipment. Receipt of these certificates will be required for final payment.

3.3 RADIOACTIVE MATERIALS MANAGEMENT

In consultation with the Contracting Officer Representative, evaluate, prior to shipment of any material offsite, whether the material is regulated as a hazardous waste in addition to being regulated as a radioactive material; this shall be done for the purpose of determining proper shipping descriptions, marking requirements, etc., as described below.

3.3.1 Identification of Proper Shipping Names

Use 49 CFR 172, Section .101 to identify proper shipping names for each hazardous material (including hazardous wastes) to be shipped offsite. Submit proper shipping names to the Contracting Officer Representative in the form of draft shipping documents for review and approval.

3.3.2 Packaging, Labeling, and Marking

Package, label, and mark hazardous materials/wastes using the specified materials and in accordance with the referenced authorizations. Mark each container of hazardous waste of 110 gallons or less with the following:

"HAZARDOUS WASTE - Federal Law Prohibits Improper Disposal.
If found, contact the nearest police or public safety authority or the U.S. Environmental Protection Agency.
Generator's name _____
Manifest Document Number _____".

3.3.3 Shipping Documents

Ensure that each shipment of hazardous material sent offsite is accompanied by properly completed shipping documents. This includes shipments of samples that may potentially meet the definition of a Department of Transportation regulated hazardous material.

3.3.3.1 PCB Waste Shipment Documents

Prepare hazardous waste manifests for each shipment of PCB waste shipped offsite. Complete manifests using instructions in 40 CFR 761, Sections .207 and .208 and all other applicable requirements. Submit documents to Contracting Officer Representative for review and approval.

3.3.3.2 Asbestos Waste Shipment Documents

Prepare waste shipment records, as required by 40 CFR 61, for shipments of asbestos. Submit waste shipment records to the Contracting Officer Representative for review and approval. Waste shipment records shall be signed by the Contractor.

3.3.3.3 Other Hazardous Material Shipment Documents

Prepare a bill of lading for each shipment of hazardous material which is not accompanied by a hazardous waste manifest or asbestos waste shipment record which fulfills the shipping paper requirements. The bill of lading shall satisfy the requirements of 49 CFR 172, Subpart C, and 40 CFR 279 if shipping used oil and any applicable state or local law or regulation, and shall be submitted to the Contracting Officer Representative for review and approval. For laboratory samples and treatability study samples, prepare bills of lading and other documentation as necessary to satisfy conditions of the sample exclusions in 40 CFR 261, Section .4(d) and (e) and any applicable state or local law or regulation. Bill of ladings requiring shipper's certifications shall be signed by the Contractor.

3.4 OBTAINING EPA ID NUMBERS

Complete EPA Form 8700-12, Notification of Hazardous Waste Activity, and submit to the Contracting Officer Representative for review and approval. Allow a minimum of 30 days for processing the application and assigning the EPA ID number. Shipment shall be made not earlier than one week after receipt of the EPA ID number.

3.5 SPECIAL REQUIREMENTS FOR ASBESTOS WASTES

If work involves asbestos containing wastes, manage these wastes in accordance with specification Section 02 82 14.00 10 ASBESTOS HAZARD

CONTROL ACTIVITIES.

3.6 RECORDKEEPING

The Contractor is responsible for maintaining adequate records to support information provided to the Contracting Officer Representative regarding exception reports, annual reports, and biennial reports; maintaining asbestos waste shipment records for a minimum of 3 years from the date of shipment or any longer period required by any applicable law or regulation or any other provision of this contract; and maintaining bill of ladings for a minimum of 375 days from the date of shipment or any longer period required by any applicable law or regulation or any other provision of this contract. Submit information necessary to file state annual or EPA biennial reports for all hazardous waste transported, treated, stored, or disposed of under this contract. Do not forward these data directly to the regulatory agency but to the Contracting Officer Representative at the specified time. The submittal shall contain all the information necessary for filing of the formal reports in the form and format required by the governing Federal or state regulatory agency. A cover letter shall accompany the data to include the contract number, Contractor name, and project location. In the events that a manifest copy documenting receipt of hazardous waste at the treatment storage and disposal facility is not received within 35 days of shipment initiation, or that a manifest copy documenting receipt of PCB waste at the designated facility is not received within 35 days of shipment initiation, prepare and submit an exception report to the Contracting Officer Representative within 37 days of shipment initiation.

3.7 SPILL RESPONSE

In the event of a spill or release of a hazardous substance (as designated in 40 CFR 302), or pollutant or contaminant, or oil (as governed by the Oil Pollution Act (OPA), 33 U.S.C. 2701 et seq.), notify the Contracting Officer Representative immediately. Any direction from the Contracting Officer Representative concerning a spill or release shall not be considered a change under the contract. If the spill exceeds a reporting threshold, follow the pre-established procedures for immediate reporting to the Contracting Officer Representative. Comply with all applicable requirements of Federal, state, or local laws or regulations regarding any spill incident.

3.8 EMERGENCY CONTACTS

The Contractor is responsible for complying with the emergency contact provisions in 49 CFR 172, Section .604. Whenever the Contractor ships hazardous materials, provide a 24 hr emergency response contact and phone number of a person knowledgeable about the hazardous materials being shipped and who has comprehensive emergency response and incident mitigation information for that material, or has immediate access to a person who possesses such knowledge and information. The phone shall be monitored on a 24 hour basis at all times when the hazardous materials are in transportation, including during storage incidental to transportation. Ensure that information regarding this emergency contact and phone number are placed on all hazardous material shipping documents. Designate an emergency coordinator and post the following information at areas in which hazardous wastes are managed:

a. The name of the emergency coordinator.

b. Phone number through which the emergency coordinator can be contacted on a 24 hour basis.

c. The telephone number of the local fire department.

d. The location of fire extinguishers and spill control materials.

Attachment A SAMPLE OFF-SITE POLICY CERTIFICATION MEMO	
Project/Contract #:	
Waste Stream:	
Primary TSD Facility, EPA ID #	
Alter. TSD Facility, EPA ID #	
EPA Region	Contact
I	(617) 918-1752
II	(212) 637-4130
III	(214) 814-5267
IV	(404) 562-8591
V	(312) 353-8207
VI	(214) 665-2282
VII	(913) 551-7154
VIII	(303) 312-6419
IX	(415) 972-3304
X	(206) 553-2859
EPA representative contacted:	
EPA representative phone number:	
Date contacted:	
Comment:	
The above EPA representative was contacted on _____. As of that date the above sites were considered acceptable in accordance with the Off-Site	
Date:	Signature:
Phone number:	

-- End of Section --

SECTION 02 82 14.00 10

ASBESTOS HAZARD CONTROL ACTIVITIES
02/10

PART 1 GENERAL

1.1 DESCRIPTION OF WORK AND PAYMENT

Work at the site will include site preparation activities, excavation, and consolidation of historic fill materials including Asbestos Containing Materials (ACM), as well as placement, grading, capping, and compaction of site soils, and establishment of vegetative cover in areas of disturbance associated with the work.

The Connecticut Department of Public Health (DPH) determines work practice requirements for ACM fill materials on a case by case basis through the development and review of Alternative Work Practices under 19a-332a-11 (AWP) of the Standards for Asbestos Abatement. The Contractor shall retain the services of an independent Connecticut Licensed Asbestos Firm to:

a. Develop an AWP for the site.

b. Obtain AWP approval from the DPH.

c. Provide continuous daily monitoring and on-site asbestos analysis during all ACM fill disturbance.

d. Perform soil sampling to document the effectiveness of the remediation.

All work shall be performed in accordance with the approved AWP.

The following specification provides detailed reqirements for ACM work practices. In instances where the specification varies from the approved AWP, the DPH approved AWP shall govern the work practices as determined by the Contracting Officer Representative.

Employees involved in these material handling activities will be required to meet the training and health monitoring requirements of OSHA 29 CFR 1910 and 29 CFR 1926, as well as CT DPH and DEP regulations. In addition, safety procedures and measures will be required for protection of the public. Contractor employees shall, in addition to the requirements of its HASP, comply with the Owner's hazardous waste protection reuqirements at all times when conducting work in posted hazardous areas.

In the event of a safety concern or concerns are identified during the performance of the Work, the Owner and Owner's Representative have the absolut authority to halt the Contractor's work, at no additional cost to the Owner, until the identified safety concern(s) are addressed by the Contractor.

Submit copies of weight bills and delivery tickets for payment to the Contracting Officer Representative during the progress of the work. Furnish scale tickets for each load of ACM weighed and certified. These tickets shall include tare weight; identification mark for each vehicle weighed; and date, time and location of loading and unloading. Tickets

shall be furnished at the point and time individual trucks arrive at the worksite. A master log of all vehicle loading shall be furnished for each day of loading operations. Before the final statement is allowed, file with the Contracting Officer Representative certified weigh bills and/or certified tickets and manifests of all ACM actually disposed by the Contractor for this contract.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D4397	(2010) Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications

COMPRESSED GAS ASSOCIATION (CGA)

CGA G-7	(2008) Compressed Air for Human Respiration; 6th Edition

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)

ANSI/ISEA Z87.1	(2010) Occupational and Educational Personal Eye and Face Protection Devices

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 701	(2010) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

NIOSH 2003-154	(2003; 4th Ed; Supple 3) NIOSH Manual of Analytical Methods

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2008; Errata 1-2010; Changes 1-3 2010; Changes 4-6 2011) Safety and Health Requirements Manual

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 340/1-90/018	(1990) Asbestos/NESHAP Regulated Asbestos Containing Materials Guidance

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1910.134	Respiratory Protection
29 CFR 1926	Safety and Health Regulations for Construction

29 CFR 1926.1101	Asbestos
29 CFR 1926.32	Safety and Health Regulations for Construction - Definition
40 CFR 61	National Emission Standards for Hazardous Air Pollutants
40 CFR 763	Asbestos
42 CFR 84	Approval of Respiratory Protective Devices
49 CFR 107	Hazardous Materials Program Procedures
49 CFR 171	General Information, Regulations, and Definitions
49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements
49 CFR 173	Shippers - General Requirements for Shipments and Packagings

STATE OF CONNECTICUT

19a-14	CT General Statutes Related to Asbestos
19a-17	CT General Statutes Related to Asbestos
19a-332 to 19a-333	CT General Statutes Related to Asbestos
20-435 to 20-442	CT General Statutes Related to Asbestos
19a-332a-1 to 19a-332a-16	DPH Standards for Asbestos Abatement
20-440-1 to 20-440-9	DPH Licensing and Training Requirements
20-441	DPH Licensing and Training Requirements
22a-208a-1	DEP Disposal Requirements
22a-209-1	DEP Disposal Requirements
22a-209-8	DEP Disposal Requirements

1.3 DEFINITIONS

1.3.1 Alternative Work Practice (AWP)

The Connecticut Department of Public Health (DPH) determines work practice requirements for ACM fill materials on a case by case basis in accordance with Section 19a-332a-11 of the Standards for Asbestos Abatement.

1.3.2 Asbestos-Containing Material (ACM)

Any materials containing more than one percent asbestos.

1.3.3 Authorized Person

Any person authorized by the Contractor and required by work duties to be present in the regulated areas.

1.3.4 Building Inspector

Individual who inspects buildings for asbestos and has EPA Model Accreditation Plan (MAP) "Building Inspector" training; accreditation required by 40 CFR 763, Subpart E, Appendix C, has EPA/State certification/license as a "Building Inspector".

1.3.5 Class I Asbestos Work

Activities defined by OSHA involving the removal of thermal system insulation (TSI) and surfacing ACM.

1.3.6 Class II Asbestos Work

Activities defined by OSHA involving the removal of ACM which is not thermal system insulation or surfacing material. This includes, but is not limited to, the removal of asbestos - containing wallboard, floor tile and sheeting, roofing and siding shingles, and construction mastic. Certain "incidental" roofing materials such as mastic, flashing and cements when they are still intact are excluded from Class II asbestos work. Removal of small amounts of these materials which would fit into a glovebag may be classified as a Class III job.

1.3.7 Class III Asbestos Work

Activities defined by OSHA that involve repair and maintenance operations, where ACM, including TSI and surfacing ACM, is likely to be disturbed. Operations may include drilling, abrading, cutting a hole, cable pulling, crawling through tunnels or attics and spaces above the ceiling, where asbestos is actively disturbed or asbestos-containing debris is actively disturbed.

1.3.8 Class IV Asbestos Work

Maintenance and custodial construction activities during which employees contact but do not disturb ACM and activities to clean-up dust, waste and debris resulting from Class I, II, and III activities. This may include dusting surfaces where ACM waste and debris and accompanying dust exists and cleaning up loose ACM debris from TSI or surfacing ACM following construction

1.3.9 Clean Room

An uncontaminated room having facilities for the storage of employees' street clothing and uncontaminated materials and equipment.

1.3.10 Competent Person

In addition to the definition in 29 CFR 1926.32(f), a person who is capable of identifying existing asbestos hazards as defined in 29 CFR 1926.1101, selecting the appropriate control strategy, has the authority to take prompt corrective measures to eliminate them and has EPA Model Accreditation Plan (MAP) "Contractor/Supervisor" training; has EPA/State certification/license as a "Contractor/Supervisor".

1.3.11 Contractor/Supervisor

Individual who supervises asbestos abatement work and has EPA Model Accreditation Plan "Contractor/Supervisor" training; has EPA/State certification as a "Contractor/Supervisor".

1.3.12 Critical Barrier

One or more layers of plastic sealed over all openings into a regulated area or any other similarly placed physical barrier sufficient to prevent airborne asbestos in a regulated area from migrating to an adjacent area.

1.3.13 Decontamination Area

An enclosed area adjacent and connected to the regulated area and consisting of an equipment room, shower area, and clean room, which is used for the decontamination of workers, materials, and equipment that are contaminated with asbestos.

1.3.14 Demolition

The wrecking or taking out of any load-supporting structural member and any related razing, removing, or stripping of asbestos products.

1.3.15 Disposal Bag

A 6 mil thick, leak-tight plastic bag, pre-labeled in accordance with 29 CFR 1926.1101, used for transporting asbestos waste from containment to disposal site.

1.3.16 Disturbance

Activities that disrupt the matrix of ACM, crumble or pulverize ACM, or generate visible debris from ACM. Disturbance includes cutting away small amounts of ACM, no greater than the amount which can be contained in 1 standard sized glovebag or waste bag, not larger than 60 inches in length and width in order to access a building component.

1.3.17 Equipment Room or Area

An area adjacent to the regulated area used for the decontamination of employees and their equipment.

1.3.18 Fiber

A fibrous particulate, 5 micrometers or longer, with a length to width ratio of at least 3 to 1.

1.3.19 Friable ACM

A term defined in 40 CFR 61, Subpart M and EPA 340/1-90/018 meaning any material which contains more than 1 percent asbestos, as determined using the method specified in 40 CFR 763, Polarized Light Microscopy (PLM), that when dry, can be crumbled, pulverized, or reduced to powder by hand pressure.

1.3.20 Glovebag

Not more than a 60 by 60 inch impervious plastic bag-like enclosure affixed around an asbestos-containing material, with glove-like appendages through which material and tools may be handled.

1.3.21 High-Efficiency Particulate Air (HEPA) Filter

A filter capable of trapping and retaining at least 99.97 percent of all mono-dispersed particles of 0.3 micrometers in diameter.

1.3.22 Intact

ACM which has not crumbled, been pulverized, or otherwise deteriorated so that the asbestos is no longer likely to be bound with its matrix. Removal of "intact" asphaltic, resinous, cementitious products does not render the ACM non-intact simply by being separated into smaller pieces.

1.3.23 Model Accreditation Plan (MAP)

USEPA training accreditation requirements for persons who work with asbestos as specified in 40 CFR 763.

1.3.24 Negative Initial Exposure Assessment

A demonstration by the Contractor to show that employee exposure during an operation is expected to be consistently below the OSHA Permissible Exposure Limits (PELs).

1.3.25 NESHAP

National Emission Standards for Hazardous Air Pollutants. The USEPA NESHAP regulation for asbestos is at 40 CFR 61, Subpart M.

1.3.26 Nonfriable ACM

A NESHAP term defined in 40 CFR 61, Subpart M and EPA 340/1-90/018 meaning any material containing more than 1 percent asbestos that, when dry, cannot be crumbled, pulverized or reduced to powder by hand pressure.

1.3.27 Nonfriable ACM (Category I)

A NESHAP term defined in 40 CFR 61, Subpart E and EPA 340/1-90/018 meaning asbestos-containing packings, gaskets, resilient floor covering, and asphalt roofing products containing more than 1 percent asbestos.

1.3.28 Nonfriable ACM (Category II)

A NESHAP term defined in 40 CFR 61, Subpart E and EPA 340/1-90/018 meaning any material, excluding Category I nonfriable ACM, containing more than 1 percent asbestos.

1.3.29 Permissible Exposure Limits (PELs)

1.3.29.1 Worker PEL-Time Weighted Average (TWA)

Concentration of asbestos not in excess of 0.1 fibers per cubic centimeter of air (f/cc) as an 8 hour time weighted average (TWA).

1.3.29.2 Worker PEL-Excursion Limit

An airborne concentration of asbestos not in excess of 1.0 f/cc of air as averaged over a sampling period of 30 minutes.

1.3.29.3 Ambient PEL - Clearance Criteria

An airborne concentration of asbestos not in excess of 0.01 f/cc of air at the controlled perimeter of the work area.

1.3.30 Regulated Area

An OSHA term defined in 29 CFR 1926.1101 meaning an area established by the Contractor to demarcate areas where Class I, II, and III asbestos work is conducted; also any adjoining area where debris and waste from such asbestos work accumulate; and an area within which airborne concentrations of asbestos exceed, or there is a reasonable possibility they may exceed, the permissible exposure limit.

1.3.31 Removal

All operations where ACM is taken out or stripped from structures or substrates, and includes demolition operations.

1.3.32 Repair

Overhauling, rebuilding, reconstructing, or reconditioning of structures or substrates, including encapsulation or other repair of ACM attached to structures or substrates.

1.3.33 Surfacing ACM

Asbestos-containing material which contains more than 1% asbestos and is sprayed-on, troweled-on, or otherwise applied to surfaces, such as acoustical plaster on ceilings and fireproofing materials on structural members, or other materials on surfaces for acoustical, fireproofing, or other purposes.

1.3.34 Thermal System Insulation (TSI) ACM

ACM which contains more than 1% asbestos and is applied to pipes, fittings, boilers, breeching, tanks, ducts, or other interior structural components to prevent heat loss or gain or water condensation.

1.3.35 Transite

A generic name for asbestos cement wallboard and pipe.

1.3.36 Worker

Individual (not designated as the Competent Person or a supervisor) who performs asbestos work and has completed asbestos worker training required by 29 CFR 1926.1101, to include EPA Model Accreditation Plan (MAP) "Worker" training; accreditation if required by the OSHA Class of work to be performed or by the state where the work is to be performed.

1.4 SYSTEM DESCRIPTION

This section covers all operations in which ACM are encountered. These

procedures and equipment are required to protect workers and building occupants from airborne asbestos fibers and ACM dust and debris. Activities include OSHA Class IV work operations. This section also includes containment, storage, transportation and disposal of the generated ACM wastes.

1.4.1 Abatement Work Tasks

The specific ACM to be abated is identified on the detailed plans and project drawings. A summary for each work task including the appropriate RESPONSE ACTION DETAIL SHEET (item to be abated and methods to be used) and SET-UP DETAIL SHEETS (containment techniques to include safety precautions and methods) is included in Table 1, "Individual Work Task Data Elements" at the end of this section.

1.5 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Asbestos Waste Shipment Records; G
Weight Bills and Delivery Tickets; G
Encapsulants; G
Respiratory Protection Program; G
Cleanup and Disposal; G
Qualifications; G
Training Program; G
Licenses, Permits and Notifications; G
Asbestos Management Plan; G
DPH Approved Alternative Work Practice; G
Asbestos Hazard Abatement Plan and EM 385-1-1 Activity Hazard Analysis Plans; G
Qualifications and Organization Report; G
Specific Requirements in Section 1.6; G

SD-06 Test Reports

Exposure Assessment and Air Monitoring; G
Documentation of AWP Compliance; G
Copies of Daily Logs and ACM Activities; G

SD-07 Certificates

Encapsulants; G
Medical Surveillance Requirements

1.6 QUALITY ASSURANCE

In addition to detailed requirements of this specification, work performed under this contract shall comply with EM 385-1-1, applicable federal, state, and local laws, ordinances, criteria, rules and regulations regarding handling, storing, transporting, and disposing of asbestos waste materials. Matters of interpretation of standards shall be submitted to the appropriate administrative agency for resolution before starting work.

Where the requirements of this specification, applicable laws, criteria, ordinances, regulations, and referenced documents vary, the most stringent requirements or the DPH approved AWP shall apply as determined by the Engineer. The state and local rules and regulations, govern the demolition, removal, encapsulation, construction alteration, repair, maintenance, renovation, spill/emergency cleanup, housekeeping, handling, storing, transporting and disposing of asbestos material. State rules and regulations that apply include, at a minimum, State of Connecticut General Statutes Related to Asbestos 19a-14, 19a-17, 19a-332 to 19a-333, and 20-435 to 20-442; DPH Standards for Asbestos Abatement 19a-332a-1 to 19a-332a-16; DPH Licensing and Training Requirements 20-440-1 to 20-440-9 and 20-441; and DEP Disposal Requirements 22a-208a-1, 22a-209-1, and 22a-209-8.

1.6.1 Written Qualifications and Organization Report

Submit a written qualifications and organization report providing evidence of qualifications of the Contractor, Contractor's Project Supervisor, Designated Competent Person, supervisors and workers; Designated IH; independent testing laboratory; all subcontractors to be used including disposal transportation and disposal facility firms, subcontractor supervisors, subcontractor workers; and any others assigned to perform asbestos abatement and support activities. Include in the report an organization chart showing the Contractor's staff organization chain of command and reporting relationship with all subcontractors. The report shall be signed by the Contractor, the Contractor's onsite project manager, Designated Competent Person, Designated IH, designated testing laboratory and the principals of all subcontractors to be used. Include the following statement in the report: "By signing this report I certify that the personnel I am responsible for during the course of this project fully understand the contents of 29 CFR 1926.1101, 40 CFR 61, Subpart M, and the federal, state and local requirements for those asbestos abatement activities that they will be involved in."

1.6.2 Specific Requirements

Designate in writing, personnel meeting the following qualifications:

a. Asbestos Abatement Contractor: Certified/licensed by applicable state agencies to perform asbestos-related activities.

b. Designated Competent Person: Qualified in accordance with 29 CFR 1926.32 and 29 CFR 1926.1101, has EPA MAP "Contractor/Supervisor" training accreditation, has EPA/State certification/license as a "Contractor/Supervisor" and is experienced in the administration and supervision of asbestos abatement projects, including exposure assessment and monitoring, work practices, abatement methods, protective measures for personnel, setting up and inspecting asbestos abatement work areas, evaluating the integrity of containment barriers, placement and operation of local exhaust systems, ACM generated waste containment and disposal procedures, decontamination units installation and maintenance requirements, site safety and health requirements, notification of other employees onsite, etc. The Designated Competent Person shall be responsible for compliance with applicable federal, state and local requirements, the Contractor's Accident Prevention Plan (APP) and Asbestos Hazard Abatement Plan (AHAP). Submit the "Contractor/Supervisor" course completion certificate and the most recent certificate for required refresher training, State license with the employee "Certificate of Worker Acknowledgment". Submit evidence

that this person has a minimum of 2 years of on-the-job asbestos abatement experience relevant to OSHA competent person requirements. The Designated Competent Person shall be onsite at all times during the conduct of this project.

c. Project and Other Supervisors: Have EPA MAP "Contractor/Supervisor" training accreditation. Submit the "Contractor/Supervisor" course completion certificate and the most recent certificate for required refresher training, EPA/State certification/license with the employee "Certificate of Worker Acknowledgment". Also submit evidence that the Project Supervisor has a minimum of 2 years of on-the-job asbestos abatement experience relevant to project supervisor responsibilities and the other supervisors have a minimum of 1 year on-the-job asbestos abatement experience commensurate with the responsibilities they will have on this project.

d. Designated Industrial Hygienist: Resume for the Industrial Hygienist (IH) selected to prepare the Contractor's AHAP, prepare and perform training, direct air monitoring and assist the Contractor's Competent Person in implementing and ensuring that safety and health requirements are complied with during the performance of all required work. The Designated IH shall be a person who is board certified in the practice of industrial hygiene as determined and documented by the American Board of Industrial Hygiene (ABIH), has EPA MAP "Contractor/Supervisor" training accreditation, State license, and has a minimum of 2 years of comprehensive experience in planning and overseeing asbestos abatement activities. Submit the "Contractor/Supervisor" course completion certificate and the most recent certificate for required refresher training and EPA/State certification/license with the employee "Certificate of Worker Acknowledgment". The Designated IH shall be completely independent from the Contractor according to federal, state, or local regulations; that is, shall not be a Contractor's employee or be an employee or principal of a firm in a business relationship with the Contractor negating such independent status. The Contractor is required to retain the services of an independent CT licensed asbestos designer to develop and obtain approved of the AWP. A copy of the Designated IH's current valid ABIH certification shall be included. The Designated IH shall visit the site at least once per week or as required in the AWP for the duration of asbestos activities and shall be available for emergencies. In addition, submit resumes of additional IH's and industrial hygiene technicians (IHT) who will be assisting the Designated IH in performing onsite tasks. IHs and IHTs supporting the Designated IH shall have a minimum of 2 years of practical onsite asbestos abatement experience. Indicate the formal reporting relationship between the Designated IH and the support IHs and IHTs, the Designated Competent Person, and the Contractor.

e. Asbestos Abatement Workers: Meet the requirements contained in 29 CFR 1926.1101, 40 CFR 61, Subpart M, and other applicable federal, state and local requirements. Worker training documentation shall be provided as required on the "Certificate of Workers Acknowledgment". Training documentation is required for each employee who will perform OSHA Class I, Class II, Class III, or Class IV asbestos abatement operations. Such documentation shall be submitted on a Contractor generated form titled "Certificate of Workers Acknowledgment", to be completed for each employee in the same format and containing the same information as the example certificate at the end of this section. Training course completion certificates (initial and most recent update refresher) required by the information checked on the form shall be

attached.

f. Physician: Resume of the physician who will or has performed the medical examinations and evaluations of the persons who will conduct the asbestos abatement work tasks. The physician shall be currently licensed by the state where the workers will be or have been examined, have expertise in pneumoconiosis and shall be responsible for the determination of medical surveillance protocols and for review of examination/test results performed in compliance with 29 CFR 1926.1101. The physician shall be familiar with the site's hazards and the scope of this project.

g. Independent Testing Laboratory: identify the independent CT licensed testing laboratory selected to perform the sample analyses and report the results. The testing laboratory shall be completely independent from the Contractor as recognized by federal, state or local regulations. Written verification of the following criteria, signed by the testing laboratory principal and the Contractor, shall be submitted:

(1) Phase contrast microscopy (PCM): The laboratory is fully equipped and proficient in conducting PCM of airborne samples using the methods specified by 29 CFR 1926.1101, OSHA method ID-160, the most current version of NIOSH 2003-154 Method 7400 as shown in Table 3 at the end of this Section. The laboratory and on-site analyst shall be currently judged proficient (classified as acceptable) in the American Industrial Hygiene Association (AHIA) Asbestos Analytical Registry (AAR) Program.

(2) Polarized light microscopy (PLM): The laboratory is fully equipped and proficient in conducting PLM analyses of suspect ACM bulk samples in accordance with 40 CFR 763, Subpart E, Appendix E; the laboratory is currently accredited by NIST under the NVLAP for bulk asbestos analysis and will use analysts with demonstrated proficiency to conduct PLM analyses.

(3) Transmission electron microscopy (TEM): The laboratory is fully equipped and proficient in conducting TEM analysis of airborne samples using the mandatory method specified by 40 CFR 763, Subpart E, Appendix E; the laboratory is currently accredited by NIST under the NVLAP for airborne sample analysis of asbestos by TEM; the laboratory will use analysts with demonstrated proficiency under NVLAP.

(4) PCM/TEM: The laboratory is fully equipped and each analyst is proficient in conducting PCM and TEM analysis of airborne samples using NIOSH 2003-154 Method 7400 PCM and NIOSH 2003-154 Method 7402 (TEM confirmation of asbestos content of PCM results) from the same filter.

h. Disposal Facility, Transporter: Written evidence that the landfill to be used is approved for asbestos disposal by the USEPA and state and local regulatory agencies. Copies of signed agreements between the Contractor (including subcontractors and transporters) and the asbestos waste disposal facility to accept and dispose of all asbestos containing waste shall be provided. The Contractor and transporters shall meet the DOT requirements of 49 CFR 171, 49 CFR 172, and 49 CFR 173 as well as registration requirements of 49 CFR 107 and other applicable state or local requirements. The disposal facility shall meet the requirements of 40 CFR 61, Sections .154 or .155, as required

in 40 CFR 61 150(b), and other applicable state or local requirements.

1.6.3 Federal, State or Local Citations on Previous Projects

The Contractor and all subcontractors shall submit a statement, signed by an officer of the company, containing a record of any citations issued by Federal, State or local regulatory agencies relating to asbestos activities (including projects, dates, and resolutions); a list of penalties incurred through non-compliance with asbestos project specifications, including liquidated damages, overruns in scheduled time limitations and resolutions; and situations in which an asbestos-related contract has been terminated (including projects, dates, and reasons for terminations). If there are none, a negative declaration signed by an officer of the company shall be provided.

1.6.4 Preconstruction Conference

The Contractor and the Contractor's Designated Competent Person, Project Supervisor, and Designated IH shall meet with the Contracting Officer Representative (CO) prior to beginning work at a safety preconstruction conference to discuss the details of the Contractor's submitted APP to include the AHAP and AHAs appendices. Deficiencies in the APP will be discussed. Onsite work shall not begin until the APP has been accepted.

1.7 SAFETY

Prepare a written comprehensive site-specific Accident Prevention Plan (APP) at least 30 days prior to the preconstruction conference. The APP shall be in accordance with the format and requirements in Appendix A of EM 385-1-1. The APP shall incorporate an Asbestos Hazard Abatement Plan (AHAP), and Activity Hazard Analyses (AHAs) as separate appendices into one site-specific document. The APP shall take into consideration all the individual asbestos abatement work tasks identified in Table 1.

1.7.1 Asbestos Hazard Abatement Plan Appendix

The AHAP shall include, but not be limited to, the following:

a. The personal protective equipment to be used;

b. The location and description of regulated areas including clean and dirty areas,access tunnels, and decontamination unit (clean room, shower room, equipment room, storage areas such as load-out unit);

c. Initial exposure assessment in accordance with 29 CFR 1926.1101;

d. Level of supervision;

e. Method of notification of other employers at the worksite;

f. Abatement method to include containment and control procedures;

g. Interface of trades;

h. Sequencing of asbestos related work;

i. Storage and disposal procedures and plan;

j. Type of wetting agent and asbestos encapsulant;

k. Location of local exhaust equipment;

l. Air monitoring methods (personal, environmental and clearance);

m. Bulk sampling and analytical methods (if required);

n. A detailed description of the method to be employed in order to control the spread of ACM wastes and airborne fiber;

o. Fire and medical emergency response procedures;

p. The security procedures to be used for all regulated areas.

1.7.2 Activity Hazard Analyses Appendix

AHAs for each major phase of work, shall be submitted and updated during the project. The AHAs format shall be in accordance with Figure 1-1 of EM 385-1-1. The analysis shall define the activities to be performed for a major phase of work, identify the sequence of work, the specific hazards anticipated, and the control measures to be implemented to eliminate or reduce each hazard to an acceptable level. Work shall not proceed on that phase until the AHA has been accepted and a preparatory meeting has been conducted by the Contractor to discuss its contents with everyone engaged in the activities, including the onsite Government representatives. The AHAs shall be continuously reviewed and, when appropriate, modified to address changing site conditions or operations.

1.8 SECURITY

Fenced and locked security area shall be provided for each regulated area. A log book shall be kept documenting entry into and out of the regulated area. Entry into regulated areas shall only be by personnel authorized by the Contractor and the CO. Personnel authorized to enter regulated areas shall be trained, medically evaluated, and wear the required personal protective equipment.

1.8.1 Licenses, Permits and Notifications

Under CERCLA, permits are not required for work performed on the site, however, the substantive elements that would be required by the permit must be attained.

The Contractor shall meet the substantive elements of necessary licenses, permits and notifications in conjunction with the project's asbestos abatement, transportation and disposal actions and timely notification furnished of such actions as required by federal, state, regional, and local authorities. The Government will notify the Regional Office of the USEPA and the state's environmental protection agency responsible for asbestos air emissions in writing, at least 10 days prior to the commencement of work, in accordance with 40 CFR 61, Subpart M, and state and local requirements to include the mandatory "Notification of Demolition and Renovation Record" form and other required notification documents. Notification shall be by Certified Mail, Return Receipt Requested. Furnish copies of the receipts to the CO, in writing, prior to the commencement of work.

1.8.2 Warning Signs and Tape

Warning signs and tape printed in English shall be provided at the regulated boundaries and entrances to regulated areas. Signs shall be located to allow personnel to read the signs and take the necessary protective steps required before entering the area, and displaying the following legend in the lower panel:

DANGER
ASBESTOS
CANCER AND LUNG DISEASE HAZARD
AUTHORIZED PERSONNEL ONLY
RESPIRATORS AND PROTECTIVE CLOTHING ARE REQUIRED IN THIS AREA

1.8.3 Warning Labels

Warning labels shall be affixed to all asbestos disposal containers, asbestos materials, scrap, waste debris, and other products contaminated with asbestos. Containers with preprinted warning labels conforming to requirements are acceptable.

1.9 MEDICAL SURVEILLANCE REQUIREMENTS

Medical surveillance requirements shall conform to 29 CFR 1926.1101. Asbestos workers shall be enrolled in a medical surveillance program that meets 29 CFR 1926.1101 (m) requirements and other pertinent state or local requirements. This requirement shall have been satisfied within the last 12 months. Submit required medical certification and the Physician's written opinion.

1.9.1 Respiratory Protection Program

The Contractor's Designated IH shall establish in writing, and implement a respiratory protection program in accordance with 29 CFR 1926.1101 and 29 CFR 1910.134. The Contractor's Designated IH shall establish minimum respiratory protection requirements based on measured or anticipated levels of airborne asbestos fiber concentrations.

1.9.2 Respiratory Fit Testing

The Contractor's Designated IH shall conduct a qualitative or quantitative fit test conforming to Appendix A of 29 CFR 1910.134 for each worker required to wear a respirator, and any authorized visitors who enter a regulated area where respirators are required to be worn. A respirator fit test shall be performed prior to initially wearing a respirator and every 12 months thereafter. If physical changes develop that will affect the fit, a new fit test shall be performed. Functional fit checks shall be performed each time a respirator is put on and in accordance with the manufacturer's recommendation.

1.9.3 Respirator Selection and Use Requirements

Provide respirators, and ensure that they are used as required by 29 CFR 1926.1101 and in accordance with CGA G-7 and the manufacturer's recommendations. Respirators shall be approved by the National Institute for Occupational Safety and Health NIOSH, under the provisions of 42 CFR 84, for use in environments containing airborne asbestos fibers. For air-purifying respirators, the particulate filter shall be high-efficiency particulate air (HEPA)/(N-,R-,P-100). The initial respirator selection and

the decisions regarding the upgrading or downgrading of respirator type shall be made by the Contractor's Designated IH based on the measured or anticipated airborne asbestos fiber concentrations to be encountered.

1.9.4 Personal Protective Equipment

Three complete sets of personal protective equipment shall be made available to the CO and authorized visitors for entry to the regulated area. The CO and authorized visitors shall be provided with training equivalent to that provided to Contractor employees in the selection, fitting, and use of personal protective equipment and the site safety and health requirements. Provide workers with personal protective clothing and equipment and ensure that it is worn properly. The Designated IH and Designated Competent Person shall select and approve all the required personal protective clothing and equipment.

1.9.5 Whole Body Protection

Personnel exposed to or having the potential to be exposed to airborne concentrations of asbestos that exceed the PELs, or for all OSHA Classes of work for which a required negative exposure assessment is not produced, shall be provided with whole body protection and such protection shall be worn properly. Disposable whole body protection shall be disposed of as asbestos contaminated waste upon exiting from the regulated area. Reusable whole body protection worn shall be either disposed of as asbestos contaminated waste upon exiting from the regulated area or be properly laundered in accordance with 29 CFR 1926.1101. The Contractor's Designated Competent Person, in consultation with the Designated IH, has the authority to take immediate action to upgrade or downgrade whole body protection when there is an immediate danger to the health and safety of the wearer.

1.9.5.1 Coveralls

Disposable-breathable coveralls with a zipper front shall be provided. Sleeves shall be secured at the wrists, and foot coverings secured at the ankles.

1.9.5.2 Gloves

Gloves shall be provided to protect the hands where there is the potential for hand injuries (i.e., scrapes, punctures, cuts, etc.).

1.9.5.3 Foot Coverings

Cloth socks shall be provided and worn next to the skin. Footwear, as required by OSHA and EM 385-1-1, that is appropriate for safety and health hazards in the area shall be worn. Reusable footwear removed from the regulated area shall be thoroughly decontaminated or disposed of as ACM waste.

1.9.5.4 Head Covering

Hood type disposable head covering shall be provided. In addition, protective head gear (hard hats) shall be provided as required. Hard hats shall only be removed from the regulated area after being thoroughly decontaminated.

1.9.5.5 Protective Eye Wear

Eye protection shall be provided, when operations present a potential eye injury hazard, and shall meet the requirements of ANSI/ISEA Z87.1.

1.10 TRAINING PROGRAM

Establish and submit a training program as specified by EPA MAP, training requirements at 40 CFR 763, the State of Connecticut, OSHA requirements at 29 CFR 1926.1101 (k)(9). Contractor employees shall complete the required training for the type of work they are to perform and such training shall be documented and provided to the CO.

a. Class IV operations 2 hour Awareness Training

Prior to commencement of work the Contractor's Designated IH and Competent Person shall instruct each worker about:

a. The hazards and health effects of the specific types of ACM to be abated; and

b. The content and requirements of the Contractor's APP to include the AHAP and AHAs and site-specific safety and health precautions.

PART 2 PRODUCTS

2.1 ENCAPSULANTS

Encapsulants shall conform to USEPA requirements, shall contain no toxic or hazardous substances and no solvent. Submit certificates stating that encapsulants meet the applicable specified performance requirements.

2.2 RECYCLABLE MATERIALS

Not applicable.

2.3 EXPENDABLE SUPPLIES

2.3.1 Glovebag

Glovebags shall be provided as described in 29 CFR 1926.1101. The glovebag assembly shall be 6 mil thick plastic, prefabricated and seamless at the bottom with preprinted OSHA warning label.

2.3.2 Duct Tape

Industrial grade duct tape of appropriate widths suitable for bonding sheet plastic and disposal container.

2.3.3 Disposal Containers

Leak-tight (defined as solids, liquids, or dust that cannot escape or spill out) disposal containers shall be provided for ACM wastes as required by 29 CFR 1926.1101. Disposal containers can be in the form of:

a. Disposal Bags

b. Fiberboard Drums

c. Cardboard Boxes

2.3.4 Sheet Plastic

Sheet plastic shall be polyethylene of 6 mil minimum thickness and shall be provided in the largest sheet size necessary to minimize seams. Film shall be clear, frosted or black and conform to ASTM D4397, except as specified below:

2.3.4.1 Reinforced

Reinforced sheets shall be provided where high skin strength is required, such as where it constitutes the only barrier between the regulated area and the outdoor environment. The sheet stock shall consist of translucent, nylon-reinforced or woven-polyethylene thread laminated between 2 layers of polyethylene film. Film shall meet flame resistant standards of NFPA 701.

2.3.5 Leak-tight Wrapping

Two layers of 6 mil minimum thick polyethylene sheet stock shall be used for the containment of removed asbestos-containing components or materials such as reactor vessels, large tanks, boilers, insulated pipe segments and other materials too large to be placed in disposal bags as described in DETAIL SHEET 9B. Upon placement of the ACM component or material, each layer shall be individually leak-tight sealed with duct tape.

2.3.6 Wetting Agents

Removal encapsulant (a penetrating encapsulant) shall be provided when conducting removal abatement activities that require a longer removal time or are subject to rapid evaporation of amended water. The removal encapsulant shall be capable of wetting the ACM and retarding fiber release during disturbance of the ACM greater than or equal to that provided by amended water. Performance requirements for penetrating encapsulants are specified in paragraph ENCAPSULANTS above.

2.4 EQUIPMENT

2.4.1 Air Monitoring Equipment

The Contractor's Designated IH shall approve air monitoring equipment. The equipment shall include, but shall not be limited to:

a. High-volume sampling pumps that can be calibrated and operated at a constant airflow up to 16 liters per minute.

b. Low-volume, battery powered, body-attachable, portable personal pumps that can be calibrated to a constant airflow up to approximately 3.5 liters per minute, and a self-contained rechargeable power pack capable of sustaining the calibrated flow rate for a minimum of 10 hours. The pumps shall also be equipped with an automatic flow control unit which shall maintain a constant flow, even as filter resistance increases due to accumulation of fiber and debris on the filter surface.

c. Single use standard 25 mm diameter cassette, open face, 0.8 micron pore size, mixed cellulose ester membrane filters and cassettes with 50 mm electrically conductive extension cowl, and shrink bands for personal air sampling.

d. A flow calibrator capable of calibration to within plus or minus 2 percent of reading over a temperature range of minus 4 to plus 140 degrees F and traceable to a NIST primary standard.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

Asbestos abatement work tasks shall be performed as shown in the approved AWP. Use the engineering controls and work practices required in 29 CFR 1926.1101(g) in all operations regardless of the levels of exposure. Personnel shall wear and utilize protective clothing and equipment. Do not permit eating, smoking, drinking, chewing or applying cosmetics in the regulated area. Personnel of other trades, shall not be exposed at any time to airborne concentrations of asbestos unless all the administrative and personal protective provisions of the Contractor's APP are complied with. Stop abatement work in the regulated area immediately when the airborne total fiber concentration: (1) equals or exceeds 0.01 f/cc, or the pre-abatement concentration, whichever is greater, outside the regulated area; or (2) equals or exceeds 1.0 f/cc inside the regulated area. Correct the condition to the satisfaction of the CO, including visual inspection and air sampling. Work shall resume only upon notification by the CO. Corrective actions shall be documented.

3.2 PROTECTION OF ADJACENT WORK OR AREAS TO REMAIN

Perform asbestos abatement without damage to or contamination of adjacent work or area. Where such work or area is damaged or contaminated, it shall be restored to its original condition or decontaminated at no expense to the Government. When spills occur, work shall stop in all effected areas immediately and the spill shall be cleaned. When satisfactory visual inspection and air sampling analysis results are obtained and have been evaluated by the Contractor's Designated IH and the CO, work shall proceed.

3.3 METHODS OF COMPLIANCE

3.3.1 Mandated Practices

The specific abatement techniques and items identified shall be detailed in the Contractor's AHAP and the approved AWP. Use the following engineering controls and work practices in all operations, regardless of the levels of exposure:

a. Wet methods or wetting agents except where it can be demonstrated that the use of wet methods is unfeasible due to the creation of electrical hazards, equipment malfunction, and in roofing.

b. Prompt clean-up and disposal.

c. Cleaning of equipment and surfaces of containers prior to removing them from the contaminated area.

3.3.2 Control Methods

Use the following control methods:

a. Enclosure or isolation of processes producing asbestos dust;

b. Where the feasible engineering and work practice controls are not

sufficient to reduce employee exposure to or below the PELs, use them to reduce employee exposure to the lowest levels attainable and shall supplement them by the use of respiratory protection.

c. Wet methods in accordance with the approved AWP.

3.3.3 Unacceptable Practices

The following work practices shall not be used:

a. High-speed abrasive disc saws that are not equipped with point of cut ventilator or enclosures with HEPA filtered exhaust air.

b. Compressed air used to remove asbestos containing materials, unless the compressed air is used in conjunction with an enclosed ventilation system designed to capture the dust cloud created by the compressed air.

c. Dry sweeping, shoveling, or other dry clean up.

d. Employee rotation as a means of reducing employee exposure to asbestos.

3.3.4 Abatement of Asbestos Contaminated Soil

The asbestos contaminated soil shall be removed from the 100-year floodplain in accordance with the approved AWP, along with the other Raymark waste and placed under the proposed cap on the project site.

3.3.5 Enclosure of ACM

Enclosure of Raymark Waste containing asbestos contaminated soil will be completed using a low-permeable cap.

3.4 EXPOSURE ASSESSMENT AND AIR MONITORING

3.4.1 General Requirements

a. Exposure assessment, air monitoring and analysis of airborne concentration of asbestos fibers shall be performed in accordance with 29 CFR 1926.1101, and the Contractor's air monitoring plan. Results of breathing zone samples shall be posted at the job site and made available to the CO. Submit all documentation regarding initial exposure assessments, negative exposure assessments, and air-monitoring results.

b. Worker Exposure.

(1) The Contractor's Designated IH shall collect samples representative of the exposure of each employee who is assigned to work within a regulated area. Breathing zone samples shall be taken for at least 25 percent of the workers in each shift, or a minimum of 2, whichever is greater. Air monitoring results at the 95 percent confidence level shall be calculated as shown in Table 2 at the end of this section.

(2) Workers shall not be exposed to an airborne fiber concentration in excess of 1.0 f/cc, as averaged over a sampling period of 30 minutes. Should a personal excursion concentration of 1.0 f/cc expressed as a 30-minute sample occur inside a regulated work area, stop work immediately, notify the Contracting Officer

Representative, and implement additional engineering controls and work practice controls to reduce airborne fiber levels below prescribed limits in the work area. Do not restart work until authorized by the CO.

c. Environmental Exposure

(1) All environmental air monitoring shall be performed by the Contractor's Designated IH.

(2) Environmental and final clearance air monitoring shall be performed using NIOSH 2003-154 Method 7400 (PCM) with optional confirmation of results by OSHA or EPA TEM, and as designed in the approved AWP.

(3) For environmental and final clearance, air monitoring shall be conducted at a sufficient velocity and duration to establish the limit of detection of the method used at 0.005 f/cc.

(4) When confirming asbestos fiber concentrations (asbestos f/cc) from environmental and final clearance samples, use TEM in accordance with NIOSH 2003-154 Method 7402. When such confirmation is conducted, it shall be from the same sample filter used for the NIOSH 2003-154 Method 7400 PCM analysis. All confirmation of asbestos fiber concentrations, using NIOSH 2003-154 Method 7402, shall be at the Contractor's expense.

(5) Monitoring may be duplicated by the Government at the discretion of the CO and at the Government's expense.

(6) Maintain a fiber concentration inside a regulated area less than or equal to 0.1 f/cc expressed as an 8 hour, time-weighted average (TWA) during the conduct of the asbestos abatement.

(7) At the discretion of the Contracting Officer Representative, fiber concentration may exceed 0.1 f/cc but shall not exceed 1.0 f/cc expressed as an 8-hour TWA. Should an environmental concentration of 1.0 f/cc expressed as an 8-hour TWA occur inside a regulated work area, stop work immediately, notify the Contracting Officer Representative, and implement additional engineering controls and work practice controls to reduce airborne fiber levels below prescribed limits in the work area. Work shall not restart until authorized by the CO.

3.4.2 Initial Exposure Assessment

The Contractor's Designated IH shall conduct an exposure assessment immediately before or at the initiation of an asbestos abatement operation to ascertain expected exposures during that operation. The assessment shall be completed in time to comply with the requirements, which are triggered by exposure data or the lack of a negative exposure assessment, and to provide information necessary to assure that all control systems planned are appropriate for that operation. The assessment shall take into consideration both the monitoring results and all observations, information or calculations which indicate employee exposure to asbestos, including any previous monitoring conducted in the workplace, or of the operations of the Contractor which indicate the levels of airborne asbestos likely to be encountered on the job.

3.4.3 Negative Exposure Assessment

Provide a negative exposure assessment for the specific asbestos job which will be performed within 7 days of the initiation of the project and conform to the following criteria:

a. Objective Data: Objective data demonstrating that the product or material containing asbestos minerals or the activity involving such product or material cannot release airborne fibers in concentrations exceeding the PEL-TWA and PEL-Excursion Limit under those work conditions having the greatest potential for releasing asbestos.

b. Initial Exposure Monitoring: The results of initial exposure monitoring of the current job, made from breathing zone air samples that are representative of the 8-hour PEL-TWA and 30-minute short-term exposures of each employee. The monitoring covered exposure from operations which are most likely during the performance of the entire asbestos job to result in exposures over the PELs.

3.4.4 Independent Environmental Monitoring

The air monitoring Contractor has been provided a copy of the contract that includes this abatement work. The abatement Contractor will provide the air monitoring Contractor with an up-to-date copy of the accepted AHAP, APP and pertinent detailed drawings. The air monitoring Contractor is required to comply with the abatement Contractor's safety and health requirements. The abatement Contractor will coordinate all onsite activities with the air monitoring Contractor, the COR, and other affected parties as directed by the COR. The abatement Contractor will provide the air monitoring Contractor with an up-to-date schedule of abatement Contractor work activities. The air monitoring Contractor will coordinate with the abatement Contractor and the COR during the performance Government required air monitoring. The abatement Contractor is responsible for performing exposure assessment and personal air monitoring of abatement Contractor's work. The air monitoring Contractor is responsible for performing these tasks for its employee.

3.4.5 Preabatement Environmental Air Monitoring

Preabatement environmental air monitoring shall be established 1 day prior to excavation operations for each regulated area to determine background concentrations before remediation work begins. As a minimum, pre-construction air samples shall be collected using NIOSH 2003-154 Method 7400, PCM at these locations: 2 outside the regulated area and upwind the perimeter; outside the regulated area and downwind from the site. The PCM samples shall be analyzed within 24 hours; and if any result in fiber concentration greater than 0.01 f/cc, asbestos fiber concentration shall be confirmed using NIOSH 2003-154 Method 7402 (TEM).

3.4.6 Environmental Air Monitoring During Remediation

Until an exposure assessment is provided to the CO, environmental air monitoring shall be conducted at locations and frequencies that will accurately characterize any evolving airborne asbestos fiber concentrations as identified in the approved AWP. The assessment shall demonstrate that the product or material containing asbestos minerals, or the abatement involving such product or material, cannot release airborne asbestos fibers in concentrations exceeding 0.01 f/cc as a TWA under those work conditions having the greatest potential for releasing asbestos. The monitoring shall

be at least once per shift at locations including, but not limited to, close to the work inside a regulated area; pre-construction sampling locations including 2 upwind and 2 downwind of the work area. If the sampling outside regulated area shows airborne fiber levels have exceeded background or 0.01 f/cc, whichever is greater, work shall be stopped immediately, and the Contracting Officer Representative notified. The condition causing the increase shall be corrected. Work shall not restart until authorized by the CO.

3.4.7 Final Clearance Air Monitoring

Continuous monitoring shall be performed during soil removal to document compliance with this specification. Clearance air monitoring is not required for outside work or for soil cleanups.

3.4.8 Air-Monitoring Results and Documentation

Air sample shall be read on-site and immediatley reported. A daily summary of results of air sample fiber counting shall be submitted electronically to the CO and results provided within 24 hours (breathing zone samples), and 24 hours (environmental/clearance monitoring) after completion of a sampling period. The CO shall be notified immediately of any airborne levels of asbestos fibers in excess of established requirements. Written sampling results shall be provided within 5 working days of the date of collection. The written results shall be signed by testing laboratory analyst, testing laboratory principal and the Contractor's Designated IH. The air sampling results shall be documented on a Contractor's daily air monitoring log. The daily air monitoring log shall contain the following information for each sample:

a. Sampling and analytical method used;

b. Date sample collected;

c. Sample number;

d. Sample type: BZ = Breathing Zone (Personal), P = Preabatement, E = Environmental, C = Abatement Clearance;

e. Location/activity/name where sample collected;

f. Sampling pump manufacturer, model and serial number, beginning flow rate, end flow rate, average flow rate (L/min);

g. Calibration date, time, method, location, name of calibrator, signature;

h. Sample period (start time, stop time, elapsed time (minutes);

i. Total air volume sampled (liters);

j. Sample results (f/cc and S/mm square) if EPA methods are required for final clearance;

k. Laboratory name, location, analytical method, analyst, confidence level. In addition, the printed name and a signature and date block for the Industrial Hygienist who conducted the sampling and for the Industrial Hygienist who reviewed the daily air monitoring log verifying the accuracy of the information.

3.5 CLEARANCE CERTIFICATION

The clean-up sampling criteria will be identified in the approved AWP, but at a minimum shall include at least 3 PLM soil samples analyses from each discrete excavation guide. When asbestos abatement is complete, ACM waste is removed from the regulated areas, and final clean-up is completed, the CO will allow the warning signs and boundary warning tape to be removed. The Contractor and the CO shall visually inspect all surfaces within the regulated area for residual material or accumulated debris. Reclean all areas showing residual materials. The CO will certify in writing that the area is safe before unrestricted entry is permitted. The Government will have the option to perform additional monitoring to certify the areas are safe before entry is permitted.

3.6 CLEANUP AND DISPOSAL

3.6.1 Title to ACM Materials

Not applicable.

3.6.2 Collection and Disposal of Asbestos

All ACM waste shall be collected including contaminated wastewater filters, scrap, debris, bags, containers, equipment, and asbestos contaminated clothing and placed in leak-tight containers. Waste within the containers shall be wetted in case the container is breeched. Asbestos-containing waste shall be disposed of at an EPA, state and local approved asbestos landfill. For temporary storage, sealed impermeable containers shall be stored in an asbestos waste load-out unit or in a storage/transportation conveyance (i.e., dumpster, roll-off waste boxes, etc.) in a manner acceptable to and in an area assigned by the CO. Procedure for hauling and disposal shall comply with 40 CFR 61, Subpart M, state, regional, and local standards. Submit manufacturer's catalog data for all materials and equipment to be used, including brand name, model, capacity, performance characteristics and any other pertinent information. Test results and certificates from the manufacturer of encapsulants substantiating compliance with performance requirements of this specification. Material Safety Data Sheets for all chemicals to be used onsite in the same format as implemented in the Contractor's HAZARD COMMUNICATION PROGRAM. Data shall include, but shall not be limited to, the following items:

a. High Efficiency Filtered Air (HEPA) local exhaust equipment

b. Vacuum cleaning equipment

c. Pressure differential monitor for HEPA local exhaust equipment

d. Air monitoring equipment

e. Respirators

f. Personal protective clothing and equipment

g. Glovebags. Written manufacturer's proof that glovebags will not break down under expected temperatures and conditions.

h. Duct Tape

i. Disposal Containers

j. Sheet Plastic

k. Wetting Agent

l. Strippable Coating

m. Prefabricated Decontamination Unit

n. Material Safety Data Sheets (for all chemicals proposed)

3.6.3 Records and Management Plan

3.6.3.1 Asbestos Waste Shipment Records

Complete and provide the CO final completed copies of the Waste Shipment Record for all shipments of waste material as specified in 40 CFR 61, Subpart M and other required state waste manifest shipment records, within 3 days of delivery to the landfill. Each Waste Shipment Record shall be signed and dated by the Contractor, the waste transporter and disposal facility operator.

3.6.3.2 Asbestos Management Plan

Provide a summary, in electronic form, of site activities (bulk samples, asbestos removed, repaired, encased, etc.) for updating the installation Asbestos Management Plan if any materials are left in buildings.

TABLE 1

INDIVIDUAL WORK TASK DATA ELEMENTS

Sheet_____ of _____

There is a separate data sheet for each individual work task.

1. WORK TASK DESIGNATION NUMBER _____
2. LOCATION OF WORK TASK_____
_____
3. BRIEF DESCRIPTION OF MATERIAL TO BE ABATED:_____
_____

   a. Type of Asbestos _____
   b. Percent asbestos content _____%

4. ABATEMENT TECHNIQUE TO BE USED_____
5. OSHA ASBESTOS CLASS DESIGNATION FOR WORK TASK_____
6. EPA NESHAP FRIABILITY DESIGNATION FOR WORK TASK
   Friable _____ Non-friable Category I _____
   Non-friable Category II_____
7. FORM _____ and CONDITION OF ACM: GOOD_____ FAIR_____ POOR_____
8. QUANTITY: METERS_____, SQUARE METERS_____
8a. QUANTITY: LINEAR FT._____, SQUARE FT._____
9. RESPONSE ACTION DETAIL SHEET NUMBER FOR WORK TASK_____
10. SET-UP DETAIL SHEET NUMBERS
    FOR WORK TASK _____, _____, _____, _____,
    _____, _____, _____, _____.

NOTES:

(1) Numeric sequence of individual work tasks (1,2,3,4, etc.) for each regulated area. Each category of EPA friability/OSHA class has a separate task.
(2) Specific location of work (building, floor, area, e.g., Building 1421, 2nd Floor, Rm 201)
(3) A description of material to be abated (example: horizontal pipe, cement wall panels, tile, stucco, etc.) type of asbestos (chrysotile, amosite, crocidolite, etc.); and % asbestos content.
(4) Technique to be used: Removal = REM; Encapsulation = ENCAP; Encasement = ENCAS; Enclosure = ENCL; Repair = REP.
(5) Class designation: Class I, II, III, or IV (OSHA designation).
(6) Friability of materials: Check the applicable EPA NESHAP friability designation.
(7) Form: Interior or Exterior Architectural = IA or EA; Mechanical/Electrical = ME.
Condition: Good = G; Fair = F; Poor = P.
(8) Quantity of ACM for each work task in meters or square meters.
(8a) Quantity of ACM for each work task in linear feet or square feet.
(9) Response Action Detail Sheet specifies the material to be abated and the methods to be used. There is only one Response Action Detail Sheet for each abatement task.
(10) Set-up Detail Sheets indicate containment and control methods used in support of the response action (referenced in the selected Response Action Detail Sheet).

TABLE 2

FORMULA FOR CALCULATION OF THE 95 PERCENT CONFIDENCE LEVEL
(Reference: NIOSH 7400)

Fibers/cc(01.95 percent CL) = X + ((X) * (1.645) * (CV))

Where: X = ((E)(AC))/((V)(1000))

E = ((F/Nf) - (B/Nb))/Af

CV = The precision value; 0.45 shall be used unless the analytical laboratory provides the Contracting Officer Representative with documentation (Round Robin Program participation and results) that the laboratory's precision is better.

AC = Effective collection area of the filter in square millimeters

V = Air volume sampled in liters

E = Fiber density on the filter in fibers per square millimeter

F/Nf = Total fiber count per graticule field

B/Nb = Mean field blank count per graticule field

Af = Graticule field area in square millimeters

TWA = C1/T1 + C2/T2 = Cn/Tn

Where: C = Concentration of contaminant

T = Time sampled.

TABLE 3
NIOSH METHOD 7400
PCM ENVIRONMENTAL AIR SAMPLING PROTOCOL (NON-PERSONAL)

Sample Location	Minimum No. of Samples	Filter Pore Size (Note 1)	Min. Vol. (Note 2) (Liters)	Sampling Rate (liters/min)
Inside Abatement Area	0.5/140 Square Meters (Notes 3 & 4)	0.45 microns	3850	2-16
Field Blank	2	0.45 microns	0	0
Laboratory Blank	1	0.45 microns	0	0

Notes:
1. Type of filter is Mixed Cellulose Ester.
2. Ensure detection limit for PCM analysis is established at 0.005 fibers/cc.
3. One sample shall be added for each additional 140 square meters. (The corresponding I-P units are 5/1500 square feet).
4. A minimum of 5 samples are to be taken per abatement area, plus 2 field blanks.

TABLE 4
EPA AHERA METHOD: TEM AIR SAMPLING PROTOCOL

Location Sampled	Minimum No. of Samples	Filter Pore Size	Min. Vol. (Liters)	Sampling Rate (liters/min.)
Inside Abatement Area	5	0.45 microns	1500	2-16
Outside Abatement Area	5	0.45 microns	1500	2-16
Field Blank	2	0.45 microns	0	0
Laboratory Blank	1	0.45 microns	0	0

Notes:
1. Type of filter is Mixed Cellulose Ester.
2. The detection limit for TEM analysis is 70 structures/square mm.

CERTIFICATE OF WORKER'S ACKNOWLEDGMENT

PROJECT NAME _____ CONTRACT NO. _____
PROJECT ADDRESS _____
CONTRACTOR FIRM NAME _____
EMPLOYEE'S NAME _____,_____,_____,
(Print) (Last) (First) (MI)

Social Security Number: _____-_____-_____,__(Optional)

WORKING WITH ASBESTOS CAN BE DANGEROUS. INHALING ASBESTOS FIBERS HAS BEEN LINKED WITH TYPES OF LUNG DISEASE AND CANCER. IF YOU SMOKE AND INHALE ASBESTOS FIBERS, THE CHANCE THAT YOU WILL DEVELOP LUNG CANCER IS GREATER THAN THAT OF THE NONSMOKING PUBLIC.

Your employer's contract for the above project requires that you be provided and you complete formal asbestos training specific to the type of work you will perform and project specific training; that you be supplied with proper personal protective equipment including a respirator, that you be trained in its use; and that you receive a medical examination to evaluate your physical capacity to perform your assigned work tasks, under the environmental conditions expected, while wearing the required personal protective equipment. These things are to be done at no cost to you. By signing this certification, you are acknowledging that your employer has met these obligations to you. The Contractor's Designated Industrial Hygienist will check the block(s) for the type of formal training you have completed. Review the checked blocks prior to signing this certification.

FORMAL TRAINING:
_____ a. For Competent Persons and Supervisors: I have completed EPA's Model Accreditation Program (MAP) training course, "Contractor/Supervisor", that meets this State's requirements.

b. For Workers:
_____ (1) For OSHA Class I work: I have completed EPA's MAP training course, "Worker", that meets this State's requirements.
_____ (2) For OSHA Class II work (where there will be abatement of more than one type of Class II materials, i.e., roofing, siding, floor tile, etc.): I have completed EPA's MAP training course, "Worker", that meets this State's requirements.
(3) For OSHA Class II work (there will only be abatement of one type of Class II material):
_____ (a) I have completed an 8-hour training class on the elements of 29 CFR 1926.1101(k)(9)(viii), in addition to the specific work practices and engineering controls of 29 CFR 1926.1101(g) and hands-on training.
_____ (b) I have completed EPA's MAP training course, "Worker", that meets this State's requirements.
_____ (4) For OSHA Class III work: I have completed at least a 16-hour course consistent with EPA requirements for training of local education agency maintenance and custodial staff at 40 CFR 763, Section .92(a)(2) and the elements of 29 CFR 1926.1101(k)(9)(viii), in addition to the specific work practices and engineering controls at 29 CFR 1926.1101, and hands-on training.

CERTIFICATE OF WORKER'S ACKNOWLEDGMENT

_____ (5) For OSHA Class IV work: I have completed at least a 2-hr course consistent with EPA requirements for training of local education agency maintenance and custodial staff at 40 CFR 763, (a)(1), and the elements of 29 CFR 1926.1101(k)(9)(viii), in addition to the specific work practices and engineering controls at 29 CFR 1926.1101(g) and hands-on training.

_____ c. Workers, Supervisors and the Designated Competent Person: I have completed annual refresher training as required by EPA's MAP that meets this State's requirements.

PROJECT SPECIFIC TRAINING:
_____ I have been provided and have completed the project specific training required by this Contract. My employer's Designated Industrial Hygienist and Designated Competent Person conducted the training.

RESPIRATORY PROTECTION:
_____ I have been trained in accordance with the criteria in the Contractor's Respiratory Protection program. I have been trained in the dangers of handling and breathing asbestos dust and in the proper work procedures and use and limitations of the respirator(s) I will wear. I have been trained in and will abide by the facial hair and contact lens use policy of my employer.

RESPIRATOR FIT-TEST TRAINING:
_____ I have been trained in the proper selection, fit, use, care, cleaning, maintenance, and storage of the respirator(s) that I will wear. I have been fit-tested in accordance with the criteria in the Contractor's Respiratory Program and have received a satisfactory fit. I have been assigned my individual respirator. I have been taught how to properly perform positive and negative pressure fit-check upon donning negative pressure respirators each time.

EPA/STATE CERTIFICATION/LICENSE

I have an EPA/_____ certification/license as:
Building Inspector/Management Planner; Certification #_____
Contractor/Supervisor, Certification # _____
Project Designer, Certification # _____
Worker, Certification # _____

MEDICAL EXAMINATION:
_____ I have had a medical examination within the last twelve months which was paid for by my employer. The examination included: health history, pulmonary function tests, and may have included an evaluation of a chest x-ray. A physician made a determination regarding my physical capacity to perform work tasks on the project while wearing personal protective equipment including a respirator. I was personally provided a copy and informed of the results of that examination. My employer's Industrial Hygienist evaluated the medical certification provided by the physician and checked the appropriate blank below. The physician determined that there:

_____ were no limitations to performing the required work tasks.
_____ were identified physical limitations to performing the required work tasks.

CERTIFICATE OF WORKER'S ACKNOWLEDGMENT

Date of the medical examination _____

Employee Signature _____ date _____

Contractor's Industrial
Hygienist Signature _____ date _____

-- End of Section --

SECTION 31 00 00

EARTHWORK
08/08

PART 1 GENERAL

1.1 MEASUREMENT PROCEDURES

1.1.1 Excavation - Raymark Waste

The unit of measurement for excavation will be the cubic yard, computed by the average end area method from cross sections taken before and after the excavation and borrow operations, including the excavation for ditches, gutters, and channel changes, when the material is acceptably utilized or disposed of as herein specified. The measurements will include authorized excavation of rock, authorized excavation of unsatisfactory subgrade soil, and the volume of loose, scattered rocks and boulders collected within the limits of the work; allowance will be made on the same basis for selected backfill ordered as replacement. The measurement will not include the volume of subgrade material or other material that is scarified or plowed and reused in-place, and will not include the volume excavated without authorization or the volume of any material used for purposes other than directed. The measurement will not include the volume of any excavation performed prior to the taking of elevations and measurements of the undisturbed grade.

1.1.2 Piping Trench Excavation

Not applicable.

1.1.3 Rock Excavation for Trenches

Not applicable.

1.2 PAYMENT PROCEDURES

Payment will constitute full compensation for all labor, equipment, tools, supplies, and incidentals necessary to complete the work.

1.2.1 Raymark Waste Excavation

Raymark Waste excavation will be paid for at the contract unit price per cubic yard for Raymark Waste excavation.

1.3 CRITERIA FOR BIDDING

Base bids on the following criteria:

a. Surface elevations are as indicated.

b. Pipes or other artificial obstructions, except those indicated, will not be encountered.

c. Ground water elevations indicated by the boring log were those existing at the time subsurface investigations were made and do not necessarily represent ground water elevation at the time of

construction. Ground water elevation is +1.0 foot to +3.0 foot (NAVD 88), based on measurements completed in February 2013 in exisitng monitoring wells.

d. Material character is indicated by the boring logs.

e. Hard materials and rock will be encountered in 5 percent of the excavations.

1.4 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D1140	(2000; R 2006) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve
ASTM D1556	(2007) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1557	(2009) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D2167	(2008) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D2487	(2011) Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2937	(2010) Density of Soil in Place by the Drive-Cylinder Method
ASTM D422	(1963; R 2007) Particle-Size Analysis of Soils
ASTM D4318	(2010) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D6938	(2010) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

EPA 600/4-79/020	(1983) Methods for Chemical Analysis of Water and Wastes
EPA SW-846.3-3	(1999, Third Edition, Update III-A) Test Methods for Evaluating Solid Waste:

1.5 DEFINITIONS

1.5.1 Satisfactory Materials

Satisfactory materials comprise any materials classified by ASTM D2487 as GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP. Satisfactory materials for grading comprise stones less than 6 inches in any direction.

1.5.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include highly plastic/fat silt and clay, organic soils, and/or peat (classified as MH, CH, OL, OH, and PT via ASTM D2487, stumps/brush, trash, refuse, debris, frozen soils, soils containing materials greater than the allowable size, saturated soils, fine-grained soils above their liquid limit at the time of compaction, and soils that are either too wet or too dry to compact.

1.5.3 Cohesionless and Cohesive Materials

Cohesionless materials include materials classified in ASTM D2487 as GW, GP, SW, and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic. Perform testing, required for classifying materials, in accordance with ASTM D4318, ASTM C136, ASTM D422, and ASTM D1140.

1.5.4 Topsoil

Refer to Section 02 66 00 PROTECTIVE COVER SOIL, SELECT FILL AND TOPSOIL FOR LANDFILL COVER.

1.5.5 Hard/Unyielding Materials

Hard/Unyielding materials comprise weathered rock, dense consolidated deposits, or conglomerate materials which are not included in the definition of "rock" with stones greater than 36 inch in any dimension or as defined by the pipe manufacturer, whichever is smaller. These materials usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.

1.5.6 Rock

Solid homogeneous interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement exceeding 1/2 cubic yard in volume. Removal of hard material will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.

1.5.7 Unstable Material

Unstable materials are too wet to properly support the utility pipe, conduit, or appurtenant structure.

1.6 SYSTEM DESCRIPTION

Subsurface soil boring logs are appended to the Remedial Design Report, AMEC 2013. This data represents the best subsurface information available; however, variations may exist in the subsurface between boring locations.

1.6.1 Classification of Excavation

No consideration will be given to the nature of the materials, and all excavation will be designated as unclassified excavation.

1.6.2 Blasting

Blasting will not be permitted.

1.6.3 Dewatering Work Plan

Dewatering is not anticipated.

1.7 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Shoring; G

SD-03 Product Data

Utilization of Excavated Materials; G
Opening of any Excavation or Borrow Pit

SD-06 Test Reports

Testing; G
Borrow Site Testing; G

SD-07 Certificates

Testing; G

PART 2 PRODUCTS

2.1 REQUIREMENTS FOR OFFSITE SOILS

Test offsite soils brought in for use as backfill for Total Petroleum Hydrocarbons (TPH), Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and full Toxicity Characteristic Leaching Procedure (TCLP) including ignitability, corrosivity and reactivity. Backfill shall contain a maximum of 100 parts per million (ppm) of total petroleum hydrocarbons (TPH) and a maximum of 10 ppm of the sum of Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and shall pass the TCPL test. Determine TPH concentrations by using EPA 600/4-79/020 Method 418.1. Determine BTEX concentrations by using EPA SW-846.3-3 Method 5030/8020. Perform TCLP in accordance with

EPA SW-846.3-3 Method 1311. Provide Borrow Site Testing for TPH, BTEX and TCLP from a composite sample of material from the borrow site, with at least one test from each borrow site. Within 24 hours of conclusion of physical tests, submit 2 copies of test results, including calibration curves and results of calibration tests. Do not bring material onsite until tests have been approved by the Contracting Officer Representative.

2.2 RIP-RAP

Dense, sound angular rock free from cracks, seams, and other defects conducive to accelerated weathering. Rounded stone or broken/crushed concrete are unacceptable materials. The least dimension of an individual rock shall not be less than one-third the greatest dimension.

Rip-rap shall have a d_{50} of 9 inches where 50 percent of the mixture by weight is larger than the d_{50} stone size and 50 percent by weight is smaller. Intermediate rip-rap as defined in Standard Specifications for Roads, Bridges, and Incidental Construction; Form 815 by the Connecticut Department of Transportation is considered acceptable.

PART 3 EXECUTION

3.1 NOTIFICATION

The Contractor shall notify the Connecticut Before You Dig System a minimum of 72 hours before performing work on the project. The Call Before You Dig System can be reached by calling 1-800-922-4455.

3.2 INSPECTION

Examine the areas and conditions under which excavating, filling, and grading are to be performed and notify the Contracting Officer Representative, in writing, of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.

3.3 STRIPPING OF TOPSOIL

Where indicated or directed, strip topsoil to a depth of 4 inches. Spread topsoil on areas already graded and prepared for topsoil, or transported and deposited in stockpiles convenient to areas that are to receive application of the topsoil later, or at locations indicated or specified. Keep topsoil separate from other excavated materials, brush, litter, objectionable weeds, roots, stones larger than 2 inches in diameter, and other materials that would interfere with planting and maintenance operations. Stockpile in locations indicated any surplus of topsoil from excavations and gradings.

3.4 GENERAL EXCAVATION

Perform excavation of every type of material encountered within the limits of the project to the lines, grades, and elevations indicated and as specified. Perform the grading in accordance with the typical sections shown and the tolerances specified in paragraph FINISHING. Transport satisfactory excavated materials and place in fill or embankment within the limits of the work. Excavate unsatisfactory materials encountered within the limits of the work below grade and replace with satisfactory materials as directed. Include such excavated material and the satisfactory material

ordered as replacement in excavation. Dispose surplus satisfactory excavated material not required for fill or embankment in areas approved for surplus material storage or designated waste areas. Dispose unsatisfactory excavated material in designated waste or spoil areas. During construction, perform excavation and fill in a manner and sequence that will provide proper drainage at all times. Excavate material required for fill or embankment in excess of that produced by excavation within the grading limits from the borrow areas indicated or from other approved areas selected by the Contractor as specified.

3.4.1 Drainage Structures

Not applicable.

3.4.2 Drainage

Provide for the collection and disposal of surface and subsurface water encountered during construction. Completely drain construction site during periods of construction to keep soil materials sufficiently dry. Construct storm drainage features (swales/culverts) at the earliest stages of site development, and throughout construction grade the construction area to provide positive surface water runoff away from the construction activity and or provide temporary ditches, swales, and other drainage features and equipment as required to maintain dry soils. When unsuitable working platforms for equipment operation and unsuitable soil support for subsequent construction features develop, remove unsuitable material and provide new soil material as specified herein. It is the responsibility of the Contractor to assess the soil and ground water conditions presented by the plans and specifications and to employ necessary measures to permit construction to proceed.

3.4.3 Dewatering

Dewatering is not anticipated.

3.5 SELECTION OF BORROW MATERIAL

Select borrow material to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Obtain borrow material from approved private sources. Unless otherwise provided in the contract, the Contractor is responsible for obtaining the right to procure material, pay royalties and other charges involved, and bear the expense of developing the sources, including rights-of-way for hauling from the owners. Borrow material from approved sources on Government-controlled land may be obtained without payment of royalties. Unless specifically provided, do not obtain borrow within the limits of the project site without prior written approval. Consider necessary clearing, grubbing, and satisfactory drainage of borrow pits and the disposal of debris thereon related operations to the borrow excavation.

3.6 OPENING AND DRAINAGE OF EXCAVATION AND BORROW PITS

Notify the Contracting Officer Representative sufficiently in advance of the opening of any excavation or borrow pit or borrow areas to permit elevations and measurements of the undisturbed ground surface to be taken. Except as otherwise permitted, excavate borrow pits and other excavation areas providing adequate drainage. Transport overburden and other spoil material to designated spoil areas or otherwise dispose of as directed. Provide neatly trimmed and drained borrow pits after the excavation is

completed. Ensure that excavation of any area, operation of borrow pits, or dumping of spoil material results in minimum detrimental effects on natural environmental conditions.

3.7 SHORING

3.7.1 General Requirements

The Contractor is responsible for the means and methods of excavation stability and safety. If necessary, submit a Shoring and Sheeting plan for approval 15 days prior to starting work. Submit drawings and calculations, certified by a Connecticut registered professional engineer, describing the methods for shoring and sheeting of excavations. Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross-braces, in good serviceable condition. Finish shoring, including sheet piling, and install as necessary to protect workmen, banks, adjacent paving, structures, and utilities. Remove shoring, bracing, and sheeting as excavations are backfilled, in a manner to prevent caving. Establishment requirements for trench shoring and bracing comply with codes and ordinances of authorities having jurisdiction.

3.7.2 Geotechnical Engineer

Hire a Professional Geotechnical Engineer registeredin Connecticut to provide inspection of excavations and soil/groundwater conditions throughout construction. The Geotechnical Engineer is responsible for performing pre-construction and periodic site visits throughout construction to assess site conditions. The Geotechnical Engineer is responsible for updating the excavation, sheeting and dewatering plans as construction progresses to reflect changing conditions and submit an updated plan if necessary. Submit a monthly written report, informing the Contractor and Contracting Officer Representative of the status of the plan and an accounting of the Contractor's adherence to the plan addressing any present or potential problems. The Contracting Officer Representative is responsible for arranging meetings with the Geotechnical Engineer at any time throughout the contract duration.

3.8 GRADING AREAS

Where indicated, divide work into grading areas within which satisfactory excavated material will be placed in fills and required backfills. Do not haul satisfactory material excavated in one grading area to another grading area except when so directed in writing. Place and grade stockpiles of satisfactory materials as specified. Keep stockpiles in a neat and well drained condition, giving due consideration to drainage at all times. Clear, grub, and seal by rubber-tired equipment, the ground surface at stockpile locations; separately stockpile excavated satisfactory and unsatisfactory materials. Protect stockpiles of satisfactory materials from contamination which may destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, remove and replace such material with satisfactory material from approved sources.

3.9 GROUND SURFACE PREPARATION

3.9.1 General Requirements

Remove and replace unsatisfactory material with satisfactory materials, as directed by the Contracting Officer Representative, in surfaces to receive

fill or in excavated areas. Scarify the surface to a depth of 6 inches before the fill is started. Plow, step, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that the fill material will bond with the existing material. When subgrades are less than the specified density, break up the ground surface to a minimum depth of 6 inches, pulverizing, and compacting to the specified density. When the subgrade is part fill and part excavation or natural ground, scarify the excavated or natural ground portion to a depth of 12 inches and compact it as specified for the adjacent fill.

3.9.2 Frozen Material

Do not place material on surfaces that are muddy, frozen, or contain frost. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment well suited to the soil being compacted. Moisten material as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used.

3.10 UTILIZATION OF EXCAVATED MATERIALS

Excavated materials are to be placed within the limits of the low permeable cap. Excavated materials shall be spread and compacted in 12 inch loose lifts. Compaction shall be performed in accordance with the requirement for proofrolling (see Paragrah 3.13.1 of this Specification).

3.11 BACKFILLING AND COMPACTION OF EXCAVATIONS

Place backfill adjacent to any and all types of structures, and compact to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials, to prevent wedging action or eccentric loading upon or against the structure. Prepare ground surface on which backfill is to be placed and provide compaction requirements for backfill materials in conformance with the applicable portions of paragraphs GROUND SURFACE PREPARATION. Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

3.11.1 Trench Backfill

3.11.1.1 Bedding and Initial Backfill

Place initial backfill material and compact it with approved tampers. Bring up the backfill evenly on both sides of the pipe for the full length of the pipe. Take care to ensure thorough compaction of the fill under the haunches of the pipe. Compact backfill to top of pipe to 90 percent of ASTM D1557 maximum density. Provide materials as follows:

a. Class I: Angular, 0.25 to 1.5 inch, graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shells.

b. Class II: Coarse sands and gravels with maximum particle size of 1.5 inch, including various graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class as specified in ASTM D2487.

3.11.1.2 Final Backfill

Fill the remainder of the trench, except for special materials with satisfactory material.

3.12 EMBANKMENTS

3.12.1 Earth Embankments

Not applicable.

3.13 SUBGRADE PREPARATION - CAP AREA

3.13.1 Proof Rolling

Perform proof rolling on subgrade surfaces free of surface water (wet conditions resulting from rainfall) or excessive moisture which would promote degradation of an otherwise acceptable subgrade. Notify the Contracting Officer Representative a minimum of 3 days prior to proof rolling.

After clearing and grubbing, proof roll the exposed subgrade of the cap limits with four complete passes of a 10 ton, pneumatic-tired roller. Operate the roller in a systematic manner to ensure the number of passes over all areas, and at speeds between 2-1/2 to 3-1/2 mph. When proof rolling, provide one-half of the passes made with the roller in a direction perpendicular to the other passes. Perform proof rolling in the presence of the Contracting Officer Representative. The amount of compactive effort shall be as directed by the Contracting Officer Representative, but in no case shall be less than four complete passes of the equipment being used.

Undercut rutting or pumping of material as directed by the Contracting Officer Representative to a depth of 12 inches and replace with fill and backfill material. Spread the undercut material so as to cause no further issue on-site.

3.13.2 Construction

Shape subgrade to line, grade, and cross section, and compact as specified. Include plowing, disking, and any moistening or aerating required to obtain specified compaction for this operation. Remove soft or otherwise unsatisfactory material and replace with satisfactory excavated material or other approved material as directed. Shape the entire subgrade to line, grade, and cross section and compact as specified. Do not vary the elevation of the finish subgrade more than 0.25 foot from the established grade and cross section.

3.13.3 Compaction

Finish compaction by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Compact each layer of imported subgrade fill to at least 90 percent of laboratory maximum density (ASTM D1557).

Raymark Waste is to be compacted in conformance with the requirement of paragraph 3.13.1 Proof Rolling.

3.13.3.1 Subgrade for Pavements

Not applicable.

3.14 FINISHING

Finish the surface of excavations, embankments, and subgrades to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. Provide the degree of finish for graded areas within 0.1 foot of the grades and elevations indicated. Repair graded, topsoiled, or backfilled areas prior to acceptance of the work, and re-established grades to the required elevations and slopes.

3.14.1 Subgrade

During construction, keep excavations shaped and drained. Maintain ditches and drains along subgrade to drain effectively at all times. Do not disturb the finished subgrade by traffic or other operation. Protect and maintain the finished subgrade in a satisfactory condition until the next overlying material is placed. Do not permit the storage or stockpiling of materials on the finished subgrade.

3.14.1.1 Subgrade Acceptence

Finished subgrade of Raymark Waste shall be inspected and approved by the Contracting Officer Representative within the proposed limit of cap prior to installation of the low-permeable cap.

Raymark Waste surfaces that are excessively wet, contain large protuberances, and/or do not provide suitable support for the cap as determined by the Contracting Officer Representative shall be corrected by the Contractor. Corrective actions may include the import and installation of clean soil fill, the installation of a reinforcing geosynthetic such as a geotextile or geogrid, and/or scarifying, disking, re-working, and/or re-compacting (proof rolling) as approved by the Contracting Officer Representative.

3.15 TESTING

Perform testing by a Corps validated commercial testing laboratory or the Contractor's validated testing facility. Submit qualifications of the Corps validated commercial testing laboratory or the Contractor's validated testing facilities. If the Contractor elects to establish testing facilities, do not permit work requiring testing until the Contractor's facilities have been inspected, Corps validated and approved by the Contracting Officer Representative.

a. Determine field in-place density in accordance with ASTM D1556, ASTM D2167, or ASTM D6938. When ASTM D6938 is used, check the calibration curves and adjust using only the sand cone method as described in ASTM D1556. ASTM D6938 results in a wet unit weight of soil in determining the moisture content of the soil when using this method.

b. Check the calibration curves furnished with the moisture gauges along with density calibration checks as described in ASTM D6938; check the calibration of both the density and moisture gauges at the beginning of a job on each different type of material encountered and at intervals as directed by the Contracting Officer Representative.

ASTM D2937, use the Drive Cylinder Method only for soft, fine-grained, cohesive soils. When test results indicate, as determined by the Contracting Officer Representative, that compaction is not as specified, remove the material, replace and recompact to meet specification requirements.

c. Perform tests on recompacted areas to determine conformance with specification requirements. Appoint a licensed professional civil engineer to certify inspections and test results. These certifications shall state that the tests and observations were performed by or under the direct supervision of the engineer and that the results are representative of the materials or conditions being certified by the tests. The following number of tests, if performed at the appropriate time, will be the minimum acceptable for each type operation.

3.15.1 Excavation Backfill Material Gradation

One test per 2,000 cubic yards stockpiled or in-place source material. Determine gradation of fill and backfill material in accordance with ASTM D422.

3.15.2 In-Place Densities

a. One test per 10,000 square feet, or fraction thereof, of each lift of fill or backfill areas compacted.

3.15.3 Check Tests on In-Place Densities

If ASTM D6938 is used, check in-place densities by ASTM D1556 as follows:

a. One check test per lift for each 40,000 square feet, or fraction thereof, of each lift of fill or backfill compacted by other than hand-operated machines.

b. One check test per lift for each 20,000 square feet, of fill or backfill areas compacted by hand-operated machines.

3.15.4 Moisture Contents

In the stockpile, excavation, or borrow areas, perform a minimum of two tests per day per type of material or source of material being placed during stable weather conditions. During unstable weather, perform tests as dictated by local conditions and approved by the Contracting Officer Representative.

3.15.5 Optimum Moisture and Laboratory Maximum Density

Perform tests for each type material or source of material including borrow material to determine the optimum moisture and laboratory maximum density values. One representative test per 2,000 cubic yards of fill and backfill, or when any change in material occurs which may affect the optimum moisture content or laboratory maximum density.

3.15.6 Tolerance Tests for Subgrades

Perform continuous checks on the degree of finish specified in paragraph FINISHING during construction of the subgrade.

-- End of Section --

SECTION 31 05 19

GEOTEXTILE
08/08

PART 1 GENERAL

1.1 MEASUREMENT

Measure the as-built surface area, covered by geotextile, in square feet. Allowance will be made for geotextile in anchor and/or drainage trenches but no allowance will be made for waste, overlaps, damaged materials, repairs, or materials used for the convenience of the Contractor.

1.2 PAYMENT

Geotextile installed and accepted will be paid for at the respective contract unit price in the bidding schedule. This unit price will include the cost of materials, equipment, installation, testing, and other costs associated with placement of the geotextile.

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D4354	(1999; R 2009) Sampling of Geosynthetics for Testing
ASTM D4355	(2007) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D4491	(1999a; R 2009) Water Permeability of Geotextiles by Permittivity
ASTM D4533	(2011) Trapezoid Tearing Strength of Geotextiles
ASTM D4632	(2008) Grab Breaking Load and Elongation of Geotextiles
ASTM D4751	(2004) Determining Apparent Opening Size of a Geotextile
ASTM D4759	(2011) Determining the Specification Conformance of Geosynthetics
ASTM D4873	(2002; R 2009) Identification, Storage, and Handling of Geosynthetic Rolls and Samples

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Thread; G
Manufacturing Quality Control Sampling and Testing; G

SD-04 Samples

Quality Assurance Samples and Tests

SD-07 Certificates

Geotextile; G

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver, store, and handle geotextile in accordance with ASTM D4873.

1.5.1 Delivery

Notify the Contracting Officer Representative a minimum of 24 hours prior to delivery and unloading of geotextile rolls packaged in an opaque, waterproof, protective plastic wrapping. The plastic wrapping shall not be removed until deployment. If quality assurance samples are collected, immediately rewrap rolls with the plastic wrapping. Geotextile or plastic wrapping damaged during storage or handling shall be repaired or replaced, as directed. Label each roll with the manufacturer's name, geotextile type, roll number, roll dimensions (length, width, gross weight), and date manufactured.

1.5.2 Storage

Protect rolls of geotextile from construction equipment, chemicals, sparks and flames, temperatures in excess of 160 degrees F, or any other environmental condition that may damage the physical properties of the geotextile. To protect geotextile from becoming saturated, either elevate rolls off the ground or place them on a sacrificial sheet of plastic in an area where water will not accumulate.

1.5.3 Handling

Handle and unload geotextile rolls with load carrying straps, a fork lift with a stinger bar, or an axial bar assembly. Rolls shall not be dragged along the ground, lifted by one end, or dropped to the ground.

PART 2 PRODUCTS

2.1 RAW MATERIALS

A minimum of 7 days prior to scheduled use, submit manufacturer's certificate of compliance stating that the geotextile meets the requirements of this section. For needle punched geotextiles, the

manufacturer shall also certify that the geotextile has been continuously inspected using permanent on-line full-width metal detectors and does not contain any needles which could damage other geosynthetic layers. The certificate of compliance shall be attested to by a person having legal authority to bind the geotextile manufacturer.

2.1.1 Geotextile

The geotextiles shall be composed of synthetic fibers formed into a woven or non-woven fabric. Fibers used in manufacture of the geotextiles shall consist of polypropylene, polyvinyl chloride, nylon, polyolefins, polyamides, or polyester. The fibers shall be formed into network such that the filaments or yarns retain dimensional stability relative to each other, including selvages. The geotextile shall contain stabilizers and/or inhibitors to make the fibers resistant to deterioration resulting from exposure to sunlight, water, or heat. The geotextile shall be free of defects or flaws which will affect the physical properties. Use a geotextile fabric meeting the following requirement:

Property	Test Method	Nonwoven	Woven
Tensile Strength (lbs)	ASTM D4632	200	315
Elongation (%)	ASTM D4632	50	12
CBR Puncture Strength (lbs)	ASTM D6241	500	900
Trapezoid Tear (lbs)	ASTM D4533	75	113
Permittivity (sec^{-1})	ASTM D4491	0.50	0.05
Ultraviolet Stability (% for min. 500 hrs)	ASTM D4355	70	70
Apparent Opening Size (standard sieve)	ASTM D4751	70	70

All numberical values represent minimum average roll values in a weaker principal direction.

2.1.2 Thread

A minimum of 7 days prior to scheduled use, submit proposed thread type for sewn seams along with data sheets showing the physical properties of the thread. Construct sewn seams with high-strength polyester, nylon, or other approved thread type. Thread shall have ultraviolet light stability equivalent to the geotextile and the color shall contrast with the geotextile.

2.2 MANUFACTURING QUALITY CONTROL SAMPLING AND TESTING

The Manufacturer is responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. A minimum of 7 days prior to scheduled use, submit manufacturer's quality control manual. Documentation describing the quality control program shall be made available upon request. Perform manufacturing quality control sampling and testing in accordance with the

manufacturer's approved quality control manual. As a minimum, geotextiles shall be randomly sampled for testing in accordance with ASTM D4354, Procedure A. Acceptance of geotextile shall be in accordance with ASTM D4759. Tests not meeting the specified requirements will result in the rejection of applicable rolls.

PART 3 EXECUTION

3.1 SAMPLES AND TESTS

3.1.1 Samples

Provide assistance to the Contracting Officer Representative in the collection of quality assurance samples for quality assurance testing; assign 7 days in the schedule to allow for testing. Collect samples upon delivery to the site at the request of the Contracting Officer Representative at a frequency of one per 40,000 square feet. Identify samples with a waterproof marker by manufacturer's name, product identification, lot number, roll number, and machine direction. The date and a unique sample number shall also be noted on the sample. Discard the outer layer of the geotextile roll prior to sampling a roll. Samples shall then be collected by cutting the full-width of the geotextile sheet a minimum of 3 feet long in the machine direction. Rolls which are sampled shall be immediately resealed in their protective covering.

3.1.2 Conformance Tests

The Contractor shall provide quality assurance samples to an Independent Laboratory identified by the Contracint Officer Representative. Samples will be tested to verify that geotextile meets the requirements specified in Table 1. Test method ASTM D4355 shall not be performed on the collected samples. Geotextile product acceptance shall be based on ASTM D4759. Tests not meeting the specified requirements will result in the rejection of applicable rolls.

3.2 INSTALLATION

3.2.1 Subgrade Preparation

The surface underlying the geotextile shall be smooth and free of ruts or protrusions which could damage the geotextile. Subgrade materials and compaction requirements shall be in accordance with Section 31 00 00 EARTHWORK.

3.2.2 Placement

Notify the Contracting Officer Representative a minimum of 24 hours prior to installation of geotextile. Geotextile rolls which are damaged or contain imperfections shall be repaired or replaced as directed. The geotextile shall be laid flat and smooth so that it is in direct contact with the subgrade. The geotextile shall also be free of tensile stresses, folds, and wrinkles. On slopes steeper than 10 horizontal on 1 vertical, lay the geotextile with the machine direction of the fabric parallel to the slope direction.

3.3 SEAMS

3.3.1 Overlap Seams

Continuously overlap geotextile panels a minimum of 12 inches at all longitudinal and transverse joints. Where seams must be oriented across the slope, lap the upper panel over the lower panel. If approved, sewn seams may be used instead of overlapped seams.

3.3.2 Sewn Seams

Factory and field seams shall be continuously sewn at the locations shown on the drawings. The stitch type used shall be a 401 locking chain stitch or as recommended by the manufacturer. For field and factory seams which are sewn, provide at least a 2-meter sample of sewn seam before the geotextile is installed. For seams that are field sewn, the seams shall be sewn using the same equipment and procedures as will be used for the production seams. If seams are sewn in both the machine and cross machine direction, provide samples of seams from both directions. Seam strength shall meet the minimum requirements specified in Table 1. The thread at the end of each seam run shall be tied off to prevent unraveling. Skipped stitches or discontinuities shall be sewn with an extra line of stitching with a minimum of 18 inches of overlap.

3.4 PROTECTION

Protect the geotextile during installation from clogging, tears, and other damage. Damaged geotextile shall be repaired or replaced as directed. Use adequate ballast (e.g. sand bags) to prevent uplift by wind. The geotextile shall not be left uncovered for more than 14 days after installation.

3.5 REPAIRS

Repair torn or damaged geotextile. Clogged areas of geotextile shall be removed. Perform repairs by placing a patch of the same type of geotextile over the damaged area. The patch shall extend a minimum of 12 inches beyond the edge of the damaged area. Patches shall be continuously fastened using approved methods. The machine direction of the patch shall be aligned with the machine direction of the geotextile being repaired. Remove and replace geotextile rolls which cannot be repaired. Repairs shall be performed at no additional cost to the Government

3.6 PENETRATIONS

Construct engineered penetrations of the geotextile as shown on the drawings.

3.7 COVERING

Do not cover geotextile prior to inspection and approval by the Contracting Officer Representative. Place overlying soil aggregate in a manner that prevents material from entering the geotextile overlap zone, prevents tensile stress from being mobilized in the geotextile, and prevents wrinkles from folding over onto themselves. On side slopes, soil backfill shall be placed from the bottom of the slope upward. Cover soil shall not be dropped onto the geotextile from a height greater than 3 feet. No equipment shall be operated directly on top of the geotextile without approval of the Contracting Officer Representative. Use equipment with

ground pressures less than 7 psi to place the first lift over the geotextile. A minimum of 12 inches of soil shall be maintained between full-scale construction equipment and the geotextile. Cover soil material type, compaction, and testing requirements are described in Section 31 00 00 EARTHWORK. Equipment placing cover soil shall not stop abruptly, make sharp turns, spin their wheels, or travel at speeds exceeding 5 mph.

-- End of Section --

SECTION 31 05 20

GEOCOMPOSITE
08/08

PART 1 GENERAL

1.1 MEASUREMENT AND PAYMENT

Measure the total separate surface areas in square feet covered by geocomposite for the drainage layer (GDL) and the geocomposite venting layer (GVL). Base final quantities on as-built conditions. Allowance will be made for each geocomposite layer in anchor and/or drainage trenches but no allowance will be made for waste, overlap, or materials used for the convenience of the Contractor. Geocomposite accepted by the Contracting Officer Representative will be paid for at the respective contract unit prices in the bidding schedule.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D1238	(2010) Melt Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D1505	(2010) Density of Plastics by the Density-Gradient Technique
ASTM D1557	(2009) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D1603	(2011) Carbon Black Content in Olefin Plastics
ASTM D4218	(1996; R 2008) Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
ASTM D4355	(2007) Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus
ASTM D4491	(1999a; R 2009) Water Permeability of Geotextiles by Permittivity
ASTM D4533	(2011) Trapezoid Tearing Strength of Geotextiles
ASTM D4632	(2008) Grab Breaking Load and Elongation of Geotextiles

ASTM D4716	(2008) Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
ASTM D4751	(2004) Determining Apparent Opening Size of a Geotextile
ASTM D5199	(2011) Measuring Nominal Thickness of Geosynthetics
ASTM D5321	(2008) Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
ASTM D5888	(2006; R 2011) Storage and Handling of Geosynthetic Clay Liners
ASTM D6102	(2006) Standard Guide for Installation of Geosynthetic Clay Liners
ASTM D6243	(2009) Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method
ASTM D7005	(2003; R 2008) Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites
ASTM G154	(2006) Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Manufacturer's Quality Control Manual
Manufacturer's Product Datasheet for proposed material; G
Project Reference List for geocomposite consisting of at least 10 projects totaling 10 million square feet in size; G

SD-03 Product Data

Sampling and Testing; G
Penetrations; G
Construction Quality Control (QC) Laboratory; G

SD-04 Samples

Geocomposite Drainage Layer; G
Geocomposite Venting Layer; G

SD-06 Test Reports

Sampling and Testing; G
Geosynthetic Drainage Layer; G

1.4 QUALITY CONTROL

Provide a construction quality control (QC) laboratory that has also performed quality control (QC) testing of geocomposite for at least five completed projects, having a total minimum area of 2 million square feet. Submit qualifications of laboratory which shall carry current accreditation via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests it will be required to perform.

1.5 DELIVERY, STORAGE, AND HANDLING

Conform to the Manufacturer's requirements and ASTM D5888 unless otherwise specified. The Installer shall be reponsible for the handling, storage, and care of the geocomposites from the time of delivery to the site until final acceptance of the completed work by the Contractor. Material storage and handling practices shall meet the manufacturer's recommendations.

The QC inspector shall be present during delivery and unloading of the geocomposite. Ensure the material has not been damaged during shipping, storage, or handling. Any material found to be damaged shall be repaired or replaced. Each roll shall be labeled with the manufacturer's name, product identification, lot number, roll number, and roll dimensions. Rolls shall be individually wrapped in plastic. Store the rolls in a level and dry area.

1.5.1 Delivery

a. Deliver material to the site only after the Contracting Officer Representative accepts required submittals.

b. Material shall be covered with a waterproof plastic covering resistant to ultraviolet degradation.

c. Ship less than one month prior to scheduled installation unless otherwise approved by Contracting Officer Representative.

d. Each roll shall be marked with the following information:

(1) Manufacturer's name.

(2) Product identification.

(3) Roll dimensions.

(4) Roll number.

(5) Lot number.

1.5.2 Storage

a. Store rolls in space approved by Contracting Officer. Space should be at high ground level or elevated above ground surface.

b. Stack no more than 3 rolls high.

c. Protect rolls from UV, precipitation, other sources of moisture, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.

d. An additional tarpaulin or plastic sheet shall be used over the stacked rolls to provide extra protection for GDL material stored outdoors.

e. Preserve integrity and readability of roll labels.

1.5.3 Warranty

Material shall be warranted, on a pro-rate basis against manufacturer's defects for a period of 1 year from the date of substantial completion of work

Installation shall be warranted against defects in workmanship for a period of 1 year from the date of substantial completion of work.

PART 2 PRODUCTS

2.1 GEOCOMPOSITE

The polymer used to manufacture the geonet component of the geocomposite shall be polyethylene which is clean and free of any foreign contaminants. Submit manufacturer's quality control test results. Regrind material which consists of edge trimmings and other scraps may be used to manufacture the geonet; however, post-consumer recycled materials shall not be used. Conform the geocomposites to the property requirements listed in Table 1. Component criteria for the geonet alone and geotextile alone are also listed in Table 1. The geonet shall be covered on both sides with nonwoven geotextile. Create geocomposite by heat bonding geotextile to the geonet. The geotextile shall not be bonded to the drainage net within 6 inches of the edges of the rolls. Where applicable, Table 1 property values represent minimum average roll values (MARV). The value for AOS represents the maximum average roll value (MaxARV).

The GDL shall be tri-planar geocomposite meeting the properties listed in Table 1. Syntec Tenflow 770-2 or equal shall be considered an acceptable GDL product. The GVL shall be bi-planar geocomposite meeting the properties listed in Table 1. Skaps TransNet TN-160 or equal shall be considered an acceptable GVL product.

TABLE 1 - GEOCOMPOSITE PROPERTIES

PROPERTY	TEST METHOD	TEST VALUE GDL	TEST VALUE GVL	MINIMUM MQC TESTING FREQUENCY
GEONET (Properties prior to lamination)				
Thickness, minimum avg, Note 1	ASTM D5199	350 mil	150 mil	100,000 SF

PROPERTY	TEST METHOD	TEST VALUE GDL	TEST VALUE GVL	MINIMUM MQC TESTING FREQUENCY
Polymer Density, minimum avg	ASTM D1505	0.940 g/cc	0.940 g/cc	100,000 SF
Carbon Black	ASTM D1603 ASTM D4218	2-3 percent (range)	2-3 percent	100,000 SF
GEOTEXTILE (Properties prior to lamination)				
Grab Strength,	ASTM D4632	160 lbs	160 lbs	100,000 SF
Grab Elongation, MARV	ASTM D4632	50 percent	50 percent	100,000 SF
Tear Strength,	ASTM D4533	60 lbs	65 lbs	100,000 SF
CBR Puncture,	ASTM D 6241	400 lbs	475 lbs	100,000 SF
Permittivity, MARV	ASTM D4491 (falling	1.4/sec	1.63/sec	500,000 SF
Water Flow Rate, MARV	ASTM D 4491	110 gpm/SF	125 gps/SF	
AOS (O95), MaxARV	ASTM D4751	US Sieve 70	US Sieve 70	500,000 SF
UV Stability, percent retained	ASTM D4355/ ASTM G154	70 percent	70 percent	Note 3
GEOCOMPOSITE				
Transmissivit min, including attached geotextiles Note 4	ASTM D4716	7.9×10^{-3} m^2/sec @ 0.05 gradient 1.3×10^{-3} m^2/sec @ 0.33 gradient	-	75,000 SF
Geonet/Geotex Ply Adhesion, min avg	ASTM D7005	0.5 lbs/in 1.0 lbs/in	0.5 lbs/in 1.0 lbs/in	500,000 SF

Note 1: The diameter of the presser foot shall be 2.22 inches and the pressure shall be 2.9 psi. For other thickness options, see manufacturer's literature.

Note 2: This is the average peak value for five equally spaced machine direction tests across the roll width.

Note 3: Manufacturer's historical data.

Note 4: Measure site specific transmissivity for GDL at test gradients of 0.05 and 0.33. Use a minimum seating period of 100 hours and applied normal stress of 1,000 psf. Test boundary conditions shall be steel

plate/site-specific protective cover soil/GDL/site-specific geomembrane steel plate. Protective cover soil shall be compacted to 90 percent of density, as a percentage of maximum dry density as determined by ASTM D1557 with the moisture content of a maximum of 3 percent wet of optimum. Site-specific transmissivity testing for the GVL is not required.

2.2 RESIN

Resin used to manufacture the geonet core shall be new first quality, compounded polyethylene resin. No post-consumer reclaimed polymer shall be added to the resin during the manufacture of the geonet material. Natural resin (without carbon black) shall meet the following minimum requirements in Table 2.

TABLE 2
Natural Resin

Property	Test Method	Value
Density (g/cm^3)	ASTM D1505	>0.94
Melt Flow Index (g/10 min)	ASTM D1238	$\leq$1.0

2.2.1 Ties

a. Ties used to secure adjacent sheets of geocomposite geonet shall be plastic fasteners or polymer braid.

b. Metallic ties will not be allowed.

c. Ties shall be yellow or white to facilitate inspection.

2.2.2 Thread

Thread used to seam the geotextile portion of the geocomposite geonet shall be polymeric material with chemical resistance properties equal to or exceeding those of the geotextile. The thread shall be a different color than the geotextile to facilitate inspection.

2.3 SAMPLING AND TESTING

2.3.1 Manufacturing Quality Control Testing

The geocomposite shall be manufactured in accordance with the Manufacturer's Quality Control Plan, as submitted to and approved by the Contracting Officer Representative. The GDL and GVL shall be tested according to the test methods and frequencies listed in Table 1.

2.3.2 Conformance Testing

2.3.2.1 Tests

Conformance testing shall be performed by the independent Quality Assurance Laboratory (QAL) provided and paid for by the Contracting Officer Representative. The Manufacturer shall obtain the samples from the roll, mark the machine direction and identification number, and ship the samples to the QAL. The following conformance tests shall be conducted at the laboratory prior to shipment to the site.

a. Geonet thickness.

b. Geotextile AOS.

c. Geotextile grab stength.

d. Geonet/geotextile ply adhesion.

2.3.2.2 Frequency

These conformance tests shall be performed in accordance with Table 1 at a frequency of one sample per 100,000 square feet unless otherwise noted by the Contracting Officer Representative.

2.3.3 Site-Specific Quality Control Testing

Conduct interface friction testing using site-specific materials at a frequency of one sample per 75,000 square feet. The test methods and required results shall be as outlined in Table 3.

TABLE 3
Geocomposite Site-Specific Properties(1)

Interface	Test Method	Minimum Value(3)
GDL/Geomembrane (textured)	ASTM D5321	See Section 02 56 13 WASTE CONTAINMENT GEOMEMBRANE
GCL/GVL(2)(4)(5)(6)	ASTM D6243	Peak = 21 degrees Residual = 18 degrees

NOTES:

1. Site-specific testing shall be conducted at the frequency of 1 test/75,000 square feet unless otherwise noted.

2. Perform interface tests at confining normal stresses of 1, 2, and 3 psi with a displacement rate of 0.04 in/min, under non-inundated conditions, report peak and residual values. Conducted in accordance with ASTM D5321 or ASTM D6243, as noted.

3. Cohesion/adhesion intercept = 0 psf. Interface friction values less than those specified but containing cohesion/adhesion will be evaluated for acceptance by the Contracting Officer Representative.

4. The GCL shall be hydrated with de-ionized water for a minimum of 48 hours at the target normal stress prior to testing.

5. Test shear box configuration (top to bottom): top plate, GCL, GVL, bottom plate).

6. GCL shall be tested in the orientation it will be installed. The upper and lower geotextiles shall be in contact with adjacent interfaces to match field condition.

Report all data as required by the referenced testing standard and/or project specifications including the following:

a. Residual strength (i.e., large-displacement strain) values shall be reported for a minimum 20 percent strain or the maximum allowable displacement of the test equipment.

b. The final condition of the tested soil and geosynthetics (i.e., did it rip/tear along surfaces or at connections to the shear box).

The Contracting Officer Representative shall review and accept site-specific QC testing completed and submitted by the Contractor for compliance with the project requirements.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Surface Preparation

Prior to placement of the geocomposite, the subgrade shall be smooth and free of all materials which could damage the material.

a. The subgrade upon which the geocomposite is to be deployed shall be suitable for the placement of geocompsite material, subject to the applicable section of this specification.

b. Subgrade: The surface upon which the geocomposite will be installed shall be inspected by the Contracting Officer Representative and certified by the Contractor to be in accordance with the requirements of this specification.

c. The surface upon with the geocomposite is installed should be smooth and free of wheel ruts, debris, roots, sticks, and rocks larger than 1 inch.

d. The subgrade surface and preparation should be inspected and certified by the CQA Inspector prior to GDL or GVL installation. Upon approval by the CQA Inspector, it is the geosynthetic installer's responsibility to communicate to the Contractor and Contracting Officer Representative of any changes in the condition of the subgrade that might render it out of compliance, with any of the requirements of the Project Specifications or ASTM D6102.D.

3.1.2 Placement

The geocomposite shall not be damaged during placement. Unroll the material in the direction of maximum slope, keeping the net flat against the subgrade to minimize wrinkles and folds. The drainage layer shall not be dragged across textured geomembrane if a geotextile is attached to the surface facing the geomembrane. Place adequate ballast (e.g. sandbags) to prevent uplift by wind prior to covering. Geocomposite shall be placed in general accordance with the procedure specified below or modified to account for site specific conditions.

3.1.2.1 Geocomposite Panel Position

Where possible, all slope panels should be installed parallel to the maximum slope while panels installed in flat areas require no particular

orientation.

3.1.2.2 Panel Deployment

Geocomposite shall be installed in general accordance with the procedures set forth in this section, subject to site specific conditions which wouldn't necessitate modifications.

a. Deployment should proceed from the highest elevation to the lowest to facilitate drainage in the event of precipitation.

b. The geocomposite may be deployed on slopes by pulling the material from a suspended roll or securing a roll end into an anchor trench and unrolling each panel as the handling equipment slowly moves backward.

c. Deployment on flat areas shall be conducted in the same manner as that for the slopes, however, care should be taken to minimize "dragging" the material. Slip-sheet may be used to facilitate positioning of the liner while ensuring the GDL is not damaged from underlying sources.

d. The geocomposite will have seam overlaps a minimum of 4 inches for all side seams. End of panel or butt end seams shall be minimum overlaps of 12 inches. All seams shall be free of wrinkles, folds, or "fish-mouths".

3.1.3 Seams and Overlaps

3.1.3.1 Geonet Side Seams

Overlap geonet side seams a minimum of 4 inches. Side seam fastener spacing shall be a maximum of 5 feet. In anchor trenches, fastener spacing shall be a maximum of 1 foot.

3.1.3.2 Geonet End Seams

Overlap geonet end seams a minimum of 1 foot. End seam fastener spacing shall be a maximum of 1 foot. The overlaps shall be in the direction of flow.

3.1.3.3 Geonet Fasteners

Tie geonet rolls together with plastic fasteners. The fasteners shall be a contrasting color from the geonet and attached geotextiles. Metallic fasteners will not be allowed.

3.1.3.4 Geotextile Seams

The geotextile component of the geocomposite shall be thermally bonded using approved methods or sewn using approved methods.

3.1.3.5 Geotextile Cap Strips

Place geotextile cap strips over any exposed edges of geocomposite. Cap strips shall be a minimum of 2 feet in width and shall be thermally bonded to the geotextile component of the geocomposite.

3.1.4 Stacked Geosynthetic Drainage Layers

When geosynthetic drainage layers are to be stacked, stagger roll ends and edges so that joints do not lie above one another.

3.1.5 Penetrations

Submit penetration details. Mechanically attach a geotextile apron to pipes and other appurtenances penetrating through the drainage layer so that soil is prevented from getting into the drainage layer. The apron of the attached geotextile shall extend out from the pipe or appurtenance a minimum of 2 feet. The apron geotextile shall be thermally bonded to the geotextile overlying the geonet.

3.2 REPAIRS

3.2.1 Geonet Damage

Make repairs by placing a patch of the geocomposite over the damaged area. Extend the patch a minimum of 2 feet beyond the edge of the damage. Use approved fasteners, spaced every 6 inches around the patch, to hold the patch in place. If more than 25 percent of the roll width is damaged, approval must be obtained to repair or replace the damaged roll.

3.2.2 Geotextile Damage

Repair damaged geotextile by placing a patch of geotextile over the damaged area with a minimum of 12 inches of overlap in all directions. The geotextile patch shall be thermally bonded in place.

3.3 PROTECTION AND BACKFILLING

Cover the geocomposite with the specified materials within 5 days of acceptance. Place cover soil from the bottom of the slope upward and shall not be dropped directly onto the drainage layer from a height greater than 3 feet. The cover soil shall be pushed out over the geocomposite in an upward tumbling motion so that wrinkles in the drainage layer do not fold over. No equipment shall be operated on the top surface of the geocomposite without permission from the Contracting Officer Representative. The initial loose soil lift thickness shall be 15 inches. Use equipment with ground pressures no greater than 7 psi to place all soil above the geocomposite. Cover soil compaction and testing requirements are described in Section 31 00 00 EARTHWORK.

-- End of Section --

SECTION 31 11 00

CLEARING AND GRUBBING
08/08

PART 1 GENERAL

1.1 DELIVERY, STORAGE, AND HANDLING

Deliver materials to store at the site, and handle in a manner which will maintain the materials in their original manufactured or fabricated condition until ready for use.

PART 2 PRODUCTS

2.1 TREE WOUND PAINT

Submit samples in cans with manufacturer's label of bituminous based paint of standard manufacture specially formulated for tree wounds.

PART 3 EXECUTION

3.1 PROTECTION

3.1.1 Roads and Walks

Keep roads and walks free of dirt and debris at all times.

3.1.2 Trees, Shrubs, and Existing Facilities

Trees and vegetation to be left standing shall be protected from damage incident to clearing, grubbing, and construction operations by the erection of barriers or by such other means as the circumstances require. Existing features or structures that are indicated or make know prior to the start of clearing or grubbing operations shall be repaired in the event of any damage during such operations.

3.1.3 Utility Lines

Protect existing utility lines that are indicated to remain from damage. Notify the Contracting Officer Representative immediately of damage to or an encounter with an unknown existing utility line. The Contractor is responsible for the repairs of damage to existing utility lines that are indicated or made known to the Contractor prior to start of clearing and grubbing operations. When utility lines which are to be removed are encountered within the area of operations, notify the Contracting Officer Representative in ample time to minimize interruption of the service. Refer to Section 01 57 19.00 20, TEMPORARY ENVIRONMENTAL CONTROLS for additional utility protection.

3.2 CLEARING

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. Trees, stumps, roots, brush, and other vegetation in areas to be cleared shall be cut off flush with or

below the original ground surface, except such trees and vegetation as may be indicated or directed to be left standing. Trees designated to be left standing within the cleared areas shall be trimmed of dead branches 1-1/2 inches or more in diameter and shall be trimmed of all branches the heights indicated or directed. Limbs and branches to be trimmed shall be neatly cut close to the bole of the tree or main branches. Cuts more than 1-1/2 inches in diameter shall be painted with an approved tree-wound paint.

3.3 TREE REMOVAL

Where indicated or directed, trees and stumps that are designated as trees shall be removed from areas outside those areas designated for clearing and grubbing. This work shall include the felling of such trees and the removal of their stumps and roots. Trees shall be disposed of as specified in paragraph 3.6 DISPOSAL OF MATERIALS.

3.4 PRUNING

Trim trees designated to be left standing within the cleared areas of dead branches 1 1/2 inches or more in diameter; and trim branches to heights and in a manner as indicated. Neatly cut limbs and branches to be trimmed close to the bole of the tree or main branches. Paint cuts more than 1 1/4 inches in diameter with an approved tree wound paint.

3.5 GRUBBING

No grubbing is anticipated.

3.6 DISPOSAL OF MATERIALS

3.6.1 Saleable Timber

No timber shall be considered saleable from the site.

All timber, limbs, tops, stumps, and debris cleared shall become property of the Contractor and shall be disposed of by the Contractor as specified.

Logs, stumps, roots, brush, and other weedy debris is required to be disposed of pursuant to any Emerald Ash Borer regulations that are in place when the work is performed. If no restrictions are in place, the Contractor shall be diligent and inspect ash trees for signs of the Emerald Ash Borer prior to off-site disposal.

3.6.2 Nonsaleable Materials

Written permission to dispose of such products on private property shall be filed with the Contracting Officer Representative. Logs, stumps, roots, brush, rotten wood, and other refuse from the clearing operations shall be disposed of in an approved disposal facility, except when otherwise directed in writing. Such directive will state the conditions covering the disposal of such products and will also state the areas in which they may be placed.

-- End of Section --

SECTION 31 21 00

PIPING; OFF-GAS
08/08

PART 1 GENERAL

1.1 UNIT PRICES

Measurement and payment will be based on completed work performed in accordance with the drawings, specifications, and the contract payment schedules. No payment will be made under this section for excavation, trenching, or backfilling. Payment for such work will be made under Section 31 00 00 EARTHWORK.

1.1.1 Measurement

The length of pipe lines to be paid for will be determined by measuring along the centerline of the various sizes of pipe furnished and installed. Pipe will be measured from center of fitting to center of fitting and from connection to connection to wells or treatment units. No deduction will be made for the space occupied by valves or fittings.

1.1.2 Payment

Payment will be made for off-gas piping at the contract unit price per linear foot, and will be full compensation for pipes, joints, specials, and fittings, complete in place. Payment will include the furnishing of testing, plant, labor, and material and incidentals necessary to complete the work, as specified and as shown.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASME INTERNATIONAL (ASME)

ASME B16.21	(2011) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.5	(2009) Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard

ASTM INTERNATIONAL (ASTM)

ASTM D2513	(2012a; E 2012) Thermoplastic Gas Pressure Pipe, Tubing, and Fittings
ASTM D2657	(2007) Heat Fusion Joining Polyolefin Pipe and Fittings
ASTM D2683	(2010) Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing

ASTM D3035	(2012; E 2012) Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D3261	(2012) Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM D3892	(1993; R 2009) Packaging/Packing of Plastics
ASTM F1055	(2013) Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing

1.3 SYSTEM DESCRIPTION

The off-gas piping system shall consist of buried and above ground pipe, fittings, equipment and accessories for gas collection and venting.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Off-gas Piping System; G

SD-03 Product Data

Materials and Equipment; G
Statement of Satisfactory Installation

SD-07 Certificates

Off-gas Piping System

1.5 QUALITY CONTROL

1.5.1 Contractor Qualifications

Contractor shall have had a minimum of 5 years of experience in the construction of piping systems for off-gas, specifically butt fusion jointing of pipes.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Packaging

Plastic pipe shall be packed, packaged and marked in accordance with ASTM D3892.

1.6.2 Storage

Store materials with protection from puncture, dirt, grease, moisture, mechanical abrasions, excessive heat, ultraviolet (UV) damage, or other damage. Pipe and fittings shall be handled and stored in accordance with the manufacturer's recommendations. Piping bundles shall be stored on a prepared surface and should not be stacked more than two bundles high.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Provide materials and equipment that are new and unused, except for testing equipment. Components that serve the same function and are the same size shall be identical products of the same manufacturer. Piping material and appurtenances shall be as specified and as shown on the drawings, and shall be suitable for the service intended. Submit manufacturer's descriptive data and technical literature for each piping system, including design recommendations, pressure and temperature ratings, dimensions, type, grade and strength of pipe and fittings, thermal characteristics (coefficient of expansion and thermal conductivity) and chemical resistivity. Manufacturer's recommended installation procedures including materials preparation, and installations.

2.2 HIGH DENSITY POLYETHYLENE (HDPE) PIPING

Design and fabrication of the off-gas piping system shall be in accordance with ASTM D2513 except as modified herein.

2.2.1 HDPE Pipe

Solid wall pipe shall be in accordance with ASTM D3035, 6-inch diameter with a standard dimension ratio (SDR) of 17.

Perforated pipe shall be 6-inch diameter, SDR 17 with two (2) rows of 1/2-inch diameter perforations spaced at a minimum of 6 inches apart.

2.2.2 HDPE Joints and Fittings

Fittings shall be pressure rated electrofusion fittings in accordance with ASTM F1055, butt heat fusion fittings in accordance with ASTM D3261 or socket-type fittings in accordance with ASTM D2683 except where flanged connections are required at expansion joints, or otherwise shown. Flanges shall be joined to pipe by heat fusion in accordance with ASTM D2657.

2.3 FLANGED CONNECTIONS

2.3.1 Flanges

Flanges shall be Class 150, socket weld, flat face in accordance with ASME B16.5. Drilling and dimensions of flanges, bolts, nuts, and bolt patterns shall be in accordance with ASME B16.5, Class 150. Bolts and nuts shall be 304 stainless steel.

2.3.2 Gaskets

Gaskets shall be full face, non-asbestos compressed material compatible with the expected condensates in accordance with ASME B16.21, 1/4 inch minimum thickness, full face or self-centering flat ring type.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer Representative of any discrepancy before performing the work.

3.2 MANUFACTURER'S REPRESENTATIVE

Provide the services of a manufacturer's field service representative who is experienced in the installation of the materials and equipment furnished and who has complete knowledge of the proper operation and maintenance of the system. Submit the name and qualifications of the manufacturer's representative and written certification from the manufacturer that the representative is technically qualified.

3.3 PRESSURE REGULATOR

3.3.1 Vents

Locate vents where gas can be discharged into the atmosphere without undue hazard at locations shown on the drawings. Vents shall terminate in the outside air in rain and insect resistant fittings.

3.4 INSTALLING PIPE UNDERGROUND

Installation shall be as specified in Section 31 00 00 EARTHWORK.

3.5 JOINTING PIPE

3.5.1 Flanged Joints

Use hexagon head nuts and bolts. Bolt projection through the end of the nut shall be limited to 1/4 inch maximum. Manufacturer's rating and instructions for specified service shall be followed.

3.5.2 Butt Fusion Jointing

Follow the manufacturer's recommended procedures and/or ASTM D3261 for butt fusion jointing.

3.5.3 Expansion Couplings

Install expansion couplings along the gas collection pipe at intervals recommended by the manufacturer. Expansion couplings shall be provided as recommended by the manufacturer.

3.6 PRESSURE AND LEAKAGE TESTS

Testing of installed gas collection and venting pipe is not required.

3.7 INSPECTION

The Contracting Officer Representative shall inspect jointing procedures and completed pipe joints for compliance with the requirements of this specification.

3.7.1 Demonstration

Upon completion of the work and before final acceptance, submit a Statement of Satisfactory Installation signed by the principal officer of the contracting firm stating that: the installation is satisfactory and in accordance with the contract plans and specifications; the manufacturer's prescribed procedures and techniques have been followed; and at a time designated by the Contracting Officer Representative.

-- End of Section --

SECTION 31 32 11

SOIL SURFACE EROSION CONTROL

08/08

PART 1 GENERAL

1.1 SYSTEM DESCRIPTION

The work consists of erosion and sediment control as defined in the Project Environmental Protection Plan. This work includes all necessary materials, labor, supervision and equipment for installation of a complete system. Coordinate this section with the requirements of Section 02 61 13 EXCAVATION AND HANDLING OF CONTAMINATED MATERIAL and Section 32 92 19 SEEDING.

1.2 QUALITY ASSURANCE

1.2.1 SUSTAINABLE DESIGN REQUIREMENTS

1.3 DELIVERY, STORAGE, AND HANDLING

Prior to delivery of materials, submit certificates of compliance attesting that materials meet the specified requirements. Store materials in designated areas and as recommended by the manufacturer protected from the elements, direct exposure, and damage. Do not drop containers from trucks. Material shall be free of defects that would void required performance or warranty. Deliver geosynthetic binders and synthetic soil binders in the manufacturer's original sealed containers and stored in a secure area.

a. Furnish erosion control blankets and geotextile fabric in rolls with suitable wrapping to protect against moisture and extended ultraviolet exposure prior to placement. Label erosion control blanket and geotextile fabric rolls to provide identification sufficient for inventory and quality control purposes.

b. For items listed in this section, certified copies of the material certificates shall include the following:

1). Certification of recycled content or,

2). Statement of recycled content.

3). Certification that straw and hay are weed free.

PART 2 PRODUCTS

2.1 BINDERS

2.1.1 Soil Binders

Short-lived plant-based binder materials such as guar, psyllium, or starch that are compatible with vegetation to be used for dust suppression, erosion control, and soil stabilization.

2.2 MULCH

Mulch shall be free from weeds, mold, and other deleterious materials. Mulch materials shall be native to the region.

2.2.1 Straw

Straw shall be certified weed-free stalks from oats, wheat, rye, barley, or rice, furnished in air-dry condition and with a consistency for placing with commercial mulch-blowing equipment.

2.2.2 Hay

Hay shall be certified weed-free
native hay, sudan-grass hay, broomsedge hay, or other herbaceous mowings, furnished in an air-dry condition suitable for placing with commercial mulch-blowing equipment.

2.2.3 Shredded Bark

Locally shredded material shall be treated to retard the growth of mold and fungi.

2.2.4 Wood By-Products

Submit composition, source, and particle size. Products shall be free from toxic chemicals or hazardous material. Wood locally chipped or ground bark shall be treated to retard the growth of mold and fungi. Gradation: A maximum 2 inch wide by 4 inch long.

2.3 EROSION CONTROL BLANKETS

2.3.1 Erosion Control Blankets Type VI

Use Type VI blankets for erosion control and vegetation establishment on roadside embankments, berms, shoulders, and median swales where natural vegetation will provide long term stabilization. Erosion control blankets shall be a machine-produced mat of 100% biodegradable straw. The blanket shall be of consistent thickness with the straw evenly distributed over the entire area of the mat. Cover the blanket on the top side with a 100 percent biodegradable woven natural organic fiber netting. The netting shall consist of machine directional strands formed from two intertwined yarns with cross-directional strands interwoven through the twisted machine strands (commonly referred to as Leno weave) to form an approximate 1/2 inch by 1/2 inch mesh. Sew the blanket together on a maximum 1.5 inch centers with biodegradable thread. The erosion control blanket shall have the following properties:

Material Content

Straw	100 percent with approximately 0.50 lb/yd^2 weight
Netting	One side only, Leno wove 100 percent biodegradable natural organic fiber, approximately 9.3 lb/1000 sq.ft.
Thread	Biodegradable

Note 1: Photodegradable life a minimum of 10 months with a minimum 90

Material Content
percent light penetration. Apply to slopes up to a maximum 2:1 gradient.

2.3.2 Staking

Stakes shall be 100 percent biodegradable manufactured from recycled plastic or wood and shall be designed to safely and effectively secure erosion control blankets for temporary or permanent applications. The biodegradable stake shall be fully degradable by biological activity within a reasonable time frame. The bio-plastic resin used in production of the biodegradable stake shall consist of polylactide, a natural, completely biodegradable substance derived from renewable agricultural resources. The biodegradable stake must exhibit ample rigidity to enable being driven into hard ground, with sufficient flexibility to resist shattering. Serrate the biodegradable stake on the leg to increase resistance to pull-out from the soil.

2.3.3 Staples

Staples shall be as recommended by the manufacturer.

PART 3 EXECUTION

3.1 WEATHER CONDITIONS

Perform erosion control operations under favorable weather conditions; when excessive moisture, frozen ground or other unsatisfactory conditions prevail, the work shall be stopped as directed. Do not apply erosion control materials in adverse weather conditions which could affect their performance.

3.1.1 Finished Grade

Verify that finished grades are as indicated on the drawings; complete finish grading and compaction in accordance with Section 31 00 00 EARTHWORK, prior to the commencement of the work. Verify and mark the location of underground utilities and facilities in the area of the work. Repair damage to underground utilities and facilities at the Contractor's expense.

3.1.2 Placement of Erosion Control Blankets

Before placing the erosion control blankets, ensure the subgrade has been graded smooth; has no depressed, void areas; is free from obstructions, such as tree roots, projecting stones or other foreign matter. Vehicles will not be permitted directly on the blankets.

3.2 SITE PREPARATION

3.2.1 Layout

Erosion control material locations may be adjusted to meet field conditions.

3.2.2 Protecting Existing Vegetation

Protect or replace existing vegetation after construction operations. Identify existing features that are to be preserved. Mitigate damage to existing trees at no additional cost to the Government.

3.2.3 Obstructions Below Ground

Consult with Government Contracting Officer Representative when obstructions below ground affect the work.

3.3 INSTALLATION

3.3.1 Mulch Installation

Install mulch in the areas indicated.

3.3.2 Non-Asphaltic Tackifier

Apply hydrophilic colloid at the rate recommended by the manufacturer, using hydraulic equipment suitable for thoroughly mixing with water. Apply a uniform mixture over the area.

3.3.3 Erosion Control Blankets

a. Install erosion control blankets as indicated and in accordance with manufacturer's recommendations.

b. Orient erosion control blankets in vertical strips and anchored with staples, as indicated. Abut adjacent strips to allow for installation of a common row of staples. Overlap horizontal joints between erosion control blankets sufficiently to accommodate a common row of staples with the uphill end on top.

c. Where exposed to overland sheet flow, locate a trench at the uphill termination. Staple the erosion control blanket to the bottom of the trench. Backfill and compact the trench as required.

d. Where terminating in a channel containing an installed blanket, the erosion control blanket shall overlap installed blanket sufficiently to accommodate a common row of staples.

3.4 CLEAN-UP

Dispose of excess material, debris, and waste materials offsite at an approved landfill or recycling center. Clear adjacent paved areas. Immediately upon completion of the installation in an area, protect the area against traffic or other use by erecting barricades and providing signage as required, or as directed.

-- End of Section --

SECTION 32 31 13

CHAIN LINK FENCES AND GATES
05/09

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A 116	(2005) Standard Specification for Metallic-Coated, Steel Woven Wire Fence Fabric
ASTM A 153/A 153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 702	(1989; R 2006) Standard Specification for Steel Fence Posts and Assemblies, Hot Wrought
ASTM A 780/A 780M	(2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A 90/A 90M	(2009) Standard Test Method for Weight of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
ASTM C 94/C 94M	(2009a) Standard Specification for Ready-Mixed Concrete
ASTM F 1043	(2008) Strength and Protective Coatings on Metal Industrial Chain-Link Fence Framework
ASTM F 1083	(2008) Standard Specification for Pipe, Steel, Hot-Dipped Zinc Coated (Galvanized) Welded, for Fence Structures
ASTM F 567	(2007) Standard Practice for Installation of Chain Link Fence
ASTM F 626	(2008) Standard Specification for Fence Fittings

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS RR-F-191/3	(Rev D) Fencing, Wire and Post, Metal (Chain-Link Fence Posts, Top Rails and Braces)

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Submit Erection/Installation Drawings for the following items in accordance with paragraph entitled, "Assembly and Installations Instructions," of this section.

Fence Assembly
Location of Gate, Corner, End, and Posts
Gate Assembly
Gate Hardware and Accessories

SD-03 Product Data

Submit Manufacturer's catalog data for the following items:

Fence Assembly
Gate Assembly
Gate Hardware and Accessories
Recycled material content

SD-07 Certificates

Submit Certificates of compliance in accordance with the applicable reference standards and descriptions of this section for the following items:

Zinc Coating
PVC coating
Fabric
Stretcher Bars
Gate Hardware and Accessories

1.3 ASSEMBLY AND INSTALLATION INSTRUCTIONS

Provide manufacturer's instructions that detail proper assembly and materials in the design for fence, gate, hardware and accessories.

Submit Erection/Installation drawings along with manufacturer's catalog data for Complete fence assembly, gate assembly, hardware assembly and accessories.

1.4 DELIVERY, STORAGE, AND HANDLING

Deliver materials to site in an undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact.

1.5 QUALITY ASSURANCE

1.5.1 Required Report Data

Submit reports of listing of chain-link fencing and accessories regarding weight in ounces for zinc coating and thickness of PVC coating.

PART 2 PRODUCTS

2.1 GENERAL

Provide fencing materials that conform to the requirements of ASTM A 116, ASTM A 702, ASTM F 626, and as specified.

Submit manufacturer's data indicating percentage of recycled material content in protective fence materials, including chain link fence, fabric, and gates to verify affirmative procurement compliance.

2.2 ZINC COATING

Provide hot-dip galvanized (after fabrication) ferrous-metal components and accessories, except as otherwise specified.

Provide zinc coating of weight not less than 1.94 ounces per square foot, as determined from the average result of two specimens, when tested in accordance with ASTM A 90/A 90M.

Provide zinc coating that conforms to the requirements of the following:

Pipe: FS RR-F-191/3 Class 1 Grade A in accordance with ASTM F 1083.

Hardware and accessories: ASTM A 153/A 153M, Table 1

Surface: ASTM F 1043

External: Type B-B surface zinc with organic coating, 0.97 ounce per square foot minimum thickness of acrylated polymer.

Internal: Surface zinc coating of 0.97 ounce per square foot minimum.

Provide galvanizing repair material that is cold-applied zinc-rich coating conforming to ASTM A 780/A 780M.

2.3 FABRIC

Provide fabric consisting of No. 9-gage wires woven into a 2-inch diamond mesh, with dimensions of fabric and wire conforming to ASTM A 116, ASTM A 702 and ASTM F 626, with 1.29 ounces per square foot zinc galvanizing.

Provide one-piece fabric widths for fence heights up to 12 feet.

2.4 TOP AND BOTTOM SELVAGES

Provide knuckled selvages at top and bottom for fabric with 2 inch mesh and up to 60 inches high, and if over 60 inches high, provide twisted and barbed top selvage and knuckled bottom selvage.

2.5 LINE POSTS

Minimum acceptable line posts are as follows:

Up to 6-feet high:

Grade A: 1.900 inch O.D. pipe weighing 2.72 pounds per linear foot.

Grade B: 2.375 inch O.D. pipe weighing 3.12 pounds per linear foot.

Over 6-feet high:

2.0 inch O.D. pipe weighing 3.65 pounds per linear foot.

2.6 END, CORNER, AND PULL POSTS

Provide minimally acceptable end, corner, and pull posts as follows:

Up to 6 feet high:

Grade A: 2.375 inch O.D. pipe weighing 3.65 pounds per linear foot.

Grade B: 2.375 inch O.D. pipe weighing 3.12 pounds per linear foot.

Over 6 feet high:

Grade A: 2.875 inch O.D. pipe weighing 5.79 pounds per linear foot.

Grade B: 2.875 inch O.D. pipe weighing 4.64 pounds per linear foot.

2.7 SLEEVES

Provide sleeves for setting into concrete construction of the same material as post sections, sized 1-inch greater than the diameter or dimension of the post. Weld flat plates to each sleeve base to provide anchorage and prevent intrusion of concrete.

2.8 TOP RAIL

Provide Grade A weighing 2.27 pounds per linear foot. Provide expansion couplings 6-inches long at each joint in top rails.

2.9 CENTER RAILS BETWEEN LINE POSTS

For fencing over 6-feet high, provide 1.660 inches O.D. pipe center rails, Grade A weighing 2.27 pounds per linear foot

2.10 POST-BRACE ASSEMBLY

Provide bracing consisting of 1.660 inches O.D. pipe Grade A weighing 2.27 pounds per linear foot and 3/8 inch adjustable truss rods and turnbuckles.

2.11 TENSION WIRE

Provide galvanized wire, No. 7-gage, coiled spring wire, provided at the bottom of the fabric only. Provide Zinc Coating that weighs not less than 1.6 ounces per square foot.

2.12 STRETCHER BARS

Provide bars that have one-piece lengths equal to the full height of the fabric with a minimum cross section of 3/16 by 3/4 inch, in accordance with ASTM A 116, ASTM A 702 and ASTM F 626.

2.13 POST TOPS

Provide tops that are steel, wrought iron, or malleable iron designed as a weathertight closure cap. Provide one cap for each post, unless equal protection is provided by a combination post-cap and barbed-wire supporting arm. Provide caps with an opening to permit through passage of the top rail.

2.14 STRETCHER BAR BANDS

Provide bar bands for securing stretcher bars to posts that are steel, wrought iron, or malleable iron spaced not over 15 inches on center. Bands may also be used in conjunction with special fittings for securing rails to posts. Provide bands with projecting edges chamfered or eased.

2.15 GATE POSTS

Provide a gate post for supporting each gate leaf as follows:

Up to 6-feet wide:

2.875 inch O.D. pipe Grade A weighing 5.79 pounds per linear foot.

Over 6 feet wide and up to 13 feet wide:

2.875 inch O.D. pipe Grade A weighing 5.79 pounds per linear foot.

2.16 GATES

For gate leaves up to 6-feet high or 6-feet wide, provide perimeter gate frames of 1.66 inch O.D. pipe Grade A weighing 2.27 pounds per linear foot.

For gate leaves over 6 feet high or 6 feet wide, provide perimeter gate frames of 1.90 inch O.D. pipe Grade A weighing 2.72 pounds per linear foot.

Provide gate frame assembly that is welded or assembled with special malleable or pressed-steel fittings and rivets to provide rigid connections. Install fabric with stretcher bars at vertical edges; stretcher bars may also be used at top and bottom edges. Attach stretcher bars and fabric to gate frames on all sides at intervals not exceeding 15 inches. Attach hardware with rivets or by other means which provides equal security against breakage or removal.

Provide diagonal cross-bracing, consisting of 3/8-inch diameter adjustable-length truss rods on welded gate frames, where necessary to obtain frame rigidity without sag or twist. Provide nonwelded gate frames with diagonal bracing.

2.17 GATE HARDWARE AND ACCESSORIES

Provide gate hardware and accessories that conforms to ASTM A 116, ASTM A 702, ASTM F 626, and be as specified:

Provide forged or pressed steel hinges to suit gate size, non-lift-off type, offset to permit 180-degree opening.

Provide latch that permits operation from either side of the gate, with a padlock eye provided as an integral part of the latch.

Provide stops and holders of malleable iron for vehicular gates.

Provide stops that automatically engage the gate and hold it in the open position until manually released.

If required, provide double gates with a cane bolt and ground-set keeper, with latch or locking device and padlock eye designed as an integral part.

2.18 MISCELLANEOUS HARDWARE

Provide miscellaneous hot-dip galvanized hardware as required.

2.19 WIRE TIES

Provide 9-gage galvanized steel wire for tying fabric to line posts,spaced 12 inches on center. For tying fabric to rails and braces, space wire ties 24 inches on center. For tying fabric to tension wire, space 0.105-inch hog rings 24 inches on center.

Manufacturer's standard procedure will be accepted if of equal strength and durability.

Provide wire ties constructed of the same material as the fencing fabric. If used, provide accessories with polyvinyl (PVC) coatings similar to that specified for chain-link fabric or framework.

2.20 CONCRETE

Provide concrete conforming to ASTM C 94/C 94M, and obtaining a minimum 28-day compressive strength of 3,000 psi.

2.21 GROUT

Provide grout of proportions one part portland cement to three parts clean, well-graded sand and a minimum amount of water to produce a workable mix.

PART 3 EXECUTION

Provide complete installation conforming to ASTM F 567.

3.1 GENERAL

Ensure final grading and established elevations are complete prior to commencing fence installation.

3.2 EXCAVATION

Provide excavations for post footings which are in virgin or compacted soil, of minimum sizes as indicated.

Space footings for line posts 10 feet on center maximum and at closer intervals when indicated, with bottoms of the holes approximately 3-inches below the bottoms of the posts. Set bottom of each post not less than 36-inches below finished grade when in firm, undisturbed soil. Set posts deeper, as required, in soft and problem soils and for heavy, lateral loads.

Remove excavated soil from Government property.

When solid rock is encountered near the surface, drill into the rock at least 12 inches for line posts and at least 18 inches for end, pull,

corner, and gate posts. Drill holes at least 1 inch greater in diameter than the largest dimension of the placed post.

If solid rock is below the soil overburden, drill to the full depth required except that penetration into rock need not exceed the minimum depths specified above.

3.3 SETTING POSTS

Remove loose and foreign materials from holes and the soil moistened prior to placing concrete.

Provide tops of footings that are trowel finished and sloped or domed to shed water away from posts. Set hold-open devices, sleeves, and other accessories in concrete.

Keep exposed concrete moist for at least 7 calendar days after placement or cured with a membrane curing material, as approved.

Grout all posts set into sleeved holes in concrete with an approved grouting material.

Maintain vertical alignment of posts set in concrete construction until concrete has set.

3.3.1 Earth and Bedrock

Provide concrete bases of dimensions indicated except in bedrock. Compact concrete to eliminate voids, and finish to a dome shape. In bedrock, set posts with a minimum of 1 inch of grout around each post. Work grout into hole to eliminate voids, and finish to a dome shape.

3.3.2 Concrete Slabs and Walls

Set posts into zinc-coated sleeves, set in concrete slab or wall, to a minimum depth of 12 inches. Fill sleeve joint with lead, nonshrink grout, or other approved material. Set posts for support of removable fence sections into sleeves that provide a tight sliding joint and hold posts aligned and plumb without use of lead or setting material.

3.3.3 Bracing

Brace gate, corner, end, and pull posts to nearest post with a horizontal brace used as a compression member, placed at least 12 inches below top of fence, and a diagonal tension rod.

3.4 CONCRETE STRENGTH

Provide Concrete that has attained at least 75 percent of its minimum 28-day compressive strength, but in no case sooner than 7 calendar days after placement, before rails, tension wire, or fabric are installed. Do not stretch fabric and wires or hang gates until the concrete has attained its full design strength.

Take samples and test concrete to determine strength as specified.

3.5 TOP RAILS

Provide top rails that run continuously through post caps or extension

arms, bending to radius for curved runs. Provide expansion couplings as recommended by the fencing manufacturer.

3.6 CENTER RAILS

Provide single piece center rails between posts set flush with posts on the fabric side, using special offset fittings where necessary.

3.7 BRACE ASSEMBLY

Provide bracing assemblies at end and gate posts and at both sides of corner and pull posts, with the horizontal brace located at midheight of the fabric.

Install brace assemblies so posts are plumb when the diagonal rod is under proper tension.

Provide two complete brace assemblies at corner and pull posts where required for stiffness and as indicated.

3.8 TENSION WIRE INSTALLATION

Install tension wire by weaving them through the fabric and tying them to each post with not less than 7-gage galvanized wire or by securing the wire to the fabric with 9-gage ties or 0.105 inch hog rings spaced 24 inches on center.

3.9 FABRIC INSTALLATION

Provide Fabric in single lengths between stretch bars with bottom barbs placed approximately 1-1/2-inches above the ground line. Pull fabric taut and tied to posts, rails, and tension wire with wire ties and bands.

Install fabric on the security side of fence, unless otherwise directed.

Ensure fabric remains under tension after the pulling force is released.

3.10 STRETCHER BAR INSTALLATION

Thread stretcher bars through or clamped to fabric 4 inches on center and secured to posts with metal bands spaced 15 inches on center.

3.11 GATE INSTALLATION

Install gates plumb, level, and secure, with full opening without interference. Install ground set items in concrete for anchorage as recommended by the fence manufacturer. Adjust hardware for smooth operation and lubricated where necessary.

3.12 TIE WIRES

Provide tie wires that are U-shaped to the pipe diameters to which attached. Twist ends of tie wires not less than two full turns and bent so as not to present a hazard.

3.13 FASTENERS

Install nuts for tension bands and hardware on the side of the fence opposite the fabric side. Peen ends of bolts to prevent removal of nuts.

3.14 ZINC-COATING REPAIR

Clean and repair galvanized surfaces damaged by welding or abrasion, and cut ends of fabric, or other cut sections with specified galvanizing repair material applied in strict conformance with the manufacturer's printed instructions.

3.15 TOLERANCES

Provide posts that are straight and plumb within a vertical tolerance of 1/4 inch after the fabric has been stretched. Provide fencing and gates that are true to line with no more than 1/2 inch deviation from the established centerline between line posts. Repair defects as directed.

3.16 SITE PREPARATION

3.16.1 Clearing and Grading

Clear fence line of trees, brush, and other obstacles to install fencing. Establish a graded, compacted fence line prior to fencing installation.

3.17 FENCE INSTALLATION

Install fence on prepared surfaces to line and grade indicated. Install fence in accordance with fence manufacturer's written installation instructions except as modified herein.

3.17.1 Post Spacing

Provide line posts spaced equidistantly apart, not exceeding 10 feeton center. Provide gate posts spaced as necessary for size of gate openings. Do not exceed 500 feet on straight runs between braced posts. Provide corner or pull posts, with bracing in both directions, for changes in direction of 15 degrees or more, or for abrupt changes in grade. Provide drawings showing location of gate, corner, end, and posts.

3.17.2 Top and Bottom Tension Wire

Install tension wires before installing chain-link fabric, and pull wires taut. Place top and bottom tension wires within 8 inches of respective fabric line.

3.18 ACCESSORIES INSTALLATION

3.18.1 Post Caps

Install post caps as indicated and as recommended by the manufacturer.

3.19 GROUNDING

Ground fences on each side of all gates, at each corner, at the closest approach to each building located within 50 feet of the fence, and where the fence alignment changes more than 15 degrees. Grounding locations can not exceed 1000 feet. Bond each gate panel with a flexible bond strap to its gate post. Ground fences crossed by powerlines of 600 volts or more at or near the point of crossing and at distances not exceeding 150 feet on each side of crossing. Provide ground conductor consisting of No. 8 AWG solid copper wire. Provide copper-clad steel rod grounding electrodes 3/4

inch by 10 foot long. Drive electrodes into the earth so that the top of the electrode is at least 6 inches below the grade. Where driving is impracticable, bury electrodes a minimum of 12 inches deep and radially from the fence, with top of the electrode not less than 2 feet or more than 8 feet from the fence. Clamp ground conductor to the fence and electrodes with bronze grounding clamps to create electrical continuity between fence posts, fence fabric, and ground rods. Total resistance of the fence to ground cannot exceed 25 ohms.

3.20 CLEANUP

Remove waste fencing materials and other debris from the work site.

-- End of Section --

SECTION 32 92 19

SEEDING
10/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C602	(2007) Agricultural Liming Materials

CONNECTICUT DEPARTMENT OF ENVIRONMENTAL PROTECTION (CTDEP)

CTDEP SESC	(2002) Guidelines for Soil Erosion and Sediment Controls (CTDEP Bulletin 34)

U.S. DEPARTMENT OF AGRICULTURE (USDA)

AMS Seed Act	(1940; R 1988; R 1998) Federal Seed Act

1.2 DEFINITIONS

1.3 RELATED REQUIREMENTS

Section 31 00 00 EARTHWORK, applies to this section for pesticide use and plant establishment requirements, with additions and modifications herein.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Fertilizer; G

Submit the fertilizer manufacturer's product data showing chemical analysis and percent composition.

Lime; G

Seed; G

Wood Cellulose Fiber Mulch; G

Binders for Mulch; G

Erosion Control Blankets; G

SD-07 Certificates

Grass seed vendor's certificate; G

Submit the seed vendor's certified statement for the grass seed mixture required, showing common name, percentage of seed mix by weight, percentages of purity and germination, year of production, date of packaging, and location of packaging.

Hydraulic Seeding Method; G

If the Hydraulic Seeding Method is used, submit a certified statement as to the number of pounds of materials to be used per 100 gallons of water, and specify the number of square feet of seeding that can be covered with the quantity of solution in the hdyroseeder.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

1.5.1.1 Seed Protection

Protect from drying out and from contamination during delivery, on-site storage, and handling.

1.5.1.2 Fertilizer and Lime Delivery

Deliver to the site in original, unopened containers bearing manufacturer's chemical analysis, name, trade name, trademark, and indication of conformance to state and federal laws. Instead of containers, fertilizer and lime may be furnished in bulk with certificate indicating the above information.

1.5.2 Storage

1.5.2.1 Seed, Fertilizer and Lime Storage

Store in cool, dry locations away from contaminants.

1.5.2.2 Topsoil

See Section 02 66 00 PROTECTIVE COVER SOIL, SELECT FILL, AND TOPSOIL FOR LANDFILL COVER.

1.5.2.3 Handling

Do not drop or dump materials from vehicles.

1.6 TIME RESTRICTIONS AND PLANTING CONDITIONS

1.6.1 Restrictions

Do not plant when the ground is frozen, muddy, or when air temperature exceeds 90 degrees Fahrenheit.

1.7 TIME LIMITATIONS

1.7.1 Seed

Apply seed within twenty four hours after seed bed preparation.

PART 2 PRODUCTS

2.1 MATERIALS

Obtain and retain as part of the project records, certifications, and/or labels of materials supplied.

Topsoil, fertilizer, lime, seed, and mulch shall not be utilized or placed within wetlands.

2.1.1 Topsoil

See Section 31 00 00 EARTHWORK. Existing soils within the cap limits are not to be reused for the project.

2.1.2 Fertilizer

Outside of wetland areas and where a soil nutrient analysis is not available, provide a standard commercial 10-10-10 grade containing at least 10 percent available nitrogen, 10 percent readily available phosphoric acid, and 10 percent total available potash in conformity with the Standards of the Association of Official Agricultural Chemists. Supply in unopened bags with the weight, contents and guaranteed analysis shown thereon or on a securely attached tag.

2.1.3 Lime

Commercial grade hydrate or burnt limestone containing a calcium carbonate equivalent (C.C.E.) as specified in ASTM C602 of not less than 89 percent. At least 85 percent shall pass a No. 10 mesh screen and 50 percent shall pass a No. 40 mesh screen.

2.1.4 Seed (Permanent Seed)

Shall meet the following minimum requirements:

a. Seeding mixture shall include no "primary noxious weed seeds."

b. Furnish in fully-labeled, standard sealed containers.

c. Percentage and germination of each seed type in the mixture, purity, and weed seed content of the mixture shall be clearly stated on the label.

d. Subject to the testing provisions of the Connecticut State Seed Law and with the Association of Official Seed Analysis, with the month and year of test clearly stated on the label.

e. Seed which has become wet, moldy, or otherwise damaged will not be acceptable.

f. Other suitable seed mix is acceptable if approved by the Owner's Representative and is recommended by the Town of Stratford.

g. For temporary seeding requirements, see Section 31 32 11 SOIL SURFACE EROSION CONTROL.

2.1.5 Mulch

a. Staw or Hay: Unrotted air dried, small grain straw, salt hay, or hay free from noxious weeds or undesirable seeds and coarse material.

b. Wood Cellulose Fiber: Having no growth or germination inhibiting materials.

c. Use of organic mulch within the wetlands of Small Pond and adjacent areas subject to flooding will not be permitted. Fiber biodegradable erosion control blankets shall be used, in lieu of organic mulch, within areas adjacent to Small Pond subject to flooding.

2.1.6 Binders for Mulch

Binder, if used, shall conform to CTDEP SESC Guidelines Chapter 5, Section 4. Emulsified asphalt binders shall not be used.

2.1.7 Erosion Control Blankets

See Section 31 32 11 SOIL SURFACE EROSION CONTROL for temporary matting which may be used for mulching.

2.2 SEED

2.2.1 Classification

Provide State-certified seed of the latest season's crop delivered in original sealed packages, bearing producer's guaranteed analysis for percentages of mixtures, purity, germination, weedseed content, and inert material. Label in conformance with AMS Seed Act and applicable state seed laws. Wet, moldy, or otherwise damaged seed will be rejected. Field mixes will be acceptable when field mix is performed on site in the presence of the Contracting Officer Representative.

2.2.2 Planting Dates

Optimum seeding dates for permanent seed are April 1 to May 15 and August 15 to October 1. When weather and soil conditions are suitable, other seeding times may be acceptable as approved by the Owner's Representative, otherwise provide temporary seeding in accordance with Section 31 32 11 SOIL SURFACE EROSION CONTROL.

2.2.3 Seed Purity

As indicated on Design Drawings.

2.2.4 Seed Mixture

Use seed mixtures as specified below.

2.2.4.1 Temporary Seeding

Perennial Rye Grass 40 lbs/acre (1 lb/1,000 sf) or other approved seeds. Temporary seeding must later be replaced by plantings for permanent vegetative cover.

2.2.4.2 Permanent Seeding (Inside Limits of Cap)

CT DOT All Purpose Mix (blend of 5 cultivars) 100 lbs/acre (2.3 lbs/1,000 sf).

SEED	Lbs/Acre	Lbs/1,000 SF	Minimum Purity (Percent)	Minimum Germination (Percent)
Chewing Fescue	35	0.80	97	80
Hard Fescue	30	0.70	96	85
Colonial Bentgrass	5	0.10	95	90
Birds-Foot Trefoil (Empire, Viking)	10	0.20	96	90
Perennial Ryegrass	20	0.20	96	90

Other suitable seed mix is acceptable if approved by the Contracting Officer Representative.

2.2.4.3 Permanent Seeding (Outside Limits of Cap)

New England Conservation/Wildlife Mix, New England Wetland Plants, Inc. 25 lbs/acre (0.58 lbs/1,000 sf) or other approved seeds. The Contractor shall have the New England Conservation/Wildlife Mix blended specifically to exclude Partridge Pea (Chamaecriota fasciculata) which has the potential to overtake other seed types as an invasive species.

2.3 SOIL CONDITIONERS

Conditioners may be added to topsoil as required to bring into compliance with standard for topsoil.

2.3.1 Lime

Commercial grade hydrate or burnt limestone containing a calcium carbonate equivalent (C.C.E.) as specified in ASTM C602 of not less than 89 percent.

2.3.2 Peat

Not applicable.

2.3.3 Sand

Clean and free of materials harmful to plants.

2.3.4 Perlite

Horticultural grade.

2.3.5 Composted Derivatives

Ground bark, nitrolized sawdust, humus or other green wood waste material free of stones, sticks, and soil stabilized with nitrogen and having the following properties:

2.3.5.1 Particle Size

Minimum percent by weight passing:

No. 4 mesh screen	95
No. 8 mesh screen	80

2.3.5.2 Nitrogen Content

Minimum percent based on dry weight:

Fir Sawdust	0.7
Fir or Pine Bark	1.0

2.3.6 Gypsum

Coarsely ground gypsum comprised of calcium sulfate dihydrate 61 percent, calcium 22 percent, sulfur 17 percent; minimum 96 percent passing through 20 mesh screen, 100 percent passing thru 16 mesh screen.

2.3.7 Calcined Clay

Calcined clay shall be granular particles produced from montmorillonite clay calcined to a minimum temperature of 1200 degrees F. Gradation: A minimum 90 percent shall pass a No. 8 sieve; a minimum 99 percent shall be retained on a No. 60 sieve; and a maximum 2 percent shall pass a No. 100 sieve. Bulk density: A maximum 40 pounds per cubic foot.

2.4 FERTILIZER

2.4.1 Granular Fertilizer

Standard commercial, granular controlled release fertilizer containing the following minimum percentages, by weight, of plant food nutrients:

10 percent available nitrogen
10 percent available phosphorus
10 percent available potassium

2.4.2 Hydroseeding Fertilizer

Controlled release fertilizer, to use with hydroseeding and composed of pills coated with plastic resin to provide a continuous release of nutrients for at least 6 months and containing the following minimum percentages, by weight, of plant food nutrients.

10 percent available nitrogen
10 percent available phosphorus

10 percent available potassium

2.5 MULCH

Mulch shall be free from noxious weeds, mold, and other deleterious materials.

2.5.1 Straw

Stalks from oats, wheat, rye, barley, or rice. Furnish in air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Straw shall contain no fertile seed.

2.5.2 Hay

Air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Hay shall be sterile, salt hay, or hay free from noxious weeds or undesirable seeds and coarse materials.

2.5.3 Wood Cellulose Fiber Mulch

Use recovered materials of either paper-based (100 percent) or wood-based (100 percent) hydraulic mulch. Processed to contain no growth or germination-inhibiting factors and dyed an appropriate color to facilitate visual metering of materials application. Composition on air-dry weight basis: 9 to 15 percent moisture, pH range from 5.5 to 8.2. Use with hydraulic application of grass seed and fertilizer.

2.6 WATER

Source of water shall be approved by Contracting Officer Representative and of suitable quality for irrigation, containing no elements toxic to plant life.

2.7 EROSION CONTROL MATERIALS

Erosion control material shall conform to the following:

2.7.1 Erosion Control Blanket

100 percent agricultural straw stitched with a biodegradable nettings, designed to degrade within 12 months.

2.7.2 Erosion Control Material Anchors

Erosion control anchors shall be as recommended by the manufacturer.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 EXTENT OF WORK

Provide soil preparation (including soil conditioners as required), fertilizing, seeding, and surface topdressing of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

3.2 SEEDING

3.2.1 Seed Application Seasons and Conditions

Immediately before seeding, restore soil to proper grade. Do not seed when ground is muddy or in an unsatisfactory condition for seeding. If special conditions exist that may warrant a variance in the above seeding dates or conditions, submit a written request to the Contracting Officer Representative stating the special conditions and proposed variance. Apply seed within twenty four hours after seedbed preparation. Sow seed by approved sowing equipment. Sow one-half the seed in one direction, and sow remainder at right angles to the first sowing.

3.2.2 Seed Application Method

Seeding method shall be broadcasted and drop seeding or hydroseeding.

3.2.2.1 Broadcast and Drop Seeding

Seed shall be uniformly broadcast at the rate of 150 pounds per acre. Use broadcast or drop seeders. Sow one-half the seed in one direction, and sow remainder at right angles to the first sowing. Cover seed uniformly to a maximum depth of 1/4 inch in clay soils and 1/2 inch in sandy soils by means of spike-tooth harrow, cultipacker, raking or other approved devices.

3.2.2.2 Hydroseeding

First, mix water and fiber. Wood cellulose fiber, paper fiber, or recycled paper shall be applied as part of the hydroseeding operation. Fiber shall be added at 1,000 pounds, dry weight, per acre. Then add and mix seed and fertilizer to produce a homogeneous slurry. Seed shall be mixed to ensure broadcasting at the rate of 165 pounds per acre. When hydraulically sprayed on the ground, material shall form a blotter like cover impregnated uniformly with grass seed. Spread with one application with no second application of mulch.

3.2.3 Mulching

3.2.3.1 Hay or Straw Mulch

Hay or straw mulch shall be spread uniformly at the rate of 2 tons per acre. Mulch shall be spread by hand, blower-type mulch spreader, or other approved method. Mulching shall be started on the windward side of relatively flat areas or on the upper part of steep slopes, and continued uniformly until the area is covered. The mulch shall not be bunched or clumped. Sunlight shall not be completely excluded from penetrating to the ground surface. All areas installed with seed shall be mulched on the same day as the seeding. Mulch shall be anchored immediately following spreading.

3.2.3.2 Non-Asphaltic Tackifier

Hydrophilic colloid shall be applied at the rate recommended by the manufacturer, using hydraulic equipment suitable for thoroughly mixing with water. A uniform mixture shall be applied over the area.

3.2.4 Rolling

Immediately after seeding, firm entire area except for slopes in excess of

3 to 1 with a roller not exceeding 90 pounds for each foot of roller width. If seeding is performed with cultipacker-type seeder or by hydroseeding, rolling may be eliminated.

3.2.5 Erosion Control Material

Install in accordance with manufacturer's instructions, where indicated or as directed by the Contracting Officer Representative.

3.2.6 Watering

Start watering areas seeded as required by temperature and wind conditions. Apply water at a rate sufficient to insure thorough wetting of soil to a depth of 2 inches without run off. During the germination process, seed is to be kept actively growing and not allowed to dry out.

-- End of Section --

SECTION 33 40 00

STORM DRAINAGE UTILITIES
02/10

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 198	(2008) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants
AASHTO M 294	(2009) Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm Diameter

ASTM INTERNATIONAL (ASTM)

ASTM C 443	(2005ae1) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C 877	(2008) External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections
ASTM C 923	(2008) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM C 923M	(2008b) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals (Metric)
ASTM D 1056	(2007) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D 1171	(1999; R 2007) Rubber Deterioration - Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens)
ASTM D 1557	(2009) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)

ASTM D 2167	(2008) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2321	(2008) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D 3212	(2007) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3350	(2008) Polyethylene Plastics Pipe and Fittings Materials
ASTM D 6938	(2008a) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Placing Pipe

SD-07 Certificates

Pipeline Testing
Hydrostatic Test on Watertight Joints
Determination of Density

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. Keep a copy of the manufacturer's instructions available at the construction site at all times and follow these instructions unless directed otherwise by the Contracting Officer Representative. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install plastic pipe shall be stored in accordance with the manufacturer's recommendations and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

1.3.2 Handling

Materials shall be handled in a manner that ensures delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not

dragged.

PART 2 PRODUCTS

2.1 PIPE FOR CULVERTS AND STORM DRAINS

Pipe for culverts and storm drains shall be of the sizes indicated and shall conform to the requirements specified. Culverts shall be HDPE pipe.

2.1.1 Perforated Piping

2.1.1.1 Corrugated HDPE Pipe

AASHTO M 252, Type S.

2.1.2 HDPE Pipe

The minimum cell classification for polyethylene plastic shall apply to each of the seven primary properties of the cell classification limits in accordance with ASTM D 3350.

2.1.2.1 Corrugated HDPE Pipe

AASHTO M 294, Type S. For slow crack growth resistance, acceptance of resins shall be determined by using the notched constant ligament-stress (NCLS) test meeting the requirements of AASHTO M 294. Pipe walls shall have the following properties:

Nominal Size (in.)	Minimum Wall Area (square in/ft)	Minimum Moment of Inertia of Wall Section (in to the 4th/in)
12	1.50	0.024
15	1.91	0.053
18	2.34	0.062
24	3.14	0.116

2.2 MISCELLANEOUS MATERIALS

2.2.1 Joints

2.2.1.1 Flexible Watertight Joints

a. Materials: Flexible watertight joints shall be made with plastic or rubber-type gaskets with factory-fabricated resilient materials. Factory-fabricated resilient joint materials shall conform to ASTM C 923M. Gaskets shall have not more than one factory-fabricated splice, except that two factory-fabricated splices of the rubber-type gasket are permitted if the nominal diameter of the pipe being gasketed exceeds 54 inches.

b. Test Requirements: Watertight joints shall be tested and shall meet test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS. Rubber gaskets shall comply with the oil resistant gasket requirements of ASTM C 443. Certified copies of test results shall be delivered to the Contracting Officer Representative before gaskets or jointing materials are installed. Alternate types of watertight joint may be

furnished, if specifically approved.

2.2.1.2 External Sealing Bands

Requirements for external sealing bands shall conform to ASTM C 877.

2.2.1.3 Flexible Watertight, Gasketed Joints

a. Gaskets: When infiltration or exfiltration is a concern for pipe lines, the couplings may be required to have gaskets. The closed-cell expanded rubber gaskets shall be a continuous band approximately 7 inches wide and approximately 3/8 inch thick, meeting the requirements of ASTM D 1056, Type 2 A1, and shall have a quality retention rating of not less than 70 percent when tested for weather resistance by ozone chamber exposure, Method B of ASTM D 1171. Rubber O-ring gaskets shall be 13/16 inch in diameter for pipe diameters of 36 inches or smaller and 7/8 inch in diameter for larger pipe having 1/2 inch deep end corrugation. Rubber O-ring gaskets shall be 1-3/8 inches in diameter for pipe having 1 inch deep end corrugations. O-rings shall meet the requirements of AASHTO M 198 or ASTM C 443. Flexible plastic gaskets shall conform to requirements of AASHTO M 198, Type B.

b. Connecting Bands: Connecting bands shall be of the type, size and sheet thickness of band, and the size of angles, bolts, rods and lugs as indicated or where not indicated as specified in the applicable standards or specifications for the pipe. Exterior rivet heads in the longitudinal seam under the connecting band shall be countersunk or the rivets shall be omitted and the seam welded. Watertight joints shall be tested and shall meet the test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS.

2.2.1.4 Corrugated HDPE Plastic Pipe

Pipe joints shall be soil tight and shall conform to the requirements in AASHTO M 294.

2.3 RESILIENT CONNECTORS

Flexible, watertight connectors used for connecting pipe shall conform to ASTM C 923.

2.4 HYDROSTATIC TEST ON WATERTIGHT JOINTS

2.4.1 HDPE Pipe

At the discretion of the Contracting Officer Representative, a hydrostatic test shall be made on the watertight joint types by the Contractor. Only one sample joint of each type needs testing; however, if the sample joint fails because of faulty design or workmanship, an additional sample joint may be tested. During the test period, gaskets or other jointing material shall be protected from extreme temperatures which might adversely affect the performance of such materials. Test requirements for HDPE plastic pipe shall conform to ASTM D 3212.

2.5 EROSION CONTROL RIPRAP

Provide nonerodible rock as specified in Section 31 00 00 EARTHWORK to provide a dense mass with a minimum thickness as indicated on the Contract Drawings.

PART 3 EXECUTION

3.1 EXCAVATION FOR PIPE

Excavation and backfilling for culverts shall be in accordance with the applicable portions of Section 31 00 00 EARTHWORK and the requirements specified below.

3.1.1 Removal of Unstable Material

Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the Contracting Officer Representative, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in paragraph BACKFILLING. When removal of unstable material is due to the fault or neglect of the Contractor while performing shoring and sheeting, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the Government.

3.2 BEDDING

The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe.

3.2.1 Plastic Pipe

Bedding for HDPE shall be in accordance with CPPA 100. Installation of Perforated HDPE shall conform to ASTM D 2321. Do not use ASTM D 2321 Class IV or V materials for bedding, haunching or initial backfill materials.

3.3 PLACING PIPE

Install piping in accordance with manufacturer’s recommendations.

Each pipe shall be thoroughly examined before being laid; defective or damaged pipe shall not be used. Plastic pipe shall be protected from exposure to direct sunlight prior to laying, if necessary to maintain adequate pipe stiffness and meet installation deflection requirements. Pipelines shall be laid to the grades and alignment indicated. Pipe shall not be laid in water, and pipe shall not be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. Deflection of installed flexible pipe shall not exceed the following limits:

TYPE OF PIPE	MAXIMUM ALLOWABLE DEFLECTION (%)
Plastic (HDPE)	5

Note post installation requirements of paragraph 'Deflection Testing' in PART 3 of this specification for all pipe products including deflection testing requirements for flexible pipe.

3.3.1 Corrugated HDPE Pipe

Installation shall be in accordance with CPPA 100. Laying shall be with

the separate sections joined firmly on a bed shaped to line and grade and shall follow manufacturer's recommendations.

3.4 BACKFILLING

3.4.1 Backfilling Pipe in Trenches

After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 6 inches in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation equal to an elevation of at least 12 inches above the top of the pipe for flexible pipe. The remainder of the trench shall be backfilled and compacted according to manufacturers recommendations. Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below.

3.4.2 Backfilling Pipe in Fill Sections

For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified below. The fill material shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 6 inches in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12 inches above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 12 feet, whichever is less. After the backfill has reached at least 12 inches above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 6 inchescompacted. Use select granular material for this entire region of backfill for flexible pipe installations.

3.4.3 Movement of Construction Machinery

When compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert or storm drain at any stage of construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.

3.4.4 Compaction

3.4.4.1 General Requirements

Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, clays, silts, and very fine sands. When results of compaction tests for moisture-density relations are recorded on graphs, cohesionless soils will show straight lines or reverse-shaped moisture-density curves, and cohesive soils will show normal moisture-density curves.

3.4.4.2 Minimum Density

Backfill over and around the pipe and backfill around and adjacent to drainage structures shall be compacted at the approved moisture content to the following applicable minimum density, which will be determined as specified below.

a. Under unpaved or turfed traffic areas, density shall not be less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material.

b. Under nontraffic areas, density shall be not less than that of the surrounding material.

3.4.5 Determination of Density

Testing is the responsibility of the Contractor and performed at no additional cost to the Government. Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Tests shall be performed in sufficient number to ensure that specified density is being obtained. Laboratory tests for moisture-density relations shall be made in accordance with ASTM D 1557 except that mechanical tampers may be used provided the results are correlated with those obtained with the specified hand tamper. Field density tests shall be determined in accordance with ASTM D 2167 or ASTM D 6938. When ASTM D 6938 is used, the calibration curves shall be checked and adjusted, if necessary, using the sand cone method as described in paragraph Calibration of the referenced publications. ASTM D 6938 results in a wet unit weight of soil and ASTM D 6938 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D 6938. Test results shall be furnished the Contracting Officer Representative. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed.

3.5 PIPELINE TESTING

3.5.1 Deflection Testing

No sooner than 30 days after completion of installation and final backfill, an initial post installation inspection shall be accomplished. Clean or flush all lines prior to inspection. Perform a deflection test on entire length of installed flexible pipeline on completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads. Deflection of pipe in the installed pipeline under external loads shall not exceed limits in paragraph PLACING PIPE above as percent of the average inside diameter of pipe. Determine whether the allowable deflection has been exceeded by use of a laser profiler or mandrel.

a. Laser Profiler Inspection: If deflection readings in excess of the allowable deflection of average inside diameter of pipe are obtained, remove pipe which has excessive deflection, and replace with new pipe. Initial post installation inspections of the pipe interior with laser profiling equipment shall utilize low barrel distortion video equipment for pipe sizes 48 inches or less. Use a camera with lighting suitable to allow a clear picture of the entire periphery of the pipe interior. Center the camera in the pipe both vertically and horizontally and be

able to pan and tilt to a 90 degree angle with the axis of the pipe rotating 360 degrees. Use equipment to move the camera through the pipe that will not obstruct the camera's view or interfere with proper documentation of the pipe's condition. The video image shall be clear, focused, and relatively free from roll static or other image distortion qualities that would prevent the reviewer from evaluating the condition of the pipe. For initial post installation inspections for pipe sizes larger than 48 inches, visual inspection shall be completed of the pipe interior.

b. Pull-Through Device Inspection: Pass the pull-through device through each run of pipe by pulling it by hand. If deflection readings in excess of the allowable deflection of average inside diameter of pipe are obtained, retest pipe by a run from the opposite direction. If retest continues to show excess allowable deflections of the average inside diameter of pipe, remove pipe which has excessive deflection, replace with new pipe, and completely retest in same manner and under same conditions. Pull-through device: The mandrel shall be rigid, nonadjustable having a minimum of 9 fins, including pulling rings at each end, engraved with the nominal pipe size and mandrel outside diameter. The mandrel shall be 5 percent less than the certified-actual pipe diameter for Plastic Pipe, 5 percent less than the certified-actual pipe diameter for Corrugated Steel and Aluminum Alloy, 3 percent less than the certified-actual pipe diameter for Concrete-Lined Corrugated Steel and Ductile Iron Culvert provided by manufacturer. When mandrels are utilized to verify deflection of flexible pipe products, the Government will verify the mandrel OD through the use of proving rings that are manufactured with an opening that is certified to be as shown above.

c. Deflection measuring device: Shall be approved by the Contracting Officer Representative prior to use.

d. Warranty period test: Pipe found to have a deflection of greater than allowable deflection in paragraph PLACING PIPE above, just prior to end of one-year warranty period shall be replaced with new pipe and tested as specified for leakage and deflection. Inspect 100 percent of all pipe systems under the travel lanes, including curb and gutter. Random inspections of the remaining pipe system outside of the travel lanes shall represent at least 10 percent of the total pipe footage of each pipe size. Inspections shall be made, depending on the pipe size, with video camera or visual observations. In addition, for flexible pipe installations, perform deflection testing on 100 percent of all pipes under the travel lanes, including curb and gutter, with either a laser profiler or 9-fin mandrel. For flexible pipe, random deflection inspections of the pipe system outside of the travel lanes shall represent at least 10 percent of the total pipe footage of each pipe size. When mandrels are utilized to verify deflection of flexible pipe products during the final post installation inspection, the Government will verify the mandrel OD through the use of proving rings.

3.5.2 Post-Installation Inspection

One hundred percent of all flexible pipes (HDPE) shall be checked for rips, tears, joint separations, soil migration through the joint, cracks, localized bucking, bulges, settlement and alignment.

a. Replace pipes having cracks greater than 0.1 inches in width or deflection greater than 5 percent deflection. An engineer shall

evaluate all pipes with cracks greater than 0.01 inches but less than 0.10 inches to determine if any remediation or repair is required. Repair or replace any pipe with crack exhibiting displacement across the crack, exhibiting bulges, creases, tears, spalls, or delamination.

b. Reports: The deflection results and finial post installation inspection report shall include: a copy of all video taken, pipe location identification, equipment used for inspection, inspector name, deviation from design, grade, deviation from line, deflection and deformation of flexible pipe systems, inspector notes, condition of joints, condition of pipe wall (e.g. distress, cracking, wall damage dents, bulges, creases, tears, holes, etc.).

-- End of Section --

APPENDIX D

DRAWINGS

RAYMARK INDUSTRIES, INC. SUPERFUND SITE

REMEDIAL DESIGN OF A LANDFILL CAP
576/600 EAST BROADWAY, STRATFORD, CONNECTICUT

VICINITY MAP

0 2000 4000 8000
SCALE IN FEET

LOCATION MAP

0 250 500 1000
SCALE IN FEET

ENGINEERING FIRM:

AMEC ENVIRONMENT & INFRASTRUCTURE, INC.
2 ROBBINS ROAD
WESTFORD, MASSACHUSETTS 01886
(978) 692-9090

LAND SURVEYOR:

CONKLIN & SOROKA, INC.
1484 HIGHLAND AVENUE
CHESHIRE, CONNECTICUT 06410
(203) 272-1135

DRAWING INDEX

G-001	COVER SHEET
G-002	GENERAL NOTES AND LEGEND
C-101	EXISTING CONDITIONS PLAN
C-102	EXCAVATION AND SEDIMENTATION CONTROL PLAN
C-103	SUBGRADE PLAN
C-104	FINAL GRADING PLAN
C-301	SOIL EROSION & SEDIMENT CONTROL DETAILS
C-302	SOIL EROSION & SEDIMENT CONTROL NOTES
C-303	CIVIL DETAILS
C-304	GAS VENT DETAILS & CULVERT DETAILS
C-501	CROSS SECTIONS

CONTACT INFORMATION:

US ENVIRONMENTAL PROTECTION AGENCY
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100% FINAL REMEDIAL DESIGN

US Army Corps of Engineers
New England District

REV	DESCRIPTION	DATE	APPR.
D	100% FINAL REMEDIAL DESIGN	6/27/14	
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B	95% PRE-FINAL DESIGN FOR REVIEW	7/12/13	
A	60% DESIGN FOR REVIEW	7/20/12	

DESIGNED BY: SHM
DWN BY: RHH
CKD BY: MAP
SUBMITTED BY:
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FILE NAME: FILE NAME
DATE: DATE
SOLICITATION NO.: SOLICITATION NO.
CONTRACT NO.: CONTRACT NO.
FILE NUMBER: FILE NO.

U.S. ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
CONNECTICUT

amec
AMEC ENVIRONMENT & INFRASTRUCTURE, INC.
WESTFORD, MASSACHUSETTS 01886
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REMEDIAL DESIGN OF A LANDFILL CAP
576/600 EAST BROADWAY
STRATFORD, CONNECTICUT

COVER SHEET

SHEET IDENTIFICATION
G-001
SHEET 1 OF 11

FILE NAME: Z:\Projects\USACE\RAYMARK-OU6\OU6-G-001.dwg PLOT DATE: Fri, 27 Jun 2014 PLOT TIME: 12:58 PM

GENERAL NOTES

1. COORDINATE USE OF SITE WITH USACE, USEPA, CT DEEP, THE ENGINEER, THE SITE OWNER AND THE TOWN OF STRATFORD.

2. CONTRACTOR SHALL VISUALLY INSPECT THE SITE TO ASCERTAIN THE CONDITION OF EXISTING FEATURES AND FAMILIARIZE THEMSELVES WITH THE PROPOSED WORK.

3. THE CONTRACTOR SHALL BE RESPONSIBLE TO MEET THE SUBSTANTIVE REQUIREMENTS OF ALL NECESSARY PERMITS, INCLUDING BUT NOT LIMITED TO FOLLOWING:
   - SOIL EROSION AND SEDIMENT CONTROL PERMIT
   - NPDES PERMIT
   - GENERAL CONSTRUCTION PERMIT
   - WETLAND IMPACT PERMIT
   - FLOODPLAIN ENCROACHMENT PERMIT
   - PERIMETER AIR MONITORING PERMIT

4. KNOWN UNDERGROUND UTILITIES AND STRUCTURES ARE SHOWN ON THE DRAWINGS. THE LOCATION OF THESE EXISTING UNDERGROUND UTILITIES AND STRUCTURES SHOULD BE CONSIDERED APPROXIMATE. THEREFORE, PRIOR TO THE COMMENCEMENT OF SITE ACTIVITIES, THE CONTRACTOR SHALL VERIFY THE LOCATION OF ALL EXISTING UTILITIES OR STRUCTURES IN THE AREAS OF WORK (CALL BEFORE YOU DIG: CT CALL 1-800-922-4455 OR DIAL 811). IF UTILITIES ARE TO REMAIN IN PLACE, PROVIDE ADEQUATE MEANS OF PROTECTION. THE CONTRACTOR SHALL CONFIRM THAT ANY ABANDONED UTILITY LOCATED WITHIN THE LIMIT OF WORK HAS BEEN ABANDONED IN ACCORDANCE WITH THE REQUIREMENTS OF THE UTILITY OWNER AND THE TOWN OF STRATFORD.

5. RAYMARK WASTE IS LOCATED ON THE SITE AND IN PORTIONS OF THE 100-YR FLOODPLAIN. RAYMARK WASTE IS KNOWN TO CONTAIN VOLATILE ORGANIC COMPOUNDS (VOCS), SEMI-VOLATILE ORGANIC COMPOUNDS (SVOCS), POLY CHLORINATED BIPHENYLS (PCBS), PESTICIDES, DIOXINS AND FURANS, METALS (PRIMARILY LEAD AND COPPER), AND ASBESTOS. RAYMARK WASTE IN SOIL IS DEFINED AS A SINGLE SOIL SAMPLE CONTAINING LEAD ABOVE 400 PARTS PER MILLION (PPM), AND ASBESTOS (CHRYSOTILE ONLY) GREATER THAN 1 PERCENT, AND EITHER COPPER ABOVE 288 PPM OR POLYCHLORINATED BIPHENYLS (PCBS) (AROCLOR 1268 ONLY) ABOVE 1 PPM.

6. THE CONTRACTOR IS RESPONSIBLE FOR THE DESIGN AND IMPLEMENTATION OF AN APPROVED AIR MONITORING PROGRAM IN ACCORDANCE WITH THE SPECIFICATIONS IN SECTION 01 35 29.13.

7. ON-SITE DISTURBED AREAS SHALL BE FINISHED WITH TOPSOIL AND SEEDED OR FINISHED WITH A GRAVEL SURFACE IN ACCORDANCE WITH THE DRAWINGS AND SPECIFICATIONS IN SECTIONS 02 66 00 AND 32 92 19.

8. A DECONTAMINATION PAD SHALL BE PROVIDED TO DECONTAMINATE TRUCKS PRIOR TO EXITING THE SITE. THE DECONTAMINATION PAD MAY BE RELOCATED AS REQUIRED.

9. CONSTRUCTION WATER MANAGEMENT WILL BE REQUIRED DURING EXCAVATION ACTIVITIES. SURFACE WATER RUNOFF IS TO BE DIVERTED FROM FLOWING INTO EXCAVATION. SURFACE WATER RUNOFF WILL NOT BE DIVERTED TO FERRY CREEK OR LONGBROOK TRIBUTARY WITHOUT APPROPRIATE STORM WATER TREATMENT IN CONFORMANCE WITH THE CT GUIDELINES FOR SOIL EROSION AND SEDIMENT CONTROL.

10. EXCAVATION DEWATERING MAY BE REQUIRED. THE SEASONAL HIGH GROUNDWATER TABLE AVERAGE DEPTH IS 6 FEET. SOIL EXCAVATION WILL BE CONDUCTED TO APPROXIMATELY 4 FEET BELOW GROUND SURFACE DEPENDING ON THE LOCATION OF RAYMARK WASTE. ANY NECESSARY TREATMENT AND DISCHARGE OF DEWATERING WATER WILL BE PERFORMED IN ACCORDANCE WITH ALL FEDERAL, STATE AND LOCAL REGULATIONS AS DESCRIBED IN THE SPECIFICATIONS.

11. SEQUENCING OF SITE PREPARATION AND DEMOLITION ACTIVITIES SHALL BE COORDINATED WITH THE SEQUENCE OF RAYMARK WASTE EXCAVATION.

12. DELINEATION OF EXCAVATION LIMITS AND DEPTHS ARE BASED ON THE LIMITS OF RAYMARK WASTE IMPACT ESTABLISHED DURING THE SOIL SAMPLING AND TESTING PROGRAMS CONDUCTED DURING REMEDIAL INVESTIGATION ACTIVITIES TO ESTABLISH WASTE LIMITS. CONTRACTOR SHALL PREPARE AND IMPLEMENT A POST EXCAVATION CONFIRMATION SAMPLING PLAN. THE PLAN SHALL BE SUBMITTED AND APPROVED BY EPA AND CTDEEP PRIOR TO IMPLEMENTATION.

13. RAYMARK WASTE SHALL BE LOADED DIRECTLY INTO HAUL TRUCKS TO THE EXTENT PRACTICAL, TRANSPORTED TO THE CAP AREA, SPREAD, GRADED AND COMPACTED. RAYMARK WASTE SHALL BE COVERED AS SOON AS PRACTICAL TO PREVENT WIND BLOWN ASBESTOS. RAYMARK WASTE REMOVED FROM THE SITE MUST BE TRANSPORTED IN HAUL TRUCKS THAT ARE COMPLIANT WITH ALL ASBESTOS HANDLING REQUIREMENTS.

14. THE CONTRACTOR IS RESPONSIBLE FOR MAINTAINING SAFE WORKING CONDITIONS THROUGHOUT THE PROJECT INCLUDING, BUT LIMITED TO SHORING, SHEETING AND OTHER SOIL EXCAVATION ACTIVITIES, TRANSPORTATION OF MATERIALS, GRADING, COMPACTION AND CAP INSTALLATION. THE CONTRACTOR IS ALSO RESPONSIBLE FOR INSURING PUBLIC SAFETY THROUGH WORK PRACTICES.

15. SOME EXCAVATION AREAS WILL BE PERFORMED ADJACENT TO OPEN WATER BODIES. CONTRACTOR IS TO DESIGN SOIL RETENTION SYSTEMS FOR ALL EXCAVATION AREAS, AND SUBMIT TO CONTRACTING OFFICER AND CT DEEP FOR REVIEW AND APPROVAL. EXCAVATIONS PERFORMED ADJACENT TO OPEN WATER BODIES MUST COMPLY WITH PERMIT AND REGULATION REQUIREMENTS.

16. DURING EXCAVATION ACTIVITIES, PROTECT THE EXPOSED SOIL FROM EXCESS DRYING (KEEP MOIST BUT NOT WET) FOR DUST CONTROL PURPOSES, SEE THE CT GUIDELINES FOR SOIL EROSION AND SEDIMENT CONTROL CHAPTER 5, SECTION 2, DUST CONTROL. PROTECT CUT SLOPES FROM EROSION DUE TO PRECIPITATION OR STORM RUNOFF AND DETERIORATION DUE TO CONSTRUCTION ACTIVITIES (FOOT OR EQUIPMENT TRAFFIC).

17. FAIRFIELD COUNTY SOIL AND WATER CONSERVATION DISTRICT WILL BE NOTIFIED 72 HOURS PRIOR TO THE START OF WORK. ALSO PROVIDE NOTICE TO THE TOWN OF STRATFORD CONVERSATION OFFICER (BRIAN CAREY) AND THE STRATFORD HEALTH DEPARTMENT (ANDREA BOISSEVAIN).
   - FAIRFIELD COUNTY SOIL AND WATER CONSERVATION DISTRICT (203) 744-6108
   - TOWN OF STRATFORD CONVERSATION OFFICER (203) 385-4080
   - TOWN OF STRATFORD HEALTH DEPARTMENT (203) 385-4090

18. ELEVATIONS ARE BASED ON CONNECTICUT STATE PLANE NAD83 AND NAVD88.

19. ALL STOCKPILES ARE TO BE LOCATED IN AREAS ABOVE THE SITE FLOOD PLAIN.

20. FOR REQUIREMENTS RELATED TO SUBGRADE PREPARATION AND PLACEMENT OF MATERIALS WITHIN THE CAP AREA REFER TO THE "EARTHWORK" SPECIFICATION.

21. CONTRACTOR SHALL FIELD VERIFY DIMENSIONS AND CHECK FOR CLEARANCES PRIOR TO STARTING WORK. ACTUAL FIELD CONDITIONS MAY VARY FROM THOSE ILLUSTRATED IN THE DRAWINGS. NOTIFY USACE IF FIELD CONDITIONS CONFLICT WITH THE DESIGN.

22. PERFORM ALL WORK IN COMPLIANCE WITH ALL LOCAL, STATE, AND FEDERAL CODES AND ORDINANCES. PERFORM ALL SURVEYS AND NOTIFICATIONS, AND PROVIDE ALL MATERIALS AND DETAILS REQUIRED FOR COMPLIANCE. INSPECT AND RECORD FIELD CONSTRUCTION TO DOCUMENT COMPLIANCE.

23. GROUNDWATER MONITORING WELLS ENCOUNTERED WITHIN THE EXCAVATION AREAS, SHALL BE DECOMMISSIONED, SEALED, AND ABANDONED WITH PERMIT AND IN COMPLIANCE WITH ALL CODE REQUIREMENTS. OBTAIN WELL ABANDONMENT PERMITS, AND PROVIDE RECORD COPIES TO THE CONTRACTING OFFICER.

24. GROUNDWATER MONITORING WELLS TO REMAIN SHALL BE PROTECTED FROM DAMAGE BY CONSTRUCTION ACTIVITIES AT ALL TIMES. WELLS DAMAGED BY THE CONTRACTOR SHALL BE REPAIRED OR REPLACED BY THE CONTRACTOR AT NO COST TO THE GOVERNMENT.

GENERAL NOTES (CONT.)

25. CONTRACTOR SHALL PROTECT ALL MAILBOXES, TREES, BUSHES, FENCES, STONE WALLS AND ALL OTHER PERSONAL AND PUBLIC PROPERTY FROM DAMAGE. CONTRACTOR SHALL REPAIR OR REPLACE TREES, BUSHES, FENCES, WALLS OR OTHER PERSONAL AND PUBLIC PROPERTY DAMAGED BY CONSTRUCTION AT NO COST TO THE TOWN OF STRATFORD, GOVERNMENT AND/OR OWNER.

26. EXISTING PROPERTY AND RIGHT-OF-WAY PINS AND MONUMENTATION SHALL NOT BE DISTURBED BY CONSTRUCTION. IF DISTURBED, THEY SHALL BE RESET TO THEIR ORIGINAL LOCATIONS AT THE CONTRACTOR'S EXPENSE BY A REGISTERED CONNECTICUT PROFESSIONAL LAND SURVEYOR UNLESS OTHERWISE DIRECTED BY THE OWNER.

27. THE CONTRACTOR SHALL MONITOR WEATHER CONDITIONS AND SUBMIT A CONTIGENCY PLAN FOR REVIEW AND APPROVAL, FOR A MAJOR STORM EVENT.

DEMOLITION NOTES:

1. BITUMINOUS PAVEMENT SHALL BE DEMOLISHED AND REMOVED FROM EXCAVATION AREAS AS DELINEATED. PAVEMENT SHALL BE SAW CUT AT LIMITS OF REMOVAL PRIOR TO RESTORATION.

2. SHOULD UNCHARTED, OR INCORRECTLY CHARTED, PIPING OR OTHER UTILITIES BE ENCOUNTERED DURING PERFORMANCE OF WORK, CONSULT THE UTILITY OWNER AND ENGINEER IMMEDIATELY FOR DIRECTION.

3. THE CONTRACTOR SHALL BE PERMITTED TO SALVAGE ANY EQUIPMENT OR MATERIALS HE/SHE DEEMS FOR THAT PURPOSE. ALL SALVAGE MATERIALS SHALL BE DECONTAMINATED IF NECESSARY PRIOR TO REMOVAL. ALL SALVAGED MATERIALS SHALL BE REMOVED FROM THE SITE IMMEDIATELY. NO SUCH MATERIALS SHALL BE STORED ON THE SITE. ABSOLUTELY NO SALE OF SALVAGED MATERIALS WILL BE ALLOWED ON THE SITE. ANY SALVAGED MATERIALS SHALL BE REMOVED AND TRANSPORTED OFF SITE IN A LEGAL MANNER.

4. THE CONTRACTOR SHALL DISPOSE OF ALL DEMOLITION WASTES IN ACCORDANCE WITH ALL APPLICABLE REGULATIONS AND REQUIREMENTS.

5. EXISTING BUILDINGS ON THE SITE ARE SCHEDULED TO REMAIN DURING REMEDIATION ACTIVITES AND ALL ACTIVE UTILITIES SHALL BE PROTECTED. IF IT IS DETERMINED THE BUILDINGS MUST BE REMOVED TO COMPLETE REMEDIAL CONSTRUCTION THE DEMOLITION WORK SHALL BE COMPLETED UNDER A SEPARATE CONTRACT.

STORMWATER MANAGEMENT AND EROSION CONTROL:

1. CONTRACTOR TO PERFORM ALL WORK IN ACCORDANCE WITH THE PROJECT STORMWATER POLLUTION PREVENTION PLAN.

TRAFFIC CONTROL NOTES:

1. MAINTENANCE OF TRAFFIC:
   A. CONTRACTOR SHALL BE RESPONSIBLE FOR SCHEDULING AND PERFORMING WORK IN SUCH A MANNER TO PROVIDE SAFE PASSAGE FOR PUBLIC TRAFFIC AT ALL TIMES WITH MINIMUM OBSTRUCTION TO TRAFFIC.

   B. PRIOR TO START OF WORK, CONTRACTOR SHALL SUBMIT A TRAFFIC CONTROL PLAN IN ACCORDANCE WITH MUTCD AND CTDOT GUIDELINES FOR REVIEW BY THE OWNER AND ENGINEER.

   C. CONTRACTOR SHALL MAINTAIN TWO-WAY TRAFFIC OVER THE AREA DURING THE WORK DAY AND SHALL PROVIDE NECESSARY TRAFFIC BARRELS, BARRICADES, WARNING SIGNS, FLAGS AND FLAGGER TO ACCOMPLISH THIS. FURTHER, THE CONTRACTOR SHALL LEAVE THE AREA IN A SATISFACTORY STATE, ACCEPTABLE TO THE ENGINEER, AT THE END OF EACH DAY SO AS TO PROVIDE TWO-WAY (I.E. TWO LANE) TRAFFIC DURING THE NIGHT AND OVER THE WEEKEND. ACCESS TO ALL DRIVEWAYS MUST BE PROVIDED AT THE CLOSE OF EACH WORK DAY.

   D. CONTRACTOR SHALL CONSULT WITH ENGINEER, OWNER, POLICE DEPARTMENT AND THE FIRE DEPARTMENT PRIOR TO ANY STREET CLOSINGS UNDER THE APPROVED TRAFFIC CONTROL PLAN DURING THE TERM OF CONSTRUCTION. CONTRACTOR SHALL MAINTAIN SAFE PEDESTRIAN ACCESS TO BUILDINGS AT ALL TIMES.

   E. CONTRACTOR SHALL PROVIDE CERTIFIED AND EQUIPPED FLAGGERS TO REGULATE TRAFFIC EVERY DAY THAT CONSTRUCTION CREWS ARE ON SITE. FLAGGERS WHO, IN THE OPINION OF THE TOWN OF STRATFORD'S CHIEF OF POLICE, DIRECTOR OF PUBLIC WORKS, OR ENGINEER, ARE DEEMED TO BE INEFFECTUAL DURING THE COURSE OF THE WORK SHALL BE REMOVED FROM THE SITE AND REPLACED WITH ANOTHER CERTIFIED FLAGGER.

   F. THE CONTRACTOR SHALL PROVIDE POST-MOUNTED AND WALL MOUNTED TRAFFIC CONTROL AND INFORMATIONAL SIGNS IN ACCORDANCE WITH THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES FOR STREETS AND HIGHWAYS, PUBLISHED BY THE U.S. DEPARTMENT OF COMMERCE.

2. PROVIDE SIGNS IN ACCORDANCE WITH CTDOT SPECIFICATIONS AND SPECIAL PROVISIONS.

EXCAVATION NOTES:

1. CONTRACTOR SHALL PROVIDE ALL EQUIPMENT AND MATERIALS AS NECESSARY TO EXCAVATE RAYMARK WASTE ALONG THE PROPERTY LINE SUCH THAT THERE IS NO IMPACT TO ABUTTING PROPERTY. EXCAVATIONS SHALL BE SLOPED AND/OR APPROPRIATE SOIL RETENTION METHODS SUCH AS SHEETING AND SHORING SHALL BE UTILIZED TO PROVIDE STABILITY. CONTRACTOR IS TO DESIGN SOIL RETENTION SYSTEMS AS APPROPRIATE AND SUBMIT TO CONTRACTING OFFICER AND CT DEEP FOR APPROVAL.

2. CONTRACTOR SHALL PREPARE AND IMPLEMENT A POST EXCAVATION SAMPLING PLAN TO VALIDATE THE LATERAL EXTENDS OF RAYMARK WASTE. THIS PLAN SHALL BE SUBMITTED AND APPROVED BY EPA AND CTDEEP PRIOR TO IMPLEMENTATION.

3. THE FOLLOWING IS A SUMMARY OF EXCAVATION VOLUMES AND CAPACITIES:
   - 576/600 EAST BROADWAY ON-SITE WASTE = 5,300 C.Y.
   - THIRD AVENUE WASTE = 750 C.Y.
   - AVAILABLE CAP STORAGE = 6,800 C.Y.

MONITORING AND MAINTENANCE:

THE CONTRACTOR SHALL PROVIDE A LONG TERM MONITORING PLAN, AND AN OPERATIONS & MAINTENANCE SCHEDULE.

GENERAL CONSTRUCTION SEQUENCE:

SOME ITEMS MAY BE PERFORMED CONCURRENTLY AND THIS ORDER MAY BE MODIFIED DURING CONSTRUCTION DUE TO SITE CONDITIONS, WEATHER AND OTHER VARIABLES. ALL MODIFICATIONS MUST BE APPROVED BY THE ENGINEER.

1. MOBILIZE TEMPORARY FACILITES, EQUIPMENT, AND MATERIALS TO THE SITE.
2. INSTALL SITE SECURITY MEASURES AND MAINTAIN THROUGHOUT THE CONDUCT OF THE WORK.
3. INSTALL INITIAL EROSION CONTROL MEASURES (SILTATION FENCING, STABILIZED CONSTRUCTION ENTRANCES). MAINTAIN, INSPECT, AND INSTALL ADDITIONAL PROVISIONS AS NECESSARY THROUGHOUT THE CONDUCT OF THE WORK.
4. PERFORM LAYOUT AND CONTROL MEASURES. MAINTAIN THROUGHOUT THE CONDUCT OF THE WORK.
5. ESTABLISH AND BEGIN AIR MONITORING ACTIVITIES PRIOR TO DISTURBANCE. CONDUCT AIR MONITORING THROUGHOUT THE WORK.
6. ESTABLISH DECONTAMINATION AREA.
7. PERFORM VEGETATION CLEARING.
8. PERFORM DEMOLITION AND REMOVAL OF SITE FEATURES (I.E. FENCE, BITUMINOUS PAVEMENT) AS NECESSARY TO COMPLETE SITE GRADING, EXCAVATION AND CAP CONSTRUCTION.
9. EXCAVATE RAYMARK WASTE FROM THE LIMITS SHOWN ON THE DRAWINGS TO AN APPROXIMATE DEPTH OF 4-FEET BELOW GROUND SURFACE.
10. TRANSPORT RAYMARK WASTE TO THE CAP AREA, SPREAD AND COMPACT IN LOOSE LIFTS NOT TO EXCEED 1-FT.
11. CONDUCT DUST CONTROL MEASURES THROUGHOUT THE WORK IN CONFORMANCE WITH THE CT GUIDELINES FOR SOIL EROSION AND SEDIMENT CONTROL CHAPTER 5, SECTION 2, DUST CONTROL.
12. BACKFILL COMPLETED EXCAVATIONS IN CONFORMANCE WITH THE DRAWINGS AND SPECIFICATIONS IN SECTION 02 61 13.
13. CONSTRUCT THE LOW PERMEABLE CAP IN ACCORDANCE WITH THE DRAWINGS AND SPECIFICATIONS IN SECTIONS 02 56 13, 02 56 15, 02 66 00, 31 05 19 AND 31 05 20.
14. TOPSOIL, SEED AND MULCH THE EXCAVATIONS, CAP AND OTHER DISTURBED AREAS OF THE SITE.
15. CONSTRUCT PERMANENT FENCING AND GATES.
16. PERFORM SITE CLEANUP AND DEMOBILIZATION.

LEGEND

- PROPERTY LINE
- EASEMENT LINE
- STRUCTURE
- UTILITY POLE
- LIGHT POLE
- HYDRANT
- MANHOLE
- TREE LINE
- WATER (W)
- TELEPHONE (T)
- SEWER (S)
- EDGE OF PAVEMENT
- GRAVEL ACCESS ROAD
- SIDEWALK
- SPOT GRADE (×10.6)
- EXISTING CONTOURS
- PROPOSED CONTOURS
- 100-YR FLOODPLAIN
- RAYMARK WASTE
- CAP LIMIT
- GAS VENT PIPE
- EXISTING FENCE
- PROPOSED SILT FENCE (SF)
- PROPOSED SECURITY FENCE
- LIMIT OF CAP PER RECORD OF DECISION
- PROPOSED CONSTRUCTION ENTRANCE
- PROPOSED ACCESS ROAD
- PROPOSED CULVERT
- MONITORING WELLS
- BORINGS BY OTHERS
- BORINGS BY AMEC

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DWN BY: RHH	CKD BY: MAP	SOLICITATION NO.: SOLICITATION NO.
SUBMITTED BY: SUBMITTED BY		CONTRACT NO.: CONTRACT NO.
PLOT SCALE: PLOT SCALE	PLOT DATE: PLOT DATE	FILE NUMBER: FILE NO.
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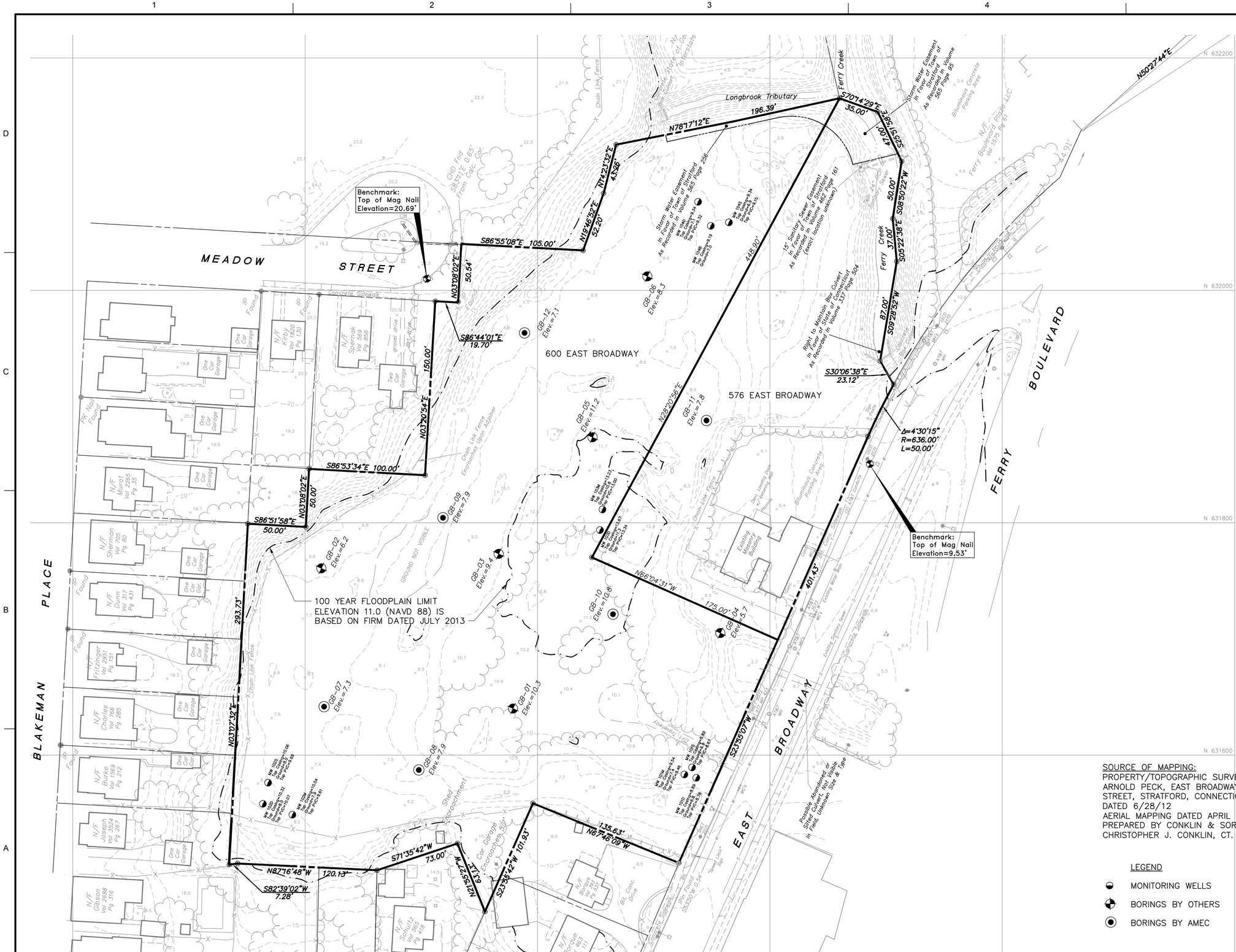
REMEDIAL DESIGN OF A LANDFILL CAP
576/600 EAST BROADWAY
STRATFORD, CONNECTICUT

GENERAL NOTES AND LEGEND

SHEET IDENTIFICATION
G-002
SHEET 2 OF 11



SOURCE OF MAPPING:
PROPERTY/TOPOGRAPHIC SURVEY, LAND OF ARNOLD PECK, EAST BROADWAY & MEADOW STREET, STRATFORD, CONNECTICUT.
DATED 6/28/12
AERIAL MAPPING DATED APRIL 2012
PREPARED BY CONKLIN & SOROKA, INC.
CHRISTOPHER J. CONKLIN, CT. L.S. #70,241

LEGEND

- MONITORING WELLS
- BORINGS BY OTHERS
- BORINGS BY AMEC

N

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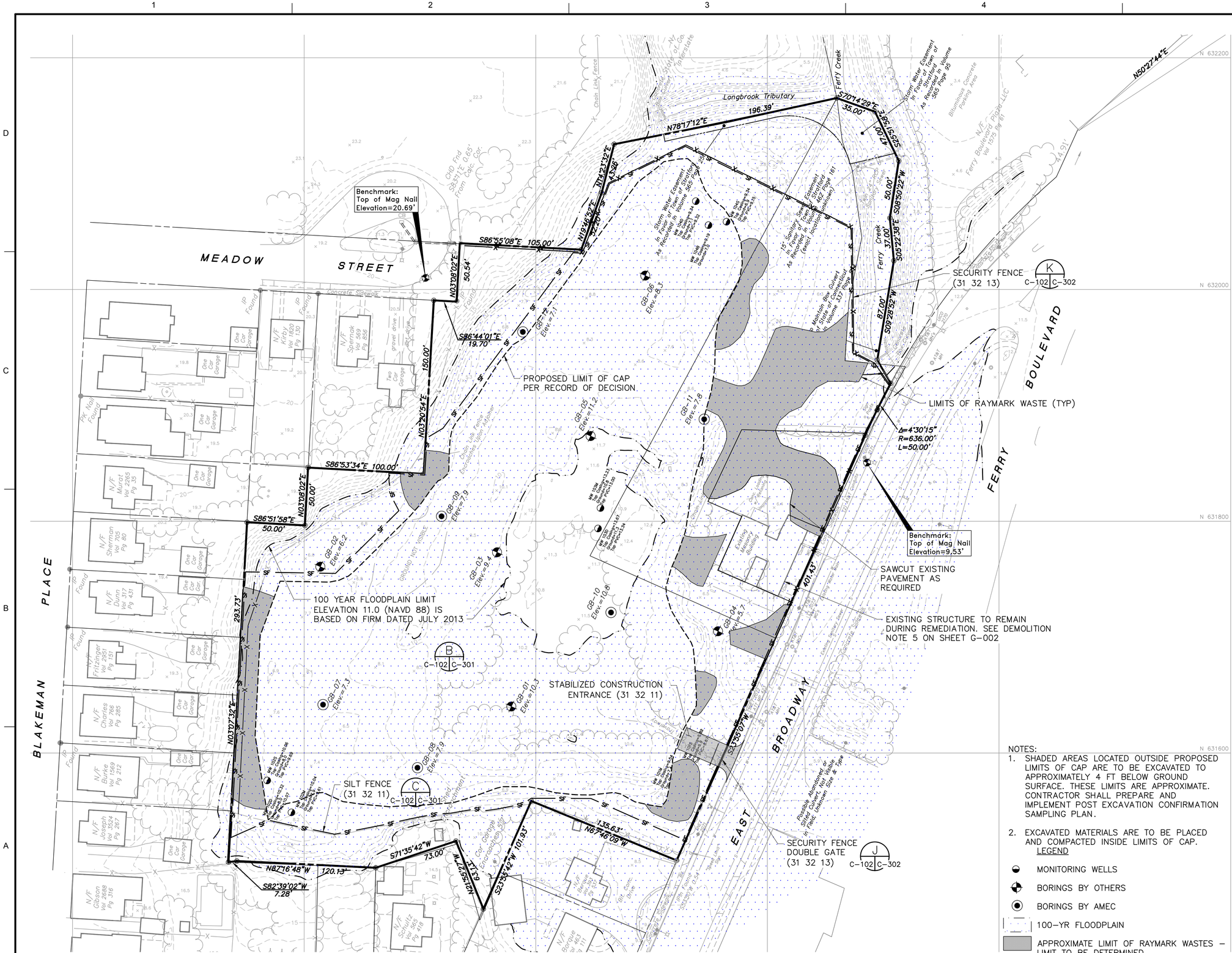
REMEDIAL DESIGN OF A LANDFILL CAP
576/600 EAST BROADWAY
STRATFORD, CONNECTICUT

EXISTING CONDITIONS PLAN

SHEET IDENTIFICATION
C-101
SHEET 3 OF 11

FILE NAME: Z:\Projects\USACE\RAYMARK-OU6\OU6-C-101.dwg PLOT DATE: Fri, 27 Jun 2014 PLOT TIME: 1:12 PM



NOTES:

1. SHADED AREAS LOCATED OUTSIDE PROPOSED LIMITS OF CAP ARE TO BE EXCAVATED TO APPROXIMATELY 4 FT BELOW GROUND SURFACE. THESE LIMITS ARE APPROXIMATE. CONTRACTOR SHALL PREPARE AND IMPLEMENT POST EXCAVATION CONFIRMATION SAMPLING PLAN.
2. EXCAVATED MATERIALS ARE TO BE PLACED AND COMPACTED INSIDE LIMITS OF CAP.

LEGEND

- MONITORING WELLS
- BORINGS BY OTHERS
- BORINGS BY AMEC
- 100-YR FLOODPLAIN
- APPROXIMATE LIMIT OF RAYMARK WASTES – LIMIT TO BE DETERMINED

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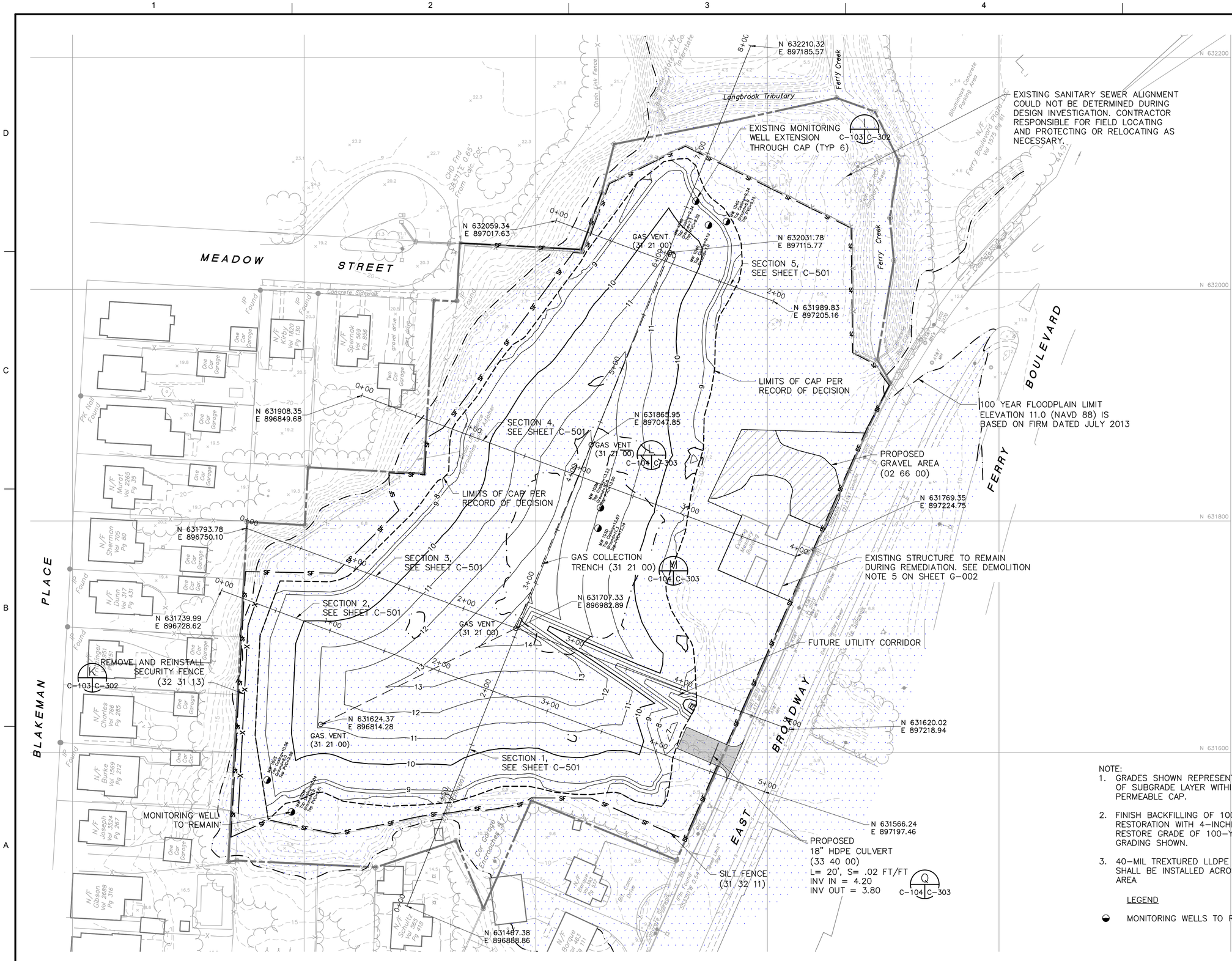
CONNECTICUT

REMEDIAL DESIGN OF A LANDFILL CAP
576/600 EAST BROADWAY
STRATFORD, CONNECTICUT

EXCAVATION AND SEDIMENTATION CONTROL PLAN

SHEET IDENTIFICATION
C-102
SHEET 4 OF 11

FILE NAME: Z:\Projects\USACE\RAYMARK-OU6\OU6-C-102.dwg PLOT DATE: Fri, 27 Jun 2014 PLOT TIME: 12:59 PM



NOTE:

1. GRADES SHOWN REPRESENT FINAL GRADING OF SUBGRADE LAYER WITHIN LIMITS OF LOW PERMEABLE CAP.
2. FINISH BACKFILLING OF 100-YR FLOODPLAIN RESTORATION WITH 4-INCHES OF TOPSOIL. RESTORE GRADE OF 100-YR FLOODPLAIN TO GRADING SHOWN.
3. 40-MIL TREXTURED LLDPE GEOMEMBRANE SHALL BE INSTALLED ACROSS THE ENTIRE CAP AREA

LEGEND

◒ MONITORING WELLS TO REMAIN

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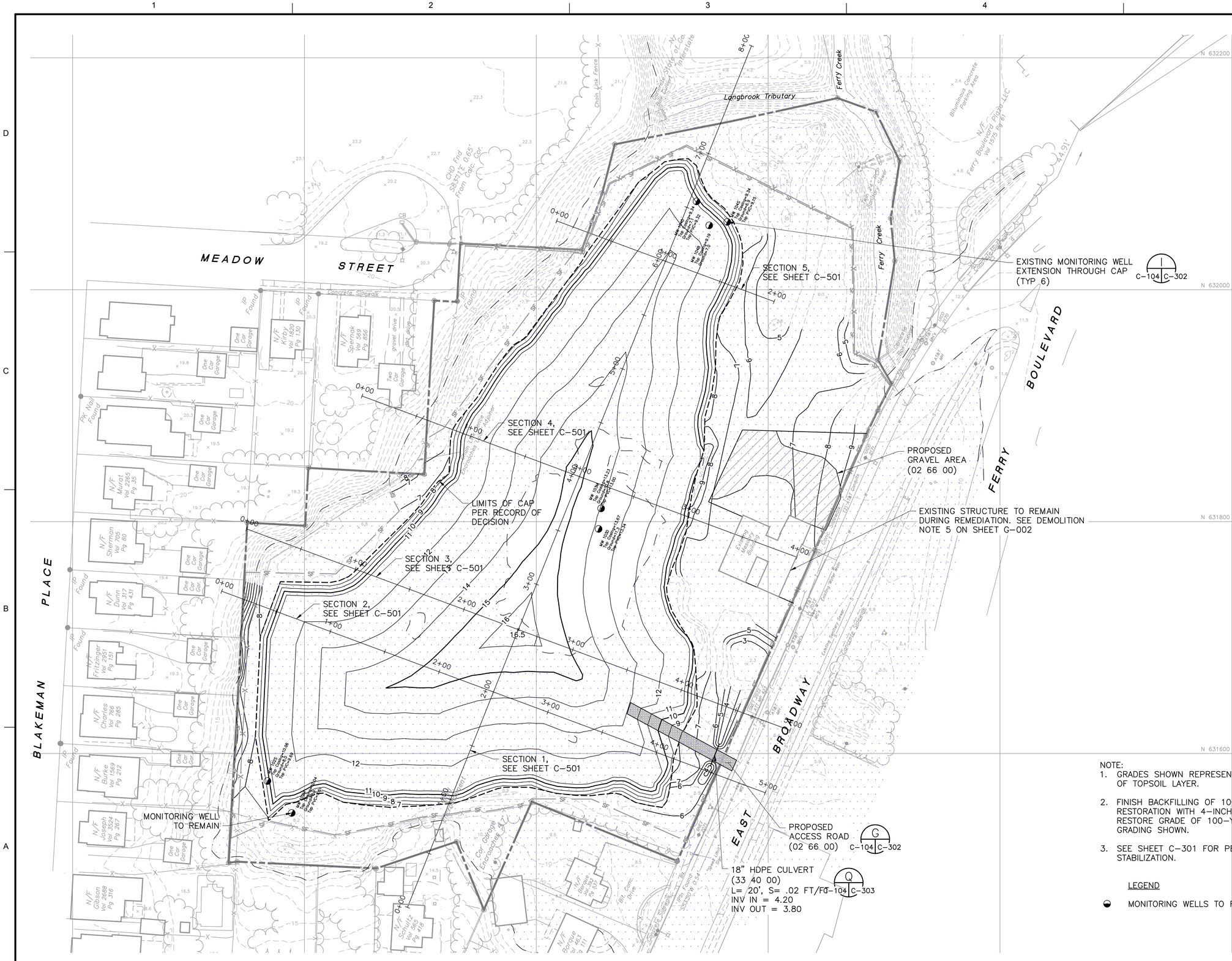
SUBGRADE PLAN

SHEET IDENTIFICATION
C-103
SHEET 5 OF 11

FILE NAME: Z:\Projects\USACE\RAYMARK-OU6\OU6-C-103.dwg PLOT DATE: Fri, 27 Jun 2014 PLOT TIME: 1:14 PM



NOTE:

1. GRADES SHOWN REPRESENT FINAL GRADING OF TOPSOIL LAYER.
2. FINISH BACKFILLING OF 100-YR FLOODPLAIN RESTORATION WITH 4-INCHES OF TOPSOIL. RESTORE GRADE OF 100-YR FLOODPLAIN TO GRADING SHOWN.
3. SEE SHEET C-301 FOR PERMANENT STABILIZATION.

LEGEND

◒ MONITORING WELLS TO REMAIN

US Army Corps of Engineers
New England District

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A	60% DESIGN FOR REVIEW	7/20/12	

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DWN BY: RHH | CKD BY: MAP | CONTRACT NO.: CONTRACT NO.
SUBMITTED BY: SUBMITTED BY | PLOT SCALE: 1:40 | PLOT DATE: FILE NUMBER: FILE NO.
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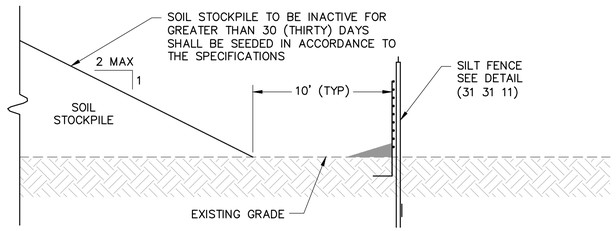
REMEDIAL DESIGN OF A LANDFILL CAP
576/600 EAST BROADWAY
STRATFORD, CONNECTICUT

FINAL GRADING PLAN

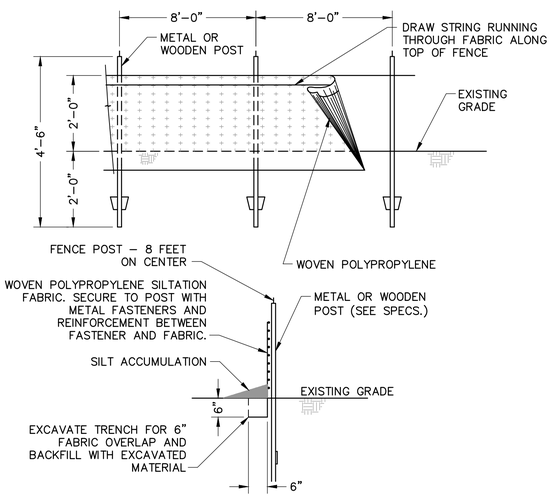
SHEET IDENTIFICATION
C-104
SHEET 6 OF 11

FILE NAME: Z:\Projects\USACE\RAYMARK-OU6\OU6-C-104.dwg PLOT DATE: Fri, 27 Jun 2014 PLOT TIME: 1:00 PM



STOCKPILE CONTAINMENT AREA (NON–CONTAMINATED SEDIMENT/SOIL) (A)

NTS (TYP) C–301



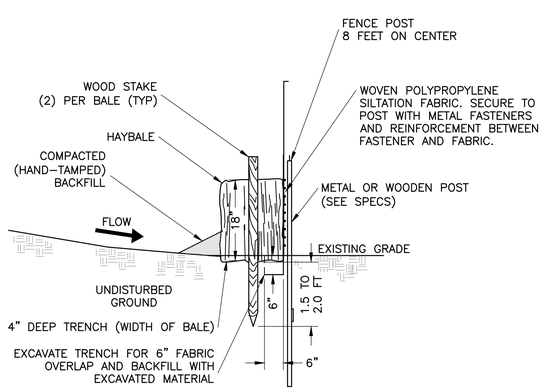
NOTE:

WHERE REQUIRED AT CRITICAL LOCATIONS, SILTATION FENCE REINFORCED WITH HOG OR CHICKEN WIRE OR INTEGRAL PLASTIC MESH REINFORCING MAY BE USED.

SEE SPECIFICATION 21 32 11

SILT FENCE (C)

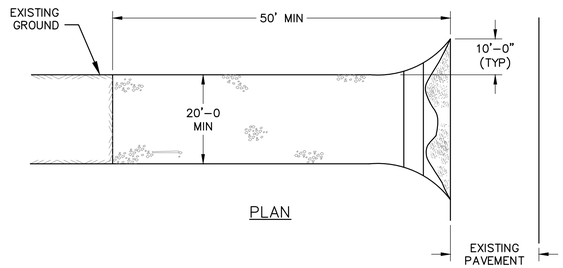
NTS (TYP) C–301

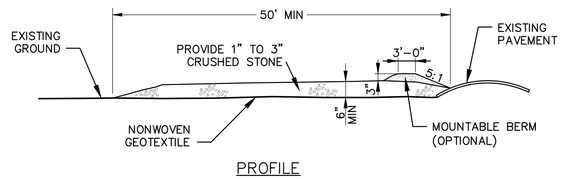


NOTE:
SEE SPECIFICATION 21 32 11

AUGMENTED SILTATION FENCE (D)

NTS (TYP) C–301

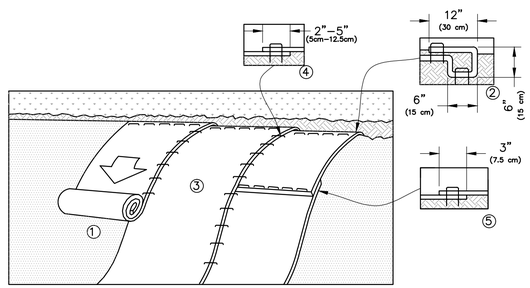




NOTE:
SEE SPECIFICATION 21 32 11

STABILIZED CONSTRUCTION ENTRANCE (B)

NTS (TYP) C–301

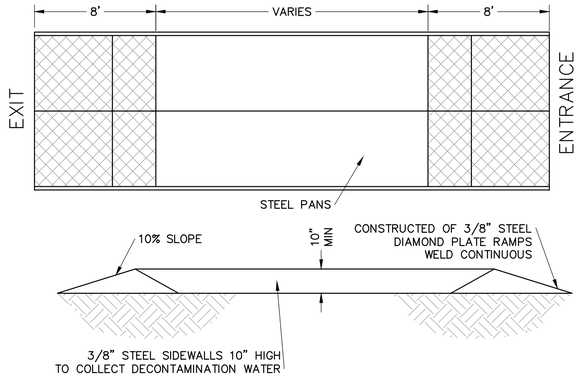


NOTE:

1. PREPARE TOPSOIL BEFORE INSTALLING BLANKETS, INCLUDING ANY NECESSARY APPLICATION OF LIME, FERTILIZER, AND SEED.
2. BEGIN AT THE TOP OF THE SLOPE BY ANCHORING THE BLANKET IN A 6" (15cm) DEEP X 6" (15cm) WIDE TRENCH WITH APPROXIMATELY 12" (30cm) OF BLANKET EXTENDED BEYOND THE UP–SLOPE PORTION OF THE TRENCH. ANCHOR THE BLANKET WITH A ROW OF STAPLES/STAKES APPROXIMATELY 12" (30cm) APART IN THE BOTTOM OF THE TRENCH. BACKFILL AND COMPACT THE TRENCH AFTER STAPLING. APPLY SEED TO COMPACTED GROWING MEDIUM AND FOLD REMAINING 12" (30cm) PORTION OF BLANKET BACK OVER SEED AND COMPACTED GROWING MEDIUM. SECURE BLANKET OVER COMPACTED GROWING MEDIUM WITH A ROW OF STAPLES/STAKES SPACED APPROXIMATELY 12" (30cm) APART ACROSS THE WIDTH OF THE BLANKET.
3. ROLL THE BLANKETS DOWN THE SLOPE. BLANKETS WILL UNROLL WITH APPROPRIATE SIDE AGAINST THE GROWING MEDIUM SURFACE. ALL BLANKETS MUST BE SECURELY FASTENED TO GROWING MEDIUM SURFACE BY PLACING STAPLES/STAKES IN APPROPRIATE LOCATIONS AS SHOWN IN THE STAPLE PATTERN GUIDE. WHEN USING MANUFACTURER STAPLE PATTERN MARKING, STAPLES/STAKES SHOULD BE PLACED THROUGH EACH OF THE COLORED MARKS CORRESPONDING TO THE APPROPRIATE STAPLE PATTERN.
4. THE EDGES OF PARALLEL BLANKETS MUST BE STAPLED WITH APPROXIMATELY 2"–5" (5cm–12.5cm) OVERLAP DEPENDING ON BLANKET TYPE. TO ENSURE PROPER SEAM ALIGNMENT, PLACE THE EDGE OF THE OVERLAPPING BLANKET (BLANKET BEING INSTALLED ON TOP) EVEN WITH THE SEAM ON THE PREVIOUSLY INSTALLED BLANKET.
5. CONSECUTIVE BLANKETS SPLICED DOWN THE SLOPE MUST BE PLACED END OVER END (SHINGLE STYLE) WITH AN APPROXIMATE 3" (7.5cm) OVERLAP. STAPLE THROUGH OVERLAPPED AREA, APPROXIMATELY 12" (30cm) APART ACROSS ENTIRE BLANKET WIDTH.
6. EROSION CONTROL BLANKET TO BE 100% AGRICULTURAL STRAW STITCHED WITH BIODEGRADABLE NETTING.
7. DETAIL PROVIDED BY NORTH AMERICAN GREEN ®.
8. SEE SPECIFICATION 21 32 11.

SLOPE EROSION CONTROL BLANKET (E)

NTS (TYP) C–301



NOTE:

THE CONTRACTOR MAY PROVIDE AN ALTERNATE METHOD FOR VEHICLE/EQUIPMENT DECONTAMINATION UPON ACCEPTANCE OF THE ENGINEER, THE METHOD SHALL CONTAIIN ALL DECONTAMINATION FLUIDS AND SOLIDS, AND PROVIDE A MEANS TO REMOVE ALL COLLECTED FLUIDS AND SOLIDS.

PORTABLE TRUCK DECONTAMINATION TRAYS (OR EQUAL) (F)

NTS TYP C–301

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REMEDIAL DESIGN OF A LANDFILL CAP
576/600 EAST BROADWAY
STRATFORD, CONNECTICUT

EROSION AND SEDIMENT CONTROL DETAILS

SHEET IDENTIFICATION
C-301
SHEET 7 OF 11

SOIL EROSION AND SEDIMENT CONTROL NOTES

1. ALL SOIL EROSION AND SEDIMENT CONTROL PRACTICES WILL BE INSTALLED IN ACCORDANCE WITH THE CONNECTICUT GUIDELINES FOR SOIL EROSION AND SEDIMENT CONTROL AND WILL BE INSTALLED IN PROPER SEQUENCE AND MAINTAINED UNTIL PERMANENT STABILIZATION IS ESTABLISHED.

2. ANY DISTURBED AND STOCKPILE AREAS THAT WILL BE LEFT EXPOSED FOR MORE THAN 30 DAYS AND NOT SUBJECT TO CONSTRUCTION TRAFFIC SHALL IMMEDIATELY RECEIVE A TEMPORARY SEEDING AND MULCHING. IF THE SEASON PROHIBITS TEMPORARY SEEDING, THE DISTURBED AREA WILL BE MULCHED WITH STRAW, HAY, OR EQUIVALENT AND BOUND IN ACCORDANCE WITH THE CT STANDARDS (I.E., TACKIFIERS, NETTING, ETC.).

3. IMMEDIATELY FOLLOWING INITIAL DISTURBANCE OR ROUGH GRADING, ALL CRITICAL AREAS SUBJECT TO EROSION WILL RECEIVE A TEMPORARY SEEDING IN COMBINATION WITH STRAW MULCH OR A SUITABLE EQUIVALENT, AT A MINIMUM RATE OF 40 POUNDS PER ACRE AND IN ACCORDANCE WITH THE CT STANDARDS.

4. STABILIZATION SPECIFICATIONS
   A. TEMPORARY SEEDING AND MULCHING:
      LIME – 90 LBS/1000 SF GROUND LIMESTONE
      FERTILIZER – 7.5 LBS/1000 SF, PHOSPHORUS FREE FERTILIZER WORKED INTO THE SOIL A MINIMUM OF 4"
      SEED – PERENNIAL RYE GRASS 40LBS/ACRE (1LB/1000SF) OR OTHER APPROVED SEEDS.
      PLANT – PLANT BETWEEN MARCH 15 AND JULY 1 OR BETWEEN AUGUST 1 AND OCTOBER 15
      MULCH – HAY, STRAW, OR CELLULOSE FIBER CAPABLE OF BEING APPLIED EVENLY SUCH THAT IT PROVIDES 80% TO 95% SOIL COVERAGE. HAY OR STRAW SHALL BE APPLIED AT A MAXIMUM RATE OF 3 TONS PER ACRE. MULCH SHALL BE APPLIED AND SECURED BY APPROVED METHODS AND IN ACCORDANCE WITH THE CT STANDARDS.
   B. PERMANENT SEEDING AND MULCHING: (INSIDE LIMITS OF CAP)
      TOPSOIL – UNIFORM APPLICATION TO A DEPTH OF 4" (FINISHED DEPTH)
      LIME – 200 LBS/1000 SF GROUND LIMESTONE
      FERTILIZER – 7.5 LBS/1000 SF, 10–10–10 OR EQUIVALENT WORKED INTO THE SOIL A MINIMUM OF 4"
      SEED – CT DOT ALL PURPOSE MIX (BLEND OF 5 CULTIVARS) SEE SPECIFICATION 32 92 19 "SEEDING" 100 LBS/ACRE (2.3 LBS/1000 SF) OR OTHER APPROVED SEEDS. OPTIMUM SEEDING DATES ARE FROM APRIL 1 THROUGH JUNE 15 AND AUGUST 15 THROUGH OCTOBER 1.
      MULCH – HAY, STRAW, OR CELLULOSE FIBER CAPABLE OF BEING APPLIED EVENLY SUCH THAT IT PROVIDES 80% TO 95% SOIL COVERAGE. HAY OR STRAW SHALL BE APPLIED AT A MAXIMUM RATE OF 3 TONS PER ACRE. MULCH SHALL BE APPLIED AND SECURED BY APPROVED METHODS AND IN ACCORDANCE WITH THE CT STANDARDS.
   C. PERMANENT SEEDING AND MULCHING: (OUTSIDE LIMITS OF CAP)
      TOPSOIL – UNIFORM APPLICATION TO A DEPTH OF 4" (FINISHED DEPTH)
      LIME – 200 LBS/1000 SF GROUND LIMESTONE
      FERTILIZER – 7.5 LBS/1000 SF, 10–10–10 OR EQUIVALENT WORKED INTO THE SOIL A MINIMUM OF 4"
      SEED – NEW ENGLAND CONSERVATION/WILDLIFE MIX, NEW ENGLAND WETLAND PLANTS, INC. WITH NEW ENGLAND CONSERVATION/WILDLIFE MIX BLENDED SPECIFICALLY TO EXCLUDE PARTRIDGE PEA (CHAMAECRISTA FASCICULATA). SEE SPECIFICATION 32 92 19 "SEEDING" 25 LBS/ACRE (0.58 LBS/1000 SF). OPTIMUM SEEDING DATES ARE FROM APRIL 1 THROUGH JUNE 15 AND AUGUST 15 THROUGH OCTOBER 1.
      MULCH – HAY, STRAW, OR CELLULOSE FIBER CAPABLE OF BEING APPLIED EVENLY SUCH THAT IT PROVIDES 80% TO 95% SOIL COVERAGE. HAY OR STRAW SHALL BE APPLIED AT A MAXIMUM RATE OF 3 TONS PER ACRE. MULCH SHALL BE APPLIED AND SECURED BY APPROVED METHODS AND IN ACCORDANCE WITH THE CT STANDARDS.

5. THE SITE SHALL AT ALL TIMES BE GRADED AND MAINTAINED SUCH THAT ALL STORMWATER RUNOFF IS DIVERTED AWAY FROM DISTURBED AREAS TO APPROPRIATE SEDIMENT CONTROLS.

6. SOIL EROSION AND SEDIMENT CONTROL MEASURES WILL BE INSPECTED AND MAINTAINED ON A REGULAR BASIS, INCLUDING AFTER EVERY STORM EVENT.

7. AUGMENTED SILT FENCE SHALL BE INSTALLED AS NECESSARY TO MAINTAIN SOIL EROSION AND SEDIMENT CONTROLS.

8. STOCKPILES ARE NOT TO BE LOCATED WITHIN 50' OF A SLOPE, ROADWAY OR DRAINAGE FACILITY. ALL STOCKPILES SHALL BE ADEQUATELY PROTECTED FROM THE 100–YEAR FLOOD EVENT AND LOCATED AT LEAST 50 FEET FROM A WATER COURSE. THE BASE OF ALL STOCKPILES SHALL BE CONTAINED BY SILT FENCE.

9. SLOPE EROSION CONTROL BLANKETS SHALL BE UTILIZED ON SLOPES IN EXCESS OF 10%.

10. A CRUSHED STONE, VEHICLE WHEEL–CLEANING BLANKET WILL BE INSTALLED WHEREVER A CONSTRUCTION ACCESS ROAD INTERSECTS ANY PAVED ROADWAY. SAID BLANKET WILL BE COMPOSED OF SIZE NO. 2 OR 3 ANGULAR STONE PER ASTM C–33, 4" THICK, WILL BE AT LEAST 12' X 100' AND SHOULD BE UNDERLAIN WITH A SUITABLE SYNTHETIC SEDIMENT FILTER SPECIFICALLY INTENDED FOR ROAD STABILIZATION.

11. ALL SOIL WASHED, DROPPED, SPILLED OR TRACKED OUTSIDE THE LIMIT OF DISTURBANCE OR ONTO PUBLIC RIGHT–OF–WAYS WILL BE REMOVED IMMEDIATELY. PAVED ROADWAYS MUST BE KEPT CLEAN AT ALL TIMES.

12. DUST SHALL BE CONTROLLED VIA THE APPLICATION OF WATER, OR OTHER APPROVED METHOD IN ACCORDANCE WITH THE CT GUIDELINES FOR SOIL EROSION AND SEDIMENT CONTROL, CHAPTER 5, SECTION 2, DUST CONTROL.

13. TREES TO REMAIN AFTER CONSTRUCTION ARE TO BE PROTECTED WITH A SUITABLE FENCE INSTALLED AT THE DRIP LINE OR BEYOND IN ACCORDANCE WITH THE CT GUIDELINES FOR SOIL EROSION AND SEDIMENT CONTROL, CHAPTER 5, SECTION 1, TREE PROTECTION.

14. A COPY OF THE SOIL EROSION AND SEDIMENT CONTROL PLAN MUST BE AVAILABLE AT THE PROJECT SITE THROUGHOUT CONSTRUCTION.

15. THE TOWN OF STRATFORD MAY REQUEST ADDITIONAL MEASURES TO MINIMIZE ON OR OFF–SITE EROSION PROBLEMS DURING CONSTRUCTION.

INSPECTION AND MAINTENANCE

1. INSPECT DISTURBED AREAS OF THE CONSTRUCTION ACTIVITY THAT HAVE NOT BEEN FINALLY STABILIZED, THAT HAVE STRUCTURAL CONTROL MEASURES, AND LOCATIONS WHERE VEHICLES ENTER OR EXIT THE SITE AT LEAST ONCE EVERY SEVEN CALENDAR DAYS AND WITHIN 24 HOURS OF THE END OF A STORM THAT IS 0.1 INCHES OR GREATER. WHERE SITES HAVE BEEN TEMPORARILY OR FINALLY STABILIZED, SUCH INSPECTION SHALL BE CONDUCTED AT LEAST ONCE EVERY MONTH FOR THREE MONTHS.

SEDIMENT BARRIERS

1. SEDIMENT SHALL BE REMOVED ONCE THE VOLUME REACHES $\frac{1}{4}$ TO $\frac{1}{2}$ THE HEIGHT OF THE SEDIMENT BARRIER OR IF THE CONTROL SHOWS SIGNS OF FAILURE.

2. REPAIR OR REPLACE BARRIER (FABRIC, POSTS, BALES, ETC.) WHEN DAMAGED.

3. BARRIERS SHALL BE INSPECTED DAILY FOR SIGNS OF DETERIORATION AND THE NEED TO REMOVE SEDIMENT.

STABILIZED CONSTRUCTION ACCESS

1. THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION WHICH WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO ROADWAYS. THIS MAY REQUIRE PERIODIC TOP DRESSING WITH ADDITIONAL STONE OR ADDITIONAL LENGTH AS CONDITIONS DEMAND AND REPAIR AND/OR CLEANOUT OF ANY MEASURES USED TO TRAP SEDIMENT. ALL SEDIMENT SPILLED, DROPPED, WASHED, OR TRACKED ONTO ROADWAYS (PUBLIC OR PRIVATE) OR OTHER IMPERVIOUS SURFACES MUST BE REMOVED IMMEDIATELY.

2. WHERE ACCUMULATION OF DUST/SEDIMENT IS INADEQUATELY CLEANED OR REMOVED BY CONVENTIONAL METHODS, A POWER BROOM OR STREET SWEEPER WILL BE REQUIRED TO CLEAN PAVED OR IMPERVIOUS SURFACES. ALL OTHER ACCESS POINTS WHICH ARE NOT STABILIZED SHALL BE BLOCKED OFF.

3. STABILIZED CONSTRUCTION ACCESSES SHALL BE REMOVED AND THE AREA RESTORED AT PROJECT COMPLETION.

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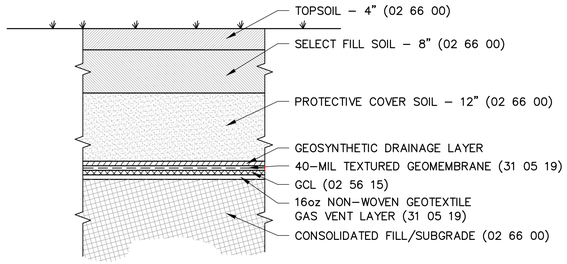
REMEDIAL DESIGN OF A LANDFILL CAP
576/600 EAST BROADWAY
STRATFORD, CONNECTICUT

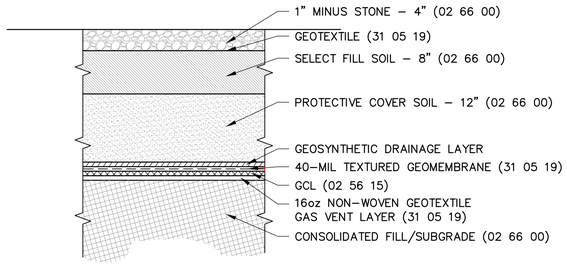
EROSION AND SEDIMENT CONTROL NOTES

SHEET IDENTIFICATION
C-302
SHEET 8 OF 11



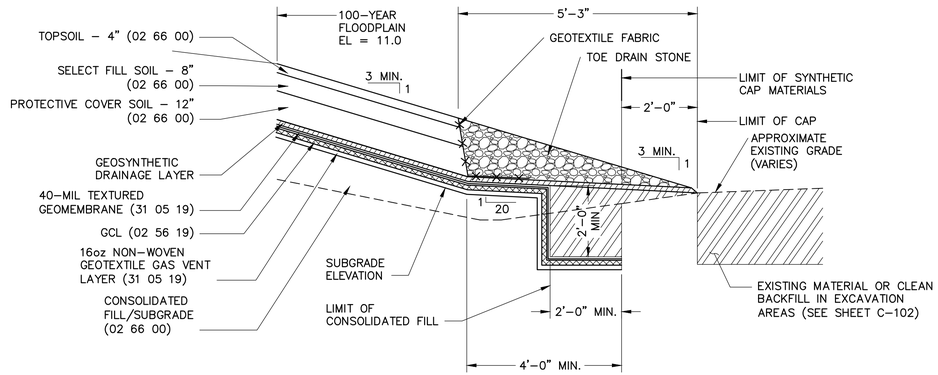
CAP CROSS SECTION (F)

NTS (TYP) C–302



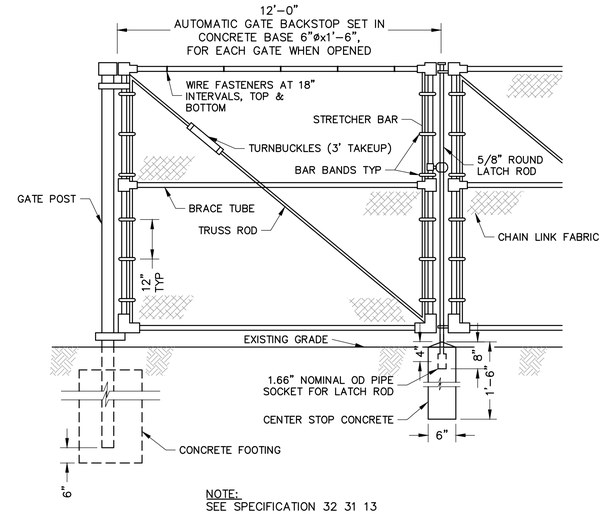
ACCESS ROAD SECTION (G)

NTS (TYP) C–302



CAP PERIMETER SECTION DETAIL (H)

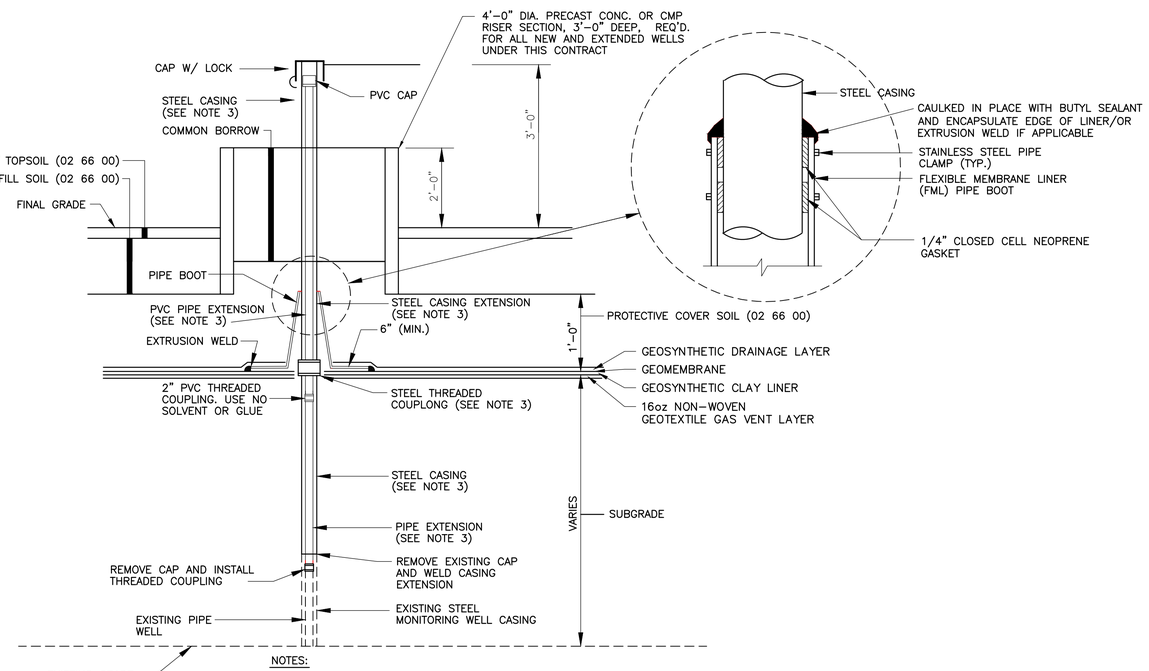
NTS (TYP) C–302



NOTE:
SEE SPECIFICATION 32 31 13

CHAIN LINK FENCE WITH DOUBLE GATE (J)

NTS (TYP) C–302

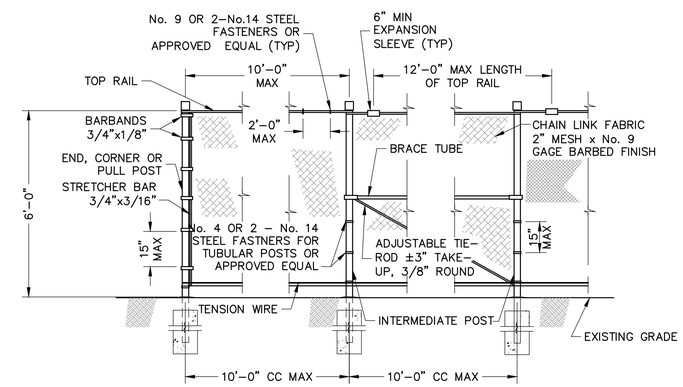


NOTES:

1. NO SOLVENTS ALLOWED FOR PIPE OR CASING JOINTS.
2. EXTEND MONITORING WELL PIPE AND CASING FOR PLACEMENT OF SUBGRADE FILL.
3. WELL AND CASING EXTENSION PIPE DIAMETERS TO MATCH EXISTING PIPE DIAMETERS.

EXISTING MONITORING WELL EXTENSION THROUGH CAP DETAIL (I)

NTS (TYP) C–302



DESCRIPTION

END, CORNER AND PULL POSTS FOR FABRIC HEIGHT:
ROUND 2.375"ø SCHEDULE 40 STEEL PIPE

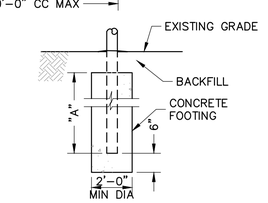
INTERMEDIATE POSTS FOR FABRIC HEIGHTS:
ROUND 1.90"ø SCHEDULE 40 STEEL PIPE

BRACE TUBES:
1.625" OD SCHEDULE 40 STEEL PIPE.

STRETCHER BARS:
LENGTH TO BE 1" LESS THAN FULL HEIGHT OF FABRIC. ONE STRETCHER BAR FOR EACH GATE AND END POST. TWO STRETCHER BARS FOR CORNERS AND BRACING.

TENSION WIRE:
7 GA GALVANIZED

TOP RAIL:
1.66"OD SCHEDULE 40 STEEL PIPE.



FOOTING DETAIL

GATE POST BASE

"A" = 6'–0" FOR ALL GATE POSTS

LINE POSTS MAY BE DRIVEN IF CONDITIONS PERMIT

NOTE:
POST DIMENSIONS SHOWN ARE OD NOMINAL

SEE SPECIFICATION 32 31 13

CHAIN LINK FENCE (K)

NTS (TYP) C–302

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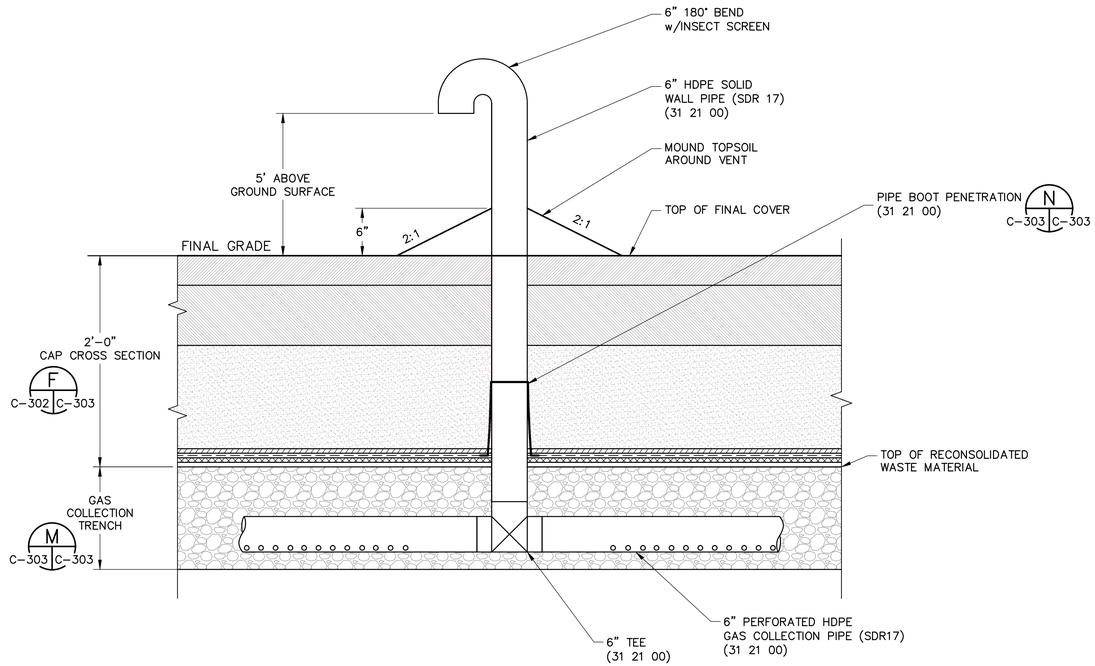
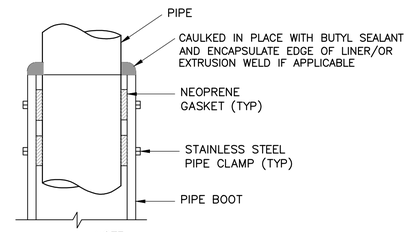
CIVIL DETAILS

SHEET IDENTIFICATION
C-303
SHEET 9 OF 11

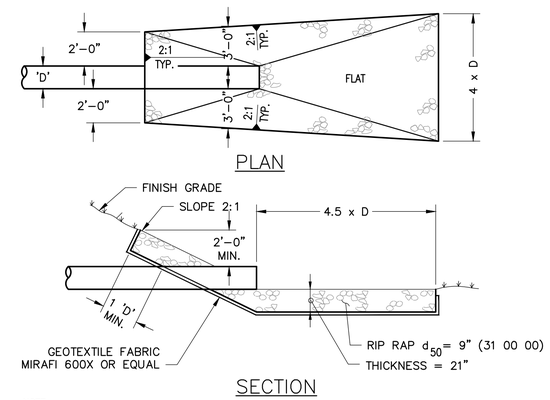


GAS VENT SECTION (L) C-104 | C-303
NTS



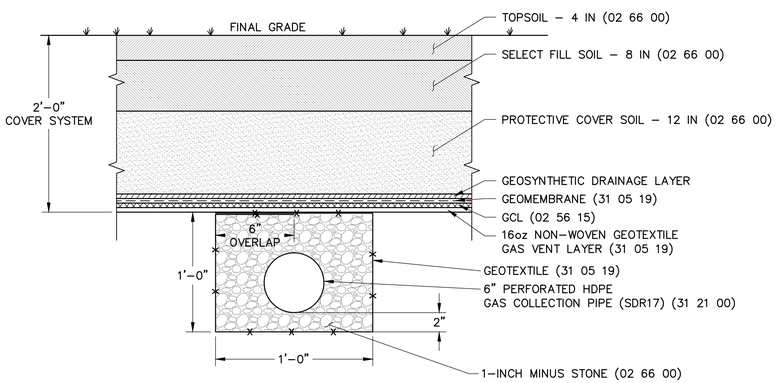
NOTE:
SEE SPECIFICATION 31 21 00

PIPE BOOT PENETRATION (N) C-303 | C-303
NTS



NOTE:
'D' = PIPE DIAMETER

RIP RAP OUTLET DETAIL (O) (TYP) C-303
NTS



GAS COLLECTION TRENCH (M) C-104 | C-303
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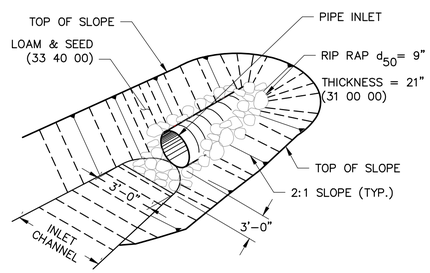

RIP RAP INLET DETAIL (P) (TYP) C-303
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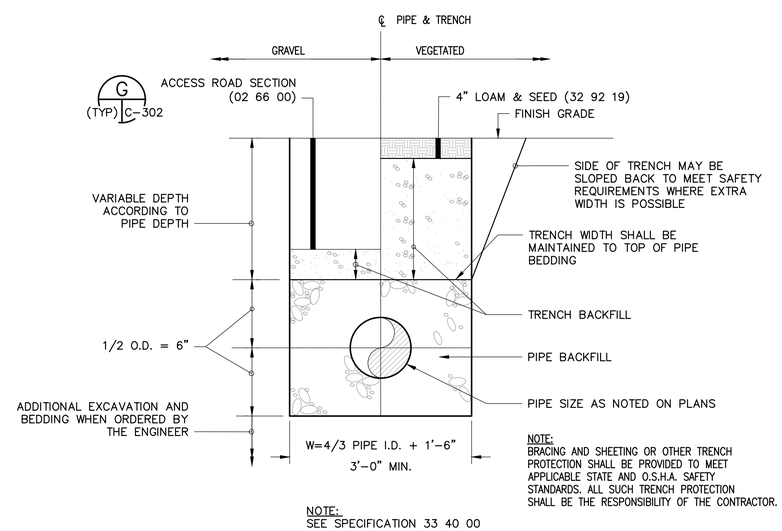

NOTE:
BRACING AND SHEETING OR OTHER TRENCH PROTECTION SHALL BE PROVIDED TO MEET APPLICABLE STATE AND O.S.H.A. SAFETY STANDARDS. ALL SUCH TRENCH PROTECTION SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR.

NOTE:
SEE SPECIFICATION 33 40 00

CULVERT TRENCH SECTION (Q) (TYP) C-303
NTS

US Army Corps of Engineers
New England District

REV	DESCRIPTION	DATE	APPR.
D	100% FINAL REMEDIAL DESIGN	6/27/14	
C	100% FINAL DESIGN FOR CLIENT REVIEW	6/23/14	
B	95% PRE-FINAL DESIGN FOR REVIEW	7/12/13	
A	60% DESIGN FOR REVIEW	7/20/12	

DESIGNED BY: SHM | DATE: DATE | SOLICITATION NO.: SOLICITATION NO.
DWN BY: RHH | CKD BY: MAP | CONTRACT NO.: CONTRACT NO.
SUBMITTED BY: SUBMITTED BY | PLOT DATE: PLOT DATE | FILE NUMBER: FILE NO.
PLOT SCALE: PLOT SCALE | PLOT DATE: PLOT DATE
SIZE: ANSI F | FILE NAME: FILE NAME

U.S. ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
CONNECTICUT

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AMEC E&I, INC.
WESTFORD, MASSACHUSETTS 01886
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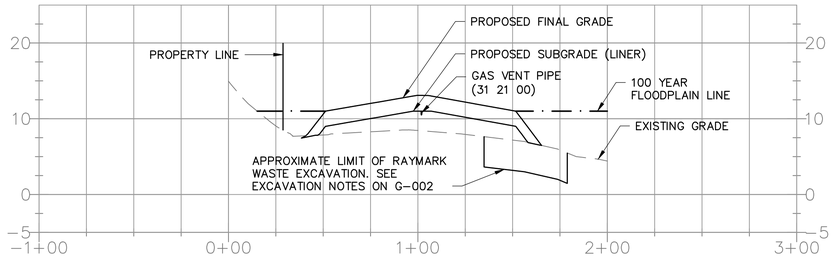
REMEDIAL DESIGN OF A LANDFILL CAP
576/600 EAST BROADWAY
STRATFORD, CONNECTICUT

GAS VENT DETAILS
& CULVERT DETAILS

SHEET IDENTIFICATION
C-304
SHEET 10 OF 11



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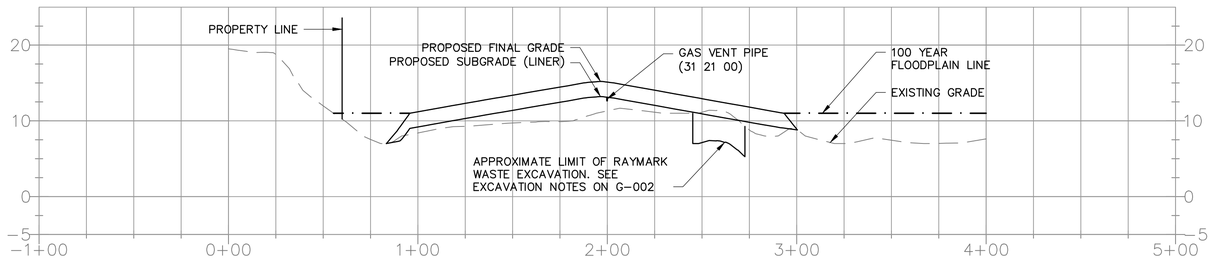

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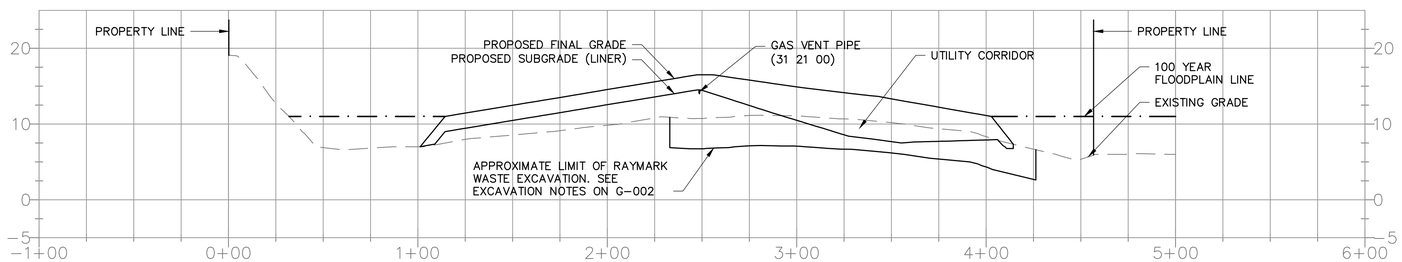

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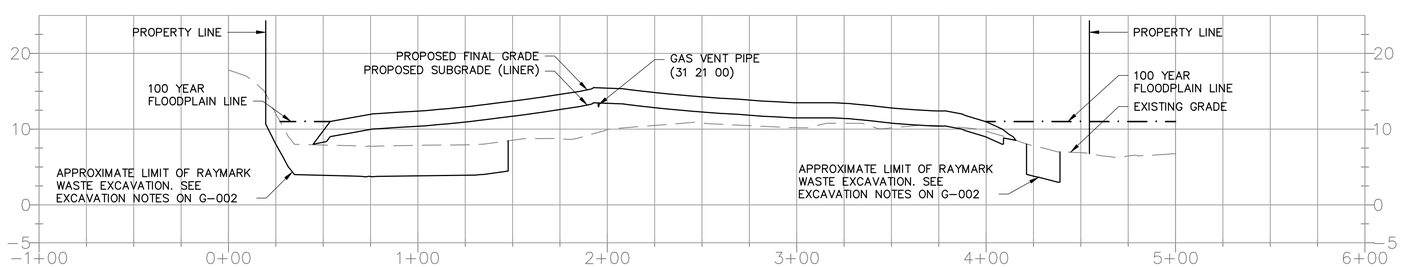

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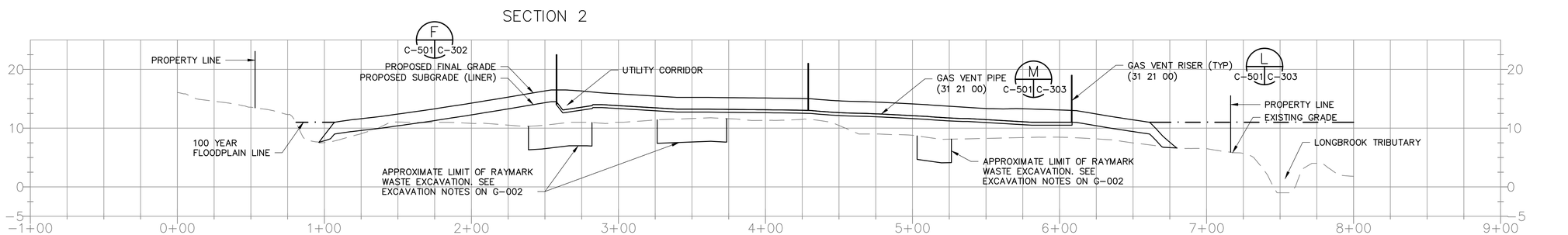

SECTION 1

0 20 40 80
SCALE IN FEET
HORIZONTAL

0 5 10 20
SCALE IN FEET
VERTICAL

US Army Corps of Engineers®
New England District

REV	DESCRIPTION	DATE	APPR.
D	100% FINAL REMEDIAL DESIGN		
C	100% FINAL DESIGN FOR CLIENT REVIEW	6/23/14	
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A	60% DESIGN FOR REVIEW	7/20/12	

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FILE NUMBER: FILE NO.
PLOT SCALE: PLOT SCALE
PLOT DATE: PLOT DATE
SIZE: ANSI F
FILE NAME: FILE NAME

U.S. ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
CONNECTICUT

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ATTN: MARK PLOTTS
WESTFORD, MASSACHUSETTS 01886
P: (978) 692-6067 - F: (978) 692-6633
CONTRACT NO. W912WJ-09-D-0002

REMEDIAL DESIGN OF A LANDFILL CAP
576/600 EAST BROADWAY
STRATFORD, CONNECTICUT

CROSS SECTIONS

SHEET IDENTIFICATION
C-501
SHEET 11 OF 11

FILE NAME: Z:\Projects\USACE\RAYMARK-OU6\OU6-C-501.dwg PLOT DATE: Fri, 27 Jun 2014 PLOT TIME: 1:03 PM

APPENDIX E

SITE DEVELOPMENT EVALUATIONS

APPENDIX E-1

TECHNICAL MEMORANDUM

TASK 5D

ESTIMATION OF BUILDING FOUNDATION LOADS

TECHNICAL MEMORANDUM

DATE: February 19, 2013

TO: Dean Brammer, USACE

COPY: Charles Collet, Stephen Mitchell, Travis Carpenter, AMEC

FROM: Jeffrey Walker, P.E., Senior Structural Engineer

SUBJECT: Estimation of Building Foundation Loads

Raymark Superfund Site – 576/600 East Broadway, Stratford, CT

AMEC Environment & Infrastructure (AMEC) has been tasked with evaluating the feasibility of constructing a building on top of Raymark waste cap. The maximum elevation increase, above existing grade, of the cap is limited to approximately 5-feet. This restriction makes traditional footing and frost wall foundation construction impractical, therefore an alternate foundation system will be required. For this condition, AMEC recommends the use of a mat foundation to remain within the geometric constraints and to avoid penetrating the cap over the waste.

To determine if construction of a mat foundation on top of the cap is feasible, structural loading for three typical building types have been estimated. The three building types are as follows:

1. **Light Industrial:** This building type consists of single story, high bay, pre-engineered metal building. Possible uses include vehicle maintenance, light manufacturing, and light warehouse. Assumed construction consists of steel frames with metal roofing and siding consistent with buildings in most industrial parks.

2. **Light Commercial:** This building type consists of a single story retail space with light storage typical of most strip mall areas. Assumed floor loading does not include "Big Box" retail or grocery store floor load. Construction consists of conventional steel framed structure, with a flat membrane roof, and metal stud walls with EFIS finish. Assumed floor loading does not include

3. **Office:** This building type consists of a single story, light framed office space. Assumed construction consists of wood framed walls with pre-engineered wood roof trusses.

Results of the load calculations, and additional assumptions, are included in the attached table. All loads have been calculated in accordance with the 2005 Connecticut State Building Code., and loading in the table only includes building self weight (dead load), roof snow load, and floor

live load. Short term load, wind and seismic, have not been included due to difficulties in making useful assumptions for the lateral load resisting systems. This omission should have limited impact, since these loads typically have a very minor impact on the design of mat foundations.

Table 1
Summary of Estimated Foundation Loads

Building Type	Structural Framing System	Roof Construction	Wall Construction	Column or Wall Load	Floor Load	Average Foundation Load[1]
Light Industrial	Pre-engineered metal building with 30-foot x 50-foot column spacing	Standing seam metal roof, cold formed purlins, and batt insulation	CMU wall to 6-feet above grade, metal siding, cold formed girts, and batt insulation above	51,000 lb	125 psf	460 psf
Light Commercial	Conventional steel framed building with 30-foot x 30-foot column spacing	Membrane roofing with rigid insulation and metal roof deck	Metal studs with drywall on inside and EFIS on exterior	32,500 lb	100 psf	435 psf
Office	Wood framed structure with 2x6 bearing walls spaced at 30-foot	Asphalt shingles and plywood on pre-engineered wood trusses	Wood framed walls with drywall on inside and	1,400 plf	50 psf	375 psf

1 - Assumes a 2-foot thick mat foundation under building

Light Industrial

Eave Height	18	(feet)
Masonry Height	6	(feet)
Column Spacing	30	(feet)
Column Spacing	50	(feet)
Roof		
Standing Seam Roofing	3	(psf)
Purlins	4	(psf)
Batt Insulation	1	(psf)
MEP Allowance	2	(psf)
Framing	3	(psf)
Total	13	(psf)
Walls		
8-inch CMU	42	(psf)
Snow		
Ground	30	(psf)
Flat	21	(psf)
Live		
Floor	125	(psf)
Wall Load	**252**	**(plf)**
Column Load	**51000**	**(lb)**
Average Load	**459**	**(psf)**

Light Commercial

Eave Height	12	(feet)
Masonry Height	0	(feet)
Column Spacing	30	(feet)
Column Spacing	30	(feet)
Roof		
Membrane	1	(psf)
Insulation	2	(psf)
Metal Deck	3	(psf)
Joists	2	(psf)
Framing	3	
MEP Allowance	4	(psf)
Total	15	(psf)
Walls		
Metal Studs	2	(psf)
Insulation	2	(psf)
Drywall	2	(psf)
Sheathing	3	(psf)
Finish	2	(psf)
Total	11	(psf)
Snow		
Ground	30	(psf)
Flat	21	(psf)
Live		
Floor	100	(psf)
Wall Load	**132**	**(plf)**
Column Load	**32400**	**(lb)**
Average Load	**436**	**(psf)**

Office

Eave Height	10	(feet)
Wall Spacing	30	(feet)
Roof		
Singles	2	(psf)
Plywood	2	(psf)
Trusses	6	(psf)
Insulation	1	(psf)
Ceiling	7	(psf)
MEP Allowance	2	(psf)
Total	20	(psf)
Walls		
Wood Studs	2	(psf)
Insulation	2	(psf)
Sheathing	3	(psf)
Drywall	2	(psf)
MEP Allowance	1	(psf)
Total	10	(psf)
Snow		
Ground	30	(psf)
Flat	23.1	(psf)
Live		
Floor	50	(psf)
Wall Load (Perimeter)	**747**	**(plf)**
Wall Load (Interior)	**1393**	
Average Load	**375**	**(psf)**

APPENDIX E-2

TECHNICAL MEMORANDUM

TASK 5E

FINDINGS FOR ESTIMATION OF SETTLEMENT, EVALUATION OF CAP COMPONENTS, AND CONCEPTUAL RETAINING WALL DESIGN FOR POTENTIAL SITE DEVELOPMENT

TECHNICAL MEMORANDUM

DATE: June 4, 2013

TO: Dean Brammer; USACE

COPY TO: Charles Collet, P.E., Stephen Mitchell, P.E., and Jeffrey Walker; AMEC

FROM: Travis Carpenter, P.E. (Maine) and Kim LaMarre, P.E. (Maine); AMEC

SUBJECT: FINAL – Task 5E Findings for Estimation of Settlement, Evaluation of Cap Components, and Conceptual Retaining Wall Design for Potential Site Development, Raymark Industries, Inc. Superfund Site (576/600 East Broadway), Stratford, Connecticut

PROJECT: 3651-12-0004

1.0 INTRODUCTION

AMEC Environment and Infrastructure, Inc. (AMEC) has estimated the magnitude and duration of settlement that would result from potential site development, based on an assumed final grade and finish-floor elevation of +15 feet and a mat foundation load (from Task 5D of Modification No. 2 to Delivery Order 0007, Raymark Superfund Site, Stratford, Connecticut (authorized on April 12, 2013)) of 500 pounds per square foot (psf). AMEC also evaluated the potential site development and foundation loads relative to a low-permeable capping system to be constructed as part of a planned Remedial Action. Additionally, AMEC has identified and evaluated a suitable retaining wall system to maximize the potential site development footprint.

The estimation of settlement, evaluation of cap components, and conceptual retaining wall design were performed in accordance with Task 5E of Modification No. 2 to Delivery Order 0007, Raymark Superfund Site, Stratford, Connecticut (authorized on April 12, 2013). This Technical Memorandum (TM) documents the work performed and presents the results of these evaluations.

This TM is organized as follows:

- Section 2.0 briefly summarizes relevant project background information;
- Section 3.0 presents the methodology, assumptions, results, and conclusions of the settlement evaluation;

- Section 4.0 reviews the evaluation of cap components; and
- Section 5.0 describes a suitable perimeter retaining wall system and summarizes the results of preliminary design calculations.

2.0 PROJECT BACKGROUND INFORMATION

Elevations reported herein are based on the North American Vertical Datum (NAVD) of 1988. Elevations are reported in units of feet. The horizontal datum is the Connecticut State Plane Coordinate System, based on the North American Datum (NAD) of 1983.

2.1 Site Description

The Raymark Industries, Inc. Superfund Site (i.e., the Site) is located at 576/600 East Broadway in Stratford, Connecticut. The adjacent East Broadway properties encompass approximately 6 acres of commercially-zoned (light industrial) land that is presently overgrown and undeveloped, except for two small buildings and associated pavements situated on the 576 East Broadway parcel. Central portions of the Site are relatively flat and level with existing ground surface elevations generally ranging between +8.0 and +12.5 feet. The Site slopes downward toward the site perimeter to an elevation of about +4.0 to +5.0 feet in most areas. Existing Site features and topography are depicted in Figure 1.

Beginning in the late 1980s, the Site received waste fill from the former Raymark Industries, Inc. facility. The fill consists of both natural and manmade materials. The manmade materials include presumed asbestos containing material (PACM) (fibrous asbestos mats and pads), asphalt, brake pads, brick, cinders, coal, concrete, gasket material, glass, metal debris, plastic, steel, tiles, shingles, slag, and wood. Raymark waste found in the fill materials at this Site consists of asbestos, lead, copper and/or Aroclor 1268.

Most of the Site was originally a tidal/seasonal floodplain marsh prior to filling. Much of the Site is still presently located within the 100-year floodplain.

2.2 Site-Specific Soil and Groundwater Conditions

AMEC carried out a site-specific geotechnical investigation to characterize subsurface conditions and obtain geotechnical data to support the planning, design, and construction of the planned Remedial Action and to evaluate the feasibility of site development (AMEC, 2013a). The geotechnical investigation indicates that the Site is underlain by the following primary soil strata:

- Fill: Heterogeneous fill materials comprised predominantly of sand, silt, gravel, and debris. Typically loose to medium dense. Thickness ranges from about 2 to 17 feet across the Site.
- Marsh Deposit: Marsh/floodplain deposit consisting primarily of organic silt (OH) with lesser amounts of organic clay (OH) and peat (PT). Variable amounts of sand throughout the deposit. Usually soft to medium stiff. Occasionally stratified with distinct layers of sand/silty sand (SM). Thickness varies from about 3.5 (GB-12) to about 17.5 feet (GB-03) across the Site.
- Fluvial Sand: Glacial fluvial deposit comprised of fine to coarse sand with varying amounts of silt and gravel. Typically medium dense to dense. Extends to Glacial Till and/or bedrock (based on site-specific monitoring well installations by others).

Figure 1 depicts the locations of site-specific geotechnical borings. Geotechnical Boring Records are provided in Attachment 1A. Tables 1A and 1B summarize the results of geotechnical laboratory testing performed on the Marsh Deposit. Site-specific consolidation testing data summaries are provided in Attachment 1B.

The one-dimensional consolidation testing data indicates that the Marsh Deposit is slightly over-consolidated with an average over-consolidation ratio (OCR) of 1.2. The data also indicate an average modified compression index ($C_{c\varepsilon}$) of 0.35, an average modified recompression index ($C_{r\varepsilon}$) of 0.07, and an average coefficient of consolidation (c_v) of about 0.20 feet^2/day. The Marsh Deposit is considered to be moderately to highly compressible based on the available geotechnical data. Consequently, this stratum is of prime concern for consolidation resulting from increases in effective stress due to grade raises and/or foundation loadings.

In January and February of 2013, AMEC measured the depth to groundwater in several existing (i.e., previously installed by others) monitoring wells. The depths ranged from about 4.5 feet to 5.5 feet below the ground surface (bgs) in the shallow monitoring wells (i.e., screened within the fill materials and/or Marsh Deposit). These depths correspond to groundwater elevations of about +1.5 to +3.0 feet. The monitoring well locations are shown in Figure 1. Groundwater depths, elevations, and gradients are summarized in Table 2.

2.3 Planned Remedial Action

The remediation of 576/600 East Broadway is being performed as a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Action (RA) under the *Record of Decision for Final Source Control Actions at Four Properties*

Within Operable Unit 6 (Additional Properties) and Interim Actions at Other Locations Containing Raymark Waste (USEPA, 2011). As described in the Record of Decision (ROD), the selected RA for this Site is to excavate Raymark waste from the 100-year floodplain, consolidate the waste on the upland portion of the Site, and contain the waste with a low-permeable Resource Conservation and Recovery Act (RCRA) cap.

2.4 Potential Site Development

AMEC understands that the Site is being considered for development following and/or in conjunction with the planned Remedial Action. A conceptual building footprint was provided to AMEC in August of 2012 and is depicted in Figure 1.

AMEC understands that Site development plans have not been developed or permitted. As such, AMEC has assumed that Site grades will be raised to an elevation of about +15.0 feet within the proposed limits of the cap (Figure 1). Similarly, AMEC has assumed that the building will have a finish-floor elevation of about +15.0 feet and that the building will be founded (at a foundation subgrade elevation of about +13.0 feet) on a 2-foot thick reinforced concrete mat foundation (AMEC, 2013b). A maximum uniformly distributed foundation load of 500 psf was assumed (AMEC, 2013b). A sketched cross-section of the potential development/loads relative to existing conditions is provided as Figure 2.

A retaining wall may be installed in some areas along and/or proximate to the site perimeter to maximize the potential site development footprint.

3.0 ESTIMATION OF SETTLEMENT

AMEC performed a settlement evaluation to estimate the magnitude and duration of primary consolidation settlement that would result from potential site development, based on an assumed final grade of +15 feet for parking areas and building finish-floor elevation of +15 feet with a mat foundation load 500 psf. AMEC also estimated the amount of secondary compression that might occur during the building's design life (i.e., 50 years) due to the organic nature/content of the Marsh Deposit.

Settlement was assessed at nine distinct geotechnical boring locations (GB-01, GB-03, GB-05, GB-06, GB-07, GB-08, GB-09, GB-10, GB-11, and GB-12). Geotechnical boring locations are depicted in Figure 1. Settlement estimates assume that any primary consolidation due to historic and/or recent fill placement is complete.

3.1 Methodology and Assumed Compressibility Parameters

AMEC developed and utilized an in-house spreadsheet calculator to estimate primary consolidation settlement and secondary compression settlement at the referenced locations. The principal inputs and steps/calculations performed for each assessment point are summarized as follows:

1. Input existing grade and groundwater depth;
2. Input proposed grade and unit weight of proposed grading fill;
3. Input proposed building foundation load, if applicable;
4. Input subsurface soil profile;
5. Calculate in-situ stress and proposed stress versus depth (see Subsection 3.1.1);
6. Input compressibility parameters for applicable soil strata;
7. Indicate whether the principal compressible stratum is singly- or doubly-drained;
8. Calculate primary consolidation settlement (see Subsection 3.1.2);
9. Calculate the time-rate of primary consolidation (see Subsection 3.1.3); and
10. Calculate secondary compression settlement (see Subsection 3.1.4).

Spreadsheet calculations for each assessment point are provided in Attachment 2. The calculations performed and the parameters utilized for this evaluation are further detailed in the subsections below.

3.1.1 Calculate In-Situ Stress and Proposed Stress vs. Depth

AMEC estimated in-situ total stress, pore pressure, and effective stress at the top, bottom, and middle of each primary soil stratum based on the subsurface soil and groundwater conditions at the referenced borehole location. At each assessment point, AMEC compared the assumed site development grade (+15 feet) to the existing grade in order to estimate the proposed grade raise. The increase in effective stress was then estimated based on an assumed fill unit weight of 125 pounds per cubic foot (pcf).

The foundation load of 500 psf was applied for assessment points located within or proximate to the conceptual building footprint (GB-01, GB-03, GB-05, GB-07, GB-09, and GB-10). For the purposes of this evaluation, the entire foundation load was applied to the full subsurface profile at the referenced boring locations. The entire foundation load was also applied regardless of whether the boring location was in the middle of the building, along the edge, or near a corner because the actual/exact location of a building has not

been determined. Subsequent settlement estimates for a designed building location should consider reducing the foundation load at/near building corners and along/near the perimeter based on Boussinesq theory of elasticity.

3.1.2 Calculate Primary Consolidation Settlement

AMEC estimated the primary consolidation settlement at each assessment point using standard consolidation theory equations (*Day, 2006*):

For normally consolidated soil (i.e., OCR = 1):

- $$S_c = C_{c\varepsilon} * H_o * \log(\sigma_{vo}' + \Delta\sigma_v)/\sigma_{vo}'$$

For over-consolidated soil (i.e., OCR > 1):

- Case I: $(\sigma_{vo}' + \Delta\sigma_v) \leq \sigma_p'$

  $$S_c = C_{r\varepsilon} * H_o * (\sigma_{vo}' + \Delta\sigma_v)/\sigma_{vo}'$$

- Case II: $(\sigma_{vo}' + \Delta\sigma_v) > \sigma_p'$

  $$S_c = C_{r\varepsilon} * H_o * \log(\sigma_p'/\sigma_{vo}') + C_{c\varepsilon} * H_o * \log(\sigma_{vo}' + \Delta\sigma_v)/\sigma_p'$$

Where:

- S_c = Primary consolidation settlement in feet;
- $C_{r\varepsilon}$ = Recompression index;
- $C_{c\varepsilon}$ = Compression index;
- H_o = Thickness of layer in feet;
- σ_p' = Estimated maximum past pressure in psf (from consolidation tests/OCR estimates);
- σ_{vo}' = Estimated existing effective stress in psf; and
- $\Delta\sigma_v$ = Change in vertical stress, or the weight of the grade raise fill and building foundation load as applicable, in psf.

For the purposes of this evaluation, the Marsh Deposit was assumed to be slightly over-consolidated (OCR = 1.2). The modified compression and recompression indices (strain based) utilized for this assessment are summarized in Table 3.

Table 3: Assumed Modified Compression/Recompression Indices

Stratum	Description	$C_{c\varepsilon}$	$C_{r\varepsilon}$
Marsh Deposit (Typical/Average)	Organic Silt/Clay/Peat (OH/PT)	0.35[1]	0.07
Marsh Deposit (Values used for GB-03)	Organic Silt/Clay/Peat (OH/PT) Stratified w/Sand Layers	0.18[2]	0.07
Marsh Deposit (Values used for GB-09)	Organic Silt/Clay/Peat (OH/PT) Sandy	0.30[3]	0.07

Notes:

1. Typical/average value used for most assessment points. Value based on the average of six one-dimensional consolidation tests.
2. Assumed value used for GB-03 only. Reduced compressibility based on observations of several distinct sand and inorganic silt layers within the Marsh Deposit. These sand/silt layers comprise nearly one-half of the overall Marsh Deposit thickness. As such, the typical/average value was reduced by approximately one-half.
3. Assumed value used for GB-09 only. Nominally reduced compressibility based on observations of higher (than typical) sand content within the Marsh Deposit soil matrix at this location.

3.1.3 Calculate Time-Rate of Primary Consolidation

AMEC estimated the time required for primary consolidation to occur at each point based on the Terzaghi theory of consolidation. Double drainage was assumed for the Marsh Deposit based on presence of granular soils above (Fill) and below (Fluvial Sand).

The coefficient of consolidation, c_v, was estimated based on the results of site-specific one-dimensional consolidation testing data, empirical correlations to published values utilizing index testing data (i.e., Atterberg Limits), and engineering judgment. The coefficients of consolidation utilized for this assessment are summarized in Table 4.

Table 4: Assumed Coefficient of Consolidation Parameters

Stratum	Description	c_v (feet^2/day)
Marsh Deposit (Typical/Average)	Organic Silt/Clay/Peat (OH/PT)	0.20[1]
Marsh Deposit (Value used for GB-03)	Organic Silt/Clay/Peat (OH/PT) Stratified w/Sand Layers	0.40[2]
Marsh Deposit (Value used for GB-09)	Organic Silt/Clay/Peat (OH/PT) Sandy	0.20[3]

Notes:

1. Typical/average value used for most assessment points. Value based on the average of six one-dimensional consolidation tests.
2. Assumed value used for GB-03 only. Increased rate of consolidation based on observations of several distinct sand and inorganic silt layers within the Marsh Deposit. These sand/silt layers comprise nearly one-half of the overall Marsh Deposit thickness.
3. The virgin compressibility parameter for GB-09 was nominally reduced (see Table 3) based on observations of higher (than typical) sand content within the Marsh Deposit soil matrix at this location. However, the coefficient of consolidation was not increased (based on increased sand content) for this evaluation, which may be slightly conservative.

The time to achieve primary consolidation was estimated using the following equation (Day, 2006):

- $t_p = T * H_{dr}^2 / c_v$

Where:

- t_p = Time to achieve primary consolidation;
- T = Time factor (e.g., 0.848 for 90 percent consolidation);
  - For $U_{avg} < 60\%$, $T = 1/4 * \Pi * (U_{avg}/100)^2$, where U_{avg} = avg. degree of consolidation
  - For $U_{avg} \geq 60\%$, $T = 1.781 - 0.933 * \text{Log}(100 - U_{avg})$
- H_{dr} = Length of longest drainage path in feet; and
- c_v = Coefficient of consolidation, in feet^2/day.

3.1.4 Calculate Secondary Compression

Secondary compression of organic soils can result in a substantial amount of additional settlement following the completion of primary consolidation and dissipation of load-induced excess pore pressure. Secondary compression may continue to occur throughout the design life of the project.

AMEC estimated the secondary compression of the potential site development and building using on an estimated secondary compression ratio ($C_{\acute{a}\varepsilon}$) of 0.02 (from consolidation testing data), a Marsh Deposit thickness of about 7 to 17 feet (after primary consolidation), an assumed 6-month (0.5-year) primary consolidation period (based on the assumed implementation of a surcharge program), and an assumed building design life of 50 years.

Secondary compression was estimated using the following equation (Day, 2006):

- $S_{sec} = C_{\acute{a}\varepsilon} * H_o * \log(t_{sec}/t_p)$

Where:

- S_{sec} = Secondary compression settlement in feet;
- $C_{\acute{a}\varepsilon}$ = Secondary compression index;
- H_o = Thickness of layer in feet (after primary consolidation);
- t_{sec} = Time of interest in secondary compression in years;
    - Commonly equivalent to the design life of the structure/facility, but other durations/periods may be considered
- t_p = End of primary consolidation in years.

3.2 RESULTS

Table 5 summarizes the estimated settlements at the geotechnical boring locations referenced herein:

Table 5: Summary of Settlement

Location	Estimated Settlement (to nearest inch)			
	Primary Consolidation		Secondary Compression	
	Magnitude (inches)	Estimated Time To EOP[1] (months)	~ 5 Years[2] (inches)	~ 50 Years[3] (inches)
GB-01 (Building)	13	12	3	6
GB-03 (Building)	13	11	2	4
GB-05 (Building)	9	5	2	4
GB-06 (Site/Parking)	9	5	2	4
GB-07 (Building)	17	11	3	5
GB-08 (Site/Parking)	13	17	3	7
GB-09 (Building)	21	13	3	6
GB-10 (Building)	8	6	2	4
GB-11 (Site/Parking)	11	7	2	4

Notes:

1. EOP = end of primary (based on estimate to approximately 99 percent primary consolidation). Rounded to the nearest month.
2. Five years [following an assumed surcharge-influenced primary consolidation period of about 6 months (0.5 years)] of secondary compression equates to one log cycle [Log (5/0.5) = 1].
3. Fifty years [following an assumed surcharge-influenced primary consolidation period of about 6 months (0.5 years)] of secondary compression equates to two log cycles [Log (50/0.5) = 2].

3.3 DISCUSSION AND RECOMMENDATIONS

Primary consolidation settlement is estimated to range between 8 and 21 inches across the potential footprint of site development (represented by the proposed limits of landfill cap on Figure 1). This same range (GB-10 to GB-09) applies to the potential building footprint depicted in Figure 1 and translates to roughly 13 inches of differential settlement within the potential building footprint due to primary consolidation.

This relative large range of primary consolidation settlement is driven by substantial variation among the following parameters:

- Variable thickness of the Marsh Deposit;

- Variable thickness of existing fill, which results in variable existing effective stress in Marsh Deposit; and
- Variable existing Site grades within potential footprint of site development (resulting in variable load increase due to site development grading).

Given the variability in these parameters, AMEC recommends that primary consolidation settlement, at a minimum, be addressed via the implementation of a monitored surcharge program, prior to the construction of a building on a reinforced concrete mat foundation. In general terms, a surcharge consists of placing fill to an elevation that is in excess of the anticipated final grades (and any additional loads) in order to force the primary consolidation attributable to the final grading to occur more rapidly. Furthermore, surcharging provides a relatively simple/constructible means of addressing variabilities identified herein. Typically, the magnitude of the surcharge can be increased to reduce consolidation time, or the consolidation period can be extended to reduce the amount of surcharge fill.

Following the completion of primary consolidation, secondary compression settlement will occur. After about five years (or one log cycle), secondary compression is estimated to range between 2 and 3 inches across the site development footprint. After about 50 years (or two log cycles), secondary compression is estimated to range between 4 and 7 inches. Secondary compression, and hence long-term total and differential settlement, can be minimized via a more substantial surcharge and/or a longer duration of surcharging and monitoring (i.e., a larger surcharge fill and/or more time relative to a surcharge program that targets the removal of primary consolidation only).

4.0 EVALUATION OF CAP COMPONENTS

The planned capping system will be comprised of a combination of cover soil and geosynthetics, and will consist of the following from the ground surface down:

- Topsoil (4 inches);
- Vegetative soil (8 inches);
- Protective cover soil (12 inches);
- Geocomposite drainage layer;
- Linear low density polyethylene (LLDPE) geomembrane;
- Geocomposite clay liner (GCL); and
- Geocomposite gas collection layer.

The geosynthetics will be subjected to compressive loads from cover soils and a potential building mat foundation to be constructed on top of the cap, as well as strain induced from differential settlement. AMEC has evaluated the impact on these components based on the estimated loads, predicted differential settlement, and reviewed manufacturer's literature.

4.1 Performance of Geosynthetics Under Anticipated Compressive Loads

Two feet of cover soil will be placed above the geosynthetics. This equates to a surcharge load of 250 psf assuming a cover soil unit weight of 125 pounds per cubic foot (pcf). Additionally, it is estimated that loading from potential building founded on a reinforced concrete mat foundation will induce approximately 500 psf in surcharge (AMEC, 2013b); therefore the total anticipated weight on the geosynthetics would be 750 psf (35 kPa), or an equivalent 6 feet of soil cover.

Geocomposite Drainage/Gas Vent layer: Geocomposite drainage materials are promoted for their ability to continue to perform under high compressive loads. Cut sheets from Mirafi G-Series drainage composite indicate a compressive strength of 18,000 psf; Tenax geocomposite drainage products are performance tested at compressive loads of 20 to 500 kPa, or 417 to 10,447 psf. Therefore, the anticipated stresses are well within the performance testing criteria established for these products.

LLDPE: LLDPE geomembrane are routinely used to cap and/or line landfills and are not considered crushable. These stresses are well within the standard application limits of the geomembrane.

GCL: GCLs are routinely used to line or cap and/or line landfills and are routinely subjected to high compressive loads, in some cases as high as 25,000 to 30,000 psf. Studies indicate the hydraulic conductivity of GCLs decrease with increase in confining pressures. The equivalent 6 feet of soil is within the acceptable application limits of the GCL.

Supporting documents and information pertaining to the three geosynthetic materials described above are included in Attachment 3.

4.2 Differential Settlement and Survivability of Geosynthetics

Because of the organic nature of the deposit, both primary and secondary settlement is anticipated. A monitored surcharge/pre-loading program is proposed (Task 5F) to remove

estimated primary consolidation settlement prior to construction of the cap, however, secondary compression is likely to continue indefinitely following capping and building construction. As such, there is potential for differential settlement to occur, which could induce stresses, and accordingly strains, on the geosynthetics. Table 6 lists published values for typical elongation at peak strength or break for the various geosynthetic materials, as determined during wide-width tensile strength testing of the material.

Table 6: Typical Elongation Properties of Geosynthetics

Material	Elongation at Peak Strength or at Break (%)
Geocomposite Drainage/Gas Vent Material[1]	50-60
Geomembrane[2]	200
GCL[3]	15-20

1. Tenax geocomposite drainage material, at peak.
2. Project specifications minimum requirement at break; Polyflex 60 mil LLPDE: 250%.
3. Bentomat, at peak load.

AMEC compared the typical percent elongation values, as listed in manufacturer's literature to the anticipated strains that could be induced by the predicted differential secondary compression.

Secondary compression (over 50 years) is estimated at about 4 to 6 inches within the potential building footprint. Secondary compression predicted at GB-09 is approximately 6 inches; predicted secondary compression at GB-03 is 4 inches, resulting in a differential settlement of about 2 inches between the two locations. Two inches of differential settlement over a 50-foot distance results in 0.0003 feet of elongation, or 0.0006% strain. To further illustrate, by assuming a controlling elongation of 15 percent, the geosynthetic would need to stretch 15 feet over a 100-foot length before tearing. This translates to nearly 60 feet of differential settlement.

Based on this evaluation, differential settlement is not considered to be an issue for cap geosynthetics.

5.0 CONCEPTUAL RETAINING WALL DESIGN

To facilitate construction of a parking lot surrounding a potential building, AMEC evaluated the feasibility of constructing a 5-foot tall earth retaining system to be placed along the perimeter of the property. The retaining wall system would support fill materials used to raise site grades to those anticipated for site development. To limit interference with the

capping system behind the wall, AMEC selected a free-standing retaining wall that should not require reinforcement, such as tie-backs or geogrid. Several manufacturers are available for these types of "big block" modular retaining wall systems. For conceptual design purposes, AMEC considered the use of a system manufactured by Stone Strong; should design proceed, other block wall systems may be considered.

Stone Strong products consist of pre-cast concrete wall sections that are in-filled with granular material. The pre-cast concrete is fabricated to appear like natural stone. The wall is constructed on an aggregate base and/or a lean concrete base at least 6 inches thick. At least 12 inches of free draining granular backfill, as well as perimeter drainage, is typically provided directly behind the wall. Stone Strong blocks are available in several sizes to accommodate the application needs, along with other associated system components for top or end capping, and for accommodating turns or corners in the retaining wall alignment. There are also four different appearance packages (stone types) to choose from.

For conceptual design purposes, AMEC analyzed a retaining wall located at the northeast corner of the property. The following assumptions were made:

- The wall would remain within the limits of the landfill (i.e. outside the 100 year flood plain);
- A maximum wall height of approximately 5 feet;
- The wall backfill slopes 1.5 feet over a 50-foot length;
- A surcharge load behind the wall equivalent to standard passenger vehicle loading of 100 psf;
- No reinforcement would be required; and
- The soil material properties listed in Table 7.

Table 7: Assumed Material Properties

Soil Material	Moist unit Weight (pcf)	Saturated Unit Weight, pcf	Angle of internal Friction, degrees
Existing Subgrade Fill	115	125	30
Grading Fill	125	-	32

Stone Strong provides proprietary software to analyze the suitability of the wall selected. The software analyzes bearing capacity, sliding stability, and overturning stability of the wall. The minimum required safety factor (SF_{min}) for each static analysis is as follows:

- Bearing Capacity SF_{min} = 3.0;
- Sliding SF_{min} = 1.5; and
- Overturning SF_{min} = 2.0.

To achieve the desired wall height, AMEC assumed that the wall would be comprised of two stacked block sizes; the bottom block would consist of the 24SF and the top the 6SF. The top of the wall would be finished with a cap component. Cut sheets of these wall components are included in Attachment 4.

Using Stone Strong's spreadsheet, preliminary analyses suggest that the assumed wall configuration meets the required minimum SFs for static loading conditions:

- Computed Bearing Capacity SF = 7.0
- Computed Sliding SF = 2.5; and
- Computed Overturning SF = 4.1.

A copy of the spreadsheet calculations is included in Attachment 4.

AMEC performed an independent global (i.e., deep-seated) stability analysis of the conceptual retaining wall under static loading conditions. The analyses also included a surcharge load behind the wall of 100 psf. The evaluation was performed utilizing SLOPE/W (GeoStudio 2004, Version 6.22), an industry-standard two-dimensional slope stability software program developed and distributed by Geo-Slope International, Ltd. A minimum SF of 1.6 was calculated for the static analysis, which is greater than the minimum acceptable SF of 1.5. The results of the analysis are provided in Attachment 4.

6.0 REFERENCES

AMEC, 2013a. "Remedial Design Sampling Report, Remedial Design of a Landfill Cap, Waste Consolidation, Institutional Controls, and Interim Actions, Operable Unit (OU6)," February 14, 2013.

AMEC, 2013b. "Technical Memorandum, Estimation of Building Foundation Loads, Raymark Superfund Site – 576/600 East Broadway, Stratford, CT", February 19, 2013.

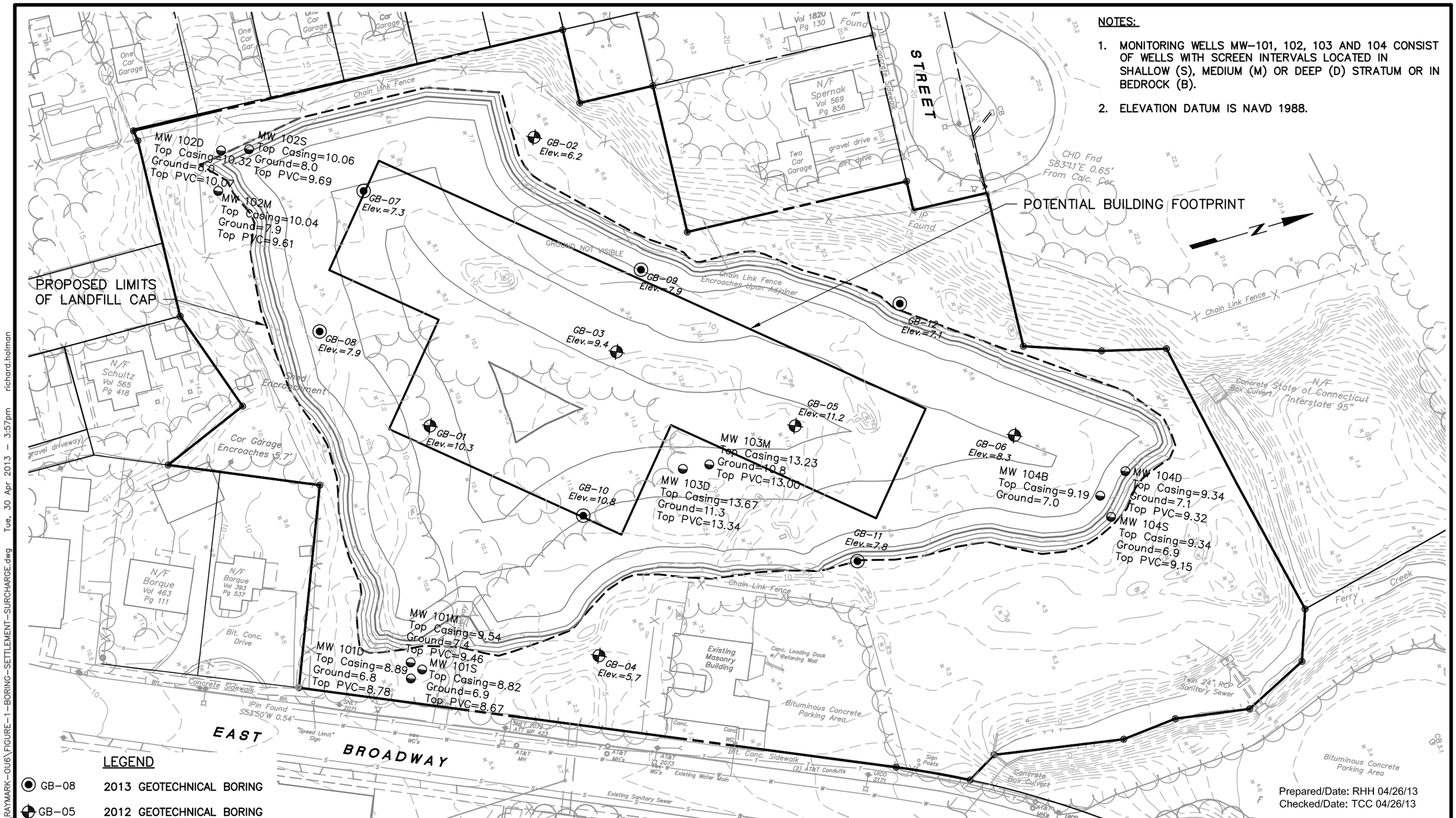
Day, Robert W., 2006. Foundation Engineering Handbook, The McGraw-Hill Companies, Inc., 2006.

Department of the Navy, Naval Facilities Engineering Command, 1982. "Soil Mechanics, Design Manual 7.1" (NAVFAC DM-7.1), May 1982.

FIGURES

NOTES:

1. MONITORING WELLS MW–101, 102, 103 AND 104 CONSIST OF WELLS WITH SCREEN INTERVALS LOCATED IN SHALLOW (S), MEDIUM (M) OR DEEP (D) STRATUM OR IN BEDROCK (B).
2. ELEVATION DATUM IS NAVD 1988.



LEGEND

GB–08	2013 GEOTECHNICAL BORING
GB–05	2012 GEOTECHNICAL BORING
MW 103(D)	1994 MONITORING WELL
	EXISTING GROUND SURFACE ELEVATION CONTOUR
	PROPOSED CAP GRADING (60% REMEDIAL DESIGN)

0 30 60 120
SCALE IN FEET HORIZONTAL

Prepared/Date: RHH 04/26/13
Checked/Date: TCC 04/26/13

RAYMARK INDUSTRIES, INC.
576/600 EAST BROADWAY
STRATFORD, CONNECTICUT

amec

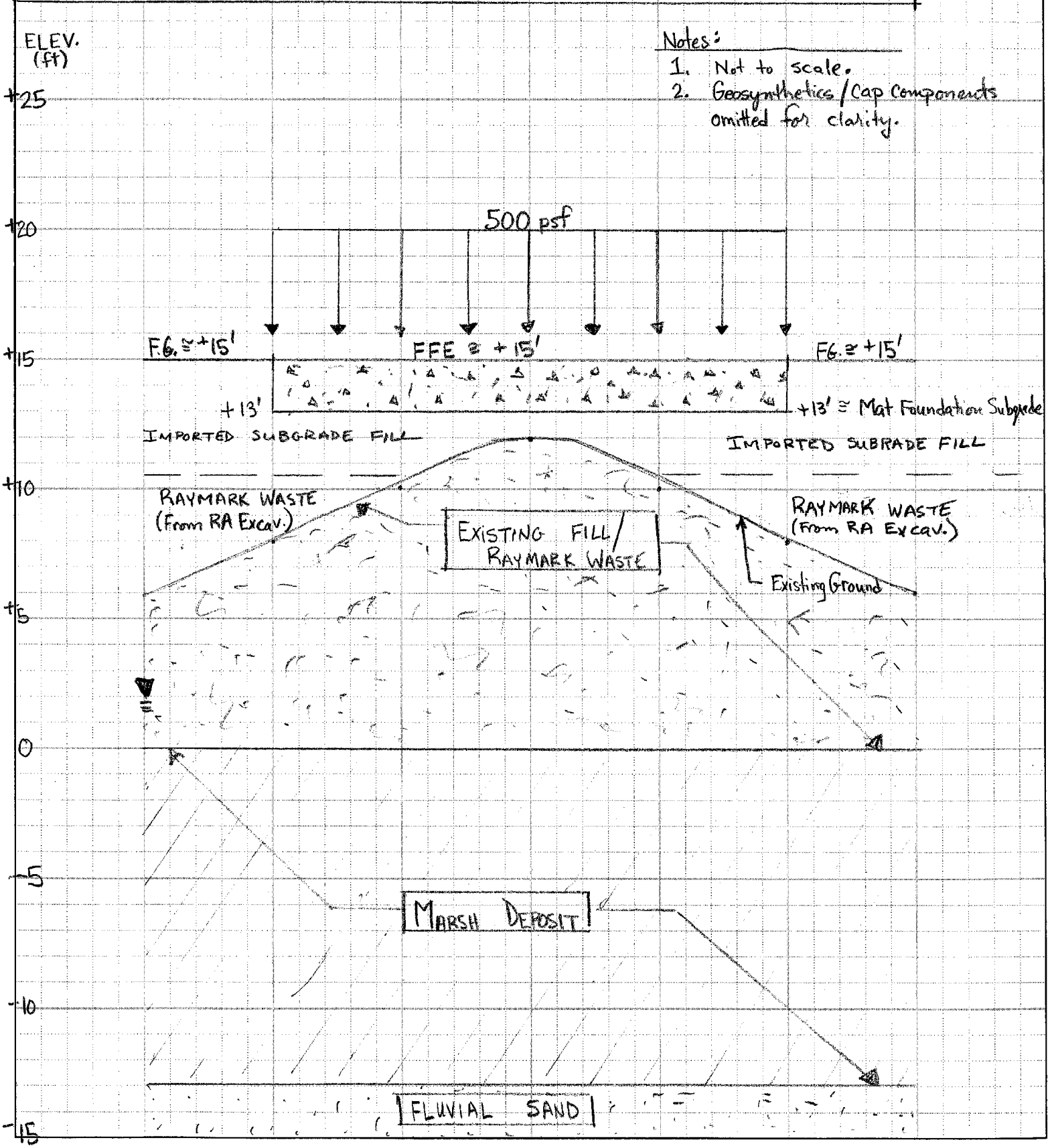
GEOTECHNICAL BORING LOCATIONS
SETTLEMENT AND SURCHARGE EVALUATION
Project 3651-12-0004
FIGURE 1

Z:\Projects\USACE\RAYMARK–OU6\FIGURE–1–BORING–SETTLEMENT–SURCHARGE.dwg Tue, 30 Apr 2013 – 3:57pm richard.holman

JOB NO.	3651120004	SHEET	1 OF 1
PHASE	—	TASK	—
JOB NAME	Raymark Industries, Inc. Superfund Site		
BY	TCC	DATE	06/03/13
CHECKED BY	—	DATE	—

amec
511 Congress Street Suite 200
Portland, ME 04101
+1 (207) 775-5401 Fax +1 (207) 772-4762

GENERALIZED CROSS-SECTION THROUGH POTENTIAL BUILDING FOOTPRINT



TABLES

Table 1A
Summary of Geotechnical Laboratory Testing Data - Marsh Deposit (All)

Borehole No.	Ground Elevation (ft bgs)	Sample Information							Laboratory Testing Data																						
		No.	Type	Depth Interval	In-Situ Effective Stress	Primary Stratum	USCS D 2487 / D 2488		Water Content D 2216	Organic Content D 2974	Total Unit Weight	Dry Unit Weight	Void Ratio	Satur.	Particle-Size Analysis D 422				Atterberg Limits D 4318						Specific Gravity D 854	Undrained Shear Strength		1-D Consolidation (Raw Lab Data) D 2435					
							Description	Symbol							Gravel	Sand	Silt	Clay	LL Wet Prep.	LL Oven Dried	LL ODLL WPLL Ratio	PL	PI	LI		Torvane	Lab Vane D 4648						
				(ft bgs)	(psf)				(%)	(%)	(pcf)	(pcf)		(%)	(%)	(%)	(%)	(%)								(psf)	(psf)				(ft²/day)	
GB-01	10.3	SS-09	Jar	16 - 18	-	Marsh Deposit	Organic Silt	OH	71.1	-	-	-	-	-	0.0	5.0	95.0		-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-10	Jar	20 - 22	-	Marsh Deposit	Organic Silt	OH	117.0	11.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-11	Jar	22 - 24	-	Marsh Deposit	Organic Silt	OH	114.8	-	-	-	-	-	-	-	-	-	143	-	-	67	76	0.6		-	-	-	-	-	-	-
		SS-12	Jar	24 - 26	-	Marsh Deposit	Organic Silt	OH	151.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GB-02	6.2	SS-04	Jar	06 - 08	-	Marsh Deposit	Silty Sand w/organics	SM	80.0	20.6	-	-	-	-	9.5	66.0	24.5		-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-07	Jar	12 - 14	-	Marsh Deposit	Organic Silt	OH	149.6	18.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GB-03	9.4	SS-05	Jar	08 - 10	-	Marsh Deposit	Silty Sand	SM	-	-	-	-	-	-	8.4	64.8	26.8		-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SH-07	Tube	12 - 14.5	900	Marsh Deposit	Organic Silt	OH	205.9	-	80.3	26.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									192.0	22.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									181.7	-	70.4	25.0	4.49	89.1	-	-	-	-	-	-	-	-	-	-	-	-	-	860	1.0	0.31	0.07	0.04	0.02
									206.0	-	-	-	-	-	-	-	-	-	191	-	-	88	103	1.1	-	-	-	-	-	-	-	-	-
									167.7	-	80.5	30.1	-	-	-	-	-	-	-	-	-	-	-	-	-	280	-	-	-	-	-	-
									205.9	-	33.9	11.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									205.9	-	70.4	23.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									107.4	-	79.1	38.2	2.60	90.9	0.0	16.8	83.2		-	-	-	-	-	-	2.20	-	-	-	-	-	-	-
		SS-09	Jar	16.5 - 18.5	-	Marsh Deposit	Organic Silt	OH	121.2	14.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-10	Jar	18.5 - 20.5	-	Marsh Deposit	Organic Silt	OH	169.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-11	Jar	20.5 - 22.5	-	Marsh Deposit	Organic Silt	OH	150.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-12	Jar	22.5 - 24.5	-	Marsh Deposit	Organic Silt	OH	179.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GB-05	11.2	SS-07A	Jar	12 - 14	-	Marsh Deposit	Sandy Organic Silt	OH	134.0	18.1	-	-	-	-	8.7	32.6	58.7		-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-09	Jar	16.5 - 18.5	-	Marsh Deposit	Organic Silt	OH	153.3	7.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GB-06	8.3	SS-07	Jar	12 - 14	-	Marsh Deposit	Organic Silt	OH	104.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SH-08	Tube	14 - 16.5	1000	Marsh Deposit	Organic Silt	OH	103.9	-	88.9	43.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									107.5	-	86.1	41.5	3.26	93.4	-	-	-	-	-	-	-	-	-	-	-	-	-	1100	1.1	0.24	0.06	0.16	0.01
									105.0	8.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									92.0	-	94.3	49.1	-	-	-	-	-	-	-	-	-	-	-	-	-	440	-	-	-	-	-	-
									103.9	-	88.9	43.6	-	-	-	-	-	-	128	-	-	58	70	0.7	-	-	-	-	-	-	-	-
									104.0	-	103.2	50.6	2.16	89.1	0.0	21.0	79.0		-	-	-	-	-	-	2.56	-	-	-	-	-	-	-
GB-07	7.3	VS-07B	Jar	17 - 19	-	Marsh Deposit	Organic Silt/Peat	OH/PT	260.5	-	-	-	-	-	-	-	-	-	341	NP	-	130	211	0.6	-	-	-	-	-	-	-	-
		SS-08	Jar	20 - 22	-	Marsh Deposit	Organic Silt/Peat	OH/PT	318.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ST-09	Tube	22.5 - 24.5	1275	Marsh Deposit	Organic Silt/Peat	OH/PT	259.0	38.0	-	-	-	-	-	-	-	-	475	NP	-	184	291	0.3	1.94	-	-	-	-	-	-	-
									370.8	-	63.8	13.6	-	-	-	-	-	-	-	-	-	-	-	-	-	600	580	-	-	-	-	-
									461.0	-	62.8	11.2	9.79	91.4	-	-	-	-	-	-	-	-	-	-	-	-	-	1600	1.3	0.55	0.08	0.16	0.02
		SS-10A	Jar	25 - 27	-	Marsh Deposit	Organic Silt	OH	119.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GB-08	7.9	SS-05B	Jar	12 - 14	-	Marsh Deposit	Organic Silt/Peat	OH/PT	274.0	49.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		VS-07B	Jar	16 - 18	-	Marsh Deposit	Organic Silt	OH	117.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ST-08	Tube	18 - 20	1175	Marsh Deposit	Organic Silt	OH	129.0	15.8	-	-	-	-	-	-	-	-	146	81	0.6	71	75	0.8	2.44	-	-	-	-	-	-	-
									116.8	-	79.2	36.5	-	-	-	-	-	-	-	-	-	-	-	-	-	620	560	-	-	-	-	-
									135.8	-	77.8	33.0	3.61	91.8	-	-	-	-	-	-	-	-	-	-	-	-	-	1450	1.2	0.36	0.06	0.20	0.02
		SS-09B	Jar	20 - 22	-	Marsh Deposit	Organic Silt/Peat	OH/PT	275.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-10	Jar	22.5 - 24.5	-	Marsh Deposit	Organic Silt/Peat	OH/PT	286.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-11B	Jar	25 - 27	-	Marsh Deposit	Organic Silt/Peat	OH/PT	208.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GB-09	7.9	SS-04	Jar	10 - 12	-	Marsh Deposit	Organic Silt	OH	143.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		VS-05	Jar	12.5 - 14.5	-	Marsh Deposit	Organic Silt/Peat	OH/PT	338.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-06	Jar	15 - 17	-	Marsh Deposit	Organic Silt/Peat	OH/PT	352.6	-	-	-	-	-	-	-	-	-	355	NP	-	163	192	1.0	-	-	-	-	-	-	-	-
		ST-07	Tube	17.5 - 19.5	775	Marsh Deposit	Sandy Organic Clay	OH	41.0	4.9	-	-	-	-	-	-	33.9		76	NP	-	33	43	0.2	-	-	-	-	-	-	-	-
									46.2	-	101.2	69.2	1.47	86.0	-	-	-	-	-	-	-	-	-	-	-	-	-	1300	1.7	0.18	0.02	0.19	0.01
GB-10	10.8	SS-06	Jar	17 - 19	-	Marsh Deposit	Organic Silt	OH	109.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ST-07	Tube	19 - 21	1550	Marsh Deposit	Organic Silt/Peat	OH/PT	189.0	28.9	-	-	-	-	-	-	-	-	239	NP	-	93	146	0.7	2.15	-	-	-	-	-	-	-
									175.2	-	71.7	26.1	-	-	-	-	-	-	-	-	-	-	-	-	-	660	580	-	-	-	-	-
									199.8	-	70.2	23.4	4.74	90.7	-	-	-	-	-	-	-	-	-	-	-	-	-	1600	1.0	0.43	0.07	0.51	0.02
		VS-08	Jar	22 - 24	-	Marsh Deposit	Organic Silt/Peat	OH/PT	172.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-09A	Jar	25 - 27	-	Marsh Deposit	Organic Silt	OH	98.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GB-11	7.8	SS-03	Jar	10 - 12	-	Marsh Deposit	Organic Silt	OH	101.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		VS-05	Jar	14 - 16	-	Marsh Deposit	Organic Silt/Peat	OH/PT	231.6	-	-	-	-	-	-	-	-	-	191	81	0.4	82	109	1.4	-	-	-	-	-	-	-	-
		SS-07A	Jar	18 - 20	-	Marsh Deposit	Organic Silt/Peat	OH/PT	245.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GB-12	7.1	SS-03	Jar	08 - 10	-	Marsh Deposit	Organic Silt	OH	116.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SS-04A	Jar	10 - 12	-	Marsh Deposit	Sandy Organic Silt	SM/OH	44.9	-	-	-	-	-	-	-	35.7		-	-	-	-	-	-	-	-	-	-	-	-	-	-
								Count:	57	13	18	18	-	-	-	-	-	-	10	-	-	10	10	10	5	-	-	6	6	6	6	6	6
								Minimum:	41.0	4.9	33.9	11.1	-	-	-	-	-	-	76	-	-	33	43	0.2	1.94	-	-	-	1.0	0.18	0.02	0.04	0.01
								Average:	**170.6**	**19.9**	**77.9**	**33.1**	-	-	-	-	-	-	**229**	-	-	**97**	**132**	**0.7**	**2.26**	-	-	-	**1.2**	**0.35**	**0.06**	**0.21**	**0.02**
								Maximum:	461.0	49.5	103.2	69.2	-	-	-	-	-	-	475	-	-	184	291	1.4	2.56	-	-	-	1.7	0.55	0.08	0.51	0.02
								Average (excluding min & max):	**167.6**	**18.6**	**79.1**	**32.2**	-	-	-	-	-	-	**217**	-	-	**94**	**123**	**0.7**	**2.26**	-	-	-	**1.2**	**0.34**	**0.07**	**0.18**	**0.02**

Table 1B
Summary of Geotechnical Laboratory Testing Data - Marsh Deposit (Shelby Tube Samples Only)

Borehole No.	Ground Elevation (ft bgs)	Sample Information							Laboratory Testing Data																					
		No.	Type	Depth Interval	In-Situ Effective Stress	Primary Stratum	USCS D 2487 / D 2488		Water Content	Organic Content	Total Unit Weight	Dry Unit Weight	Void Ratio	Satur.	Particle-Size Analysis D 422				Atterberg Limits D 4318						Specific Gravity	Undrained Shear Strength		1-D Consolidation (Raw Lab Data) D 2435					
					σ'_v		Description	Symbol	D 2216	D 2974	γ_t	γ_d	e_0	S	Gravel	Sand	Silt	Clay	LL Wet Prep.	LL Oven Dried	LL ODLL WPLL Ratio	PL	PI	LI	D 854	Torvane S_u	Lab Vane D 4648 S_u	$\sigma'_{p\text{-}max.}$	OCR	$C_{c\varepsilon}$	$C_{r\varepsilon}$	c_v	$C_{\alpha\varepsilon}$
				(ft bgs)	(psf)				(%)	(%)	(pcf)	(pcf)		(%)	(%)	(%)	(%)	(%)								(psf)	(psf)					(ft²/day)	
GB-03	9.4	SH-07	Tube	12 - 14.5	900	Marsh Deposit	Organic Silt	OH	205.9	-	80.3	26.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									192.0	22.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									181.7	-	70.4	25.0	4.49	89.1	-	-	-	-	-	-	-	-	-	-	-	-	-	860	1.0	0.31	0.07	0.04	0.02
									206.0	-	-	-	-	-	-	-	-	-	191	-	-	88	103	1.1	-	-	-	-	-	-	-	-	-
									167.7	-	80.5	30.1	-	-	-	-	-	-	-	-	-	-	-	-	-	280	-	-	-	-	-	-	-
									205.9	-	33.9	11.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									205.9	-	70.4	23.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									107.4	-	79.1	38.2	2.60	90.9	0.0	16.8	83.2		-	-	-	-	-	-	2.20	-	-	-	-	-	-	-	-
GB-06	8.3	SH-08	Tube	14 - 16.5	1000	Marsh Deposit	Organic Silt	OH	103.9	-	88.9	43.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									107.5	-	86.1	41.5	3.26	93.4	-	-	-	-	-	-	-	-	-	-	-	-	-	1100	1.1	0.24	0.06	0.16	0.01
									105.0	8.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
									92.0	-	94.3	49.1	-	-	-	-	-	-	-	-	-	-	-	-	-	440	-	-	-	-	-	-	-
									103.9	-	88.9	43.6	-	-	-	-	-	-	128	-	-	58	70	0.7	-	-	-	-	-	-	-	-	-
									104.0	-	103.2	50.6	2.16	89.1	0.0	21.0	79.0		-	-	-	-	-	-	2.56	-	-	-	-	-	-	-	-
GB-07	7.3	ST-09	Tube	22.5 - 24.5	1275	Marsh Deposit	Organic Silt/Peat	OH/PT	259.0	38.0	-	-	-	-	-	-	-	-	475	NP	-	184	291	0.3	1.94	-	-	-	-	-	-	-	-
									370.8	-	63.8	13.6	-	-	-	-	-	-	-	-	-	-	-	-	-	600	580	-	-	-	-	-	-
									461.0	-	62.8	11.2	9.79	91.4	-	-	-	-	-	-	-	-	-	-	-	-	-	1600	1.3	0.55	0.08	0.16	0.02
GB-08	7.9	ST-08	Tube	18 - 20	1175	Marsh Deposit	Organic Silt	OH	129.0	15.8	-	-	-	-	-	-	-	-	146	81	0.6	71	75	0.8	2.44	-	-	-	-	-	-	-	-
									116.8	-	79.2	36.5	-	-	-	-	-	-	-	-	-	-	-	-	-	620	560	-	-	-	-	-	-
									135.8	-	77.8	33.0	3.61	91.8	-	-	-	-	-	-	-	-	-	-	-	-	-	1450	1.2	0.36	0.06	0.20	0.02
GB-09	7.9	ST-07	Tube	17.5 - 19.5	775	Marsh Deposit	Sandy Organic Clay	OH	41.0	4.9	-	-	-	-	-	-	33.9		76	NP	-	33	43	0.2	-	-	-	-	-	-	-	-	-
									46.2	-	101.2	69.2	1.47	86.0	-	-	-	-	-	-	-	-	-	-	-	-	-	1300	1.7	0.18	0.02	0.19	0.01
GB-10	10.8	ST-07	Tube	19 - 21	1550	Marsh Deposit	Organic Silt/Peat	OH/PT	189.0	28.9	-	-	-	-	-	-	-	-	239	NP	-	93	146	0.7	2.15	-	-	-	-	-	-	-	-
									175.2	-	71.7	26.1	-	-	-	-	-	-	-	-	-	-	-	-	-	660	580	-	-	-	-	-	-
									199.8	-	70.2	23.4	4.74	90.7	-	-	-	-	-	-	-	-	-	-	-	-	-	1600	1.0	0.43	0.07	0.51	0.02
								Count:	25	6	18	18	8	-	-	-	-	-	6	-	-	6	6	6	5	-	-	-	6	6	6	6	6
								Minimum:	41.0	4.9	33.9	11.1	1.5	-	-	-	-	-	76	-	-	33	43	0.2	1.94	-	-	-	1.0	0.18	0.02	0.04	0.01
								Average:	**168.5**	**19.9**	**77.9**	**33.1**	**4.0**	-	-	-	-	-	**209**	-	-	**88**	**121**	**0.6**	**2.26**	-	-	-	**1.2**	**0.35**	**0.06**	**0.21**	**0.02**
								Maximum:	461.0	38.0	103.2	69.2	9.8	-	-	-	-	-	475	-	-	184	291	1.1	2.56	-	-	-	1.7	0.55	0.08	0.51	0.02
								Average (excluding min & max):	**161.3**	**19.1**	**79.1**	**32.2**	**3.5**	-	-	-	-	-	**176**	-	-	**78**	**99**	**0.6**	**2.26**	-	-	-	**1.2**	**0.34**	**0.07**	**0.18**	**0.02**

Prepared By/Date: TCC/NDL/KL
Checked By/Date: TCC

Table 2
Summary of Water Depths, Elevations, & Gradients

Site Area	Well/Piezometer Information							Water Level Measurements									
	ID No.	Ground Ele.[1] (ft)	TOC Ele.[1] (ft)	TOR Ele.[1] (ft)	Screened Interval			1/28/13 to 1/30/13					02/04/13				
					Top Depth (ft bgs)	Bottom Depth (ft bgs)	Primary Stratum	Depth (ft btor)	Depth (ft bgs)	Elev. (ft)	Gradient (ft/ft)		Depth (ft btor)	Depth (ft bgs)	Elev. (ft)	Gradient (ft/ft)	
576/600 East Broadway	MW-101 S	6.9	8.8	8.7	5	15	Fill/Marsh	6.39	4.62	**2.28**	-0.11	-	7.25	5.48	**1.42**	-0.05	-
	MW-101 M	7.4	9.5	9.5	21	26	Fluvial Sand	8.69	6.63	0.77		0.00	8.68	6.62	0.78		0.01
	MW-101 D	6.8	8.9	8.8	59	69	Sand/Till	7.94	5.96	0.84	-		7.92	5.94	0.86	-	
	MW-102 S	8.0	10.1	9.7	6	10	Fill/Marsh	-	-	-	-		6.65	4.96	**3.04**	-0.04	-
	MW-102 M	7.9	10.0	9.6	20	30	Fluvial Sand	7.30	5.59	2.31			7.30	5.59	2.31		-0.01
	MW-102 D	8.0	10.2	10.1	102	112	Sand/Till	-	-	-			8.85	6.79	1.21	-	
	MW-103 M	10.8	13.2	13.0	28	38	Fill/Marsh	-	-	-	-		12.22	10.02	0.78	0.00	
	MW-103 D	11.3	13.7	13.3	73	83	Sand/Till	12.43	10.39	0.91			12.54	10.50	0.80		
	MW-104 S	6.9	9.3	9.2	7	11	Fill	6.86	4.61	2.29	-0.02		6.70	4.45	**2.45**	-0.03	
	MW-104 D	7.1	9.3	9.3	69	79	Sand/Till	8.65	6.43	0.67			8.95	6.73	0.37		
	MW-104 B	7.0	9.2	-	19	29	Fluvial Sand	-	-	-	-		-	-	-	-	

Notes:
1. 2012 Survey; NAVD 1988 Datum

Prepared By/Date: NDL 04-2013
Checked By/Date: TCC 04-2013

ATTACHMENT 1

SITE-SPECIFIC GEOTECHNICAL DATA

Attachment 1A

Geotechnical Boring Records

MAJOR DIVISIONS			GROUP SYMBOLS	GENERAL DESCRIPTIONS
COARSE GRAINED SOILS (More than 50% RETAINED on No. 200 sieve)	GRAVELS (More than 50% of coarse fraction RETAINED on No. 4 sieve)	CLEAN GRAVELS (Less than 5% fines)	GW	Well graded gravels or gravel-sand mixtures; trace or no fines.
			GP	Poorly graded gravels or gravel-sand mixtures; trace or no fines.
		GRAVELS WITH FINES (More than 12% fines)	GM	Silty gravels or gravel-sand-silt mixtures.
			GC	Clayey gravels or gravel-sand-clay mixtures.
	SANDS (50% or more of coarse fraction PASSES the No. 4 sieve)	CLEAN SANDS (Less than 5% fines)	SW	Well graded sands or sand-gravel mixtures; trace or no fines.
			SP	Poorly graded sands or sand-gravel mixtures, trace or no fines.
		SANDS WITH FINES (More than 12% fines)	SM	Silty sands or sand-gravel-silt mixtures.
			SC	Clayey sands or sand-gravel-clay mixtures.
FINE GRAINED SOILS (50% or more PASSES the No. 200 sieve)	SILTS AND CLAYS (Liquid Limit LESS than 50)		ML	Inorganic silts or rock flour. Non-plastic or very slightly plastic. PI < 4 or plots below "A" line.
			CL	Inorganic lean clay. Low to medium plasticity. PI > 7 and plots on or above "A" line.
			OL	Organic silts, clays, and silty clays. Low to medium plasticity.
	SILTS AND CLAYS (Liquid Limit of 50 or GREATER)		MH	Inorganic elastic silt. PI plots below "A" line.
			CH	Inorganic fat clay. High plasticity. PI plots on or above "A" line.
			OH	Organic silts and clays. High plasticity.
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils. Decomposed vegetable tissue. Fibrous to amorphous texture.

BOUNDARY CLASSIFICATIONS: Soils possessing characteristics of two groups are designated by combinations of group symbols.

SILT OR CLAY	SAND			GRAVEL		Cobbles	Boulders
	Fine	Medium	Coarse	Fine	Coarse		

No.200 No.40 No.10 No.4 3/4" 3" 12"

U.S. STANDARD SIEVE SIZE

References: ASTM D 2487 (Unified Soil Classification System) and ASTM D 2488 (Visual-Manual Procedure).

TYPICAL SYMBOLS

Shelby Tube	Auger Cuttings
Standard Split Spoon Sample	3" Split Spoon Sample
Rock Core	Dynamic Cone Penetrometer
Vane Shear	Bulk/Grab Sample
Geoprobe Sample	Sonic or Vibro-Core Sample
Water Table at time of drilling	Water Table after 24 hours

CORRELATION OF STANDARD PENETRATION TEST (SPT) WITH RELATIVE DENSITY AND CONSISTENCY

GRAVEL, SAND, & SILT (NON-PLASTIC)		SILT (PLASTIC) & CLAY		
N-Value	Relative Density	N-Value	Su (psf)	Consistency
0 - 4	Very Loose	0 - 2	0 - 250	Very Soft
4 - 10	Loose	2 - 4	250 - 500	Soft
10 - 30	Medium Dense	4 - 8	500 - 1000	Medium Stiff
30 - 50	Dense	8 - 15	1000 - 2000	Stiff
Over 50	Very Dense	15 - 30	2000 - 4000	Very Stiff
		Over 30	Over 4000	Hard

SPT Notes: WR = Weight of Rods; WH = Weight of Hammer

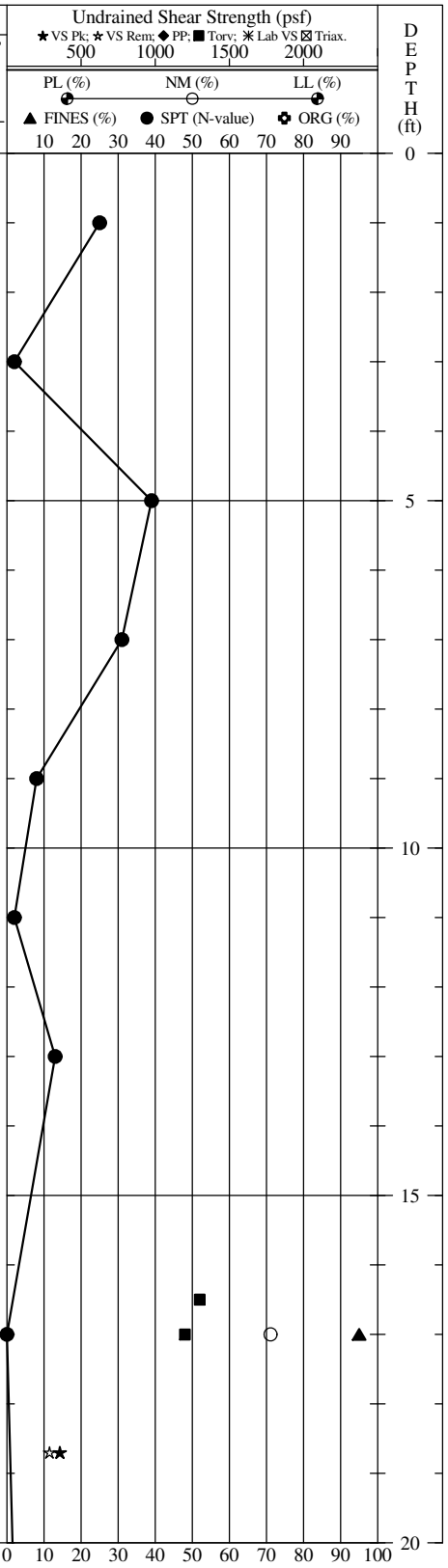
TERMS DESCRIBING SOILS (excludes particles > 3", organics, debris, etc.)	TERMS DESCRIBING MATERIALS (i.e. particles > 3", organics, debris, etc.)
Trace: Particles present, but < 5%	Occasional: Particles present, but < 10%
Few: 5% to 15%	Some: 10% to 25%
Little: 15% to 25%	Frequent: > 25%
Some: 25% to 50%	

TERMS DESCRIBING MOISTURE	TERMS DESCRIBING STRUCTURE
Dry: Absence of moisture; dusty	Layer: > 3" thick
Moist: Damp, but no visible water	Seam: 1/16" to 3" thick
Wet: Visible/free water	Parting: < 1/16" thick

KEY TO SYMBOLS AND DESCRIPTIONS

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
0	FILL (Sand, Silt, Gravel, Debris) Gravel and organics changing to Brown to reddish brown, fine to coarse SAND, some gravel, few/little silt (SW-SM/SM), very loose, dry to moist.		10.3	SS-01 [0]		4-12-13-12 (N = 25)
	- 2.0' to 2.2' bgs: cobble and asphalt fragments in spoon			SS-02 []		1-1-1-19 (N = 2)
	- 4.0' to 4.6' bgs: Brown, fine to coarse SAND, some gravel, little silt, (SM). - 4.6' to 5' bgs: fractured cobble					
5	Brown, fine to coarse SAND, trace silt (SW), dense, moist, occasional asphalt fragments.		5.3	SS-03 []		9-27-12-12 (N = 39)
	Brown, fine to coarse SAND, some gravel, few silt (SW-SM), dense, moist. - 6.6' bgs: fractured cobble					
	Dark brown, fine to coarse SAND, few to some silt (SM), dense, moist to wet, non-plastic. - 7.3' bgs: becomes wet			SS-04 [0]		28-19-12-10 (N = 31)
	- 8.0' bgs: becomes loose			SS-05 [0]		16-5-3-1 (N = 8)
10	Dark brown, fine to coarse SAND, little gravel, few silt (SW-SM), very loose, wet.		0.3	SS-06 [0]		3-1-1-4 (N = 2)
	- 12.0' to 13' bgs: fractured cobble					
	MARSH DEPOSIT (Silt, Sand, Organics/Peat)					
	Dark brown, SILT, trace fine sand, with organics (OH), stiff.			SS-07 []		12-10-3-3 (N = 13)
15			-4.7	ST-08 []		
	Dark Brown, SILT with organics, trace fine sand (OH), soft, moist, medium plasticity, slow dilatancy, strong organic odor.			SS-09 [0]		2-WH-WH-1
	VS-1 at 18.0' bgs: Su => 357 psf VS-1 at 18.0' bgs: Sremolded = 287 psf					
20			-9.7			



BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Truck rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/081012

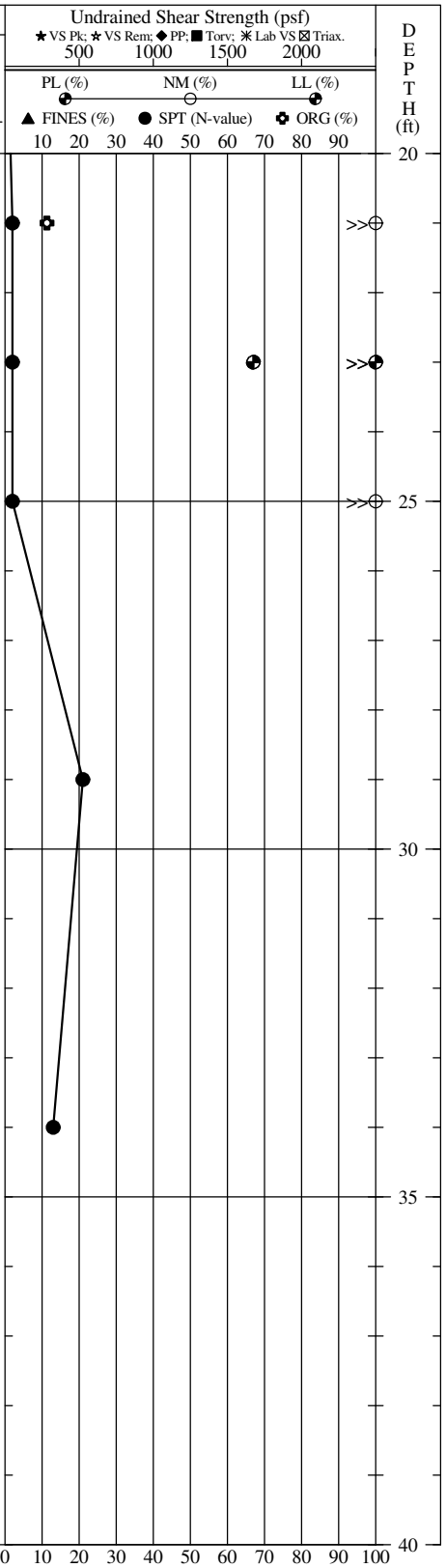
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-01
DRILLED: 5/30/12 - 6/1/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
20	MARSH DEPOSIT (Silt, Sand, Organics/Peat)		-9.7			
	Similar to SS-09; medium plasticity, slow dilatancy, strong organic odor.			SS-10 [0]		WH-1-1-2 (N = 2)
	Similar to SS-09.			SS-11 [0]		WH-1-1-1 (N = 2)
	Similar to SS-09.					
25			-14.7	SS-12 [0]		WH-1-1-6 (N = 2)
	FLUVIAL DEPOSIT (Sand, Gravel, Silt) Dark brown, fine to coarse SAND, few silt (SW-SM), wet.					
	Gray, fine to coarse SAND, trace gravel and silt (SW), medium dense, wet.			SS-13 [0]		14-11-10-8 (N = 21)
30			-19.7			
	Reddish-brown to grayish brown, fine SAND, little silt (SM), with bands of reddish brown to brown, fine to coarse SAND, little gravel, trace silt (SP), medium dense, wet.			SS-14 [0]		3-7-6-7 (N = 13)
35	Bottom of Exploration at 35 ft bgs.		-24.7			
40			-29.7			



BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Truck rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-01
DRILLED: 5/30/12 - 6/1/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLE IDENT	PID (ppm)	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
0	Topsoil, frequent organics FILL (Sand, Silt, Gravel, Debris) Fractured concrete Brown, fine to medium SAND, few/little silt (SM), pieces of asphalt, medium dense, dry. - 0.3' to 0.7' bgs: fractured asphalt Concrete	6.2	SS-01	[0]		10-8-10-50/3" (N = 18)
5	MARSH DEPOSIT (Silt, Sand, Organics/Peat) Primarily organic fibers in silt (PT), wet, slight odor.	1.2	SS-03	[0]		1-1-2-1 (N = 3)
	Brown, fine to coarse SAND, some silt, with organics (SM), wet, very loose, no to low plasticity, slow dilatancy, slight odor.		SS-04	[0]		3-2-1-1 (N = 3)
			ST-05	[]		
10	- 10.5' to 12.0' bgs: Dark brown, SILT with organics, little fine sand (OL), low plasticity, rapid dilatancy, strong organic odor. Changing to fine to coarse sandy SILT (OL), very soft, wet, low plasticity, rapid dialtancy. Dark brown, SILT with organics, few fine sand (OL-PT), very soft, wet, low plasticity, slow dilatancy, strong organic odor.	-3.8	SS-06	[]		1-WH-WH
			SS-07	[0]		WR-WR-WR-WH
	Dark brown, fine to medium SAND, some silt, with organics (SM-PT), very loose, wet.					
15		-8.8	SS-08	[0]		WR-WR-WH-WH
	Dark brown, fine to medium SAND, some silt, trace organics (SM). FLUVIAL DEPOSIT (Sand, Gravel, Silt) Grayish-brown, fine to coarse SAND, little silt, trace organics and gravel (SM), very loose, wet, slight organic odor.		SS-09	[0]		WH-WH-1-WH
	Gray, GRAVEL, some fine to coarse sand, few silt (GM), medium dense, wet.		SS-10	[0]		7-13-10-7 (N = 23)
20		-13.8				

Undrained Shear Strength (psf): ★ VS Pk; ☆ VS Rem; ◆ PP; ■ Torv; ✳ Lab VS ⊠ Triax. 500 1000 1500 2000

PL (%) NM (%) LL (%)

▲ FINES (%) ● SPT (N-value) ✿ ORG (%)

10 20 30 40 50 60 70 80 90

0 10 20 30 40 50 60 70 80 90 100

BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Track rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/081012

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-02
DRILLED: 6/7/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC	Undrained Shear Strength (psf) ★ VS Pk; ☆ VS Rem; ◆ PP; ■ Torv; ✳ Lab VS ⊠ Triax. 500 1000 1500 2000 / PL (%) NM (%) LL (%) / ▲ FINES (%) ● SPT (N-value) ✿ ORG (%) 10 20 30 40 50 60 70 80 90	DEPTH (ft)
20	FLUVIAL DEPOSIT (Sand, Gravel, Silt) Gray, fine to coarse SAND, few silt and fine gravel, changing to orange-brown fine to coarse SAND, some gravel, few silt, (SW-SM), medium dense, wet.		-13.8	SS-11 [0]		9-17-13-18 (N = 30)		20
25	Brown fine to coarse SAND with gravel, trace silt (SP), medium dense, wet.		-18.8	SS-12 []		18-12-14-35 (N = 26)	▲	25
	Bottom of Exploration at 27 ft bgs.							
30			-23.8					30
35			-28.8					35
40			-33.8				0 10 20 30 40 50 60 70 80 90 100	40

BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Track rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-02
DRILLED: 6/7/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLE IDENT [PID (ppm)]	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
0	FILL (Sand, Silt, Gravel, Debris)	9.4			
	Brown, fine to coarse SAND, few to little silt, trace to few gravel (SP-SM/SM), medium dense, moist. -1.0' to 2.0' bgs: fractured cobble		SS-01 [0]		2-5-10-6 (N = 15)
	- 2.0' to 2.2' bgs: fractured cobble and asphalt Brown, fine to medium SAND, few silt (SP-SM), medium dense, moist.		SS-02 [0]		5-6-7-8 (N = 13)
	Dark brown to reddish brown, fine to medium SAND, some silt, with organics (PT-SM), no to low plasticity, loose, wet.				
5		4.4	SS-03 [0]		6-4-3-6 (N = 7)
	Dark brown, fine to coarse SAND, little fine gravel, few silt and organics (SW-SM), wet, slight organic odor.				
	MARSH DEPOSIT (Silt, Sand, Organics/Peat) Grayish-brown, SILT, some fine to coarse sand (ML), medium stiff, wet, low plasticity, rapid dilatancy.		SS-04 [0]		4-4-1-1 (N = 5)
	Grayish-brown, coarse SAND, some silt, trace to few gravel (SM), very loose, wet.		SS-05 [0]		2-1-WH-1
10	Grayish-brown, SILT, few fine sand (ML), soft, wet.	-0.6	SS-06 [0]		2-1-2-1 (N = 3)
	Brown, SAND with silt and gravel (SP-SM)				
	Dark brown, SILT with sand and organics (OH)		ST-07 []		
	Grayish-brown, fine to coarse SAND, some silt, little gravel (SM), very loose, wet.				
15		-5.6	SS-08 [0]		2-1-1-2 (N = 2)
	Dark grayish-brown, SILT with organics, trace fine sand (OH), low plasticity, slow dilatancy, soft, wet, strong organic odor.		SS-09 [0.1]		2-1-1-2 (N = 2)
	Similar to SS-09, strong organic odor.				
20		-10.6	SS-10 [0]		WH-WH-2-2

Undrained Shear Strength (psf): ★ VS Pk; ☆ VS Rem; ◆ PP; ■ Torv; ✳ Lab VS ⊠ Triax. (500, 1000, 1500, 2000)

PL (%) NM (%) LL (%)

▲ FINES (%) ● SPT (N-value) ✿ ORG (%)

10 20 30 40 50 60 70 80 90

0 10 20 30 40 50 60 70 80 90 100

BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Track rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/081012

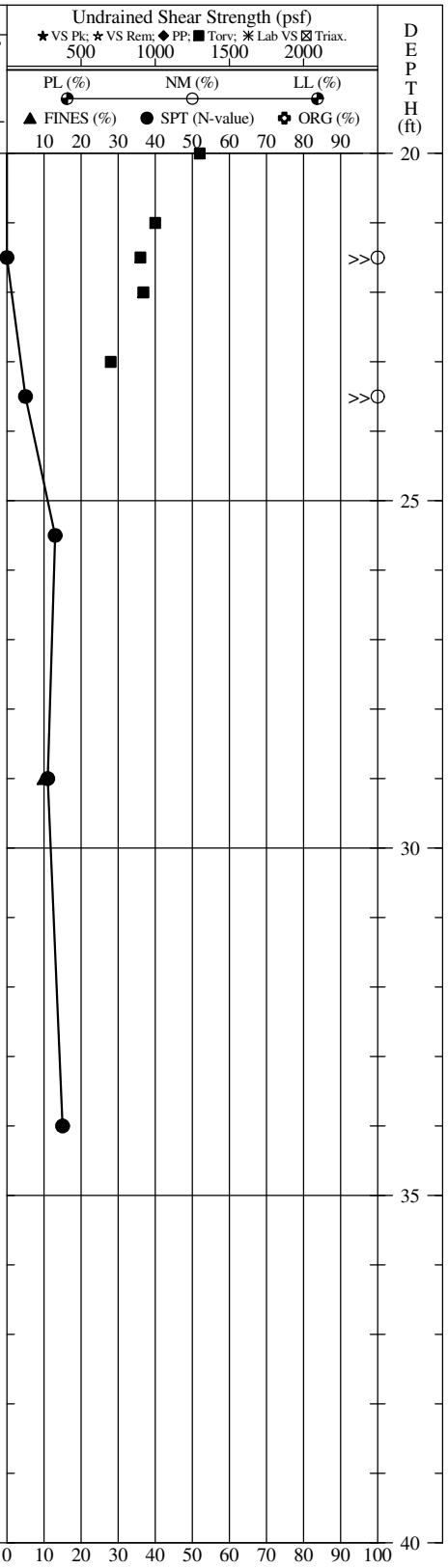
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-03
DRILLED: 6/6/12 - 6/7/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
20	MARSH DEPOSIT (Silt, Sand, Organics/Peat) Similar to SS-09, strong organic odor.		-10.6			
				SS-11 [0]		WH-WH-2-2
	Similar to SS-09, slight organic odor.					
				SS-12 [0]		WH-2-3-4 (N = 5)
	FLUVIAL DEPOSIT (Sand, Gravel, Silt)					
25			-15.6			
	Gray, fine to coarse SAND, trace silt and fine gravel (SW), medium dense, wet, slight organic odor.			SS-13 [0]		7-7-6-7 (N = 13)
	Orange-brown, fine to medium SAND, few silt (SW-SM), medium dense, wet, no odor.			SS-14 [0]		4-5-6-4 (N = 11)
30			-20.6			
	Similar to SS-14, brown, trace gravel.			SS-15 [0]		7-8-7-9 (N = 15)
35	Bottom of Exploration at 35 ft bgs.		-25.6			
40			-30.6			



BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Track rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

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GEOTECHNICAL BORING RECORD

BORING NO.: GB-03
DRILLED: 6/6/12 - 6/7/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC	PL (%) NM (%) LL (%) ▲ FINES (%) ● SPT (N-value) ✪ ORG (%) 10 20 30 40 50 60 70 80 90	DEPTH (ft)
0	Topsoil, frequent organics		5.7					0
	FILL (Sand, Silt, Gravel, Debris) Brown, fine to coarse SAND, few to little silt, trace to few gravel (SW-SM/SM), very loose, moist.			SS-01 [0]		1-1-1-2 (N = 2)		
	MARSH DEPOSIT (Silt, Sand, Organics/Peat)							
	Dark brown, fine SAND and fibrous ORGANICS, some silt (SM/PT), very loose, moist to wet.			SS-02 [0]		1-WH-1-1		
	Dark gray, fine to coarse SAND, little gravel, little silt (SM), transitioning to black, decomposed organic fibers (PT), very loose, wet, moderate to strong organic odor.							
5			0.7	SS-03 [0]		1-1-1-1 (N = 2)		5
	Dark gray, fine to coarse SAND, few silt and fine gravel (SW-SM), changing to black fine SAND and ORGANICS, some silt (SM/PT), very loose, wet.			SS-04 [0]		1-1-1-1 (N = 2)		
	Similar to SS-04.			SS-05 [4.8]		3-2-1-1 (N = 3)		
10	Dark gray, GRAVEL, little fine to coarse sand, few silt (GM), very loose, wet, changing to dark gray, SILT, some fine sand (OL), slow dilatancy, low to medium plasticity, wet.		-4.3	SS-06 [0]		1-1-1-3 (N = 2)		10
	Similar to SS-06 with trace organics(GM/OL), coarse gravel in spoon.							
	FLUVIAL DEPOSIT (Sand, Gravel, Silt)			SS-07 [0]		1-1-1-1 (N = 2)		
	Dark gray, fine to coarse SAND, little gravel, little silt (SM), loose, wet.							
15			-9.3	SS-08 [0]		3-2-5-5 (N = 7)		15
	Grayish-brown, fine to coarse SAND, trace silt, trace gravel (SW), loose, wet.			SS-09 [0]		8-3-6-4 (N = 9)		
20			-14.3				0 10 20 30 40 50 60 70 80 90 100	20

BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Track rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/081012

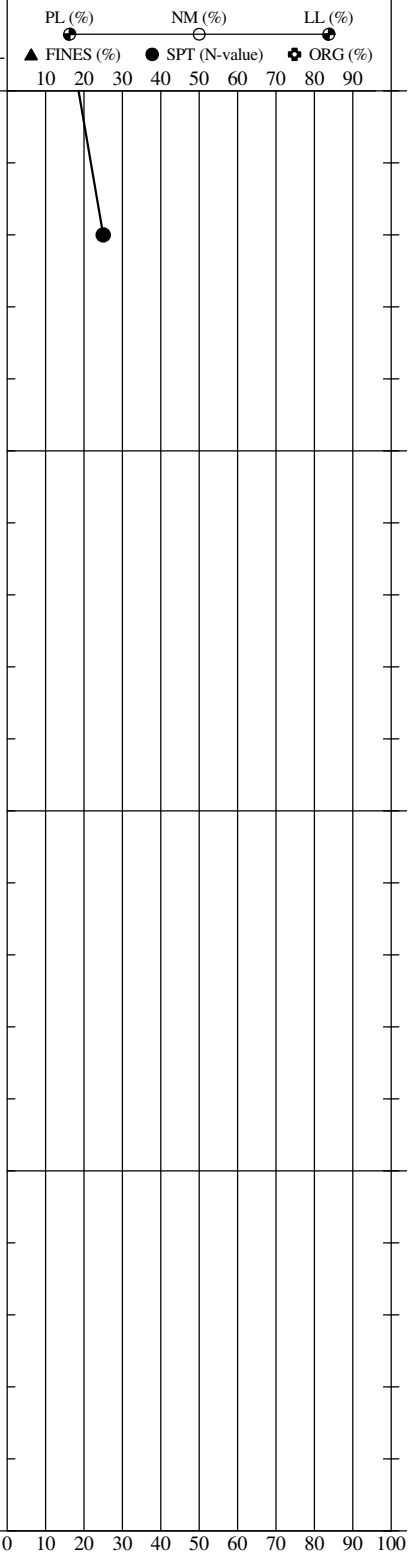
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-04
DRILLED: 6/6/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
20	FLUVIAL DEPOSIT (Sand, Gravel, Silt)		-14.3			
	Brown, fine to coarse SAND, little gravel, trace silt (SW), medium dense, wet.			SS-10 [0]		10-12-13-13 (N = 25)
	Bottom of Exploration at 23 feet bgs.					
25			-19.3			
30			-24.3			
35			-29.3			
40			-34.3			



BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Track rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

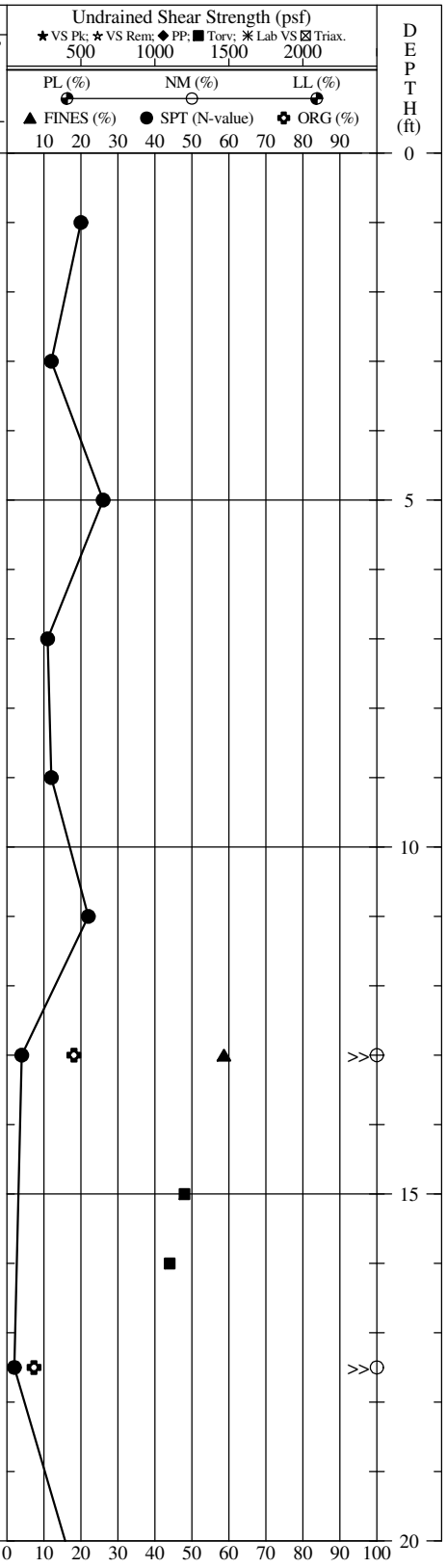
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-04
DRILLED: 6/6/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	IDENT	PID (ppm)	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
0	Topsoil, frequent organics	11.2				
	FILL (Sand, Silt, Gravel, Debris) Brown, fine to coarse SAND, few to little silt and gravel (SW-SM/SM), medium dense, moist.		SS-01	[0]		2-5-15-13 (N = 20)
	- 2.0' to 4.0' bgs: occasional organics (roots) - 2.1' to 2.4' bgs: fractured cobble		SS-02	[0]		13-8-4-5 (N = 12)
5	Dark brown to dark reddish brown, fine SAND, some silt (SM), medium dense, moist. - 5.0' to 6.0' bgs: occasional brick fragments and staining	6.2	SS-03	[0]		7-14-12-6 (N = 26)
			SS-04	[0]		5-5-6-7 (N = 11)
	Dark grayish brown, fine to coarse SAND, few/little silt and gravel (SM), medium dense, wet. - 8.0' to 8.7' bgs: brick fragment		SS-05	[0.1]		7-6-6-3 (N = 12)
10	Dark gray, fine to coarse SAND, few silt (SW-SM), medium dense, wet. - 10.0' to 12.4' bgs: frequent brick fragments and wood. - Note: Poor recovery in SS-06 and SS-07. Borehole was moved a few feet and resampled at those depths.	1.2	S3-06A	[]	a	17-14-8-6 (N = 22)
	MARSH DEPOSIT (Silt, Sand, Organics/Peat) Black, SILT, some fine to coarse sand with organics (OH), soft, moist, strong organic odor, wood fragment in tip.		S3-07A	[0]	a	7-2-2-4 (N = 4)
	Note: Shelby tube had no recovery. SS sample taken through tube depth. Sample descriptions obtained and torvanes performed on recovered sample.					
15	Grayish-brown, SILT with organics, trace fine sand (OH), low to medium plasticity, slow dilatancy, moist.	-3.8	ST-08	[0]		
	Similar to SS-08, saturated, soft.		SS-09	[0]		1-1-1-2 (N = 2)
	Sampled through vane test interval: 18.5 to 20.5': Grayish-brown, fine to coarse SAND, some silt, trace organics (SM), non-plastic, wet. - 19.5' to 20.5': Grayish-brown fine SAND, few silt, with organics (OH), wet, medium plasticity, slow dilatancy, strong organic odor.		S3-10	[0.3]	a	
20		-8.8				



BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Truck rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/081012

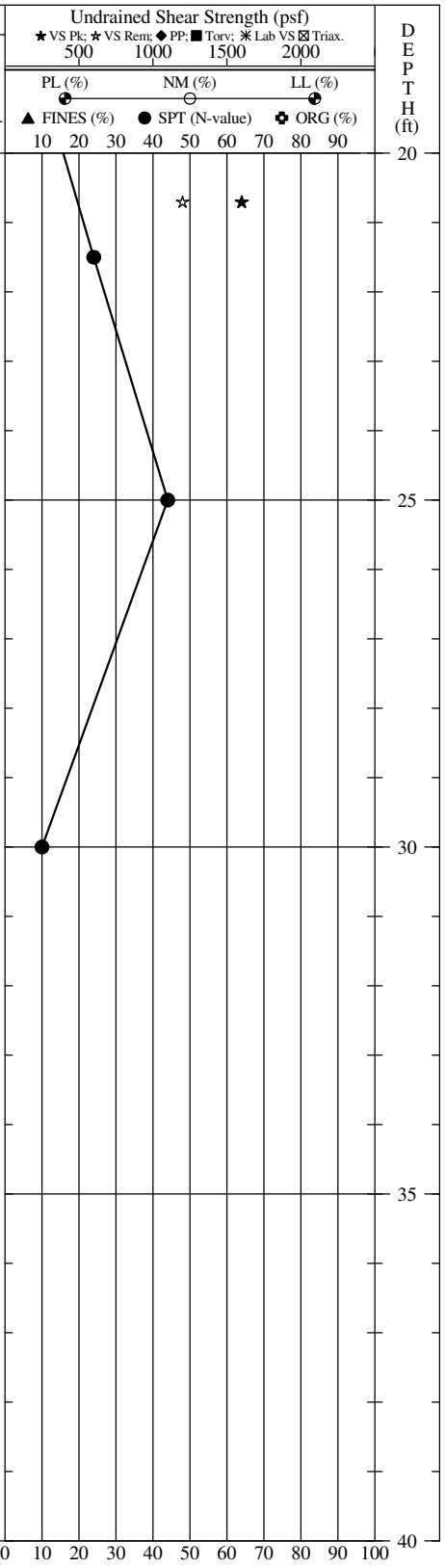
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-05
DRILLED: 6/4/12 - 6/5/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
20	MARSH DEPOSIT (Silt, Sand, Organics/Peat) VS-1 at 20.0' bgs: Su => 1600 psf (sand layer) VS-1 at 20.0' bgs: Sremolded = 1200 psf (sand layer)		-8.8			
	FLUVIAL DEPOSIT (Sand, Gravel, Silt) - 20.5' to 22.0' bgs: Grayish-brown, fine to coarse SAND, little gravel, few silt (SW-SM) - 22.0' to 22.5' bgs: Orange-brown, fine to coarse SAND, some gravel, few silt (SW-SM), medium dense, wet.			SS-11 [0]		10-12-12-10 (N = 24)
	Reddish-brown, fine to coarse SAND, some gravel, trace silt (SW), dense, wet.					
25			-13.8	SS-12 [0]		16-23-21-22 (N = 44)
	Brown, fine to coarse SAND, few gravel, trace silt (SW), loose, wet.					
30			-18.8	SS-13 [0]		4-4-6-6 (N = 10)
	Bottom fo Exploration at 31 feet bgs.					
35			-23.8			
40			-28.8			



BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Truck rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

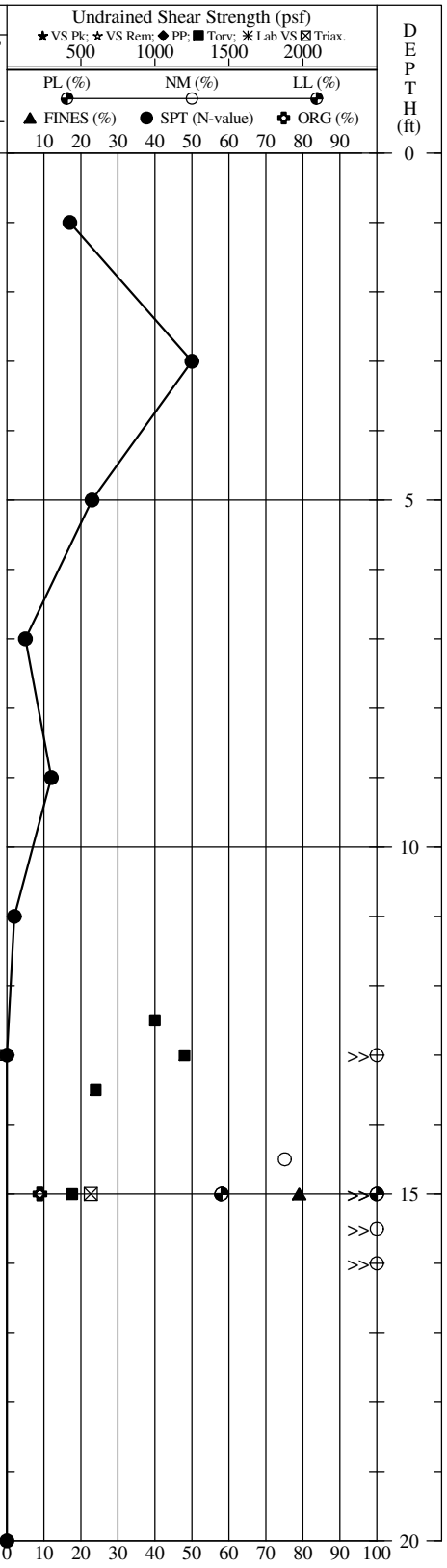
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-05
DRILLED: 6/4/12 - 6/5/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLE IDENT	PID (ppm)	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
0	Topsoil, frequent organics	8.3				
	FILL (Sand, Silt, Gravel, Debris) - 0.8' to 1.1' bgs: fractured cobble Light brown to dark brown, fine to coarse SAND, few to little silt, trace to little gravel (SW-SM/SM), medium dense to dense, dry to moist. - 2.0' to 6.0' bgs: occasional to frequent brick and asphalt fragments, organics - 2.0' to 3.0' bgs: organics		SS-01	[0]		1-9-8-10 (N = 17)
			SS-02	[0]		35-30-20-24 (N = 50)
5		3.3	SS-03	[0.6]		8-13-10-7 (N = 23)
	Gray, fine to coarse SAND, some silt, few gravel, occasional organics (SM), loose to medium dense, wet.		SS-04	[0.1]		5-3-2-2 (N = 5)
	- 8.0' to 10' bgs: frequent asphalt fragments		SS-05	[0.4]		10-7-5-1 (N = 12)
10	MARSH DEPOSIT (Silt, Sand, Organics/Peat)	-1.7				
	No recovery		SS-06	[]		WH-1-1-1 (N = 2)
	Grayish-brown, SILT with organics, trace fine sand (OH), medium plasticity, slow dilatancy, very soft, wet.		SS-07	[0]		WH-WH-WH-WH
	Similar to SS-07					
15		-6.7	ST-08	[0]		
	- sample was difficult to extract; likely disturbed		ST-09	[0]		
	FLUVIAL DEPOSIT (Sand, Gravel, Silt)					
	Dark grayish-brown, fine to coarse SAND, some silt, few gravel, with organic fibers (SM), very loose, wet, slight organic odor.					
20		-11.7				



BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Truck rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/081012

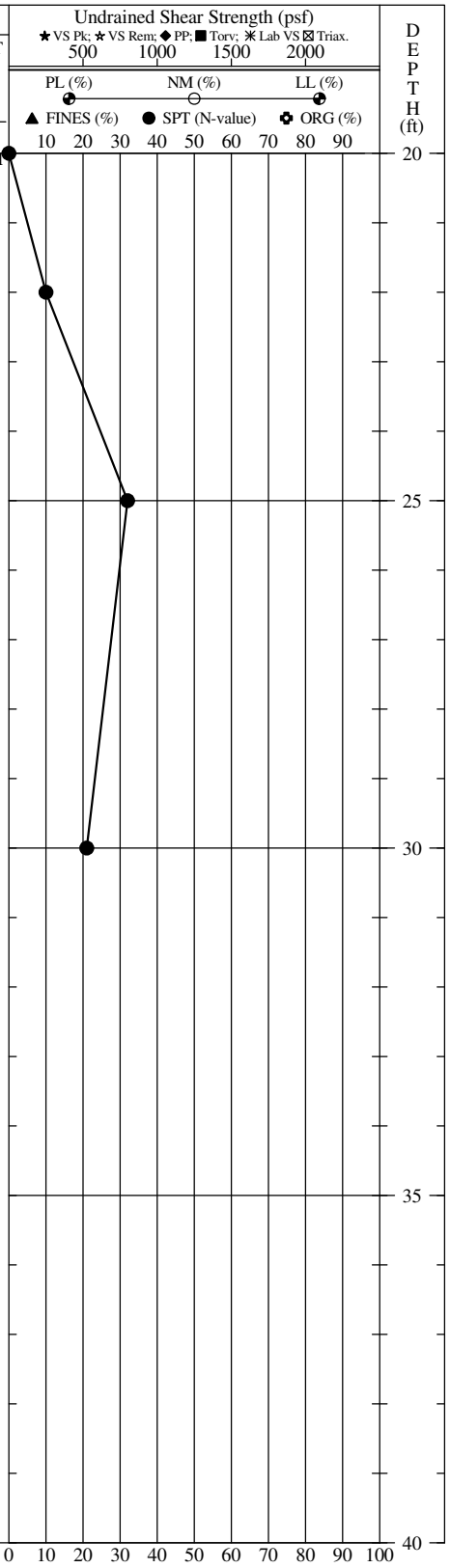
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-06
DRILLED: 6/1/12 - 6/4/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
20	FLUVIAL DEPOSIT (Sand, Gravel, Silt)		-11.7	SS-10 []		1-WH-WH-WH
	Grayish-brown, fine to coarse SAND, little silt, few gravel (SM) changing to brown GRAVEL, some fine to coarse sand, little silt (GM), loose, wet.			SS-11 []		1-5-5-4 (N = 10)
	Orange-brown, fine to coarse SAND, little silt, little to some gravel (SW-SM), dense, wet.					
25			-16.7	SS-12 []		5-16-16-8 (N = 32)
30	Similar to SS-12 changing to Grayish-brown, SILT, some fine sand (ML), non-plastic, medium dense, wet.		-21.7	SS-13 []		15-10-11-7 (N = 21)
	Bottom of Exploration at 31 ft bgs.					
35			-26.7			
40			-31.7			



BOREHOLE: STANDARD (0-2500 PSF) USACE_RAYMARK_BORING LOGS.GPJ 2007_12-12_PORT_DTMPLT.GDT 2/7/13

DRILLER: Aquifer D & T
RIG TYPE: CME (Auto-Hammer); Truck rig
METHOD: Variable (HSA and Rotary Wash)
HOLE DIAM.: 4"
SPTs:
REMARKS:

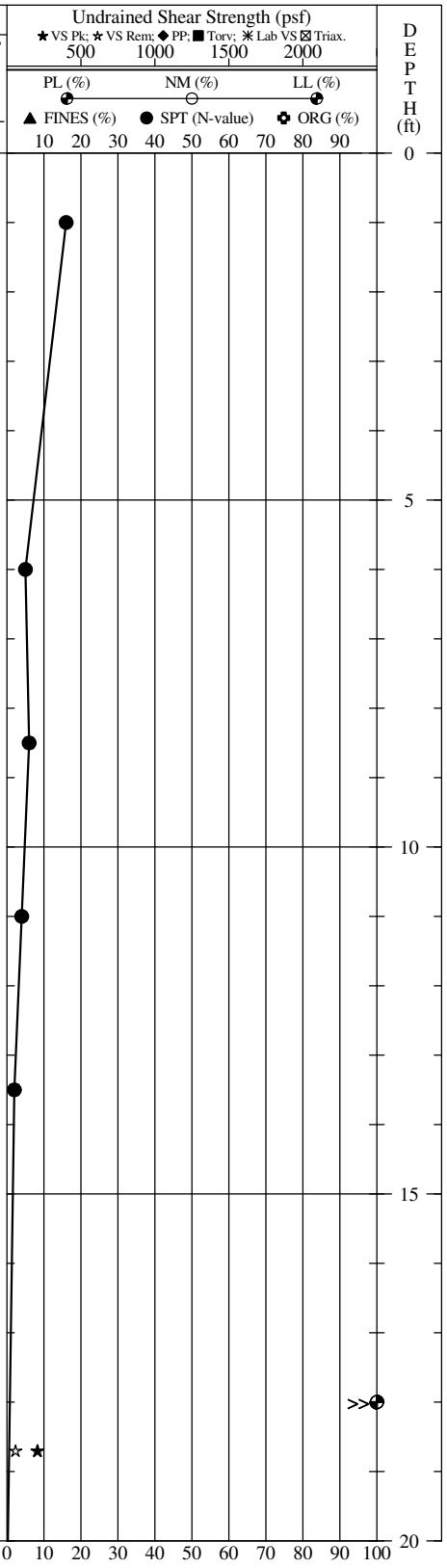
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-06
DRILLED: 6/1/12 - 6/4/12
PROJECT: USACE - Raymark
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4B

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLE IDENT	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
0	Topsoil	7.3			
	FILL Orange brown to dark brown, fine to coarse SAND, little to some silt, few gravel, medium dense, moist (SM)		SS-1		1-4-12-20 (N = 16)
5	Dark gray, fine to coarse SAND, little to some silt, trace to little gravel, loose, wet (SM)	2.3	SS-2		5-2-3-2 (N = 5)
	Similar to SS-2		SS-3		2-3-3-2 (N = 6)
10	Similar to SS-2	-2.7	SS-4		4-3-1-2 (N = 4)
	Grayish brown, SILT/CLAY, some fine sand, medium stiff, wet (ML/CL) Dark gray, fine SAND, some silt, little gravel, loose, (SM)		SS-5		4-1-1-2 (N = 2)
15	MARSH DEPOSIT Grayish brown to dark brown, ORGANIC SILT, few fine sand, very soft to medium stiff, wet, low to moderate plasticity (OH) - occasional to frequent organics	-7.7	ST-6		
			VS-7		
20		-12.7			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	Rotary Wash with Water (Cased) to 30' bgs.
HOLE DIAM.:	4"
SPTs:	Automatic Hammer; NW rods
REMARKS:	Backfilled w/cement-bentonite grout.

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/3-28-13

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-07
DRILLED: 1/31/13 - 2/1/13
PROJECT: Former Raymark Industries (OU6)
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC	Undrained Shear Strength (psf) ★ VS Pk; ☆ VS Rem; ◆ PP; ■ Torv; ✳ Lab VS ⊠ Triax. 500 1000 1500 2000 / PL (%) NM (%) LL (%) / ▲ FINES (%) ● SPT (N-value) ✿ ORG (%) 10 20 30 40 50 60 70 80 90	DEPTH (ft)
20	MARSH DEPOSIT		-12.7					20
	Similar to ST-6			SS-8		WH-WH-1-2		
	Dark brown, ORGANIC SILT			ST-9			>>	
25			-17.7					25
	FLUVIAL SAND Gray to yellow brown, fine to coarse SAND, few to little silt, few gravel, loose to medium dense, wet (SW-SM/SM)			SS-10		3-2-6-11 (N = 8)		
30			-22.7					30
	Similar to SS-10			SS-11		6-3-6-7 (N = 9)		
	End of Exploration at 32' bgs							
35			-27.7					35
40			-32.7					40

0 10 20 30 40 50 60 70 80 90 100

BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER: ADT
RIG TYPE: Tracked CME-55 LC
METHOD: Rotary Wash with Water (Cased) to 30' bgs.
HOLE DIAM.: 4"
SPTs: Automatic Hammer; NW rods
REMARKS: Backfilled w/cement-bentonite grout.

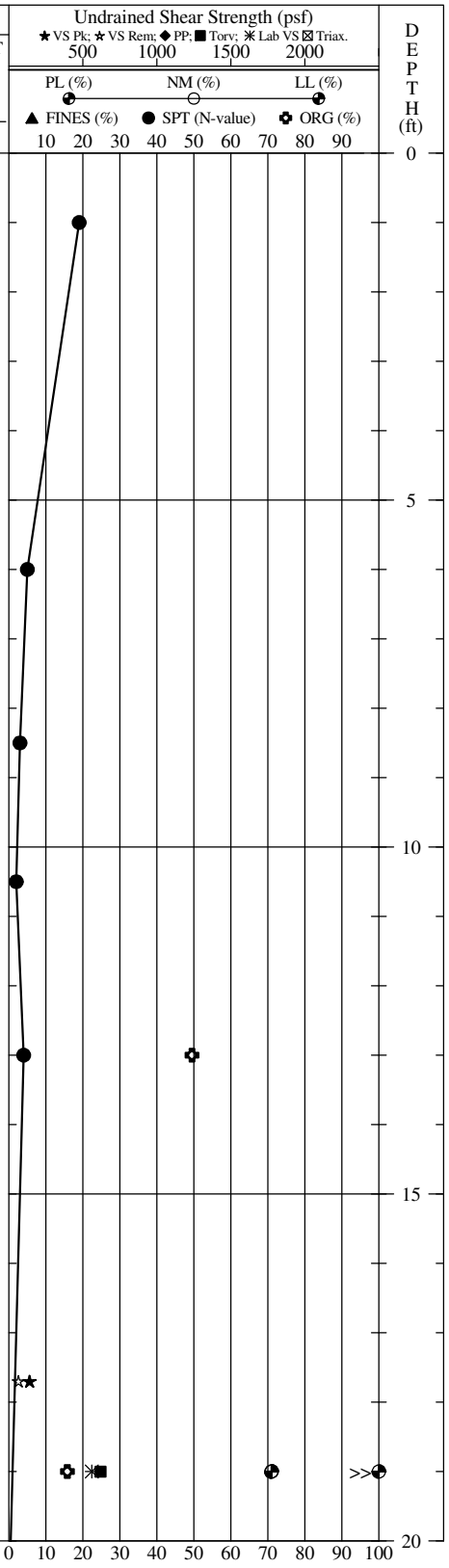
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-07
DRILLED: 1/31/13 - 2/1/13
PROJECT: Former Raymark Industries (OU6)
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLE IDENT	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
0	Topsoil	7.9			
	FILL Gray, GRAVEL, some fine to coarse sand, few silt, medium dense, dry (GP-GM)		SS-1		10-10-9-10 (N = 19)
5	Grayish brown, fine SAND, some silt, little gravel, very loose to loose, wet (SM) - 5.0' to 7.0' bgs: occasional organics	2.9	SS-2		4-3-2-3 (N = 5)
	SS-3: no recovery		SS-3		4-2-1-WH (N = 3)
10		-2.1	SS-4		2-1-1-2 (N = 2)
	Grayish brown, fine to medium SAND, little gravel, few silt, loose, wet (SP-SM)				
	MARSH DEPOSIT Brown, ORGANIC SILT, some fine sand, soft, wet, non-plastic (OH)		SS-5		8-2-2-2 (N = 4)
15		-7.1	ST-6		
	Grayish brown, ORGANIC SILT, few fine sand, very soft to medium stiff, wet, low to moderate plasticity (OH) - 16.0' to 22.0' bgs: occasional to frequent organics		VS-7		
	Similar to VS-7		ST-8		
20		-12.1			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER: ADT
RIG TYPE: Tracked CME-55 LC
METHOD: Rotary Wash with Water (Cased) to 33' bgs.
HOLE DIAM.: 4"
SPTs: Automatic Hammer; NW rods
REMARKS: Backfilled w/cement-bentonite grout.

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/3-28-13

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-08
DRILLED: 1/30/13 - 1/31/13
PROJECT: Former Raymark Industries (OU6)
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC	Undrained Shear Strength (psf) ★ VS Pk; ☆ VS Rem; ◆ PP; ■ Torv; ✳ Lab VS ⊠ Triax. (500, 1000, 1500, 2000)
20	MARSH DEPOSIT		-12.1				
	Similar to ST-8			SS-9		WH-WH-WH-3	
	Similar to SS-9			SS-10		WH-WH-2-2	
25	- 25.0' bgs: becomes brown to dark brown		-17.1				
	Similar to SS-10			SS-11		WH-WH-WH-1	
	FLUVIAL SAND Gray, fine to coarse SAND, fet to little gravel, few silt, loose to dense, wet (SW-SM)			SS-12		20-21-19-22 (N = 40)	
30			-22.1				
	SS-13: no recovery			SS-13		10-5-3-3 (N = 8)	
	Gray, SILT/CLAY, some fine sand, stiff, wet, low plasticity (ML/CL)						
	Gray, fine SAND, some silt, medium dense, wet (SM)			SS-14		7-15-14-6 (N = 29)	
35	End of Exploration at 35' bgs		-27.1				
40			-32.1				

Undrained Shear Strength (psf): 500 1000 1500 2000

PL (%) NM (%) LL (%)

▲ FINES (%) ● SPT (N-value) ✪ ORG (%)

10 20 30 40 50 60 70 80 90

0 10 20 30 40 50 60 70 80 90 100

BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	Rotary Wash with Water (Cased) to 33' bgs.
HOLE DIAM.:	4"
SPTs:	Automatic Hammer; NW rods
REMARKS:	Backfilled w/cement-bentonite grout.

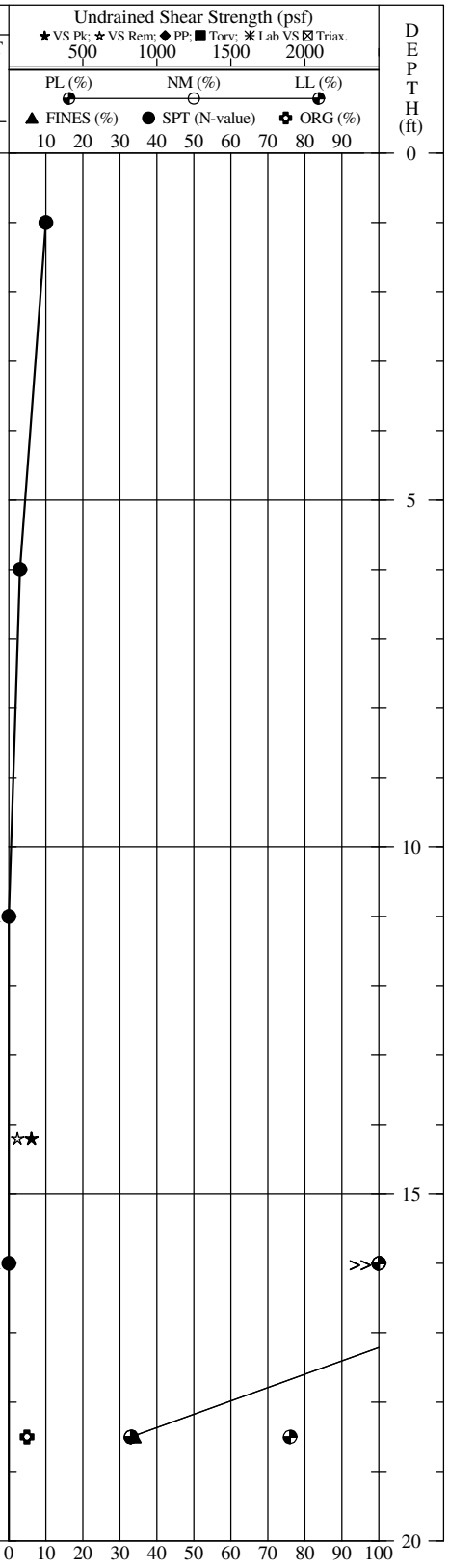
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.:	GB-08
DRILLED:	1/30/13 - 1/31/13
PROJECT:	Former Raymark Industries (OU6)
LOCATION:	Stratford, CT
PROJECT NO.:	3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
0	Topsoil		7.9			
	FILL Light brown, fine to medium SAND, few silt, medium dense, dry (SM) - occasional asphalt and concrete debris			SS-1		20-6-4-9 (N = 10)
	MARSH DEPOSIT					
5	Dark grayish brown, SILT, few fine sand, soft to medium stiff, wet, low plasticity (OH) - occasional to some organics		2.9	SS-2		2-2-1-2 (N = 3)
				ST-3		
10	Grayish brown, ORGANIC SILT/CLAY, few fine sand, very soft to soft, wet, low to moderate plasticity (CH/OH) - some to frequent organics		-2.1	SS-4		WH-WH-WH-1
				VS-5		
15	Similar to SS-4		-7.1	SS-6		WH-WH-WH-1
	Dark brown, ORGANIC CLAY			ST-7		
	FLUVIAL SAND					
20			-12.1			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	Rotary Wash with Water and/or Mud (Cased) to 67' bgs.
HOLE DIAM.:	4"; 3"
SPTs:	Automatic Hammer; NW rods
REMARKS:	Casing advanced to ~ 67' bgs. Abandon hole during roller bitting at ~ 60' bgs due to detached drive shoe/casing. Backfilled w/cement-bentonite grout.

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/3-28-13

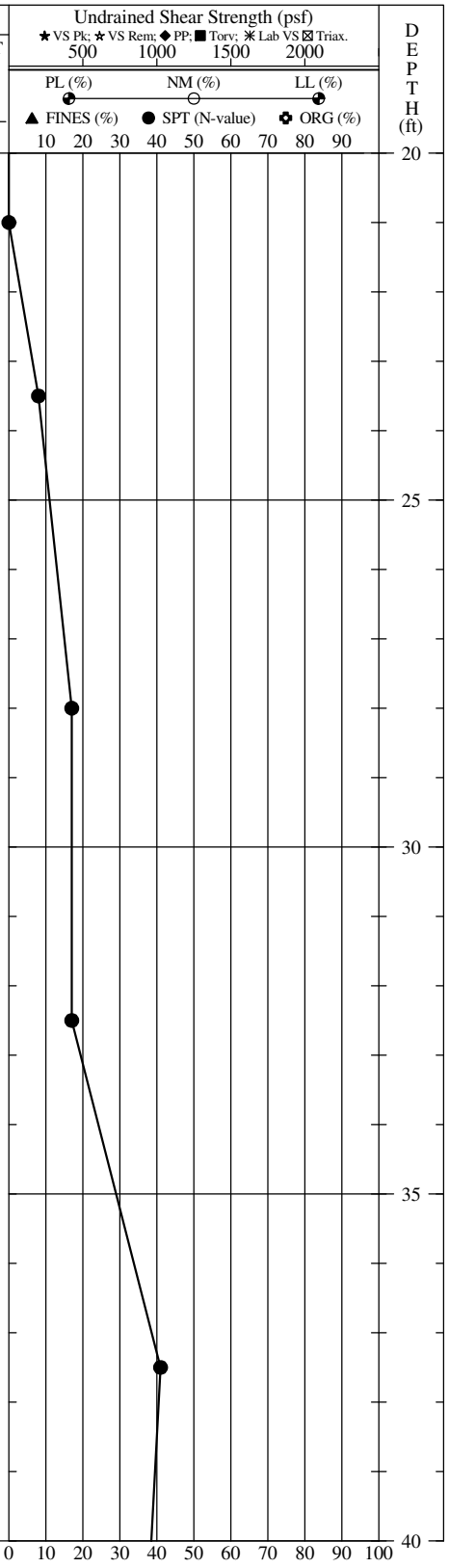
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.:	GB-09
DRILLED:	2/1/13 - 2/5/13
PROJECT:	Former Raymark Industries (OU6)
LOCATION:	Stratford, CT
PROJECT NO.:	3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLE IDENT	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
20	FLUVIAL SAND Gray, fine to coarse SAND, few to little silt, trace gravel, very loose, wet (SW-SM/SM)	-12.1	SS-8		WH-1-WH-1
	- 22.5' bgs: little gravel, becomes loose		SS-9		3-2-6-15 (N = 8)
25		-17.1			
	- 27.0' bgs: becomes grayish brown to orange brown, medium dense (SW-SM)		SS-10		3-7-10-14 (N = 17)
30		-22.1			
	Similar to SS-10		SS-11		7-9-8-6 (N = 17)
35		-27.1			
	- 36.5' bgs: becomes dense		SS-12		35-20-21-20 (N = 41)
40		-32.1			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	Rotary Wash with Water and/or Mud (Cased) to 67' bgs.
HOLE DIAM.:	4"; 3"
SPTs:	Automatic Hammer; NW rods
REMARKS:	Casing advanced to ~ 67' bgs. Abandon hole during roller bitting at ~ 60' bgs due to detached drive shoe/casing. Backfilled w/cement-bentonite grout.

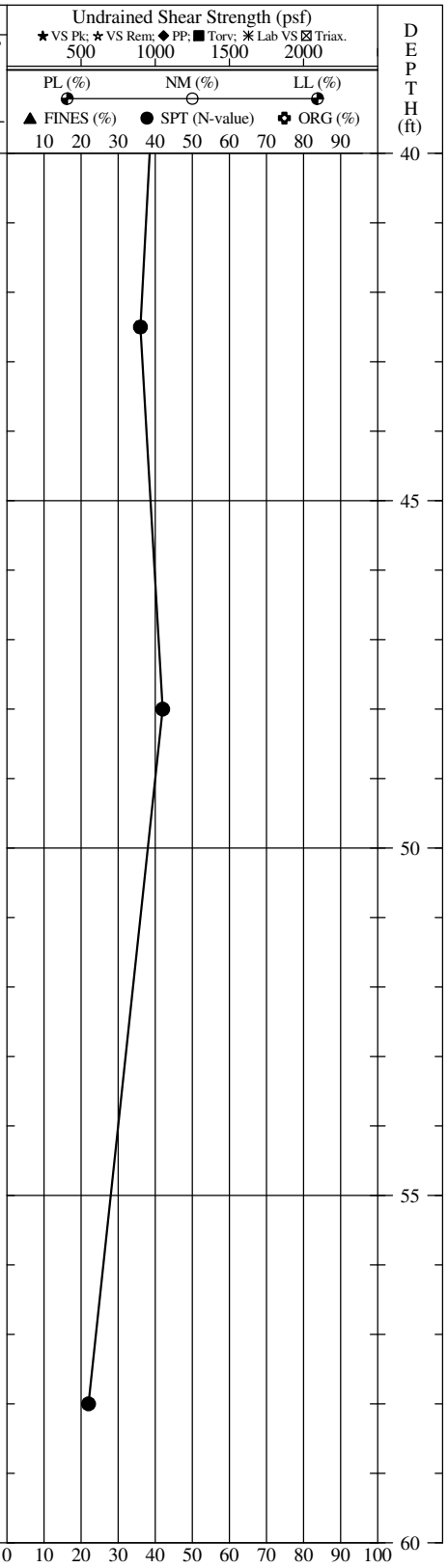
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.:	GB-09
DRILLED:	2/1/13 - 2/5/13
PROJECT:	Former Raymark Industries (OU6)
LOCATION:	Stratford, CT
PROJECT NO.:	3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
40	FLUVIAL SAND	-32.1			
	Similar to SS-12		SS-13		16-16-20-20 (N = 36)
45		-37.1			
	- 47.0' bgs: becomes light brown				
	Similar to SS-13		SS-14		14-23-19-16 (N = 42)
50		-42.1			
55		-47.1			
	Light brown to orange brown, fine to coarse SAND, few gravel, trace silt, medium dense, wet (SW)		SS-15		8-11-11-13 (N = 22)
60		-52.1			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	Rotary Wash with Water and/or Mud (Cased) to 67' bgs.
HOLE DIAM.:	4"; 3"
SPTs:	Automatic Hammer; NW rods
REMARKS:	Casing advanced to ~ 67' bgs. Abandon hole during roller bitting at ~ 60' bgs due to detached drive shoe/casing. Backfilled w/cement-bentonite grout.

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.:	GB-09
DRILLED:	2/1/13 - 2/5/13
PROJECT:	Former Raymark Industries (OU6)
LOCATION:	Stratford, CT
PROJECT NO.:	3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC	Undrained Shear Strength (psf) ★ VS Pk; ☆ VS Rem; ◆ PP; ■ Torv; ✳ Lab VS ⊠ Triax. 500 1000 1500 2000	DEPTH (ft)
60	FLUVIAL SAND		-52.1					60
65			-57.1					65
	End of Exploration at 67' bgs							
70			-62.1					70
75			-67.1					75
80			-72.1					80

PL (%) NM (%) LL (%)
▲ FINES (%) ● SPT (N-value) ✿ ORG (%)
10 20 30 40 50 60 70 80 90
0 10 20 30 40 50 60 70 80 90 100

BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	Rotary Wash with Water and/or Mud (Cased) to 67' bgs.
HOLE DIAM.:	4"; 3"
SPTs:	Automatic Hammer; NW rods
REMARKS:	Casing advanced to ~ 67' bgs. Abandon hole during roller bitting at ~ 60' bgs due to detached drive shoe/casing. Backfilled w/cement-bentonite grout.

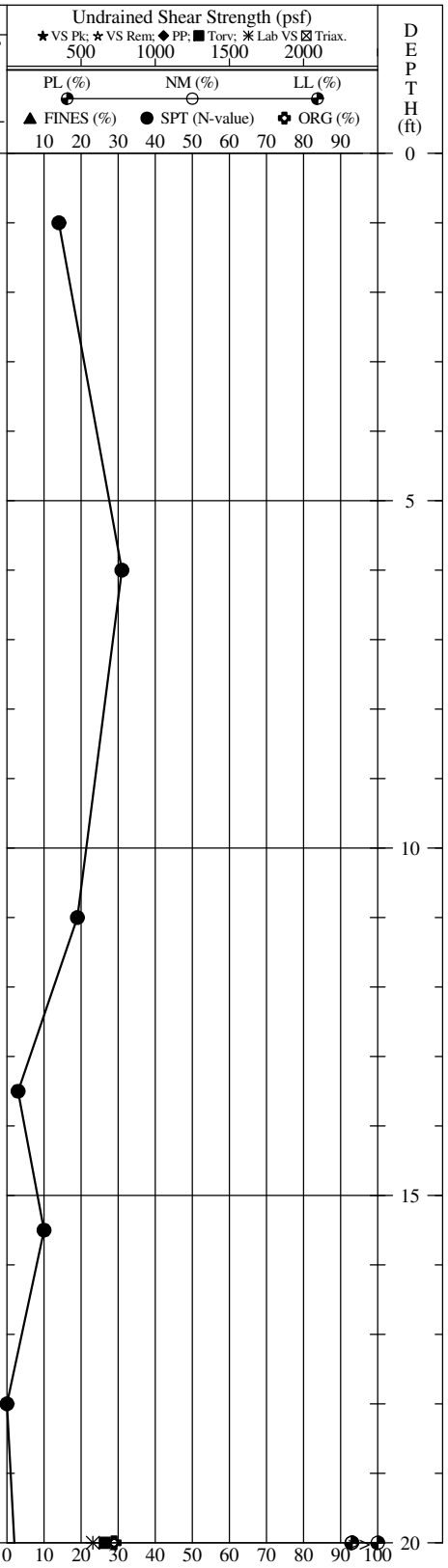
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-09
DRILLED: 2/1/13 - 2/5/13
PROJECT: Former Raymark Industries (OU6)
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLE IDENT	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
0	Topsoil	10.8			
	FILL Light brown, fine to coarse SAND, little silt and gravel, medium dense, dry (SM) - 0.5' to 2.0' bgs: occasional concrete fragments		SS-1		1-5-9-14 (N = 14)
5	Dark gray, fine to coarse SAND, little silt and gravel, dense, wet (SM) - 5.0' to 7.0' bgs: occasional debris	5.8	SS-2		5-13-18-11 (N = 31)
10	Yellowish gray to dark gray, fine to medium SAND, little silt, few gravel, medium dense, wet (SM) - 10.0' to 12.0' bgs: occasional debris - 12.5' to 14.5' bgs: very loose	0.8	SS-3		6-9-10-6 (N = 19)
	SS-4: no recovery		SS-4		6-2-1-2 (N = 3)
15	Dark grayish brown, fine to coarse SAND, little silt, trace fine gravel, medium dense, wet (SM)	-4.2	SS-5		9-7-3-3 (N = 10)
	MARSH DEPOSIT Brownish gray, ORGANIC SILT, little fine sand, very soft to medium stiff, wet, low plasticity (OH) - occasional organics		SS-6		WH-WH-WH-3
	- 19.0' to 21.0' bgs: stiff				
20		-9.2			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER: ADT
RIG TYPE: Tracked CME-55 LC
METHOD: Rotary Wash with Water (Cased) to 25' bgs.
HOLE DIAM.: 4"
SPTs: Automatic Hammer; NW rods
REMARKS: Backfilled w/cement-bentonite grout.

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/3-28-13

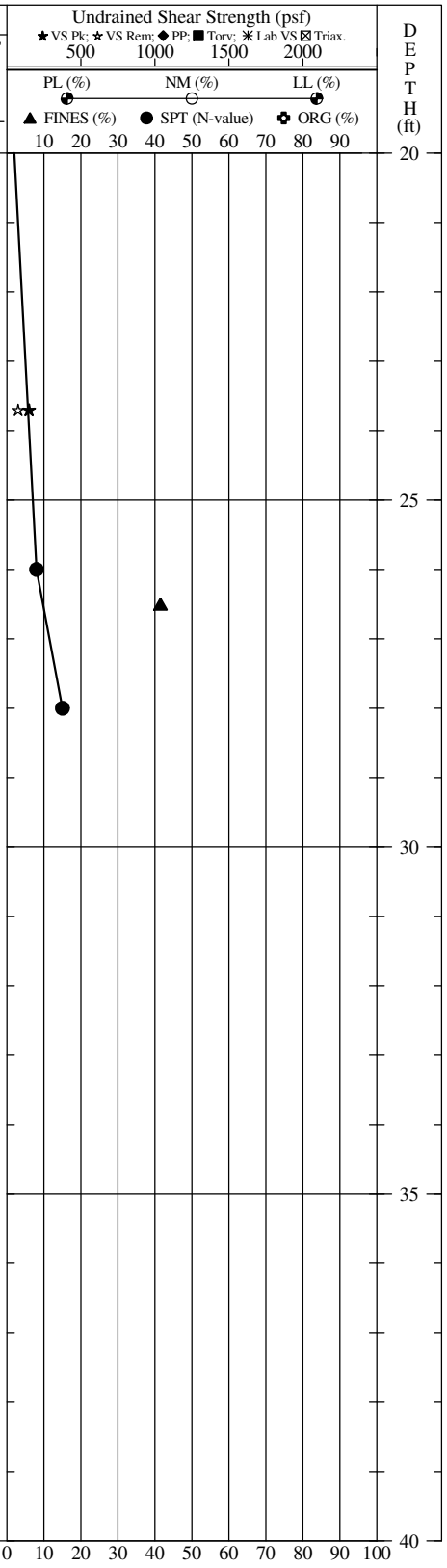
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-10
DRILLED: 1/30/13
PROJECT: Former Raymark Industries (OU6)
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
20	MARSH DEPOSIT Black, ORGANIC SILT		-9.2	ST-7		
	Brownish gray, ORGANIC SILT, few fine sand, very soft, wet, low to moderate plasticity (OH)			VS-8		
25	- 25.0' bgs: soft		-14.2			
	FLUVIAL SAND Grayish brown, fine SAND, some silt, loose, wet (SM)			SS-9		WH-2-6-11 (N = 8)
	Gray, fine to coarse SAND, few silt, little gravel, medium dense, wet (SW-SM)			SS-10		7-8-7-6 (N = 15)
	End of Exploration at 29' bgs					
30			-19.2			
35			-24.2			
40			-29.2			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	Rotary Wash with Water (Cased) to 25' bgs.
HOLE DIAM.:	4"
SPTs:	Automatic Hammer; NW rods
REMARKS:	Backfilled w/cement-bentonite grout.

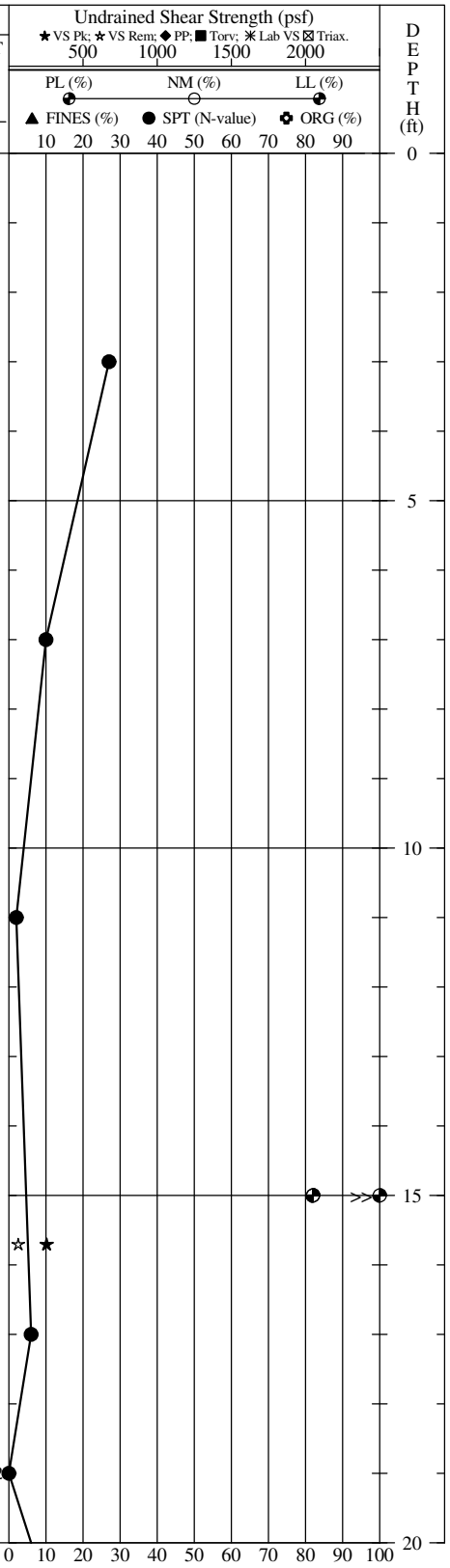
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.:	GB-10
DRILLED:	1/30/13
PROJECT:	Former Raymark Industries (OU6)
LOCATION:	Stratford, CT
PROJECT NO.:	3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	ELEV (ft)	SAMPLE IDENT [PID (ppm)]	TYPE	BLOW COUNT (1st 6" / 2nd 6" / 3rd 6" / 4th 6") Or RQD % REC
0	FILL	7.8			
	Dark brown, fine to medium SAND, few silt and gravel, medium dense, dry to moist (SP-SM) - 2.0' to 4.0' bgs: occasional organics		SS-1 []		6-20-7-10 (N = 27)
5		2.8			
	Dark brown, fine to medium SAND, some gravel, few silt, loose to medium dense, wet (SM) - 6.0' to 8.0' bgs: some wood debris		SS-2 []		12-7-3-6 (N = 10)
	MARSH DEPOSIT				
10	Grayish brown, ORGANIC SILT, few to little fine sand, very soft to medium stiff, wet, moderate plasticity (OH) - some to frequent organics	-2.2	SS-3 [0.3]		1-1-1-1 (N = 2)
	Similar to SS-3		ST-4 []		
15		-7.2	VS-5 []		
	Brown, ORGANIC SILT, few fine to medium sand, soft to medium stiff, wet, low plasticity (OH) - some organics		SS-6 []		4-3-3-3 (N = 6)
	- 18.0' to 19.5' bgs: very soft		SS-7 []		WH-WH-WH-2
	FLUVIAL SAND				
20		-12.2			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	HSA to 5' bgs; Rotary Wash with Water (Cased) to 15'
HOLE DIAM.:	bgs; Rotary Wash with Water (Open-Hole) to 22' bgs.
SPTs:	4"
REMARKS:	Automatic Hammer; NW rods Backfilled w/cement-bentonite grout.

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/3-28-13

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-11
DRILLED: 1/28/13 - 1/29/13
PROJECT: Former Raymark Industries (OU6)
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT [PID (ppm)]	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC	Undrained Shear Strength (psf) ★ VS Pk; ☆ VS Rem; ◆ PP; ■ Torv; ✳ Lab VS ⊠ Triax. 500 1000 1500 2000 / PL (%) NM (%) LL (%) / ▲ FINES (%) ● SPT (N-value) ✿ ORG (%) 10 20 30 40 50 60 70 80 90	DEPTH (ft)
20	Gray, fine to medium SAND, some silt, trace fine gravel, loose, wet (SM) FLUVIAL SAND Gray to orange-brown, fine to coarse SAND, few gravel and silt, medium dense, wet (SW-SM)		-12.2	SS-8 []		3-4-8-9 (N = 12)		20
	End of Exploration at 22' bgs							
25			-17.2					25
30			-22.2					30
35			-27.2					35
40			-32.2				0 10 20 30 40 50 60 70 80 90 100	40

BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER:	ADT
RIG TYPE:	Tracked CME-55 LC
METHOD:	HSA to 5' bgs; Rotary Wash with Water (Cased) to 15'
HOLE DIAM.:	bgs; Rotary Wash with Water (Open-Hole) to 22' bgs.
SPTs:	4"
REMARKS:	Automatic Hammer; NW rods Backfilled w/cement-bentonite grout.

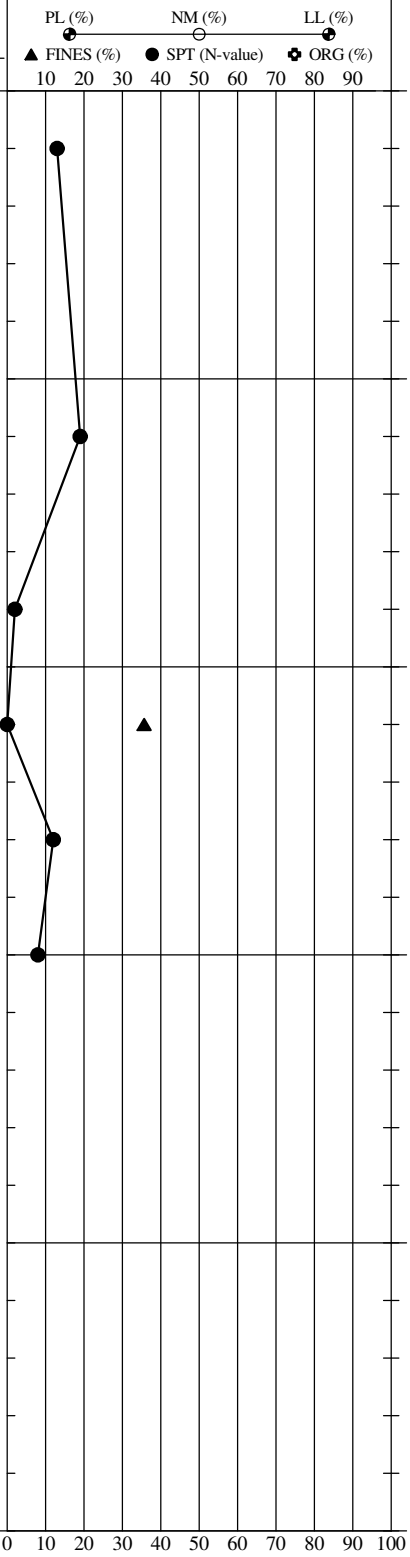
THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-11
DRILLED: 1/28/13 - 1/29/13
PROJECT: Former Raymark Industries (OU6)
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4E

amec

DEPTH (ft)	SOIL DESCRIPTION AND REMARKS SEE KEY TO SYMBOLS AND DESCRIPTIONS FOR EXPLANATION OF SYMBOLS, TERMINOLOGY, AND ABBREVIATIONS	LEGEND	ELEV (ft)	SAMPLES IDENT	TYPE	BLOW COUNT 1st 6" 2nd 6" 3rd 6" 4th 6" Or RQD % REC
0	Topsoil		7.1			
	FILL Dark grayish brown, fine to medium SAND, some silt, little gravel, medium dense, moist, non-plastic (SM)			SS-1		3-6-7-6 (N = 13)
5	Gray, fine to medium SAND, little silt, trace fine gravel, medium dense, wet, non-plastic (SM) - 5.0' to 7.0' bgs: some concrete		2.1	SS-2		5-6-13-5 (N = 19)
	MARSH DEPOSIT Brownish gray, ORGANIC SILT, few fine sand, soft, wet, low to moderate plasticity (OH) - 8.0' to 11.5' bgs: occasional to frequent organics			SS-3		3-1-1-1 (N = 2)
10	- 10.0' to 11.5' bgs: fine to medium sand, some silt, trace gravel		-2.9	SS-4		WH-WH-1-2
	FLUVIAL SAND Brownish gray, fine to medium SAND, some silt, few gravel, loose, wet (SM) - 11.5' to 12.0' bgs: occasional organics Light brown, fine to coarse SAND, little silt, few gravel, medium dense, wet (SM)			SS-5		5-5-7-7 (N = 12)
15	Brown, fine to coarse SAND, few silt, loose, wet (SW-SM)		-7.9	SS-6		5-4-4-7 (N = 8)
	End of Exploration at 16' bgs					
20			-12.9			
25			-17.9			



BOREHOLE: STANDARD (0-2500 PSF) 3651120004_RAYMARK OU6.GPJ 2007_12-12_PORT_DTMPLT.GDT 3/28/13

DRILLER: ADT
RIG TYPE: Tracked CME-55 LC
METHOD: Rotary Wash with Water (Cased) to 14' bgs.
HOLE DIAM.: 4"
SPTs: Automatic Hammer; NW rods
REMARKS: Backfilled w/cement-bentonite grout.

LOGGED BY: E. Craun CHECKED BY/DATE: KHL/3-28-13

THIS SOIL BORING RECORD PRESENTS A REASONABLE INTERPRETATION OF THE SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS MAY DIFFER. STRATA INTERFACES (AS SHOWN) ARE APPROXIMATE. ACTUAL TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

GEOTECHNICAL BORING RECORD

BORING NO.: GB-12
DRILLED: 1/29/13
PROJECT: Former Raymark Industries (OU6)
LOCATION: Stratford, CT
PROJECT NO.: 3651-12-0004-4E

amec

Attachment 1B

Consolidation Testing Data Summaries

Point	Applied Stress	% Strain	Slope C_{ce} or C_r	Max. Curvature % Change in Slope		
1	0.125	3.96	-	-	Cre	
2	0.250	7.48	0.117	59.7	0.15	**0.07**
3	0.500	13.10	0.187	42.3		
4	1.000	21.10	0.266	16.2	Cce	
5	2.000	30.40	0.309	-86.0	**0.31**	
6	0.500	27.80	0.043	92.3		
7	0.125	22.80	0.083	-76.0		
8	0.250	23.40	0.020	116.7		
9	0.500	24.70	0.043	115.4		
10	1.000	27.50	0.093	46.4		
11	2.000	31.60	0.136	102.4		
12	4.000	39.90	0.276	-		
13	-	-	-	-		
14	-	-	-	-		

MARSH DEPOSIT - ORGANIC SILT (OH)

Soil Boring:	GB-03			
Sample No.:	SH-07			
Sample Interval:	12.0 - 14.5			
Depth:	13.3			
In-Situ Eff. Stress:	0.45	tsf		
Est. Max. Past Press:	0.41	tsf	**0.9**	= OCR
Est. Future Stress:	1.04	tsf		

Conclusions: 24-hr load increm. Plot incl. substantial secondary comp.
Poor break (secondary), poss. sample disturbance.

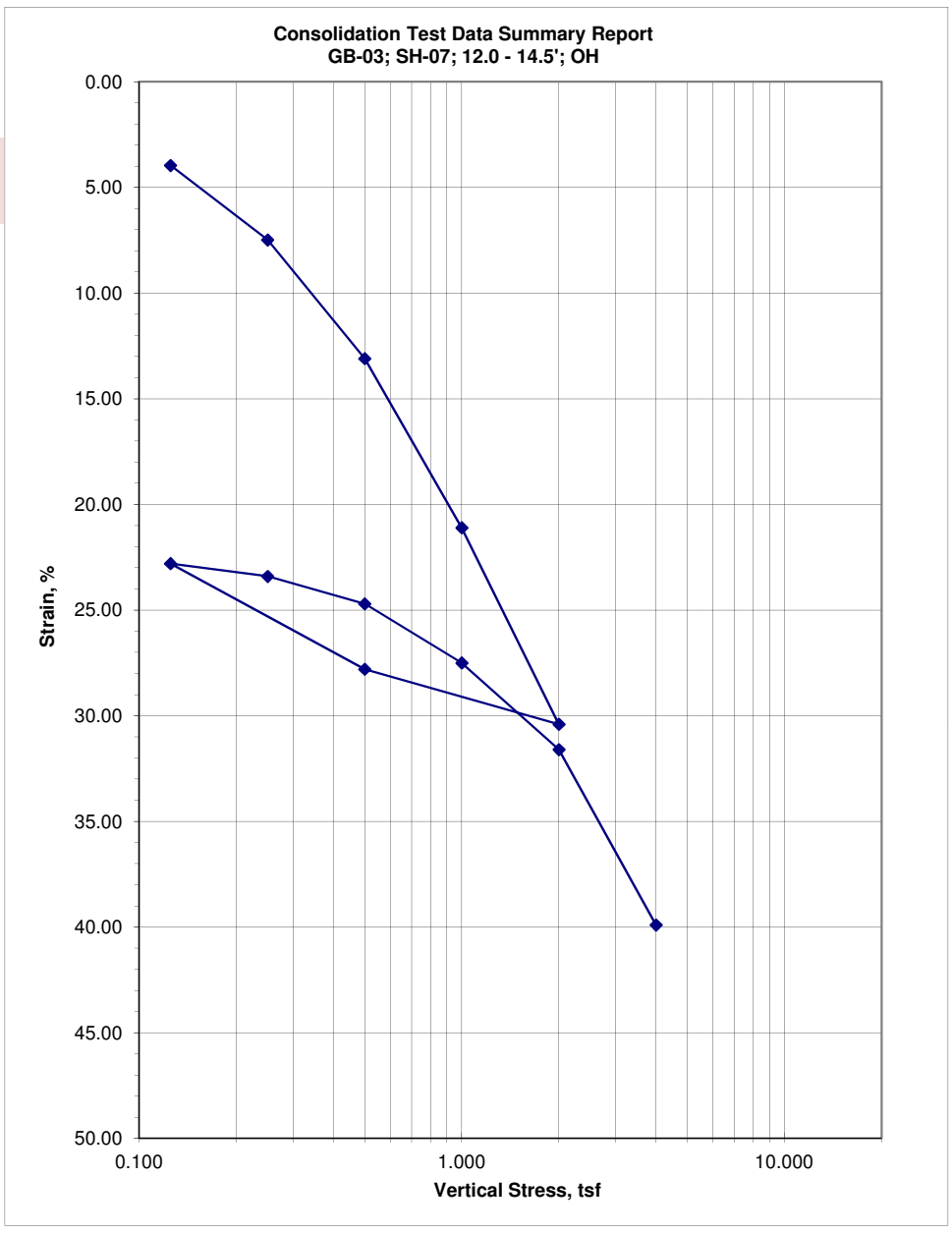
Point	Applied Stress	Sq. Rt. Of Time Cv (ft^2/s)	Cv (ft^2/day)		
1	0.125	1.11E-06	9.59E-02		
2	0.250	4.53E-07	3.91E-02		
3	0.500	4.98E-07	4.30E-02		
4	1.000	2.79E-07	2.41E-02	2.4E-02	3.0E-02
5	2.000	2.75E-07	2.38E-02		
6	0.500	3.44E-07	2.97E-02		
7	0.125	8.09E-08	6.99E-03		
8	0.250	5.14E-07	4.44E-02		
9	0.500	6.09E-07	5.26E-02		
10	1.000	5.56E-07	4.80E-02		
11	2.000	1.80E-07	1.56E-02		
12	4.000	1.49E-07	1.29E-02		
13	-	-	-		
14	-	-	-		

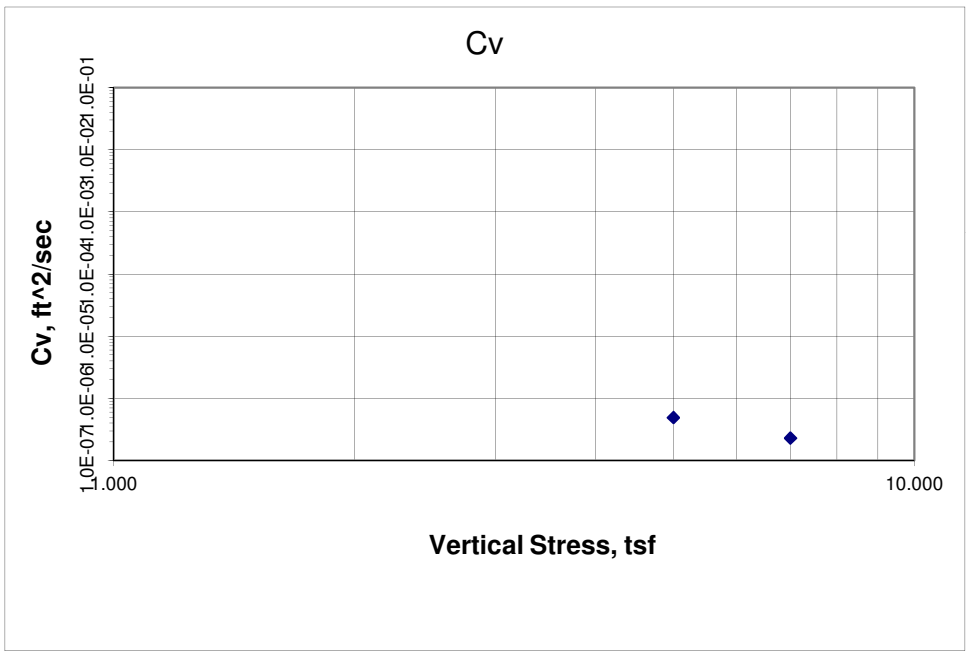
Point	Applied Stress	Log of Time Cv (ft^2/s)	Cv (ft^2/day)	
1	0.125	-	-	
2	0.250	-	-	
3	0.500	-	-	
4	1.000	-	-	
5	2.000	7.11E-07	6.14E-02	6.1E-02
6	0.500	7.97E-07	6.89E-02	
7	0.125	-	-	
8	0.250	-	-	
9	0.500	1.23E-06	1.06E-01	
10	1.000	-	-	
11	2.000	-	-	
12	4.000	3.12E-07	2.70E-02	
13	-	-	-	
14	-	-	-	

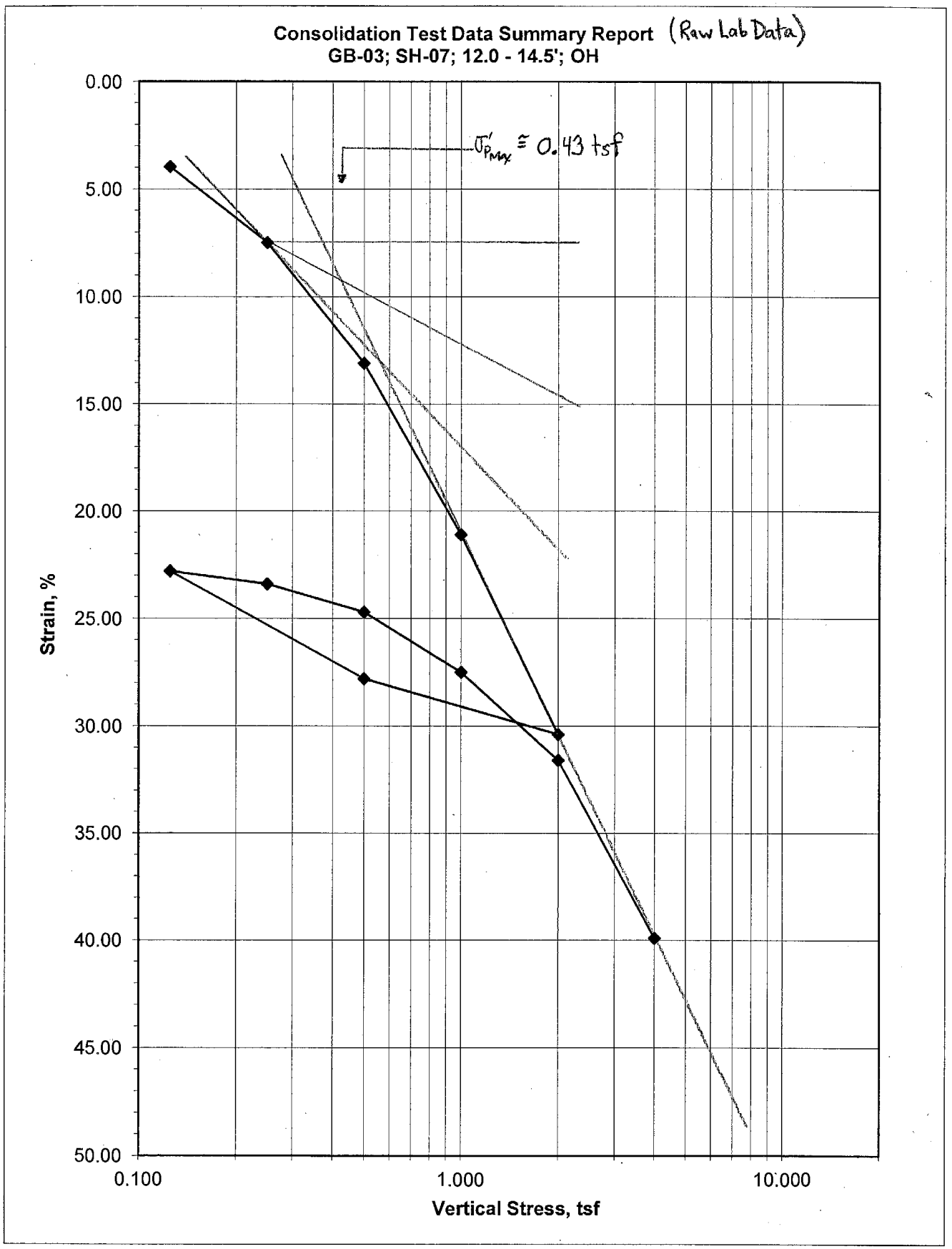
Point	Applied Stress	Average Cv (ft^2/s)	Cv (ft^2/day)	
1	0.125	-	-	
2	0.250	-	-	
3	0.500	-	-	
4	1.000	-	-	
5	2.000	4.93E-07	4.26E-02	**4.3E-02**
6	0.500	5.71E-07	4.93E-02	
7	0.125	-	-	
8	0.250	-	-	
9	0.500	9.20E-07	7.94E-02	
10	1.000	-	-	
11	2.000	-	-	
12	4.000	2.31E-07	1.99E-02	
13	-	-	-	
14	-	-	-	

MARSH DEPOSIT - ORGANIC SILT (OH)

Soil Boring:	GB-03
Sample No.:	SH-07
Sample Interval:	12.0 - 14.5
Depth:	13.3





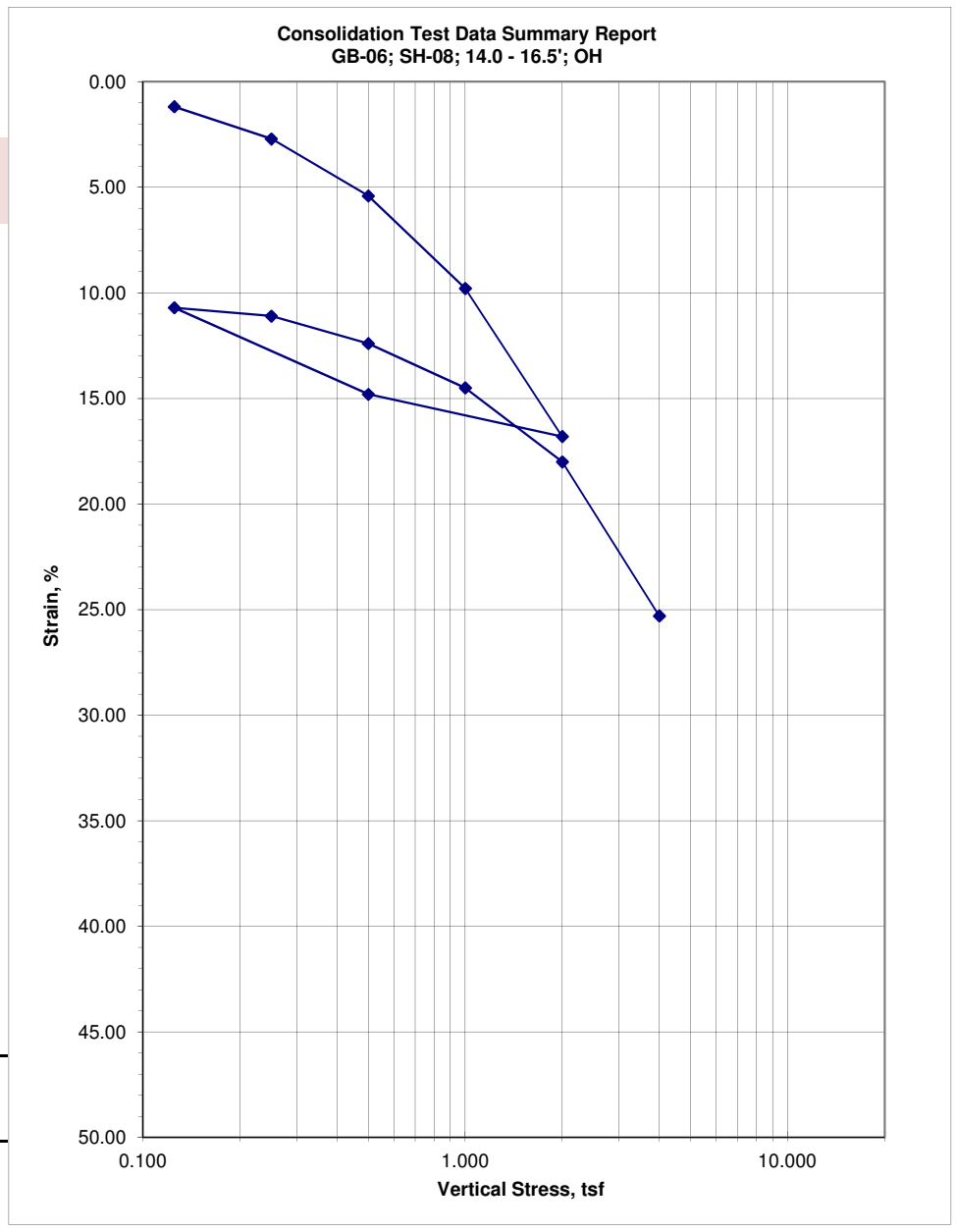

Consolidation Test Data Summary Report (Raw Lab Data)
GB-03; SH-07; 12.0 - 14.5'; OH
$\sigma'_{P_{max}} \cong 0.43$ tsf
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
Strain, %
0.100
1.000
10.000
Vertical Stress, tsf

Point	Applied Stress	% Strain	Slope C_{ce} or C_r	Max. Curvature % Change in Slope		
1	0.125	1.18	-	-	Cre	
2	0.250	2.71	0.051	76.5	0.07	**0.06**
3	0.500	5.41	0.090	62.2		
4	1.000	9.79	0.146	60.0	Cce	
5	2.000	16.80	0.233	-85.7	**0.24**	
6	0.500	14.80	0.033	105.0		
7	0.125	10.70	0.068	-80.5		
8	0.250	11.10	0.013	225.0		
9	0.500	12.40	0.043	61.5		
10	1.000	14.50	0.070	66.7		
11	2.000	18.00	0.116	108.6		
12	4.000	25.30	0.243	-		
13	-	-	-	-		
14	-	-	-	-		

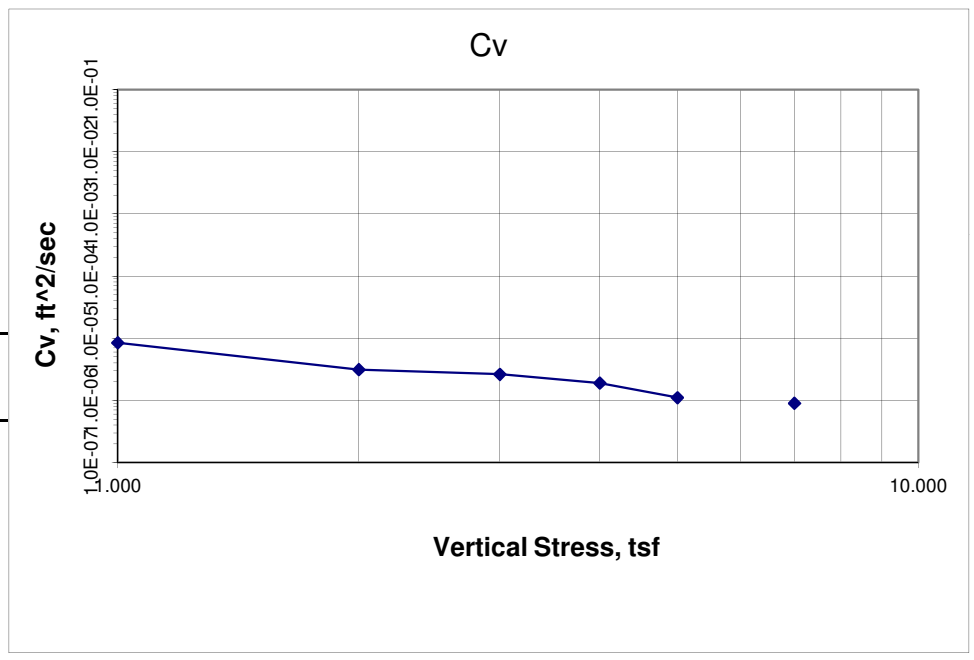
MARSH DEPOSIT - ORGANIC SILT (OH)

Soil Boring:	GB-06			
Sample No.:	SH-08			
Sample Interval:	14.0 - 16.5			
Depth:	15.3			
In-Situ Eff. Stress:	0.50	tsf		
Est. Max. Past Press:	0.55	tsf	**1.1**	= OCR
Est. Future Stress:	1.19	tsf		

Conclusions: 6-hr load increm. Plot incl. some secondary comp. Okay break.



Point	Applied Stress	Sq. Rt. Of Time Cv (ft^2/s)	Cv (ft^2/day)			
1	0.125	5.19E-06	4.48E-01			
2	0.250	2.77E-06	2.39E-01			
3	0.500	2.48E-06	2.14E-01	1.7E-01		
4	1.000	1.46E-06	1.26E-01		1.0E-01	1.4E-01
5	2.000	9.32E-07	8.05E-02			
6	0.500	1.94E-06	1.68E-01			
7	0.125	4.30E-07	3.72E-02			
8	0.250	2.33E-06	2.01E-01			
9	0.500	1.64E-06	1.42E-01			
10	1.000	2.07E-06	1.79E-01			
11	2.000	8.13E-07	7.02E-02			
12	4.000	7.67E-07	6.63E-02			
13	-	-	-			
14	-	-	-			

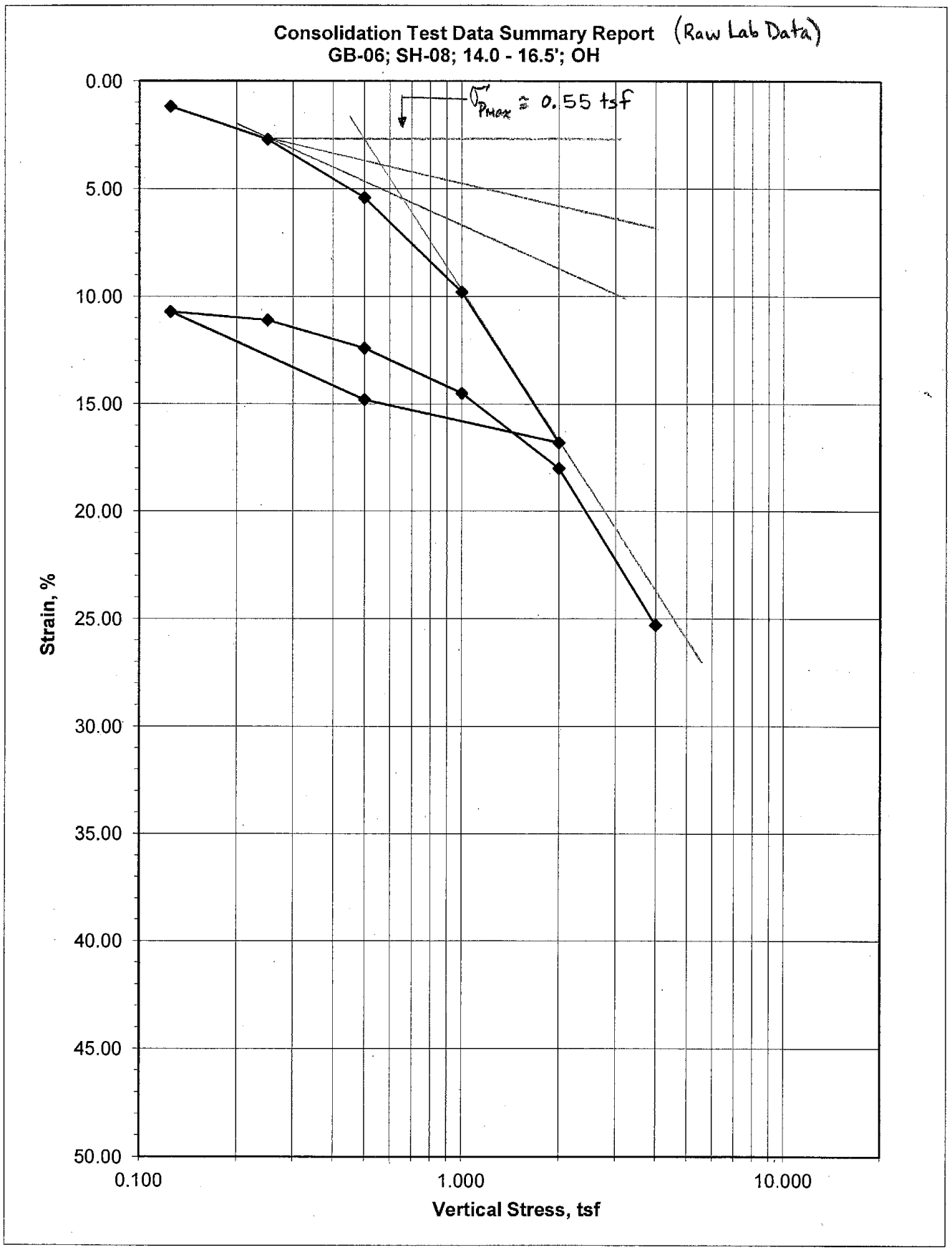


Point	Applied Stress	Log of Time Cv (ft^2/s)	Cv (ft^2/day)			
1	0.125	1.18E-05	1.02E+00			
2	0.250	3.51E-06	3.03E-01			
3	0.500	2.80E-06	2.42E-01	2.2E-01		
4	1.000	2.35E-06	2.03E-01		1.6E-01	1.9E-01
5	2.000	1.29E-06	1.11E-01			
6	0.500	2.14E-06	1.85E-01			
7	0.125	4.22E-07	3.65E-02			
8	0.250	-	-			
9	0.500	1.39E-06	1.20E-01			
10	1.000	1.70E-06	1.47E-01			
11	2.000	-	-			
12	4.000	1.04E-06	8.99E-02			
13	-	-	-			
14	-	-	-			

Point	Applied Stress	Average Cv (ft^2/s)	Cv (ft^2/day)			
1	0.125	8.50E-06	7.34E-01			
2	0.250	3.14E-06	2.71E-01			
3	0.500	2.64E-06	2.28E-01	2.0E-01		
4	1.000	1.91E-06	1.65E-01		1.3E-01	**1.6E-01**
5	2.000	1.11E-06	9.60E-02			
6	0.500	2.04E-06	1.76E-01			
7	0.125	4.26E-07	3.68E-02			
8	0.250	-	-			
9	0.500	1.52E-06	1.31E-01			
10	1.000	1.89E-06	1.63E-01			
11	2.000	-	-			
12	4.000	9.04E-07	7.81E-02			
13	-	-	-			
14	-	-	-			

MARSH DEPOSIT - ORGANIC SILT (OH)

Soil Boring:	GB-06
Sample No.:	SH-08
Sample Interval:	14.0 - 16.5
Depth:	15.3

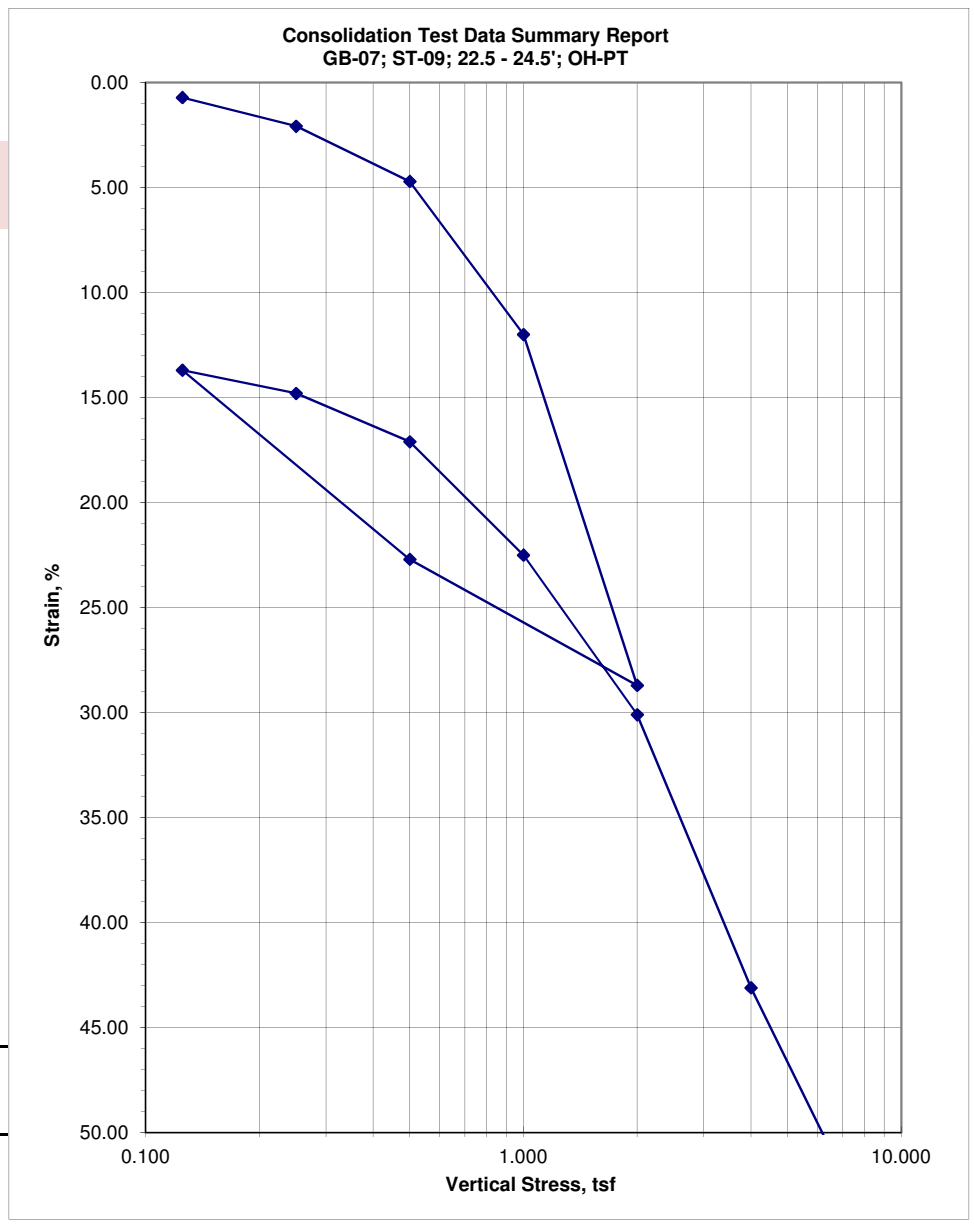

Consolidation Test Data Summary Report (Raw Lab Data)
GB-06; SH-08; 14.0 - 16.5'; OH
$\sigma'_{p_{max}} \approx 0.55$ tsf
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
Strain, %
0.100
1.000
10.000
Vertical Stress, tsf

Point	Applied Stress (tsf)	% Strain	Slope C_{ce} or C_r	Max. Curvature % Change in Slope		
1	0.125	0.71	-	-	Cre	
2	0.250	2.08	0.045	92.5	0.09	**0.08**
3	0.500	4.71	0.087	177.2		
4	1.000	12.00	0.242	129.1	Cce	
5	2.000	28.70	**0.555**	-82.0	**0.55**	
6	0.500	22.70	0.100	50.0		
7	0.125	13.70	0.149	-75.6		
8	0.250	14.80	0.037	109.1		
9	0.500	17.10	0.076	134.8		
10	1.000	22.50	0.179	40.7		
11	2.000	30.10	0.252	71.1		
12	4.000	43.10	0.432	-15.4		
13	8.000	54.10	0.365	-		

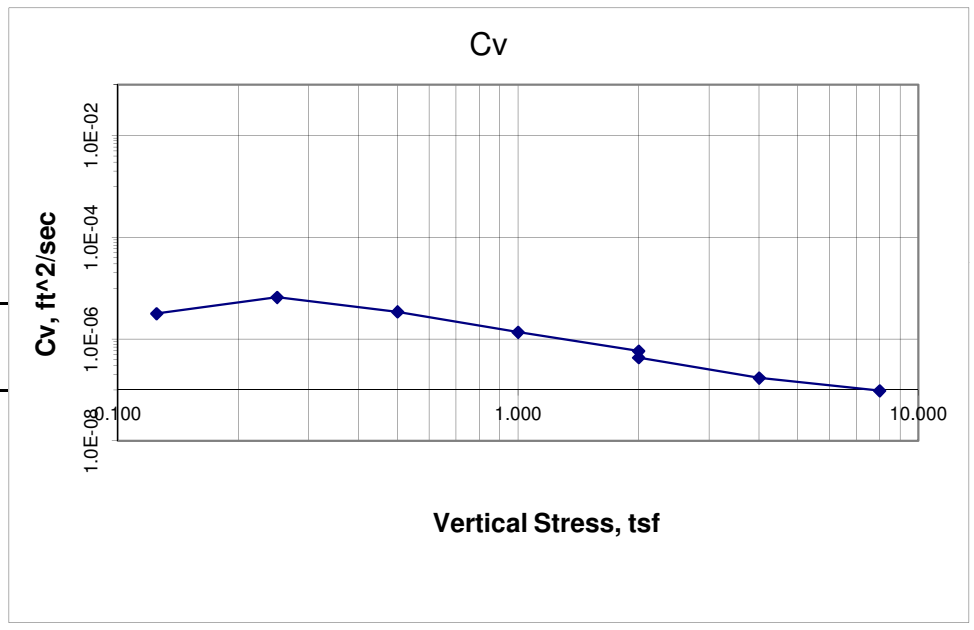
MARSH DEPOSIT - ORGANIC SILT/PEAT (OH/PT)

Soil Boring:	GB-07			
Sample No.:	ST-09			
Sample Interval:	22.5 - 24.5			
Depth:	23.5			
In-Situ Eff. Stress:	0.64	tsf		
Est. Max. Past Press:	0.80	tsf	**1.3**	= OCR
Pre-Load Max. Stress:	1.39	tsf		

Conclusions: 4-hr load increm. Plots incl. little secondary comp.
Good curve/break.



Point	Applied Stress	Sq. Rt. Of Time Cv (ft^2/s)	Cv (ft^2/day)			
1	0.125	3.06E-06	2.64E-01			
2	0.250	4.19E-06	3.62E-01			
3	0.500	3.78E-06	3.27E-01	2.0E-01		
4	1.000	7.85E-07	6.78E-02		6.2E-02	1.5E-01
5	2.000	6.45E-07	5.57E-02			
6	0.500	6.00E-07	5.18E-02			
7	0.125	2.18E-07	1.88E-02			
8	0.250	3.43E-06	2.96E-01			
9	0.500	1.09E-06	9.42E-02			
10	1.000	6.90E-07	5.96E-02			
11	2.000	4.39E-07	3.79E-02			
12	4.000	2.18E-07	1.88E-02			
13	8.000	1.23E-07	1.06E-02			

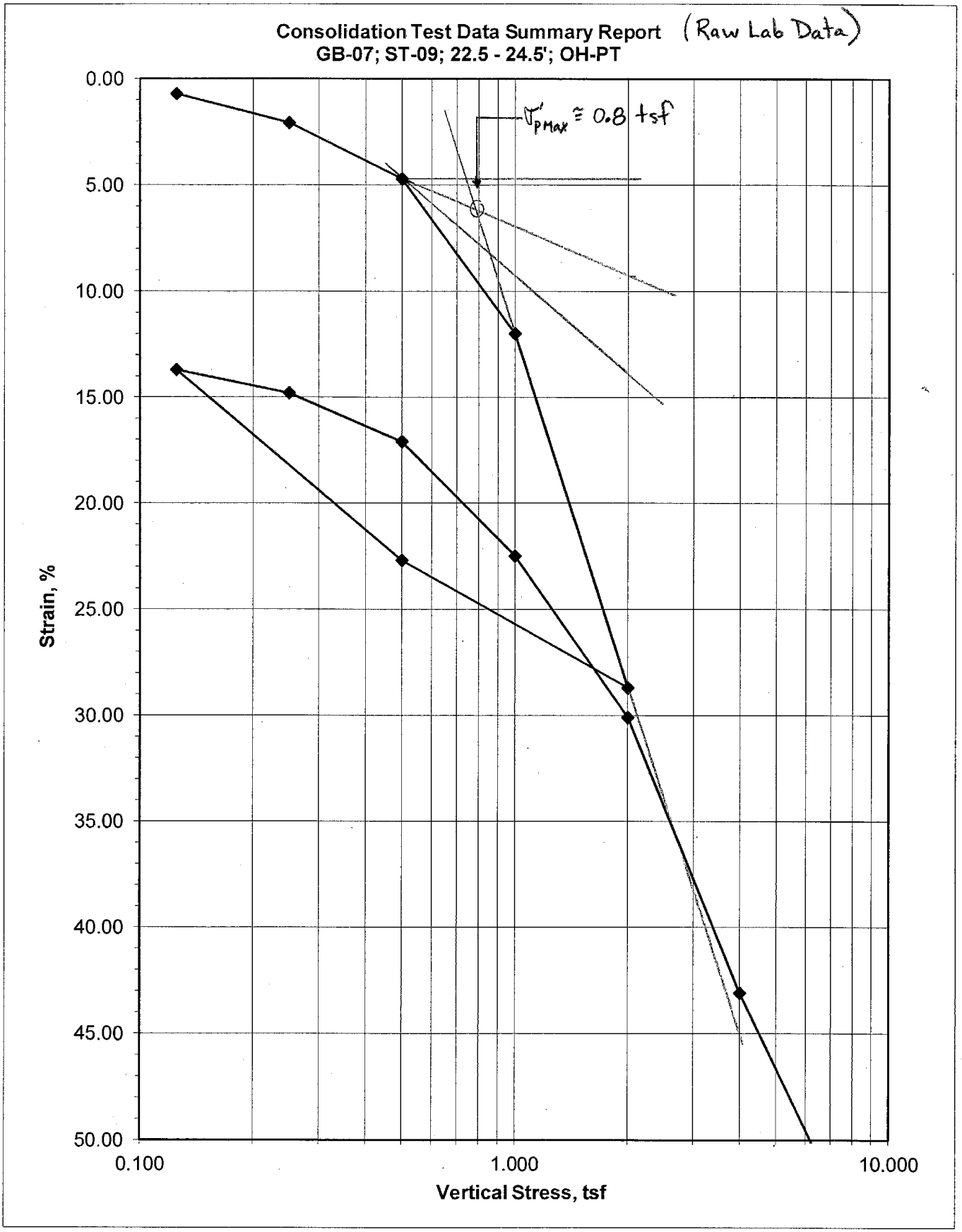


Point	Applied Stress	Log of Time Cv (ft^2/s)	Cv (ft^2/day)			
1	0.125	3.30E-06	2.85E-01			
2	0.250	9.16E-06	7.91E-01			
3	0.500	3.14E-06	2.71E-01	2.2E-01		
4	1.000	1.96E-06	1.69E-01		1.1E-01	1.6E-01
5	2.000	5.27E-07	4.55E-02			
6	0.500	3.83E-07	3.31E-02			
7	0.125	2.38E-07	2.06E-02			
8	0.250	-	-			
9	0.500	1.47E-06	1.27E-01			
10	1.000	5.94E-07	5.13E-02			
11	2.000	4.33E-07	3.74E-02			
12	4.000	1.29E-07	1.11E-02			
13	8.000	7.17E-08	6.19E-03			

Point	Applied Stress	Average Cv (ft^2/s)	Cv (ft^2/day)			
1	0.125	3.18E-06	2.75E-01			
2	0.250	6.68E-06	5.77E-01			
3	0.500	3.46E-06	2.99E-01	2.1E-01		
4	1.000	1.37E-06	1.19E-01		8.5E-02	**1.6E-01**
5	2.000	5.86E-07	5.06E-02			
6	0.500	4.92E-07	4.25E-02			
7	0.125	2.28E-07	1.97E-02			
8	0.250	-	-			
9	0.500	1.28E-06	1.11E-01			
10	1.000	6.42E-07	5.55E-02			
11	2.000	4.36E-07	3.77E-02			
12	4.000	1.74E-07	1.50E-02			
13	8.000	9.74E-08	8.41E-03			

MARSH DEPOSIT - ORGANIC SILT/PEAT (OH/PT)

Soil Boring:	GB-07
Sample No.:	ST-09
Sample Interval:	22.5 - 24.5
Depth:	23.5


Consolidation Test Data Summary Report (Raw Lab Data)
GB-07; ST-09; 22.5 - 24.5'; OH-PT
$\sigma'_{pMax} \cong 0.8$ tsf
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
Strain, %
0.100
1.000
10.000
Vertical Stress, tsf

Point	Applied Stress (tsf)	% Strain	Slope C_{ce} or C_r	Max. Curvature % Change in Slope		
1	0.125	0.87	-	-	Cre	
2	0.250	1.74	0.029	182.2	0.08	**0.06**
3	0.438	3.72	0.081	55.8		
4	0.765	6.80	0.127	81.7		
5	1.325	12.30	0.231	-81.1		
6	0.438	10.20	0.044	29.7		
7	0.125	7.12	0.057	-87.7		
8	0.250	7.33	0.007	483.9		
9	0.438	8.32	0.041	80.1		
10	0.765	10.10	0.073	77.2		
11	1.325	13.20	0.130	177.3	Cce	
12	2.625	23.90	0.360	-6.9	**0.36**	
13	5.250	34.00	0.336	-7.9		
14	10.500	43.30	0.309	-		

MARSH DEPOSIT - ORGANIC SILT (OH)

Soil Boring:	GB-08			
Sample No.:	ST-08			
Sample Interval:	18.0 - 20.0			
Depth:	19.0			
In-Situ Eff. Stress:	0.59	tsf		
Est. Max. Past Press:	0.73	tsf	**1.2**	= OCR
Pre-Load Max. Stress:	1.28	tsf		

Conclusions: 4-hr load increm. Plots incl. little secondary comp.
Good curve/break.

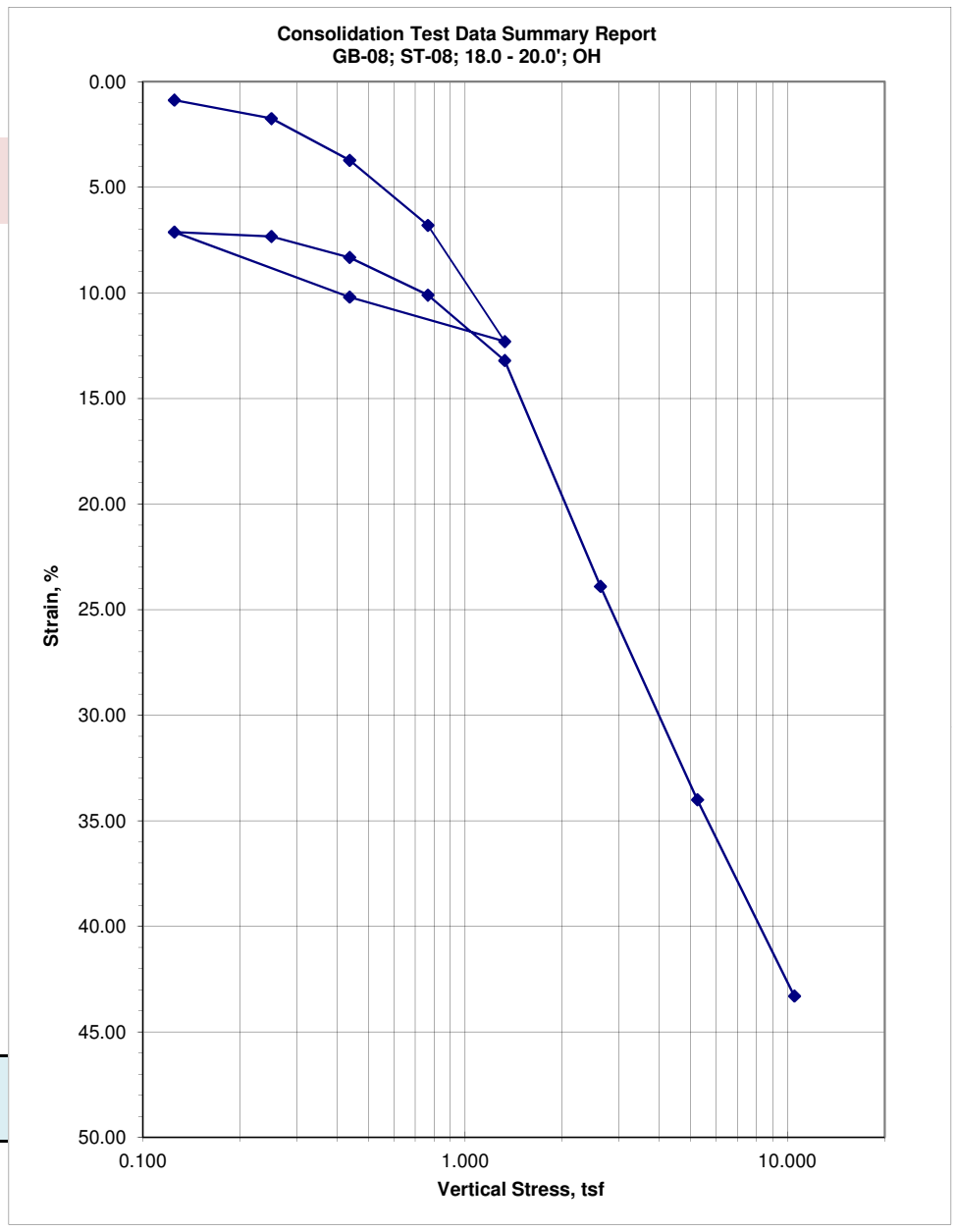
Point	Applied Stress	Sq. Rt. Of Time Cv (ft^2/s)	Cv (ft^2/day)			
1	0.125	3.23E-05	2.79E+00			
2	0.250	1.42E-06	1.23E-01			
3	0.438	3.11E-06	2.69E-01	2.7E-01		
4	0.765	3.14E-06	2.71E-01		1.7E-01	**2.0E-01**
5	1.325	8.10E-07	7.00E-02			
6	0.438	2.77E-06	2.39E-01			
7	0.125	7.54E-07	6.51E-02			
8	0.250	7.04E-07	6.08E-02			
9	0.438	1.17E-07	1.01E-02			
10	0.765	2.89E-06	2.50E-01			
11	1.325	1.14E-06	9.85E-02			
12	2.625	9.13E-07	7.89E-02			
13	5.250	7.67E-07	6.63E-02			
14	0.000	5.81E-07	5.02E-02			

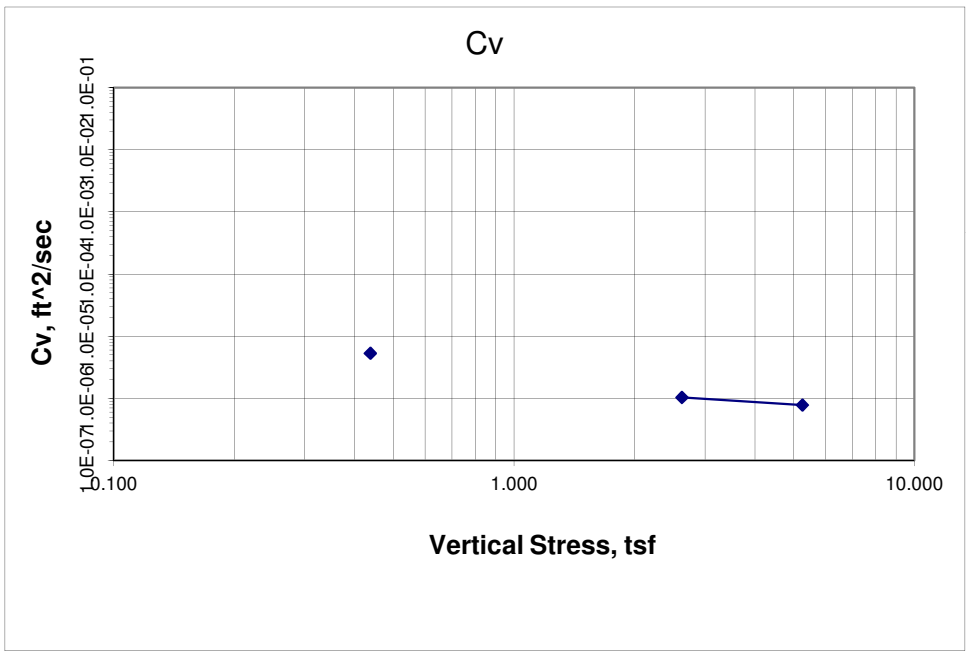
Point	Applied Stress	Log of Time Cv (ft^2/s)	Cv (ft^2/day)
1	0.125	-	-
2	0.250	-	-
3	0.438	7.59E-06	6.56E-01
4	0.765	-	-
5	1.325	-	-
6	0.438	4.08E-06	3.53E-01
7	0.125	1.14E-06	9.85E-02
8	0.250	7.87E-07	6.80E-02
9	0.438	-	-
10	0.765	4.46E-06	3.85E-01
11	1.325	-	-
12	2.625	1.17E-06	1.01E-01
13	5.250	8.04E-07	6.95E-02
14	10.500	5.99E-07	5.18E-02

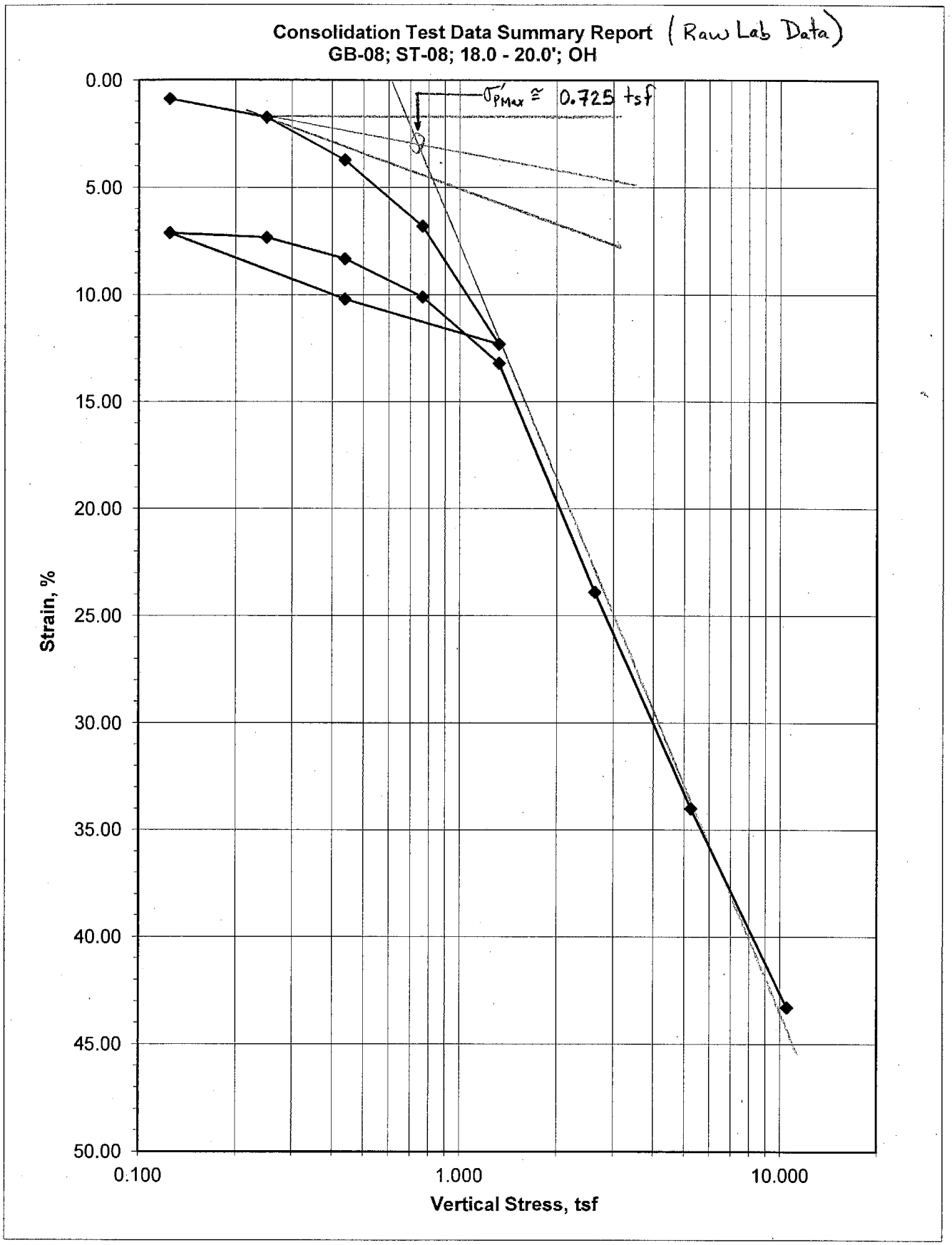
Point	Applied Stress	Average Cv (ft^2/s)	Cv (ft^2/day)
1	0.125	-	-
2	0.250	-	-
3	0.438	5.35E-06	4.62E-01
4	0.765	-	-
5	1.325	-	-
6	0.438	3.43E-06	2.96E-01
7	0.125	9.47E-07	8.18E-02
8	0.250	-	-
9	0.438	-	-
10	0.765	3.68E-06	3.18E-01
11	1.325	-	-
12	2.625	1.04E-06	9.00E-02
13	5.250	7.86E-07	6.79E-02
14	10.500	2.91E-07	2.51E-02

MARSH DEPOSIT - ORGANIC SILT (OH)

Soil Boring:	GB-08
Sample No.:	ST-08
Sample Interval:	18.0 - 20.0
Depth:	19.0





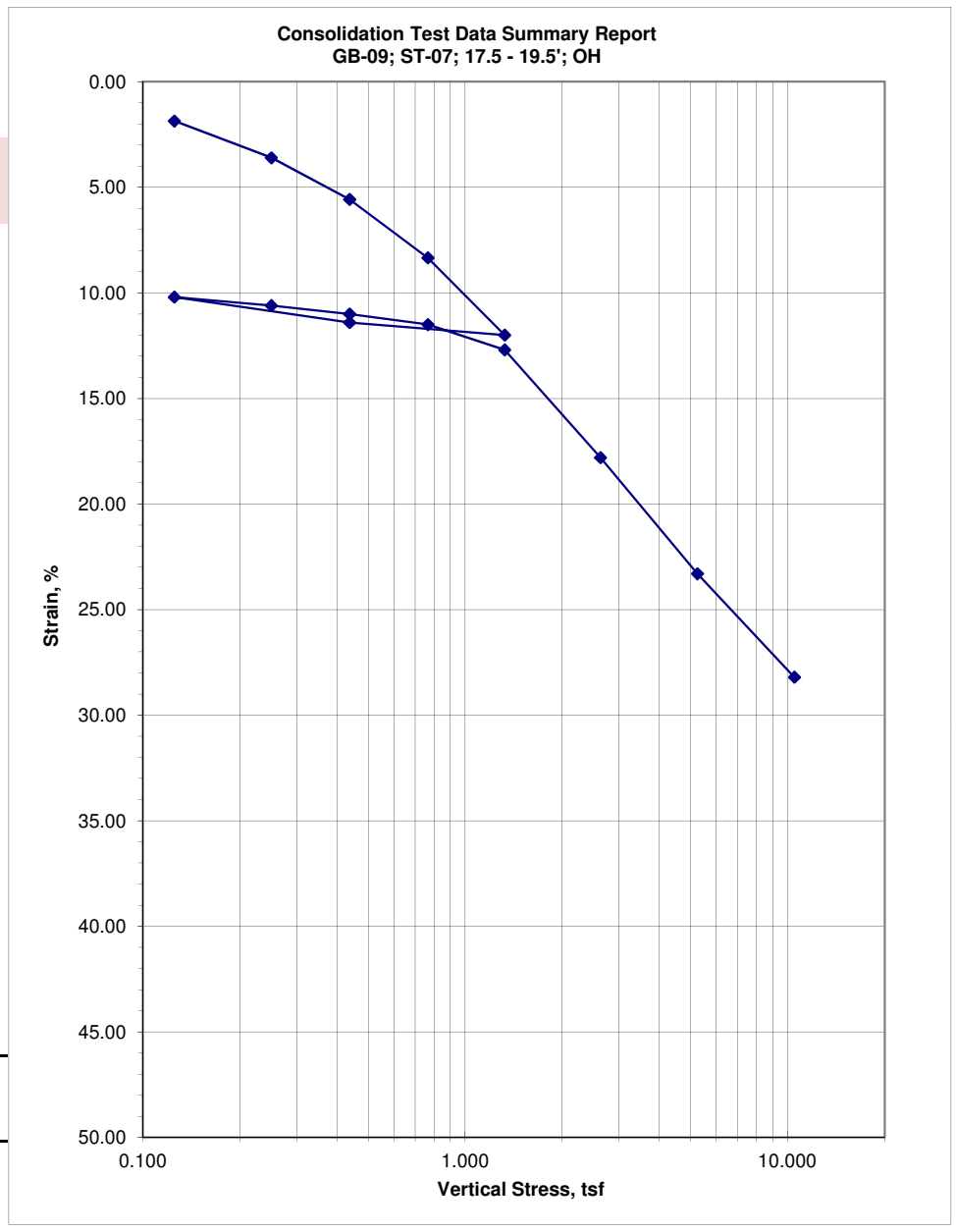

Consolidation Test Data Summary Report (Raw Lab Data)
GB-08; ST-08; 18.0 - 20.0'; OH
σ'PMax ≅ 0.725 tsf
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
Strain, %
0.100
1.000
10.000
Vertical Stress, tsf

Point	Applied Stress (tsf)	% Strain	Slope C_{ce} or C_r	Max. Curvature % Change in Slope		
1	0.125	1.86	-	-	Cre	
2	0.250	3.60	0.058	40.2	0.07	**0.02**
3	0.438	5.57	0.081	40.8		
4	0.765	8.34	0.114	34.4		
5	1.325	12.00	0.153	-91.9		
6	0.438	11.40	0.012	76.9		
7	0.125	10.20	0.022	-39.8		
8	0.250	10.60	0.013	23.9		
9	0.438	11.00	0.016	25.2		
10	0.765	11.50	0.021	144.2		
11	1.325	12.70	0.050	241.5		
12	2.625	17.80	0.172	6.4	Cce	
13	5.250	23.30	0.183	-10.9	**0.18**	
14	10.500	28.20	0.163	-		

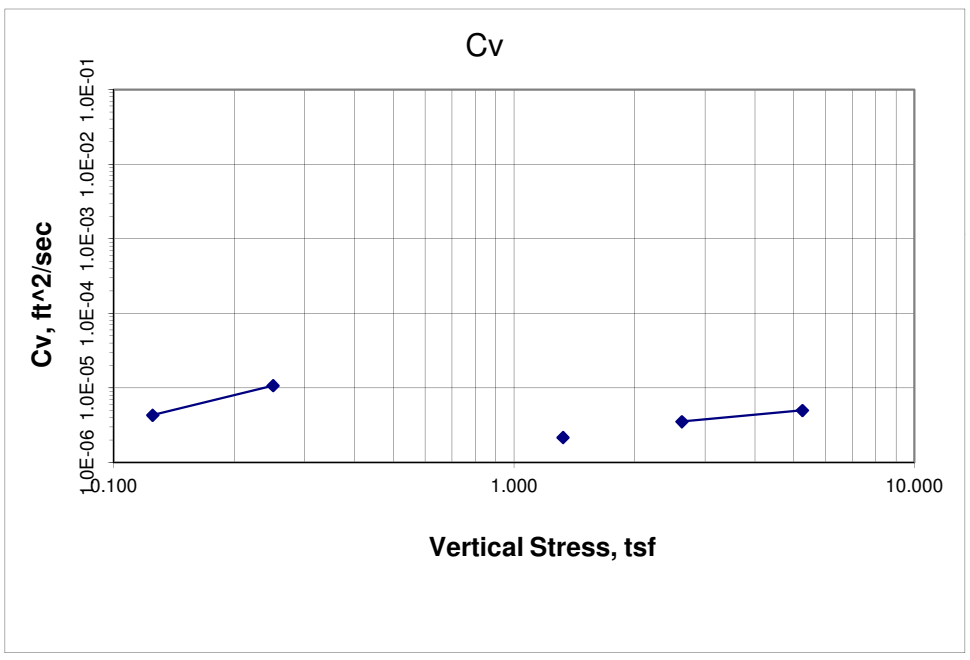
MARSH DEPOSIT - sandy ORGANIC CLAY (OH)

Soil Boring:	GB-09			
Sample No.:	ST-07			
Sample Interval:	17.5 - 19.5			
Depth:	18.5			
In-Situ Eff. Stress:	0.39	tsf		
Est. Max. Past Press:	0.65	tsf	**1.7**	= OCR
Pre-Load Max. Stress:	1.08	tsf		

Conclusions: 4-hr load increm. Plots incl. little secondary comp.
Poor break; Poss. sample disturbance; Sandy.



Point	Applied Stress	Sq. Rt. Of Time Cv (ft^2/s)	Cv (ft^2/day)			
1	0.125	1.82E-06	1.57E-01			
2	0.250	5.67E-06	4.90E-01			
3	0.438	2.23E-06	1.93E-01	1.8E-01		
4	0.765	1.84E-06	1.59E-01		1.6E-01	1.7E-01
5	1.325	1.78E-06	1.54E-01			
6	0.438	1.88E-05	1.62E+00			
7	0.125	2.03E-06	1.75E-01			
8	0.250	1.43E-06	1.24E-01			
9	0.438	1.12E-06	9.68E-02			
10	0.765	3.63E-06	3.14E-01			
11	1.325	7.90E-07	6.83E-02			
12	2.625	2.11E-06	1.82E-01			
13	5.250	2.59E-06	2.24E-01			
14	0.000	2.45E-06	2.12E-01			

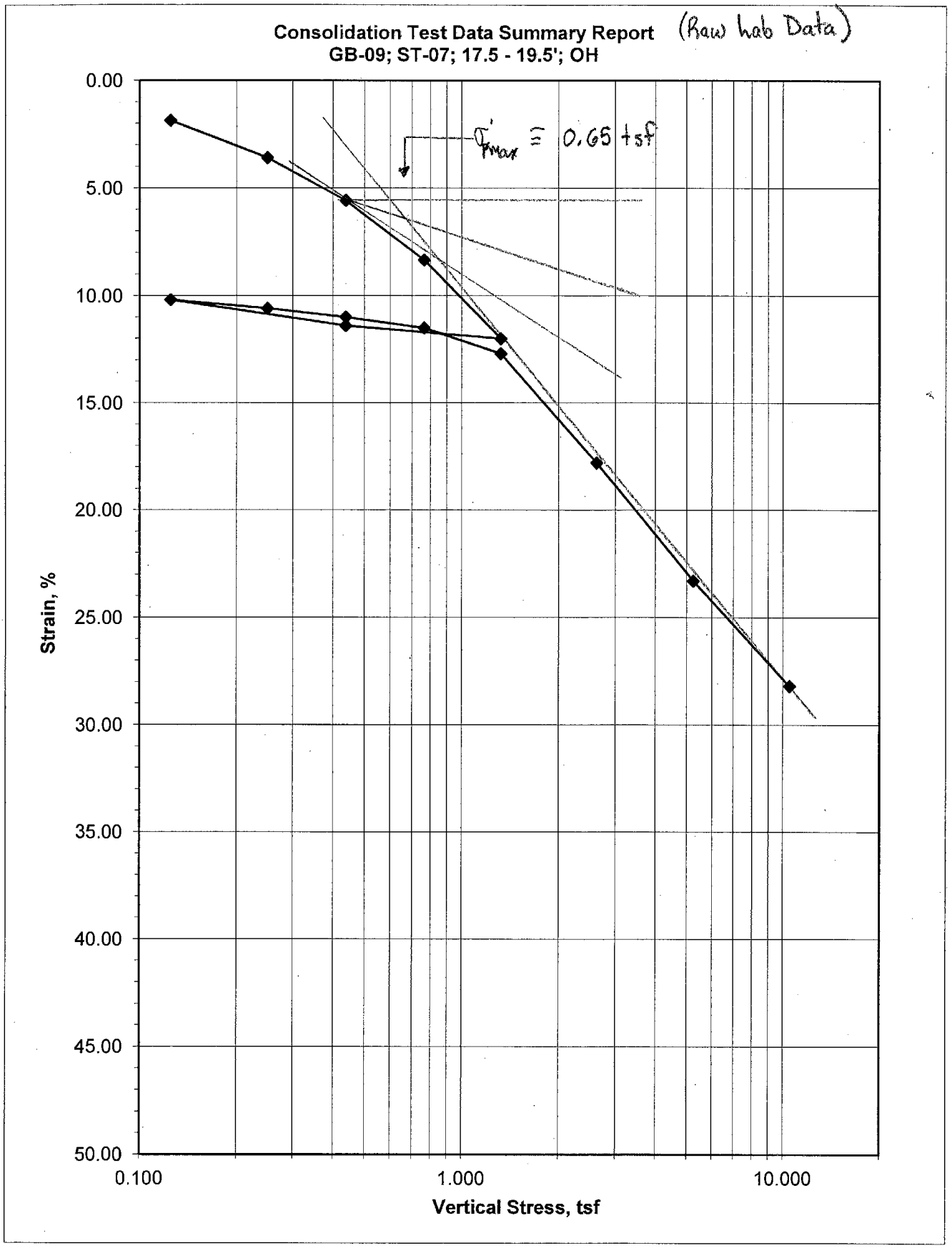


Point	Applied Stress	Log of Time Cv (ft^2/s)	Cv (ft^2/day)	
1	0.125	6.84E-06	5.91E-01	
2	0.250	1.59E-05	1.37E+00	
3	0.438	-	-	
4	0.765	-	-	
5	1.325	2.56E-06	2.21E-01	2.2E-01
6	0.438	-	-	
7	0.125	-	-	
8	0.250	-	-	
9	0.438	-	-	
10	0.765	-	-	
11	1.325	-	-	
12	2.625	4.97E-06	4.29E-01	
13	5.250	7.43E-06	6.42E-01	
14	10.500	7.11E-06	6.14E-01	

Point	Applied Stress	Average Cv (ft^2/s)	Cv (ft^2/day)	
1	0.125	4.33E-06	3.74E-01	
2	0.250	1.08E-05	9.32E-01	
3	0.438	-	-	
4	0.765	-	-	
5	1.325	2.17E-06	1.87E-01	**1.9E-01**
6	0.438	-	-	
7	0.125	-	-	
8	0.250	-	-	
9	0.438	-	-	
10	0.765	-	-	
11	1.325	-	-	
12	2.625	3.54E-06	3.06E-01	
13	5.250	5.01E-06	4.33E-01	
14	10.500	4.78E-06	4.13E-01	

MARSH DEPOSIT - sandy ORGANIC CLAY (OH)

Soil Boring:	GB-09
Sample No.:	ST-07
Sample Interval:	17.5 - 19.5
Depth:	18.5


Consolidation Test Data Summary Report
(Raw lab Data)
GB-09; ST-07; 17.5 - 19.5'; OH
σ'max ≅ 0.65 tsf
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
Strain, %
0.100
1.000
10.000
Vertical Stress, tsf

Point	Applied Stress (tsf)	% Strain	Slope C_{ce} or C_r	Max. Curvature % Change in Slope
1	0.125	1.56	-	-
2	0.250	2.94	0.046	63.8
3	0.500	5.20	0.075	130.1
4	1.000	10.40	0.173	146.2
5	2.000	23.20	0.425	-88.3
6	0.500	20.20	0.050	93.3
7	0.125	14.40	0.096	-79.3
8	0.250	15.00	0.020	150.0
9	0.500	16.50	0.050	120.0
10	1.000	19.80	0.110	78.8
11	2.000	25.70	0.196	118.6
12	4.000	38.60	0.429	-18.6
13	8.000	49.10	0.349	-
14	-	-	-	-

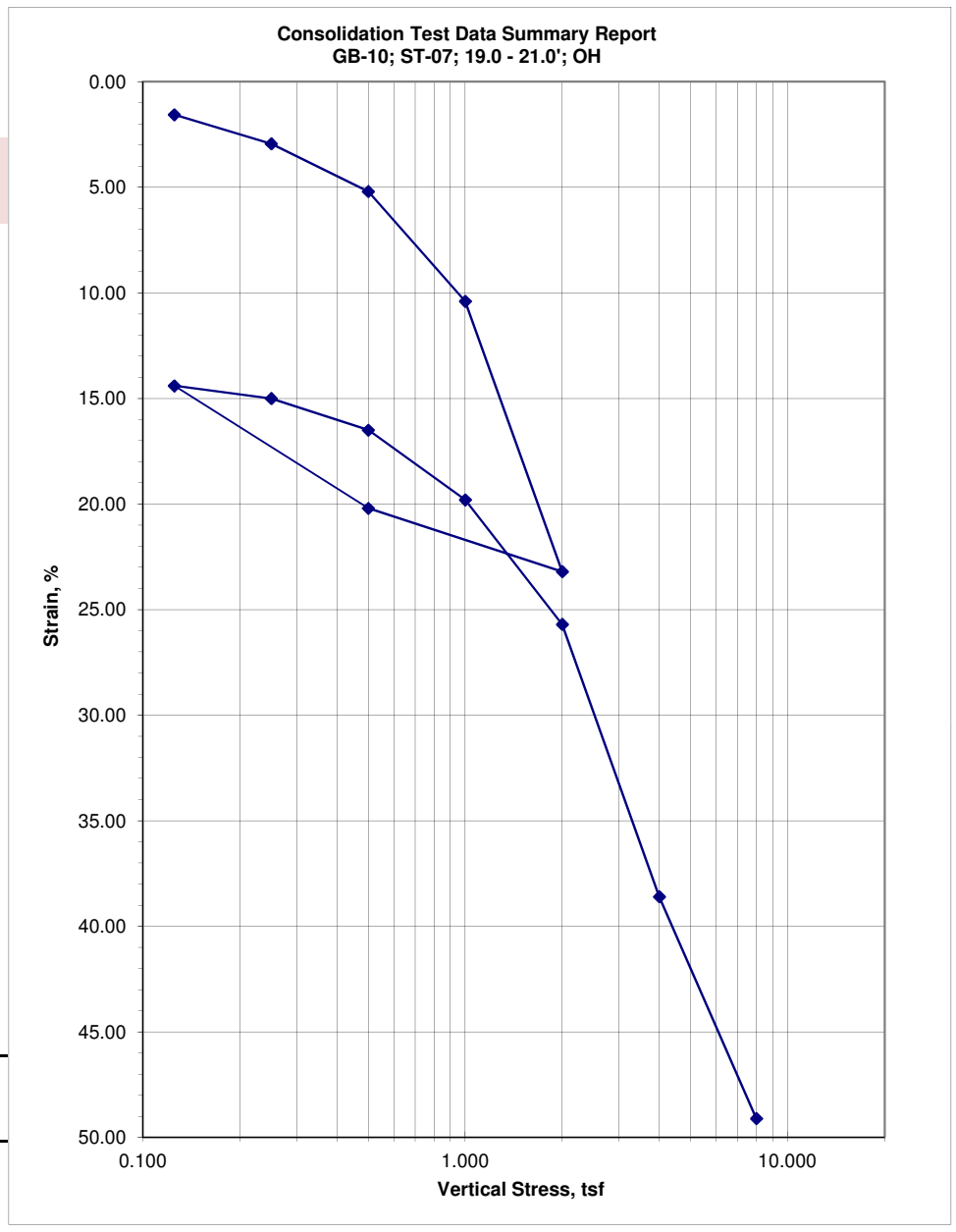
Cre	
0.06	**0.08**

Cce
0.43

MARSH DEPOSIT - ORGANIC SILT/PEAT (OH/PT)

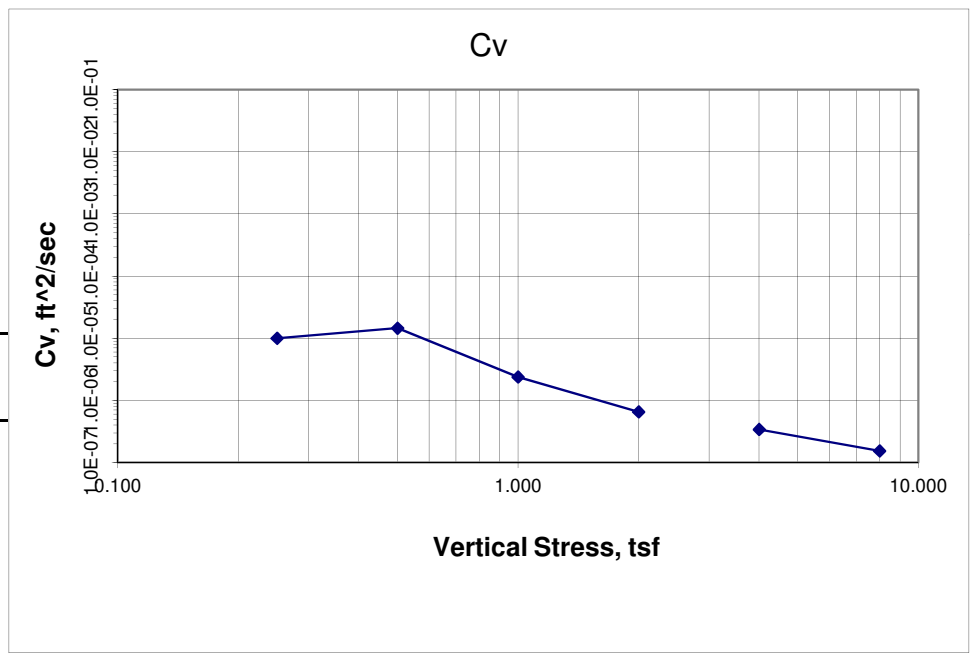
Soil Boring:	GB-10			
Sample No.:	ST-07			
Sample Interval:	19.0 - 21.0			
Depth:	20.0			
In-Situ Eff. Stress:	0.78	tsf		
Est. Max. Past Press:	0.80	tsf	**1.0**	= OCR
Pre-Load Max. Stress:	1.28	tsf		

Conclusions: 4-hr load increm. Plots incl. little secondary comp.
Good curve/break.



Point	Applied Stress	Sq. Rt. Of Time Cv (ft^2/s)	Cv (ft^2/day)
1	0.125	9.71E-06	8.39E-01
2	0.250	5.04E-06	4.35E-01
3	0.500	7.26E-06	6.27E-01
4	1.000	1.76E-06	1.52E-01
5	2.000	5.98E-07	5.17E-02
6	0.500	1.44E-06	1.24E-01
7	0.125	4.02E-07	3.47E-02
8	0.250	1.16E-05	1.00E+00
9	0.500	1.74E-06	1.50E-01
10	1.000	1.02E-06	8.81E-02
11	2.000	6.63E-07	5.73E-02
12	4.000	3.72E-07	3.21E-02
13	8.000	1.76E-07	1.52E-02
14	-	-	-

3.9E-01	1.0E-01	2.8E-01



Point	Applied Stress	Log of Time Cv (ft^2/s)	Cv (ft^2/day)
1	0.125	-	-
2	0.250	1.50E-05	1.30E+00
3	0.500	2.18E-05	1.88E+00
4	1.000	3.02E-06	2.61E-01
5	2.000	7.15E-07	6.18E-02
6	0.500	2.20E-06	1.90E-01
7	0.125	3.34E-07	2.89E-02
8	0.250	-	-
9	0.500	1.59E-06	1.37E-01
10	1.000	1.57E-06	1.36E-01
11	2.000	-	-
12	4.000	3.11E-07	2.69E-02
13	8.000	1.33E-07	1.15E-02
14	-		

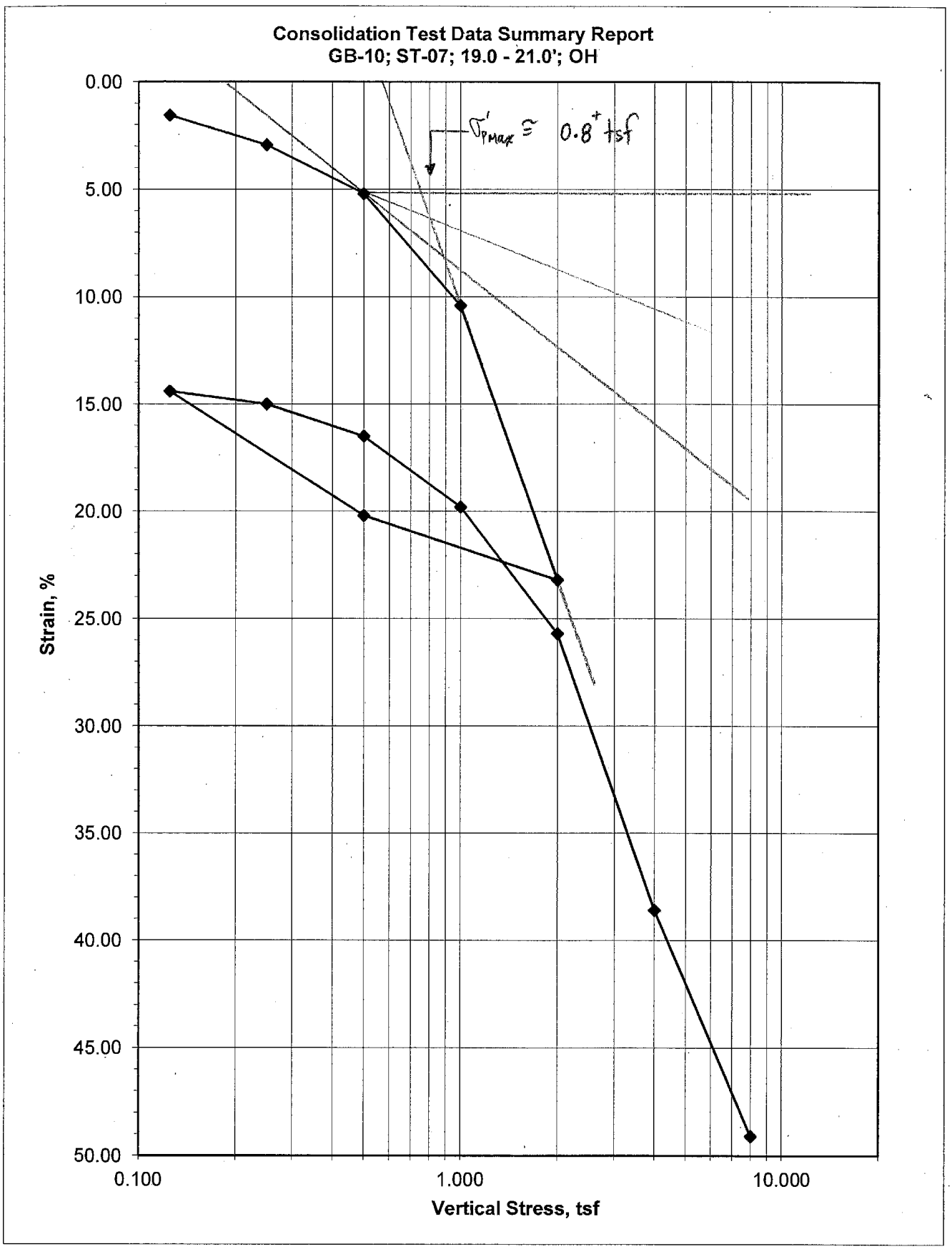
1.1E+00	1.6E-01	7.4E-01

Point	Applied Stress	Average Cv (ft^2/s)	Cv (ft^2/day)
1	0.125	-	-
2	0.250	1.00E-05	8.66E-01
3	0.500	1.45E-05	1.26E+00
4	1.000	2.39E-06	2.06E-01
5	2.000	6.57E-07	5.67E-02
6	0.500	1.82E-06	1.57E-01
7	0.125	3.68E-07	3.18E-02
8	0.250	-	-
9	0.500	1.67E-06	1.44E-01
10	1.000	1.30E-06	1.12E-01
11	2.000	-	-
12	4.000	3.42E-07	2.95E-02
13	8.000	1.55E-07	1.33E-02
14	-	-	-

7.3E-01	1.3E-01	**5.1E-01**

MARSH DEPOSIT - ORGANIC SILT/PEAT (OH/PT)

Soil Boring:	GB-10
Sample No.:	ST-07
Sample Interval:	19.0 - 21.0
Depth:	20.0


Consolidation Test Data Summary Report
GB-10; ST-07; 19.0 - 21.0'; OH
$\sigma'_{p_{max}} \cong 0.8^{+}$ tsf
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
Strain, %
0.100
1.000
10.000
Vertical Stress, tsf

ATTACHMENT 2

SETTLEMENT EVALUATION
(Spreadsheet Calculator Output)

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-01	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	10.50	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	8.00	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	15.00	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	500.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	13.0	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	11.7	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	5.9	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	12.4	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-01	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	24.00	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	13.5	-
Surcharge Height above Prop. Grade (ft):	9.0	-
Resultant Time to Consolidation:	4.5	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change + one log cycle of secondary comp.
@ % Surcharge Consolidation:	84%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	OKAY	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-01	-	
Surcharge Area/Point No:	-	-	
Coefficient of Secondary Compression, C_{α}	0.02	Marsh	(C_{α} expressed by change in strain per log cycle of time)
Coefficient of Secondary Compression, C_{α}	0	N/A	(C_{α} expressed by change in strain per log cycle of time)
Est. Time to End of Primary Consolidation, t_p	0.5	Years	1.0 No. of log cycles
Secondary Compression Design Time, t_{sec}	5.0	Years	
Est. Secondary Compression (inches):	2.9	Marsh	
Est. Secondary Compression (inches):	0.0	N/A	

Method from NAVFAC DM 7.1-231: $H_{sec} = C_{\alpha} * H_t * \log (t_{sec}/t_p)$

Where: H_{sec} = Secondary compression
H_t = Thickness of soil stratum

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-01**	
Existing Grade:	10.5	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	8.0	feet bgs
Tot./Eff. Stress @ GWT =	920.0	psf

Analysis Point/Location:	**GB-01**	
Proposed Grade:	15.00	feet
Grade Change:	4.5	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	562.5	psf
Δ Stress (Bldg. Loading):	500.0	psf

Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

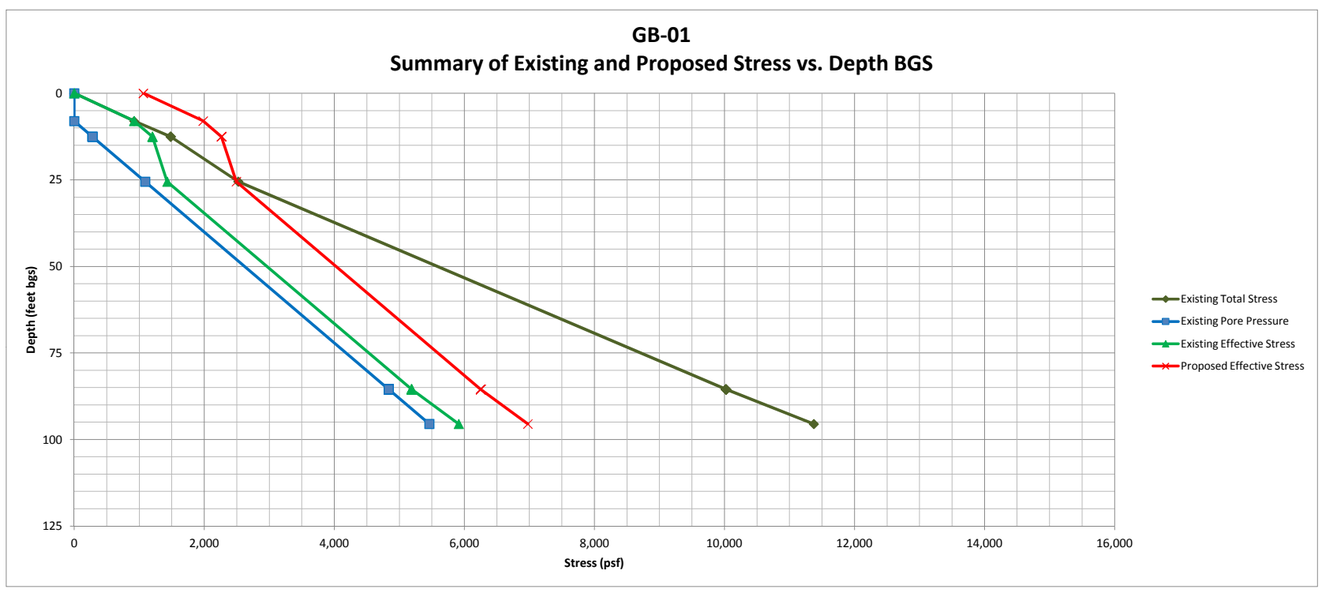
Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
Stratum	Top	Bottom		γ_t or γ_{sat}	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle
	(ft bgs)	(ft bgs)	(ft)	(pcf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)
		0.0	0.0			0.0			0.0			0.0			1062.5	
F-Unsat	0.0	8.0	8.0	115	0.0	920.0	460.0	0.0	0.0	0.0	0.0	920.0	460.0	1062.5	1982.5	1522.5
F-Satur	8.0	12.5	4.5	125	920.0	1482.5	1201.3	0.0	280.8	140.4	920.0	1201.7	1060.9	1982.5	2264.2	2123.4
-	12.5	12.5	0.0	110	1482.5	1482.5	1482.5	280.8	280.8	280.8	1201.7	1201.7	1201.7	2264.2	2264.2	2264.2
-	12.5	12.5	0.0	120	1482.5	1482.5	1482.5	280.8	280.8	280.8	1201.7	1201.7	1201.7	2264.2	2264.2	2264.2
Marsh	12.5	25.5	13.0	80	1482.5	2522.5	2002.5	280.8	1092.0	686.4	1201.7	1430.5	1316.1	2264.2	2493.0	2378.6
Fluvial	25.5	85.5	60.0	125	2522.5	10022.5	6272.5	1092.0	4836.0	2964.0	1430.5	5186.5	3308.5	2493.0	6249.0	4371.0
-	85.5	85.5	0.0	125	10022.5	10022.5	10022.5	4836.0	4836.0	4836.0	5186.5	5186.5	5186.5	6249.0	6249.0	6249.0
-	85.5	85.5	0.0	120	10022.5	10022.5	10022.5	4836.0	4836.0	4836.0	5186.5	5186.5	5186.5	6249.0	6249.0	6249.0
-	85.5	85.5	0.0	125	10022.5	10022.5	10022.5	4836.0	4836.0	4836.0	5186.5	5186.5	5186.5	6249.0	6249.0	6249.0
-	85.5	85.5	0.0	120	10022.5	10022.5	10022.5	4836.0	4836.0	4836.0	5186.5	5186.5	5186.5	6249.0	6249.0	6249.0
-	85.5	85.5	0.0	125	10022.5	10022.5	10022.5	4836.0	4836.0	4836.0	5186.5	5186.5	5186.5	6249.0	6249.0	6249.0
-	85.5	85.5	0.0	120	10022.5	10022.5	10022.5	4836.0	4836.0	4836.0	5186.5	5186.5	5186.5	6249.0	6249.0	6249.0
-	85.5	85.5	0.0	125	10022.5	10022.5	10022.5	4836.0	4836.0	4836.0	5186.5	5186.5	5186.5	6249.0	6249.0	6249.0
-	85.5	85.5	0.0	120	10022.5	10022.5	10022.5	4836.0	4836.0	4836.0	5186.5	5186.5	5186.5	6249.0	6249.0	6249.0
-	85.5	85.5	0.0	125	10022.5	10022.5	10022.5	4836.0	4836.0	4836.0	5186.5	5186.5	5186.5	6249.0	6249.0	6249.0
-	85.5	85.5	0.0	120	10022.5	10022.5	10022.5	4836.0	4836.0	4836.0	5186.5	5186.5	5186.5	6249.0	6249.0	6249.0
Till	85.5	95.5	10.0	135	10022.5	11372.5	10697.5	4836.0	5460.0	5148.0	5186.5	5912.5	5549.5	6249.0	6975.0	6612.0

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date: TCC 04-2013

Checked By/Date:



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-01**	
Proposed Grade:	15.0	feet
Grade Change:	4.5	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	562.5	psf
Δ Stress (Bldg. Loading):	500.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(Due to Proposed Grade Change) (inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	1.50	-	-	-
F-Satur	1.0	0.03	-	-	0.49	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.35	0.07	0.20	10.58	6.5	0.848	179.1
Fluvial	2.0	0.02	0.01	10.00	0.44	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					13.00			

Estimated Settlement @ 90% Consolidation
(inches)
11.70

Days	**179.1**
Months	**5.9**
Years	**0.5**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 13.0 ft

Assume Double Drainage of the "Composite" Layer
H_{dr} = 6.5 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**179.1**
Months	**5.9**
Years	**0.5**

SUMMARY OF SURCHARGE ASSESSMENT

Analysis Point/Location:	**GB-01**	
Proposed Surcharge Grade:	24.0	feet
Grade Change:	13.5	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Surcharge):	1687.5	psf

Surcharge Grade Conditions				Surcharge Assessment			
Primary Stratum	Effective Stress			Settlement		Req. Surcharge Consol.	Resulting T
	Top (psf)	Bottom (psf)	Middle (psf)	Proposed Grade (100%) Primary + Secondary (inches)	Surcharge Grade (100%) Primary Only (inches)	(%)	
-		1687.5		-	-	-	-
F-Unsat	1687.5	2607.5	2147.5	1.50	1.93	77.7%	-
F-Satur	2607.5	2889.2	2748.4	0.49	0.67	72.9%	-
-	2889.2	2889.2	2889.2	0.00	0.00	0.0%	-
-	2889.2	2889.2	2889.2	0.00	0.00	0.0%	-
Marsh	2889.2	3118.0	3003.6	13.48	16.11	83.7%	-
Fluvial	3118.0	6874.0	4996.0	0.44	0.64	-	-
-	6874.0	6874.0	6874.0	-	-	-	-
-	6874.0	6874.0	6874.0	0.00	0.00	0.0%	-
-	6874.0	6874.0	6874.0	-	-	-	-
-	6874.0	6874.0	6874.0	0.00	0.00	0.0%	-
-	6874.0	6874.0	6874.0	-	-	-	-
-	6874.0	6874.0	6874.0	0.00	0.00	0.0%	-
-	6874.0	6874.0	6874.0	-	-	-	-
-	6874.0	6874.0	6874.0	0.00	0.00	0.0%	-
-	6874.0	6874.0	6874.0	-	-	-	-
-	6874.0	6874.0	6874.0	0.00	0.00	0.0%	-
Till	6874.0	7600.0	7237.0	-	-	-	-
				15.90	**19.35**	**83.7%**	**0.650**

For Double Drainage Valid		Otherwise, Comp. D & O
137.4	**Days**	**137.4**
4.5	**Months**	**4.5**
0.4	**Years**	**0.4**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? YES

If answer to double drainage question = "YES", refer to the values above left for the estimated time to surcharge consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below (and above right) for the estimated time to surcharge consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)

(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 13 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 6.5 ft

T = 0.650 @ above surcharge consol.

Calculate Time, t, in days to Surcharge Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**137.4**
Months	**4.5**
Years	**0.4**

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-03	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	9.50	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	7.00	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	15.00	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	500.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	13.1	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	11.8	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	5.3	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	11.2	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-03	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	24.00	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	14.5	-
Surcharge Height above Prop. Grade (ft):	9.0	-
Resultant Time to Consolidation:	4.5	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change + one log cycle of secondary comp.
@ % Surcharge Consolidation:	86%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	OKAY	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-03	-	
Surcharge Area/Point No:	-	-	
Coefficient of Secondary Compression, C_{α}	0.01	Marsh	(Cα expressed by change in strain per log cycle of time)
Coefficient of Secondary Compression, C_{α}	0	N/A	(Cα expressed by change in strain per log cycle of time)
Est. Time to End of Primary Consolidation, t_p	0.5	Years	
Secondary Compression Design Time, t_{sec}	5.0	Years	1.0 No. of log cycles
Method from NAVFAC DM 7.1-231:	$H_{sec} = C\alpha * H_t * \log (t_{sec}/t_p)$		Where: H_{sec} = Secondary compression; H_t = Thickness of soil stratum
Est. Secondary Compression (inches):	2.0	Marsh	
Est. Secondary Compression (inches):	0.0	N/A	

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-03**	
Existing Grade:	9.5	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	7.0	feet bgs
Tot./Eff. Stress @ GWT =	805.0	psf

Analysis Point/Location:	**GB-03**	
Proposed Grade:	15.00	feet
Grade Change:	5.5	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	687.5	psf
Δ Stress (Bldg. Loading):	500.0	psf

Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

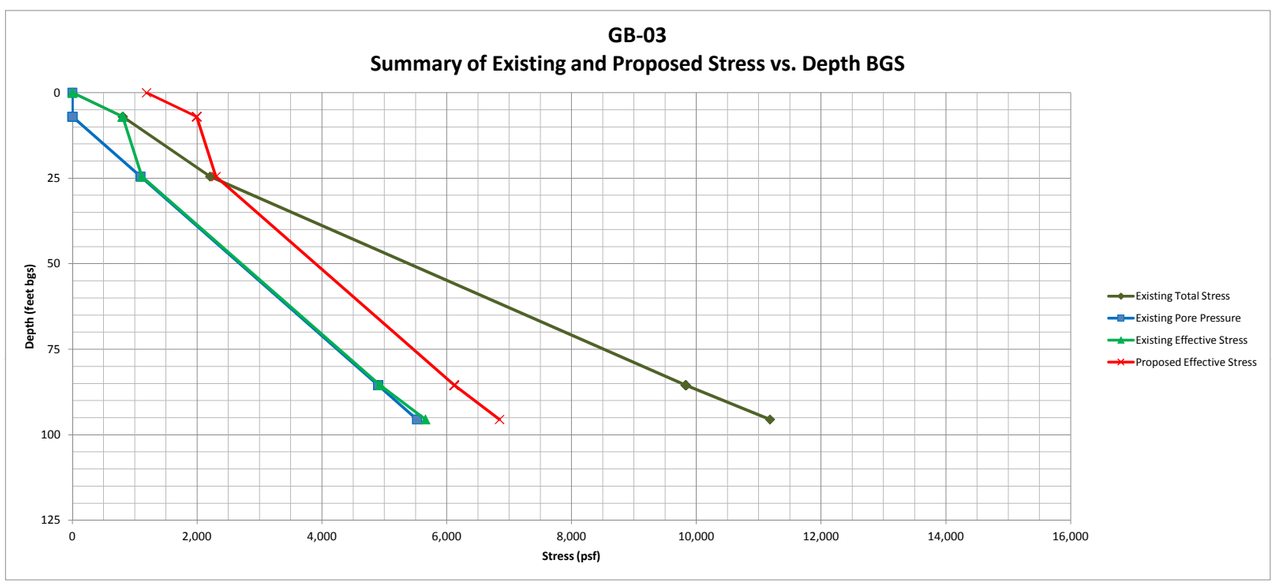
Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
Stratum	Top	Bottom		γ_t or γ_{sat}	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle
	(ft bgs)	(ft bgs)	(ft)	(pcf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)
		0.0	0.0			0.0			0.0			0.0			1187.5	
F-Unsat	0.0	7.0	7.0	115	0.0	805.0	402.5	0.0	0.0	0.0	0.0	805.0	402.5	1187.5	1992.5	1590.0
F-Satur	7.0	7.0	0.0	125	805.0	805.0	805.0	0.0	0.0	0.0	805.0	805.0	805.0	1992.5	1992.5	1992.5
-	7.0	7.0	0.0	110	805.0	805.0	805.0	0.0	0.0	0.0	805.0	805.0	805.0	1992.5	1992.5	1992.5
-	7.0	7.0	0.0	120	805.0	805.0	805.0	0.0	0.0	0.0	805.0	805.0	805.0	1992.5	1992.5	1992.5
Marsh	7.0	24.5	17.5	80	805.0	2205.0	1505.0	0.0	1092.0	546.0	805.0	1113.0	959.0	1992.5	2300.5	2146.5
Fluvial	24.5	85.5	61.0	125	2205.0	9830.0	6017.5	1092.0	4898.4	2995.2	1113.0	4931.6	3022.3	2300.5	6119.1	4209.8
-	85.5	85.5	0.0	125	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	6119.1	6119.1	6119.1
-	85.5	85.5	0.0	120	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	6119.1	6119.1	6119.1
-	85.5	85.5	0.0	125	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	6119.1	6119.1	6119.1
-	85.5	85.5	0.0	120	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	6119.1	6119.1	6119.1
-	85.5	85.5	0.0	125	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	6119.1	6119.1	6119.1
-	85.5	85.5	0.0	120	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	6119.1	6119.1	6119.1
-	85.5	85.5	0.0	125	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	6119.1	6119.1	6119.1
-	85.5	85.5	0.0	120	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	6119.1	6119.1	6119.1
Till	85.5	95.5	10.0	135	9830.0	11180.0	10505.0	4898.4	5522.4	5210.4	4931.6	5657.6	5294.6	6119.1	6845.1	6482.1

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date: TCC 04-2013

Checked By/Date:



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-03**	
Proposed Grade:	15.0	feet
Grade Change:	5.5	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	687.5	psf
Δ Stress (Bldg. Loading):	500.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(Due to Proposed Grade Change) (inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	1.50	-	-	-
F-Satur	1.0	0.03	-	-	0.00	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.18	0.07	0.40	11.11	8.8	0.848	162.3
Fluvial	2.0	0.02	0.01	10.00	0.53	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					13.14			

Estimated Settlement @ 90% Consolidation
(inches)
11.83

Days	**162.3**
Months	**5.3**
Years	**0.4**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 17.5 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 8.8 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**162.3**
Months	**5.3**
Years	**0.4**

SUMMARY OF SURCHARGE ASSESSMENT

Analysis Point/Location:	**GB-03**	
Proposed Surcharge Grade:	24.0	feet
Grade Change:	14.5	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Surcharge):	1812.5	psf

Surcharge Grade Conditions				Surcharge Assessment			
Primary Stratum	Effective Stress			Settlement		Req. Surcharge Consol.	Resulting T
	Top (psf)	Bottom (psf)	Middle (psf)	Proposed Grade (100%) Primary + Secondary (inches)	Surcharge Grade (100%) Primary Only (inches)	(%)	
-		1812.5		-	-	-	-
F-Unsat	1812.5	2617.5	2215.0	1.50	1.87	80.6%	-
F-Satur	2617.5	2617.5	2617.5	0.00	0.00	0.0%	-
-	2617.5	2617.5	2617.5	0.00	0.00	0.0%	-
-	2617.5	2617.5	2617.5	0.00	0.00	0.0%	-
Marsh	2617.5	2925.5	2771.5	13.10	15.19	86.2%	-
Fluvial	2925.5	6744.1	4834.8	0.53	0.75	-	-
-	6744.1	6744.1	6744.1	-	-	-	-
-	6744.1	6744.1	6744.1	0.00	0.00	0.0%	-
-	6744.1	6744.1	6744.1	-	-	-	-
-	6744.1	6744.1	6744.1	0.00	0.00	0.0%	-
-	6744.1	6744.1	6744.1	-	-	-	-
-	6744.1	6744.1	6744.1	0.00	0.00	0.0%	-
-	6744.1	6744.1	6744.1	-	-	-	-
-	6744.1	6744.1	6744.1	0.00	0.00	0.0%	-
-	6744.1	6744.1	6744.1	-	-	-	-
-	6744.1	6744.1	6744.1	0.00	0.00	0.0%	-
Till	6744.1	7470.1	7107.1	-	-	-	-
				15.13	17.81	86.2%	0.719

For Double Drainage Valid		Otherwise, Comp. D & O
137.6	Days	137.6
4.5	Months	4.5
0.4	Years	0.4

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? YES

If answer to double drainage question = "YES", refer to the values above left for the estimated time to surcharge consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below (and above right) for the estimated time to surcharge consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)

(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 17.5 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 8.75 ft

T = 0.719 @ above surcharge consol.

Calculate Time, t, in days to Surcharge Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	137.6
Months	4.5
Years	0.4

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-05	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	11.00	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	8.50	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	15.00	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	500.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	8.5	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	7.7	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	2.2	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	4.7	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-05	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	22.00	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	11.0	-
Surcharge Height above Prop. Grade (ft):	7.0	-
Resultant Time to Consolidation:	3.0	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change + one log cycle of secondary comp.
@ % Surcharge Consolidation:	95%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	OKAY	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-05	-	
Surcharge Area/Point No:	-	-	
Coefficient of Secondary Compression, C_{α}	0.02	Marsh	(Cα expressed by change in strain per log cycle of time)
Coefficient of Secondary Compression, C_{α}	0	N/A	(Cα expressed by change in strain per log cycle of time)
Est. Time to End of Primary Consolidation, t_p	0.5	Years	
Secondary Compression Design Time, t_{sec}	5.0	Years	1.0 No. of log cycles

Method from NAVFAC DM 7.1-231: $H_{sec} = C\alpha * H_t * \log (t_{sec}/t_p)$

Where: H_{sec} = Secondary compression
H_t = Thickness of soil stratum

Est. Secondary Compression (inches):	1.8	Marsh
Est. Secondary Compression (inches):	0.0	N/A

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-05**	
Existing Grade:	11.0	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	8.5	feet bgs
Tot./Eff. Stress @ GWT =	977.5	psf

Analysis Point/Location:	**GB-05**	
Proposed Grade:	15.00	feet
Grade Change:	4.0	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	500.0	psf
Δ Stress (Bldg. Loading):	500.0	psf

Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

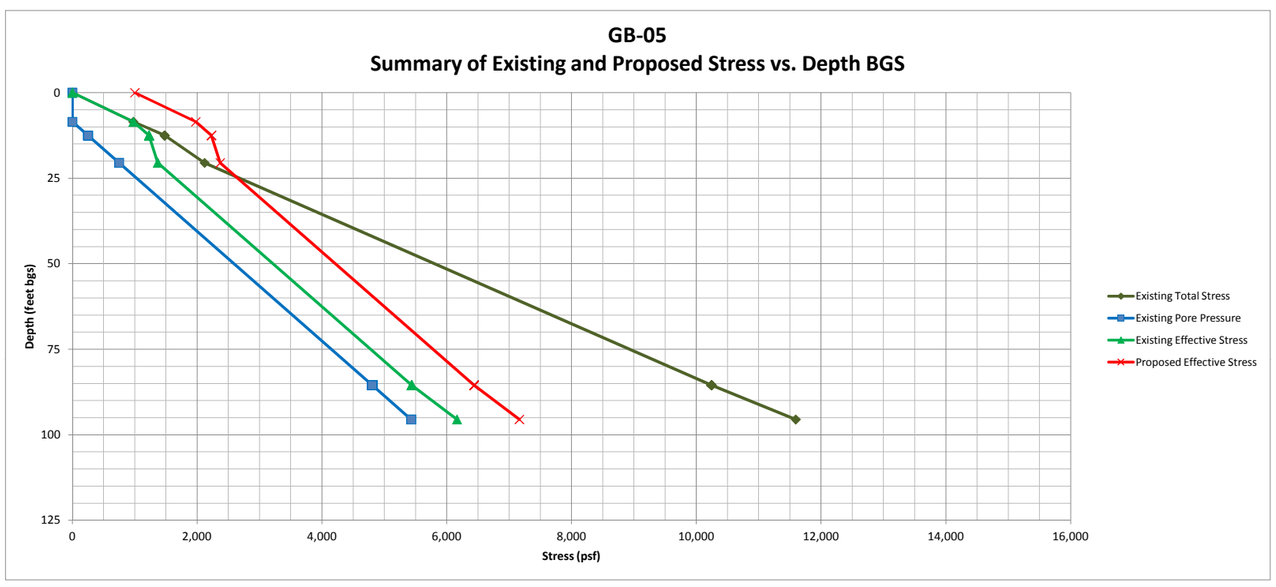
Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
Stratum	Top	Bottom		γ_t or γ_{sat}	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle
	(ft bgs)	(ft bgs)	(ft)	(pcf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)
		0.0	0.0			0.0			0.0			0.0			1000.0	
F-Unsat	0.0	8.5	8.5	115	0.0	977.5	488.8	0.0	0.0	0.0	0.0	977.5	488.8	1000.0	1977.5	1488.8
F-Satur	8.5	12.5	4.0	125	977.5	1477.5	1227.5	0.0	249.6	124.8	977.5	1227.9	1102.7	1977.5	2227.9	2102.7
-	12.5	12.5	0.0	110	1477.5	1477.5	1477.5	249.6	249.6	249.6	1227.9	1227.9	1227.9	2227.9	2227.9	2227.9
-	12.5	12.5	0.0	120	1477.5	1477.5	1477.5	249.6	249.6	249.6	1227.9	1227.9	1227.9	2227.9	2227.9	2227.9
Marsh	12.5	20.5	8.0	80	1477.5	2117.5	1797.5	249.6	748.8	499.2	1227.9	1368.7	1298.3	2227.9	2368.7	2298.3
Fluvial	20.5	85.5	65.0	125	2117.5	10242.5	6180.0	748.8	4804.8	2776.8	1368.7	5437.7	3403.2	2368.7	6437.7	4403.2
-	85.5	85.5	0.0	125	10242.5	10242.5	10242.5	4804.8	4804.8	4804.8	5437.7	5437.7	5437.7	6437.7	6437.7	6437.7
-	85.5	85.5	0.0	120	10242.5	10242.5	10242.5	4804.8	4804.8	4804.8	5437.7	5437.7	5437.7	6437.7	6437.7	6437.7
-	85.5	85.5	0.0	125	10242.5	10242.5	10242.5	4804.8	4804.8	4804.8	5437.7	5437.7	5437.7	6437.7	6437.7	6437.7
-	85.5	85.5	0.0	120	10242.5	10242.5	10242.5	4804.8	4804.8	4804.8	5437.7	5437.7	5437.7	6437.7	6437.7	6437.7
-	85.5	85.5	0.0	125	10242.5	10242.5	10242.5	4804.8	4804.8	4804.8	5437.7	5437.7	5437.7	6437.7	6437.7	6437.7
-	85.5	85.5	0.0	120	10242.5	10242.5	10242.5	4804.8	4804.8	4804.8	5437.7	5437.7	5437.7	6437.7	6437.7	6437.7
-	85.5	85.5	0.0	125	10242.5	10242.5	10242.5	4804.8	4804.8	4804.8	5437.7	5437.7	5437.7	6437.7	6437.7	6437.7
-	85.5	85.5	0.0	120	10242.5	10242.5	10242.5	4804.8	4804.8	4804.8	5437.7	5437.7	5437.7	6437.7	6437.7	6437.7
Till	85.5	95.5	10.0	135	10242.5	11592.5	10917.5	4804.8	5428.8	5116.8	5437.7	6163.7	5800.7	6437.7	7163.7	6800.7

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date: TCC 04-2013

Checked By/Date:



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-05**	
Proposed Grade:	15.0	feet
Grade Change:	4.0	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	500.0	psf
Δ Stress (Bldg. Loading):	500.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(Due to Proposed Grade Change) (inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	1.48	-	-	-
F-Satur	1.0	0.03	-	-	0.40	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.35	0.07	0.20	6.21	4.0	0.848	67.8
Fluvial	2.0	0.02	0.01	10.00	0.44	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					8.53			

Estimated Settlement @ 90% Consolidation
(inches)
7.67

Days	**67.8**
Months	**2.2**
Years	**0.2**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 8.0 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 4.0 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**67.8**
Months	**2.2**
Years	**0.2**

SUMMARY OF SURCHARGE ASSESSMENT

Analysis Point/Location:	**GB-05**	
Proposed Surcharge Grade:	22.0	feet
Grade Change:	11.0	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Surcharge):	1375.0	psf

Surcharge Grade Conditions				Surcharge Assessment			
Primary Stratum	Effective Stress			Settlement		Req. Surcharge Consol.	Resulting T
	Top (psf)	Bottom (psf)	Middle (psf)	Proposed Grade (100%) Primary + Secondary (inches)	Surcharge Grade (100%) Primary Only (inches)	(%)	
-		1375.0		-	-	-	-
F-Unsat	1375.0	2352.5	1863.8	1.48	1.78	83.2%	-
F-Satur	2352.5	2602.9	2477.7	0.40	0.51	79.7%	-
-	2602.9	2602.9	2602.9	0.00	0.00	0.0%	-
-	2602.9	2602.9	2602.9	0.00	0.00	0.0%	-
Marsh	2602.9	2743.7	2673.3	8.00	8.41	95.1%	-
Fluvial	2743.7	6812.7	4778.2	0.44	0.57	-	-
-	6812.7	6812.7	6812.7	-	-	-	-
-	6812.7	6812.7	6812.7	0.00	0.00	0.0%	-
-	6812.7	6812.7	6812.7	-	-	-	-
-	6812.7	6812.7	6812.7	0.00	0.00	0.0%	-
-	6812.7	6812.7	6812.7	-	-	-	-
-	6812.7	6812.7	6812.7	0.00	0.00	0.0%	-
-	6812.7	6812.7	6812.7	-	-	-	-
-	6812.7	6812.7	6812.7	0.00	0.00	0.0%	-
-	6812.7	6812.7	6812.7	-	-	-	-
-	6812.7	6812.7	6812.7	0.00	0.00	0.0%	-
Till	6812.7	7538.7	7175.7	-	-	-	-
				10.32	11.27	95.1%	1.140

For Double Drainage Valid		Otherwise, Comp. D & O
91.2	Days	91.2
3.0	Months	3.0
0.2	Years	0.2

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? YES

If answer to double drainage question = "YES", refer to the values above left for the estimated time to surcharge consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below (and above right) for the estimated time to surcharge consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)

(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 8 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 4 ft

T = 1.140 @ above surcharge consol.

Calculate Time, t, in days to Surcharge Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	91.2
Months	3.0
Years	0.2

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-06	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	8.50	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	6.00	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	15.00	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	0.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	9.0	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	8.1	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	2.5	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	5.3	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-06	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	15.50	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	7.0	-
Surcharge Height above Prop. Grade (ft):	0.5	-
Resultant Time to Consolidation:	3.0	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change.
@ % Surcharge Consolidation:	93%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	OKAY	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-06	-	
Surcharge Area/Point No:	-	-	
Coefficient of Secondary Compression, C_{α}	0.02	Marsh	(C_{α} expressed by change in strain per log cycle of time)
Coefficient of Secondary Compression, C_{α}	0	N/A	(C_{α} expressed by change in strain per log cycle of time)
Est. Time to End of Primary Consolidation, t_p	0.5	Years	1.0 No. of log cycles
Secondary Compression Design Time, t_{sec}	5.0	Years	

Method from NAVFAC DM 7.1-231: $H_{sec} = C_{\alpha} * H_t * \log (t_{sec}/t_p)$

Where: H_{sec} = Secondary compression
H_t = Thickness of soil stratum

Est. Secondary Compression (inches):	1.9	Marsh
Est. Secondary Compression (inches):	0.0	N/A

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-06**	
Existing Grade:	8.5	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	6.0	feet bgs
Tot./Eff. Stress @ GWT =	690.0	psf

Analysis Point/Location:	**GB-06**	
Proposed Grade:	15.00	feet
Grade Change:	6.5	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	812.5	psf
Δ Stress (Bldg. Loading):	0.0	psf

Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

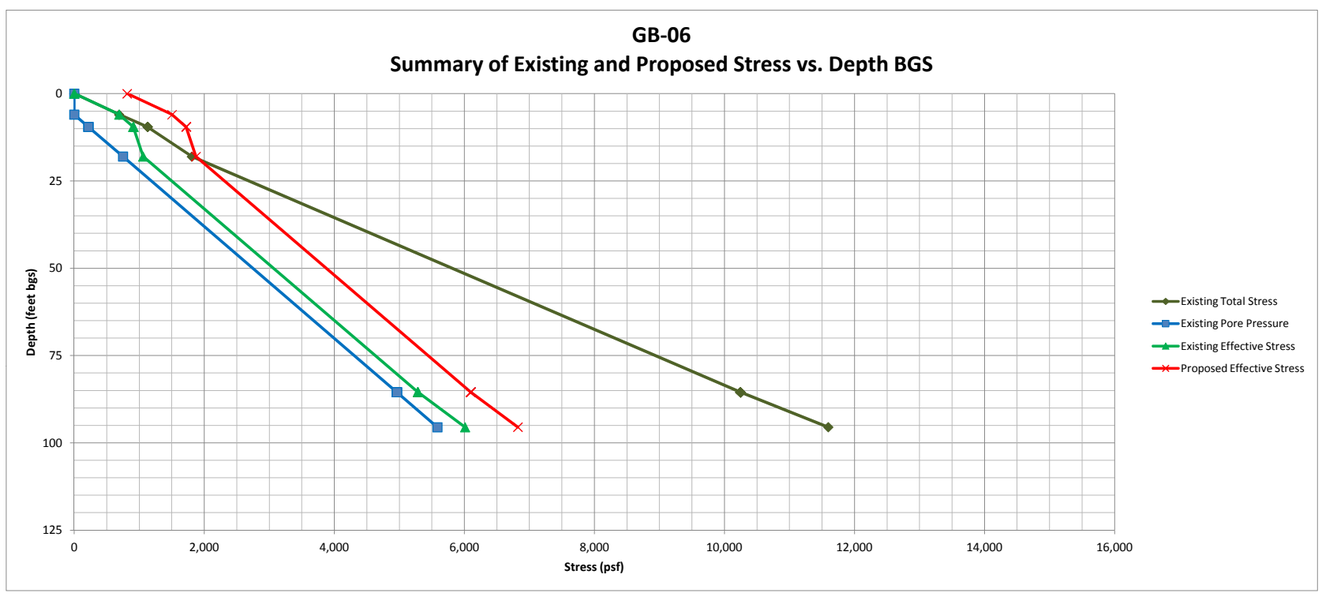
Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary Stratum	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
	Top (ft bgs)	Bottom (ft bgs)	(ft)	γ_t or γ_{sat} (pcf)	Top (psf)	Bottom (psf)	Middle (psf)	Top (psf)	Bottom (psf)	Middle (psf)	Top (psf)	Bottom (psf)	Middle (psf)	Top (psf)	Bottom (psf)	Middle (psf)
		0.0	0.0			0.0			0.0			0.0			812.5	
F-Unsat	0.0	6.0	6.0	115	0.0	690.0	345.0	0.0	0.0	0.0	0.0	690.0	345.0	812.5	1502.5	1157.5
F-Satur	6.0	9.5	3.5	125	690.0	1127.5	908.8	0.0	218.4	109.2	690.0	909.1	799.6	1502.5	1721.6	1612.1
-	9.5	9.5	0.0	110	1127.5	1127.5	1127.5	218.4	218.4	218.4	909.1	909.1	909.1	1721.6	1721.6	1721.6
-	9.5	9.5	0.0	120	1127.5	1127.5	1127.5	218.4	218.4	218.4	909.1	909.1	909.1	1721.6	1721.6	1721.6
Marsh	9.5	18.0	8.5	80	1127.5	1807.5	1467.5	218.4	748.8	483.6	909.1	1058.7	983.9	1721.6	1871.2	1796.4
Fluvial	18.0	85.5	67.5	125	1807.5	10245.0	6026.3	748.8	4960.8	2854.8	1058.7	5284.2	3171.5	1871.2	6096.7	3984.0
-	85.5	85.5	0.0	125	10245.0	10245.0	10245.0	4960.8	4960.8	4960.8	5284.2	5284.2	5284.2	6096.7	6096.7	6096.7
-	85.5	85.5	0.0	120	10245.0	10245.0	10245.0	4960.8	4960.8	4960.8	5284.2	5284.2	5284.2	6096.7	6096.7	6096.7
-	85.5	85.5	0.0	125	10245.0	10245.0	10245.0	4960.8	4960.8	4960.8	5284.2	5284.2	5284.2	6096.7	6096.7	6096.7
-	85.5	85.5	0.0	120	10245.0	10245.0	10245.0	4960.8	4960.8	4960.8	5284.2	5284.2	5284.2	6096.7	6096.7	6096.7
-	85.5	85.5	0.0	125	10245.0	10245.0	10245.0	4960.8	4960.8	4960.8	5284.2	5284.2	5284.2	6096.7	6096.7	6096.7
-	85.5	85.5	0.0	120	10245.0	10245.0	10245.0	4960.8	4960.8	4960.8	5284.2	5284.2	5284.2	6096.7	6096.7	6096.7
-	85.5	85.5	0.0	125	10245.0	10245.0	10245.0	4960.8	4960.8	4960.8	5284.2	5284.2	5284.2	6096.7	6096.7	6096.7
-	85.5	85.5	0.0	120	10245.0	10245.0	10245.0	4960.8	4960.8	4960.8	5284.2	5284.2	5284.2	6096.7	6096.7	6096.7
-	85.5	85.5	0.0	125	10245.0	10245.0	10245.0	4960.8	4960.8	4960.8	5284.2	5284.2	5284.2	6096.7	6096.7	6096.7
-	85.5	85.5	0.0	120	10245.0	10245.0	10245.0	4960.8	4960.8	4960.8	5284.2	5284.2	5284.2	6096.7	6096.7	6096.7
Till	85.5	95.5	10.0	135	10245.0	11595.0	10920.0	4960.8	5584.8	5272.8	5284.2	6010.2	5647.2	6096.7	6822.7	6459.7

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date: TCC 04-2013

Checked By/Date:



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-06**	
Proposed Grade:	15.0	feet
Grade Change:	6.5	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	812.5	psf
Δ Stress (Bldg. Loading):	0.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement (Due to Proposed Grade Change)	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	1.14	-	-	-
F-Satur	1.0	0.03	-	-	0.38	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.35	0.07	0.20	7.07	4.3	0.848	76.6
Fluvial	2.0	0.02	0.01	10.00	0.40	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					8.99			

Estimated Settlement @ 90% Consolidation
(inches)
8.09

Days	**76.6**
Months	**2.5**
Years	**0.2**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 8.5 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 4.3 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**76.6**
Months	**2.5**
Years	**0.2**

SUMMARY OF SURCHARGE ASSESSMENT

Analysis Point/Location:	**GB-06**	
Proposed Surcharge Grade:	15.5	feet
Grade Change:	7.0	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Surcharge):	875.0	psf

Surcharge Grade Conditions				Surcharge Assessment			
Primary Stratum	Effective Stress			Primary Consolidation Settlement		Req. Surcharge Consol.	Resulting T
	Top (psf)	Bottom (psf)	Middle (psf)	Proposed Grade (100%) (inches)	Surcharge Grade (100%) (inches)	(%)	
-		875.0		-	-	-	-
F-Unsat	875.0	1565.0	1220.0	1.14	1.18	95.8%	-
F-Satur	1565.0	1784.1	1674.6	0.38	0.40	94.9%	-
-	1784.1	1784.1	1784.1	0.00	0.00	0.0%	-
-	1784.1	1784.1	1784.1	0.00	0.00	0.0%	-
Marsh	1784.1	1933.7	1858.9	7.07	7.60	93.0%	-
Fluvial	1933.7	6159.2	4046.5	0.40	0.43	-	-
-	6159.2	6159.2	6159.2	-	-	-	-
-	6159.2	6159.2	6159.2	0.00	0.00	0.0%	-
-	6159.2	6159.2	6159.2	-	-	-	-
-	6159.2	6159.2	6159.2	0.00	0.00	0.0%	-
-	6159.2	6159.2	6159.2	-	-	-	-
-	6159.2	6159.2	6159.2	0.00	0.00	0.0%	-
-	6159.2	6159.2	6159.2	-	-	-	-
-	6159.2	6159.2	6159.2	0.00	0.00	0.0%	-
-	6159.2	6159.2	6159.2	-	-	-	-
-	6159.2	6159.2	6159.2	0.00	0.00	0.0%	-
Till	6159.2	6885.2	6522.2	-	-	-	-
				8.99	9.62	93.0%	0.994

For Double Drainage Valid		Otherwise, Comp. D & O
89.8	Days	89.8
3.0	Months	3.0
0.2	Years	0.2

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? YES

If answer to double drainage question = "YES", refer to the values above left for the estimated time to surcharge consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below (and above right) for the estimated time to surcharge consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)

(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 8.5 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 4.25 ft

T = 0.994 @ above surcharge consol.

Calculate Time, t, in days to Surcharge Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	89.8
Months	3.0
Years	0.2

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-07	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	7.50	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	4.50	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	15.00	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	500.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	17.3	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	15.6	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	5.0	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	10.5	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-07	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	24.00	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	16.5	-
Surcharge Height above Prop. Grade (ft):	9.0	-
Resultant Time to Consolidation:	4.8	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change + one log cycle of secondary comp.
@ % Surcharge Consolidation:	89%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	OKAY	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-07	-	
Surcharge Area/Point No:	-	-	
Coefficient of Secondary Compression, C_{α}	0.02	Marsh	(Cα expressed by change in strain per log cycle of time)
Coefficient of Secondary Compression, C_{α}	0	N/A	(Cα expressed by change in strain per log cycle of time)
Est. Time to End of Primary Consolidation, t_p	0.5	Years	
Secondary Compression Design Time, t_{sec}	5.0	Years	1.0 No. of log cycles
Est. Secondary Compression (inches):	2.6	Marsh	
Est. Secondary Compression (inches):	0.0	N/A	

Method from NAVFAC DM 7.1-231: $H_{sec} = C\alpha * H_t * \log (t_{sec}/t_p)$

Where: H_{sec} = Secondary compression
H_t = Thickness of soil stratum

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-07**	
Existing Grade:	7.5	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	4.5	feet bgs
Tot./Eff. Stress @ GWT =	517.5	psf

Analysis Point/Location:	**GB-07**	
Proposed Grade:	15.00	feet
Grade Change:	7.5	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	937.5	psf
Δ Stress (Bldg. Loading):	500.0	psf

Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

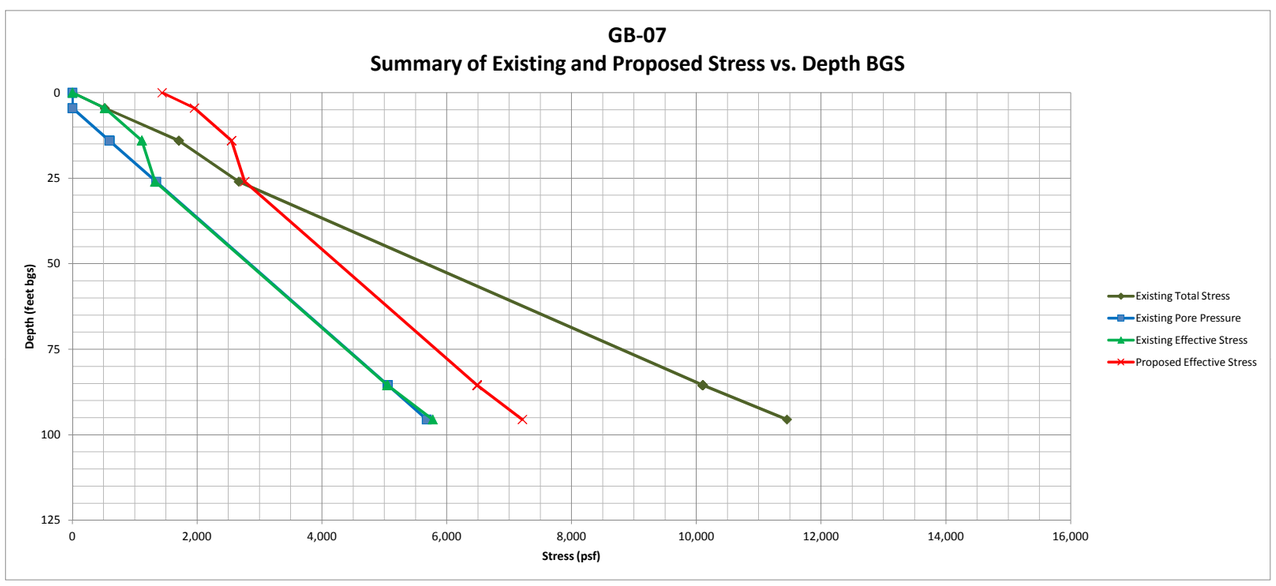
Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
Stratum	Top	Bottom		γ_t or γ_{sat}	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle
	(ft bgs)	(ft bgs)	(ft)	(pcf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)
		0.0	0.0			0.0			0.0			0.0			1437.5	
F-Unsat	0.0	4.5	4.5	115	0.0	517.5	258.8	0.0	0.0	0.0	0.0	517.5	258.8	1437.5	1955.0	1696.3
F-Satur	4.5	14.0	9.5	125	517.5	1705.0	1111.3	0.0	592.8	296.4	517.5	1112.2	814.9	1955.0	2549.7	2252.4
-	14.0	14.0	0.0	110	1705.0	1705.0	1705.0	592.8	592.8	592.8	1112.2	1112.2	1112.2	2549.7	2549.7	2549.7
-	14.0	14.0	0.0	120	1705.0	1705.0	1705.0	592.8	592.8	592.8	1112.2	1112.2	1112.2	2549.7	2549.7	2549.7
Marsh	14.0	26.0	12.0	80	1705.0	2665.0	2185.0	592.8	1341.6	967.2	1112.2	1323.4	1217.8	2549.7	2760.9	2655.3
Fluvial	26.0	85.5	59.5	125	2665.0	10102.5	6383.8	1341.6	5054.4	3198.0	1323.4	5048.1	3185.8	2760.9	6485.6	4623.3
-	85.5	85.5	0.0	125	10102.5	10102.5	10102.5	5054.4	5054.4	5054.4	5048.1	5048.1	5048.1	6485.6	6485.6	6485.6
-	85.5	85.5	0.0	120	10102.5	10102.5	10102.5	5054.4	5054.4	5054.4	5048.1	5048.1	5048.1	6485.6	6485.6	6485.6
-	85.5	85.5	0.0	125	10102.5	10102.5	10102.5	5054.4	5054.4	5054.4	5048.1	5048.1	5048.1	6485.6	6485.6	6485.6
-	85.5	85.5	0.0	120	10102.5	10102.5	10102.5	5054.4	5054.4	5054.4	5048.1	5048.1	5048.1	6485.6	6485.6	6485.6
-	85.5	85.5	0.0	125	10102.5	10102.5	10102.5	5054.4	5054.4	5054.4	5048.1	5048.1	5048.1	6485.6	6485.6	6485.6
-	85.5	85.5	0.0	120	10102.5	10102.5	10102.5	5054.4	5054.4	5054.4	5048.1	5048.1	5048.1	6485.6	6485.6	6485.6
-	85.5	85.5	0.0	125	10102.5	10102.5	10102.5	5054.4	5054.4	5054.4	5048.1	5048.1	5048.1	6485.6	6485.6	6485.6
-	85.5	85.5	0.0	120	10102.5	10102.5	10102.5	5054.4	5054.4	5054.4	5048.1	5048.1	5048.1	6485.6	6485.6	6485.6
Till	85.5	95.5	10.0	135	10102.5	11452.5	10777.5	5054.4	5678.4	5366.4	5048.1	5774.1	5411.1	6485.6	7211.6	6848.6

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date: TCC 04-2013

Checked By/Date:



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-07**	
Proposed Grade:	15.0	feet
Grade Change:	7.5	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	937.5	psf
Δ Stress (Bldg. Loading):	500.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(Due to Proposed Grade Change) (inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	1.32	-	-	-
F-Satur	1.0	0.03	-	-	1.51	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.35	0.07	0.20	13.87	6.0	0.848	152.6
Fluvial	2.0	0.02	0.01	10.00	0.58	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					17.28			

Estimated Settlement @ 90% Consolidation
(inches)
15.55

Days	**152.6**
Months	**5.0**
Years	**0.4**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 12.0 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 6.0 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**152.6**
Months	**5.0**
Years	**0.4**

SUMMARY OF SURCHARGE ASSESSMENT

Analysis Point/Location:	**GB-07**	
Proposed Surcharge Grade:	24.0	feet
Grade Change:	16.5	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Surcharge):	2062.5	psf

Surcharge Grade Conditions				Surcharge Assessment			
Primary Stratum	Effective Stress			Settlement		Req. Surcharge Consol.	Resulting T
	Top (psf)	Bottom (psf)	Middle (psf)	Proposed Grade (100%) Primary + Secondary (inches)	Surcharge Grade (100%) Primary Only (inches)	(%)	
-		2062.5		-	-	-	-
F-Unsat	2062.5	2580.0	2321.3	1.32	1.54	85.7%	-
F-Satur	2580.0	3174.7	2877.4	1.51	1.87	80.6%	-
-	3174.7	3174.7	3174.7	0.00	0.00	0.0%	-
-	3174.7	3174.7	3174.7	0.00	0.00	0.0%	-
Marsh	3174.7	3385.9	3280.3	16.47	18.50	89.1%	-
Fluvial	3385.9	7110.6	5248.3	0.58	0.77	-	-
-	7110.6	7110.6	7110.6	-	-	-	-
-	7110.6	7110.6	7110.6	0.00	0.00	0.0%	-
-	7110.6	7110.6	7110.6	-	-	-	-
-	7110.6	7110.6	7110.6	0.00	0.00	0.0%	-
-	7110.6	7110.6	7110.6	-	-	-	-
-	7110.6	7110.6	7110.6	0.00	0.00	0.0%	-
-	7110.6	7110.6	7110.6	-	-	-	-
-	7110.6	7110.6	7110.6	0.00	0.00	0.0%	-
-	7110.6	7110.6	7110.6	-	-	-	-
-	7110.6	7110.6	7110.6	0.00	0.00	0.0%	-
Till	7110.6	7836.6	7473.6	-	-	-	-
				19.88	22.69	89.1%	0.811

For Double Drainage Valid		Otherwise, Comp. D & O
146.1	Days	146.1
4.8	Months	4.8
0.4	Years	0.4

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? YES

If answer to double drainage question = "YES", refer to the values above left for the estimated time to surcharge consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below (and above right) for the estimated time to surcharge consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)

(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 12 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 6 ft

T = 0.811 @ above surcharge consol.

Calculate Time, t, in days to Surcharge Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	146.1
Months	4.8
Years	0.4

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-08	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	8.00	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	5.50	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	15.00	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	0.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	13.3	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	11.9	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	7.8	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	16.5	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-08	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	16.50	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	8.5	-
Surcharge Height above Prop. Grade (ft):	1.5	-
Resultant Time to Consolidation:	5.7	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change.
@ % Surcharge Consolidation:	82%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	OKAY	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-08	-	
Surcharge Area/Point No:	-	-	
Coefficient of Secondary Compression, C_{α}	0.02	Marsh	($C\alpha$ expressed by change in strain per log cycle of time)
Coefficient of Secondary Compression, C_{α}	0	N/A	($C\alpha$ expressed by change in strain per log cycle of time)
Est. Time to End of Primary Consolidation, t_p	0.5	Years	1.0 No. of log cycles
Secondary Compression Design Time, t_{sec}	5.0	Years	

Method from NAVFAC DM 7.1-231: $H_{sec} = C\alpha * H_t * \log (t_{sec}/t_p)$

Where: H_{sec} = Secondary compression
H_t = Thickness of soil stratum

Est. Secondary Compression (inches):	3.4	Marsh
Est. Secondary Compression (inches):	0.0	N/A

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-08**	
Existing Grade:	8.0	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	5.5	feet bgs
Tot./Eff. Stress @ GWT =	632.5	psf

Analysis Point/Location:	**GB-08**	
Proposed Grade:	15.00	feet
Grade Change:	7.0	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	875.0	psf
Δ Stress (Bldg. Loading):	0.0	psf

Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

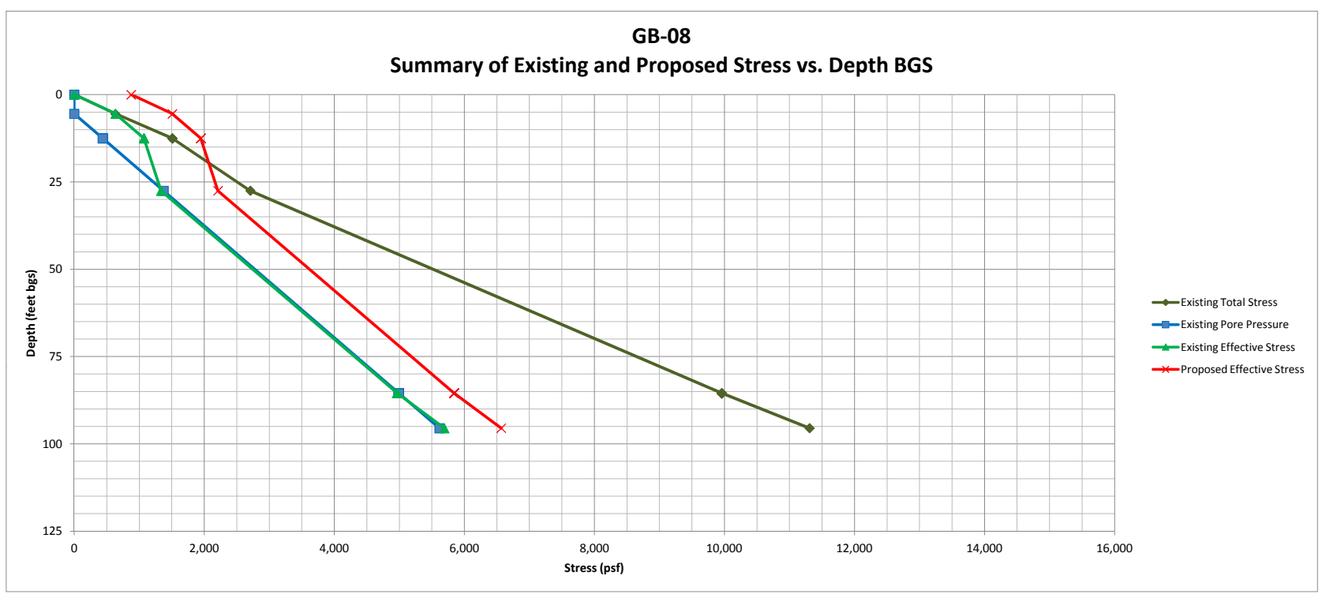
Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary Stratum	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
	Top (ft bgs)	Bottom (ft bgs)	(ft)	γ_t or γ_{sat} (pcf)	Top (psf)	Bottom (psf)	Middle (psf)	Top (psf)	Bottom (psf)	Middle (psf)	Top (psf)	Bottom (psf)	Middle (psf)	Top (psf)	Bottom (psf)	Middle (psf)
		0.0	0.0			0.0			0.0			0.0			875.0	
F-Unsat	0.0	5.5	5.5	115	0.0	632.5	316.3	0.0	0.0	0.0	0.0	632.5	316.3	875.0	1507.5	1191.3
F-Satur	5.5	12.5	7.0	125	632.5	1507.5	1070.0	0.0	436.8	218.4	632.5	1070.7	851.6	1507.5	1945.7	1726.6
-	12.5	12.5	0.0	110	1507.5	1507.5	1507.5	436.8	436.8	436.8	1070.7	1070.7	1070.7	1945.7	1945.7	1945.7
-	12.5	12.5	0.0	120	1507.5	1507.5	1507.5	436.8	436.8	436.8	1070.7	1070.7	1070.7	1945.7	1945.7	1945.7
Marsh	12.5	27.5	15.0	80	1507.5	2707.5	2107.5	436.8	1372.8	904.8	1070.7	1334.7	1202.7	1945.7	2209.7	2077.7
Fluvial	27.5	85.5	58.0	125	2707.5	9957.5	6332.5	1372.8	4992.0	3182.4	1334.7	4965.5	3150.1	2209.7	5840.5	4025.1
-	85.5	85.5	0.0	125	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5840.5	5840.5	5840.5
-	85.5	85.5	0.0	120	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5840.5	5840.5	5840.5
-	85.5	85.5	0.0	125	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5840.5	5840.5	5840.5
-	85.5	85.5	0.0	120	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5840.5	5840.5	5840.5
-	85.5	85.5	0.0	125	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5840.5	5840.5	5840.5
-	85.5	85.5	0.0	120	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5840.5	5840.5	5840.5
-	85.5	85.5	0.0	125	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5840.5	5840.5	5840.5
-	85.5	85.5	0.0	120	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5840.5	5840.5	5840.5
-	85.5	85.5	0.0	125	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5840.5	5840.5	5840.5
-	85.5	85.5	0.0	120	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5840.5	5840.5	5840.5
Till	85.5	95.5	10.0	135	9957.5	11307.5	10632.5	4992.0	5616.0	5304.0	4965.5	5691.5	5328.5	5840.5	6566.5	6203.5

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date: TCC 04-2013

Checked By/Date:



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-08**	
Proposed Grade:	15.0	feet
Grade Change:	7.0	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	875.0	psf
Δ Stress (Bldg. Loading):	0.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement (Due to Proposed Grade Change)	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	1.14	-	-	-
F-Satur	1.0	0.03	-	-	0.77	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.35	0.07	0.20	10.97	7.5	0.848	238.5
Fluvial	2.0	0.02	0.01	10.00	0.37	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					13.25			

Estimated Settlement @ 90% Consolidation
(inches)
11.93

Days	**238.5**
Months	**7.8**
Years	**0.7**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 15.0 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 7.5 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**238.5**
Months	**7.8**
Years	**0.7**

SUMMARY OF SURCHARGE ASSESSMENT

Analysis Point/Location:	**GB-08**	
Proposed Surcharge Grade:	16.5	feet
Grade Change:	8.5	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Surcharge):	1062.5	psf

Surcharge Grade Conditions				Surcharge Assessment			
Primary Stratum	Effective Stress			Primary Consolidation Settlement		Req. Surcharge Consol.	Resulting T
	Top (psf)	Bottom (psf)	Middle (psf)	Proposed Grade (100%) (inches)	Surcharge Grade (100%) (inches)	(%)	
-		1062.5		-	-	-	-
F-Unsat	1062.5	1695.0	1378.8	1.14	1.27	90.1%	-
F-Satur	1695.0	2133.2	1914.1	0.77	0.89	87.3%	-
-	2133.2	2133.2	2133.2	0.00	0.00	0.0%	-
-	2133.2	2133.2	2133.2	0.00	0.00	0.0%	-
Marsh	2133.2	2397.2	2265.2	10.97	13.33	82.3%	-
Fluvial	2397.2	6028.0	4212.6	0.37	0.44	-	-
-	6028.0	6028.0	6028.0	-	-	-	-
-	6028.0	6028.0	6028.0	0.00	0.00	0.0%	-
-	6028.0	6028.0	6028.0	-	-	-	-
-	6028.0	6028.0	6028.0	0.00	0.00	0.0%	-
-	6028.0	6028.0	6028.0	-	-	-	-
-	6028.0	6028.0	6028.0	0.00	0.00	0.0%	-
-	6028.0	6028.0	6028.0	-	-	-	-
-	6028.0	6028.0	6028.0	0.00	0.00	0.0%	-
-	6028.0	6028.0	6028.0	-	-	-	-
-	6028.0	6028.0	6028.0	0.00	0.00	0.0%	-
Till	6028.0	6754.0	6391.0	-	-	-	-
				13.25	15.92	82.3%	0.616

For Double Drainage Valid		Otherwise, Comp. D & O
173.2	Days	173.2
5.7	Months	5.7
0.5	Years	0.5

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? YES

If answer to double drainage question = "YES", refer to the values above left for the estimated time to surcharge consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below (and above right) for the estimated time to surcharge consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)

(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 15 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 7.5 ft

T = 0.616 @ above surcharge consol.

Calculate Time, t, in days to Surcharge Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	173.2
Months	5.7
Years	0.5

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-09	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	8.00	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	5.50	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	15.00	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	500.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	21.1	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	19.0	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	6.4	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	13.3	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-09	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	25.00	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	17.0	-
Surcharge Height above Prop. Grade (ft):	10.0	-
Resultant Time to Consolidation:	5.4	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change + one log cycle of secondary comp.
@ % Surcharge Consolidation:	86%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	OKAY	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-09	-		
Surcharge Area/Point No:	-	-		
Coefficient of Secondary Compression, C_{α}	0.02	Marsh	(Cα expressed by change in strain per log cycle of time)	
Coefficient of Secondary Compression, C_{α}	0	N/A	(Cα expressed by change in strain per log cycle of time)	
Est. Time to End of Primary Consolidation, t_p	0.5	Years	1.0	No. of log cycles
Secondary Compression Design Time, t_{sec}	5.0	Years		

Method from NAVFAC DM 7.1-231: $H_{sec} = C\alpha * H_t * \log (t_{sec}/t_p)$

Where: H_{sec} = Secondary compression
H_t = Thickness of soil stratum

Est. Secondary Compression (inches):	2.9	Marsh
Est. Secondary Compression (inches):	0.0	N/A

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-09**	
Existing Grade:	8.0	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	5.5	feet bgs
Tot./Eff. Stress @ GWT =	632.5	psf

Analysis Point/Location:	**GB-09**	
Proposed Grade:	15.00	feet
Grade Change:	7.0	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	875.0	psf
Δ Stress (Bldg. Loading):	500.0	psf

Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

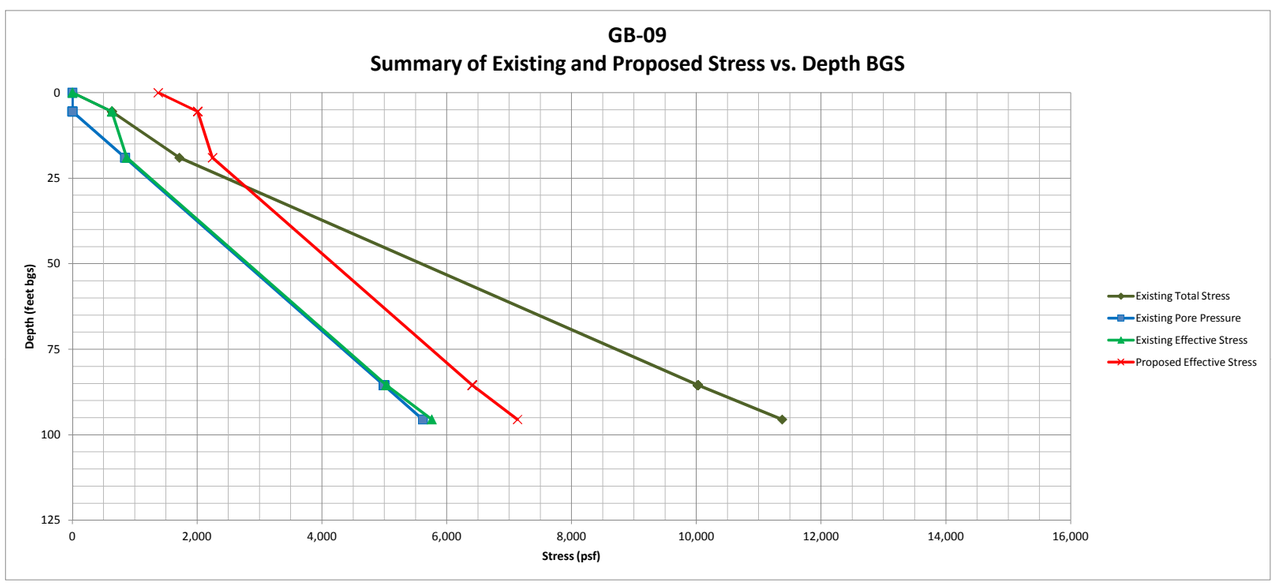
Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
Stratum	Top	Bottom		γ_t or γ_{sat}	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle
	(ft bgs)	(ft bgs)	(ft)	(pcf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)
		0.0	0.0			0.0			0.0			0.0			1375.0	
F-Unsat	0.0	5.5	5.5	115	0.0	632.5	316.3	0.0	0.0	0.0	0.0	632.5	316.3	1375.0	2007.5	1691.3
F-Satur	5.5	5.5	0.0	125	632.5	632.5	632.5	0.0	0.0	0.0	632.5	632.5	632.5	2007.5	2007.5	2007.5
-	5.5	5.5	0.0	110	632.5	632.5	632.5	0.0	0.0	0.0	632.5	632.5	632.5	2007.5	2007.5	2007.5
-	5.5	5.5	0.0	120	632.5	632.5	632.5	0.0	0.0	0.0	632.5	632.5	632.5	2007.5	2007.5	2007.5
Marsh	5.5	19.0	13.5	80	632.5	1712.5	1172.5	0.0	842.4	421.2	632.5	870.1	751.3	2007.5	2245.1	2126.3
Fluvial	19.0	85.5	66.5	125	1712.5	10025.0	5868.8	842.4	4992.0	2917.2	870.1	5033.0	2951.6	2245.1	6408.0	4326.6
-	85.5	85.5	0.0	125	10025.0	10025.0	10025.0	4992.0	4992.0	4992.0	5033.0	5033.0	5033.0	6408.0	6408.0	6408.0
-	85.5	85.5	0.0	120	10025.0	10025.0	10025.0	4992.0	4992.0	4992.0	5033.0	5033.0	5033.0	6408.0	6408.0	6408.0
-	85.5	85.5	0.0	125	10025.0	10025.0	10025.0	4992.0	4992.0	4992.0	5033.0	5033.0	5033.0	6408.0	6408.0	6408.0
-	85.5	85.5	0.0	120	10025.0	10025.0	10025.0	4992.0	4992.0	4992.0	5033.0	5033.0	5033.0	6408.0	6408.0	6408.0
-	85.5	85.5	0.0	125	10025.0	10025.0	10025.0	4992.0	4992.0	4992.0	5033.0	5033.0	5033.0	6408.0	6408.0	6408.0
-	85.5	85.5	0.0	120	10025.0	10025.0	10025.0	4992.0	4992.0	4992.0	5033.0	5033.0	5033.0	6408.0	6408.0	6408.0
-	85.5	85.5	0.0	125	10025.0	10025.0	10025.0	4992.0	4992.0	4992.0	5033.0	5033.0	5033.0	6408.0	6408.0	6408.0
-	85.5	85.5	0.0	120	10025.0	10025.0	10025.0	4992.0	4992.0	4992.0	5033.0	5033.0	5033.0	6408.0	6408.0	6408.0
Till	85.5	95.5	10.0	135	10025.0	11375.0	10700.0	4992.0	5616.0	5304.0	5033.0	5759.0	5396.0	6408.0	7134.0	6771.0

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date: TCC 04-2013

Checked By/Date:



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-09**	
Proposed Grade:	15.0	feet
Grade Change:	7.0	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	875.0	psf
Δ Stress (Bldg. Loading):	500.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(Due to Proposed Grade Change) (inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	1.44	-	-	-
F-Satur	1.0	0.03	-	-	0.00	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.30	0.07	0.20	19.01	6.8	0.848	193.2
Fluvial	2.0	0.02	0.01	10.00	0.66	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					21.11			

Estimated Settlement @ 90% Consolidation
(inches)
19.00

Days	**193.2**
Months	**6.4**
Years	**0.5**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 13.5 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 6.8 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**193.2**
Months	**6.4**
Years	**0.5**

SUMMARY OF SURCHARGE ASSESSMENT

Analysis Point/Location:	**GB-09**	
Proposed Surcharge Grade:	25.0	feet
Grade Change:	17.0	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Surcharge):	2125.0	psf

Surcharge Grade Conditions				Surcharge Assessment			
Primary Stratum	Effective Stress			Settlement		Req. Surcharge Consol.	Resulting T
	Top (psf)	Bottom (psf)	Middle (psf)	Proposed Grade (100%) Primary + Secondary (inches)	Surcharge Grade (100%) Primary Only (inches)	(%)	
-		2125.0		-	-	-	-
F-Unsat	2125.0	2757.5	2441.3	1.44	1.76	82.0%	-
F-Satur	2757.5	2757.5	2757.5	0.00	0.00	0.0%	-
-	2757.5	2757.5	2757.5	0.00	0.00	0.0%	-
-	2757.5	2757.5	2757.5	0.00	0.00	0.0%	-
Marsh	2757.5	2995.1	2876.3	21.87	25.38	86.1%	-
Fluvial	2995.1	7158.0	5076.6	0.66	0.94	-	-
-	7158.0	7158.0	7158.0	-	-	-	-
-	7158.0	7158.0	7158.0	0.00	0.00	0.0%	-
-	7158.0	7158.0	7158.0	-	-	-	-
-	7158.0	7158.0	7158.0	0.00	0.00	0.0%	-
-	7158.0	7158.0	7158.0	-	-	-	-
-	7158.0	7158.0	7158.0	0.00	0.00	0.0%	-
-	7158.0	7158.0	7158.0	-	-	-	-
-	7158.0	7158.0	7158.0	0.00	0.00	0.0%	-
-	7158.0	7158.0	7158.0	-	-	-	-
-	7158.0	7158.0	7158.0	0.00	0.00	0.0%	-
Till	7158.0	7884.0	7521.0	-	-	-	-
				23.97	28.08	86.1%	0.716

For Double Drainage Valid		Otherwise, Comp. D & O
163.1	Days	163.1
5.4	Months	5.4
0.4	Years	0.4

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? YES

If answer to double drainage question = "YES", refer to the values above left for the estimated time to surcharge consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below (and above right) for the estimated time to surcharge consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)

(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 13.5 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 6.75 ft

T = 0.716 @ above surcharge consol.

Calculate Time, t, in days to Surcharge Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	163.1
Months	5.4
Years	0.4

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-10	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	11.00	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	8.50	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	15.00	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	500.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	8.1	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	7.3	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	2.7	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	5.6	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-10	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	22.00	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	11.0	-
Surcharge Height above Prop. Grade (ft):	7.0	-
Resultant Time to Consolidation:	4.6	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change + one log cycle of secondary comp.
@ % Surcharge Consolidation:	98%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	OKAY	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-10	-	
Surcharge Area/Point No:	-	-	
Coefficient of Secondary Compression, C_{α}	0.02	Marsh	(Cα expressed by change in strain per log cycle of time)
Coefficient of Secondary Compression, C_{α}	0	N/A	(Cα expressed by change in strain per log cycle of time)
Est. Time to End of Primary Consolidation, t_p	0.5	Years	
Secondary Compression Design Time, t_{sec}	5.0	Years	1.0 No. of log cycles

Method from NAVFAC DM 7.1-231: $H_{sec} = C\alpha * H_t * \log (t_{sec}/t_p)$

Where: H_{sec} = Secondary compression
H_t = Thickness of soil stratum

Est. Secondary Compression (inches):	2.0	Marsh
Est. Secondary Compression (inches):	0.0	N/A

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-10**	
Existing Grade:	11.0	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	8.5	feet bgs
Tot./Eff. Stress @ GWT =	977.5	psf

Analysis Point/Location:	**GB-10**	
Proposed Grade:	15.00	feet
Grade Change:	4.0	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	500.0	psf
Δ Stress (Bldg. Loading):	500.0	psf

Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

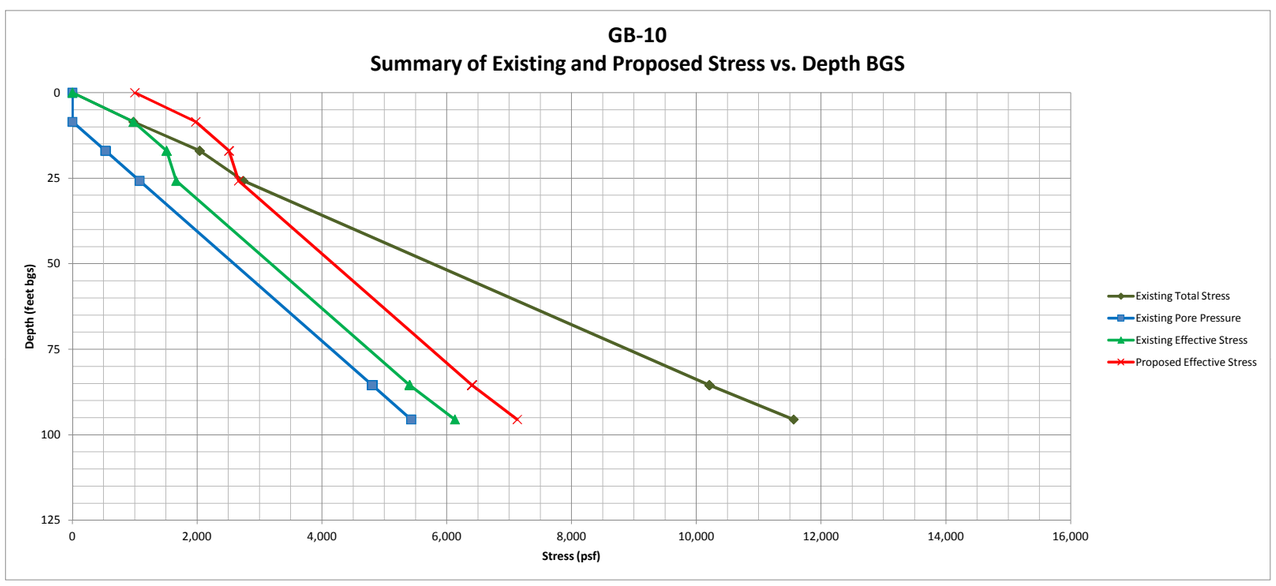
Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
Stratum	Top	Bottom		γ_t or γ_{sat}	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle
	(ft bgs)	(ft bgs)	(ft)	(pcf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)
		0.0	0.0			0.0			0.0			0.0			1000.0	
F-Unsat	0.0	8.5	8.5	115	0.0	977.5	488.8	0.0	0.0	0.0	0.0	977.5	488.8	1000.0	1977.5	1488.8
F-Satur	8.5	17.0	8.5	125	977.5	2040.0	1508.8	0.0	530.4	265.2	977.5	1509.6	1243.6	1977.5	2509.6	2243.6
-	17.0	17.0	0.0	110	2040.0	2040.0	2040.0	530.4	530.4	530.4	1509.6	1509.6	1509.6	2509.6	2509.6	2509.6
-	17.0	17.0	0.0	120	2040.0	2040.0	2040.0	530.4	530.4	530.4	1509.6	1509.6	1509.6	2509.6	2509.6	2509.6
Marsh	17.0	25.8	8.8	80	2040.0	2740.0	2390.0	530.4	1076.4	803.4	1509.6	1663.6	1586.6	2509.6	2663.6	2586.6
Fluvial	25.8	85.5	59.8	125	2740.0	10208.8	6474.4	1076.4	4804.8	2940.6	1663.6	5404.0	3533.8	2663.6	6404.0	4533.8
-	85.5	85.5	0.0	125	10208.8	10208.8	10208.8	4804.8	4804.8	4804.8	5404.0	5404.0	5404.0	6404.0	6404.0	6404.0
-	85.5	85.5	0.0	120	10208.8	10208.8	10208.8	4804.8	4804.8	4804.8	5404.0	5404.0	5404.0	6404.0	6404.0	6404.0
-	85.5	85.5	0.0	125	10208.8	10208.8	10208.8	4804.8	4804.8	4804.8	5404.0	5404.0	5404.0	6404.0	6404.0	6404.0
-	85.5	85.5	0.0	120	10208.8	10208.8	10208.8	4804.8	4804.8	4804.8	5404.0	5404.0	5404.0	6404.0	6404.0	6404.0
-	85.5	85.5	0.0	125	10208.8	10208.8	10208.8	4804.8	4804.8	4804.8	5404.0	5404.0	5404.0	6404.0	6404.0	6404.0
-	85.5	85.5	0.0	120	10208.8	10208.8	10208.8	4804.8	4804.8	4804.8	5404.0	5404.0	5404.0	6404.0	6404.0	6404.0
-	85.5	85.5	0.0	125	10208.8	10208.8	10208.8	4804.8	4804.8	4804.8	5404.0	5404.0	5404.0	6404.0	6404.0	6404.0
-	85.5	85.5	0.0	120	10208.8	10208.8	10208.8	4804.8	4804.8	4804.8	5404.0	5404.0	5404.0	6404.0	6404.0	6404.0
Till	85.5	95.5	10.0	135	10208.8	11558.8	10883.8	4804.8	5428.8	5116.8	5404.0	6130.0	5767.0	6404.0	7130.0	6767.0

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date: TCC 04-2013

Checked By/Date:



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-10**	
Proposed Grade:	15.0	feet
Grade Change:	4.0	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	500.0	psf
Δ Stress (Bldg. Loading):	500.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(Due to Proposed Grade Change) (inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	1.48	-	-	-
F-Satur	1.0	0.03	-	-	0.78	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.35	0.07	0.20	5.47	4.4	0.848	81.2
Fluvial	2.0	0.02	0.01	10.00	0.39	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					8.13			

Estimated Settlement @ 90% Consolidation
(inches)
7.31

Days	**81.2**
Months	**2.7**
Years	**0.2**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 8.8 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 4.4 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**81.2**
Months	**2.7**
Years	**0.2**

SUMMARY OF SURCHARGE ASSESSMENT

Analysis Point/Location:	**GB-10**	
Proposed Surcharge Grade:	22.0	feet
Grade Change:	11.0	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Surcharge):	1375.0	psf

Surcharge Grade Conditions				Surcharge Assessment			
Primary Stratum	Effective Stress			Settlement		Req. Surcharge Consol.	Resulting T
	Top (psf)	Bottom (psf)	Middle (psf)	Proposed Grade (100%) Primary + Secondary (inches)	Surcharge Grade (100%) Primary Only (inches)	(%)	
-		1375.0		-	-	-	-
F-Unsat	1375.0	2352.5	1863.8	1.48	1.78	83.2%	-
F-Satur	2352.5	2884.6	2618.6	0.78	0.99	79.2%	-
-	2884.6	2884.6	2884.6	0.00	0.00	0.0%	-
-	2884.6	2884.6	2884.6	0.00	0.00	0.0%	-
Marsh	2884.6	3038.6	2961.6	7.46	7.63	97.8%	-
Fluvial	3038.6	6779.0	4908.8	0.39	0.51	-	-
-	6779.0	6779.0	6779.0	-	-	-	-
-	6779.0	6779.0	6779.0	0.00	0.00	0.0%	-
-	6779.0	6779.0	6779.0	-	-	-	-
-	6779.0	6779.0	6779.0	0.00	0.00	0.0%	-
-	6779.0	6779.0	6779.0	-	-	-	-
-	6779.0	6779.0	6779.0	0.00	0.00	0.0%	-
-	6779.0	6779.0	6779.0	-	-	-	-
-	6779.0	6779.0	6779.0	0.00	0.00	0.0%	-
-	6779.0	6779.0	6779.0	-	-	-	-
-	6779.0	6779.0	6779.0	0.00	0.00	0.0%	-
Till	6779.0	7505.0	7142.0	-	-	-	-
				10.12	10.91	97.8%	1.456

For Double Drainage Valid		Otherwise, Comp. D & O
139.3	Days	139.3
4.6	Months	4.6
0.4	Years	0.4

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? YES

If answer to double drainage question = "YES", refer to the values above left for the estimated time to surcharge consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below (and above right) for the estimated time to surcharge consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)

(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 8.75 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 4.375 ft

T = 1.456 @ above surcharge consol.

Calculate Time, t, in days to Surcharge Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	139.3
Months	4.6
Years	0.4

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-11	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	8.00	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	5.50	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	15.00	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	0.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	11.1	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	10.0	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	3.5	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	7.3	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-11	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	15.50	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	7.5	-
Surcharge Height above Prop. Grade (ft):	0.5	-
Resultant Time to Consolidation:	4.3	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change.
@ % Surcharge Consolidation:	94%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	OKAY	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-11	-	
Surcharge Area/Point No:	-	-	
Coefficient of Secondary Compression, C_{α}	0.02	Marsh	(C_{α} expressed by change in strain per log cycle of time)
Coefficient of Secondary Compression, C_{α}	0	N/A	(C_{α} expressed by change in strain per log cycle of time)
Est. Time to End of Primary Consolidation, t_p	0.5	Years	1.0 No. of log cycles
Secondary Compression Design Time, t_{sec}	5.0	Years	

Method from NAVFAC DM 7.1-231: $H_{sec} = C_{\alpha} * H_t * \log (t_{sec}/t_p)$

Where: H_{sec} = Secondary compression
H_t = Thickness of soil stratum

Est. Secondary Compression (inches):	2.2	Marsh
Est. Secondary Compression (inches):	0.0	N/A

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-11**	
Existing Grade:	8.0	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	5.5	feet bgs
Tot./Eff. Stress @ GWT =	632.5	psf

Analysis Point/Location:	**GB-11**	
Proposed Grade:	15.00	feet
Grade Change:	7.0	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	875.0	psf
Δ Stress (Bldg. Loading):	0.0	psf

Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

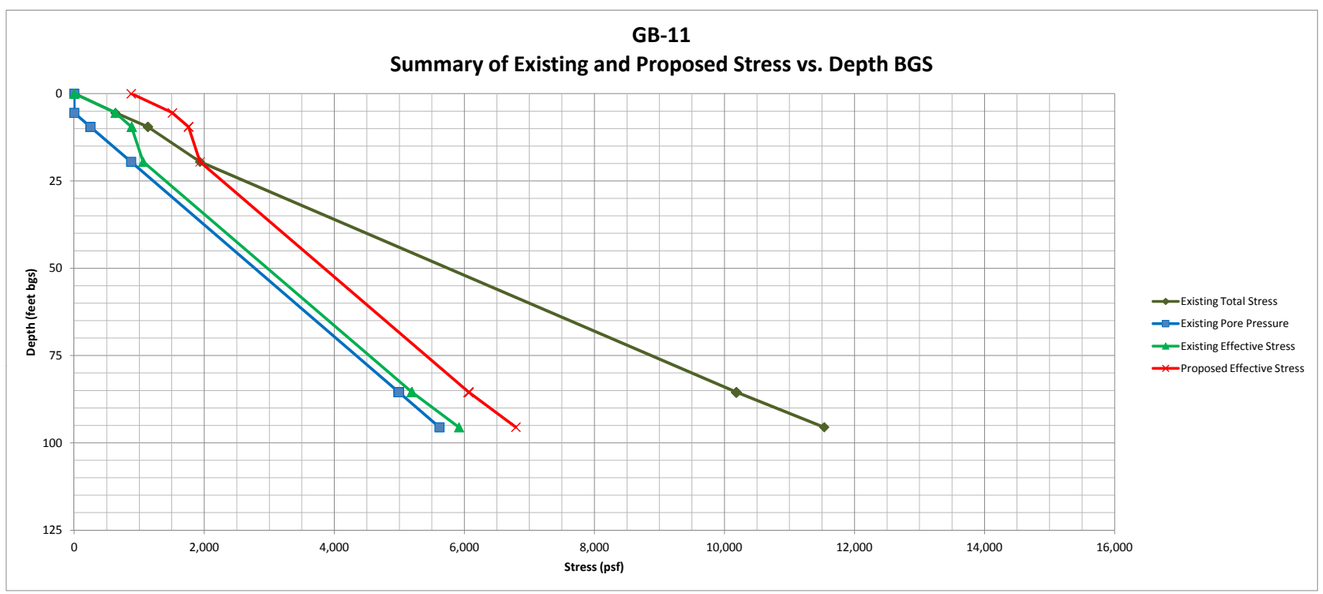
Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary Stratum	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
	Top (ft bgs)	Bottom (ft bgs)	(ft)	γ_t or γ_{sat} (pcf)	Top (psf)	Bottom (psf)	Middle (psf)	Top (psf)	Bottom (psf)	Middle (psf)	Top (psf)	Bottom (psf)	Middle (psf)	Top (psf)	Bottom (psf)	Middle (psf)
		0.0	0.0			0.0			0.0			0.0			875.0	
F-Unsat	0.0	5.5	5.5	115	0.0	632.5	316.3	0.0	0.0	0.0	0.0	632.5	316.3	875.0	1507.5	1191.3
F-Satur	5.5	9.5	4.0	125	632.5	1132.5	882.5	0.0	249.6	124.8	632.5	882.9	757.7	1507.5	1757.9	1632.7
-	9.5	9.5	0.0	110	1132.5	1132.5	1132.5	249.6	249.6	249.6	882.9	882.9	882.9	1757.9	1757.9	1757.9
-	9.5	9.5	0.0	120	1132.5	1132.5	1132.5	249.6	249.6	249.6	882.9	882.9	882.9	1757.9	1757.9	1757.9
Marsh	9.5	19.5	10.0	80	1132.5	1932.5	1532.5	249.6	873.6	561.6	882.9	1058.9	970.9	1757.9	1933.9	1845.9
Fluvial	19.5	85.5	66.0	125	1932.5	10182.5	6057.5	873.6	4992.0	2932.8	1058.9	5190.5	3124.7	1933.9	6065.5	3999.7
-	85.5	85.5	0.0	125	10182.5	10182.5	10182.5	4992.0	4992.0	4992.0	5190.5	5190.5	5190.5	6065.5	6065.5	6065.5
-	85.5	85.5	0.0	120	10182.5	10182.5	10182.5	4992.0	4992.0	4992.0	5190.5	5190.5	5190.5	6065.5	6065.5	6065.5
-	85.5	85.5	0.0	125	10182.5	10182.5	10182.5	4992.0	4992.0	4992.0	5190.5	5190.5	5190.5	6065.5	6065.5	6065.5
-	85.5	85.5	0.0	120	10182.5	10182.5	10182.5	4992.0	4992.0	4992.0	5190.5	5190.5	5190.5	6065.5	6065.5	6065.5
-	85.5	85.5	0.0	125	10182.5	10182.5	10182.5	4992.0	4992.0	4992.0	5190.5	5190.5	5190.5	6065.5	6065.5	6065.5
-	85.5	85.5	0.0	120	10182.5	10182.5	10182.5	4992.0	4992.0	4992.0	5190.5	5190.5	5190.5	6065.5	6065.5	6065.5
-	85.5	85.5	0.0	125	10182.5	10182.5	10182.5	4992.0	4992.0	4992.0	5190.5	5190.5	5190.5	6065.5	6065.5	6065.5
-	85.5	85.5	0.0	120	10182.5	10182.5	10182.5	4992.0	4992.0	4992.0	5190.5	5190.5	5190.5	6065.5	6065.5	6065.5
-	85.5	85.5	0.0	125	10182.5	10182.5	10182.5	4992.0	4992.0	4992.0	5190.5	5190.5	5190.5	6065.5	6065.5	6065.5
-	85.5	85.5	0.0	120	10182.5	10182.5	10182.5	4992.0	4992.0	4992.0	5190.5	5190.5	5190.5	6065.5	6065.5	6065.5
Till	85.5	95.5	10.0	135	10182.5	11532.5	10857.5	4992.0	5616.0	5304.0	5190.5	5916.5	5553.5	6065.5	6791.5	6428.5

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date: TCC 04-2013

Checked By/Date:



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-11**	
Proposed Grade:	15.0	feet
Grade Change:	7.0	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	875.0	psf
Δ Stress (Bldg. Loading):	0.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement (Due to Proposed Grade Change)	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	1.14	-	-	-
F-Satur	1.0	0.03	-	-	0.48	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.35	0.07	0.20	9.06	5.0	0.848	106.0
Fluvial	2.0	0.02	0.01	10.00	0.42	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					11.10			

Estimated Settlement @ 90% Consolidation
(inches)
9.99

Days	**106.0**
Months	**3.5**
Years	**0.3**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 10.0 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 5.0 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**106.0**
Months	**3.5**
Years	**0.3**

SUMMARY OF SURCHARGE ASSESSMENT

Analysis Point/Location:	**GB-11**	
Proposed Surcharge Grade:	15.5	feet
Grade Change:	7.5	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Surcharge):	937.5	psf

Surcharge Grade Conditions				Surcharge Assessment			
Primary Stratum	Effective Stress			Primary Consolidation Settlement		Req. Surcharge Consol.	Resulting T
	Top (psf)	Bottom (psf)	Middle (psf)	Proposed Grade (100%) (inches)	Surcharge Grade (100%) (inches)	(%)	
-		937.5		-	-	-	-
F-Unsat	937.5	1570.0	1253.8	1.14	1.18	96.3%	-
F-Satur	1570.0	1820.4	1695.2	0.48	0.50	95.3%	-
-	1820.4	1820.4	1820.4	0.00	0.00	0.0%	-
-	1820.4	1820.4	1820.4	0.00	0.00	0.0%	-
Marsh	1820.4	1996.4	1908.4	9.06	9.67	93.7%	-
Fluvial	1996.4	6128.0	4062.2	0.42	0.45	-	-
-	6128.0	6128.0	6128.0	-	-	-	-
-	6128.0	6128.0	6128.0	0.00	0.00	0.0%	-
-	6128.0	6128.0	6128.0	-	-	-	-
-	6128.0	6128.0	6128.0	0.00	0.00	0.0%	-
-	6128.0	6128.0	6128.0	-	-	-	-
-	6128.0	6128.0	6128.0	0.00	0.00	0.0%	-
-	6128.0	6128.0	6128.0	-	-	-	-
-	6128.0	6128.0	6128.0	0.00	0.00	0.0%	-
-	6128.0	6128.0	6128.0	-	-	-	-
-	6128.0	6128.0	6128.0	0.00	0.00	0.0%	-
Till	6128.0	6854.0	6491.0	-	-	-	-
				11.10	11.81	93.7%	1.036

For Double Drainage Valid		Otherwise, Comp. D & O
129.5	Days	129.5
4.3	Months	4.3
0.4	Years	0.4

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? YES

If answer to double drainage question = "YES", refer to the values above left for the estimated time to surcharge consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below (and above right) for the estimated time to surcharge consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)

(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 10 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 5 ft

T = 1.036 @ above surcharge consol.

Calculate Time, t, in days to Surcharge Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	129.5
Months	4.3
Years	0.4

ATTACHMENT 3

EVALUATION OF CAP COMPONENTS

TENCATE Mirafi®

DRAINAGE

G100N G-Series Drainage Composite

G100N Drainage Composite is produced from a high compressive strength polystyrene core with a Mirafi® 140NC nonwoven filter geotextile bonded to one side.

Core Mechanical Properties	Test Method	Unit	Typical Roll Value
Thickness	ASTM D1777	in (mm)	0.4 (10.2)
Compressive Strength	ASTM D1621	psf (kPa)	18,000 (861)
Maximum Flow Rate[1]	ASTM D4716	gal/min/ft (l/min/m)	21 (260)
Installed Vertically Flow Rate[2]	ASTM D4716	gal/min/ft (l/min/m)	12.5 (155)
Installed Horizontally Flow Rate[3]	ASTM D4716	gal/min/ft (l/min/m)	2.4 (30)

[1] In plane flow rate at 173 kPa (3600 psf) with a gradient of 1.0
[2] Installed flow rate with soil overburden at a vertical gradient of 1.0
[3] Installed flow rate with soil overburden at a horizontal gradient of 0.05

Geotextile Mechanical Properties Mirafi® 140NC	Test Method	Unit	Typical Roll Value	
			MD	CD
Grab Tensile Strength	ASTM D4632	lbs (N)	111 (494)	111 (494)
CBR Puncture Strength	ASTM D6241	lbs (N)	337 (1500)	
Apparent Opening Size (AOS)	ASTM D4751	U.S. Sieve (mm)	70 (0.21)	
Permittivity	ASTM D4491	sec^{-1}	1.9	
Flow Rate	ASTM D4491	$gal/min/ft^2$ ($l/min/m^2$)	140 (5704)	

Physical Properties	Unit	Typical Value
Roll Dimensions (width x length)	ft (m)	4.0 x 50 (1.2 x 15.2)
Roll Area	ft^2 (m^2)	200 (18.6)
Estimated Roll Weight	lb (kg)	50 (23)

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FGS000537
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TENCATE™
materials that make a difference

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••• TENDER SPECIFICATION

GEONETS AND GEOCOMPOSITE DRAINAGE

1. The core of the Geocomposite Drainage Layer shall be manufactured by extruding three sets of high density polyethylene strands to form a triaxial void maintaining structure consisting of a thick vertical rib with diagonally placed top and bottom ribs. Under no circumstances shall the drainage core be formed either by the extrusion of a bi-planar net or the moulding or other process of cuspated cores.

2. The geotextile shall be non-woven needle-punched and thermo-calendared without resins or glues and manufactured from 100% polypropylene. The material shall be UV resistant and predicted to be durable for more than 25 years in natural soils with 4<ph<9 and soil temperature < 25°C (ENV 12224). When tested in accordance with PrEN ISO 13438 for Oxidisation, EN 14030, Chemical Resistance and EN 12225, Microbiological Resistance, the geotextiles shall retain a tensile strength greater than 90%.

3. The Geocomposite Drainage Layer rolls shall be identified in accordance with ISO 10320 Standard and manufactured in accordance with ISO 9001 Quality Assurance System. The Geocomposite shall be certified "**CE MARKING**" in accordance with the requirements of the following standards:

   EN 13249 Characteristics required for use in the construction of roads and other trafficked areas
   EN 13250 Characteristics required for use in the construction of railways
   EN 13251 Characteristics required for use in earthworks, foundations and retaining structures
   EN 13252 Characteristics required for use in drainage system
   EN 13254 Characteristics required for use in the construction of reservoirs and dams
   EN 13255 Characteristics required for use in the construction of canals
   EN 13257 Characteristics required for use in solid waste disposal
   EN 13265 Characteristics required for use in liquid waste containment projects

4. The Geocomposite drainage layer shall comply in full with the following specification:

TECHNICAL CHARACTERISTICS	TEST METHOD	UNIT	TENDRAIN 750/2	TENDRAIN 1000/2	TENDRAIN 1300/2	NOTES
THICKNESS	ISO 9863	mm	6.0	7.0	7.5	a
HYDRAULIC FLOW RATE						
i=1 σv = 20 kPa	ISO 12958	l/m/s	1.30	1.40	1.50	min
i=1 σv = 100 kPa	ISO 12958	l/m/s	1.10	1.20	1.30	min
i=1 σv = 200 kPa	ISO 12958	l/m/s	0.95	1.10	1.20	min
i=1 σv = 500 kPa	ISO 12958	l/m/s	0.65	0.80	0.90	min
TENSILE STRENGTH	ISO 10319	kN/m	20.0	25.0	28.0	min
ELONGATION AT PEAK	ISO 10319	%	50	60	60	min

0799-CPD-25

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GEOTEXTILE CHARACTERISTICS	TEST METHOD	UNIT	TENDRAIN 750/2	TENDRAIN 1000/2	TENDRAIN 1300/2	NOTES
MASS PER UNIT WEIGHT	ISO 9864	g/m²	120 – 140	120 – 140	120 – 140	mean
OPENING SIZE	ISO 12956	mm	0.08	0.08	0.08	mean

5. Creep reduction factor RFcr is determined from 10,000 hour compressive creep data. When the manufacturer of an alternative product is unable to supply such long term test data then an additional RF_{CR} of 1.5 will be applied to the values in table1.

Table 1: Extrapolated and Experimental Reduction Factor RF_{CR} from Compressive Creep Tests on Tenax GNT geonet (drainage core of Tenax Tendrain geocomposite series)

Product Core drainage	Pressure (kPa)	Reduction Factor for Creep (RF_{CR}) at 10000 hours (1 year)	Reduction Factor for Creep (RF_{CR}) at 30 years (extrapolated)	Reduction Factor for Creep (RF_{CR}) at 50 years (extrapolated)
TENAX GNT 750	100	1.23	1.3	1.31
TENAX GNT 750	200	1.06	1.11	1.12
TENAX GNT 750	500	1.07	1.24	1.26
TENAX GNT 1300	200	103	1.07	1.08
TENAX GNT 1300	500	1,2	1.3	1.32

Table 2: Extrapolated and Experimental Residual Thickness at 10'000 hours and 30 years from Compressive Creep Tests on Tenax GNT geonet (Core drainage of Tenax Tendrain geocomposite series)

Product Core drainage	Pressure (kPa)	Residual Thickness at 10000 hours (1 year) (%)	Residual Thickness at 30 years (extrapolated) (%)
TENAX GNT 750	100	87.50	86.20
TENAX GNT 750	200	82.60	81.50
TENAX GNT 750	500	70.70	68.10
TENAX GNT 1300	200	91.00	90.60
TENAX GNT 1300	500	81.00	79.50

6. For both MQC and CQA, transmissivity tests shall be conducted at the frequency of 1 test every 12,000 m². The normal compressive load shall be 20 – 100 – 200 – 500 kPa at a hydraulic gradients of 1.0 Testing boundary conditions from the top to bottom shall be: Upper steel load plate / Geomembrane / Geocomposite / Geomembrane / lower load plate.

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7. Manufacturers claiming equivalency using other manufacturers' product test data shall not be approved.

8. The Geocomposite Drainage Layer shall be inert to all chemicals naturally found in soils and shall have no solvents at ambient temperature. It shall not be susceptible to hydrolysis, shall be resistant to aqueous solutions of salts, acids and alkalis.

9. An approved supplier is Tenax SpA, Italy or their designated representative.

10. The submittal packages for alternate Geocomposite Drainage Layer materials must include:

    a) A list of 10 comparable projects that are similar in terms of size and application, and where the results of using the specific alternate material can be verified after a minimum of 5 years of service life.
    b) A sample alternate geocomposite material and independent certified specification sheets.
    c) A verified design, including drawings and calculations, prepared by a Registered Professional Civil Engineer, using the material reduction factors described above.

0799-CPD-25

TEXTURED LLDPE GEOMEMBRANE
ENGLISH UNITS

POLY-FLEX
POLYETHYLENE GEOMEMBRANES

Property	Test Method	Minimum Average Values 40 Mil	60 Mil	80 Mil
Thickness, mils	ASTM D 5994			
minimum average		38	57	76
lowest individual of 8 of 10 readings		36	54	72
lowest individual of 10 readings		34	51	68
Asperity Height[1], mils	ASTM D 7466	10	10	10
Sheet Density, g/cc (max.)	ASTM D 1505/D 792	0.939	0.939	0.939
Tensile Properties[2]	ASTM D 6693			
1. Break Strength, lb/in		60	90	120
2. Break Elongation, %		250	250	250
2% Modulus, lb/in^2 (max.)	ASTM D 5323	60,000	60,000	60,000
Tear Resistance, lb	ASTM D 1004	22	33	44
Puncture Resistance, lb	ASTM D 4833	44	66	88
Axi-Symetric Break Strain, %	ASTM D 5617	30	30	30
Carbon Black Content[3], %	ASTM D 1603	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596		--Note 4--	
Oxidative Induction Time (OIT) Standard OIT, minutes	ASTM D 3895	100	100	100
Oven Aging at 85°C	ASTM D 5721			
High Pressure OIT - % retained after 90 days	ASTM D 5885	60	60	60
UV Resistance[5]	GRI GM11			
High Pressure OIT[6] - % retained after 1600 hrs	ASTM D 5885	35	35	35
Seam Properties	ASTM D 6392 (@ 2 in/min)			
1. Shear Strength, lb/in		60	90	120
2. Peel Strength, lb/in - Hot Wedge		50	75	100
- Extrusion Fillet		44	66	88
Roll Dimensions				
1. Width (feet):		23	23	23
2. Length (feet):		750	500	375
3. Area (square feet):		17,250	11,500	8,625
4. Gross weight (pounds, approx.):		3,465	3,465	3,435

1 Of 10 readings; 8 must be ≥ 7 mils and lowest individual reading must be ≥ 5 mils.
2 Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction. Break elongation is calculated using a gauge length of 2.0 inches.
3 Other methods such as ASTM D 4218 or microwave methods are acceptable if an appropriate correlation can be established.
4 Carbon black dispersion for 10 different views: Nine in Categories 1 and 2 with one allowed in Category 3.
5 The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
6 UV resistance is based on percent retained value regardless of the original HP-OIT value.

This data is provided for informational purposes only and is not intended as a warranty or guarantee. Poly-Flex, Inc. assumes no responsibility in connection with the use of this data. These values are subject to change without notice. REV.06/09

POLY-FLEX
POLYETHYLENE GEOMEMBRANES

TEXTURED LLDPE GEOMEMBRANE METRIC UNITS

Property	Test Method	Minimum Average Values 1.00 mm	1.50 mm	2.00 mm
Thickness, microns	ASTM D 5994			
minimum average		950	1,425	1,900
lowest individual of 8 of 10 readings		900	1,350	1,800
lowest individual of 10 readings		850	1,275	1,700
Asperity Height[1], microns	ASTM D 7466	250	250	250
Sheet Density, g/cc (max.)	ASTM D 1505/D 792	0.939	0.939	0.939
Tensile Properties[2]	ASTM D 6693			
1. Break Strength, kN/m		11	16	21
2. Break Elongation, %		250	250	250
2% Modulus, MPa (max.)	ASTM D 5323	414	414	414
Tear Resistance, N	ASTM D 1004	100	150	200
Puncture Resistance, N	ASTM D 4833	200	300	400
Axi-Symetric Break Strain, %	ASTM D 5617	30	30	30
Carbon Black Content[3], %	ASTM D 1603	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596		--Note 4--	
Oxidative Induction Time (OIT)				
Standard OIT, minutes	ASTM D 3895	100	100	100
Oven Aging at 85°C	ASTM D 5721			
High Pressure OIT - % retained after 90 days	ASTM D 5885	60	60	60
UV Resistance[5]	GRI GM11			
High Pressure OIT[6] - % retained after 1600 hrs	ASTM D 5885	35	35	35
Seam Properties	ASTM D 6392 (@ 5 cm/min)			
1. Shear Strength, kN/m		10.5	15.8	21.0
2. Peel Strength, kN/m - Hot Wedge		8.7	13.1	17.5
- Extrusion Fillet		5.9	7.7	11.5
Roll Dimensions				
1. Width (meters):		7	7	7
2. Length (meters):		228.7	152.4	114.3
3. Area (square meters):		1,603	1,068	801
4. Gross weight (kilograms, approx.):		1,572	1,572	1,558

1 Of 10 readings; 8 must be ≥ 180 microns and lowest individual reading must be ≥ 130 microns.
2 Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction. Break elongation is calculated using a gauge length of 50 mm.
3 Other methods such as ASTM D 4218 or microwave methods are acceptable if an appropriate correlation can be established.
4 Carbon black dispersion for 10 different views: Nine in Categories 1 and 2 with one allowed in Category 3.
5 The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.
6 UV resistance is based on percent retained value regardless of the original HP-OIT value.

This data is provided for informational purposes only and is not intended as a warranty or guarantee. Poly-Flex, Inc. assumes no responsibility in connection with the use of this data. These values are subject to change without notice. REV.06/09

BENTOMAT® CL CERTIFIED PROPERTIES

MATERIAL PROPERTY	ANALYSIS CONDUCTED BASED ON TEST METHOD	TEST FREQUENCY	REQUIRED VALUES
Bentonite Swell Index[2]	ASTM D 5890	10,000 m^2	24ml / 2g min.
Bentonite Mass per unit Area[3]	ASTM D 5993/EN 14196	5,000 m^2	4.0 kg/m^2
Bentonite Fluid Loss	ASTM D 5891	10,000 m^2	18 ml max.
GCL Peel Strength	ASTM D 6496	5,000 m^2	65 N
GCL Index Flux	ASTM D 5887	25,000 m^2	No Observable Flow
GCL Permeability	ASTM D 5887	25,000m^2	No Observable Flow
Tensile Strength[1]	EN ISO 10319	20,000 m^2	8 kN/m
Elongation	EN ISO 10319	20,000 m^2	15 percent typical
Mass per unit area of woven geotextile	ASTM D 5261	1 per 20,000 m^2	100 g/m^2
Mass per unit area of (non woven) needle-punched geotextiles	ASTM D 5261	1 per 20,000 m^2	200 g/m^2
Mass per unit area of flexible Membrane liner	ASTM D 5261	1 per 20,000 m^2	160 g/m^2

Bentomat® CL is a reinforced GCL consisting of a layer of natural sodium Bentonite between a woven and a non-woven geotextile which are needle-punched together and laminated to a thin flexible membrane liner.

Notes:

[1] All tensile testing is performed in the machine direction.
[2] Bentonite properties as removed from the finished GCL.
[3] Bentonite mass/area reported at 12 percent moisture.

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For the most up-to-date product information, please visit our website, www.cetco.com.
A wholly owned subsidiary of AMCOL International Corporation. The information and data contained herein are believed to be accurate and reliable, CETCO makes no warranty of any kind and accepts no responsibility for the results obtained through application of this information.

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tel: +48 (89) 6249279
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e-mail: biuro@cetco.pl

TECHNICAL DATA

BENTOMAT AS50

MATERIAL PROPERTY	TEST METHOD	REQUIRED VALUES	TEST FREQUENCY
Geosynthetic Clay Liner			
Permeability	ASTM D 5084	$5{,}0 \times 10^{-11}$ m/s	1/production week (1)
Total Mass/unit area (2)	EN 14196	3,80kg/m^2	5.000m^2
Bentonite Mass/unit area(2)	EN 14196	3,50kg/m^2	5.000m^2
Tensile strength	ASTM D 4632	400N	5.000m^2
Elongation	ASTM D 4632	20%typical	5.000m^2
Peel Strength	ASTM D 6496	65N/10cm	5.000m^2
Length (4)	N/A	40m (standard)	Continuous
Width (4)	N/A	5,0m(standard)	Continuous
Bentonite			
Free swell	ASTM D 5890	24ml/2g	5.000m^2
Fluid loss	ASTM D 5891	18ml	5.000m^2
Geotextilies			
Nonwoven	EN 9864	200g/m^2	Certified by supplier
Woven	EN 9864	100g/m^2	Certified by supplier

Notes:

1 1/production week – average 75.000m^2 one type of Bentomat
2 Bentonite mass/area reported at 12% moisture content.
3 Length/width of the roll according to customer's requirements

Certified Properties

BENTOMAT® SS100 CERTIFIED PROPERTIES

MATERIAL PROPERTY	ANALYSIS CONDUCTED BASED ON TEST METHOD	TEST FREQUENCY	REQUIRED VALUES
Bentonite Swell Index[3]	ASTM D 5890	10,000 m^2	24 ml / 2g min.
Bentonite Mass per unit Area[4]	ASTM D 5993/EN 14196	5,000 m^2	4.8 kg/m^{-2}
Bentonite Fluid Loss	ASTM D 5891	10,000 m^2	18 ml max.
GCL Peel Strength	ASTM D 6496	5,000 m^2	65 N
GCL Index Flux[1]	ASTM D 5887	25,000 m^2	2×10^{-9} $(m^3/m^2)/s^{-1}$
GCL Permeability[1]	ASTM D 5887	25,000m^2	1×10^{-11} m/s^{-1}
Tensile Strength[2]	EN ISO 10319	20,000 m^2	8 kN/m
Elongation	EN ISO 10319	20,000 m^2	15 percent typical
Mass per unit area of woven geotextile	ASTM D 5261	1 per 20,000 m^2	100 g/m^2
Mass per unit area of (non woven) needle-punched geotextiles	ASTM D 5261	1 per 20,000 m^2	200 g/m^2

Bentomat® SS100 is a reinforced GCL consisting of a layer of natural sodium Bentonite between a woven and a non-woven geotextile which are needle-punched together.

Notes:

1. Index flux and permeability testing with de-aired distilled/de-ionized water at 80 psi (551 kPa) cell pressure, 77 psi (531 kPa) headwater pressure and 75 psi (517 kPa) tail water pressure.
2. All tensile testing is performed in the machine direction.
3. Bentonite properties as removed from the finished GCL.
4. Bentonite mass/area reported at 12 percent moisture.

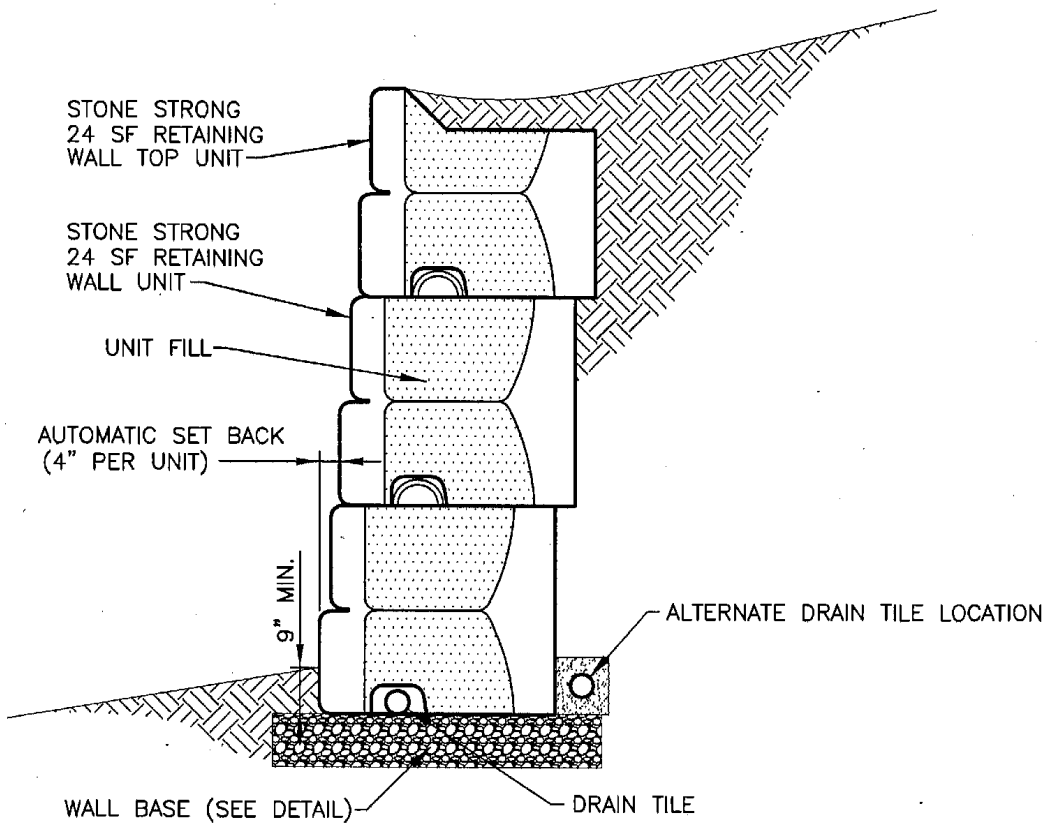
Birch House, Scotts Quays, Birkenhead, Merseyside, CH41 1FB
Tel: +44 (0)151 606 5900
Fax: +44 (0)151 606 5932

ATTACHMENT 4

CONCEPTUAL RETAINING WALL DESIGN

NOTES:

1. DRAIN TILE MAY BE ELIMINATED AT THE DISCRETION OF THE SITE ENGINEER.
2. DAYLIGHT DRAIN TILE AT LOW POINTS THROUGH WALL FACE OR AT ENDS; MAXIMUM SPACING 100 FEET OR PER SITE CONDITIONS.



24 SF GRAVITY WALL CROSS SECTION

NOT TO SCALE

DISCLAIMER:

These typical details are preliminary and conceptual in nature. They are provided for general information purposes only. Anyone making use of these details and related information does so at their own risk and assumes all liability for such use. Site specific design should be performed by a licensed Professional Engineer based on the actual site conditions, materials, and local practices.

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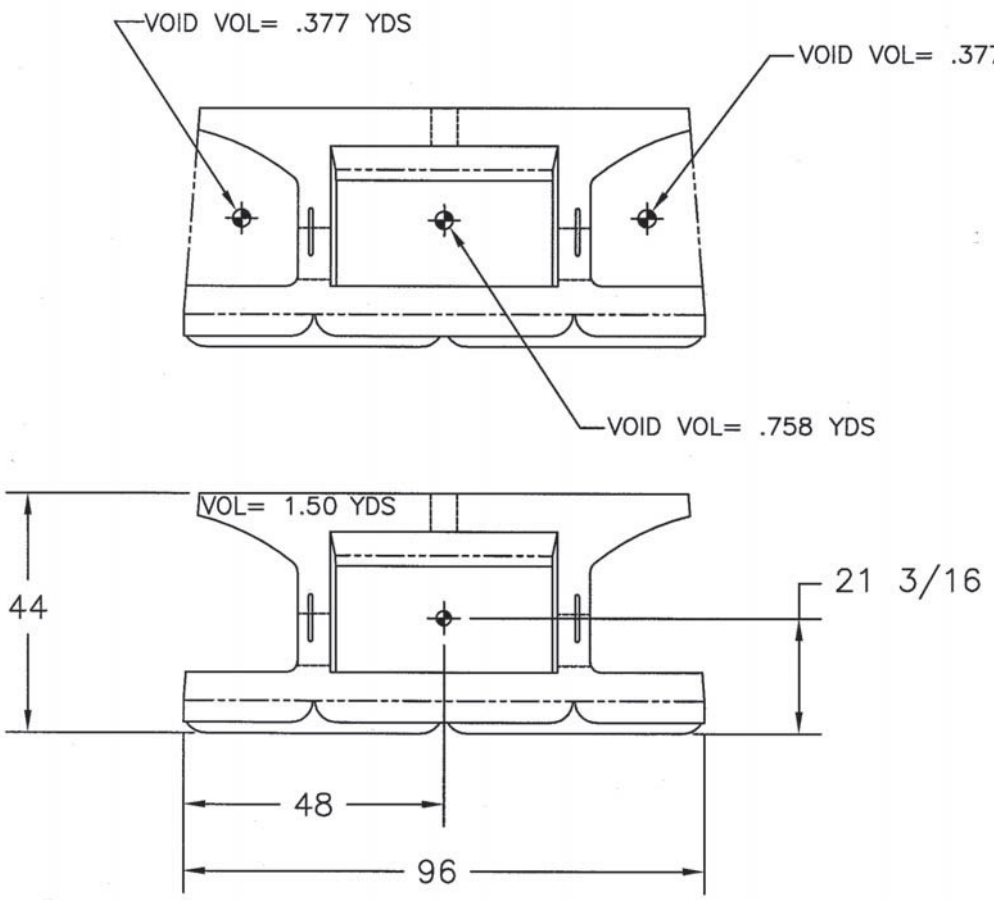
STONE STRONG systems

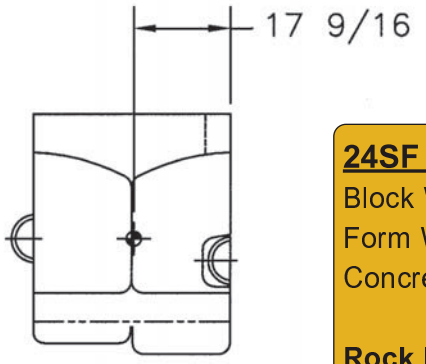
PROJECT

CROSS SECTIONS
STONE STRONG SYSTEMS

DATE: 7/1/11 | FILE: 01_24sf.XSec.Grav

Block Dimensions and Volumes





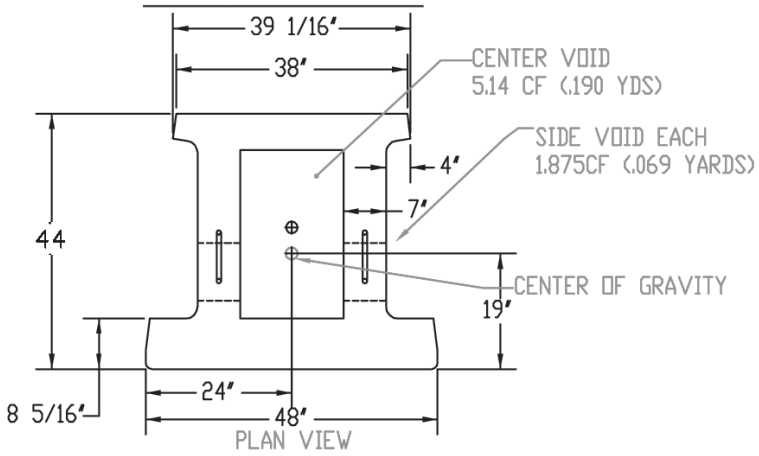
24SF Block
Block Wt. = 6,000 lbs
Form Wt. = 4,600 lbs
Concrete Volume = 1.5 cu. yds.

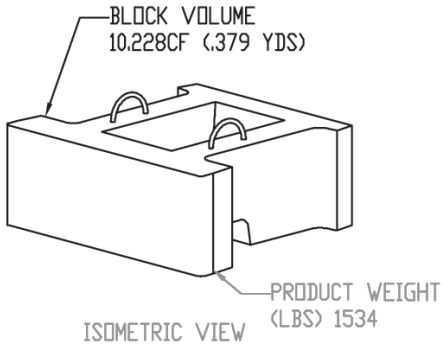
Rock In-fill for installation ~ 1.7 cu. yds. equivalent to 2.3 tons

Metric Dimensions (m)
2.44x0.92x1.1

Metric Weight (kg)
2722

Block Dimensions and Volumes





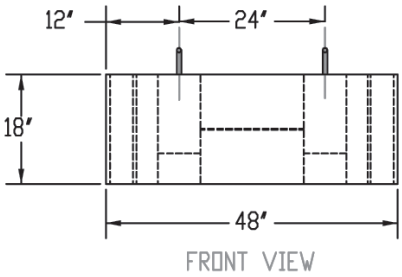
6SF Block

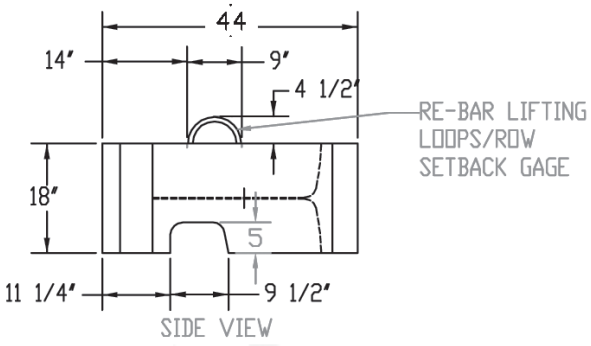
Block Wt. = 1,500 lbs

Form Wt. = 1,800 lbs

Concrete Volume = 0.379 cu. yds.

Rock In-fill for installation ~ 0.33 cu. yds.





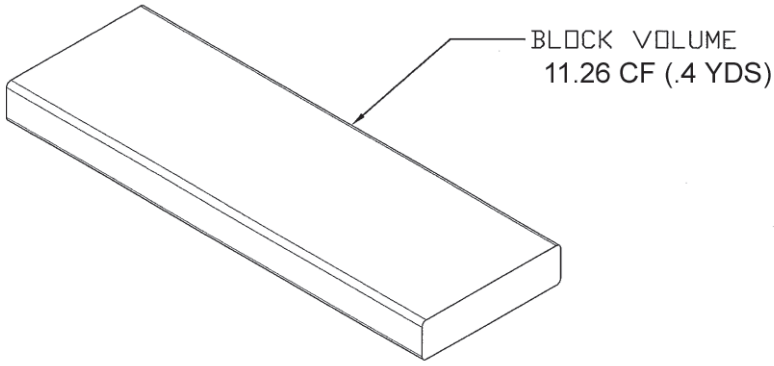
Metric Dimensions (m)

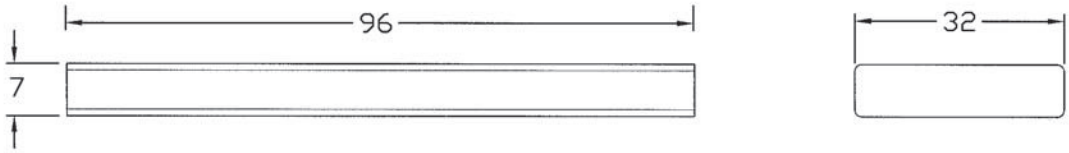
1.22x0.46x1.1

Metric Weight (kg)

680

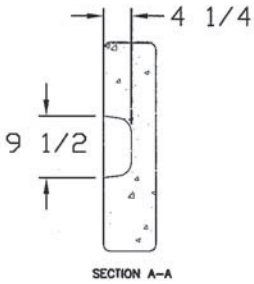
Block Dimensions and Volumes





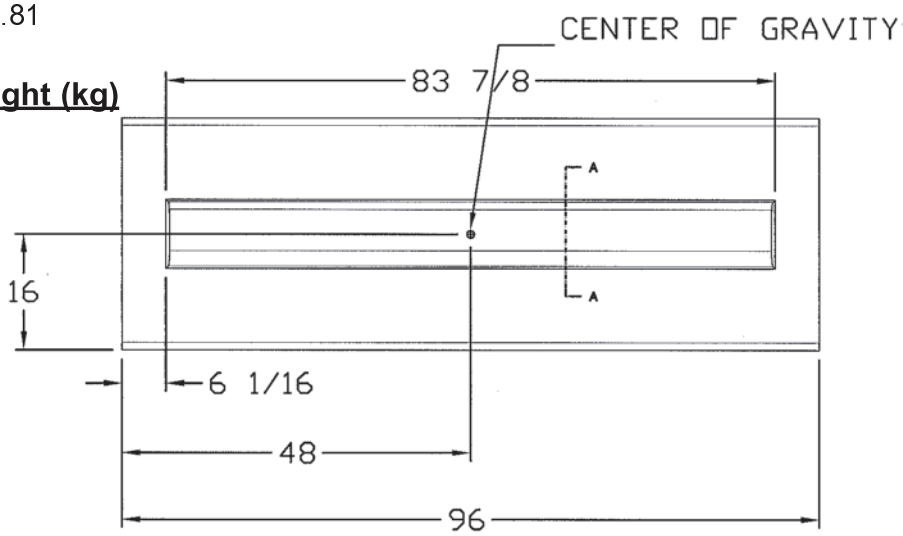
Cap Unit
Block Wt. = 1,600 lbs
Form Wt. = 1,425 lbs

Concrete Volume = 0.4 cu. yds.
Rock In-fill for installation ~ 0 cu. yds.



Metric Dimensions (m)
2.44x0.18x0.81

Metric Weight (kg)
726



STONE STRONG GRAVITY CALCULATIONS - ver 4.7

Project Name: Raymark
Location: Stratford, CT
Job#:
Section:
Calc by: NDL

4/29/13 13:11

Notes

5 ft high retaining wall
Static analysis

Wall Configuration

block	w (in)	h (ft)	batter/setback face (in)	batter/setback tail (in)	block units W_b (lb)	block units x_b (in)	unit fill W_a (lb)	unit fill x_a (in)	soil wedge W_s (lb)	soil wedge x_s (in)	CIP Extension w_e (in)	CIP Extension h_t
Cap	32.0	0.58	7.0	-5.0	200	21.00	0	21.00	24	40.00		
6	44.0	1.50	4.0	4.0	400	23.00	296	25.50	0	0.00		
24	44.0	3.00	0.0	0.0	750	19.20	601	22.80	0	0.00		
OK!	44.0	5.08	7.0	-5.0	1,350	20.59	897	23.69	24	40.00		

backfill height **5.08** feet ω= 7.39 deg
exposed height 4.58 feet ω'= -4.69 deg

Retained Soil
γ **125** pcf
ϕ **32** deg

interface friction angle
δ 24.0 deg

Aggregate Unit Fill
γ **110** pcf

Foundation Soil
γ **115** pcf
c' psf
ϕ **30** deg

allowable bearing pressure
(net) **1,500** psf (if specified)

base embedment **6** in
base thickness **6** in
agg/conc/reinf base **agg** μ_b 0.69

Seismic Load
PGA G kh 0.00

Toe Slope
H:1V slope

Backfill Slope & Surcharge

		rise in grade	LL surcharge	Tier Height
length 1	**50** feet (horizontal)	**1.5** ft	**100** psf	ft
length 2	feet (horizontal)	ft	psf	ft
length 3	feet (horizontal)	ft	psf	ft
length 4	feet (horizontal)	ft	psf	

effective slope 31.17 H:1V slope failure plane α 57.90 deg avg LL q 100 psf
β 1.8 deg zone of influence 6.93 ft

© STONE STRONG SYSTEMS

STONE STRONG GRAVITY CALCULATIONS - ver 4.7

Project Name: Raymark
Location: Stratford, CT
Job#:
Section:
Calc by: NDL

4/29/13 13:11

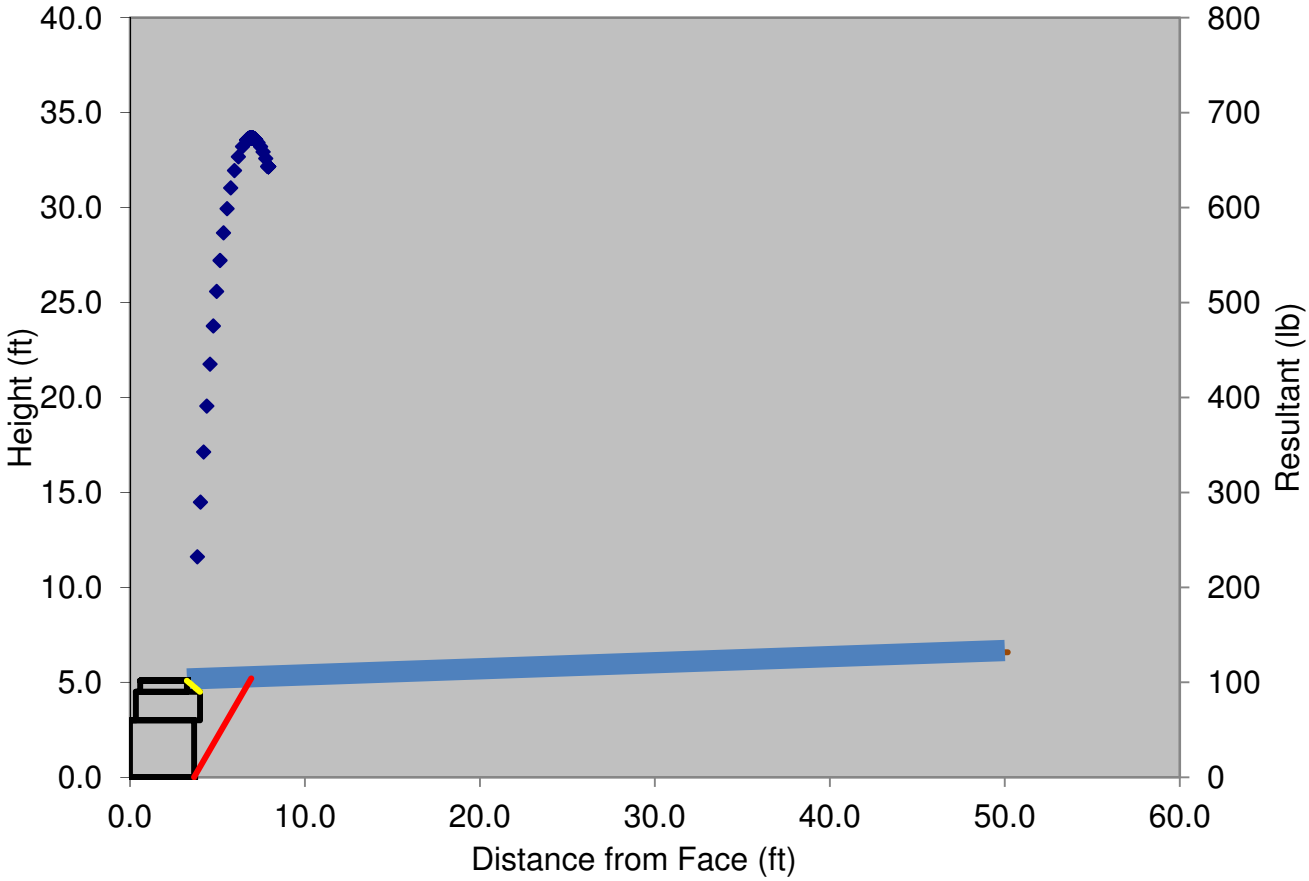
Analysis

								e=	0.21 ft
K_a =	0.317	Q_{lh} =	141 lb	ΔK_{AE} =	0.000			B_f' =	3.58 ft
P_h =	450 lb	R_s =	1,453 lb	P_{IR} =	0 lb			e_{eq}=	0.07 ft
P_v =	246 lb	q_{ult} =	6,725 psf	P_{AEh} =	0 lb			$B_{f\,eq}'$ =	3.86 ft

Results

Overturning:	Desired FS =	2	**Actual FS=**	**4.13**	***OK!***
Sliding:	Desired FS =	1.5	**Actual FS=**	**2.46**	***OK!***
Bearing Capacity:		3			
(net)	q_{all} =	1,500 psf	q_c =	646 psf	***OK!***

Ground Surface & Trial Wedge Plot



© S T O N E S T R O N G S Y S T E M S

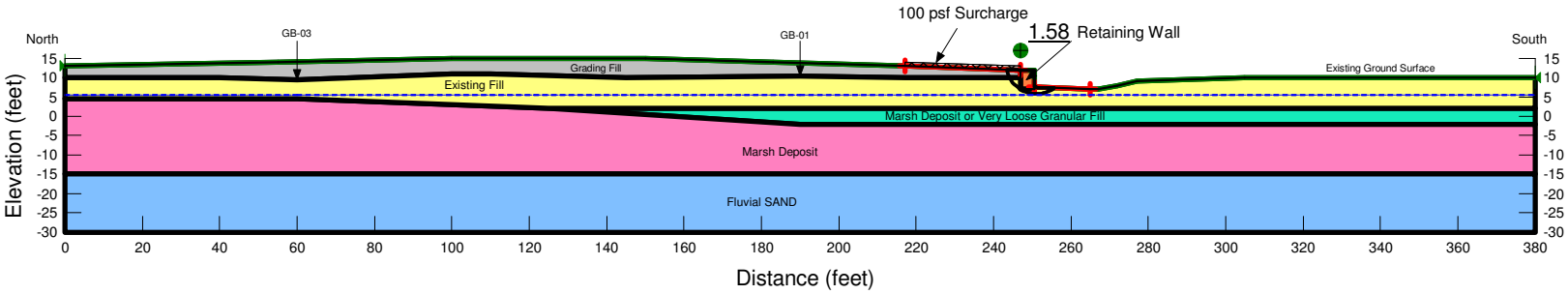
Date: 4/29/2013

Title: Raymark
Comments: Section A-A' - Retaining Wall

Factor of Safety: 1.58
Method: Spencer
Name: 05b_USACE_Raymark_Global_Section A-A_Retaining Wall_Static_100 Surcharge_Ent-Ex.gsz

USACE - RAYMARK
GLOBAL STABILITY EVALUATION
SECTION A-A'
PROPOSED CONDITIONS

Material #: 1 Description: Existing Fill Wt: 125 Cohesion: 0 Phi: 30 Unit Wt. Above WT: 115
Material #: 2 Description: Grading Fill Wt: 125 Cohesion: 0 Phi: 32
Material #: 3 Description: Marsh Deposit or Very Loose Granular Fill Wt: 80 Cohesion: 0 Phi: 26
Material #: 4 Description: Marsh Deposit or Very Loose Granular Fill Wt: 80 Cohesion: 750
Material #: 5 Description: Marsh Deposit Wt: 80 Cohesion: 0 Phi: 26
Material #: 6 Description: Marsh Deposit Wt: 80 Cohesion: 750
Material #: 7 Description: Fluvial SAND Wt: 125 Cohesion: 0 Phi: 34
Material #: 8 Description: Retaining Wall Wt: 125 Cohesion: 4.32e+005



APPENDIX E-3

TECHNICAL MEMORANDUM

TASK 5F

STRUCTURAL ASSESSMENT OF SETTLEMENT ON POTENTIAL BUILDING

TECHNICAL MEMORANDUM

DATE: June 4, 2013

TO: Dean Brammer, USACE

COPY: Charles Collet, Stephen Mitchell, Travis Carpenter, AMEC

FROM: Jeffrey Walker, Senior Structural Engineer

SUBJECT: FINAL – Structural Assessment of Settlement on Potential Building

---

AMEC has evaluated the effect of settlement predictions on building types which could potentially be proposed for construction at the Raymark OU6 Site. This evaluation has been performed in accordance with Task 5F of Modification No. 2 to Delivery Order 0007, Raymark Superfund Site, Stratford, Connecticut (authorized January 17th, 2013). This Technical Memorandum presents the results of the evaluation.

Buildings and their components have varying sensitivity to foundation settlements, and the selection of framing systems and finish materials must account for the expected settlements to ensure satisfactory performance. Geotechnical analyses completed under Task 5E (presented in a separate Technical Memorandum) provide the estimated primary and secondary settlement expected for this site under a specific scenario of assumed build-out. Primary settlement can be addressed before the building is constructed, and is typically not a building design consideration. The secondary settlement that occurs over longer periods of time, after building construction, should be considered. In general, the total value of settlement is not as important as the difference in settlement between two different points in the building, and this is referred to as differential settlement. Typically differential settlement is measured between building columns, bearing walls, or other significant components of the building system. Table 1 below gives typical allowable differential settlement values for various structural framing systems and finish materials:

Table 1: Tolerable Differential Settlements

Type of Structure	Tolerable Differential Settlement (in/ft)[1]
One story brick walls	0.012 to 0.024
Plaster walls	0.012
Drywall walls	0.024 to 0.036
Concrete building frame	0.03 to 0.048
Steel frame (continuous)	0.024
Steel frame (simple)	0.06

1 – Differential settlement values are measured as inches of differential settlement per foot of distance between measurement points in the building.

The results of the geotechnical analyses predict secondary settlement between 4 and 7 inches, if the surcharge only removes primary settlement. Boring locations are presented on Figure 1. Table 2 below summarizes the expected differential settlements for the two worst-case conditions:

Table 2: Calculated Differential Settlements - Surcharge for Primary Settlement Only

Boring	Calculated Settlement (in)	Distance Between Borings (ft)	Differential Settlement (in/ft)
GB-01	6	120	0.017
GB-10	4		
GB-03	4	60	0.033
GB-09	6		

Comparing the expected differential settlement in Table 2 to the tolerable values in Table 1, it is clear that a building with brittle interior and exterior finishes will most likely suffer from cracking over its lifetime. Also, rigid building frame systems such as concrete should be avoided. Therefore an office building, of typical construction with sheetrocked interior walls and ceilings, or brick façade, would not be a good choice for this site. A more suitable type of building is a steel framed industrial style building with metal roofing and siding. Possible uses for such a facility could include shop space, garage and vehicle maintenance, light manufacturing, and possibly retail space.

If the surcharge program is modified to remove 1 log cycle of secondary settlement in addition to the primary settlement, the expected differential settlements are significantly reduced. Table 3 below summarizes the expected differential settlements for a modified surcharge program:

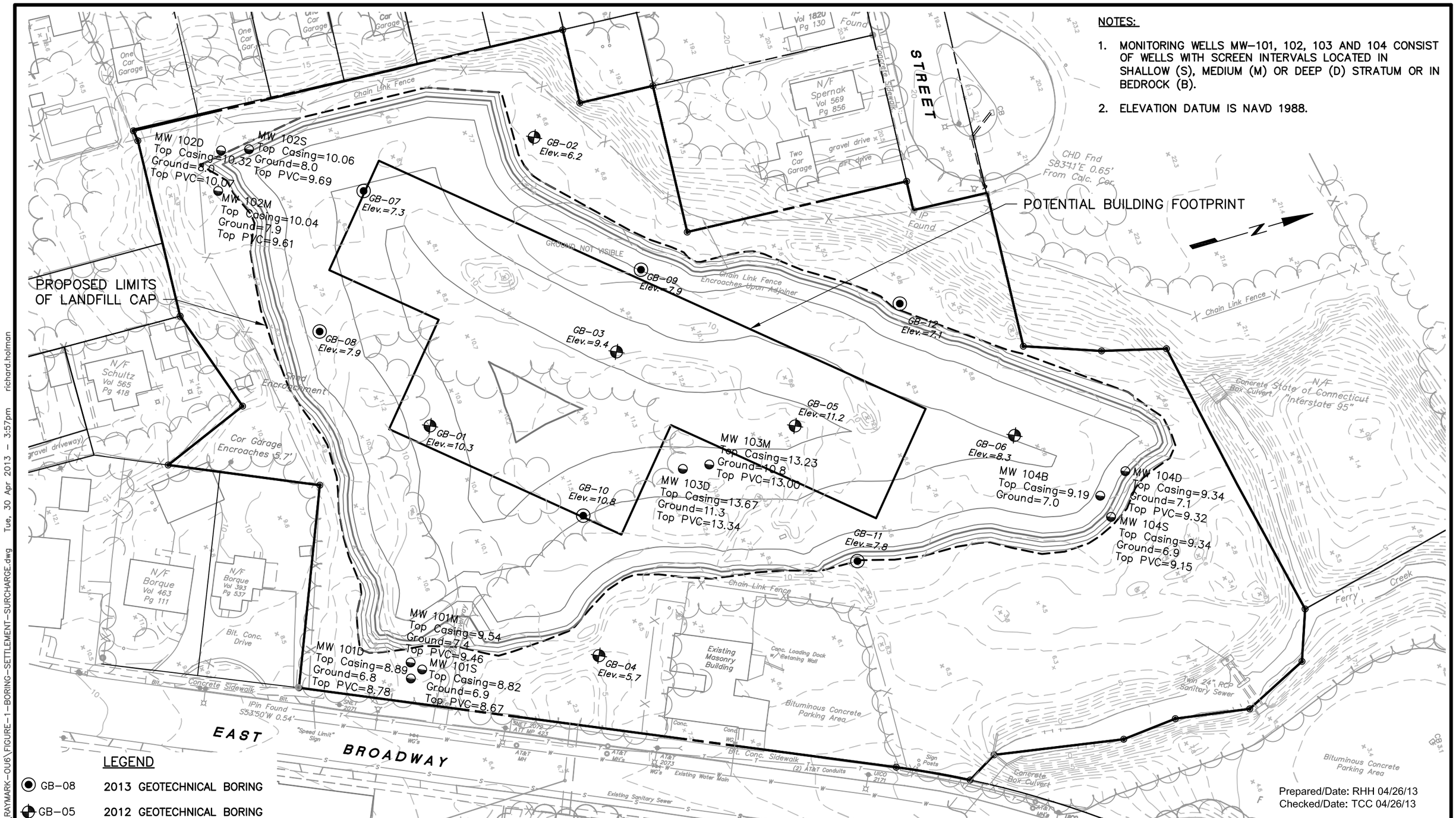
Table 3: Calculated Differential Settlements - Surcharge for Partial Secondary Settlement

Boring	Calculated Settlement (in)	Distance Between Borings (ft)	Differential Settlement (in/ft)
GB-01	3	120	0.008
GB-10	2		
GB-03	2	60	0.017
GB-09	3		

These differential settlements are well within the acceptable limits for most common building materials and framing systems, and would remove most limits on potential development of the site.

NOTES:

1. MONITORING WELLS MW–101, 102, 103 AND 104 CONSIST OF WELLS WITH SCREEN INTERVALS LOCATED IN SHALLOW (S), MEDIUM (M) OR DEEP (D) STRATUM OR IN BEDROCK (B).
2. ELEVATION DATUM IS NAVD 1988.



LEGEND

GB–08	2013 GEOTECHNICAL BORING
GB–05	2012 GEOTECHNICAL BORING
MW 103(D)	1994 MONITORING WELL
	EXISTING GROUND SURFACE ELEVATION CONTOUR
	PROPOSED CAP GRADING (60% REMEDIAL DESIGN)

0 30 60 120
SCALE IN FEET HORIZONTAL

Prepared/Date: RHH 04/26/13
Checked/Date: TCC 04/26/13

RAYMARK INDUSTRIES, INC.
576/600 EAST BROADWAY
STRATFORD, CONNECTICUT

amec

GEOTECHNICAL BORING LOCATIONS
SETTLEMENT AND SURCHARGE EVALUATION
Project 3651-12-0004
FIGURE 1

Z:\Projects\USACE\RAYMARK–OU6\FIGURE–1–BORING–SETTLEMENT–SURCHARGE.dwg Tue, 30 Apr 2013 – 3:57pm richard.holman

APPENDIX E-4

TECHNICAL MEMORANDUM

TASK 5G

EVALUATION OF POTENTIAL GROUND IMPROVEMENTS TO MINIMIZE PREDICTED SETTLEMENT FOR POSSIBLE SITE DEVELOPMENT

TECHNICAL MEMORANDUM

DATE: June 14, 2013

TO: Dean Brammer; USACE

COPY TO: Charles Collet, P.E., Stephen Mitchell, P.E., and Jeffrey Walker; AMEC

FROM: Travis Carpenter, P.E. (Maine) and Kim LaMarre, P.E. (Maine); AMEC

SUBJECT: FINAL - Task 5G Evaluation of Potential Ground Improvements to Minimize Predicted Settlement for Possible Site Development, Raymark Industries, Inc. Superfund Site (576/600 East Broadway), Stratford, Connecticut

PROJECT: 3651-12-0004

1.0 INTRODUCTION

AMEC Environment and Infrastructure, Inc. (AMEC) has evaluated potential ground improvement strategies to address settlement that is predicted to occur due to site development. AMEC has recommended that primary consolidation settlement, at a minimum, be addressed via the implementation of a monitored surcharge program. As such, the primary purpose of this evaluation is to estimate the surcharge configuration and duration necessary to minimize post-construction settlement of the potential site development footprint.

This evaluation of potential ground improvements was performed in accordance with Task 5G of Modification No. 2 to Delivery Order 0007, Raymark Superfund Site, Stratford, Connecticut (authorized on April 12, 2013). This Technical Memorandum (TM) documents the work performed and presents the results of this evaluation. This TM is organized as follows:

- Section 2.0 briefly summarizes relevant project background information;
- Section 3.0 briefly reviews the results of AMEC's prior evaluation of settlement;
- Section 4.0 presents the methodology, assumptions, and results of the surcharge assessment and briefly reviews other/alternate ground improvement strategies (surcharging with wick drains and dynamic compaction); and
- Section 5.0 provides an order of magnitude cost estimate for the recommended ground improvement strategy (monitored surcharge program).

2.0 PROJECT BACKGROUND INFORMATION

Elevations reported herein are based on the North American Vertical Datum (NAVD) of 1988. Elevations are reported in units of feet. The horizontal datum is the Connecticut State Plane Coordinate System, based on the North American Datum (NAD) of 1983.

2.1 Site Description

The Raymark Industries, Inc. Superfund Site (i.e., the Site) is located at 576/600 East Broadway in Stratford, Connecticut. The adjacent East Broadway properties encompass approximately 6 acres of commercially-zoned (light industrial) land that is presently overgrown and undeveloped, except for two small buildings and associated pavements situated on the 576 East Broadway parcel. Central portions of the Site are relatively flat and level with existing ground surface elevations generally ranging between +8.0 and +12.5 feet. The Site slopes downward from central portions towards the perimeter where existing elevations are on the order +4.0 to +5.0 feet in most areas. Existing Site features and topography are depicted in Figure 1.

Beginning in the late 1980s, the Site received waste fill from the former Raymark Industries, Inc. facility. The fill consists of both natural and manmade materials. The manmade materials include presumed asbestos containing material (PACM) (fibrous asbestos mats and pads), asphalt, brake pads, brick, cinders, coal, concrete, gasket material, glass, metal debris, plastic, steel, tiles, shingles, slag, and wood. Raymark waste found in the fill materials at this Site consists of asbestos, lead, copper and/or Aroclor 1268.

Most of the Site was originally a tidal/seasonal floodplain marsh prior to filling. Much of the Site is still presently located within the 100-year floodplain.

2.2 Site-Specific Soil Conditions

AMEC carried out a site-specific geotechnical investigation to characterize subsurface conditions and obtain geotechnical data to support the planning, design, and construction of the planned Remedial Action and to evaluate the feasibility of site development (AMEC, 2013a). The geotechnical investigation indicates that the Site is underlain by the following primary soil strata:

- Fill: Heterogeneous fill materials comprised predominantly of sand, silt, gravel, and debris. Typically loose to medium dense. Thickness ranges from about 2 to 17 feet across the Site.

- Marsh Deposit: Marsh/floodplain deposit consisting primarily of organic silt (OH) with lesser amounts of organic clay (OH) and peat (PT). Variable amounts of sand throughout the deposit. Usually soft to medium stiff. Occasionally stratified with distinct layers of sand/silty sand (SM). Thickness varies from about 3.5 (GB-12) to 17.5 feet (GB-03) across the Site.
- Fluvial Sand: Glacial fluvial deposit comprised of fine to coarse sand with varying amounts of silt and gravel. Typically medium dense to dense. Extends to Glacial Till and/or bedrock (based on site-specific monitoring well installations by others).

Figure 1 depicts the locations of site-specific geotechnical borings. Geotechnical boring records and relevant laboratory testing data were attached to AMEC's settlement evaluation memorandum (AMEC, 2013c). The Marsh Deposit is considered to be moderately to highly compressible based on the available geotechnical data. Consequently, this stratum is of prime concern for consolidation resulting from increases in effective stress due to grade raises and/or foundation loadings.

2.3 Planned Remedial Action

The remediation of 576/600 East Broadway is being performed as a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Action (RA) under the *Record of Decision for Final Source Control Actions at Four Properties Within Operable Unit 6 (Additional Properties) and Interim Actions at Other Locations Containing Raymark Waste* (USEPA, 2011). As described in the Record of Decision (ROD), the selected Remedial Action for this Site is to excavate Raymark waste from the 100-year floodplain, consolidate the waste on the upland portion of the Site, and contain the waste with a low-permeable Resource Conservation and Recovery Act (RCRA) cap.

2.4 Potential Site Development

AMEC understands that the Site is being considered for development following and/or in conjunction with the planned Remedial Action. A conceptual building footprint was provided to AMEC in August of 2012 and is depicted in Figure 1.

AMEC understands that the Site development has not been designed or permitted. As such, AMEC has assumed that Site grades will be raised to an elevation of about +15.0 feet within the proposed limits of the cap (Figure 1). Similarly, AMEC has assumed that the building will have a finish-floor elevation of about +15.0 feet and that the building will be founded (at a foundation subgrade elevation of about +13.0 feet) on a 2-foot thick reinforced concrete mat foundation (AMEC, 2013b). A maximum uniformly distributed foundation load of 500 psf has been assumed (AMEC, 2013b).

AMEC also understands that a retaining wall may be installed in some areas along and/or proximate to the Site perimeter to maximize the potential site development footprint.

3.0 ESTIMATED SETTLEMENT

AMEC performed a settlement evaluation (AMEC, 2013c) to estimate the magnitude and duration of primary consolidation settlement that would result from potential site development. The evaluation was based on an assumed final grade of +15 feet for parking areas and building finish-floor elevation of +15 feet with a mat foundation load 500 psf. The results indicate an estimated 8 to 21 inches of primary consolidation across the potential footprint of site development. An additional 4 to 7 inches of secondary compression were also predicted to occur across the Site during the assumed design life of the building (i.e., 50 years) due to the organic content of the Marsh Deposit.

4.0 EVALUATION OF GROUND IMPROVEMENTS

AMEC has recommended that primary consolidation settlement, at a minimum, be addressed via the implementation of a monitored surcharge program, prior to the construction of a building on a reinforced concrete mat foundation. The USEPA has since requested that primary consolidation plus some amount of secondary compression be removed by the surcharge program. The following subsections present the methodology, assumptions, and results of the surcharge assessment and briefly review two other ground improvement strategies (surcharging with wick drains and dynamic compaction).

4.1 Surcharge Assessment (Monitored Surcharge Program)

In general terms, a surcharge consists of placing fill to an elevation that is in excess of the anticipated final grades (and any additional loads) in order to force the primary consolidation attributable to the final grading (and any additional loads) to occur more rapidly. Furthermore, surcharging provides a relatively simple/constructible means of addressing variable Site and subsurface conditions (i.e., variable thickness of compressible soils, variable fill thickness/site grading requirements, etc.). Typically, the magnitude of the surcharge can be increased to reduce consolidation time, or the consolidation period can be extended to reduce the amount of surcharge fill.

AMEC selected surcharge assessment points to coincide with those evaluated for the settlement evaluation. As such, the magnitude and duration of a surcharge was assessed at nine distinct geotechnical boring locations (GB-01, GB-03, GB-05, GB-06,

GB-07, GB-08, GB-09, GB-10, and GB-11). The principal steps of this surcharge assessment are summarized in the following subsections.

4.1.1 Estimate Minimum Required Surcharge Configuration

AMEC developed and utilized an in-house spreadsheet calculator to estimate primary consolidation settlement (due to site development grading and/or building foundation loads), secondary compression settlement, and the required surcharge configuration at the referenced locations. Spreadsheet calculations for each assessment point are provided in Attachment 1.

AMEC estimated the required surcharge configuration for each assessment point based on the following performance objectives:

1. Require 100% of the primary consolidation settlement attributable to proposed site development grading and/or building foundation loads to occur during the surcharge period;
2. Remove one log cycle of secondary compression settlement during the surcharge period. This will force an additional 2 to 3 inches of total settlement (in addition to the 8 to 21 inches of primary consolidation settlement) to occur during the surcharge period, which should limit post-surcharge total settlements (due to continued secondary compression over 50 years) to about 2 to 3 inches and differential settlements within the potential building footprint to about 1 inch.
3. Limit the surcharge period following surcharge fill placement to no more than six months. Target four to six months.

The estimated surcharge configuration was established via an iterative process. The principal steps are summarized as follows:

1. Estimate primary consolidation settlement, time-rate of primary consolidation, and secondary compression settlement (for one log cycle) due to proposed site development grading and/or building loads [see AMEC's settlement evaluation (AMEC, 2013c)];
2. Select a proposed surcharge elevation;
3. Calculate stress increase due to surcharge;
4. Estimate primary consolidation settlement due to the surcharge ($PC_{surcharge}$) stress increase using the same methodology and compressibility parameters presented in the settlement evaluation (AMEC, 2013c).

5. Compare the result from Step 4 to the estimated primary consolidation due to proposed site development grading and/or building loads combined with the estimated secondary compression for one log cycle [$PC_{proposed}$ = Primary + Secondary (one log cycle)]. This ratio ($PC_{proposed}/PC_{surcharge}$) represents the average degree of surcharge-induced primary consolidation required to force 100% of $PC_{proposed}$ to occur.
6. Use Terzaghi theory of consolidation to estimate the time required to achieve the target degree of surcharge-induced consolidation.
7. Repeat Steps 1 through 5, as necessary, adjusting the surcharge elevation in increments of 0.5 to 1.0 feet until estimated consolidation time (Step 5) is on the order of 6 months or less.

The results are summarized in Table 1.

Table 1: Minimum Required Surcharge Configuration

General Location	Surcharge Assess. Point	Existing Ground Elev. (feet)	Proposed Grade/ Elev. (feet)	Top of Pre-Load Elev. (feet)	Minimum Surcharge Elev. (feet)	Minimum Surcharge Height/Thickness		
						Above Existing (feet)	Above Proposed (feet)	Above Pre-Load (feet)
Potential Building Footprint	GB-01	10.5	15.0	19.0	24.0	13.5	9.0	5.0
	GB-03	9.5	15.0	19.0	24.0	14.5	9.0	5.0
	GB-05	11.0	15.0	19.0	22.0	11.0	7.0	3.0
	GB-07	7.5	15.0	19.0	24.0	16.5	9.0	5.0
	GB-09	8.0	15.0	19.0	25.0	17.0	10.0	6.0
	GB-10	11.0	15.0	19.0	22.0	11.0	7.0	3.0
Parking/ General	GB-06	8.5	15.0	15.0	15.5	7.0	0.5	0.5
	GB-08	8.0	15.0	15.0	16.5	8.5	1.5	1.5
	GB-11	8.0	15.0	15.0	15.5	7.5	0.5	0.5

4.1.2 Develop Preliminary Surcharge Grading Plan and Fill Volumes

The minimum required surcharge thicknesses/elevations were utilized to develop a preliminary surcharge grading plan. In some locations, the minimum surcharge elevations were adjusted (i.e., increased) to facilitate construction of a uniformly graded embankment, which results in a nominal increase in surcharge fill thickness and volume in some locations. The end result is a recommended top of surcharge elevation of +25 feet within the building footprint and a top of surcharge elevation of +16 feet across the remainder of the site development footprint. The preliminary surcharge grading is depicted in Figure 2.

The CADD-estimated volume of fill between existing ground surface and the top of the surcharge elevation is about 46,000 cubic yards (Figure 2).

4.1.3 Surcharge Monitoring

AMEC recommends that the surcharge program, if selected, be implemented using an "observational approach", in which the Site's response (e.g., amount and/or rate of consolidation) to the surcharge is regularly observed (i.e., monitored) in order to confirm that adequate consolidation has occurred.

A Geotechnical Monitoring Plan would be developed prior to the issue of bid/construction documents. The aforementioned observational approach will require the installation and regular monitoring of commonly used geotechnical instrumentation. The following types of instrumentation are anticipated:

- Settlement monuments to track the rate and amount of settlement;
- Vibrating wire piezometers to monitor pore pressure dissipation; and
- Slope inclinometers to monitor any lateral movement and/or monuments to monitor any perimeter/toe heave.

Regular monitoring of the installed instrumentation will enable a comparison of actual time-settlement data with the predicted behavior. This data can be used to assess whether adjustments to either the surcharge configuration or the surcharge duration are needed to meet the stated performance objectives.

4.2 Surcharge Program With Wick Drains

Wick drains, or prefabricated vertical drains, have been used extensively to accelerate consolidation of fine-grained soil. These vertical drains are artificially created drainage pathways installed for the purpose of shortening drainage paths, and therefore accelerating the rate at which consolidation takes place. Wick drains could be considered in place of some of the surcharge fill used to accelerate consolidation within the building footprint.

For the time-rate of consolidation analysis, AMEC assumed a maximum drainage path length of about 9 feet, which corresponds to one-half the maximum thickness of the compressible Marsh Deposit. For conceptual design purposes, wick drains could be installed across the Site (or possibly just within the building footprint) at distances of 10

feet on center, which shortens the drainage path to about 5 feet and thereby speeds up primary consolidation. The benefit would be a possible reduction in imported surcharge fill volume (5,000 to 7,500 cubic yards less estimated), based on a 3-foot reduction in the top of surcharge elevation

At 10 feet on center, about 1,500 wick drains would be installed across the Site. For cost estimating purposes, an average installation depth of 35 feet (25 feet +/- to the bottom of the Marsh Deposit plus 10 feet of subgrade, pre-load, and/or surcharge fill) was assumed. Typical industry pricing on wick drains is about $0.50 to $1.00 per linear foot of wick, excluding equipment mobilization. Therefore, wick drain installation could potentially add $50,000 to $75,000 to the surcharge program, assuming $25,000 for mobilization.

Besides the added installation costs, a disadvantage of wick drains is that, by design they are intended to shorten drainage paths by providing the pore water “a place to go” and a significant volume of Site groundwater could be expelled from the wicks. Therefore, added costs will be incurred assuming the water needs to be containerized and treated or disposed of off-site, and these costs could be significant. Wick drains can also be problematic if a large amount of settlement is expected, such as the 21 inches predicted for this Site, because there is the risk of the wick collapsing on itself and thus rendering it ineffective. For these reasons, the installation of wick drains as part of a monitored surcharge program is not considered to be the best or most cost-effective ground improvement option.

4.3 Dynamic Compaction

Dynamic compaction has been used to densify loose sands, many types of fill, and sanitary landfill refuse. It is most appropriate in soils that have relatively low fines content (ASCE, 1987). It is typically not recommended for soils that are fully saturated and/or have a high “fines” content (i.e., silt and clay sized particles), which are both characteristics of the Marsh Deposit. Further, studies show that dynamic compaction is most effective to depths of about 3 meters, or 10 feet, which is above the Marsh Deposit in most locations. Therefore, dynamic compaction is not considered a viable potential ground improvement method for this particular Site/application.

4.4 Conclusions/Recommendations

A monitored surcharge program appears to be the most viable ground improvement strategy. AMEC recommends that primary consolidation settlement, at a minimum, be addressed via the implementation of a monitored surcharge program, prior to the construction of a building on a reinforced concrete mat foundation. The USEPA has

requested that some amount of secondary compression also be removed by the surcharge program in order to further minimize the amount of secondary compression, and hence the total and differential settlement, that will continue to occur (due to the organic nature of the Marsh Deposit) throughout the design life of the building.

5.0 COST ESTIMATE

AMEC has prepared an order of magnitude cost estimate for the recommended ground improvement strategy, monitored surcharge program, to address primary consolidation settlement and one log cycle of secondary compression settlement attributable to an assumed/potential site development scenario. AMEC's settlement evaluation (AMEC, 2013c), surcharge assessment (described herein), and monitored surcharge program cost estimate assume a site development/finish-floor elevation of +15.0 feet with an assumed foundation load (reinforced concrete mat foundation) of 500 psf uniformly distributed across the building footprint. The following construction/loading sequence is anticipated:

1. Install geotechnical instrumentation and obtain baseline readings.
2. Excavate existing Raymark waste from the 100-year floodplain.
3. Place and compact the excavated waste as subgrade fill within the footprint of the cap.
4. Place a separation geotextile atop the consolidated waste fill.
5. Place and compact imported subgrade fill materials up to cap subgrade elevation (s).
6. Place surcharge fill materials (imported fill) to top of surcharge elevation(s).
7. Monitor instrumentation, compare actual time-settlement data with the predicted response, assess need for changes to surcharge configuration, and terminate surcharge based on successful demonstration (i.e., via actual time-settlement data) that stated performance objectives have been met.
8. Remove surcharge fill materials.
9. Construct cap and building pad (mat foundation).

For the above scenario, the probable cost to install, monitor, and then remove the surcharge fill (Steps 1, 5, 6, 7, and 8) is on the order of $1,200,000. The cost estimate, assumptions, and supporting data are provided in Attachment 2.

6.0 REFERENCES

AMEC, 2013a. "Remedial Design Sampling Report, Remedial Design of a Landfill Cap, Waste Consolidation, Institutional Controls, and Interim Actions, Operable Unit (OU6)," February 14, 2013.

AMEC, 2013b. "Technical Memorandum, Estimation of Building Foundation Loads, Raymark Superfund Site – 576/600 East Broadway, Stratford, CT", February 19, 2013.

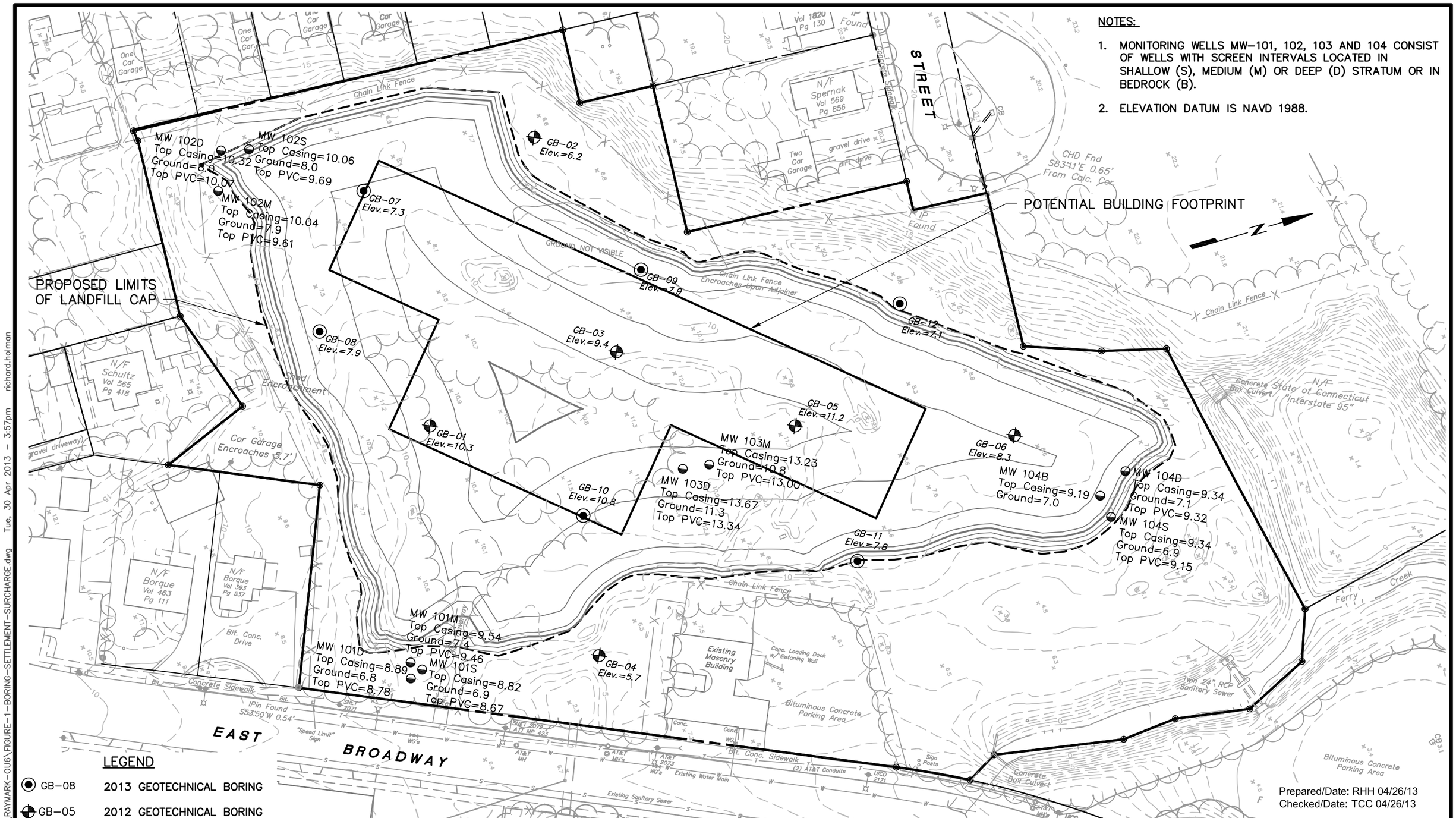
AMEC, 2013c. "Technical Memorandum, Task 5E Findings for Estimation of Settlement, Evaluation of Cap Components, and Conceptual Retaining Wall Design for Potential Site Development, Raymark Industries, Inc. Superfund Site, (576/600 East Broadway), Stratford, Connecticut", April 30, 2013.

ASCE, 1987. "Soil Improvement – A Ten Year Update; Geotechnical Special Publication No. 12; ASCE; April 28, 1987.

FIGURES

NOTES:

1. MONITORING WELLS MW–101, 102, 103 AND 104 CONSIST OF WELLS WITH SCREEN INTERVALS LOCATED IN SHALLOW (S), MEDIUM (M) OR DEEP (D) STRATUM OR IN BEDROCK (B).
2. ELEVATION DATUM IS NAVD 1988.



LEGEND

GB–08	2013 GEOTECHNICAL BORING
GB–05	2012 GEOTECHNICAL BORING
MW 103(D)	1994 MONITORING WELL
	EXISTING GROUND SURFACE ELEVATION CONTOUR
	PROPOSED CAP GRADING (60% REMEDIAL DESIGN)

0 30 60 120
SCALE IN FEET HORIZONTAL

Prepared/Date: RHH 04/26/13
Checked/Date: TCC 04/26/13

RAYMARK INDUSTRIES, INC.
576/600 EAST BROADWAY
STRATFORD, CONNECTICUT

amec

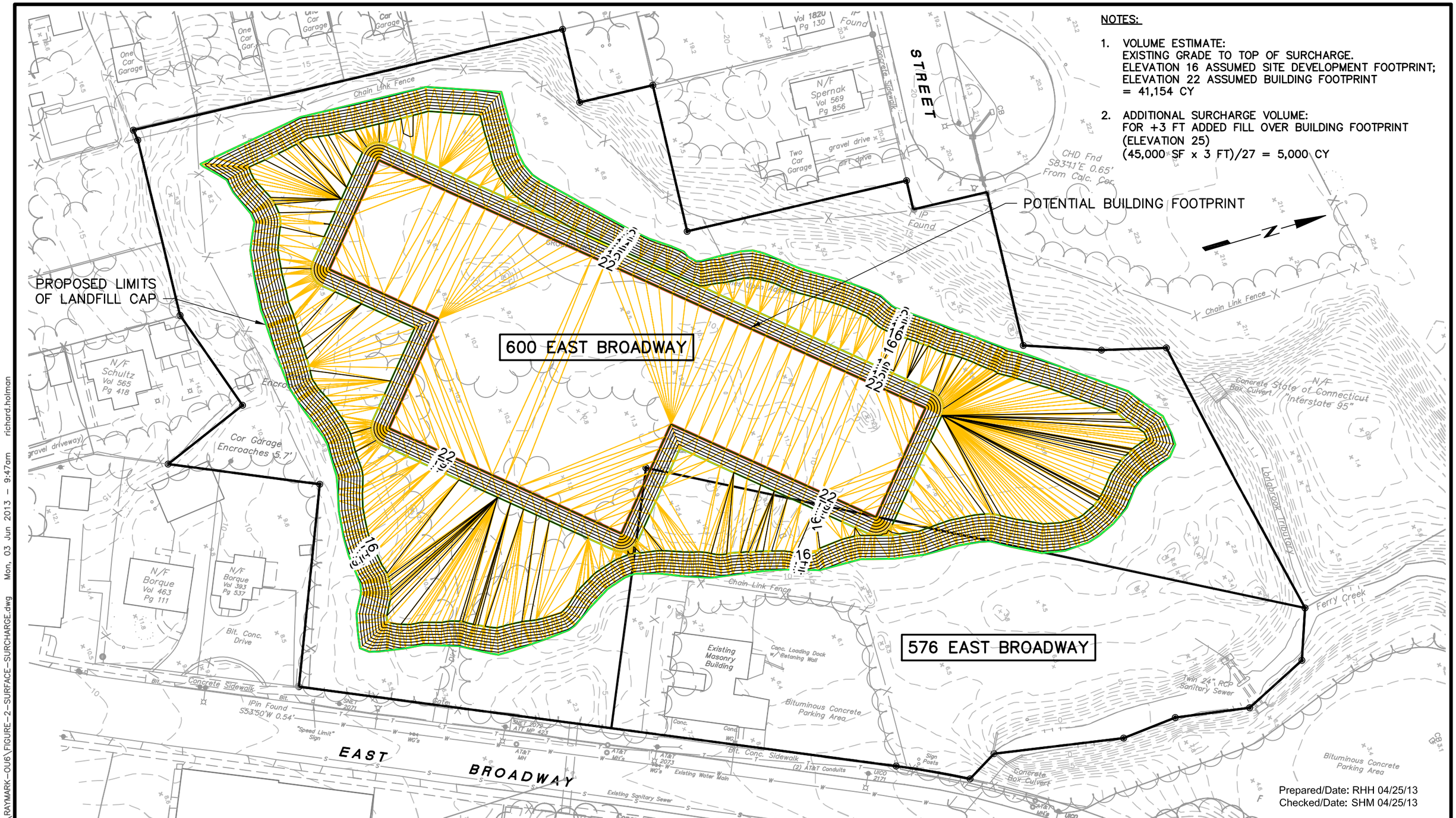
GEOTECHNICAL BORING LOCATIONS
SETTLEMENT AND SURCHARGE EVALUATION
Project 3651-12-0004
FIGURE 1

Z:\Projects\USACE\RAYMARK–OU6\FIGURE–1–BORING–SETTLEMENT–SURCHARGE.dwg Tue, 30 Apr 2013 – 3:57pm richard.holman

NOTES:

1. VOLUME ESTIMATE:
   EXISTING GRADE TO TOP OF SURCHARGE.
   ELEVATION 16 ASSUMED SITE DEVELOPMENT FOOTPRINT;
   ELEVATION 22 ASSUMED BUILDING FOOTPRINT
   = 41,154 CY

2. ADDITIONAL SURCHARGE VOLUME:
   FOR +3 FT ADDED FILL OVER BUILDING FOOTPRINT
   (ELEVATION 25)
   (45,000 SF x 3 FT)/27 = 5,000 CY



Prepared/Date: RHH 04/25/13
Checked/Date: SHM 04/25/13

0 30 60 120
SCALE IN FEET
HORIZONTAL

RAYMARK INDUSTRIES, INC.
576/600 EAST BROADWAY
STRATFORD, CONNECTICUT

amec

SURCHARGE VOLUME
ESTIMATE
Project 3651-12-0004
Figure 2

Z:\Projects\USACE\RAYMARK-OU6\FIGURE-2-SURFACE-SURCHARGE.dwg Mon, 03 Jun 2013 - 9:47am richard.holman

ATTACHMENT 1

SURCHARGE ASSESSMENT
SPREADSHEET CALCULATOR OUTPUT

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-01	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	10.50	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	8.00	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	15.00	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	500.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	13.0	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	11.7	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	5.9	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	12.4	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-01	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	24.00	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	13.5	-
Surcharge Height above Prop. Grade (ft):	9.0	-
Resultant Time to Consolidation:	4.5	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change + one log cycle of secondary comp.
@ % Surcharge Consolidation:	84%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	OKAY	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-01	-	
Surcharge Area/Point No:	-	-	
Coefficient of Secondary Compression, C_{α}	0.02	Marsh	(C_{α} expressed by change in strain per log cycle of time)
Coefficient of Secondary Compression, C_{α}	0	N/A	(C_{α} expressed by change in strain per log cycle of time)
Est. Time to End of Primary Consolidation, t_p	0.5	Years	1.0 No. of log cycles
Secondary Compression Design Time, t_{sec}	5.0	Years	
Est. Secondary Compression (inches):	2.9	Marsh	
Est. Secondary Compression (inches):	0.0	N/A	

Method from NAVFAC DM 7.1-231: $H_{sec} = C_{\alpha} * H_t * \log (t_{sec}/t_p)$

Where: H_{sec} = Secondary compression
H_t = Thickness of soil stratum

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-01**	
Existing Grade:	10.5	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	8.0	feet bgs
Tot./Eff. Stress @ GWT =	920.0	psf

Analysis Point/Location:	**GB-01**	
Proposed Grade:	15.00	feet
Grade Change:	4.5	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	562.5	psf
Δ Stress (Bldg. Loading):	500.0	psf

Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

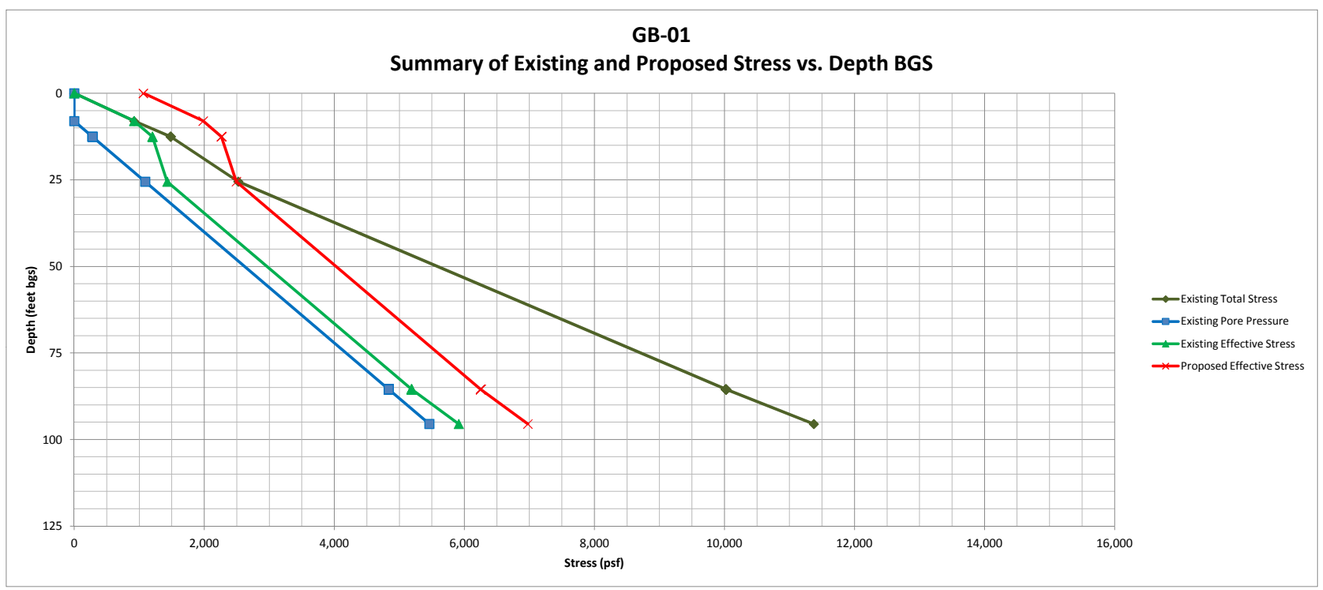
Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
Stratum	Top	Bottom		γ_t or γ_{sat}	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle
	(ft bgs)	(ft bgs)	(ft)	(pcf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)
		0.0	0.0			0.0			0.0			0.0			1062.5	
F-Unsat	0.0	8.0	8.0	115	0.0	920.0	460.0	0.0	0.0	0.0	0.0	920.0	460.0	1062.5	1982.5	1522.5
F-Satur	8.0	12.5	4.5	125	920.0	1482.5	1201.3	0.0	280.8	140.4	920.0	1201.7	1060.9	1982.5	2264.2	2123.4
-	12.5	12.5	0.0	110	1482.5	1482.5	1482.5	280.8	280.8	280.8	1201.7	1201.7	1201.7	2264.2	2264.2	2264.2
-	12.5	12.5	0.0	120	1482.5	1482.5	1482.5	280.8	280.8	280.8	1201.7	1201.7	1201.7	2264.2	2264.2	2264.2
Marsh	12.5	25.5	13.0	80	1482.5	2522.5	2002.5	280.8	1092.0	686.4	1201.7	1430.5	1316.1	2264.2	2493.0	2378.6
Fluvial	25.5	85.5	60.0	125	2522.5	10022.5	6272.5	1092.0	4836.0	2964.0	1430.5	5186.5	3308.5	2493.0	6249.0	4371.0
-	85.5	85.5	0.0	125	10022.5	10022.5	10022.5	4836.0	4836.0	4836.0	5186.5	5186.5	5186.5	6249.0	6249.0	6249.0
-	85.5	85.5	0.0	120	10022.5	10022.5	10022.5	4836.0	4836.0	4836.0	5186.5	5186.5	5186.5	6249.0	6249.0	6249.0
-	85.5	85.5	0.0	125	10022.5	10022.5	10022.5	4836.0	4836.0	4836.0	5186.5	5186.5	5186.5	6249.0	6249.0	6249.0
-	85.5	85.5	0.0	120	10022.5	10022.5	10022.5	4836.0	4836.0	4836.0	5186.5	5186.5	5186.5	6249.0	6249.0	6249.0
-	85.5	85.5	0.0	125	10022.5	10022.5	10022.5	4836.0	4836.0	4836.0	5186.5	5186.5	5186.5	6249.0	6249.0	6249.0
-	85.5	85.5	0.0	120	10022.5	10022.5	10022.5	4836.0	4836.0	4836.0	5186.5	5186.5	5186.5	6249.0	6249.0	6249.0
-	85.5	85.5	0.0	125	10022.5	10022.5	10022.5	4836.0	4836.0	4836.0	5186.5	5186.5	5186.5	6249.0	6249.0	6249.0
-	85.5	85.5	0.0	120	10022.5	10022.5	10022.5	4836.0	4836.0	4836.0	5186.5	5186.5	5186.5	6249.0	6249.0	6249.0
-	85.5	85.5	0.0	125	10022.5	10022.5	10022.5	4836.0	4836.0	4836.0	5186.5	5186.5	5186.5	6249.0	6249.0	6249.0
-	85.5	85.5	0.0	120	10022.5	10022.5	10022.5	4836.0	4836.0	4836.0	5186.5	5186.5	5186.5	6249.0	6249.0	6249.0
Till	85.5	95.5	10.0	135	10022.5	11372.5	10697.5	4836.0	5460.0	5148.0	5186.5	5912.5	5549.5	6249.0	6975.0	6612.0

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date: TCC 04-2013

Checked By/Date:



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-01**	
Proposed Grade:	15.0	feet
Grade Change:	4.5	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	562.5	psf
Δ Stress (Bldg. Loading):	500.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(Due to Proposed Grade Change) (inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	1.50	-	-	-
F-Satur	1.0	0.03	-	-	0.49	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.35	0.07	0.20	10.58	6.5	0.848	179.1
Fluvial	2.0	0.02	0.01	10.00	0.44	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					13.00			

Estimated Settlement @ 90% Consolidation
(inches)
11.70

Days	**179.1**
Months	**5.9**
Years	**0.5**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 13.0 ft

Assume Double Drainage of the "Composite" Layer
H_{dr} = 6.5 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**179.1**
Months	**5.9**
Years	**0.5**

SUMMARY OF SURCHARGE ASSESSMENT

Analysis Point/Location:	**GB-01**	
Proposed Surcharge Grade:	24.0	feet
Grade Change:	13.5	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Surcharge):	1687.5	psf

Surcharge Grade Conditions				Surcharge Assessment			
Primary Stratum	Effective Stress			Settlement		Req. Surcharge Consol.	Resulting T
	Top (psf)	Bottom (psf)	Middle (psf)	Proposed Grade (100%) Primary + Secondary (inches)	Surcharge Grade (100%) Primary Only (inches)	(%)	
-		1687.5		-	-	-	-
F-Unsat	1687.5	2607.5	2147.5	1.50	1.93	77.7%	-
F-Satur	2607.5	2889.2	2748.4	0.49	0.67	72.9%	-
-	2889.2	2889.2	2889.2	0.00	0.00	0.0%	-
-	2889.2	2889.2	2889.2	0.00	0.00	0.0%	-
Marsh	2889.2	3118.0	3003.6	13.48	16.11	83.7%	-
Fluvial	3118.0	6874.0	4996.0	0.44	0.64	-	-
-	6874.0	6874.0	6874.0	-	-	-	-
-	6874.0	6874.0	6874.0	0.00	0.00	0.0%	-
-	6874.0	6874.0	6874.0	-	-	-	-
-	6874.0	6874.0	6874.0	0.00	0.00	0.0%	-
-	6874.0	6874.0	6874.0	-	-	-	-
-	6874.0	6874.0	6874.0	0.00	0.00	0.0%	-
-	6874.0	6874.0	6874.0	-	-	-	-
-	6874.0	6874.0	6874.0	0.00	0.00	0.0%	-
-	6874.0	6874.0	6874.0	-	-	-	-
-	6874.0	6874.0	6874.0	0.00	0.00	0.0%	-
Till	6874.0	7600.0	7237.0	-	-	-	-
				15.90	**19.35**	**83.7%**	**0.650**

For Double Drainage Valid		Otherwise, Comp. D & O
137.4	**Days**	**137.4**
4.5	**Months**	**4.5**
0.4	**Years**	**0.4**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? YES

If answer to double drainage question = "YES", refer to the values above left for the estimated time to surcharge consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below (and above right) for the estimated time to surcharge consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)

(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 13 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 6.5 ft

T = 0.650 @ above surcharge consol.

Calculate Time, t, in days to Surcharge Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**137.4**
Months	**4.5**
Years	**0.4**

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-03	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	9.50	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	7.00	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	15.00	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	500.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	13.1	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	11.8	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	5.3	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	11.2	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-03	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	24.00	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	14.5	-
Surcharge Height above Prop. Grade (ft):	9.0	-
Resultant Time to Consolidation:	4.5	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change + one log cycle of secondary comp.
@ % Surcharge Consolidation:	86%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	OKAY	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-03	-	
Surcharge Area/Point No:	-	-	
Coefficient of Secondary Compression, C_{α}	0.01	Marsh	(Cα expressed by change in strain per log cycle of time)
Coefficient of Secondary Compression, C_{α}	0	N/A	(Cα expressed by change in strain per log cycle of time)
Est. Time to End of Primary Consolidation, t_p	0.5	Years	
Secondary Compression Design Time, t_{sec}	5.0	Years	1.0 No. of log cycles
Method from NAVFAC DM 7.1-231:	$H_{sec} = C\alpha * H_t * \log (t_{sec}/t_p)$		Where: H_{sec} = Secondary compression; H_t = Thickness of soil stratum
Est. Secondary Compression (inches):	2.0	Marsh	
Est. Secondary Compression (inches):	0.0	N/A	

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-03**	
Existing Grade:	9.5	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	7.0	feet bgs
Tot./Eff. Stress @ GWT =	805.0	psf

Analysis Point/Location:	**GB-03**	
Proposed Grade:	15.00	feet
Grade Change:	5.5	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	687.5	psf
Δ Stress (Bldg. Loading):	500.0	psf

Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

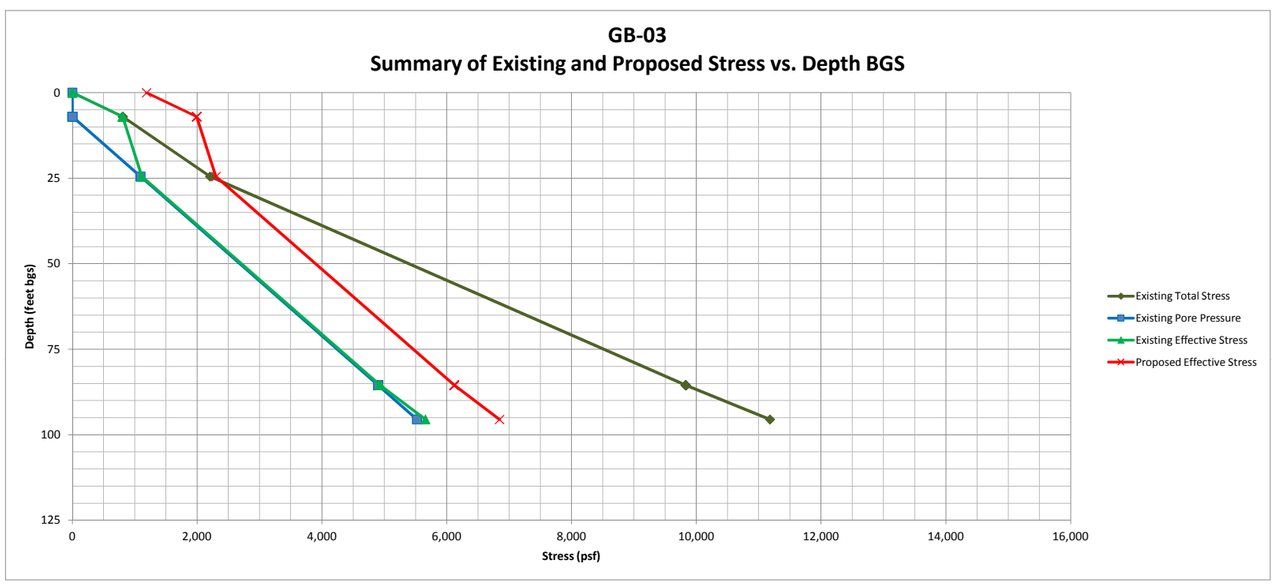
Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
Stratum	Top	Bottom		γ_t or γ_{sat}	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle
	(ft bgs)	(ft bgs)	(ft)	(pcf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)
		0.0	0.0			0.0			0.0			0.0			1187.5	
F-Unsat	0.0	7.0	7.0	115	0.0	805.0	402.5	0.0	0.0	0.0	0.0	805.0	402.5	1187.5	1992.5	1590.0
F-Satur	7.0	7.0	0.0	125	805.0	805.0	805.0	0.0	0.0	0.0	805.0	805.0	805.0	1992.5	1992.5	1992.5
-	7.0	7.0	0.0	110	805.0	805.0	805.0	0.0	0.0	0.0	805.0	805.0	805.0	1992.5	1992.5	1992.5
-	7.0	7.0	0.0	120	805.0	805.0	805.0	0.0	0.0	0.0	805.0	805.0	805.0	1992.5	1992.5	1992.5
Marsh	7.0	24.5	17.5	80	805.0	2205.0	1505.0	0.0	1092.0	546.0	805.0	1113.0	959.0	1992.5	2300.5	2146.5
Fluvial	24.5	85.5	61.0	125	2205.0	9830.0	6017.5	1092.0	4898.4	2995.2	1113.0	4931.6	3022.3	2300.5	6119.1	4209.8
-	85.5	85.5	0.0	125	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	6119.1	6119.1	6119.1
-	85.5	85.5	0.0	120	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	6119.1	6119.1	6119.1
-	85.5	85.5	0.0	125	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	6119.1	6119.1	6119.1
-	85.5	85.5	0.0	120	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	6119.1	6119.1	6119.1
-	85.5	85.5	0.0	125	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	6119.1	6119.1	6119.1
-	85.5	85.5	0.0	120	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	6119.1	6119.1	6119.1
-	85.5	85.5	0.0	125	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	6119.1	6119.1	6119.1
-	85.5	85.5	0.0	120	9830.0	9830.0	9830.0	4898.4	4898.4	4898.4	4931.6	4931.6	4931.6	6119.1	6119.1	6119.1
Till	85.5	95.5	10.0	135	9830.0	11180.0	10505.0	4898.4	5522.4	5210.4	4931.6	5657.6	5294.6	6119.1	6845.1	6482.1

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date: TCC 04-2013

Checked By/Date:



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-03**	
Proposed Grade:	15.0	feet
Grade Change:	5.5	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	687.5	psf
Δ Stress (Bldg. Loading):	500.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(Due to Proposed Grade Change) (inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	1.50	-	-	-
F-Satur	1.0	0.03	-	-	0.00	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.18	0.07	0.40	11.11	8.8	0.848	162.3
Fluvial	2.0	0.02	0.01	10.00	0.53	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					13.14			

Estimated Settlement @ 90% Consolidation
(inches)
11.83

Days	**162.3**
Months	**5.3**
Years	**0.4**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 17.5 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 8.8 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**162.3**
Months	**5.3**
Years	**0.4**

SUMMARY OF SURCHARGE ASSESSMENT

Analysis Point/Location:	**GB-03**	
Proposed Surcharge Grade:	24.0	feet
Grade Change:	14.5	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Surcharge):	1812.5	psf

Surcharge Grade Conditions				Surcharge Assessment			
Primary Stratum	Effective Stress			Settlement		Req. Surcharge Consol.	Resulting T
	Top (psf)	Bottom (psf)	Middle (psf)	Proposed Grade (100%) Primary + Secondary (inches)	Surcharge Grade (100%) Primary Only (inches)	(%)	
-		1812.5		-	-	-	-
F-Unsat	1812.5	2617.5	2215.0	1.50	1.87	80.6%	-
F-Satur	2617.5	2617.5	2617.5	0.00	0.00	0.0%	-
-	2617.5	2617.5	2617.5	0.00	0.00	0.0%	-
-	2617.5	2617.5	2617.5	0.00	0.00	0.0%	-
Marsh	2617.5	2925.5	2771.5	13.10	15.19	86.2%	-
Fluvial	2925.5	6744.1	4834.8	0.53	0.75	-	-
-	6744.1	6744.1	6744.1	-	-	-	-
-	6744.1	6744.1	6744.1	0.00	0.00	0.0%	-
-	6744.1	6744.1	6744.1	-	-	-	-
-	6744.1	6744.1	6744.1	0.00	0.00	0.0%	-
-	6744.1	6744.1	6744.1	-	-	-	-
-	6744.1	6744.1	6744.1	0.00	0.00	0.0%	-
-	6744.1	6744.1	6744.1	-	-	-	-
-	6744.1	6744.1	6744.1	0.00	0.00	0.0%	-
-	6744.1	6744.1	6744.1	-	-	-	-
-	6744.1	6744.1	6744.1	0.00	0.00	0.0%	-
Till	6744.1	7470.1	7107.1	-	-	-	-
				15.13	17.81	86.2%	0.719

For Double Drainage Valid		Otherwise, Comp. D & O
137.6	Days	137.6
4.5	Months	4.5
0.4	Years	0.4

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? YES

If answer to double drainage question = "YES", refer to the values above left for the estimated time to surcharge consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below (and above right) for the estimated time to surcharge consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)

(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 17.5 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 8.75 ft

T = 0.719 @ above surcharge consol.

Calculate Time, t, in days to Surcharge Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	137.6
Months	4.5
Years	0.4

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-05	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	11.00	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	8.50	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	15.00	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	500.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	8.5	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	7.7	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	2.2	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	4.7	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-05	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	22.00	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	11.0	-
Surcharge Height above Prop. Grade (ft):	7.0	-
Resultant Time to Consolidation:	3.0	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change + one log cycle of secondary comp.
@ % Surcharge Consolidation:	95%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	OKAY	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-05	-	
Surcharge Area/Point No:	-	-	
Coefficient of Secondary Compression, C_{α}	0.02	Marsh	(Cα expressed by change in strain per log cycle of time)
Coefficient of Secondary Compression, C_{α}	0	N/A	(Cα expressed by change in strain per log cycle of time)
Est. Time to End of Primary Consolidation, t_p	0.5	Years	
Secondary Compression Design Time, t_{sec}	5.0	Years	1.0 No. of log cycles

Method from NAVFAC DM 7.1-231: $H_{sec} = C\alpha * H_t * \log (t_{sec}/t_p)$

Where: H_{sec} = Secondary compression
H_t = Thickness of soil stratum

Est. Secondary Compression (inches):	1.8	Marsh
Est. Secondary Compression (inches):	0.0	N/A

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-05**	
Existing Grade:	11.0	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	8.5	feet bgs
Tot./Eff. Stress @ GWT =	977.5	psf

Analysis Point/Location:	**GB-05**	
Proposed Grade:	15.00	feet
Grade Change:	4.0	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	500.0	psf
Δ Stress (Bldg. Loading):	500.0	psf

Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

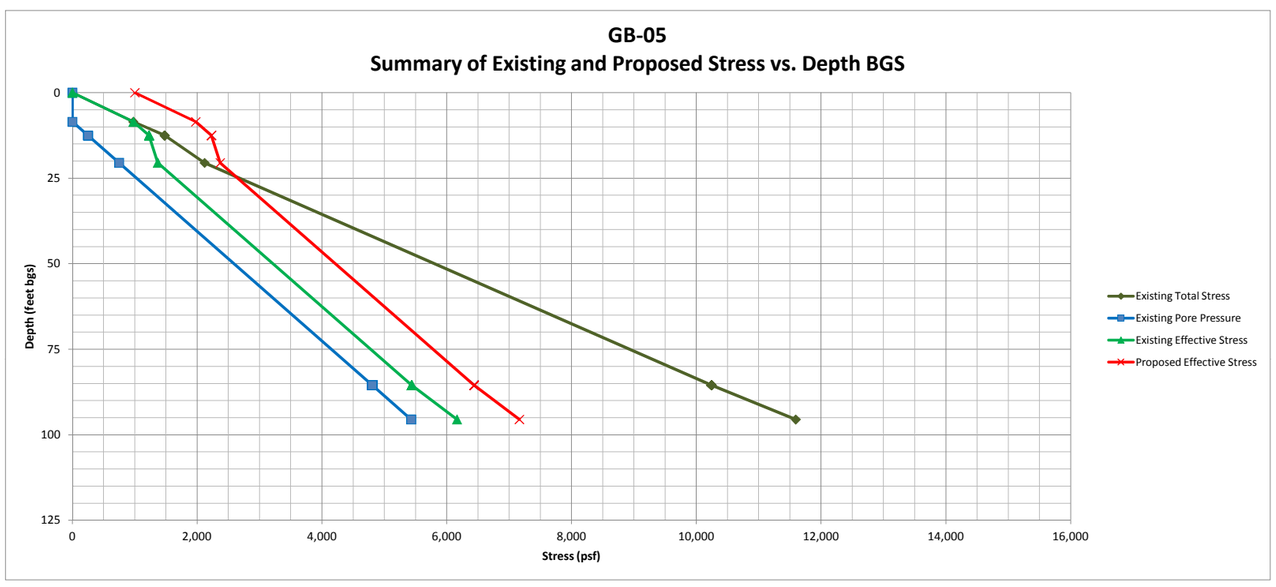
Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
Stratum	Top	Bottom		γ_t or γ_{sat}	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle
	(ft bgs)	(ft bgs)	(ft)	(pcf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)
		0.0	0.0			0.0			0.0			0.0			1000.0	
F-Unsat	0.0	8.5	8.5	115	0.0	977.5	488.8	0.0	0.0	0.0	0.0	977.5	488.8	1000.0	1977.5	1488.8
F-Satur	8.5	12.5	4.0	125	977.5	1477.5	1227.5	0.0	249.6	124.8	977.5	1227.9	1102.7	1977.5	2227.9	2102.7
-	12.5	12.5	0.0	110	1477.5	1477.5	1477.5	249.6	249.6	249.6	1227.9	1227.9	1227.9	2227.9	2227.9	2227.9
-	12.5	12.5	0.0	120	1477.5	1477.5	1477.5	249.6	249.6	249.6	1227.9	1227.9	1227.9	2227.9	2227.9	2227.9
Marsh	12.5	20.5	8.0	80	1477.5	2117.5	1797.5	249.6	748.8	499.2	1227.9	1368.7	1298.3	2227.9	2368.7	2298.3
Fluvial	20.5	85.5	65.0	125	2117.5	10242.5	6180.0	748.8	4804.8	2776.8	1368.7	5437.7	3403.2	2368.7	6437.7	4403.2
-	85.5	85.5	0.0	125	10242.5	10242.5	10242.5	4804.8	4804.8	4804.8	5437.7	5437.7	5437.7	6437.7	6437.7	6437.7
-	85.5	85.5	0.0	120	10242.5	10242.5	10242.5	4804.8	4804.8	4804.8	5437.7	5437.7	5437.7	6437.7	6437.7	6437.7
-	85.5	85.5	0.0	125	10242.5	10242.5	10242.5	4804.8	4804.8	4804.8	5437.7	5437.7	5437.7	6437.7	6437.7	6437.7
-	85.5	85.5	0.0	120	10242.5	10242.5	10242.5	4804.8	4804.8	4804.8	5437.7	5437.7	5437.7	6437.7	6437.7	6437.7
-	85.5	85.5	0.0	125	10242.5	10242.5	10242.5	4804.8	4804.8	4804.8	5437.7	5437.7	5437.7	6437.7	6437.7	6437.7
-	85.5	85.5	0.0	120	10242.5	10242.5	10242.5	4804.8	4804.8	4804.8	5437.7	5437.7	5437.7	6437.7	6437.7	6437.7
-	85.5	85.5	0.0	125	10242.5	10242.5	10242.5	4804.8	4804.8	4804.8	5437.7	5437.7	5437.7	6437.7	6437.7	6437.7
-	85.5	85.5	0.0	120	10242.5	10242.5	10242.5	4804.8	4804.8	4804.8	5437.7	5437.7	5437.7	6437.7	6437.7	6437.7
Till	85.5	95.5	10.0	135	10242.5	11592.5	10917.5	4804.8	5428.8	5116.8	5437.7	6163.7	5800.7	6437.7	7163.7	6800.7

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date: TCC 04-2013

Checked By/Date:



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-05**	
Proposed Grade:	15.0	feet
Grade Change:	4.0	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	500.0	psf
Δ Stress (Bldg. Loading):	500.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(Due to Proposed Grade Change) (inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	1.48	-	-	-
F-Satur	1.0	0.03	-	-	0.40	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.35	0.07	0.20	6.21	4.0	0.848	67.8
Fluvial	2.0	0.02	0.01	10.00	0.44	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					8.53			

Estimated Settlement @ 90% Consolidation
(inches)
7.67

Days	**67.8**
Months	**2.2**
Years	**0.2**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 8.0 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 4.0 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**67.8**
Months	**2.2**
Years	**0.2**

SUMMARY OF SURCHARGE ASSESSMENT

Analysis Point/Location:	**GB-05**	
Proposed Surcharge Grade:	22.0	feet
Grade Change:	11.0	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Surcharge):	1375.0	psf

Surcharge Grade Conditions				Surcharge Assessment			
Primary Stratum	Effective Stress			Settlement		Req. Surcharge Consol.	Resulting T
	Top (psf)	Bottom (psf)	Middle (psf)	Proposed Grade (100%) Primary + Secondary (inches)	Surcharge Grade (100%) Primary Only (inches)	(%)	
-		1375.0		-	-	-	-
F-Unsat	1375.0	2352.5	1863.8	1.48	1.78	83.2%	-
F-Satur	2352.5	2602.9	2477.7	0.40	0.51	79.7%	-
-	2602.9	2602.9	2602.9	0.00	0.00	0.0%	-
-	2602.9	2602.9	2602.9	0.00	0.00	0.0%	-
Marsh	2602.9	2743.7	2673.3	8.00	8.41	95.1%	-
Fluvial	2743.7	6812.7	4778.2	0.44	0.57	-	-
-	6812.7	6812.7	6812.7	-	-	-	-
-	6812.7	6812.7	6812.7	0.00	0.00	0.0%	-
-	6812.7	6812.7	6812.7	-	-	-	-
-	6812.7	6812.7	6812.7	0.00	0.00	0.0%	-
-	6812.7	6812.7	6812.7	-	-	-	-
-	6812.7	6812.7	6812.7	0.00	0.00	0.0%	-
-	6812.7	6812.7	6812.7	-	-	-	-
-	6812.7	6812.7	6812.7	0.00	0.00	0.0%	-
-	6812.7	6812.7	6812.7	-	-	-	-
-	6812.7	6812.7	6812.7	0.00	0.00	0.0%	-
Till	6812.7	7538.7	7175.7	-	-	-	-
				10.32	11.27	95.1%	1.140

For Double Drainage Valid		Otherwise, Comp. D & O
91.2	Days	91.2
3.0	Months	3.0
0.2	Years	0.2

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? YES

If answer to double drainage question = "YES", refer to the values above left for the estimated time to surcharge consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below (and above right) for the estimated time to surcharge consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)

(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 8 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 4 ft

T = 1.140 @ above surcharge consol.

Calculate Time, t, in days to Surcharge Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	91.2
Months	3.0
Years	0.2

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-06	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	8.50	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	6.00	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	15.00	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	0.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	9.0	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	8.1	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	2.5	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	5.3	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-06	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	15.50	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	7.0	-
Surcharge Height above Prop. Grade (ft):	0.5	-
Resultant Time to Consolidation:	3.0	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change.
@ % Surcharge Consolidation:	93%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	OKAY	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-06	-	
Surcharge Area/Point No:	-	-	
Coefficient of Secondary Compression, C_{α}	0.02	Marsh	(C_{α} expressed by change in strain per log cycle of time)
Coefficient of Secondary Compression, C_{α}	0	N/A	(C_{α} expressed by change in strain per log cycle of time)
Est. Time to End of Primary Consolidation, t_p	0.5	Years	1.0 No. of log cycles
Secondary Compression Design Time, t_{sec}	5.0	Years	

Method from NAVFAC DM 7.1-231: $H_{sec} = C_{\alpha} * H_t * \log (t_{sec}/t_p)$

Where: H_{sec} = Secondary compression
H_t = Thickness of soil stratum

Est. Secondary Compression (inches):	1.9	Marsh
Est. Secondary Compression (inches):	0.0	N/A

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-06**	
Existing Grade:	8.5	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	6.0	feet bgs
Tot./Eff. Stress @ GWT =	690.0	psf

Analysis Point/Location:	**GB-06**	
Proposed Grade:	15.00	feet
Grade Change:	6.5	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	812.5	psf
Δ Stress (Bldg. Loading):	0.0	psf

Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

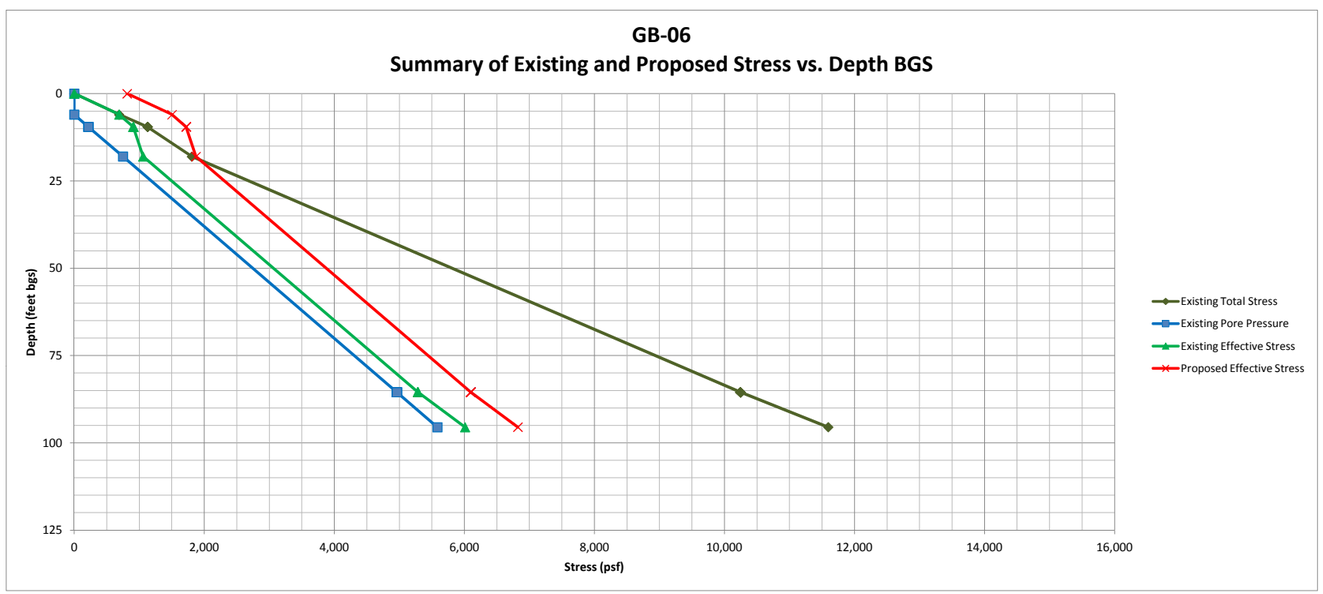
Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary Stratum	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
	Top (ft bgs)	Bottom (ft bgs)	(ft)	γ_t or γ_{sat} (pcf)	Top (psf)	Bottom (psf)	Middle (psf)	Top (psf)	Bottom (psf)	Middle (psf)	Top (psf)	Bottom (psf)	Middle (psf)	Top (psf)	Bottom (psf)	Middle (psf)
		0.0	0.0			0.0			0.0			0.0			812.5	
F-Unsat	0.0	6.0	6.0	115	0.0	690.0	345.0	0.0	0.0	0.0	0.0	690.0	345.0	812.5	1502.5	1157.5
F-Satur	6.0	9.5	3.5	125	690.0	1127.5	908.8	0.0	218.4	109.2	690.0	909.1	799.6	1502.5	1721.6	1612.1
-	9.5	9.5	0.0	110	1127.5	1127.5	1127.5	218.4	218.4	218.4	909.1	909.1	909.1	1721.6	1721.6	1721.6
-	9.5	9.5	0.0	120	1127.5	1127.5	1127.5	218.4	218.4	218.4	909.1	909.1	909.1	1721.6	1721.6	1721.6
Marsh	9.5	18.0	8.5	80	1127.5	1807.5	1467.5	218.4	748.8	483.6	909.1	1058.7	983.9	1721.6	1871.2	1796.4
Fluvial	18.0	85.5	67.5	125	1807.5	10245.0	6026.3	748.8	4960.8	2854.8	1058.7	5284.2	3171.5	1871.2	6096.7	3984.0
-	85.5	85.5	0.0	125	10245.0	10245.0	10245.0	4960.8	4960.8	4960.8	5284.2	5284.2	5284.2	6096.7	6096.7	6096.7
-	85.5	85.5	0.0	120	10245.0	10245.0	10245.0	4960.8	4960.8	4960.8	5284.2	5284.2	5284.2	6096.7	6096.7	6096.7
-	85.5	85.5	0.0	125	10245.0	10245.0	10245.0	4960.8	4960.8	4960.8	5284.2	5284.2	5284.2	6096.7	6096.7	6096.7
-	85.5	85.5	0.0	120	10245.0	10245.0	10245.0	4960.8	4960.8	4960.8	5284.2	5284.2	5284.2	6096.7	6096.7	6096.7
-	85.5	85.5	0.0	125	10245.0	10245.0	10245.0	4960.8	4960.8	4960.8	5284.2	5284.2	5284.2	6096.7	6096.7	6096.7
-	85.5	85.5	0.0	120	10245.0	10245.0	10245.0	4960.8	4960.8	4960.8	5284.2	5284.2	5284.2	6096.7	6096.7	6096.7
-	85.5	85.5	0.0	125	10245.0	10245.0	10245.0	4960.8	4960.8	4960.8	5284.2	5284.2	5284.2	6096.7	6096.7	6096.7
-	85.5	85.5	0.0	120	10245.0	10245.0	10245.0	4960.8	4960.8	4960.8	5284.2	5284.2	5284.2	6096.7	6096.7	6096.7
-	85.5	85.5	0.0	125	10245.0	10245.0	10245.0	4960.8	4960.8	4960.8	5284.2	5284.2	5284.2	6096.7	6096.7	6096.7
-	85.5	85.5	0.0	120	10245.0	10245.0	10245.0	4960.8	4960.8	4960.8	5284.2	5284.2	5284.2	6096.7	6096.7	6096.7
Till	85.5	95.5	10.0	135	10245.0	11595.0	10920.0	4960.8	5584.8	5272.8	5284.2	6010.2	5647.2	6096.7	6822.7	6459.7

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date: TCC 04-2013

Checked By/Date:



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-06**	
Proposed Grade:	15.0	feet
Grade Change:	6.5	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	812.5	psf
Δ Stress (Bldg. Loading):	0.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement (Due to Proposed Grade Change)	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	1.14	-	-	-
F-Satur	1.0	0.03	-	-	0.38	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.35	0.07	0.20	7.07	4.3	0.848	76.6
Fluvial	2.0	0.02	0.01	10.00	0.40	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					8.99			

Estimated Settlement @ 90% Consolidation
(inches)
8.09

Days	**76.6**
Months	**2.5**
Years	**0.2**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 8.5 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 4.3 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**76.6**
Months	**2.5**
Years	**0.2**

SUMMARY OF SURCHARGE ASSESSMENT

Analysis Point/Location:	**GB-06**	
Proposed Surcharge Grade:	15.5	feet
Grade Change:	7.0	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Surcharge):	875.0	psf

Surcharge Grade Conditions				Surcharge Assessment			
Primary Stratum	Effective Stress			Primary Consolidation Settlement		Req. Surcharge Consol.	Resulting T
	Top (psf)	Bottom (psf)	Middle (psf)	Proposed Grade (100%) (inches)	Surcharge Grade (100%) (inches)	(%)	
-		875.0		-	-	-	-
F-Unsat	875.0	1565.0	1220.0	1.14	1.18	95.8%	-
F-Satur	1565.0	1784.1	1674.6	0.38	0.40	94.9%	-
-	1784.1	1784.1	1784.1	0.00	0.00	0.0%	-
-	1784.1	1784.1	1784.1	0.00	0.00	0.0%	-
Marsh	1784.1	1933.7	1858.9	7.07	7.60	93.0%	-
Fluvial	1933.7	6159.2	4046.5	0.40	0.43	-	-
-	6159.2	6159.2	6159.2	-	-	-	-
-	6159.2	6159.2	6159.2	0.00	0.00	0.0%	-
-	6159.2	6159.2	6159.2	-	-	-	-
-	6159.2	6159.2	6159.2	0.00	0.00	0.0%	-
-	6159.2	6159.2	6159.2	-	-	-	-
-	6159.2	6159.2	6159.2	0.00	0.00	0.0%	-
-	6159.2	6159.2	6159.2	-	-	-	-
-	6159.2	6159.2	6159.2	0.00	0.00	0.0%	-
-	6159.2	6159.2	6159.2	-	-	-	-
-	6159.2	6159.2	6159.2	0.00	0.00	0.0%	-
Till	6159.2	6885.2	6522.2	-	-	-	-
				8.99	9.62	93.0%	0.994

For Double Drainage Valid		Otherwise, Comp. D & O
89.8	Days	89.8
3.0	Months	3.0
0.2	Years	0.2

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? YES

If answer to double drainage question = "YES", refer to the values above left for the estimated time to surcharge consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below (and above right) for the estimated time to surcharge consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)

(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 8.5 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 4.25 ft

T = 0.994 @ above surcharge consol.

Calculate Time, t, in days to Surcharge Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	89.8
Months	3.0
Years	0.2

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-07	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	7.50	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	4.50	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	15.00	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	500.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	17.3	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	15.6	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	5.0	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	10.5	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-07	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	24.00	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	16.5	-
Surcharge Height above Prop. Grade (ft):	9.0	-
Resultant Time to Consolidation:	4.8	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change + one log cycle of secondary comp.
@ % Surcharge Consolidation:	89%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	OKAY	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-07	-	
Surcharge Area/Point No:	-	-	
Coefficient of Secondary Compression, C_{α}	0.02	Marsh	(Cα expressed by change in strain per log cycle of time)
Coefficient of Secondary Compression, C_{α}	0	N/A	(Cα expressed by change in strain per log cycle of time)
Est. Time to End of Primary Consolidation, t_p	0.5	Years	
Secondary Compression Design Time, t_{sec}	5.0	Years	1.0 No. of log cycles
Est. Secondary Compression (inches):	2.6	Marsh	
Est. Secondary Compression (inches):	0.0	N/A	

Method from NAVFAC DM 7.1-231: $H_{sec} = C\alpha * H_t * \log (t_{sec}/t_p)$

Where: H_{sec} = Secondary compression
H_t = Thickness of soil stratum

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-07**	
Existing Grade:	7.5	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	4.5	feet bgs
Tot./Eff. Stress @ GWT =	517.5	psf

Analysis Point/Location:	**GB-07**	
Proposed Grade:	15.00	feet
Grade Change:	7.5	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	937.5	psf
Δ Stress (Bldg. Loading):	500.0	psf

Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

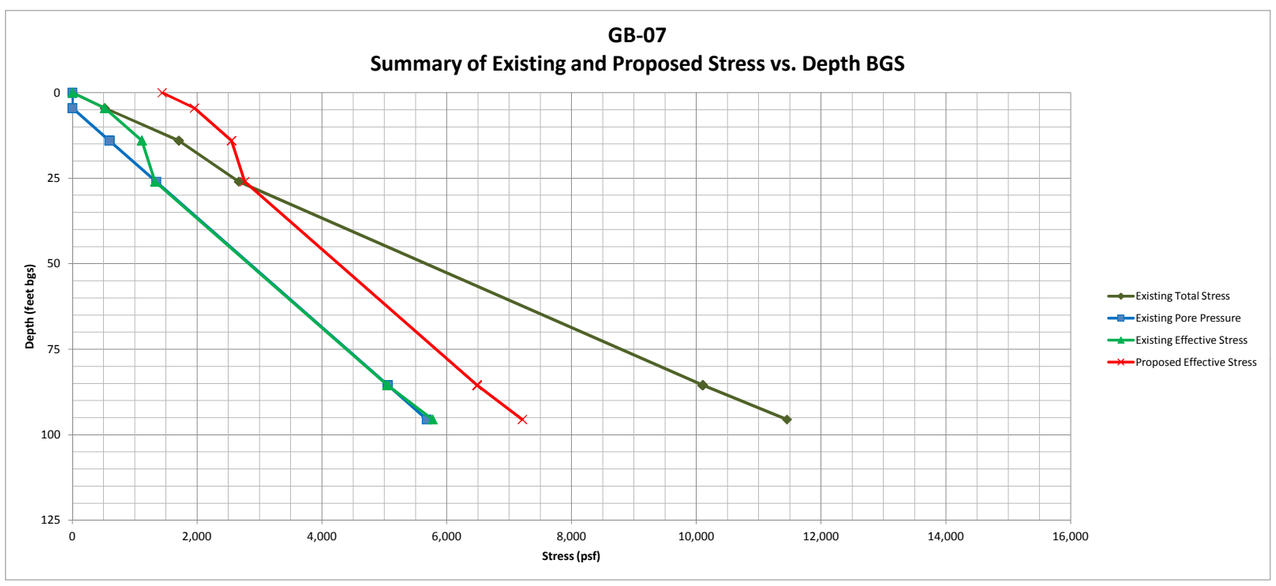
Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
Stratum	Top	Bottom		γ_t or γ_{sat}	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle
	(ft bgs)	(ft bgs)	(ft)	(pcf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)
		0.0	0.0			0.0			0.0			0.0			1437.5	
F-Unsat	0.0	4.5	4.5	115	0.0	517.5	258.8	0.0	0.0	0.0	0.0	517.5	258.8	1437.5	1955.0	1696.3
F-Satur	4.5	14.0	9.5	125	517.5	1705.0	1111.3	0.0	592.8	296.4	517.5	1112.2	814.9	1955.0	2549.7	2252.4
-	14.0	14.0	0.0	110	1705.0	1705.0	1705.0	592.8	592.8	592.8	1112.2	1112.2	1112.2	2549.7	2549.7	2549.7
-	14.0	14.0	0.0	120	1705.0	1705.0	1705.0	592.8	592.8	592.8	1112.2	1112.2	1112.2	2549.7	2549.7	2549.7
Marsh	14.0	26.0	12.0	80	1705.0	2665.0	2185.0	592.8	1341.6	967.2	1112.2	1323.4	1217.8	2549.7	2760.9	2655.3
Fluvial	26.0	85.5	59.5	125	2665.0	10102.5	6383.8	1341.6	5054.4	3198.0	1323.4	5048.1	3185.8	2760.9	6485.6	4623.3
-	85.5	85.5	0.0	125	10102.5	10102.5	10102.5	5054.4	5054.4	5054.4	5048.1	5048.1	5048.1	6485.6	6485.6	6485.6
-	85.5	85.5	0.0	120	10102.5	10102.5	10102.5	5054.4	5054.4	5054.4	5048.1	5048.1	5048.1	6485.6	6485.6	6485.6
-	85.5	85.5	0.0	125	10102.5	10102.5	10102.5	5054.4	5054.4	5054.4	5048.1	5048.1	5048.1	6485.6	6485.6	6485.6
-	85.5	85.5	0.0	120	10102.5	10102.5	10102.5	5054.4	5054.4	5054.4	5048.1	5048.1	5048.1	6485.6	6485.6	6485.6
-	85.5	85.5	0.0	125	10102.5	10102.5	10102.5	5054.4	5054.4	5054.4	5048.1	5048.1	5048.1	6485.6	6485.6	6485.6
-	85.5	85.5	0.0	120	10102.5	10102.5	10102.5	5054.4	5054.4	5054.4	5048.1	5048.1	5048.1	6485.6	6485.6	6485.6
-	85.5	85.5	0.0	125	10102.5	10102.5	10102.5	5054.4	5054.4	5054.4	5048.1	5048.1	5048.1	6485.6	6485.6	6485.6
-	85.5	85.5	0.0	120	10102.5	10102.5	10102.5	5054.4	5054.4	5054.4	5048.1	5048.1	5048.1	6485.6	6485.6	6485.6
Till	85.5	95.5	10.0	135	10102.5	11452.5	10777.5	5054.4	5678.4	5366.4	5048.1	5774.1	5411.1	6485.6	7211.6	6848.6

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date: TCC 04-2013

Checked By/Date:



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-07**	
Proposed Grade:	15.0	feet
Grade Change:	7.5	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	937.5	psf
Δ Stress (Bldg. Loading):	500.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(Due to Proposed Grade Change) (inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	1.32	-	-	-
F-Satur	1.0	0.03	-	-	1.51	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.35	0.07	0.20	13.87	6.0	0.848	152.6
Fluvial	2.0	0.02	0.01	10.00	0.58	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					17.28			

Estimated Settlement @ 90% Consolidation
(inches)
15.55

Days	**152.6**
Months	**5.0**
Years	**0.4**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 12.0 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 6.0 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**152.6**
Months	**5.0**
Years	**0.4**

SUMMARY OF SURCHARGE ASSESSMENT

Analysis Point/Location:	**GB-07**	
Proposed Surcharge Grade:	24.0	feet
Grade Change:	16.5	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Surcharge):	2062.5	psf

Surcharge Grade Conditions				Surcharge Assessment			
Primary Stratum	Effective Stress			Settlement		Req. Surcharge Consol.	Resulting T
	Top (psf)	Bottom (psf)	Middle (psf)	Proposed Grade (100%) Primary + Secondary (inches)	Surcharge Grade (100%) Primary Only (inches)	(%)	
-		2062.5		-	-	-	-
F-Unsat	2062.5	2580.0	2321.3	1.32	1.54	85.7%	-
F-Satur	2580.0	3174.7	2877.4	1.51	1.87	80.6%	-
-	3174.7	3174.7	3174.7	0.00	0.00	0.0%	-
-	3174.7	3174.7	3174.7	0.00	0.00	0.0%	-
Marsh	3174.7	3385.9	3280.3	16.47	18.50	89.1%	-
Fluvial	3385.9	7110.6	5248.3	0.58	0.77	-	-
-	7110.6	7110.6	7110.6	-	-	-	-
-	7110.6	7110.6	7110.6	0.00	0.00	0.0%	-
-	7110.6	7110.6	7110.6	-	-	-	-
-	7110.6	7110.6	7110.6	0.00	0.00	0.0%	-
-	7110.6	7110.6	7110.6	-	-	-	-
-	7110.6	7110.6	7110.6	0.00	0.00	0.0%	-
-	7110.6	7110.6	7110.6	-	-	-	-
-	7110.6	7110.6	7110.6	0.00	0.00	0.0%	-
-	7110.6	7110.6	7110.6	-	-	-	-
-	7110.6	7110.6	7110.6	0.00	0.00	0.0%	-
Till	7110.6	7836.6	7473.6	-	-	-	-
				19.88	22.69	89.1%	0.811

For Double Drainage Valid		Otherwise, Comp. D & O
146.1	Days	146.1
4.8	Months	4.8
0.4	Years	0.4

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? YES

If answer to double drainage question = "YES", refer to the values above left for the estimated time to surcharge consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below (and above right) for the estimated time to surcharge consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)

(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 12 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 6 ft

T = 0.811 @ above surcharge consol.

Calculate Time, t, in days to Surcharge Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	146.1
Months	4.8
Years	0.4

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-08	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	8.00	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	5.50	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	15.00	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	0.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	13.3	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	11.9	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	7.8	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	16.5	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-08	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	16.50	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	8.5	-
Surcharge Height above Prop. Grade (ft):	1.5	-
Resultant Time to Consolidation:	5.7	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change.
@ % Surcharge Consolidation:	82%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	OKAY	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-08	-	
Surcharge Area/Point No:	-	-	
Coefficient of Secondary Compression, C_{α}	0.02	Marsh	($C\alpha$ expressed by change in strain per log cycle of time)
Coefficient of Secondary Compression, C_{α}	0	N/A	($C\alpha$ expressed by change in strain per log cycle of time)
Est. Time to End of Primary Consolidation, t_p	0.5	Years	1.0 No. of log cycles
Secondary Compression Design Time, t_{sec}	5.0	Years	

Method from NAVFAC DM 7.1-231: $H_{sec} = C\alpha * H_t * \log (t_{sec}/t_p)$

Where: H_{sec} = Secondary compression
H_t = Thickness of soil stratum

Est. Secondary Compression (inches):	3.4	Marsh
Est. Secondary Compression (inches):	0.0	N/A

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-08**	
Existing Grade:	8.0	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	5.5	feet bgs
Tot./Eff. Stress @ GWT =	632.5	psf

Analysis Point/Location:	**GB-08**	
Proposed Grade:	15.00	feet
Grade Change:	7.0	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	875.0	psf
Δ Stress (Bldg. Loading):	0.0	psf

Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

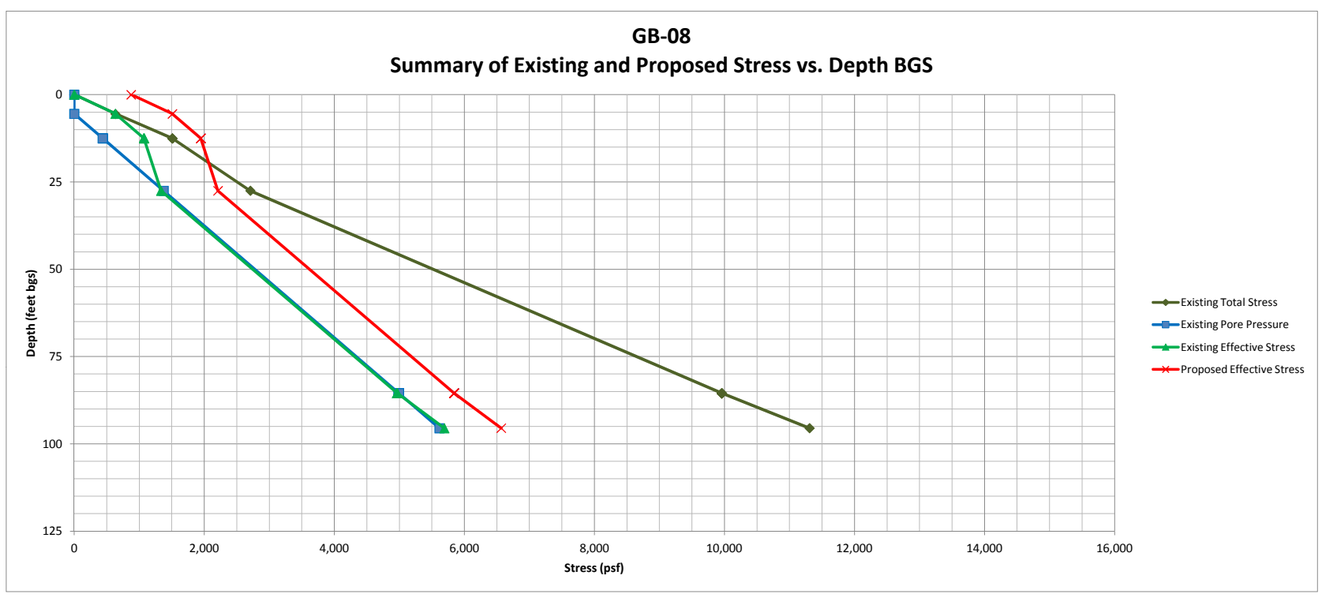
Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary Stratum	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
	Top (ft bgs)	Bottom (ft bgs)	(ft)	γ_t or γ_{sat} (pcf)	Top (psf)	Bottom (psf)	Middle (psf)	Top (psf)	Bottom (psf)	Middle (psf)	Top (psf)	Bottom (psf)	Middle (psf)	Top (psf)	Bottom (psf)	Middle (psf)
		0.0	0.0			0.0			0.0			0.0			875.0	
F-Unsat	0.0	5.5	5.5	115	0.0	632.5	316.3	0.0	0.0	0.0	0.0	632.5	316.3	875.0	1507.5	1191.3
F-Satur	5.5	12.5	7.0	125	632.5	1507.5	1070.0	0.0	436.8	218.4	632.5	1070.7	851.6	1507.5	1945.7	1726.6
-	12.5	12.5	0.0	110	1507.5	1507.5	1507.5	436.8	436.8	436.8	1070.7	1070.7	1070.7	1945.7	1945.7	1945.7
-	12.5	12.5	0.0	120	1507.5	1507.5	1507.5	436.8	436.8	436.8	1070.7	1070.7	1070.7	1945.7	1945.7	1945.7
Marsh	12.5	27.5	15.0	80	1507.5	2707.5	2107.5	436.8	1372.8	904.8	1070.7	1334.7	1202.7	1945.7	2209.7	2077.7
Fluvial	27.5	85.5	58.0	125	2707.5	9957.5	6332.5	1372.8	4992.0	3182.4	1334.7	4965.5	3150.1	2209.7	5840.5	4025.1
-	85.5	85.5	0.0	125	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5840.5	5840.5	5840.5
-	85.5	85.5	0.0	120	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5840.5	5840.5	5840.5
-	85.5	85.5	0.0	125	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5840.5	5840.5	5840.5
-	85.5	85.5	0.0	120	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5840.5	5840.5	5840.5
-	85.5	85.5	0.0	125	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5840.5	5840.5	5840.5
-	85.5	85.5	0.0	120	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5840.5	5840.5	5840.5
-	85.5	85.5	0.0	125	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5840.5	5840.5	5840.5
-	85.5	85.5	0.0	120	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5840.5	5840.5	5840.5
-	85.5	85.5	0.0	125	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5840.5	5840.5	5840.5
-	85.5	85.5	0.0	120	9957.5	9957.5	9957.5	4992.0	4992.0	4992.0	4965.5	4965.5	4965.5	5840.5	5840.5	5840.5
Till	85.5	95.5	10.0	135	9957.5	11307.5	10632.5	4992.0	5616.0	5304.0	4965.5	5691.5	5328.5	5840.5	6566.5	6203.5

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date: TCC 04-2013

Checked By/Date:



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-08**	
Proposed Grade:	15.0	feet
Grade Change:	7.0	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	875.0	psf
Δ Stress (Bldg. Loading):	0.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement (Due to Proposed Grade Change)	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	1.14	-	-	-
F-Satur	1.0	0.03	-	-	0.77	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.35	0.07	0.20	10.97	7.5	0.848	238.5
Fluvial	2.0	0.02	0.01	10.00	0.37	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					13.25			

Estimated Settlement @ 90% Consolidation
(inches)
11.93

Days	**238.5**
Months	**7.8**
Years	**0.7**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 15.0 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 7.5 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**238.5**
Months	**7.8**
Years	**0.7**

SUMMARY OF SURCHARGE ASSESSMENT

Analysis Point/Location:	**GB-08**	
Proposed Surcharge Grade:	16.5	feet
Grade Change:	8.5	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Surcharge):	1062.5	psf

Surcharge Grade Conditions				Surcharge Assessment			
Primary Stratum	Effective Stress			Primary Consolidation Settlement		Req. Surcharge Consol.	Resulting T
	Top (psf)	Bottom (psf)	Middle (psf)	Proposed Grade (100%) (inches)	Surcharge Grade (100%) (inches)	(%)	
-		1062.5		-	-	-	-
F-Unsat	1062.5	1695.0	1378.8	1.14	1.27	90.1%	-
F-Satur	1695.0	2133.2	1914.1	0.77	0.89	87.3%	-
-	2133.2	2133.2	2133.2	0.00	0.00	0.0%	-
-	2133.2	2133.2	2133.2	0.00	0.00	0.0%	-
Marsh	2133.2	2397.2	2265.2	10.97	13.33	82.3%	-
Fluvial	2397.2	6028.0	4212.6	0.37	0.44	-	-
-	6028.0	6028.0	6028.0	-	-	-	-
-	6028.0	6028.0	6028.0	0.00	0.00	0.0%	-
-	6028.0	6028.0	6028.0	-	-	-	-
-	6028.0	6028.0	6028.0	0.00	0.00	0.0%	-
-	6028.0	6028.0	6028.0	-	-	-	-
-	6028.0	6028.0	6028.0	0.00	0.00	0.0%	-
-	6028.0	6028.0	6028.0	-	-	-	-
-	6028.0	6028.0	6028.0	0.00	0.00	0.0%	-
-	6028.0	6028.0	6028.0	-	-	-	-
-	6028.0	6028.0	6028.0	0.00	0.00	0.0%	-
Till	6028.0	6754.0	6391.0	-	-	-	-
				13.25	15.92	82.3%	0.616

For Double Drainage Valid		Otherwise, Comp. D & O
173.2	Days	173.2
5.7	Months	5.7
0.5	Years	0.5

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? YES

If answer to double drainage question = "YES", refer to the values above left for the estimated time to surcharge consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below (and above right) for the estimated time to surcharge consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)

(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 15 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 7.5 ft

T = 0.616 @ above surcharge consol.

Calculate Time, t, in days to Surcharge Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	173.2
Months	5.7
Years	0.5

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-09	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	8.00	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	5.50	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	15.00	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	500.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	21.1	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	19.0	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	6.4	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	13.3	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-09	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	25.00	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	17.0	-
Surcharge Height above Prop. Grade (ft):	10.0	-
Resultant Time to Consolidation:	5.4	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change + one log cycle of secondary comp.
@ % Surcharge Consolidation:	86%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	OKAY	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-09	-		
Surcharge Area/Point No:	-	-		
Coefficient of Secondary Compression, C_{α}	0.02	Marsh	(Cα expressed by change in strain per log cycle of time)	
Coefficient of Secondary Compression, C_{α}	0	N/A	(Cα expressed by change in strain per log cycle of time)	
Est. Time to End of Primary Consolidation, t_p	0.5	Years	1.0	No. of log cycles
Secondary Compression Design Time, t_{sec}	5.0	Years		

Method from NAVFAC DM 7.1-231: $H_{sec} = C\alpha * H_t * \log (t_{sec}/t_p)$

Where: H_{sec} = Secondary compression
H_t = Thickness of soil stratum

Est. Secondary Compression (inches):	2.9	Marsh
Est. Secondary Compression (inches):	0.0	N/A

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-09**	
Existing Grade:	8.0	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	5.5	feet bgs
Tot./Eff. Stress @ GWT =	632.5	psf

Analysis Point/Location:	**GB-09**	
Proposed Grade:	15.00	feet
Grade Change:	7.0	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	875.0	psf
Δ Stress (Bldg. Loading):	500.0	psf

Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

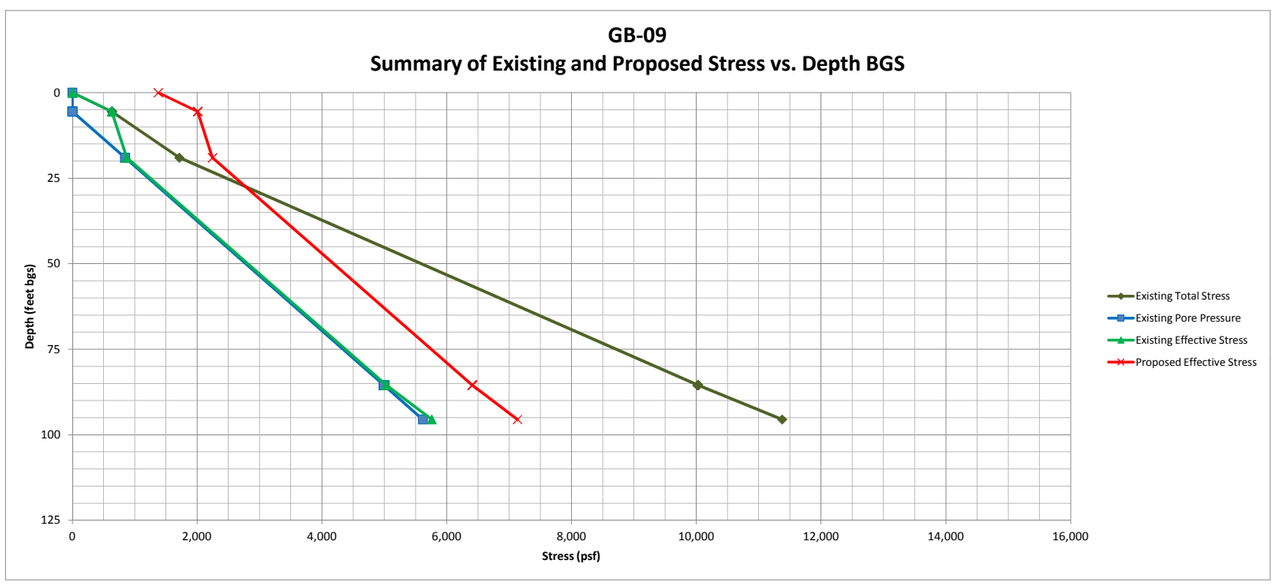
Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
Stratum	Top	Bottom		γ_t or γ_{sat}	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle
	(ft bgs)	(ft bgs)	(ft)	(pcf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)
		0.0	0.0			0.0			0.0			0.0			1375.0	
F-Unsat	0.0	5.5	5.5	115	0.0	632.5	316.3	0.0	0.0	0.0	0.0	632.5	316.3	1375.0	2007.5	1691.3
F-Satur	5.5	5.5	0.0	125	632.5	632.5	632.5	0.0	0.0	0.0	632.5	632.5	632.5	2007.5	2007.5	2007.5
-	5.5	5.5	0.0	110	632.5	632.5	632.5	0.0	0.0	0.0	632.5	632.5	632.5	2007.5	2007.5	2007.5
-	5.5	5.5	0.0	120	632.5	632.5	632.5	0.0	0.0	0.0	632.5	632.5	632.5	2007.5	2007.5	2007.5
Marsh	5.5	19.0	13.5	80	632.5	1712.5	1172.5	0.0	842.4	421.2	632.5	870.1	751.3	2007.5	2245.1	2126.3
Fluvial	19.0	85.5	66.5	125	1712.5	10025.0	5868.8	842.4	4992.0	2917.2	870.1	5033.0	2951.6	2245.1	6408.0	4326.6
-	85.5	85.5	0.0	125	10025.0	10025.0	10025.0	4992.0	4992.0	4992.0	5033.0	5033.0	5033.0	6408.0	6408.0	6408.0
-	85.5	85.5	0.0	120	10025.0	10025.0	10025.0	4992.0	4992.0	4992.0	5033.0	5033.0	5033.0	6408.0	6408.0	6408.0
-	85.5	85.5	0.0	125	10025.0	10025.0	10025.0	4992.0	4992.0	4992.0	5033.0	5033.0	5033.0	6408.0	6408.0	6408.0
-	85.5	85.5	0.0	120	10025.0	10025.0	10025.0	4992.0	4992.0	4992.0	5033.0	5033.0	5033.0	6408.0	6408.0	6408.0
-	85.5	85.5	0.0	125	10025.0	10025.0	10025.0	4992.0	4992.0	4992.0	5033.0	5033.0	5033.0	6408.0	6408.0	6408.0
-	85.5	85.5	0.0	120	10025.0	10025.0	10025.0	4992.0	4992.0	4992.0	5033.0	5033.0	5033.0	6408.0	6408.0	6408.0
-	85.5	85.5	0.0	125	10025.0	10025.0	10025.0	4992.0	4992.0	4992.0	5033.0	5033.0	5033.0	6408.0	6408.0	6408.0
-	85.5	85.5	0.0	120	10025.0	10025.0	10025.0	4992.0	4992.0	4992.0	5033.0	5033.0	5033.0	6408.0	6408.0	6408.0
Till	85.5	95.5	10.0	135	10025.0	11375.0	10700.0	4992.0	5616.0	5304.0	5033.0	5759.0	5396.0	6408.0	7134.0	6771.0

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date: TCC 04-2013

Checked By/Date:



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-09**	
Proposed Grade:	15.0	feet
Grade Change:	7.0	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	875.0	psf
Δ Stress (Bldg. Loading):	500.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(Due to Proposed Grade Change) (inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	1.44	-	-	-
F-Satur	1.0	0.03	-	-	0.00	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.30	0.07	0.20	19.01	6.8	0.848	193.2
Fluvial	2.0	0.02	0.01	10.00	0.66	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					21.11			

Estimated Settlement @ 90% Consolidation
(inches)
19.00

Days	**193.2**
Months	**6.4**
Years	**0.5**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 13.5 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 6.8 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**193.2**
Months	**6.4**
Years	**0.5**

SUMMARY OF SURCHARGE ASSESSMENT

Analysis Point/Location:	**GB-09**	
Proposed Surcharge Grade:	25.0	feet
Grade Change:	17.0	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Surcharge):	2125.0	psf

Surcharge Grade Conditions				Surcharge Assessment			
Primary Stratum	Effective Stress			Settlement		Req. Surcharge Consol.	Resulting T
	Top (psf)	Bottom (psf)	Middle (psf)	Proposed Grade (100%) Primary + Secondary (inches)	Surcharge Grade (100%) Primary Only (inches)	(%)	
-		2125.0		-	-	-	-
F-Unsat	2125.0	2757.5	2441.3	1.44	1.76	82.0%	-
F-Satur	2757.5	2757.5	2757.5	0.00	0.00	0.0%	-
-	2757.5	2757.5	2757.5	0.00	0.00	0.0%	-
-	2757.5	2757.5	2757.5	0.00	0.00	0.0%	-
Marsh	2757.5	2995.1	2876.3	21.87	25.38	86.1%	-
Fluvial	2995.1	7158.0	5076.6	0.66	0.94	-	-
-	7158.0	7158.0	7158.0	-	-	-	-
-	7158.0	7158.0	7158.0	0.00	0.00	0.0%	-
-	7158.0	7158.0	7158.0	-	-	-	-
-	7158.0	7158.0	7158.0	0.00	0.00	0.0%	-
-	7158.0	7158.0	7158.0	-	-	-	-
-	7158.0	7158.0	7158.0	0.00	0.00	0.0%	-
-	7158.0	7158.0	7158.0	-	-	-	-
-	7158.0	7158.0	7158.0	0.00	0.00	0.0%	-
-	7158.0	7158.0	7158.0	-	-	-	-
-	7158.0	7158.0	7158.0	0.00	0.00	0.0%	-
Till	7158.0	7884.0	7521.0	-	-	-	-
				23.97	28.08	86.1%	0.716

For Double Drainage Valid		Otherwise, Comp. D & O
163.1	Days	163.1
5.4	Months	5.4
0.4	Years	0.4

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? YES

If answer to double drainage question = "YES", refer to the values above left for the estimated time to surcharge consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below (and above right) for the estimated time to surcharge consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)

(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 13.5 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 6.75 ft

T = 0.716 @ above surcharge consol.

Calculate Time, t, in days to Surcharge Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	163.1
Months	5.4
Years	0.4

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-10	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	11.00	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	8.50	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	15.00	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	500.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	8.1	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	7.3	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	2.7	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	5.6	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-10	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	22.00	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	11.0	-
Surcharge Height above Prop. Grade (ft):	7.0	-
Resultant Time to Consolidation:	4.6	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change + one log cycle of secondary comp.
@ % Surcharge Consolidation:	98%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	OKAY	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-10	-	
Surcharge Area/Point No:	-	-	
Coefficient of Secondary Compression, C_{α}	0.02	Marsh	(Cα expressed by change in strain per log cycle of time)
Coefficient of Secondary Compression, C_{α}	0	N/A	(Cα expressed by change in strain per log cycle of time)
Est. Time to End of Primary Consolidation, t_p	0.5	Years	
Secondary Compression Design Time, t_{sec}	5.0	Years	1.0 No. of log cycles

Method from NAVFAC DM 7.1-231: $H_{sec} = C\alpha * H_t * \log (t_{sec}/t_p)$

Where: H_{sec} = Secondary compression
H_t = Thickness of soil stratum

Est. Secondary Compression (inches):	2.0	Marsh
Est. Secondary Compression (inches):	0.0	N/A

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-10**	
Existing Grade:	11.0	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	8.5	feet bgs
Tot./Eff. Stress @ GWT =	977.5	psf

Analysis Point/Location:	**GB-10**	
Proposed Grade:	15.00	feet
Grade Change:	4.0	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	500.0	psf
Δ Stress (Bldg. Loading):	500.0	psf

Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

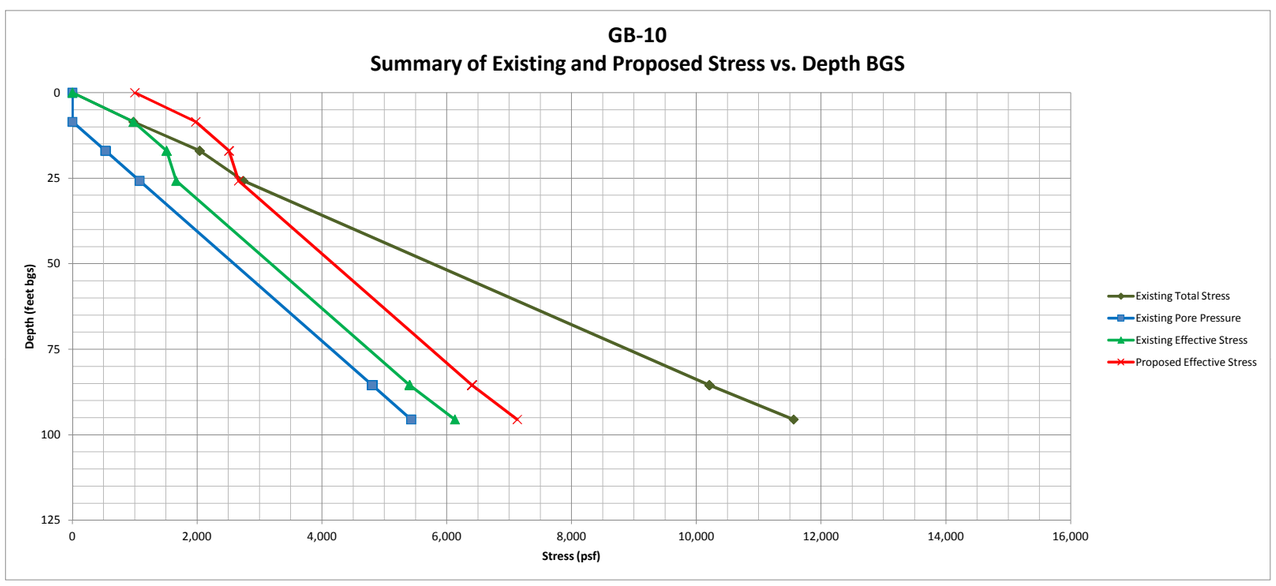
Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
Stratum	Top	Bottom		γ_t or γ_{sat}	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle	Top	Bottom	Middle
	(ft bgs)	(ft bgs)	(ft)	(pcf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)	(psf)
		0.0	0.0			0.0			0.0			0.0			1000.0	
F-Unsat	0.0	8.5	8.5	115	0.0	977.5	488.8	0.0	0.0	0.0	0.0	977.5	488.8	1000.0	1977.5	1488.8
F-Satur	8.5	17.0	8.5	125	977.5	2040.0	1508.8	0.0	530.4	265.2	977.5	1509.6	1243.6	1977.5	2509.6	2243.6
-	17.0	17.0	0.0	110	2040.0	2040.0	2040.0	530.4	530.4	530.4	1509.6	1509.6	1509.6	2509.6	2509.6	2509.6
-	17.0	17.0	0.0	120	2040.0	2040.0	2040.0	530.4	530.4	530.4	1509.6	1509.6	1509.6	2509.6	2509.6	2509.6
Marsh	17.0	25.8	8.8	80	2040.0	2740.0	2390.0	530.4	1076.4	803.4	1509.6	1663.6	1586.6	2509.6	2663.6	2586.6
Fluvial	25.8	85.5	59.8	125	2740.0	10208.8	6474.4	1076.4	4804.8	2940.6	1663.6	5404.0	3533.8	2663.6	6404.0	4533.8
-	85.5	85.5	0.0	125	10208.8	10208.8	10208.8	4804.8	4804.8	4804.8	5404.0	5404.0	5404.0	6404.0	6404.0	6404.0
-	85.5	85.5	0.0	120	10208.8	10208.8	10208.8	4804.8	4804.8	4804.8	5404.0	5404.0	5404.0	6404.0	6404.0	6404.0
-	85.5	85.5	0.0	125	10208.8	10208.8	10208.8	4804.8	4804.8	4804.8	5404.0	5404.0	5404.0	6404.0	6404.0	6404.0
-	85.5	85.5	0.0	120	10208.8	10208.8	10208.8	4804.8	4804.8	4804.8	5404.0	5404.0	5404.0	6404.0	6404.0	6404.0
-	85.5	85.5	0.0	125	10208.8	10208.8	10208.8	4804.8	4804.8	4804.8	5404.0	5404.0	5404.0	6404.0	6404.0	6404.0
-	85.5	85.5	0.0	120	10208.8	10208.8	10208.8	4804.8	4804.8	4804.8	5404.0	5404.0	5404.0	6404.0	6404.0	6404.0
-	85.5	85.5	0.0	125	10208.8	10208.8	10208.8	4804.8	4804.8	4804.8	5404.0	5404.0	5404.0	6404.0	6404.0	6404.0
-	85.5	85.5	0.0	120	10208.8	10208.8	10208.8	4804.8	4804.8	4804.8	5404.0	5404.0	5404.0	6404.0	6404.0	6404.0
Till	85.5	95.5	10.0	135	10208.8	11558.8	10883.8	4804.8	5428.8	5116.8	5404.0	6130.0	5767.0	6404.0	7130.0	6767.0

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date: TCC 04-2013

Checked By/Date:



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-10**	
Proposed Grade:	15.0	feet
Grade Change:	4.0	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	500.0	psf
Δ Stress (Bldg. Loading):	500.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(Due to Proposed Grade Change) (inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	1.48	-	-	-
F-Satur	1.0	0.03	-	-	0.78	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.35	0.07	0.20	5.47	4.4	0.848	81.2
Fluvial	2.0	0.02	0.01	10.00	0.39	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					8.13			

Estimated Settlement @ 90% Consolidation
(inches)
7.31

Days	**81.2**
Months	**2.7**
Years	**0.2**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 8.8 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 4.4 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**81.2**
Months	**2.7**
Years	**0.2**

SUMMARY OF SURCHARGE ASSESSMENT

Analysis Point/Location:	**GB-10**	
Proposed Surcharge Grade:	22.0	feet
Grade Change:	11.0	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Surcharge):	1375.0	psf

Surcharge Grade Conditions				Surcharge Assessment			
Primary Stratum	Effective Stress			Settlement		Req. Surcharge Consol.	Resulting T
	Top (psf)	Bottom (psf)	Middle (psf)	Proposed Grade (100%) Primary + Secondary (inches)	Surcharge Grade (100%) Primary Only (inches)	(%)	
-		1375.0		-	-	-	-
F-Unsat	1375.0	2352.5	1863.8	1.48	1.78	83.2%	-
F-Satur	2352.5	2884.6	2618.6	0.78	0.99	79.2%	-
-	2884.6	2884.6	2884.6	0.00	0.00	0.0%	-
-	2884.6	2884.6	2884.6	0.00	0.00	0.0%	-
Marsh	2884.6	3038.6	2961.6	7.46	7.63	97.8%	-
Fluvial	3038.6	6779.0	4908.8	0.39	0.51	-	-
-	6779.0	6779.0	6779.0	-	-	-	-
-	6779.0	6779.0	6779.0	0.00	0.00	0.0%	-
-	6779.0	6779.0	6779.0	-	-	-	-
-	6779.0	6779.0	6779.0	0.00	0.00	0.0%	-
-	6779.0	6779.0	6779.0	-	-	-	-
-	6779.0	6779.0	6779.0	0.00	0.00	0.0%	-
-	6779.0	6779.0	6779.0	-	-	-	-
-	6779.0	6779.0	6779.0	0.00	0.00	0.0%	-
-	6779.0	6779.0	6779.0	-	-	-	-
-	6779.0	6779.0	6779.0	0.00	0.00	0.0%	-
Till	6779.0	7505.0	7142.0	-	-	-	-
				10.12	10.91	97.8%	1.456

For Double Drainage Valid		Otherwise, Comp. D & O
139.3	Days	139.3
4.6	Months	4.6
0.4	Years	0.4

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? YES

If answer to double drainage question = "YES", refer to the values above left for the estimated time to surcharge consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below (and above right) for the estimated time to surcharge consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)

(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 8.75 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 4.375 ft

T = 1.456 @ above surcharge consol.

Calculate Time, t, in days to Surcharge Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	139.3
Months	4.6
Years	0.4

DATA INPUT AND OUTPUT SUMMARY

KEY

Data Input Cells:	Input Data Here	Input location-specific information for this Analysis Point
Data Output Cells:	Calculation/Output	Calculated value. Read output cell for result.
Design/Change Cells:	Design Surcharge Elev.	Adjust surcharge elev. in 0.5 ft increments to achieve design/consol. criteria.

EXISTING CONDITIONS, PROPOSED GRADING, & PRIMARY CONSOLIDATION

Analyis Point No.:	GB-11	Input analysis point no./exploration location.
Surcharge Area/Point No.:	-	Input surcharge area/point no., if applicable.
Existing Grade (ft):	8.00	Input existing ground surface elev. (to nearest 0.25') at analysis point location.
Groundwater Depth (ft bgs):	5.50	Input existing groundwater depth (to nearest 0.25') at analysis point location.
Proposed Grade (ft):	15.00	Input proposed grade (to nearest 0.25') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Proposed Building Load (psf):	0.0	Input proposed building load (to nearest 50 psf), from structural evaluation.
Est. Primary Consol. Settlement:	11.1	Estimated primary consol. settlement (in inches) due to proposed grading/loading.
Est. Primary Consol. Settlement:	10.0	Estimated primary consol. settlement (in inches) at 90% consolidation.
Est. Time to 90% Primary Conol.:	3.5	Estimated time (in months) to achieve 90% of the est. primary consol. settlement.
Est. Time to 99% Primary Consol.:	7.3	Estimated time (in months) to achieve 99% of the est. primary consol. settlement.

SURCHARGE ASSESSMENT

Analyis Point No.:	GB-11	-
Surcharge Area/Point No.:	-	-
Proposed Surcharge Grade (ft):	15.50	Input proposed surcharge grade (to nearest 0.5') at analysis point location.
Unit Weight of Prop. Fill (pcf):	125.0	Input unit weight of grade change fill/materials.
Surcharge Height above Exist. Grade (ft):	7.5	-
Surcharge Height above Prop. Grade (ft):	0.5	-
Resultant Time to Consolidation:	4.3	Estimated time (in months) to achieve 100% of the est. primary consol. settlement due to proposed grade change.
@ % Surcharge Consolidation:	94%	Estimated % consolidation (Marsh Deposit) required to terminate the surcharge at this location.
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of second compressible stratum (N/A).
@ Resultant Time to Consolidation:	N/A	Estimated % consolidation of third compressible stratum (N/A).
Check:	OKAY	Check to verify that surcharge time (based on Marsh Deposit) is sufficient for necessary consolidation in other primary stratum.

SECONDARY CONSOLIDATION

Analysis Point No:	GB-11	-	
Surcharge Area/Point No:	-	-	
Coefficient of Secondary Compression, C_{α}	0.02	Marsh	(C_{α} expressed by change in strain per log cycle of time)
Coefficient of Secondary Compression, C_{α}	0	N/A	(C_{α} expressed by change in strain per log cycle of time)
Est. Time to End of Primary Consolidation, t_p	0.5	Years	1.0 No. of log cycles
Secondary Compression Design Time, t_{sec}	5.0	Years	

Method from NAVFAC DM 7.1-231: $H_{sec} = C_{\alpha} * H_t * \log (t_{sec}/t_p)$

Where: H_{sec} = Secondary compression
H_t = Thickness of soil stratum

Est. Secondary Compression (inches):	2.2	Marsh
Est. Secondary Compression (inches):	0.0	N/A

SUMMARY OF EXISTING CONDITIONS AND PROPOSED GRADING

Analysis Point/Location:	**GB-11**	
Existing Grade:	8.0	feet
Assumed Bedrock Depth:	95.5	feet bgs
Groundwater Depth:	5.5	feet bgs
Tot./Eff. Stress @ GWT =	632.5	psf

Analysis Point/Location:	**GB-11**	
Proposed Grade:	15.00	feet
Grade Change:	7.0	feet
Fill Unit Weight:	125.00	pcf
Δ Stress (Prop. Grading):	875.0	psf
Δ Stress (Bldg. Loading):	0.0	psf

Input assumed or known depth (ft bgs) to bedrock above. Then input the bottom depth (ft bgs) and unit weight (pcf) for each primary stratum below.

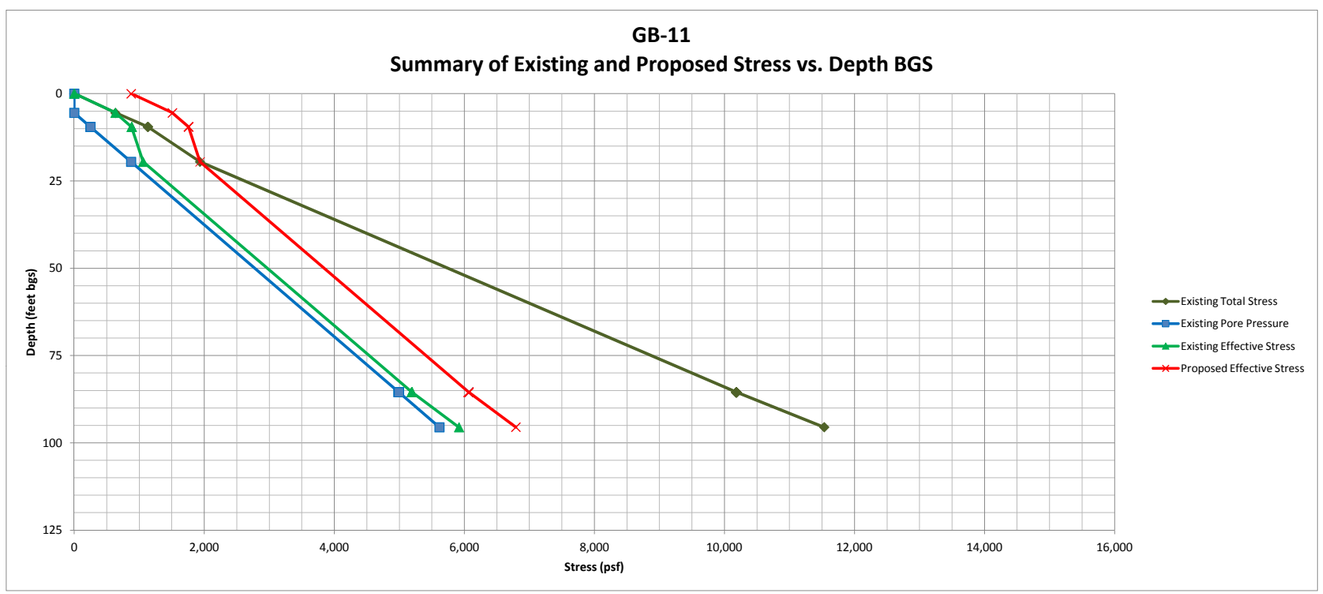
Subsurface Conditions					Existing Grade Conditions									Proposed Grade (& Loading) Conditions		
Primary Stratum	Depth		Thickness	Unit Weight	Total Stress			Pore Pressure			Effective Stress			Effective Stress		
	Top (ft bgs)	Bottom (ft bgs)	(ft)	γ_t or γ_{sat} (pcf)	Top (psf)	Bottom (psf)	Middle (psf)	Top (psf)	Bottom (psf)	Middle (psf)	Top (psf)	Bottom (psf)	Middle (psf)	Top (psf)	Bottom (psf)	Middle (psf)
		0.0	0.0			0.0			0.0			0.0			875.0	
F-Unsat	0.0	5.5	5.5	115	0.0	632.5	316.3	0.0	0.0	0.0	0.0	632.5	316.3	875.0	1507.5	1191.3
F-Satur	5.5	9.5	4.0	125	632.5	1132.5	882.5	0.0	249.6	124.8	632.5	882.9	757.7	1507.5	1757.9	1632.7
-	9.5	9.5	0.0	110	1132.5	1132.5	1132.5	249.6	249.6	249.6	882.9	882.9	882.9	1757.9	1757.9	1757.9
-	9.5	9.5	0.0	120	1132.5	1132.5	1132.5	249.6	249.6	249.6	882.9	882.9	882.9	1757.9	1757.9	1757.9
Marsh	9.5	19.5	10.0	80	1132.5	1932.5	1532.5	249.6	873.6	561.6	882.9	1058.9	970.9	1757.9	1933.9	1845.9
Fluvial	19.5	85.5	66.0	125	1932.5	10182.5	6057.5	873.6	4992.0	2932.8	1058.9	5190.5	3124.7	1933.9	6065.5	3999.7
-	85.5	85.5	0.0	125	10182.5	10182.5	10182.5	4992.0	4992.0	4992.0	5190.5	5190.5	5190.5	6065.5	6065.5	6065.5
-	85.5	85.5	0.0	120	10182.5	10182.5	10182.5	4992.0	4992.0	4992.0	5190.5	5190.5	5190.5	6065.5	6065.5	6065.5
-	85.5	85.5	0.0	125	10182.5	10182.5	10182.5	4992.0	4992.0	4992.0	5190.5	5190.5	5190.5	6065.5	6065.5	6065.5
-	85.5	85.5	0.0	120	10182.5	10182.5	10182.5	4992.0	4992.0	4992.0	5190.5	5190.5	5190.5	6065.5	6065.5	6065.5
-	85.5	85.5	0.0	125	10182.5	10182.5	10182.5	4992.0	4992.0	4992.0	5190.5	5190.5	5190.5	6065.5	6065.5	6065.5
-	85.5	85.5	0.0	120	10182.5	10182.5	10182.5	4992.0	4992.0	4992.0	5190.5	5190.5	5190.5	6065.5	6065.5	6065.5
-	85.5	85.5	0.0	125	10182.5	10182.5	10182.5	4992.0	4992.0	4992.0	5190.5	5190.5	5190.5	6065.5	6065.5	6065.5
-	85.5	85.5	0.0	120	10182.5	10182.5	10182.5	4992.0	4992.0	4992.0	5190.5	5190.5	5190.5	6065.5	6065.5	6065.5
-	85.5	85.5	0.0	125	10182.5	10182.5	10182.5	4992.0	4992.0	4992.0	5190.5	5190.5	5190.5	6065.5	6065.5	6065.5
-	85.5	85.5	0.0	120	10182.5	10182.5	10182.5	4992.0	4992.0	4992.0	5190.5	5190.5	5190.5	6065.5	6065.5	6065.5
Till	85.5	95.5	10.0	135	10182.5	11532.5	10857.5	4992.0	5616.0	5304.0	5190.5	5916.5	5553.5	6065.5	6791.5	6428.5

Notes, Comments, and/or Adjustments Made to Subsurface Conditions

1. n/a
2. n/a
3. n/a

Prepared By/Date: TCC 04-2013

Checked By/Date:



SUMMARY OF COMPRESSIBILITY PARAMETERS, ESTIMATED PRIMARY CONSOLIDATION SETTLEMENT, & TIME-RATE OF CONSOLIDATION

Analysis Point/Location:	**GB-11**	
Proposed Grade:	15.0	feet
Grade Change:	7.0	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Prop. Grading):	875.0	psf
Δ Stress (Bldg. Loading):	0.0	psf

Input assumed over-consolidation ratio, compression index (= $C_c/1+e_0$), recompression index (= $C_r/1+e_0$), and coefficient of consolidation (ft^2/day) for each primary stratum below.

Assumed Compressibility Parameters					Primary Consolidation Settlement (Due to Proposed Grade Change)	Time-Rate of Consolidation (to 90% Consolidation)		
Primary Stratum	**OCR**	**Comp. Index $C_{c\varepsilon}$**	**Recomp. Index $C_{r\varepsilon}$**	**Coef. of Consol. c_v (ft^2/day)**	**(inches)**	**Drainage Height H_{dr} (feet)**	**Time Factor T**	**Time t (days)**
-	-	-	-	-	-	-	-	-
F-Unsat	1.0	0.03	-	-	1.14	-	-	-
F-Satur	1.0	0.03	-	-	0.48	-	-	-
-	1.0	0.15	0.05	0.25	0.00	0.0	0.848	0.0
-	1.0	0.20	-	0.10	0.00	0.0	0.848	0.0
Marsh	1.2	0.35	0.07	0.20	9.06	5.0	0.848	106.0
Fluvial	2.0	0.02	0.01	10.00	0.42	-	-	-
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
-	-	-	-	-	-	-	-	-
-	3.0	0.10	0.02	10.00	0.00	0.0	0.848	0.0
Till	-	-	-	-	-	-	-	-
					11.10			

Estimated Settlement @ 90% Consolidation
(inches)
9.99

Days	**106.0**
Months	**3.5**
Years	**0.3**

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? **YES**

If answer to double drainage question = "YES", refer to the values above for the estimated time to 90% consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below for the estimated time to 90% consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)
(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 10.0 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 5.0 ft
T = 0.848 90% consolidation

Calculate Time, t, in days to 90% Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	**106.0**
Months	**3.5**
Years	**0.3**

SUMMARY OF SURCHARGE ASSESSMENT

Analysis Point/Location:	**GB-11**	
Proposed Surcharge Grade:	15.5	feet
Grade Change:	7.5	feet
Fill Unit Weight:	125.0	pcf
Δ Stress (Surcharge):	937.5	psf

Surcharge Grade Conditions				Surcharge Assessment			
Primary Stratum	Effective Stress			Primary Consolidation Settlement		Req. Surcharge Consol.	Resulting T
	Top (psf)	Bottom (psf)	Middle (psf)	Proposed Grade (100%) (inches)	Surcharge Grade (100%) (inches)	(%)	
-		937.5		-	-	-	-
F-Unsat	937.5	1570.0	1253.8	1.14	1.18	96.3%	-
F-Satur	1570.0	1820.4	1695.2	0.48	0.50	95.3%	-
-	1820.4	1820.4	1820.4	0.00	0.00	0.0%	-
-	1820.4	1820.4	1820.4	0.00	0.00	0.0%	-
Marsh	1820.4	1996.4	1908.4	9.06	9.67	93.7%	-
Fluvial	1996.4	6128.0	4062.2	0.42	0.45	-	-
-	6128.0	6128.0	6128.0	-	-	-	-
-	6128.0	6128.0	6128.0	0.00	0.00	0.0%	-
-	6128.0	6128.0	6128.0	-	-	-	-
-	6128.0	6128.0	6128.0	0.00	0.00	0.0%	-
-	6128.0	6128.0	6128.0	-	-	-	-
-	6128.0	6128.0	6128.0	0.00	0.00	0.0%	-
-	6128.0	6128.0	6128.0	-	-	-	-
-	6128.0	6128.0	6128.0	0.00	0.00	0.0%	-
-	6128.0	6128.0	6128.0	-	-	-	-
-	6128.0	6128.0	6128.0	0.00	0.00	0.0%	-
Till	6128.0	6854.0	6491.0	-	-	-	-
				11.10	11.81	93.7%	1.036

For Double Drainage Valid		Otherwise, Comp. D & O
129.5	Days	129.5
4.3	Months	4.3
0.4	Years	0.4

Above calcs assume double drainage of each stratum. Check this assumption relative to Stratum O & Stratum D. If both strata are present, assumption of double drainage for each is not valid. In this case, convert to a composite stratum as per below.

Double drainage of Stratum O & Stratum D? YES

If answer to double drainage question = "YES", refer to the values above left for the estimated time to surcharge consolidation. If the answer to the question = "NO", refer to the composite Stratum O and D calculation below (and above right) for the estimated time to surcharge consolidation.

COMPOSITE STRATUM O & D

Convert to One "Composite" Layer (NAVFAC DM 7.1-235)

(w/ C_v properties of Stratum D)

$$H_{comp} = H_d + H_o(Cv_d / Cv_o)^{1/2}$$

H_{comp} = 10 ft

Assume Double Drainage of the "Composite" Layer

H_{dr} = 5 ft

T = 1.036 @ above surcharge consol.

Calculate Time, t, in days to Surcharge Consolidation

$$t = (T * H_{dr}^2) / Cv_d$$

Days	129.5
Months	4.3
Years	0.4

ATTACHMENT 2

COST ESTIMATE
MONITORED SURCHARGE PROGRAM

Date: 6/5/2013
Project: Raymark Industries, Inc. Superfund Site Surcharge
Location: Stratford, Connecticut
Prepared By: AMEC Environment & Infrastructure, Inc.
ACOE Proj No. W912WJ-11-D-0005
AMEC Proj No. 3651120004.5B

BASIS FOR COST ESTIMATE

1 The cost estimate is based upon drawings and information supplied by the engineers. The engineer has made a site visit to the project location.

2 Material unit costs are based on multiple sources including in-house data, estimating publications, estimating programs such as R. S. Means 2013 and National Estimator 2013.

3 Craft rates and crew mixes are developed with assistance from multi sources including in-house estimating programs such as R. S. Means 2013 and National Estimator 2013. Commercial and industrial wage rates to satisfy Davis Bacon Wage Rate requirements.

4 Equipment Costs are based on multiple sources including in-house data, estimating publications, estimating programs such as R. S. Means 2013 and National Estimator 2013.

5 General conditions include supervision, field operation costs, telephones, daily project documentation and safety equipment, temporary trailers and utilities such as electric. It is assumed that some work will be performed using portable generators.

6 There is a 5% contingency in the cost estimate.

7 It is assumed that the project will be executed during fair weather months.

8 It is assumed that ledge and subgrade obstructions will not be encountered.

9 Excavated material is suitable as backfill.

10 It is assumed that haul distances are 10 to 14 miles one way.

11 It is assumed that existing buildings and associated utility and structure demolition is not part of this contract scope.

12 It is assumed that no special permits are required.

13 It is estimated that complted site settlement will require approximately 10,000 cubic yards of surcharge will be left onsite to maintain site finish grade elevations with the remaining surcharge being exported from the site.

14 It is expected that the site civil contractor will purchase materials for the surcharge and upon the removal not provide a credit for materials. There are varied scenarios that may affect surcharge credits that may impact bid results. It is recommended that bid forms reflect contractors intent.

Raymark Industries, Inc Superfund Site OU 6

576/600 East Broadway, Stratford, CT

Remove Waste from Flood Zone

SURCHARGE (Pre load)

	ITEM DESCRIPTION	Quantity		Engineering Estimate	
		Number	Unit	Unit Cost	Total
1	Mobilize (assume local excavation firm)	1	**ls**	3,000	**3,000**
2	Erosion Control, Mulch, Silt Fence and Maintenance	1	**ls**	15,000	**15,000**
3	Barriers & Traffic Control	8.5	**wk**	1,500	**12,750**
4	Site Supervision	8.5	**wk**	2,000	**17,000**
5	Job Trailer - Not Required for haul project	0	**mos**	600	**-**
6	Portable Toilet	8.5	**wk**	250	**2,125**
7	Utility Locater Contractor	1	**ls**	1,500	**1,500**
8	Survey & Layout	1	**ls**	5,500	**5,500**
9	Import & Grade Surcharge (preload)	40,654	**cy**	15	**603,305**
10	Export Surcharge (preload) load and haul	30,654	**cy**	8	**245,232**
17	Instrumentation: Install & Monitor	1	**ls**	67,500	**67,500**
	Sub Total				**972,912**
	General Conditions			5%	48,646
	CT Sales Tax			0%	-
	Performance Bond			1.5%	15,323
	Sub Total				**1,036,881**
	GC Fee			10%	103,688
	Sub Total				**1,140,569**
	Contingency:			5%	57,028
	Probable Cost to Construct				**1,197,598**

Vendor Pricing from Stratford, CT Market

1 **JJ Brennan**
2 Riverdale Ave
Shelton, CT
203-924-1154
Contact: **Mz Angela**

				tn pcy	per CY delivered
Structural fill - DOT CT Spec - 3 1/2	*$*	*14.00*	*per ton delivered*	1.417	**$ 19.84**
Borrow	*$*	*9.00*	*per ton delivered*	1.2	**$ 10.80**
Topsoil	*$*	*26.00*	*per ton delivered*	1	**$ 26.00**

2 **O & G Industries**
Stamford Sand & Gravel
Contact: **Sue Duffy**
1-860-485-6622
Cell 1-860-307-0782

Structural fill - DOT CT Spec - 3 1/2	***$***	***15.60***	*per yard delivered*
Borrow	***$***	***11.00***	*per yard delivered*
Topsoil	***$***	***26.00***	*per yard delivered*

3 **Elm City Materials, Inc**
7 Spring Street
West Haven, CT 06516
203-933-3478
Cathy
Cathy@elmcitymaterials.com

Structural fill - DOT CT Spec - 3 1/2	***$***	***16.25***	*per yard delivered*
Borrow	***$***	***10.15***	*per yard delivered*
Topsoil	***$***	***28.50***	*per yard delivered*

4 **Haynes Materials**
Seymour Quarry
600 Derby Ave
Seymour, CT 06483
203-888-4697
Michael Papper
cell: 203-577-9471
mpapper@haynesmaterials.com

Structural fill - DOT CT Spec - 3 1/2	***$***	***14.50***	*per yard delivered*
Borrow	***$***	***11.50***	*per yard delivered*
Topsoil	***$***	***30.25***	*per yard delivered*

AMEC Data Base

Sand Products				
Screened Sand	$7.00	Ton	$9.45	Yard
Mortar Sand	$18.75	Ton	$27.50	Yard
Bank Run Sand	$5.50	Ton	$5.75	Yard
Sand Clay Fill	$4.75	Ton	$9.45	Yard
Common Borrow	$2.25	Ton	$3.60	Yard
Underdrain Sand	$10.00	Ton	$12.50	Yard
Gravel Products				
Gravel Borrow	$4.50	Ton	$6.00	Yard
4" Reclaim Gravel	$5.75	Ton	$6.50	Yard
Private Gravel	$6.25	Ton	$7.25	Yard
Type "D" Gravel	$7.50	Ton	$9.00	Yard
Type "B" Gravel	$9.00	Ton	$11.00	Yard
1 1/2" Gravel	$8.00	Ton	$10.75	Yard
7/16" Reclaim	$19.00	Ton	$27.00	Yard
9/16" Reclaim	$16.00	Ton	$22.00	Yard
11/2" Reclaim	$13.00	Ton	$16.50	Yard
QPR Cold Patch	$120.00	Ton		Yard
3/4" Crushed Gravel	$8.25	Ton	$12.00	Yard
Type "A" Gravel	$11.00	Ton	$13.00	Yard
Straight Pavement Grindings	$27.50	Ton	$33.50	Yard
Stone Products				
2" to 4" Environmental Stone	$14.25	Ton	$16.50	Yard
11/2" Crushed Stone	$14.25	Ton	$17.00	Yard
3/4" Crushed Stone	$15.00	Ton	$18.00	Yard
1/2" Crushed Stone	$17.75	Ton	$19.00	Yard
3/8" Crushed Stone	$18.75	Ton	$22.00	Yard
1/4" Crushed Stone	$20.00	Ton	$22.00	Yard
1" Round Stone	$25.00	Ton		Yard
2" Round Stone	$25.00	Ton		Yard
Stone Dust	$7.00	Ton	$7.75	Yard
Fine Stone Dust	?		?	
Rip Rap Products				
3" Stone	$17.00	Ton	$21.00	Yard
3" to 6"	$17.00	Ton	$21.00	Yard
6" to 12"	$17.00	Ton	$21.00	Yard
12" to 24"	$19.50	Ton	$22.00	Yard
24" to 48"	$21.75	Ton	$24.00	Yard
Landscape Products				
Cobblestones - Small	$3.00	Each	$3.00	Each
Cobblestones - Large	$6.00	Each	$6.00	Each
Cobblestones - Bulk	$150.00	Ton	$150.00	Yard
Hand Spilt Granite Blocks	$200.00	Ton	$200.00	Yard
Miscellaneous Granite	$12.00	Foot	$12.00	Foot
Clay/Low permeability	$8.00	Ton	$8.00	Yard
Screened Loam	$14.00	Yard	$14.00	Yard
Unscreened Loam	$7.00	Yard	$7.00	Yard
Loam Tailings	$4.75	Yard	$4.75	Yard
Compost	$35.00	Yard	$35.00	Yard
Ball Field Mix	$31.00	Yard	$31.00	Yard
Erosion Control Material	$16.00	Yard	$16.00	Yard
Bark Mulch	$34.00	Yard	$34.00	Yard
Soil Filter Media	$36.00	Yard	$36.00	Yard
Recycling Center				
Stump / Brush Disposal	$13.75	Yard	$13.75	Yard
Concrete Disposal	$5.75	Ton	$5.75	Ton
Concrete w/ Rebar Disposal	$16.00	Ton	$16.00	Ton
Pavement Disposal	No Chg	Vat Plant	No Chg	Vat Plant

Delivery Rates

Screened Loam - 7 yard minimum $22.00 per yard - 14 yards or more $18.00 per yard

10 miles or less $4.50 per ton or $5.00 per yard is added to the loaded price.

11 to 15 miles $5.50 per ton or $6.00 per yard is added to the loaded price. Deliveries beyond 15 miles require analysis

APPENDIX F

TECHNICAL MEMORANDUM

THIRD AVENUE RAYMARK WASTE VOLUME ESTIMATE

TECHNICAL MEMORANDUM

DATE: July 12, 2013

TO: Dean Brammer; USACE

COPY TO: Charles Collet, P.E. and Stephen Mitchell, P.E.; AMEC

FROM: Caitlyn Abbott; AMEC

SUBJECT: Third Avenue Raymark Waste Volume Estimate, Raymark Industries, Inc. Superfund Site (OU6 - 576/600 East Broadway), Stratford, Connecticut

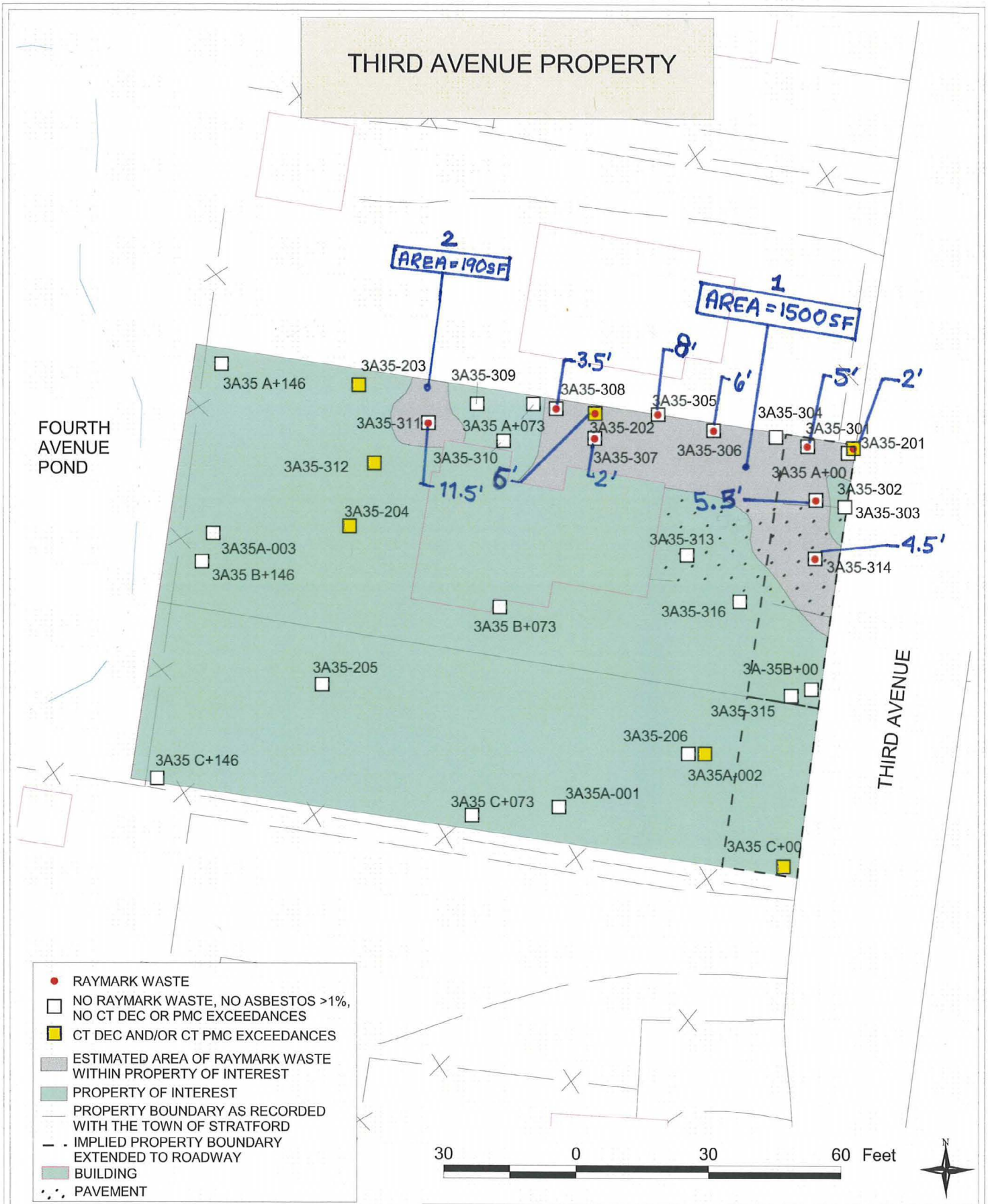
PROJECT: 3651-12-0004

Third Avenue Excavation

The property at 35 Third Avenue has been identified to contain Raymark waste in the fill materials. Boring logs by Tetra Tech NUS, Inc. (May of 2003) show evidence of Raymark Waste in 10 out of 34 boring locations. The boring logs are included in this memorandum for reference. The manmade materials identified in the soil borings include PACM, asphalt, brick, glass, metal debris, plastic, concrete, copper pieces and tile. Tetra Tech NUS, Inc. estimated the lateral limits of the Raymark waste area, as shown in Figure 3-24, by the presence of asbestos, lead, copper and/or Aroclor 1268 in the boring logs. In the Remedial Investigation Report written and submitted to the EPA by Tetra Tech NUS, Inc. in June 2005, the total volume of Raymark waste at the 35 Third Avenue property is estimated to be 630 cubic yards.

The Third Avenue Soil Sample Locations Figure created by Tetra Tech NUS, Inc. in 2005 contains two areas with Raymark waste, as shown in Figure 3-24. For the purposes of this evaluation AMEC Environment & Infrastructure, Inc. (AMEC) has identified these areas as Area 1 and Area 2 (see attached figure). Area 1, containing 9 boring locations, is a 1,500 square foot area located along the northern property line of the Site. After review of the boring logs, a maximum depth of 8-feet was noted in this area for Raymark waste. Area 2, consisting of approximately 190 square feet of Raymark waste, shows a maximum depth of 11.5-feet. AMEC estimated the volume of Raymark Waste by taking each maximum depth multiplied by the corresponding area to give a total Raymark waste volume of 525 cubic yards for the Site (as shown in the calculations attached). The difference in Raymark Waste volume estimates, between Tetra Tech NUS, Inc. and AMEC is due to the variation in maximum depth. Tetra Tech NUS used a maximum depth of 10-feet for both areas, giving a total Raymark waste volume of 630 cubic yards. AMEC used the individual depth for each area in it's estimate.

After review of the boring logs and calculations, a Raymark waste volume of 630 cubic yards will be assumed for the 35 Third Avenue project Site. This estimate is more conservative, and will allow for additional consolidation space under the landfill cap at the 576/600 East Broadway Site if more Raymark waste is discovered during implementation of the remedy.



NOTES:
1) PLAN NOT TO BE USED FOR DESIGN
2) ALL LOCATIONS TO BE CONSIDERED APPROXIMATE
3) PROPERTY BOUNDARIES ARE APPROXIMATE BASED ON TOWN OF STRATFORD ENGINEERING DEPARTMENT PLANS
4) DUE TO UNCERTAINTIES OF PROPERTY BOUNDARIES DURING THE SAMPLING PROCESS, SAMPLES LOCATED ADJACENT TO THE PROPERTY ARE UNDERSTOOD TO BE ON THE PROPERTY
5) CT DIRECT EXPOSURE CRITERIA (CT DEC) FOR RESIDENTIAL SOILS AND CT POLLUTANT MOBILITY CRITERIA (CT PMC) USED TO DETERMINE EXCEEDANCES.

SOIL SAMPLE LOCATIONS	FIGURE 3-24 (revision 1)
RAYMARK - OU6	TETRA TECH NUS, INC.
STRATFORD, CONNECTICUT	
DRAWN BY: L. SEYDEWITZ / DATE: APRIL 11, 2005	55 JONSPIN ROAD WILMINGTON, MA 01887 (978)658-7899
CHECKED BY: D. CHISHOLM / FILE: C:\...\OU6_RI_2003.APR	

ISOMETRIC

amec

BY CCA DATE 7/22/12 SUBJECT 35 Third Avenue Raymark Waste Excavation SHEET NO. 1 OF 1

CHKD BY SHM DATE 6/26/13 JOB NO. 36511200004.

AREA 1: 1,500 square feet, 8-foot max depth of Raymark waste

1,500 sf × 8 ft = 12,000 cubic feet

12,000 cf × 0.037 = 444 cubic yards ~~≈444 cy~~

AREA 2: 190 square feet, 11.5-foot max depth of Raymark waste

190 sf × 11.5 ft = 2,185 cubic ~~yards~~ feet

2,185 cf × 0.037 = 80.85 cy ≈ 81 cy

444 cy + 81 cy = 525 cy

Taking into account any additional Raymark waste discovered during excavation (≈100 cy), 630 cubic yards should be assumed for the total volume at 35 Third Avenue in Stratford, CT.

35 THIRD AVENUE

BORING LOG FOR:	Raymark OU6			BORING NO.:	3A35-201
PROJECT NO.:	N4106-0320			START DATE:	5/28/03
LOGGED BY:	J. Lambert	TRANSCRIBED BY:	LJD	COMPLETION DATE:	5/28/03
DRILLED BY (Company/Driller):	ADT/Scott P.			MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		ELEVATION FROM:		CHECKED BY:	TD

DEPTH (FEET) 0	BLOWS PER 6" N/A	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA *METHOD* = [FID, (PPM)]
		1.1 / 2.0	OU6-SO-3A35-201-0002 0850		Slight	Light	Fine-medium SAND, some silt	SP		PID/FID
2					Dense	Brown	Fine-coarse SAND, trace silt	SW		
		1.3 / 2.0	OU6-SO-3A35-201-0204 0855		2.5'	Black	Asphalt, broken pieces			0.0 / 0.0
4						Light Brown	Fine-coarse SAND, some gravel	SW		
		1.0 / 2.0	OU6-SO-3A35-201-0406 0900			Dark Brown	Fine-coarse SAND, trace silt	SW	Wet, water in sleeve	
6						Dark Brown	Fine-medium SAND and SILT	SM	Also organics roots and	
		1.4 / 2.0	OU6-SO-3A35-201-0608 0905			Dark	SILT, some fine sand	ML	Wood fragments, organic odor	
8						Brown				0.0 / 0.0
				EOB @ 8' bgs						

TYPE OF DRILLING RIG:	Geo-probe		Tetra Tech NUS, Inc.
METHOD OF ADVANCING BORING:	D.P.T.		
METHOD OF SOIL SAMPLING:	Grab using macro-core		
METHOD OF ROCK CORING:	NA		
GROUNDWATER LEVELS:	NA		
OTHER OBSERVATIONS:	Instrument Group: D	BORING NO.: 3A35-201	PAGE: 1 OF 1

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6			BORING NO.:	3A35-202
PROJECT NO.:	N4106-0320			START DATE:	5/28/03
LOGGED BY:	J. Lambert	TRANSCRIBED BY:	LJD	COMPLETION DATE:	5/28/03
DRILLED BY (Company/Driller):	ADT/Scott P.			MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		ELEVATION FROM:		CHECKED BY:	TD

DEPTH (FEET) 0	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA *METHOD* = [FID, (PPM)]
		N/A	OU6-SO-3A35-202-0002 1030		Slight Dense	Light Brown	SILT, some fine sand, trace gravel	ML	Moist	PID/FID
2										
		1.2 / 2.0	OU6-SO-3A35-202-0204 1040			Light Brown	SILT, trace fine sand, trace gravel	ML	Brick fragment at 3'	0.0
4										
		1.5 / 2.0	OU6-SO-3A35-202-0406 1050						Tile (1" thick) at 5.5'	
6					5.6'	Black	Possible asphalt and copper pieces			
		1.8 / 2.0	OU6-SO-3A35-202-0608 1100			Light Brown	Fine-coarse SAND, some silt		Wet	0.0
8						Red-Brown	Deteriorated fabric or gasket material with small fibers throughout possible asbestos.		Plastic at 8'	
		1.5 / 2.0	OU6-SO-3A35-202-0810 1115							
10						Dark Brown	SILT, some organics (roots), trace fine sand	OL	Organic odor	
		1.5 / 2.0	OU6-SO-3A35-202-1012 1140							
12										
				EOB @ 12' bgs						

TYPE OF DRILLING RIG:	Geo-probe - hand auger first 0 -2'		Tetra Tech NUS, Inc.
METHOD OF ADVANCING BORING:	D.P.T.		
METHOD OF SOIL SAMPLING:	Grab using macro-core		
METHOD OF ROCK CORING:	NA		
GROUNDWATER LEVELS:	NA		
OTHER OBSERVATIONS:	Instrument Group: D, full suite samples taken here	BORING NO.: 3A35-202	PAGE: 1 OF 1

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6		
PROJECT NO.:	N4106-0320		
LOGGED BY:	J. Lambert	TRANSCRIBED BY:	LAH
DRILLED BY (Company/Driller):	ADT/Scott P.		
GRD. SURFACE ELEVATION:		ELEVATION FROM:	

BORING NO.:	3A35-203
START DATE:	5/28/03
COMPLETION DATE:	5/28/03
MON. WELL NO.:	N/A
CHECKED BY:	TD

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA *METHOD* = [FID, (PPM)]
0	N/A									
		N/A	OU6-SO-3A35-203-0002 1215		0.5'	Dark Brown	Topsoil, fine-coarse SAND and SILT	SM	(organics – grass roots)	PID/FID 0.0
2					loose	Light Brown	Fine-coarse SAND and SILT, trace gravel	SM	Dry	
		1.5/2.0	OU6-SO-3A35-203-0204 1250 *co-located dup @ 1350			Light Brown	Fine-coarse SAND, some silt, some gravel	SW	Moist	
4									Cobble @ 4'	
		1.2/2.0	OU6-SO-3A35-203-0406 1310 *conf dup 04 @ 1400		4.2		Asphalt pieces		2" concrete lens @ 5.5'	
					Slightly loose	Black/red	brick			
6						Light Brown	Fine-coarse SAND, and gravel	SW		0.0
		1.0/2.0	OU6-SO-3A35-203-0608 1315						Wet – water in sleeve	
8						Dark Brown	SILT, red and wood fiber fragments	OL		
		1.5/2.0	OU6-SO-3A35-203-0810 1320							
10						Lt brown	1" lens, fine SAND	SP		
						Dk brown	SILT, wood fragments	OL		0.0
				EOB @ 10' bgs						

TYPE OF DRILLING RIG:	Geo-probe– hand auger used for 0 -2' sample		Tetra Tech NUS, Inc.
METHOD OF ADVANCING BORING:	D.P.T.		
METHOD OF SOIL SAMPLING:	Grab using macro-core		
METHOD OF ROCK CORING:	NA		
GROUNDWATER LEVELS:	NA		
OTHER OBSERVATIONS:	Instrument Group: D	BORING NO.: 3A35-203	PAGE: 1 OF 1

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6	BORING NO.:	3A35-204
PROJECT NO.:	N4106-0320	START DATE:	5/28/03
LOGGED BY:	J. Lambert	TRANSCRIBED BY: LAH	COMPLETION DATE: 5/28/03
DRILLED BY (Company/Driller):	ADT/Scott P.	MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		ELEVATION FROM:	CHECKED BY: TD

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA *METHOD* = [FID, (PPM)]
0	N/A									
		N/A	OU6-SO-3A35-204-0002 1430		Slightly Loose	Light Brown	Fine-coarse SAND and SILT, some gravel	SM		PID/FID
2							FINES downward			
		2.0/2.0	OU6-SO-3A35-204-0204 1440			Light Brown	Fine SAND, some silt, trace gravel	SM	Cobble @ 3.3'	0.0
4							Fine-coarse SAND, trace silt, some gravel	SW		
		2.0/2.0	OU6-SO-3A35-204-0406 1450			Black	Fine SAND, pieces of concrete, some fibers	SP		
6										
		2.0/2.0	OU6-SO-3A35-204-0608 1500			Black	Same as above; also asphalt pieces			0.0
8										
		2.0/2.0	OU6-SO-3A35-204-0810 1510		Slightly Loose	Dark Brown	Fine-medium SAND, some gravel	SP		0.0
10					Slightly Dense	Light Brown	Fine SAND and SILT, organics (reed and root fragments)	OL		
				EOB @ 10' bgs						

TYPE OF DRILLING RIG:	Geo-probe– hand auger used for 0 -2' sample		Tetra Tech NUS, Inc.
METHOD OF ADVANCING BORING:	D.P.T.		
METHOD OF SOIL SAMPLING:	Grab using macro-core		
METHOD OF ROCK CORING:	NA		
GROUNDWATER LEVELS:	NA		
OTHER OBSERVATIONS:	Instrument Group: D	BORING NO.: 3A35-204	PAGE: 1 OF 1

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6			BORING NO.:	3A35-205
PROJECT NO.:	N4106-0320			START DATE:	5/28/03
LOGGED BY:	K. O'Neill	TRANSCRIBED BY:	LAH	COMPLETION DATE:	5/28/03
DRILLED BY (Company/Driller):	ADT/Scott			MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		ELEVATION FROM:		CHECKED BY:	TD

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA *METHOD* = [FID, (PPM)]
0	N/A									
		Hand Auger	OU6-SO-3A35-205-0002 1540	N/A	Loose	Brown	Removed turf grass Silty medium SAND with fine-coarse gravel	SM	Moist	
2				Fill						
		1.2 / 2.0	OU6-SO-3A35-205-0204 1550		Loose	Brown	fine-coarse SAND with some silt and fine-coarse gravel			0.0 PID
4										
		1.4 / 2.0	OU6-SO-3A35-205-0406 1555				0-0.2 - Similar to above 0.2-0.5 - Concrete lens			
6							0.5-0.8 - See 2-4 interval above 0.8-1.0 - Asphalt lens (remainder is similar to 2-4')			
	No Sample	0.3 / 2.0	OU2-SO-3A35-205-0608 Poor Recovery		Very	Dark	fine-coarse GRAVEL with some sand			
8					Loose	Gray	Not enough fine material for sample, mostly GRAVEL			
	No Sample		OU2-SO-3A35-205-0810 **No Recovery**						Saturated	0.0 PID
10										
		0.9 / 2.0	OU6-SO-3A35-205-1012 1610				0 – 0.8 - Slough		Asbestos only	Asbestos Only
12							0.8-0.9 - Medium SAND with silt	SM		
		1.4 / 2.0	OU6-SO-3A35-205-1214 1612			Gray	0-0.7 - SILT with trace clay			
14						Dark Gray	0.7-1.4 - SILT with fine sand and fine vegetation roots.			
				EOB @ 14' bgs			Native at 12' bgs			

8'

not considered Raymark waste

TYPE OF DRILLING RIG:	Geo-probe		*Tetra Tech NUS, Inc.*
METHOD OF ADVANCING BORING:	D.P.T.		
METHOD OF SOIL SAMPLING:	Grab using macro-core		
METHOD OF ROCK CORING:	NA		
GROUNDWATER LEVELS:	NA		
OTHER OBSERVATIONS:	Instrument Group:	BORING NO.: 3A35-205	PAGE: 1 OF 1

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6			BORING NO.:	3A35-206
PROJECT NO.:	N4106-0320			START DATE:	5/28/03
LOGGED BY:	K. O'Neill	TRANSCRIBED BY:	LAH	COMPLETION DATE:	5/28/03
DRILLED BY (Company/Driller):	ADT/Scott			MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		ELEVATION FROM:		CHECKED BY:	TD

DEPTH (FEET) 0	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA *METHOD* = [FID, (PPM)]
	Hand auger	N/A	OU6-SO-3A35-206-0002 1630	N/A	Loose	Brown	Turf grass removed		Slightly moist	0.0 PID
2						Black	Sandy loam, fine-med sand with some silt			
		1.8 / 2.0	OU6-SO-3A35-206-0204 1640			Gray	Fine-coarse SAND with angular gravel with asphalt intermixed		Fill Dry	
4										
		1.7 / 2.0	OU6-SO-3A35-206-0406 1645		Loose		Similar to above with petroleum odor		Fill	0.1 PID
6					Loose	Gray				
		1.3 / 2.0	OU6-SO-3A35-206-0608 1650				0-0.5 - Similar to above		Saturated ~ 6' bgs	
8					Dense	Light Gray	0.5-1.3 - Fine-coarse SAND with trace gravel	SW		
		0.4 / 2.0	OU6-SO-3A35-206-0810 1655	All		Brown	SILT with fine sand			
10					Dense	Gray				
				EOB @ 10' bgs			Native @ 7.8' bgs			

TYPE OF DRILLING RIG:	Geo-Probe		*Tetra Tech NUS, Inc.*
METHOD OF ADVANCING BORING:	D.P.T.		
METHOD OF SOIL SAMPLING:	Grab using macro-core		
METHOD OF ROCK CORING:	NA		
GROUNDWATER LEVELS:	NA		
OTHER OBSERVATIONS:	Instrument Group: D	BORING NO.: 3A35-206	PAGE: 1 OF 1

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6 RI/FS	BORING NO.:	3A35-301
PROJECT NO.:	N1369	START DATE:	5/19/04
LOGGED BY:	K. Jalkut	COMPLETION: DATE:	5/19/04
DRILLED BY (Company/Driller):	Aquifer Drilling and Testing/S. Przybylski	MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		CHECKED BY:	JL
TRANSCRIBED BY:	RAC		
ELEVATION FROM:			

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA METHOD = [FID, (PPM)] FID	PID
0	NA										
0.3		1.6' / 2'	OU6-SO-3A35-301-0002 Screening 5/19/04 @ 1515		Loose	Dark Brown	0' – 0.3' – ROOT MAT (perlite or vermiculite material), organics, roots, twigs. Trace fine subrounded gravel to ½"		Topsoil; fill, dry – damp (raining)	0.0	0.0
0.7					Medium Dense	Brown	0.3' – 0.7' - SAND, some silt, trace gravel. Fine-medium sand, fines, fine subrounded gravel to ½" (2 pieces), organic material	SM	Damp; fill	0.0	0.0
1.6						Tan-Brown	0.7' – 1.6' - SAND, trace silt, fine-medium sand, poorly graded	SP	Damp – Wet Fill	0.3	0.0
2									Partial recovery		
2.7		1.7' / 2'	OU6-SO-3A35-301-0204 Screening 5/19/04 @ 1520		Dense	Brown	0' – 0.7' - SAND, some silt, trace gravel. Fine-medium, trace coarse sand, poorly graded, fine subangular gravel to ¼", coarse subangular gravel to 1 ½"	SM	Wet fill	0.0	0.0
3.7						Dark Brown - Black	0.7' – 1.7' – FILL - Brick, glass shards, charcoal clinkers, fibrous material, a-secular needle like fibers, (PACM), glass, concrete charred wood mixed with silty sand, some gravel	Fill	Possible PACM	39.8	
4									Partial recovery		
5		1.3' / 2'	OU6-SO-3A35-301-0406 Screening 5/19/04 @ 1540		Soft	Brown	0' – 0.3' – SILT, some fine-medium sand, trace roots	ML	Saturated, no man-made material	0.7	0.0
					Medium Dense	Black-Brown	0.3' – 1.8' – FILL - Processed material, fibrous material, needle like fibers, mottled red coloration, spongy material	Fill	Possible PACM		
6							Charred wood at bottom, large chunks				

5'

TYPE OF DRILLING RIG:	Geoprobe
METHOD OF ADVANCING BORING:	Direct Push Technique
METHOD OF SOIL SAMPLING:	Macro-Core
METHOD OF ROCK CORING:	N/A
GROUNDWATER LEVELS:	
OTHER OBSERVATIONS:	

Note:
PACM – Potential asbestos containing material

Tetra Tech NUS, Inc.

BORING NO.: 3A35-301

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6 RI/FS	BORING NO.:	3A35-301
PROJECT NO.:	N1369	START DATE:	5/19/04
LOGGED BY:	K. Jalkut	COMPLETION: DATE:	5/19/04
DRILLED BY (Company/Driller):	Aquifer Drilling and Testing/S. Przybylski	MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		CHECKED BY:	JL
TRANSCRIBED BY:	RAC		
ELEVATION FROM:			

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA METHOD = [FID, (PPM)] FID	PID
6	NA										
		2' / 2'	OU6-SO-3A35-301-0608 Screening 5/19/04 @ 1550		Soft	Black - Brown	0' – 1' – SILT, with brick pieces	ML	Saturated at 6'	4.7	0
7						Black	1' – 1.5' – GRAVEL, some silt, fine and coarse subangular gravel to 1 ½", fines, brick, charred wood	GM	Fill; saturated	45	0
						Gray	1.5' – 2' – SILT, some clay, some organic material. Silt and clay sized particles, organic roots, reeds	OL/ OH	Native material, H_2S odor	58	0
8											
				EOB @ 8' bgs			EOB @ 8' bgs – Backfill with bentonite chips (8' – 1') and topsoil (1' – 0')				

TYPE OF DRILLING RIG:	Geoprobe
METHOD OF ADVANCING BORING:	Direct Push Technique
METHOD OF SOIL SAMPLING:	Macro-Core
METHOD OF ROCK CORING:	N/A
GROUNDWATER LEVELS:	
OTHER OBSERVATIONS:	

BORING NO.: 3A35-301

Tetra Tech NUS, Inc.

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6 RI/FS		
PROJECT NO.:	N1369		
LOGGED BY:	K. Jalkut	TRANSCRIBED BY:	RAC
DRILLED BY (Company/Driller):	Aquifer Drilling and Testing/S. Przybylski		
GRD. SURFACE ELEVATION:		ELEVATION FROM:	

BORING NO.:	3A35-302
START DATE:	5/19/04
COMPLETION: DATE:	5/19/04
MON. WELL NO.:	N/A
CHECKED BY:	JL

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA *METHOD* = [FID, (PPM)] FID	PID
0	NA										
1		1.4' / 2'	OU6-SO-3A35-302-0002 Screening 5/19/04 @ 1605		Medium Dense	Red – Brown	0' – 0.5' – SAND, some silt, some organics, trace gravel. Fine-medium sand, trace coarse sand, poorly graded, fines, roots, twigs, fine and coarse subangular and subrounded gravel ½" – ¾"	SM	Damp topsoil	0	0
2					Loose	Brown	0.5' – 1' – Similar to above, with some gravel, roots	SM/ GM	Damp	0	0
						Black	1' – 1.4' – SAND, fine-medium, poorly graded, some broken rock (schist), metal debris, glass, charred wood	Fill/ SP	Dry; fill, no visible PACM	0	0
3		1.5' / 2'	OU6-SO-3A35-302-0204 Screening 5/19/04 @ 1615			Black – Brown	0' – 0.5' – SAND, some silt, some gravel. Fine to coarse sand, well graded, fine subangular gravel to ½"	SM	Damp No visible PACM, Man-made material	0	0
						Gray	0.5' – 1' – CONCRETE, some pulverized, some to 1 ½"	Fill			
4						Black	1' – 1.5' – SAND and GRAVEL, some silt. Fine to coarse sand, well graded, fines, fine and coarse subangular, subrounded gravel to 1", asphalt pieces, concrete	SW/ Fill	Dry No visible man-made material or PACM Damp	0	0
5		1.7' / 2'	OU6-SO-3A35-302-0406 Screening 5/19/04 @ 1625		Soft	Dark Brown	0' – 1' – SILT, with sand intervals, organic roots, reeds	OL/ OH	0.5' – 0.6' – interval of fine-medium gray sand Native material	199	0
6			Also DUP 303 @ 1630			Brown-Black	1' – 1.7' – Similar to above, with twigs, reeds, wood		0.8' - 0.9' – broken weathered schist-soft organic odor (H_2S) No visible PACM or spongy material	242	0
7		1.3' / 2'	OU6-SO-3A35-302-0608 Screening 5/19/04 @ 1635		Loose	Black-Brown	0' – 0.5' – SILT, some organics (roots, organic fibers)		Saturated at 6'	91.6	0
						Gray	0.5' – 0.8' – GRAVEL, some sand. Fine subrounded and subangular gravel to ½". Fine to coarse sand, well graded	GP	Damp	0	0
8				EOB @ 8' bgs	Soft	Black - Brown	0.8' – 1.3' – SILT and ORGANICS. Roots, reeds, organic fibers	OL/ OH	Damp	245.2	0

5.5'

TYPE OF DRILLING RIG:	Geoprobe
METHOD OF ADVANCING BORING:	Direct Push Technique
METHOD OF SOIL SAMPLING:	Macro-Core
METHOD OF ROCK CORING:	N/A
GROUNDWATER LEVELS:	
OTHER OBSERVATIONS:	

Note:
PACM – Potential asbestos containing material

BORING NO.: 3A35-302

Tetra Tech NUS, Inc.

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6 RI/FS	BORING NO.:	3A35-303
PROJECT NO.:	N1369	START DATE:	5/19/04
LOGGED BY:	K. Jalkut	COMPLETION: DATE:	5/19/04
DRILLED BY (Company/Driller):	Aquifer Drilling and Testing/S. Przybylski	MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		CHECKED BY:	JL
TRANSCRIBED BY:	RAC		
ELEVATION FROM:			

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA METHOD = [FID, (PPM)] FID	PID
0	NA										
1		1.2' / 2'	OU6-SO-3A35-303-0002 Screening 5/19/04 @ 1645		Loose	Dark Brown	0' – 1.2' – SAND, some silt, some gravel, some organics. Mostly fine-medium sand, trace coarse sand, fines, fine subangular to subrounded gravel ¼" – ½", coarse subrounded and subangular gravel to 1", roots, trace broken rock	SM	Topsoil; dry fill	0	0
2									No visible PACM		
3		1' / 2'	OU6-SO-3A35-303-0204 Screening and Confirmation 5/19/04 @ 1650			Brown	0' – 1' – SAND and GRAVEL, some silt. Fine to coarse sand, well graved, fine and coarse subangular and subrounded gravels to 2"	GM/ SM	Damp fill No visible PACM	0	0
4											
5		0.6' / 2'	OU6-SO-3A35-303-0406 Screening 5/19/04 @ 1700				0' – 0.6' – Similar to above, with less fine gravel, more coarse gravel		Damp fill No visible PACM	0	0
6											
7		2' / 2'	OU6-SO-3A35-303-0608 Screening 5/19/04 @ 1705			Gray – Brown	0' – 0.9' – SAND, some silt, some gravel. Mostly fine to coarse sand, well graded, fines, fine subangular to subrounded gravel to ½"	SM	Saturated at 6'	0	0
8				EOB @ 8' bgs	Soft	Gray Brown	0.9' – 1.3' – GRAVEL, some sand. Fine and coarse angular to subangular gravels to 1" 1.3' – 2' – PEAT with silt. Fibrous material mostly with silt.	GW PT/ OL	Damp	0 245	0 0

TYPE OF DRILLING RIG:	Geoprobe
METHOD OF ADVANCING BORING:	Direct Push Technique
METHOD OF SOIL SAMPLING:	Macro-Core
METHOD OF ROCK CORING:	N/A
GROUNDWATER LEVELS:	Approximately 6' bgs
OTHER OBSERVATIONS:	

Note:
PACM – Potential asbestos containing material

BORING NO.: 3A35-303

Tetra Tech NUS, Inc.

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6 RI/FS			BORING NO.:	3A35-304
PROJECT NO.:	N1369			START DATE:	5/20/04
LOGGED BY:	T. Dorgan	TRANSCRIBED BY:	RAC	COMPLETION: DATE:	5/20/04
DRILLED BY (Company/Driller):	Aquifer Drilling & Testing			MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		ELEVATION FROM:		CHECKED BY:	JL

DEPTH (FEET) 0	BLOWS PER 6" NA	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION Location in garden	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA *METHOD* = [FID, (PPM)] FID	PID
			OU6-SO-3A35-0002			Brown	0' – 1' – Plant Roots approximately 0.2', silty fine to coarse SAND, trace gravel	Fill/SW	Fill	0	0
2			5/20/04 @ 0840				1' – 3' - Fine to coarse subangular GRAVEL, increasing silt, fine to coarse sand, gravel and cobble fill. Coarse fill increasing with depth. Cobble/gravel fill consists of schist fragments				
3							Refusal at 1st attempt at 3' bgs, refusal at 2nd attempt 2.25' bgs				
				EOB @ 3' bgs							

TYPE OF DRILLING RIG:	Hand Auger		Tetra Tech NUS, Inc.
METHOD OF ADVANCING BORING:	Hand Auger		
METHOD OF SOIL SAMPLING:	Hand Auger		
METHOD OF ROCK CORING:	N/A		
GROUNDWATER LEVELS:			
OTHER OBSERVATIONS:		BORING NO.: 3A35-304	PAGE: 1 OF 1

TtNUS Form 0018

BORING LOG FOR:	Raymark OU9 RI/FS	BORING NO.:	3A35-305
PROJECT NO.:	N1369	START DATE:	5/20/04
LOGGED BY:	K. Jalkut	COMPLETION: DATE:	5/20/04
DRILLED BY (Company/Driller):	Aquifer Drilling & Testing/S. Przybylski	MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		CHECKED BY:	JL
TRANSCRIBED BY:	RAC		
ELEVATION FROM:			

DEPTH (FEET) 0	BLOWS PER 6" NA	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA METHOD = [FID, (PPM)] FID	PID
1		1.2' / 2'	OU6-SO-3A35-305-0002 Screening 5/20/04 @ 0900		Loose	Brown	SAND, some silt, trace gravel, organic material. Fine-medium sand, trace coarse sand, poorly graded, coarse subrounded gravel to ¾", roots/grass	SM	Topsoil; fill	0	2.2
2											
3		1.3' / 2'	OU6-SO-3A35-305-0204 Screening 5/20/04 @ 0910		Medium Dense		SAND, some silt, trace gravel. Similar to above with brick, charcoal, clinkers, plastic, concrete pieces		Damp – wet (fines) Fill	1.1	2.3
4											
5		1.4' / 2'	OU6-SO-3A35-305-0406 Screening 5/20/04 @ 0920		Loose		SAND, trace silt, trace gravel. Fine-medium sand mostly, trace coarse sand, poorly graded, fine subangular gravel to ½", fibrous pad with glassy fibers at end (PACM)	SP	Fill	0	1.5
6									Possible PACM at end		
7		2' / 2'	OU6-SO-3A35-305-0608 Screening 5/20/04 @ 0910				0' – 0.5' - SAND, some silt, trace gravel. Fine-medium poorly graded sand, coarse subangular gravel to 1" (1 piece) 0.5' – 1.4' - SAND, some silt, trace gravel. Fine to coarse well graded sand, fines (less than above), fine subrounded gravel to ½"	SM SW	Damp; fill	0	0
8			Dup-301 @ 0935		Spongy	Black	1.4' – 2' – Sponge-like material with glassy fibers throughout, needle like, sludge like material	Fill	PACM	0 59.7	1.4 0.4

8'

TYPE OF DRILLING RIG:	Geoprobe
METHOD OF ADVANCING BORING:	Direct Push Technique
METHOD OF SOIL SAMPLING:	Macro-Core
METHOD OF ROCK CORING:	N/A
GROUNDWATER LEVELS:	
OTHER OBSERVATIONS:	

Note:
PACM – Potential asbestos containing material

BORING NO.: 3A35-305

Tetra Tech NUS, Inc.

TtNUS Form 0018

BORING LOG FOR:	Raymark OU9 RI/FS		
PROJECT NO.:	N1369		
LOGGED BY:	K. Jalkut	TRANSCRIBED BY:	RAC
DRILLED BY (Company/Driller):	Aquifer Drilling & Testing/S. Przybylski		
GRD. SURFACE ELEVATION:		ELEVATION FROM:	

BORING NO.:	3A35-305
START DATE:	5/20/04
COMPLETION: DATE:	5/20/04
MON. WELL NO.:	N/A
CHECKED BY:	JL

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA METHOD = [FID, (PPM)] FID	PID
8	NA										
		1.8' / 2'	OU6-SO-3A35-305-0810 Screening and Confirmation 5/20/04 @ 0940		Spongy	Black-Red	0' – 1.4' – FILL, sponge-like material with glassy fibers throughout, reddish colored padding material, sludge like	Fill	Mottled color PACM		
9										725	0.0
			OU6-SO-DUP-302 Confirmation Dup @ 0950		Soft	Gray - Black	1.4' – 2' – PEAT and ORGANIC SILT, organic fibers, reeds, roots, with silt	PT/ OL/OH	Native material	12.9	0.0
10										↓	↓
				EOB @ 10' bgs			EOB @ 10' bgs – Backfill with bentonite chips (10' – 1') and topsoil (1' – 0')				
		RETURN FOR 1 MORE SAMPLE (10' – 12')									
10											
		2' / 2'	OU6-SO-3A35-305-1012 Screening 5/20/04 @ 1820		Soft	Gray-Black	0' – 1.5' – ORGANIC SILT, silt with organic roots	OL/OH	Saturated No visible PACM		
11							1.5' – 2' – PEAT and ORGANIC SILT (50/50 mix)	PT/OL-OH		499	0
12											

TYPE OF DRILLING RIG:	Geoprobe	Note: PACM – Potential asbestos containing material	Tetra Tech NUS, Inc.
METHOD OF ADVANCING BORING:	Direct Push Technique		
METHOD OF SOIL SAMPLING:	Macro-Core		
METHOD OF ROCK CORING:	N/A		
GROUNDWATER LEVELS:			
OTHER OBSERVATIONS:		BORING NO.: 3A35-305	PAGE: 2 OF 2

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6 RI/FS		
PROJECT NO.:	N1369		
LOGGED BY:	K. Jalkut	TRANSCRIBED BY:	RAC
DRILLED BY (Company/Driller):	Aquifer Drilling & Testing/S. Przybylski		
GRD. SURFACE ELEVATION:		ELEVATION FROM:	

BORING NO.:	3A35-306
START DATE:	5/20/04
COMPLETION: DATE:	5/20/04
MON. WELL NO.:	N/A
CHECKED BY:	JL

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA METHOD = [FID, (PPM)] FID	PID
0	NA										
1		1.2'/2'	OU6-SO-3A35-306-0002 Screening 5/20/04 @ 1015		Loose	Brown	SAND, some silt, trace gravel, organics. Fine-medium sand, trace coarse sand, poorly graded, 1 piece coarse subrounded gravel to 1", roots, grasses, reeds	SM	Topsoil; fill	0	0
2											
3		1.3'/2'	OU6-SO-3A35-306-0204 Screening 5/20/04 @ 1020		Medium Dense		0' – 0.8' – SAND, some silt, some gravel. Fine to coarse sand, well graded, fines, fine and coarse subrounded gravel to 1", glass, brick	SW	Fill; damp	0	0
4					Soft		0.8' – 1.3' – SAND, some silt, trace gravel. Fine-medium sand, poorly graded, fine subrounded gravel to ½", brick, plastic	SM		0	0
5		1.6'/2'	OU6-SO-3A35-306-0406 Screening 5/20/04 @ 1030		Medium Dense		0' – 0.8' – SAND, trace gravel, trace silt. Fine to coarse sand, well graded, fine and coarse subangular and subrounded gravel to 1" (2 pieces), roots	SW		4	0
6					Loose	Tan-Brown	0.8' – 1.1' – SAND. Fine sand, poorly graded 1.1' – 1.6' – SAND and GRAVEL, some silt. Fine to coarse sand, well graded, fine and coarse subangular and subrounded gravel to 1", broken rock	SP SW/GW		0 0	3.3 3
7		2'/2'	OU6-SO-3A35-306-0608 Screening 5/20/04 @ 1045		Spongy	Black-Red	0' – 2' – All sponge-like material with fibers throughout (glassy, needle like), matted fibers, mottled coloration, Black-Red-Brown	Fill	All Waste/PACM	282.2	6.9
8									Damp fill		

TYPE OF DRILLING RIG:	GEOPROBE
METHOD OF ADVANCING BORING:	Direct Push Technique
METHOD OF SOIL SAMPLING:	Macro - Core
METHOD OF ROCK CORING:	N/A
GROUNDWATER LEVELS:	
OTHER OBSERVATIONS:	

Note:
PACM – Potential asbestos containing material

BORING NO.: 3A35-306

Tetra Tech NUS, Inc.

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6 RI/FS	BORING NO.:	3A35-306
PROJECT NO.:	N1369	START DATE:	5/20/04
LOGGED BY:	K. Jalkut	TRANSCRIBED BY: RAC	COMPLETION: DATE: 5/20/04
DRILLED BY (Company/Driller):	Aquifer Drilling & Testing/S. Przybylski	MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		ELEVATION FROM:	CHECKED BY: JL

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA METHOD = [FID, (PPM)] FID	PID
8	NA										
9		2' / 2'	OU6-SO-3A35-306-0810 Screening 5/20/04 @ 1050		Spongy	Black - Brown	0' – 1.5' – WASTE, similar to 6' – 8'. Sponge-like material with glassy fibers, needle-like	Fill	PACM, saturated mottled coloration – Black-Red-Brown	119	1.8
10					Soft		1.5' – 2' – ORGANIC MATERIAL, fibrous, some silt, roots, reeds, slight plastic nature	PT/ OL-OH	H_2S odor, native material Soil damp	87	4
11		1' / 2'	OU6-SO-3A35-306-1012 Screening 5/20/04 @ 1055			Gray - Brown	0' – 1' – Organic SILT, silt sized material with organic fibers throughout	OL-OH	Native material H_2S odor Saturated Partial recovery		
12											
				EOB @ 12' bgs			EOB @ 12' bgs – Backfill with bentonite chips (12' – 1') and topsoil (1' – 0')				

TYPE OF DRILLING RIG:	GEOPROBE	Note: PACM – Potential asbestos containing material	Tetra Tech NUS, Inc.
METHOD OF ADVANCING BORING:	Direct Push Technique		
METHOD OF SOIL SAMPLING:	Macro - Core		
METHOD OF ROCK CORING:	N/A		
GROUNDWATER LEVELS:			
OTHER OBSERVATIONS:		BORING NO.: 3A35-306	PAGE: 2 OF 2

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6 RI/FS	BORING NO.:	3A35-307
PROJECT NO.:	N1369	START DATE:	5/20/04
LOGGED BY:	K. Jalkut	COMPLETION: DATE:	5/20/04
DRILLED BY (Company/Driller):	Aquifer Drilling & Testing/S. Przybylski	MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		CHECKED BY:	JL
TRANSCRIBED BY:	LJD		
ELEVATION FROM:			

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA *METHOD* = [FID, (PPM)] FID	PID
0	NA										
		0.9' / 2'	OU6-SO-3A35-307-0002 Screening 5/20/04 @ 1155		Loose	Brown	0 –0.9 –SAND, some silt, trace gravel, fine-medium sand, trace coarse sand, poorly graded, 1 piece fine subrounded gravel to ½" , roots	SM	Topsoil, dry		
1										0	3.2
2											
		2' / 2'	OU6-SO-3A35-307-0204 Screening 5/20/04 @ 1200		Medium Dense		0 -2' – SAND, some silt, trace organics, fine-medium sand, poorly graded, roots, brick pieces		Fill, damp		
3										5.4	2.7
4										1.9	1.3
		1.2' / 2'	OU6-SO-3A35-307-0406 Screening 5/20/04 @ 1205				0 – 0.3 – Similar to above			0	
5					Loose	Black - Brown	0.3 – 1.1 – SAND and GRAVEL, trace silt, fine-coarse sand, well graded, fine-coarse subrounded gravel to 1"	SW/GW	Damp, fill		2.3
										0	
6						Brown	1.1 – 1.2 – WOOD chunk, organic material	Fill		0	
		1.2' / 2'	OU6-SO-3A35-307-0608 Screening 5/20/04 @ 1210			Red-brown	0 – 0.5 – SAND, some silt, trace gravel. Fine-coarse sand, well graded, 1-2 pieces fine gravel, subrounded, plastic, brick	SM/Fill	Damp	0	3.8
7											
						Gray-White	0.5 – 0.8 – Broken Schist – coarse sized	Fill	Damp	0	3.2
8						Brown	0.8 – 1.2 – SAND, some silt, trace gravel, fine-coarse sand, well graded, 1-2 pieces coarse subrounded gravel to 1"	SM			

TYPE OF DRILLING RIG:	GEOPROBE LT54 (Track Rig)
METHOD OF ADVANCING BORING:	Direct Push Technique
METHOD OF SOIL SAMPLING:	Macro - Core Open tube continuous sampling to 4' in 2' intervals
METHOD OF ROCK CORING:	N/A
GROUNDWATER LEVELS:	
OTHER OBSERVATIONS:	

BORING NO.: 3A35-307

Tetra Tech NUS, Inc.

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6 RI/FS			BORING NO.:	3A35-307
PROJECT NO.:	N1369			START DATE:	5/20/04
LOGGED BY:	K. Jalkut	TRANSCRIBED BY:	LJD	COMPLETION: DATE:	5/20/04
DRILLED BY (Company/Driller):	Aquifer Drilling & Testing/S. Przybylski			MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		ELEVATION FROM:		CHECKED BY:	JL

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA METHOD = [FID, (PPM)] FID	PID
8	NA										
		0.9' / 2'	OU6-SO-3A35-307-0810 Screening/confirmation 5/20/04 @ 1215		Loose	Black - Brown	0 – 0.7 – SAND and GRAVEL, some silt, fine-coarse sand, well graded, fine-coarse subrounded gravel to 1"	SW/GW	Saturated @ 8'		
9										0	1.7
					Soft		0.7 – 1.5 – ORGANIC SILT, silt mixed with organics, including reeds, roots, long shiny fibers in top silt layer, PACM, cellulose	OL/ Fill	Native Long shiny fibers-PACM	47.2	3.8
10											
				EOB@ 10' bgs			EOB @ 10' – backfill with Bentonite chips 10' – 1'; topsoil 1' – 0'				
2'											
							Return to advance 10-12' (no samples 0-10')				
10											
		1.5' / 2'	OU6-SO-3A35-307-1011 Screening 5/20/04 @ 1740		Soft	Gray-brown With red	0 – 0.5' – ORGANC SILT, with long shiny fibers in top of silt layer, PACM	OL/Fill	Mottled with red splotches Saturated	42	0
11											
			OU6-SO-3A35-307-1112 Screening 5/20/04 @ 1745			Gray - Brown	0.5 – 1' – PEAT and ORGANIC SILT	PT/OL	Saturated – native	1009	0
12											

TYPE OF DRILLING RIG:	GEOPROBE LT54 (Track Rig)	Note: PACM= Potential asbestos containing material Recalibrated PID after cal check-worked ok	Tetra Tech NUS, Inc.
METHOD OF ADVANCING BORING:	Direct Push Technique		
METHOD OF SOIL SAMPLING:	Macro - Core Open tube continuous sampling to 4' in 2' intervals		
METHOD OF ROCK CORING:	N/A		
GROUNDWATER LEVELS:			
OTHER OBSERVATIONS:		BORING NO.: 3A35-307	PAGE: 2 OF 2

BORING LOG FOR:	Raymark OU6 RI/FS	BORING NO.:	3A35-308
PROJECT NO.:	N1369	START DATE:	5/20/04
LOGGED BY:	K. Jalkut	COMPLETION: DATE:	5/20/04
DRILLED BY (Company/Driller):	Aquifer Drilling & Testing/S. Przybylski	MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		CHECKED BY:	JL
TRANSCRIBED BY:	LJD		
ELEVATION FROM:			

DEPTH (FEET) 0	BLOWS PER 6" NA	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA METHOD = [FID, (PPM)] FID	PID
		1.1' / 2'	OU6-SO-3A35-308-0002 Screening 5/20/04 @ 1230	S-1	Loose	Brown Red-	(0 – 1.1') – SAND, some silt, trace gravel, fine-medium sand, trace coarse sand, poorly graded, 1 piece fine subrounded gravel to ½", roots, broken rock pieces	SM	Topsoil, fill, Dry		
1										0	0
2											
3		0.7' / 2'	OU6-SO-3A35-308-0204 Screening 5/20/04 @ 1240	S-2	Medium Dense	Brown	(0 -0.7') – SAND, some silt, trace gravel, fine-coarse sand, well graded, coarse gravel, subrounded to 1"	SW	Damp	0	0.3
4											
5		1.5' / 2'	OU6-SO-3A35-308-0406 Screening 5/20/04 @ 1245	S-3	Loose	Gray	(0 – 0.6') – SAND and GRAVEL, some silt, fine-coarse sand, well graded, fine-coarse subrounded gravel to 1"	Rock Fill	Dry Dry	0	0.2
6											
7		1.6' / 2'	OU6-SO-3A35-308-0608 Screening 5/20/04 @ 1250	S-4	Medium Dense	Brown	(0 – 0.7') – Similar to material in S-3 (0 – 0.6')	SW	Damp	0	0.7
							(0.7 – 1.3') – SAND, some silt, trace gravel, fine-coarse sand, well graded, 1 piece fine subrounded gravel to ½", glass, brick, PACM – 1" lens noted, fiberous material with needle-like fibers	SM/Fill			
8					Soft	Black	(1.3 – 1.6') – ORGANIC material, roots with glass	Fill		0	2.9

TYPE OF DRILLING RIG:	GEOPROBE LT54 (Track Rig)
METHOD OF ADVANCING BORING:	Direct Push Technique
METHOD OF SOIL SAMPLING:	Macro - Core Open tube continuous sampling to 4' in 2' intervals
METHOD OF ROCK CORING:	N/A
GROUNDWATER LEVELS:	
OTHER OBSERVATIONS:	

Note:PACM= Potential asbestos containing material

BORING NO.: 3A35-308

Tetra Tech NUS, Inc.

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6 RI/FS		
PROJECT NO.:	N1369		
LOGGED BY:	K. Jalkut	TRANSCRIBED BY:	LJD
DRILLED BY (Company/Driller):	Aquifer Drilling & Testing/S. Przybylski		
GRD. SURFACE ELEVATION:		ELEVATION FROM:	

BORING NO.:	3A35-308
START DATE:	5/20/04
COMPLETION: DATE:	5/20/04
MON. WELL NO.:	N/A
CHECKED BY:	JL

35'

DEPTH (FEET) 8	BLOWS PER 6" NA	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA *METHOD* = [FID, (PPM)] FID	PID
		1.5' / 2'	OU6-SO-3A35-308-0810 Screening/confirmation 5/20/04 @ 1300		Spongy	Red - Brown	(0 – 1.2') –FILL Matted fiberous material with needle-like fibers, spongy like waste, PACM	Fill	Saturated @ 8'		
9										142	0
			OU6-SO-3A35-308-0810 Screening/confirmation 5/20/04 @ 1310		Soft	Black	(1.2 - 1.5') – ORGANIC MATERIAL (roots) with silt, bricks (reworked)	OL	Possible top of Native		
10										220	0
				EOB@ 10' bgs			Backfill (may return for depth)				
									2nd borehole		
10							Return for depth sample 5/20/04 – 5 pm No samples collected from 0-10' bgs				
		0.7' / 2'	OU6-SO-3A35-308-1011 Screening 5/20/04 @ 1700		Soft	Gray - Black	0 – 0.2' – PEAT, fiberous organic material, some silt	PT/OL	Saturated	96	0
11							0.2-0.7' – SILT sized particles with organics, roots, trace fine sand, poorly graded				
12											
				EOB@ 12' bgs			Backfill 0 -12'				

TYPE OF DRILLING RIG:	GEOPROBE LT54 (Track Rig)		Tetra Tech NUS, Inc.
METHOD OF ADVANCING BORING:	Direct Push Technique	Note: PACM=Potential asbestos containing material	
METHOD OF SOIL SAMPLING:	Macro - Core Open tube continuous sampling to 4' in 2' intervals		
METHOD OF ROCK CORING:	N/A		
GROUNDWATER LEVELS:			
OTHER OBSERVATIONS:		BORING NO.: 3A35-308	PAGE: 2 OF 2

BORING LOG FOR:	Raymark OU6 RI/FS	BORING NO.:	3A35-309
PROJECT NO.:	N1369	START DATE:	5/20/04
LOGGED BY:	K. Jalkut	COMPLETION: DATE:	5/20/04
DRILLED BY (Company/Driller):	Aquifer Drilling & Testing/S. Przybylski	MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		CHECKED BY:	JL
TRANSCRIBED BY:	LJD		
ELEVATION FROM:			

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA *METHOD* = [FID, (PPM)] FID	PID
0	NA										
		1.5' / 2'	OU6-SO-3A35-309-0002 Screening 5/20/04 @ 1500		Loose	Brown	(0 – 1.5') – SAND and GRAVEL, some silt, fine-coarse sand, well graded, fine-coarse subrounded gravel ¾" – 1", brick, charcoal or asphalt, roots, grass	SW	Topsoil, fill, dry	0	0
1											
2											
		1.6' / 2'	OU6-SO-3A35-309-0204 Screening 5/20/04 @ 1505		Medium Dense		(0 -1.6') – SILTY SAND, some gravel, fine-coarse sand, well graded, fines, fine-coarse gravel subangular and subrounded to 1.25", brick	SM	Damp (fines) More silt than above	0	0
3											
4									Fill		
		1.2' / 2'	OU6-SO-3A35-309-0406 Screening 5/20/04 @ 1510				(0 – 0.7') – SAND and GRAVEL, some silt, fine-coarse sand, well graded, fine-coarse subangular and subrounded gravel to 1.5", glass, metal	SW/GW		0	0
5											
					Loose	Gray Tan	(0.7 – 0.9') – GRAVEL, 2 pieces coarse (0.9 – 1.1') – SAND – fine-medium, poorly graded	GP SP	Fill -dry		
6							(1.1 – 1.2') – SILTY SAND, some gravel, fine-coarse sand, fine-coarse gravel, subrounded	SM	Dry Damp	0	0
		1.2' / 2'	OU6-SO-3A35-309-0608 Screening Confirmation 5/20/04 @ 1515		Medium Dense	Brown	(0 – 1.2') – SAND and GRAVEL, some silt, fine-coarse sand, well graded, fines, brick, fine-coarse subangular and subrounded gravel, broken rock (Schist)	SW/GW	Saturated at 8'		
7										0	0
8											

TYPE OF DRILLING RIG:	GEOPROBE LT54 (Track Rig)
METHOD OF ADVANCING BORING:	Direct Push Technique
METHOD OF SOIL SAMPLING:	Macro - Core Open tube continuous sampling to 4' in 2' intervals
METHOD OF ROCK CORING:	N/A
GROUNDWATER LEVELS:	
OTHER OBSERVATIONS:	

BORING NO.: 3A35-309

Tetra Tech NUS, Inc.

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6 RI/FS	BORING NO.:	3A35-309
PROJECT NO.:	N1369	START DATE:	5/20/04
LOGGED BY:	K. Jalkut	COMPLETION: DATE:	5/20/04
DRILLED BY (Company/Driller):	Aquifer Drilling & Testing/S. Przybylski	MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		CHECKED BY:	JL
TRANSCRIBED BY:	LJD		
ELEVATION FROM:			

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA METHOD = [FID, (PPM)] FID	PID
8	NA										
		0.5' / 2'	OU6-SO-3A35-309-0810 Screening 5/20/04 @ 1525		Loose	Brown	(0 – 0.5') – SAND – some gravel, fine-coarse sand, well graded, fine-coarse subrounded and subangular gravel ½ - ¾", trace brick	SW	Saturated Fill		
9										0	0
10											
		1.5' / 2'	OU6-SO-3A35-309-1012 Screening/confirmation 5/20/04 @ 1530		Soft	Gray - Black	(0 - 0.4') – SILT sized particles, trace roots	OL	Soupy/Saturated	0	0
11							(0.4 - 0.8') – Fiberous material, PEAT, organic soil	PT		41.7	0
							(0.8 – 1.5') – SILT sized particles and organic roots, slight plastic	OL/OH	Organic Silt	54.7	0
12											
				EOB@ 12' bgs			EOB @ 12' backfill with Bentonite chips – 12'-1' topsoil 1'-0'				

TYPE OF DRILLING RIG:	GEOPROBE LT54 (Track Rig)	Notes; No visible PACM PACM=Potential asbestos containing material	Tetra Tech NUS, Inc.
METHOD OF ADVANCING BORING:	Direct Push Technique		
METHOD OF SOIL SAMPLING:	Macro - Core Open tube continuous sampling		
METHOD OF ROCK CORING:	N/A		
GROUNDWATER LEVELS:			
OTHER OBSERVATIONS:		BORING NO.: 3A35-309	PAGE: 2 OF 2

BORING LOG FOR:	Raymark OU6 RI/FS	BORING NO.:	3A35-310
PROJECT NO.:	N1369	START DATE:	5/20/04
LOGGED BY:	K. Jalkut	TRANSCRIBED BY: RAC	COMPLETION: DATE: 5/20/04
DRILLED BY (Company/Driller):	Aquifer Drilling & Testing/S. Przybylski	MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		ELEVATION FROM:	CHECKED BY: JL

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA METHOD = [FID, (PPM)] FID	PID
0	NA										
		1.3' / 2'	OU6-SO-3A35-310-0002 Screening 5/20/04 @ 1555		Loose	Brown	0' – 0.3' – SAND, some silt, organics. Fine-medium sand, trace coarse sand, poorly graded, roots	SP	Topsoil		
1					Medium Dense		0.3' – 0.6' – Silty SAND – mostly, fine-medium sand, fines	SM	Damp	0	0
					Loose		0.6' – 1.3' – SAND, trace gravel. Fine-medium sand, trace coarse sand, fine and coarse subangular and subrounded gravel to ¾"	SP	Dry		
2										0	0
		1.5' / 2'	OU6-SO-3A35-310-0204 Screening 5/20/04 @ 1600		Medium Dense	Red - Brown	0' – 1' – Silty SAND, trace gravel, mostly fine-medium sand, trace coarse sand, fines, brick pieces, 1 piece ¾" coarse subangular gravel	SM	Damp	0	0
3											
					Loose	Brown	1' – 1.5' – SAND and GRAVEL, trace silt. Fine to coarse sand, well graded, fine and coarse subrounded gravel	SW/ GW		0	0
4											
		1.7' / 2'	OU6-SO-3A35-310-0406 Screening 5/20/04 @ 1610		Medium Dense	Brown	0' – 0.5' – Silty SAND, trace gravel. Fine-medium sand, poorly graded, 1-2 pieces fine gravel, subrounded to ½"	SM		0	0
5											
					Loose		0.5' – 1.1' – SAND and GRAVEL, broken rock. Fine to coarse sand, well graded, fine and coarse subangular and subrounded gravels to 1 ½"	SW/ GW			
6							1.1' – 1.7' – ASPHALT (black), fine to coarse SAND (loose)	SW/Fill		0	0
		1.6' / 2'	OU6-SO-3A35-310-0608 Screening 5/20/04 @ 1615				0' – 0.5' – SAND, trace silt. Fine to coarse sand, well graded	SW	Dry	0	0
7						Gray	0.5' – 0.8 – Broken ROCK (Schist)	Rock			
						Brown	0.8' – 1.1' – SAND, some gravel, trace organic material. Fine to coarse sand, well graded, wood chunk, plastic piece (yellow), fine and coarse subrounded gravel to 1"	SW	Wet	0	0
8						Gray	1.1' – 1.6' – SAND. Fine to coarse, well graded				

TYPE OF DRILLING RIG:	GEOPROBE LT54
METHOD OF ADVANCING BORING:	Direct Push
METHOD OF SOIL SAMPLING:	Macro - Core
METHOD OF ROCK CORING:	N/A
GROUNDWATER LEVELS:	
OTHER OBSERVATIONS:	

BORING NO.: 3A35-310

Tetra Tech NUS, Inc.

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6 RI/FS			BORING NO.:	3A35-310
PROJECT NO.:	N1369			START DATE:	5/20/04
LOGGED BY:	K. Jalkut	TRANSCRIBED BY:	RAC	COMPLETION: DATE:	5/20/04
DRILLED BY (Company/Driller):	Aquifer Drilling & Testing/S. Przybylski			MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		ELEVATION FROM:		CHECKED BY:	JL

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA *METHOD* = [FID, (PPM)] FID	PID
8	NA										
		1.6' / 2.0'	OU6-SO-3A35-310-0810 Screening 5/20/04 @ 1620		Loose	Gray-	0' - 1.3' - SAND trace gravel. Fine to coarse sand, well graded, 1-2 pieces fine subrounded gravel to ½"	SW	Saturated at 8'		
										112	0
				S-5	Spongy/ Soft	Dark-Brown	1.3' - 1.6' - FIBROUS MAT – some silt, roots, reeds, organic fibers	PT/OL	Native - Saturated		
10										260	0
		1.7' / 2.0'	OU6-SO-3A35-310-1011 Screening 5/20/04 @ 1630		Loose	Gray-	0' - 1.3' - SAND, trace gravel. Similar to material at S-5 (0' - 1.3')- slough	SW	Slough (collapsed material)	0	0
			OU6-SO-3A35-310-1112 Screening 5/20/04 @ 1635	S-6	Spongy/ Soft	Dark-Brown	1.3' - 1.7' - FIBROUS MAT, some silt – similar to S-5 at 1.3'-1.6'	PT/OL	Native – saturated	542	0
12											
				EOB @ 12' bgs			EOB at 12' bgs - Backfill with bentonite chips 12'-1'; topsoil 1'-0				

TYPE OF DRILLING RIG:	GEOPROBE LT54 (Track Rig)		Tetra Tech NUS, Inc.
METHOD OF ADVANCING BORING:	Direct Push Technique	Note: Checked on hole- it has collapsed below the H_20 table. Sand unit at 10'-11' is likely slough	
METHOD OF SOIL SAMPLING:	Macro - Core Open tube continuous sampling to 4' in 2' intervals		
METHOD OF ROCK CORING:	N/A		
GROUNDWATER LEVELS:			
OTHER OBSERVATIONS:		BORING NO.: 3A35-310	PAGE: 2 OF 2

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6 RI/FS	BORING NO.:	3A35-311
PROJECT NO.:	N1369	START DATE:	5/21/04
LOGGED BY:	K. Jalkut	COMPLETION: DATE:	5/21/04
DRILLED BY (Company/Driller):	Aquifer Drilling & Testing	MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		CHECKED BY:	JL

TRANSCRIBED BY: RAC

ELEVATION FROM:

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA METHOD = [FID, (PPM)] FID	PID
0	NA						Grass				
		1.2' / 2'	OU6-SO-3A35-311-0002 Screening 5/21/04 @ 0835		Loose	Brown	SAND, trace gravel. Fine-medium sand mostly, trace coarse sand, fine subrounded and subangular gravel to ½", coarse subangular gravel to 1", roots, asphalt pieces (3)	SP	Topsoil; dry	0	0
1											
2											
		1.5' / 2'	OU6-SO-3A35-311-0204 Screening 5/21/04 @ 0850				0' – 0.5' – SAND, trace gravel. Fine to coarse sand, well graded, fine subangular gravel to ½:, furnace slag, ash, plastic	SW	Fill - dry	0	0.4
3											
					Medium Dense	Red Brown	0.5' – 1' – Silty SAND, trace gravel. Fine-medium sand, poorly graded, fines, 1 piece coarse gravel to 1 ½", tar paper, furnace slag, plastic, broken rock	SM	Damp (fines)		
4					Loose	Brown-Black	1' – 1.5' – SAND. Fine to coarse sand, well graded, asphalt, trace gravel, 1 piece coarse subangular gravel to 1"	SW			
		1.6' / 2'	OU6-SO-3A35-311-0406 Screening 5/21/04 @ 0855		Medium Dense		0' – 1' – SAND, some silt, some gravel. Fine to coarse sand, well graded, fine and coarse subangular gravel to 1", asphalt pieces (3"), plastic, tar paper		Dry		
5									Damp; Fill	0	0
							1' – 1.6' – Silty SAND and ASPHALT pieces. Fine to coarse sand, well graded	SM/Fill	Damp; Fill		
6											
		1.2' / 2'	OU6-SO-3A35-311-0608 Screening 5/21/04 @ 0900		Loose	Brown – Gray	0' – 0.4' – SAND/CONCRETE. Fine to coarse sand, well graded	SW/Fill	Dry - Fill	0	0.4
7						Brown	0.4' – 0.8' – SAND and GRAVEL. Fine to coarse sand, well graded, fine and coarse subangular and subrounded gravel to 1"	SW/ GW	Wet		
						Gray	0.8' – 1.2' – Similar to above		Wet - Saturated	4	0.8
8											

TYPE OF DRILLING RIG:	GEOPROBE LT54
METHOD OF ADVANCING BORING:	Direct Push
METHOD OF SOIL SAMPLING:	Macro - Core
METHOD OF ROCK CORING:	N/A
GROUNDWATER LEVELS:	
OTHER OBSERVATIONS:	

BORING NO.: 3A35-311

Tetra Tech NUS, Inc.

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6 RI/FS		
PROJECT NO.:	N1369		
LOGGED BY:	K. Jalkut	TRANSCRIBED BY:	RAC
DRILLED BY (Company/Driller):	Aquifer Drilling & Testing		
GRD. SURFACE ELEVATION:		ELEVATION FROM:	

BORING NO.:	3A35-311
START DATE:	5/21/04
COMPLETION: DATE:	5/21/04
MON. WELL NO.:	N/A
CHECKED BY:	JL

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA *METHOD* = [FID, (PPM)] FID	PID
8	NA										
		0.7' / 2'	OU6-SO-3A35-311-0810 Screening 5/21/04 @ 0910		Loose	Brown	SAND and GRAVEL –fine-coarse sand, subangular, subrounded gravel to 1.5"	SW/GW	Saturated Poor recovery- rock and end of liner	1	0
10											
		1.8' / 2'	OU6-SO-3A35-311-1011 Screening 5/21/04 @ 0915			Gray	0' -0.4' - SAND and GRAVEL. Fine to coarse sand, fine-coarse subangular and subrounded gravel to 1"		Saturated	4.0	0
					Soft	Black	0.4' - 1.4' - SILT with reeds, roots, fibers- (possibly man-made) pasty, sludge-like	OL/ Fill	* PACM	174	0
12			OU6-SO-3A35-311-1112 Screening 5/21/04 @ 0920		Loose	Tan	1.4' - 1.8' - SAND, fine-medium sand, poorly graded	SP		22	0
				EOB @ 12' bgs			EOB at 12' bgs - Backfill with bentonite chips 12'-1' topsoil (1'-0)				

TYPE OF DRILLING RIG:	GEOPROBE
METHOD OF ADVANCING BORING:	Direct Push
METHOD OF SOIL SAMPLING:	Macro - Core
METHOD OF ROCK CORING:	N/A
GROUNDWATER LEVELS:	
OTHER OBSERVATIONS:	

*Note: PACM= Potential asbestos Containing material

BORING NO.: 3A35-311

Tetra Tech NUS, Inc.

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6 RI/FS	BORING NO.:	3A35-312
PROJECT NO.:	N1369	START DATE:	05/21/04
LOGGED BY:	K. Jalkut	COMPLETION: DATE:	05/21/04
DRILLED BY (Company/Driller):	Aquifer Drilling & Testing/S. Przybylski	MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		CHECKED BY:	JL

TRANSCRIBED BY: RAC

ELEVATION FROM:

DEPTH (FEET) 0	BLOWS PER 6" NA	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA *METHOD* = [FID, (PPM)] FID	PID
1		1.4'/2'	OU6-SO-3A35-312-0002 Screening 05/21/04 @ 1015		Loose	Brown	0.0' - 0.7' – SAND, some gravel, trace silt. Fine to medium sand, trace coarse sand, poorly graded, fine and coarse subrounded gravel to ¾", roots, grass	SP	Topsoil, dry	0.1	0
2						Gray-White	0.7' - 1.0' - BROKEN ROCK	Broken Rock	(Damp)		
						Brown	1.1' - 1.4' – SAND, some silt. Fine to medium sand, poorly graded, fines	SM		1.0	0
3		1.4'/2'	OU6-SO-3A35-312-0004 Screening and Confirmation 05/21/04 @ 1020		Medium Dense	Gray - Brown	0.0' - 0.5' - SAND and GRAVEL. Fine to coarse sand, fine and coarse subangular and angular gravel to 1 ¼" , broken rock fragments	SW	Fill, dry	0	0
						Brown	0.5' - 1.4' - SAND and GRAVEL, some silt. Fine to coarse sand, fine and coarse subangular gravel to 1 ¼"	SM-	Damp	0	0
4											
		1.5'/2'	OU6-SO-3A35-312-0406 Screening 05/21/04 @ 1025		Loose	Brown	0.0' - 0.8' – SAND, some gravel, trace silt. Fine-medium sand mostly, trace coarse sand, poorly graded, coarse subrounded and subangular gravel to 1", brick	SP	Dry	0.9	0
6						White Brown	0.8' -1.1' - CONCRETE chunks 1.1' - 1.5' – SAND, some gravel, some silt. Fine to coarse sand, well graded, fine and coarse subangular gravel to 1", asphalt pieces, brick, plastic	Fill SW		0.8	0
		1.5'/2'	OU6-SO-3A35-312-0608 Screening 05/21/04 @ 1030			Gray Brown	0.0' - 0.6' - Broken ROCK – pieces up to 1 ½" 0.6' - 0.8' - ASPHALT, CONCRETE, BRICK	Rock/ Fill	Dry	0	0
						Brown Gray	0.8' - 1.1' - SAND, fine to coarse well graded, asphalt 1.1' - 1.5' - SAND, fine to coarse, similar to above	SW	Saturated	0.4	0
8											

TYPE OF DRILLING RIG:	GEOPROBE LT54
METHOD OF ADVANCING BORING:	Direct Push
METHOD OF SOIL SAMPLING:	Macro - Core
METHOD OF ROCK CORING:	N/A
GROUNDWATER LEVELS:	
OTHER OBSERVATIONS:	

BORING NO.: 3A35-312

Tetra Tech NUS, Inc.

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6 RI/FS	BORING NO.:	3A35-312
PROJECT NO.:	N1369	START DATE:	05/21/04
LOGGED BY:	K. Jalkut	TRANSCRIBED BY: RAC	COMPLETION: DATE: 05/21/04
DRILLED BY (Company/Driller):	Aquifer Drilling & Testing/S. Przybylski	MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		ELEVATION FROM:	CHECKED BY: JL

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA *METHOD* = [FID, (PPM)] FID	PID
8	NA										
		1.5' / 2'	OU6-SO-3A35-312-0810 Screening 5/21/04 @ 1035		Loose	Gray	0' - 0.4' - SAND and GRAVEL. Fine to coarse sand, well graded, fine and coarse subrounded gravel to 1"	SW/GW	Saturated		
							0.4' - 0.8' - Broken ROCK- coarse pieces	Fill		5.9	0
						Brown	0.8' - 1.2' – SAND. Fine to coarse sand, well graded, asphalt pieces to 1 ½"	SW/Fill	Saturated, fill		
10						Gray-Black Gray-Brown	1.2' - 1.4' - SAND – Fine-medium sand, poorly graded 1.4' - 1.5' - PEAT – Organic material-reeds, roots	SP/Fill PT	Native	122	0
		1.5' / 2'	OU6-SO-3A35-312-1012 Screening 5/21/04 @ 1040		Soft	Gray-Brown	0' - 1.5' – PEAT, silt sized material with organic roots, reeds, organic fibers		Native Organic odor	130	2.1
12											
				EOB @ 12' bgs			EOB at 12' bgs - Backfill with bentonite chips (12'-1'); topsoil (1'-0)				

TYPE OF DRILLING RIG:	GEOPROBE		Tetra Tech NUS, Inc.
METHOD OF ADVANCING BORING:	Direct Push		
METHOD OF SOIL SAMPLING:	Macro - Core		
METHOD OF ROCK CORING:	N/A		
GROUNDWATER LEVELS:			
OTHER OBSERVATIONS:		BORING NO.: 3A35-312	PAGE: 2 OF 2

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6 RI/FS	BORING NO.:	3A35-313
PROJECT NO.:	N1369	START DATE:	05/21/04
LOGGED BY:	K. Jalkut	TRANSCRIBED BY: RAC	COMPLETION: DATE: 05/21/04
DRILLED BY (Company/Driller):	Aquifer Drilling & Testing/S. Przybylski	MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		ELEVATION FROM:	CHECKED BY: JL

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA METHOD = [FID, (PPM)] FID	PID
0	NA						Asphalt Driveway – Approximately 5" thick				
		1.8' / 2'	OU6-SO-3A35-313-0002 Screening 05/21/04 @ 1200		Loose	Black	0.0' - 0.45' - ASPHALT	Fill	Dry Fill		
1						Brown	0.45' - 1.0' - SAND and GRAVEL. Fine to coarse sand, well graded, fine and coarse subangular and subrounded gravel to ¾"	SW	Damp	0	0
						White	1.0' - 1.3' - Broken ROCK	Rock	Dry		
2						Brown	1.3' - 1.8' – Silty SAND. Fine to medium sand, poorly graded	SM	Damp	0	0
		1.5' / 2'	OU6-SO-3A35-313-0204 Screening 05/21/04 @ 1205				0.0' - 0.4' - Similar to above		Damp	0	0
3							0.4' - 1.5' – SAND, some gravel, trace silt. Fine-medium sand mostly, trace coarse sand, poorly graded, fine subangular gravel to ½". Coarse subrounded gravel to 1 ½", tar shingles, plastic pieces, furnace slag	SP	Dry		
4											
		1.8' / 2'	OU6-SO-3A35-313-0406 Screening 05/21/04 @ 1210				0.0' - 0.8' - SAND and GRAVEL, trace silt. Fine to coarse sand, well graded, fine and coarse subangular and subrounded gravel to 1"	SW	Damp		
						Black	0.8' - 1.0' - Charred WOOD, broken ROCK	FILL	Dry	181	0
						Brown	1.0' - 1.8' - SAND and GRAVEL, trace silt. Fine to coarse sand, fine and coarse subrounded and subangular gravel to ¾", brick, plastic, tile, asphalt, roots	SW/ GW	Damp		
6										21	0
		1.8' / 2'	OU6-SO-3A35-313-0608 Screening 05/21/04 @ 1215				0.0' - 0.8' - SAND and GRAVEL, trace silt, similar to above		Damp	1.4	0
						Gray-Black	0.8' - 1.8' - SAND and GRAVEL. Fine to coarse sand, well graded, fine and coarse subrounded gravel to 1", brick		Saturated		
										367.7	0.2
8											

TYPE OF DRILLING RIG:	GEOPROBE
METHOD OF ADVANCING BORING:	Direct Push
METHOD OF SOIL SAMPLING:	Macro - Core
METHOD OF ROCK CORING:	N/A
GROUNDWATER LEVELS:	
OTHER OBSERVATIONS:	

BORING NO.: 3A35-313

Tetra Tech NUS, Inc.

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6 RI/FS			BORING NO.:	3A35-313
PROJECT NO.:	N1369			START DATE:	05/21/04
LOGGED BY:	K. Jalkut	TRANSCRIBED BY:	RAC	COMPLETION: DATE:	05/21/04
DRILLED BY (Company/Driller):	Aquifer Drilling & Testing/S. Przybylski			MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		ELEVATION FROM:		CHECKED BY:	JL

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA *METHOD* = [FID, (PPM)] FID	PID
8	NA										
		1.6' / 2'	OU6-SO-3A35-313-0810 Screening and Confirmation 5/21/04 @ 1220		Loose	Gray/ Black	0' - 0.7' - SAND and GRAVEL (similar to above without brick pieces)	SW/GW	Saturated		
					Soft	Black	0.7' - 1.6' – PEAT Organic material – some silt. Mostly degraded roots/reeds/ twigs (peat) with some silt	PT		1155	0.2
10										353	0
		1.0' / 2'	OU6-SO-3A35-313-1012 Screening 5/21/04 @ 1225			Gray-Brown	0' - 0.2' - PEAT – fibrous material mat		Saturated	111	0.2
							0.2' - 1' - Organic SILT – silt with organic material – roots, reeds, twigs	OL/OH	Plastic		
12										206	0
				EOB @ 12' bgs			EOB at 12' bgs - Backfill with bentonite chips (12'-1'), sand (1'-0.5'), cold patch (0.5'-0)				

TYPE OF DRILLING RIG:	GEOPROBE		*Tetra Tech NUS, Inc.*
METHOD OF ADVANCING BORING:	Direct Push		
METHOD OF SOIL SAMPLING:	Macro - Core		
METHOD OF ROCK CORING:	N/A		
GROUNDWATER LEVELS:			
OTHER OBSERVATIONS:		BORING NO.: 3A35-313	PAGE: 2 OF 2

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6 RI/FS	BORING NO.:	3A35-314
PROJECT NO.:	N1369	START DATE:	5/21/04
LOGGED BY:	K. Jalkut	COMPLETION: DATE:	5/21/04
DRILLED BY (Company/Driller):	Aquifer Drilling & Testing/S. Przybylski	MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		CHECKED BY:	JL
TRANSCRIBED BY:	LAH		
ELEVATION FROM:			

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA METHOD = [FID, (PPM)] FID	PID
0	NA						Asphalt surface – 4-5" thick				
		1.6' / 2'	OU6-SO-3A35-314-0002 Screening 5/21/04 @ 1305		Loose	Brown	(0 – 0.3') – SAND and GRAVEL, fine-coarse sand, well graded fine-coarse subangular, subround gravel to ¾'	SW/GW	Asphalt driveDry		
1					Medium Dense		(0.3-0.7) -- Silty SAND – mostly fine-medium sand, trace coarse sand, poorly graded	SP		0	0
					Loose	Yellow/ Brown	(0.7-1.1') – wood chunk	Fill			
2							(1.1-1.6') – SAND, some silt, fine-coarse sand, well graded, fines, brick, charred wood	SM		56.9	0.2
		1.5' / 2'	OU6-SO-3A35-314-0204 Screening 5/21/04 @1310 OU6-SO-DUP-302 Screening/Duplicate 5/21/04 @1315		Loose	Brown	(0 -0.5') – SAND and GRAVEL, fine-coarse sand, well graded, fine-coarse subrounded gravel to 1"	SW/GW	Damp	0	0
3					Spongy Soft	Black/ red	(0.5-0.8') FILL- spongy material with needle like glassy fibers, sludge-like (0.8-1.1) – organic silt, with fibers (PACM)	Fill	Mottled coloration PACM		
							(1.1-1.3') – SAND and GRAVEL, fine-coarse sand, well graded, fine-coarse subrounded gravel to 1"		PACM/Damp		
4							(1.3-1.5') –FILL- spongy material, PACM, sludge-like				
4.5'		1.6' / 2'	OU6-SO-3A35-314-0406 Screening 5/21/04 @ 1320		Spongy		(0-0.3') – similar to above		PACM/Damp		
5									PACM	0	0
					Soft/Loose		(0.3-1.2') – SAND and GRAVEL, some silt, fine-medium sand, trace coarse sand, poorly graded, fine-coarse subangular and subrounded gravel to 1.5", brick, ceramic tile, PACM,roots, concrete	SM/GM	PACM		
6											
		1.6' / 2'	OU6-SO-3A35-314-0608 Screening 5/21/04 @ 1325		Loose/ Soft	Dark Brown	(0-1') – SILT, trace fine sand (poorly graded), trace organic material visible	OL	Saturated/Liquified (slough?)	0	0
7					Soft		(1-1.6') – PEAT and ORGANIC SILT with reeds, roots	PT/OL	(sample for analysis)		
										1372	0
8							Backfill 8'-1' with bentonite, 1'-0.5'=sand, 0.5-0 =cold patch				

TYPE OF DRILLING RIG:	GEOPROBE LT54 (Track Rig)
METHOD OF ADVANCING BORING:	Direct Push Technique
METHOD OF SOIL SAMPLING:	Macro - Core Open tube continuous sampling to 4' in 2' intervals
METHOD OF ROCK CORING:	N/A
GROUNDWATER LEVELS:	
OTHER OBSERVATIONS:	

Note: PACM= Potential asbestos containg material

Tetra Tech NUS, Inc.

BORING NO.: 3A35-314

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6 RI/FS	BORING NO.:	3A35-315
PROJECT NO.:	N1369	START DATE:	5/21/04
LOGGED BY:	K. Jalkut	COMPLETION: DATE:	5/21/04
DRILLED BY (Company/Driller):	Aquifer Drilling & Testing/S. Przybylski	MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		CHECKED BY:	JL
TRANSCRIBED BY:	DH		
ELEVATION FROM:			

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA METHOD = [FID, (PPM)] FID	PID
0	NA						Grass				
		1.2'	OU6-SO-3A35-315-0002 SCREENING 5/21/04 @ 1435		Loose	Brown	0-1.2 SAND-Some silt – trace gravel (fine-medium sand, trace coarse sand, poorly graded, coarse gravel to 1" subangular, roots, grass)	SP	Topsoil; dry fill	0	0
2											
		1.8' / 2.0'	OU6-SO-3A35-315-0204 SCREENING 5/21/04 @ 1450		Loose	Brown	0-0.4' – similar to above 0.4'-0.6' Coarse GRAVEL to 1.5"	GP	Dry	25.7	0
						Light Gray Brown	0.6'-0.9' SAND fine-medium sand, poorly graded 0.9'-1.2' Silty SAND – Fine-medium sand, poorly graded	SP SM	Dry		
4						Brown	1.2'-1.8' SAND and GRAVEL/ASPHALT, fine-coarse sand, fine and coarse subangular, subrounded gravel, fine-coarse asphalt chunks	SW/Fill	Damp, strong asphalt odors	113	5.9
										125	2.4
		1.9' / 2.0'	OU6-SO-3A35-315-0406 SCREENING 5/21/04 @ 1455			Brown	0-0.8' SAND and GRAVEL – some silt , fine-coarse sand, well graded, fine and coarse subrounded gravel to 2", asphalt pieces	SW/GW	Slough Fill	234	2.2
6					Fibrous	Black-Brown	0.8'-1.6' PEAT- organic fibrous material, trace plastic	PT	No visible PACM Not native	220	0
						Gray-Brown	1.6'-1.9' SAND- fine-medium sand, trace coarse sand	SP		337	0
		1.5' / 2.0'	OU6-SO-3A35-315-0608 SCREENING 5/21/04 @ 1500		Loose		0-1.5' SAND- trace gravel, fine-medium sand, trace coarse sand, poorly Graded, fine gravel subangular, subrounded to ½"	SP	Saturated at 6'		
8										1535	0.4

TYPE OF DRILLING RIG:	GEOPROBE LT54 (Track Rig)		Tetra Tech NUS, Inc.
METHOD OF ADVANCING BORING:	Direct Push Technique	PACM=Potential asbestos containing material	
METHOD OF SOIL SAMPLING:	Macro - Core Open tube continuous sampling to 4' in 2' intervals		
METHOD OF ROCK CORING:	N/A		
GROUNDWATER LEVELS:			
OTHER OBSERVATIONS:		BORING NO.: 3A35-315	PAGE: 1 OF 2

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6 RI/FS		
PROJECT NO.:	N1369		
LOGGED BY:	K. Jalkut	TRANSCRIBED BY:	DH
DRILLED BY (Company/Driller):	Aquifer Drilling & Testing/S. Przybylski		
GRD. SURFACE ELEVATION:		ELEVATION FROM:	

BORING NO.:	3A35-315
START DATE:	5/21/04
COMPLETION: DATE:	5/21/04
MON. WELL NO.:	N/A
CHECKED BY:	JL

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA *METHOD* = [FID, (PPM)] FID	PID
8	NA										
		1.9'/2.0'	OU6-SO-3A35-315-0810 SCREENING/ CONFIRMATION 5/21/04 @ 1505		Soft	Gray-Brown	(0.-0.5') Organic SILT – Silt with root material	OL	Saturated		
						Brown	(0.5'-1.9') PEAT- Fibrous organic material, some silt	PT	Less Moist – Lightweignt	900	1.2
10											
				EOB @ 10' bgs			EOB at 10' Backfill with bentonite chips 10'-1', topsoil 1.0"				

TYPE OF DRILLING RIG:	GEOPROBE LT54 (Track Rig)		Tetra Tech NUS, Inc.
METHOD OF ADVANCING BORING:	Direct Push Technique		
METHOD OF SOIL SAMPLING:	Macro - Core Open tube continuous sampling		
METHOD OF ROCK CORING:	N/A		
GROUNDWATER LEVELS:			
OTHER OBSERVATIONS:		BORING NO.: 3A35-315	PAGE: 2 OF 2

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6 RI/FS		
PROJECT NO.:	N1369		
LOGGED BY:	K. Jalkut	TRANSCRIBED BY:	RAC
DRILLED BY (Company/Driller):	Aquifer Drilling & Testing/S. Przybylski		
GRD. SURFACE ELEVATION:		ELEVATION FROM:	

BORING NO.:	3A35-316
START DATE:	5/21/04
COMPLETION: DATE:	5/21/04
MON. WELL NO.:	N/A
CHECKED BY:	JL

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA *METHOD* = [FID, (PPM)] FID	PID
0	NA										
		1.3' / 2'	OU6-SO-3A35-316-0002 Screening 5/21/04 @ 1540		Loose	Brown	0' – 1.3' – SAND, some gravel, trace silt. Fine-medium sand mostly, trace coarse sand, poorly graded, fine gravel subrounded to ½", roots	SP	Topsoil; dry		
1										0	0
2											
		1.6' / 2'	OU6-SO-3A35-316-0204 Screening 5/21/04 @ 1545				0' – 1.6' – SAND, some silt, trace gravel. Fine-medium sand, trace coarse sand, poorly graded, coarse gravel subangular to 1", brick	SM	More fines than above Damp (fines)	3.7	0
3											
4										21.3	0
		2' / 2'	OU6-SO-3A35-316-0406 Screening 5/21/04 @ 1550				0' – 0.5' – Similar to above		Damp	122	0
5						Dark Brown	0.5' – 2' – SAND and GRAVEL, some silt. Fine to coarse sand, well graded, fine and coarse subrounded and subangular gravel to 1", ceramic tile, concrete, green glass, netting (curly fibers – do not pull apart easily), plastic	SW/GW			
6									Fill	224 / 8.9	0 / 0
		1.6' / 2'	OU6-SO-3A35-316-0608 Screening 5/21/04 @ 1600			Gray	0' – 1.1' – SAND and GRAVEL, trace silt. Fine to coarse sand, well graded, fine and coarse subrounded and subangular gravel to 1"		Damp; fill		
									Saturated	947	0.2
					Soft	Gray - Brown	1.1' – 1.6' – Organic SILT, with fibrous material (more silt than organics)	OL	Less moisture. Native		
										143	0

TYPE OF DRILLING RIG:	GEOPROBE LT54
METHOD OF ADVANCING BORING:	Direct Push
METHOD OF SOIL SAMPLING:	Macro - Core
METHOD OF ROCK CORING:	N/A
GROUNDWATER LEVELS:	
OTHER OBSERVATIONS:	

BORING NO.: 3A35-316

Tetra Tech NUS, Inc.

TtNUS Form 0018

BORING LOG FOR:	Raymark OU6 RI/FS	BORING NO.:	3A35-316
PROJECT NO.:	N1369	START DATE:	5/21/04
LOGGED BY:	K. Jalkut	COMPLETION: DATE:	5/21/04
DRILLED BY (Company/Driller):	Aquifer Drilling & Testing/S. Przybylski	MON. WELL NO.:	N/A
GRD. SURFACE ELEVATION:		CHECKED BY:	JL

TRANSCRIBED BY: RAC

ELEVATION FROM:

DEPTH (FEET)	BLOWS PER 6"	SAMP REC. / SAMP LENG.	SAMPLING TIME & SAMPLE NO. (QA/QC STATUS)	DEPTH MAT'L CHG./ WELL PROF'L	SOIL DENSITY/ CONSIS. or ROCK HARD.	CLR	MATERIAL CLASSIFICATION	USCS or ROCK BRKN	REMARKS (moisture condition; odors; geological classification; rock weathering; etc.)	FIELD SCREENING DATA *METHOD* = [FID, (PPM)] FID	PID
8	NA										
		1.5' / 2'	OU6-SO-3A35-316-0810 Screening 5/21/04 @ 1610		Soft	Gray-Brown	0' - 0.4' - Organic SILT- similar to above	OL	Less moist		
					Fibrous	Brown	0.4' - 1.5' - PEAT- Fibrous mat/roots, reeds, some silt	PT	Much less moisture	12.5	0.0
10											
				EOB @ 10' bgs			EOB @ 10' bgs - Backfill with bentonite chips 10'-1'; topsoil (1'-0)				

TYPE OF DRILLING RIG:	GEOPROBE LT54		*Tetra Tech NUS, Inc.*
METHOD OF ADVANCING BORING:	Direct Push		
METHOD OF SOIL SAMPLING:	Macro - Core		
METHOD OF ROCK CORING:	N/A		
GROUNDWATER LEVELS:			
OTHER OBSERVATIONS:		BORING NO.: 3A35-316	PAGE: 2 OF 2

TtNUS Form 0018