

## SOILS REPORT

Development of the DCP Terminal will require modifications to the site's existing topography, soils, drainage patterns, and vegetation cover. This report provides an overview of the existing soil conditions at the site and their limitations relative to the proposed development.

### **Review of Existing Soil Survey Data and Mapping**

An analysis of published soil survey data for the project area was completed using U.S. Department of Agriculture – Natural Resource Conservation Service (USDA-NRCS) soil mapping and data including the Soil Survey Geographic Database (SSURGO), the *Soil Survey of Waldo County, Maine*, and the USDA-NRCS “Official Soil Series Description” website (<https://soilsurvey.sc.egov.usda.gov/osdname.asp>). Soil limitations such as slope, depth to bedrock, surface condition, subsurface characteristics, and drainage are specified by the USDA-NRCS data.

Geographical Information System software was used to complete an overlay analysis of the georeferenced SSURGO data and the project area. A map of the soils in the project area, based on the USDA-NRCS data, is included on the Pre-Development Drainage Plan (Dwg. No. 179023-C1) in Appendix A of the Town of Searsport application package. Soils mapped by the USDA-NRCS within the project area are listed below along with summary descriptions of their characteristics and limitations.

#### **Boothbay Silt Loam (Bob/BoE3) – Fine-silty, mixed, superactive, frigid aquic Dystric Eutruudepts**

Boothbay soils are very deep, moderately well drained to somewhat poorly drained soils formed in glaciolacustrine and glaciomarine parent materials on lake and marine plains. Depth to the seasonal high water table is 16 to 40 inches in moderately well drained components, and from 7 to 16 inches in somewhat poorly drained components. Depth to bedrock is greater than 60 inches. Boothbay soils have silty textured surface horizons, and are hydrologic group C soils. Slopes range from 8 to 45 percent within the map units identified by the USDA-NRCS in the project area. There is a risk of erosion in areas with steep slopes. Subsurface drainage is also a limitation of Boothbay soils.

#### **Swanville Silt Loam (Sw) – Fine-silty, mixed, active, nonacid, frigid Aeric Epiaquepts**

Swanville soils are very deep, poorly drained soils formed in glaciolacustrine or glaciomarine deposits on lake and marine plains. The depth to bedrock is greater than 60 inches, and the seasonal high water table is within 12 inches of the surface. Swanville soils have silty textured surface horizons and are hydrologic group C soils. Slopes range from 0 to 8 percent within the map units identified by the USDA-NRCS in the project area. Subsurface drainage and a shallow seasonal high water table are limitations of Swanville soils.

#### **Udorthents (Ud) – Udorthents**

Udorthents are human-altered soils such as filled land, and stripped/cut areas. The properties and characteristics of these soils are highly variable as a result of this disturbance. Within the project area, Udorthents are mapped by the USDA-NRCS along the existing railroad corridor, and within developed areas of the Mack Point Terminal.

## **On-Site Soil Investigations**

The site's soil characteristics relative to parent materials, drainage class, texture, consistence, and hydric soil status were further evaluated as part of the on-site wetland delineations and stormwater facility siting and design. Hand dug test pits and auger borings were evaluated as part of these investigations.

The on-site soil investigations confirmed that soils within the project area are dominated by glaciomarine and glaciolacustrine deposits with silty textured surface horizons, and silt loam to silty clay loam subsoils. Somewhat poorly drained upland soils were prevalent within the project area. Poorly drained hydric soils were confirmed within wetlands, which occupy natural drainage swales, riparian zones, some previously disturbed areas, and slightly concave slopes within the project area. Bedrock was not encountered during the on-site soil investigations. Human-altered soils were identified in previously disturbed and developed areas of the project site, such as the existing railroad corridor.

The on-site soil investigations confirmed that soil limitations within the project area are primarily related to drainage, slope, and the potential for erosion. These limitations will be addressed by utilizing engineering, construction, and erosion and sediment control practices specified on the site plans provided in Appendix A, and the DCP Terminal Erosion and Sediment Control Plan (provided in Appendix E).

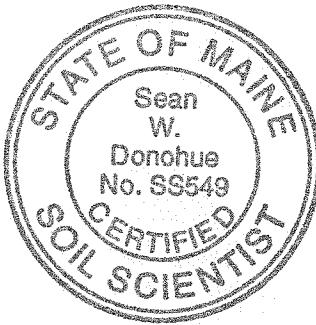
## **On-Site Geotechnical Investigations**

In addition to the review of published soil survey information and the on-site soil investigations, a geotechnical investigation was conducted for the area proposed for the LPG bulk storage tank and associated larger structures that will be constructed. The geotechnical report includes various recommendations from a Maine Professional Engineer for addressing soil limitations and constraints related to structural considerations. In locations where soils have limitations, proper engineering techniques may need to be implemented to overcome the limitations of the soils. This may include the removal of native soils and the importation of more suitable soils. The geotechnical report is included in this appendix to the Town of Searsport application package.

Respectfully submitted,



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**Geotechnical Investigation Engineering Report  
Proposed LPG Storage Facility Project**

**Searsport, Maine**



Prepared for

DCP Midstream LP

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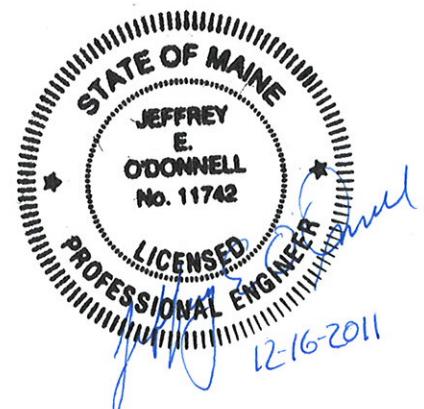
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December 16, 2011



## TABLE OF CONTENTS

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<b>1.0</b>	<b>INTRODUCTION.....</b>	<b>1</b>
<b>2.0</b>	<b>SITE CONDITIONS.....</b>	<b>1</b>
2.1	SURFACE AND DRAINAGE CHARACTERISTICS .....	1
2.1.1	<i>Surface Characteristics .....</i>	<i>1</i>
2.1.2	<i>Drainage Characteristics .....</i>	<i>1</i>
2.2	GEOLOGICAL SETTING .....	1
<b>3.0</b>	<b>DESCRIPTION OF SUBSURFACE EXPLORATION METHODOLOGY.....</b>	<b>2</b>
3.1	LPG TANK .....	2
3.1.1	<i>Soil Borings .....</i>	<i>2</i>
3.2	ANCILLARY FACILITIES .....	2
3.2.1	<i>Soil Borings .....</i>	<i>2</i>
<b>4.0</b>	<b>RESULTS OF THE SUBSURFACE INVESTIGATION.....</b>	<b>3</b>
4.1	LPG TANK .....	3
4.2	ANCILLARY FACILITIES .....	4
<b>5.0</b>	<b>LABORATORY RESULTS.....</b>	<b>5</b>
<b>6.0</b>	<b>SEISMIC DESIGN CRITERIA .....</b>	<b>6</b>
<b>7.0</b>	<b>FINDINGS AND RECOMMENDATIONS .....</b>	<b>7</b>
7.1	LPG TANK .....	8
7.2	ANCILLARY FACILITIES .....	10
7.2.1	<i>Firewater Tank .....</i>	<i>10</i>
7.2.2	<i>Containment Dike/Fuel Storage Tank .....</i>	<i>11</i>
7.2.3	<i>Compressors and Administration Building .....</i>	<i>13</i>
7.3	CONSTRUCTION CONSIDERATIONS .....	13
7.3.1	<i>Sitework and Foundation Preparation .....</i>	<i>13</i>
7.3.2	<i>Water Control .....</i>	<i>14</i>
7.3.3	<i>Backfill and Compaction .....</i>	<i>14</i>
7.3.4	<i>Quality Assurance/Quality Control .....</i>	<i>16</i>

## TABLES

- Table 1 Soil Strata & Bedrock- LPG Tank
- Table 2 Soil Strata & Bedrock- Ancillary Facilities
- Table 3 Laboratory Tests
- Table 4 Soil Parameters
- Table 5 Liquefaction Evaluation Table
- Table 6 Seismic Site Classification
- Table 7 Design Data
- Table 8 Summary of Settlement Values

## FIGURES

- Figure 1 Locus Map
- Figure 2 Exploration Location Plan
- Figure 3 Section A-A
- Figure 4 Section B-B
- Figure 5 Major Components Location Plan

## APPENDICES

- Appendix A Soil Boring Logs
- Appendix B Laboratory Results
- Appendix C Soil Stability Modeling Output Data
- Appendix D References
- Appendix E Standard Limitations

## **1.0 INTRODUCTION**

Coler & Colantonio, Inc. is pleased to submit this final report to DCP Midstream LP. The report presents the results of our geotechnical exploration services to aid in the design of a proposed LPG Storage Facility within the Town of Searsport, Maine. See Figure 1 for Locus Map of the site location.

This report has been aligned to coincide with Document Number S-0202, Revision B, Project Specification, Job Number: 4410-0873: *Specification for Geotechnical Investigation*. The following sections present the subsurface conditions, the subsurface exploration methodology, results of the subsurface investigation, laboratory results, seismic design criteria, and findings and recommendations.

## **2.0 SITE CONDITIONS**

### **2.1 Surface and Drainage Characteristics**

#### *2.1.1 Surface Characteristics*

Coler & Colantonio, Inc. conducted a topographical survey of the site in the spring of 2011 and observed the site to be a wooded area. There was one boulder noticeable; however there was no visible ledge.

#### *2.1.2 Drainage Characteristics*

The site has several natural channels that drain the surface water from north and west to the southeast. The topography of the site is provided in Figure 5.

### **2.2 Geological Setting**

The site is located on a bluff overlooking Long Cove in Searsport, Maine. The surficial geology of the site as in the rest of Maine and much of New England has been predominantly formed by the actions of continental glaciers during the Pleistocene period (commonly referred to as the last Ice Age). The glaciers extended across the site and all of Maine and well into to the Gulf of Maine. The last glacier receded from the coast of Maine around 13,000 years ago. As the glacier retreated, the sea advanced inland over the land surface which had been depressed by the weight of the glacier. Eventually the bedrock rebounded (essentially rising) to its current elevations above sea level. The effect of this activity on the site was that as the glaciers advanced and retreated, they deposited sand and gravel (glacial till), which were compressed by the weight of the glacier. Finer marine sediments (silts, clays, sands, etc.) were dispersed across the ocean floor on top of the glacial till.

The bedrock underlying the site is identified on the Bedrock Geologic Map for Maine, Osborn, Hussy & Boone Maine Geology Department (1985) as Penobscot Formation. The USGS describes the Penobscot Formation as:

*Consisting of metamorphosed shaly sediments (slates, schists, quartzites) typically developed along nearly the whole length of western shore of Penobscot Bay. Color varies from light gray through steel gray and purplish gray to black, the darker grays being predominant. Locally injected and metamorphosed by granite and diorite. Weathered surfaces usually rusty. In a few places only the rock exhibits a very perfect slaty cleavage, highly inclined to bedding planes. Conformably overlies Battie quartzite.*

This description is consistent with the rock cores recovered during the boring activity.

## **3.0 DESCRIPTION OF SUBSURFACE EXPLORATION METHODOLOGY**

### **3.1 LPG Tank**

#### *3.1.1 Soil Borings*

Coler & Colantonio, Inc. advanced a total of 5 soil borings (B-1 through B-5) at the proposed LPG tank location. One (1) boring (B-3) was located at the proposed center point of the tank and four (4) borings were located around the periphery of the tank under the proposed ringwall foundation. Boring locations were placed as close as possible to the staked-out locations, identified by Coler & Colantonio, Inc. utilizing global positioning satellite (GPS) equipment and the coordinates provided by DCP Midstream LP. Soil boring locations are depicted in Figure 2.

The soil borings were performed using a rotary auger track mounted drill rig or a drive and wash with casing method depending on soil conditions. Standard Penetration Tests (SPT) were performed for two feet per every five feet using a 1.375 inch diameter split spoon soil sampler which was advanced using a 140-pound hammer. The split spoon sampler was advanced in front of a 3 or 4 inch diameter hollow casing to collect undisturbed soil samples. All soil samples were initially evaluated for soil types. All borings at the proposed LPG tank location were advanced ten to twenty feet into the bedrock to depths of 58 to 76 feet below surface grade (bsg). Field data accumulated during this investigation has been summarized for each soil boring in boring logs provided in Appendix A.

### **3.2 Ancillary Facilities**

#### *3.2.1 Soil Borings*

Coler & Colantonio, Inc. advanced a total of three (3) soil borings (B-6 through B-8) at the location of the proposed ancillary facilities: a 40-foot diameter firewater tank (B-7), a compressor

building (B-6), an administration building (B-8), and the fuel storage tank (B-8, also referenced as the bullet tank) and dike (B-8). Completed boring locations were placed as close as possible to the staked-out locations identified by Coler & Colantonio, Inc. utilizing GPS equipment and the coordinates provided by DCP Midstream. Soil boring locations are depicted in Figure 2.

The soil borings were performed using a rotary auger track mounted drill rig or a drive and wash with casing method depending on soil conditions. Standard Penetration Tests (SPT) were performed for two feet per every five feet using a 1.375 inch diameter split spoon soil sampler which was advanced using a 140-pound hammer. The split spoon sampler was advanced in front of a 3 or 4 inch diameter hollow casing to collect undisturbed soil samples. All soil samples were initially evaluated for soil types. Borings were advanced ten feet into the bedrock. Field data accumulated during this investigation has been summarized for each soil boring in Appendix A.

## **4.0 RESULTS OF THE SUBSURFACE INVESTIGATION**

### **4.1 LPG Tank**

Coler & Colantonio, Inc.'s understanding of the subsurface conditions in the vicinity of the LPG Tank is based on the results of the investigation described in Section 3. In general, the investigation found a thin layer of organics from the surface to typically two inches below surface grade (bsg). These organics consisted primarily of a mixture of varying percentages of peat, clay silt and sand. Beneath the organics, inconsistent layers of sand, gravel, silty sand, silt, clayey sand, clay, and cobbles were typically encountered to bedrock. Much of the site soils were dominated by fine grained soils. Silt and clays were seldom uniform. The more coarse grained soils also frequently were intermixed with a significant percentage of fine grained silt or clay and thus warranted a clayey or silty prefix. The soil density and cohesive strength was also variable with silts and clays generally loose to medium stiff respectively. This variation in density was largely indicative of the geologic history of the site. In general the loose to medium stiff Marine clay, silts, sands and gravel were observed to extend from the ground surface to approximately 25 to 30 feet bsg. These are underlain by dense clayey-silty sands and gravel (glacial till) which extended to bedrock, ranging from approximately 35 to 55 feet bsg. The ground elevation, till elevation, and bedrock elevation at each boring are listed in Table 1. The distribution and nature of the fine grained soils content varied spatially and with depth. Groundwater was encountered between 3½ to 5 feet bsg.

The bedrock encountered consisted of dark gray moderate to heavily metamorphosized slate with moderate amounts of mica and some pyrite visible. 1 mm to 5 mm white feldspar banding and associated 2 cm to 6 cm masses were present. Bedding is mostly vertical gray siltstone and samples were moderately to highly fractured with Rock Quality Designations (RQDs) between 13 and 88 percent. Rocks with RQDs in this range are considered very poor to good.

Table 1: Soil Strata and Bedrock – LPG Tank

Boring Number	Boring Location	Approx. Ground Elevation (feet)	Depth to Top of Glacial Till (feet bsg)	Approx. Elevation of Glacial Till(feet)	Depth of Top of Bedrock (feet bsg)	Approx. Elevation of Bedrock (feet)
B-1	NW Tank Ring	51	30	21	37	14
B-2	NE Tank Ring	46	24	22	36	10
B-3	CL Tank	48	30	18	57	-09
B-4	SE Tank Ring	45	32	13	48	-03
B-5	SW Tank Ring	49	25	24	51	-02

## 4.2 Ancillary Facilities

Coler & Colantonio, Inc.'s understanding of the subsurface conditions in the vicinity of the ancillary facilities is based on the results of the investigation described in Section 3. The soils observed in each of these groups are described in the subsections below.

The borings conducted to evaluate the subsurface conditions at the ancillary facilities include B-6, B-7 and B-8 and are located on the proposed LPG Storage property. Bedrock was encountered in these borings at depths of 20 to 48 feet bsg. The ground elevation, till elevation, and bedrock elevation at each boring are listed in Table 2 below. Groundwater was encountered approximately between 3 to 10 feet bsg.

The bedrock encountered consisted of dark gray moderate to heavily metamorphosized slate with moderate amounts of mica and some pyrite visible. 1 mm to 5 mm white feldspar banding and associated 2 cm to 6 cm masses were present. Bedding is mostly vertical gray siltstone and samples were moderately to highly fractured with RQDs between 0 and 63 percent( very poor to fair).

Table 2: Soil Strata and Bedrock Elevation – Ancillary Facilities

Boring Number	Boring Location	Approx. Ground Elevation (feet)	Depth to Top of Glacial Till (feet bsg)	Approx. Elevation of Glacial Till(feet)	Depth of Top of Bedrock (feet bsg)	Approx. Elevation of Bedrock (feet)
B-6	Compressor	57	N/A*	N/A	20	37
B-7	Firewater Tank	64	16	48	20	44
B-8	Fuel Storage Tank	39	35	4	48	-9

\*no glacial till encountered

## 5.0 LABORATORY RESULTS

Coler & Colantonio, Inc. contracted GeoTesting Express to perform geotechnical laboratory tests as indicated in Table 3.

Table 3: Lab Tests

Sample ID	Test
--- (B-1,0-2 ft)	ASTM D 1580 - Soluble Sulfates in Soil
--- (B-1,15-17 ft)	ASTM D 422 - Combined Gradation Analysis
--- (B-1,20-22 ft)	ASTM D 422 - Combined Gradation Analysis ASTM D 4318 - Atterberg Limits
--- (B-1,25-27 ft)	ASTM D 422 - Combined Gradation Analysis
--- (B-2,5-7 ft)	ASTM D 422 - Combined Gradation Analysis
--- (B-3,15-17 ft)	ASTM D 422 - Combined Gradation Analysis ASTM D 4318 - Atterberg Limits
--- (B-4,0-2 ft)	ASTM D 1580 - Soluble Sulfates in Soil
--- (B-4,10-12 ft)	ASTM D 422 - Combined Gradation Analysis ASTM D 4318 - Atterberg Limits ASTM D 2435 – Incremental Consolidation
--- (B-5,10-12 ft)	ASTM D 422 - Combined Gradation Analysis ASTM D 4186 - CRC Consolidation ASTM D 2937 - Density of Soil In-Place; Drive Cylinder Method ASTM D 2216 - Moisture Content
--- (B-5,15-17 ft)	ASTM D 422 - Combined Gradation Analysis ASTM D 4318 - Atterberg Limits
--- (B-7,5-7 ft)	ASTM D 422 - Combined Gradation Analysis ASTM D 4318 - Atterberg Limits
--- (B-8,10-12 ft)	ASTM D 422 - Combined Gradation Analysis
--- (B-8,20-22 ft)	ASTM D 4318 - Atterberg Limits

The tests conducted focused on visual identification and index testing to provide the data needed to confirm the field identification of the soils. The results of the soil consolidation tests indicate that the marine clay soils beneath the site in general have been overconsolidated with a preconsolidation pressure ranging from 5,900-7,500 psf and overconsolidation ratios of between approximately 5-8. In B-8 the field N values drop from 6 near the top to 0 at the bottom of the layer this could indicate a transition from over consolidated state at the top of the layer to

normally consolidated at the bottom. The tests confirmed that the overburden soil consists of silts, clays, silty/clayey sands with gravels. The key soil parameters determined from the laboratory results, field work and technical literature can be found in Table 4.

Soluble Sulfates were not detected in two tests conducted on samples originating from B-1 & B-4. The results of the Laboratory Tests are provided in Appendix B.

## 6.0 SEISMIC DESIGN CRITERIA

An analysis of the potential for liquefaction of the overburden soil was conducted. This was done for the design seismic loading condition. The analysis was performed using the “simplified method” initially developed by Seed and Idriss and later augmented and updated by Whitman and Youd et. al. Data for the analysis was obtained from the standard penetration tests, and laboratory results are included in the appendices.

The seismic design criteria used in the liquefaction evaluation are based on the criteria listed in American Society of Civil Engineers Minimum Design Loads for Buildings and other Structures (ASCE /SEI, 7-05) published in 2005 and the most current version ASCE/SEI 7-10 published in 2010. The ASCE/SEI 7-05 is currently the standard included in the Maine Building Code; however, the ASCE 7-10 is the most current standard and we recommend that it be utilized in the design as the most appropriate current standard of care. Both standards use a seismic event that has a 2% probability of occurring in 50 years or a probability of 1 in 2,475 years as the Maximum Considered Earthquake. In ASCE/SEI 7-05 the peak ground acceleration (PGA) utilized for liquefaction is defined by  $S_s/2.5$  where  $S_s$  is the spectral response acceleration at short periods. The ASCE/SEI 7-10 determines the PGA bedrock motions using mapped values which are modified by a site coefficient that depends on the soil stiffness and potential groundshaking. The difference in methods results in ASCE/SEI 7-10 having a peak ground acceleration greater than the ASCE 7-05 (0.15g-0.23g vs. 0.09g) for evaluating the potential for liquefaction. An evaluation was performed for liquefaction using both accelerations.

The liquefaction evaluation was performed based on SPT field data and lab data. Clayey soils, while considered less likely to liquefy, were included in the evaluation due to the heterogeneous nature of the site's soil which add a degree of uncertainty to the determination of the representative soil characteristic for any given area or depth. The groundwater table was assumed to be at or below 5 feet for purposes of this evaluation. The results of the liquefaction evaluation indicate that for the soils profile at Borings B-1 through B-7 soil would not be considered liquefiable (i.e. at +/- 0.1 of the factor of safety of 1.1) for either peak ground acceleration. These soils are located under the LPG tank, fire water tank and compressors. The results of the evaluation are presented in Table 5.

The soils at Boring B-8, in the area of the bullet tank and containment dike, at an approximate depth of 10 to 30 feet are potentially liquefiable based on the Seed & Idriss method which is

applicable to non-cohesive soils. According to a paper published by Idriss and Boulanger in June 2007, soils with a Plasticity Index equal to greater than 7 are considered cohesive. Based on the results of laboratory tests, the soils at depth of 10 to 30 feet in B-8 have a PI of 16 and are therefore considered to be cohesive. Consequently the Seed & Idriss method for non-cohesive soils would not be considered applicable for these soils. Clays or cohesive soils are generally not considered to be as liquefiable as sands due to the cohesive strength of the clays but such soils can liquefy under certain conditions. In order to evaluate the potential for liquefaction for these specific soils, a method published by Idriss & Boulanger in 2007 for cohesive soils was utilized. Application of this method for these soils determined that the soils at Boring B-8 would not be considered liquefiable. The results of this method are highlighted in Table 5 for the applicable B-8 soils.

The seismic site classification was evaluated using the ASCE 7-05 site classification procedure for seismic design. The area under the proposed LPG Tank (B-1 to B-5) is seismic class D. The area under the proposed fire tank (B-7) is Class C. The area under the compressors (B-6) is Class D. The area under the proposed fuel storage tank and dike (B-8) is Class E. A copy of the table of seismic classification is contained in Table 6.

## 7.0 FINDINGS AND RECOMMENDATIONS

This section presents a summary of our findings for the design of foundation and other earth related structures for the LPG tank and ancillary facilities. A summary of the soil parameters used in the evaluation of the design of the foundation and earth structures is included in Table 4. The suitability of the site conditions was evaluated in conjunction with the project design data unless otherwise noted is presented in Table 7.

**Table 7: Design Data**

LNG Tank Parameters:

- a) Tank Diameter: 202 ft
- b) Hydrotest Foundation Load: 6200 psf
- c) Normal Operating Foundation Load: 3900 psf

Dike Parameters:

- a) Dike Height: 21-35 ft
- b) Dike Width: 42-70 ft at base
- c) Global Slope Stability Factor of Safety: 1.5

Firewater Tank Parameters:

- a) Tank Diameter: 40 ft
- b) Normal Operating Foundation Load: 2500 psf

Equipment Parameters

- a) Compressor: Weight = 10,000 lbs; Foundation Size = 15 ft x 8 ft foundations at a minimum of 5 feet below grade

b) LPG Bullet Tank (90,000 gal) with two foundations at a minimum of 5 feet below grade: Weight/fdn = 320,000 lbs; Foundation Size = 15 ft x 8 ft

#### Foundation Requirements

Tank settlement shall be limited to the following values:

- a) Edge settlement: 2 inches (depending on piping configuration)
- b) Dishing (edge to center settlement): Tank diameter / 300
- c) Planar tilt: Tank diameter / 500
- d) Settlement around the periphery of tank: 1/500

Bearing capacity minimum factors of safety shall be the following values:

- a) Shallow Foundations:
  - 1) Normal Operation: FS = 3.0
  - 2) Hydrotest: FS = 2.5
  - 3) Normal Operation combined with wind or seismic: FS = 2.25

### **7.1 LPG Tank**

The subsurface conditions under the proposed LPG tank consist of some loose to medium stiff layers of marine silt, clays, sands and some gravel overlying a dense layer of glacial till which overlays bedrock. The clay is oversconsolidated and varies in thickness from less than 1 foot to 15 feet across the area of the tank. As previously discussed, the soil's geotechnical properties vary spatially and the depth to bedrock is variable which can accentuate differential settlement across the tank foundation.

The results of the settlement calculations, shown on Table 8, indicate that the expected total settlement (immediate, primary, and secondary) could range from approximately 2 inches to approximately 15 inches beneath the LPG tank for the operational design load of 3,900 psf. The differential tank settlements range from 2 inches to 5 inches for dishing settlement, and less than 1 inch to 2 inches for planar tilt settlement. The upper range for the differential settlement under operating conditions is below the design criteria and the majority of the settlement is expected in the upper layers of silts and clays (0 to 30 feet). The ranges of total and differential settlement are due to the varying soil conditions at the five borings located within the footprint of the LPG tank and the use of multiple settlement calculation methods for quality control purposes for the settlement values. The various methods utilized to calculate settlement are listed on Table 8.

For the hydrotest loading almost all of the settlement will be immediate (elastic) settlement due to short period of loading (approximately 14 days). Depending on the permeability of the soils, some primary consolidation of the clays will occur which would affect the amount of "rebound" of the soil that will occur when the load is decreased to the operational load. Total immediate settlement could range from less than 1 inch to more than 9 inches. Settlement from the tank load at a distance of one diameter from the center of the LPG tank is expected to be less than one inch. Please see the attached summary Table 8 for a list of settlement value ranges.

Calculation of the allowable bearing capacity resulted in values all far greater than design load of 6200 psf for the hydrotest. However, these calculations relied upon an average for the soil parameters over the expected influence of the tank load which is directly related to the diameter of the tank. Given the large diameter of the tank, the stress from the load of the tank extends well into the dense glacial till and the bedrock which have far greater bearing capacity than the silts and clays in the upper layers. However, the potential exists for the shear failure of the softer silts and clays in the upper layers. Essentially they could be squeezed out between the LPG tanks and denser till soils and bedrock. To analyze this condition we utilized a SLIDE soil stability software model. The results of the model provide a factor of safety against failure for a given condition. A factor of safety of less than 1.0 indicates that resisting forces or moments are less than the loading forces or moments and therefore the soil would fail (i.e. slip, slide or collapse). A factor of safety of 1.5 is usually used for design purposes to allow for uncertainty in the site conditions and calculation method. The results of the analysis found that the mean factor of safety at the edge of the tank under the operating load was 1.23 (undrained) and for hydrotest load was 0.8 (undrained). A copy of the output of soil stability analysis is attached in Appendix C.

Based on the above analysis of potential settlement, bearing capacity and soil stability we recommend a shallow foundation with soil improvement of the upper layers of marine deposits (0 to 30 feet). The purpose of the soil improvements will be to increase the overall soil stiffness in the upper soil layers and provide the vertical and lateral support necessary to eliminate the potential for soil failure. Improvement of the upper layers will also reduce the potential variations in settlement, reduce pore pressure and provide for a more consistent and uniform bearing surface for the tank foundation.

One soil improvement approach that would be acceptable is a stone aggregate pier system. In the stone aggregate pier system 20 inch diameter stone columns (ungROUTed) would be installed 4.5 feet apart in a radial pattern beneath the LPG tank. The stone columns would be installed from three feet below the LPG tank into the dense silty, clayey sands and gravels and/or bedrock to an average depth of 25 to 30 feet bsg. A 3 foot thick load transfer platform (LTP) consisting of layered compacted fill material and Tensar BX 1200 geogrid, or equivalent, spaced at approximately 12 inches within the LTP section would be installed above the stone columns within the ringwall to distribute the load evenly to the columns. The LTP would not extend beyond the inside edge of the ringwall. Beneath the ringwall foundation, a pair of 20 inch diameter grouted aggregate piers, one at each edge of the ringwall foundation, would be installed every 4.5 feet to provide additional lateral support at the edges of the tank. The grouted piers would be installed directly beneath the bottom of the ringwall foundation into the dense silty, clayey sands and gravels and/or bedrock to an average depth of 25 to 30 feet bsg. This system would meet the slope stability and bearing capacity factors of safety for the expected design loads and have a maximum total settlement of 4 to 5 inches and maximum dishing differential settlement of less than 2 inches. We recommend that final utility connections to the tank are made after the tank has been hydrotested. Foundations shall be installed to a minimum depth of 5 feet below grade for frost protection.

Since soil improvement work is frequently conducted by specialty contractors with their own proprietary systems and equipment and since alternative systems which meet the performance levels are acceptable, we recommend that if an alternate system is proposed that the bid plans and specifications be prepared requiring the minimum performance levels outlined below:

1. Meet foundation total differential settlement requirements listed in Table 7. These values are not to be exceeded for the estimated design life of 20 years for the tank structure.
2. Limit maximum total settlement to less than 5 inches. This value is not to be exceeded for the estimated design life of 20 years for the tank structure.
3. The upper marine soils (0 to 30 feet bsg) shall be reinforced to provide an allowable bearing capacity that meets or exceeds hydrotest and operation loads listed in Table 7 at the factor of safety listed in Table 7 for said loads.
4. Provide sufficient lateral support to prevent lateral spread/failure of upper marine soils and meet a slope stability factor of safety of 1.5.
5. Design life of the soil improvement structure shall be 50 years.
6. The soil improvement contractor shall submit detailed design calculations and construction drawings and specifications to the Owner's Design Engineer and Geotechnical Engineer for review at least 3 weeks prior to start of construction. The plans shall be stamped by a registered engineer in the State of Maine.

## 7.2 Ancillary Facilities

The significant ancillary facilities considered in this report consist of the fire water tank, fuel storage tank, compressors, administration building and containment dike.

### 7.2.1 Firewater Tank

The layer of soil beneath the firewater tank is relatively thin with bedrock located at approximately 21 feet bsg. Some of the soils are borderline compressible. Therefore little primary settlement may occur. The results of the settlement calculations indicate that the expected total settlement (immediate, primary, and secondary) could range from less than 1 inch to 4 inches depending on sensitivity of the settlement to potential variations in soil parameters for the operational design load of 2,500 psf. The differential tank dishing settlements are less than 1 inch. A comparison of the calculated settlements with design criteria for differential settlement indicates that the firewater tank's high range dishing differential settlement criteria are below the design criteria. However, only one boring was advanced in the vicinity of the firewater tank therefore the planar tilt settlement cannot be evaluated. Please see Table 8 for a summary of settlement values. The allowable bearing capacity ranges from 4,000 psf to greater than 8,000 psf. The lower value represents the bearing capacity of the upper soils while the large value represents the average bearing capacity of the upper soil and underlying bedrock. These values are above the normal operational design load of 2,500 psf.

In order to reduce the potential settlement due to unknown conditions which could occur due to variations in subsurface conditions beneath the fire water tank and to provide a more uniform bearing surface, we recommend preloading the proposed location of the fire water tank. A soil pile approximately 20 to 30 feet high would be required for preloading. If the soils under the tank are sufficiently non-cohesive (i.e. sandy) then the majority of the settlement can be expected to be immediate settlement, the soils should consolidate in a matter of days. This approach will allow the opportunity to confirm that the settlement of the soils conform to the design criteria prior to installation of the tank. The resultant settlement shall be measured at two settlement plates installed near the center and edge of the surcharge. A piezometer shall also be installed at the center to measure pore pressure.

### 7.2.2 *Containment Dike/Fuel Storage Tank*

#### Containment Dike

The dike is proposed to be an MSE wall. It will range in height from 21 feet to 35 feet and from 42 to 70 feet wide. The maximum design wall bearing pressure varies from 3,100 psf to 4,900 psf. Allowable bearing capacity was calculated assuming 1.5 feet of embedment and 16-24 foot effective bearing width. The dike calculations were completed assuming that soils under the entire dike are similar to those encountered in B-8. Soil conditions used in the calculation for the foundation material allowable bearing capacity were based on data from soil boring B-8. The upper silty sands (approximately 0 to 10 bsg) have greater strength than the underlying marine clay layer (approximately 10 to 30 feet bsg) and therefore bearing capacity failure was calculated for the scenario of punching in of the denser silty sand into the softer clay layer beneath. Based on this scenario, the expected allowable bearing capacity is 1,900 psf (35 ft. wall section) to 2,000 psf (21 ft wall section). These values are based on factor of safety of 2.0. These values are well below the maximum design wall bearing pressures of 3,100 to 4,900 psf. The upper silty/clayey sand are borderline compressible while the marine clay layer is compressible. As previously discussed this marine clay layer transition from over consolidated state at the top of the layer to normally consolidated at the bottom. The total settlement for the dike's tallest section can be expected to range from approximately 10 inches at the wall to up to 1 inch at the tail of the dike and for the shortest section of the dike range from 7 inches at the wall to up to 1 inches at the tail of the dike. Please see table 8 for a summary of settlement values. The MSE wall designer has indicated that differential settlement of 4 inches from front to back of the dike is acceptable. The potential settlement for front and back of the dike for both the tallest and shortest section exceeds this amount. The allowable differential settlement along the length of the wall is 1% (6 inches in 50 feet). The difference in settlement between the tallest and shortest sections of the dike is expected to be in the range of approximately 3 inches. A ravine near the proposed tallest section of the dike will be filled with up to approximately 20 feet of compacted structural fill. This structural fill will not settle to the extent of the adjacent native soils therefore differential settlement between the sections of the wall located on structural fill and native material is expected.

A calculation of the global stability of the tallest section of the dike was performed using computer model SLIDE (Spencer stability analytical method). Three scenarios were run. One assuming the entire wall is acting as a unit and using the listed dike fill material unit weight of 125pcf under normal operating condition. The second scenario was the same parameters but included the added surcharge from a spill of LPG. The second scenario was designed to model the effective bearing width of 24 feet and the maximum wall bearing pressure of 4,900 psf by using and increased soil density of approximately 144pcf. The results of the first scenario indicated a critical failure surface in the clay beneath the dike with factor of safety 1.5 for the undrained condition and 2.0 for the drained condition. The results of the second scenario (spill condition) indicated a critical failure surface in the clay beneath the dike with factor of safety 1.5 for the undrained condition and 4.47 for the drained condition. The results of the third scenario(4,900 ksf load) indicated a critical failure surface in the clay beneath the dike with factor of safety 0.8 for the undrained condition and 1.47 for the drained condition.

The undrained conditions for both scenarios are at or below the recommended factor of safety of 1.5. A copy of the output of soil stability analysis is attached in Appendix C.

Based on the above analysis of potential settlement, bearing capacity and soil stability we recommend soil improvement of the upper layers of marine deposits (0 to 30 feet). The purpose of the soil improvements will be to increase the overall soil stiffness in the upper soil layers and provide the vertical and lateral support necessary to eliminate the potential for soil failure. Improvement of the upper layers will also reduce the potential variations in settlement, reduce pore pressure and provide for a more consistent and uniform bearing surface for the dike foundation.

The exact scope and type of soil improvement will depend on the technology and the site conditions encountered by the contractor in the field. The following technologies maybe suitable for use in soil improvement: rammed aggregate piers, controlled modulus columns, pressure injected footings, and wick/sand drains, dike construction staging-surcharging. The amount of additional soil information that may be required for design of the soil improvement will depend on the soil improvement technology. The soil improvement work is frequently conducted by specialty contractors with their own proprietary systems and equipment and since alternative systems which meet the performance levels are acceptable, we recommend that the bid plans and specifications be prepared requiring the minimum performance levels outlined below:

1. The upper marine soils (0 to 30 feet bsg) shall be reinforced, if necessary to meet containment dike wall foundation differential settlement requirements required by MSE wall manufacturer- 4 inches front to back of dike, 1% (6" in 50 feet) on the running length of the wall. These values are not to be exceeded for the estimated design life of 20 years for the containment dike structure.
2. Limit maximum total settlement to less than 5 inches. This value is not to be exceeded for the estimated design life of 20 years for the tank structure.

3. The upper marine soils (0 to 30 feet bsg) shall be reinforced, if necessary, to provide an allowable bearing capacity that meets or exceeds maximum wall bearing pressure loads for each MSE wall section as provided by the MSE wall designer at a minimum the factor of safety of 2.0 for said loads.
4. Provide sufficient support to prevent lateral spread/failure of upper marine soils and meet a global slope stability factor of safety of 1.5 for the normal operating condition and spill condition.
5. Design life of the soil improvement structure shall be 50 years.
6. Prior to final design the contractor shall issue a plan for additional investigation to confirm soil conditions meet the soil improvement design assumptions for the entire length of the containment dike. The additional testing plan shall be issued to the Owner's Design Engineer and Geotechnical Engineer for review 3 weeks prior to the start of the additional testing.
7. The soil improvement contractor shall submit detailed design calculations and construction drawings and specifications to the Owner's Design Engineer and Geotechnical Engineer for review at least 3 weeks prior to start of construction. The plans shall be stamped by a registered engineer in the State of Maine.

#### Fuel Storage Tank

The allowable bearing capacity for the design foundation size (8 feet by 15 feet) at a minimum of 5 feet below grade is 2,850 psf. The design load of 2,667 psf for this foundation size is below this allowable bearing capacity. The expected total tank settlement under operational loading conditions and design foundation size should be less than 2 inches.

#### *7.2.3 Compressors and Administration Building*

We recommend that shallow foundations for the compressor foundations be used with a recommended allowable bearing capacity of 1,300 psf. For the footing for the administration building we recommend shallow foundations with minimum footing width of 3 feet be used with an allowable bearing capacity of 2,000 psf. The footings should be installed to a minimum depth of 5 feet below grade for frost protection.

### **7.3 Construction Considerations**

#### *7.3.1 Sitework and Foundation Preparation*

After site clearing and stripping of all areas to receive engineered fill, shallow foundations, trench bottoms, vaults, manholes and pavement, these areas must be cleared of all organic and deleterious material. It is important that no uncontrolled fill, debris, or organic matter (such as topsoil, peat layer, etc.) be present under any foundation footprint area. Subgrade preparations for the shallow foundations should extend a minimum of 4 feet beyond the limits of the proposed structure. Dewatering if necessary shall be conducted as discussed in section 7.3.2-Water Control. Depressions and excavations that extend below the finished grade should be cleaned and

backfilled with engineered fill per section 7.3.3- Backfill and Compaction. Disturbed, frozen, excessively wet or soft soils should be removed prior to placement of foundation materials. It is recommended that the geotechnical engineer be present during the preparation of the foundation area to assist with defining the limits of unsuitable soil and to observe the preparation of the subgrade prior to placement of any engineered/structural fill or pouring of concrete.

### *7.3.2 Water Control*

Groundwater was encountered at elevations ranging from approximately 29.6 to 61 feet relative to the NAVD 88 at the site. These elevations were recorded in April and May of 2011; groundwater elevations will vary seasonally. For the LPG tank the ringwall foundation is anticipated to be installed at approximately elevation 42 feet. Groundwater elevations in soil borings advanced within the LPG tank footprint ranged from 40.6 feet to 46.6 feet. Therefore, excavation dewatering of some portions of the excavation for the LPG tank foundation is anticipated depending on the seasonal variation of the groundwater elevation. The dewatering can be accomplished through the use of sump pumps and diversion trenches with discharges downslope. This work must be done in compliance with USEPA, local and state laws and regulations. Groundwater in the area of the firewater tank and administration building was encountered at elevation 61 feet. Depending on the final grades set for these two structures, dewatering maybe required for the construction of their foundations. Groundwater was encountered at elevation 29.6 feet in the area of the proposed dike and fuel storage tank and at elevation 51 feet in the area of the proposed compressor station. Dewatering is not anticipated to be needed in these locations since the proposed elevations for the structures are over 9 feet higher than the groundwater elevations at these locations. Surface drainage should be directed away from the excavations during construction.

Exposure of glacial-marine deposits (silts and clays) or glacial tills to rain prior to being covered with crushed stone or structural fill, may result in the softening of these soils. Therefore, after the footing or slab grade soils are exposed during excavation, they should be covered by 6 inches of crushed stone or structural fill. This will provide protection from rain water and provide a drainage layer for dewatering if necessary after a storm. Compaction of the crushed stone and structural fill is discussed in section 7.3.3.

### *7.3.3 Backfill and Compaction*

Soils in the upper 5 to 10 feet at the site consist of lean clays, clayey silts and clayey or silty sands. These soils are not suitable for reuse as structural fill underneath loadbearing areas. The clayey or silty sands (20-40% fines, PI<5) maybe be suitable for reuse in the MSE wall construction and as granular fill. This use would be subject to approval by the MSE wall designer and testing (sieve analysis, atterberg limits) prior to reuse. Provided that the testing results are favorable, the granular fill could be utilized under proposed pavements and slabs and as suitable backfill a minimum of three feet laterally from foundation walls. If necessary some of the clayey/silty sands could be mixed/mechanically stabilized with off-site material for reuse

provided that the stabilized soil meets the structural fill gradation requirements or the MSE wall criteria listed below. The amount of shallow soils that could be stabilized and reused as granular fill would depend on the gradation of the site soil and the off-site material. Coler & Colantonio, Inc. recommends that soil to be reused via mixing/stabilization be separately stockpiled and representative soil testing (both atterberg limits and sieve tests) be conducted on these soils and on the off-site material with which they will be mixed and that test results be utilized to develop a proper mixing ratio. Once mixing of the soils is complete then the composite fill material shall be tested to confirm that it meets the gradation requirements.

Organic soil and/or topsoils encountered during the sitework and foundation preparation should be segregated and cannot be reused as backfill except in landscape areas.

The structural fill should consist of well graded natural sands and gravel, free from organic matter, excessive plastic fines (max 8% passing No. 200 sieve), and other deleterious material

### **Recommended Structural Fill Gradation**

<b>U.S. Sieve Size &amp; Number</b>	<b>Percent Passing</b>	
	<b>Maximum</b>	<b>Minimum</b>
1 inch	100	60
No. 4	85	25
No. 20	60	10
No. 50	35	4
No. 200	8	0

### **Recommended Crushed Stone Gradation**

<b>U.S. Sieve Size &amp; Number</b>	<b>Percent Passing</b>	
	<b>Maximum</b>	<b>Minimum</b>
1 inch	--	100
¾ inch	100	90
1/2 inch	50	10
3/8 inch.	20	0
No.4	5	0

All backfill placed in load bearing areas should be compacted to 95% of the maximum dry density as determined by the test designated ASTM D1557. In areas where large compactors can be used (Raygo 400a or equivalent), Coler & Colantonio, Inc. recommends that the loose lifts not exceed 12 inches. In areas where large compaction equipment cannot be used and a small hand manipulated vibratory compactor is used, Coler & Colantonio, Inc. recommends that the loose lifts do not exceed 6 inches. Any crushed stone layer should be compacted by a minimum of two passes with a vibratory plate compactor or roller.

Once rough graded, the subgrade material should be proof rolled and compacted in the presence of the geotechnical engineer to detect any weak or unstable areas. The surface compaction should be completed with the appropriate piece of equipment based on the size of the excavation and anticipated load.

#### *7.3.4 Quality Assurance/Quality Control*

The following Quality Assurance/Quality Control (QA/QC) procedures are recommended:

- Construction Observation - Variations in soil conditions and type maybe encountered during construction. Coler & Colantonio, Inc. recommends that the geotechnical engineer provide observation and testing services during the site earthwork and foundation construction. This will allow the geotechnical engineer to provide additional recommendations for any conditions different than those encountered during our investigation
- Coler & Colantonio, Inc. recommends that the geotechnical engineer assist in the preparation and review of final foundation and grading plans and bid plans and specifications.
- Coler & Colantonio, Inc. recommends monitoring of the settlement of the LPG tank, firewater tank and dike during construction, hydrotesting and after construction.

## **TABLES**

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DCP Midstream LP  
Proposed LPG Storage Facility  
Searsport, Maine

Geotechnical Investigation  
December 16, 2011  
C&C Project #: 15-605

Prepared by Coler & Colantonio, Inc.

**Table 4 - Soil Parameters (for Calculations & Sensitivity Analysis)**

Strata	Boring	Layer	soil type	Elevation top of layer ft.	Hi Thickness ft.	$\gamma$ lb/ft <sup>3</sup>	$N_{m\text{-avg}}$	$N'$	Esi (ksf)	$v$	$C_{rE}$	$C'_{\alpha}$	PI	$S_u$ psf	$\phi$ degrees
Fill			structural fill	47	0 - 1.5	130	32.0	491	0.3	0	0	0	0		
Marine Clay	B-1	1	clay	45.5 - 51	6.5 - 10	110 - 117	6	12.3	400 - 1000	0.5	0.02 - 0.03	0.004	12	705 - 1200	0
Clayey Gravel	B-1	2	clay & gravel	39 - 41	3 - 5	120 - 125	9	13.4	500 - 2000	0.4	0 - 0.03	0.004	7	0 - 705	0 - 31
Marine Sand & Silt	B-1	3	clay	31 - 36	15	110 - 120	16	19.9	500 - 1000	0.5	0 - 0.03	0.004	12	0 - 705	0 - 33
Glacial Till	B-1	4	cobbles & gravel	21	3 - 5	125 - 130	91	104.4	2000 - 4000	0.3	0	0	0	0	40 - 45
	B-1	5	sand & gravel	16 - 18	1 - 3	115 - 130	100	108.4	2000 - 4000	0.3	0	0	0	0	40 - 45
Bedrock	B-1	6	bedrock	15	na	150									

Strata	Boring	Layer	soil type	Elevation top of layer ft.	Hi Thickness ft.	$\gamma$ lb/ft <sup>3</sup>	$N_{m\text{-avg}}$	$N'$	Esi (ksf)	$v$	$C_{rE}$	$C'_{\alpha}$	PI	$S_u$ psf	$\phi$ degrees
Fill			structural fill	47	0 - 1.5	130	32.0	491	0.3	0	0	0	0		
Sand & Gravel	B-2	1	silty sand	45.5 - 46	14.5 - 15	90 - 125	13	18.4	600 - 1000	0.3	0 - 0.03	0.004	5	0 - 622	0 - 32
Clayey Gravel	B-2	2	clay & gravel	31	5	120 - 125	5	6.3	300 - 2000	0.4	0 - 0.03	0.004	7	0 - 622	0 - 31
Marine Sand & Gravel	B-2	3	clayey sand	26	4 - 5	125	11	13.6	500 - 1000	0.3	0 - 0.03	0.004	7	0 - 622	0 - 33
Glacial Till	B-2	4	silty sand & gravel	21 - 22	11 - 11.5	90 - 130	78	87.1	2000 - 4000	0.35	0	0	5	0	40 - 45
Bedrock	B-2	5	bedrock	10 - 10.5	na	150									

Strata	Boring	Layer	soil type	Elevation top of layer ft.	Hi Thickness ft.	$\gamma$ lb/ft <sup>3</sup>	$N_{m\text{-avg}}$	$N'$	Esi (ksf)	$v$	$C_{rE}$	$C'_{\alpha}$	PI	$S_u$ psf	$\phi$ degrees
Fill			structural fill	47	0 - 1.5	130	32.0	491	0.3	0	0	0	0		
Sand	B-3	1	clayey sand	45.5 - 48	2.5 - 5	70 - 120	3	6.2	200 - 500	0.3	0 - 0.03	0.004	6	0 - 660	0 - 32
Marine Clay	B-3	2	clay	43	7	110 - 117	8	12.9	400 - 1000	0.5	0.02 - 0.03	0.004	14	660 - 1200	0
	B-3	3	silty sand	36	3	90 - 117	10	15.2	400 - 500	0.3	0.02 - 0.03	0.004	5	660 - 1200	0
	B-3	4	silt, clayey sand	33	7	117 - 120	31	40.1	400 - 1500	0.3	0.02 - 0.03	0.004	6	660 - 1200	0
Marine Sand & Gravel	B-3	5	clayey sand	26	8 - 9	125	13	15.2	500 - 1000	0.3	0 - 0.03	0.004	6	0 - 660	0 - 33
Glacial Till	B-3	6	gravel	17 - 18	4 - 5	125 - 130	100	102.6	2722 - 4000	0.3	0	0	0	0	40 - 45
	B-3	7	silty sand & gravel	13	15	110 - 130	100	95.9	2000 - 4000	0.35	0	0	5	0	40 - 45
	B-3	8	gravel	-2	5	125 - 130	100	86.6	2320 - 4000	0.3	0	0	0	0	40 - 45
	B-3	9	silty sand	-7	1	90 - 130	100	84.1	2000 - 4000	0.3	0	0	5	0	40 - 45
Bedrock	B-3	10	bedrock	-8	na	150									

Strata	Boring	Layer	soil type	Elevation top of layer ft.	Hi Thickness ft.	$\gamma$ lb/ft <sup>3</sup>	$N_{m\text{-avg}}$	$N'$	Esi (ksf)	$v$	$C_{rE}$	$C'_{\alpha}$	PI	$S_u$ psf	$\phi$ degrees
Fill			structural fill	47	0 - 2	130	32.0	491	0.3	0	0	0	0		
Clayey Silt	B-4	1	clayey silt	45	4 - 5	90 - 120	6	9.8	500	0.3	0 - 0.03	0.004	19	0 - 886	0 - 32
	B-4	2	clayey silt	40 - 41	10 - 11	120 - 125	6	6.5	300 - 500	0.3	0 - 0.03	0.004	19	0 - 886	0 - 32
Marine Clay	B-4	3	silty clay	30	10	115 - 117	7	6.8	400 - 700	0.3	0.02 - 0.03	0.004	19	886 - 1200	0
Marine Sand & Gravel	B-4	4	clayey sand & gravel	20	5	125	15	14.5	700 - 1000	0.35	0 - 0.03	0.004	7	0 - 886	0 - 33
	B-4	5	silty sand	15	2	125	30	27.6	1000 - 1500	0.3	0 - 0.03	0.004	5	0 - 886	0 - 33
Glacial Till	B-4	6	cobbles	13	3	90 - 130	100	94.5	2000 - 4000	0.3	0	0	0	0	40 - 45
	B-4	7	silty sand & gravel	10	5	125 - 130	100	90.7	2000 - 4000	0.35	0	0	5	0	40 - 45
	B-4	8	sand	5	6.5	90 - 130	81	70.2	2000 - 4000	0.4	0	0	0	0	40 - 45
Bedrock	B-4	9	bedrock	-1.5	na	150									

Strata	Boring	Layer	soil type	Elevation top of layer ft.	Hi Thickness ft.	$\gamma$ lb/ft <sup>3</sup>	$N_{m\text{-avg}}$	$N'$	Esi (ksf)	$v$	$C_{rE}$	$C'_{\alpha}$	PI	$S_u$ psf	$\phi$ degrees
Fill			structural fill	47	0 - 1.5	130	32.0	491	0.3	0	0	0	0		
Sand	B-5	1	silty sand	45.5 - 49	1.5 - 5	90 - 120	5	10.6	300 - 500	0.3	0 - 0.03	0.004	5	0 - 718	0 - 32
Marine Clay	B-5	2	clay	44	10	1									

Table 5: Liquefaction Evaluation Table

Searsport, ME  
Date: November 15, 2011  
Prepared by: Coler Colantonio, Inc.

Boring	Layer	Depth	soil Type	Unit Weight*	% fines	N <sub>M</sub>	$\sigma_{\text{vertical}}$ lb/ft <sup>2</sup>	$\sigma'_{\text{vertical}}$ lb/ft <sup>2</sup>	R <sub>d</sub>	CSR <sub>MCE-usgs</sub>	CSR <sub>MCE-Ss</sub>	CSR <sub>MCE-PGAm</sub>	C <sub>N</sub>	(N <sub>1</sub> ) <sub>60</sub>	(N <sub>1</sub> ) <sub>60-cs</sub>	$\alpha$	$\beta$	CRR <sub>7.5</sub>	CRR <sub>MCE-usgs</sub>	F <sub>S</sub> <sub>MCE-usgs</sub>	CRR <sub>MCE-Ss</sub>	F <sub>MCE-Ss</sub>	CRR <sub>MCE-PGAm</sub>	F <sub>MCE-PGAm</sub>
B-1	1	5-10	silty clay	105	60	10	812.5	656.5	0.983	0.091	0.076	0.123	1.784	13.379	21.054	5.000	1.200	0.229	0.410	4.509	0.410	5.402	0.410	3.324
B-1	2	10-15	clay, silty sand	105	56	9	1337.5	869.5	0.971	0.112	0.093	0.151	1.550	11.858	19.229	5.000	1.200	0.206	0.369	3.304	0.369	3.957	0.369	2.435
B-1	3	15-20	clayey silt	110	56.3	6	1875.0	1095.0	0.959	0.123	0.102	0.167	1.381	7.044	13.453	5.000	1.200	0.145	0.259	2.112	0.259	2.530	0.259	1.557
B-1	4	20-25	silt	120	61.7	19	2450.0	1358.0	0.948	0.128	0.107	0.173	1.240	22.387	31.864	5.000	1.200	0.700	1.252	9.801	1.252	11.741	1.252	7.225
B-1	5	25-30	silt	120	58	22	3050.0	1646.0	0.936	0.130	0.108	0.176	1.127	23.545	33.254	5.000	1.200	1.582	2.832	21.851	2.832	26.175	2.832	16.108
<i>Layers below a depth of 30' have a (N<sub>1</sub>)<sub>60</sub> value greater than 30 until Bedrock in encountered at a depth of 37' and are therefore not liquefiable.</i>																								
B-2	1	5-10	silty sand	90	35.2	25	775.0	619.0	0.983	0.092	0.077	0.125	1.837	34.445	46.334	5.000	1.200	0.257	0.461	5.009	0.461	6.001	0.461	3.693
B-2	2	10-15	silty sand, gravel	100	25	10	1250.0	782.0	0.971	0.116	0.097	0.157	1.634	13.893	19.779	4.289	1.115	0.213	0.381	3.282	0.381	3.931	0.381	2.419
B-2	3	15-20	gravel, clay	125	40	5	1812.5	1032.5	0.959	0.126	0.105	0.171	1.422	6.045	12.254	5.000	1.200	0.134	0.239	1.899	0.239	2.275	0.239	1.400
B-2	4	20-25	clayey sand	115	25	11	2412.5	1320.5	0.948	0.129	0.108	0.176	1.258	13.144	18.944	4.289	1.115	0.203	0.363	2.803	0.363	3.358	0.363	2.067
<i>Layers below a depth of 25' have a (N<sub>1</sub>)<sub>60</sub> value greater than 30 until Bedrock in encountered at a depth of 40' and are therefore not liquefiable.</i>																								
B-3	1	5-10	clay	115	90	11	837.5	681.5	0.983	0.090	0.075	0.122	1.751	14.444	22.333	5.000	1.200	0.247	0.442	4.895	0.442	5.864	0.442	3.609
B-3	2	10-15	clay, silty sand	105	65	4	1387.5	919.5	0.971	0.110	0.091	0.149	1.507	5.125	11.150	5.000	1.200	0.123	0.221	2.017	0.221	2.416	0.221	1.487
B-3	3	15-20	silty sand	90	48.2	NT	1875.0	1095.0	0.959	0.123	0.102	0.167	1.381	NT	NT	5.000	1.200	NT	NT	NT	NT	NT	NT	NT
B-3	4	20-25	clay and gravel/cobbles	125	25	31	2412.5	1320.5	0.948	0.129	0.108	0.176	1.258	37.041	45.590	4.289	1.115	0.247	0.441	3.411	0.441	4.087	0.441	2.515
B-3	5	25-30	clay and gravel/cobbles	125	25	13	3037.5	1633.5	0.936	0.130	0.109	0.176	1.131	13.966	19.861	4.289	1.115	0.214	0.383	2.940	0.383	3.522	0.383	2.168
<i>Layers below a depth of 25' have a (N<sub>1</sub>)<sub>60</sub> value greater than 30 until Bedrock in encountered at a depth of 57' and are therefore not liquefiable.</i>																								
B-4	1	5-10	clayey silt	120	90	9	850.0	694.0	0.983	0.090	0.075	0.122	1.735	11.711	19.053	5.000	1.200	0.204	0.365	4.058	0.365	4.862	0.365	2.992
B-4	2	10-15	clayey silt	120	98.9	NT	1450.0	982.0	0.971	0.107	0.089	0.145	1.459	NT	NT	5.000	1.200	NT	NT	NT	NT	NT	NT	NT
B-4	3	15-20	silty clay	115	60	5	2037.5	1257.5	0.959	0.116	0.097	0.158	1.289	5.478	11.573	5.000	1.200	0.127	0.228	1.961	0.228	2.349	0.228	1.445
B-4	4	20-25	silty clay	125	61.7	8	2637.5	1545.5	0.948	0.121	0.101	0.164	1.163	8.836	15.603	5.000	1.200	0.166	0.297	2.461	0.297	2.948	0.297	1.814
B-4	5	25-30	clayey sand	115	35	15	3237.5	1833.5	0.936	0.124	0.103	0.168	1.067	15.211	23.253	5.000	1.200	0.261	0.467	3.781	0.467	4.530	0.467	2.787
<i>Layers below a depth of 30' have a (N<sub>1</sub>)<sub>60</sub> value greater than 30 until Bedrock in encountered at a depth of 48' and are therefore not liquefiable.</i>																								
B-5	1	5-10	clay	115	99	14	837.5	681.5	0.983	0.090	0.075	0.122	1.751	18.383	27.060	5.000	1.200	0.340	0.609	6.744	0.609	8.079	0.609	4.972
B-5	2	10-15	clay	115	99	NT	1412.5	944.5	0.971	0.109	0.091	0.147	1.487	NT	NT	5.000	1.200	NT	NT	NT	NT	NT	NT	NT
B-5	3	15-20	clayey silt	125	60.8	6	2012.5	1232.5	0.959	0.117	0.098	0.159	1.302	6.640	12.968	5.000	1.200	0.140	0.251	2.144	0.251	2.569	0.251	1.581
B-5	4	20-25	clay & gravel	125	55	3	2637.5	1545.5	0.948	0.121	0.101	0.164	1.163	3.313	8.976	5.000	1.200	0.104	0.187	1.543	0.187	1.849	0.187	1.138
<i>Layers below a depth of 25' have a (N<sub>1</sub>)<sub>60</sub> value greater than 30 until Bedrock in encountered at a depth of 51' and are therefore not liquefiable.</i>																								
B-6	1	5-10	clayey sand, clay	110	95	13																		

Table 6-Seismic Site Soil Classification

DCP MidStream, LP-LPG Tank Project

Searsport, ME

8/20/2011

Soil/Site Data				Method	N	
Boring	Layer	Depth	soil Type	N <sub>i</sub>	d <sub>i</sub> (thickness-ft.)	d <sub>i</sub> /N <sub>i</sub>
B-1	1	5-10	silty clay clay, silty sand clayey silt silt gravel, silty sand cobbles & gravel sand & gravel bedrock-schist/slate	10	5	0.50
	2	10-15		10	5	0.50
	3	15-20		6	5	0.83
	4	20-25		19	5	0.26
	5	25-30		22	5	0.23
	6	30-35		91	5	0.05
	7	35-37.5		100	2.5	0.03
	8	37.5-105		100	67.5	0.68
				100	3.08	
				Ñ=Σd <sub>i</sub> /Σd <sub>i</sub> /N <sub>i</sub>	32.481147	Class D
B-2	1	5-10	silty sand silty sand, gravel gravel, fine clay clayey sand only one blowcount bedrock-schist/slate	25	5	0.20
	2	10-15		10	5	0.50
	3	15-20		5	5	1.00
	4	20-25		11	5	0.45
	5	25-30		35	5	0.14
	6	30-35		65	5	0.08
	7	35-39.5		90	4.5	0.05
	8	39.5-105		100	65.5	0.66
				100	3.08	
				Ñ=Σd <sub>i</sub> /Σ(d <sub>i</sub> /N <sub>i</sub> )=	32.474642	Class D
B-3	1	5-10	clayey sand clay, silty sand silty sand-NT clay and gravel/cobbles clay and gravel/cobbles gravel, silty sand and gravel silty sand silty sand gravel silty sand and gravel bedrock-schist/slate	11	5	0.45
	2	10-15		4	5	1.25
	3	15-20		4	5	1.25
	4	20-25		31	5	0.16
	5	25-30		13	5	0.38
	6	30-35		100	5	0.05
	7	35-40		100	5	0.05
	8	40-45		100	5	0.05
	9	45-50		100	5	0.05
	10	50-55		100	5	0.05
	11	55-56		100	1	0.01
	12	56-105		100	49	0.49
				100	4.25	
				Ñ=Σd <sub>i</sub> /Σd <sub>i</sub> /N <sub>i</sub>	23.526914	Class D

Table 6-Seismic Site Soil Classification  
DCP MidStream, LP-LPG Tank Project

Searsport, ME

8/20/2011

Soil/Site Data				Method	N	
B-4	1	5-10	clayey silt	9	5	0.56
B-4	2	10-15	clayey silt	9	5	0.56
B-4	3	15-20	silty clay	5	5	1.00
B-4	4	20-25	clayey & gravel	8	5	0.63
B-4	5	25-30	clayey sand	15	5	0.33
B-4	6	30-35	silty sand/cobbles	30	5	0.17
B-4	7	35-40	silty sand & gravel	100	5	0.05
B-4	8	40-45	sand	81	5	0.06
B-4	9	45-46	sand	90	1	0.01
B-4	10	46-105	bedrock-schist/slate	100	59	0.59
					100	2.84
				$\check{N} = \sum d_i / \sum (d_i / N_i) =$	35.238075	Class D
				14	5	0.36
				6	5	0.83
				6	5	0.83
				3	5	1.67
				50	5	0.10
				100	5	0.05
B-5	1	5-10	silty sand	100	5	0.05
				61	5	0.08
				71	5	0.07
				100	55	0.55
					100	4.59
				$\check{N} = \sum d_i / \sum (d_i / N_i) =$	21.772898	Class D
				13	5	0.38
				5	5	1.00
				5	5	1.00
B-6	2	10-15	Bedrock-schist/slate	100	85	0.85
					100	3.23
				$\check{N} = \sum d_i / \sum (d_i / N_i) =$	30.915577	Class D
				17	5	0.29
B-7	1	5-10	clayey sand	15	5	0.33
				20	5	0.25
				100	85	0.85
					100	1.73
B-7	2	10-15	clayey sand/silt & gravel	$\check{N} = \sum d_i / \sum (d_i / N_i) =$	57.888763	Class C
				15	5	0.33
				20	5	0.25
				100	85	0.85

Table 6-Seismic Site Soil Classification  
DCP MidStream, LP-LPG Tank Project

Searsport, ME

8/20/2011

Soil/Site Data				Method	N
B-8	1	5-10	silty sand/ clayey sand	14	5
B-8	2	10-15	clayey sand, clay	6	5
B-8	3	15-20	clay, clayey sand	6	5
B-8	4	20-25	clay	1	5
B-8	5	25-30	clay	1	5
B-8	6	30-35	clayey sand	9	5
B-8	7	35-40	clayey sand & gravel	24	5
B-8	8	40-45	clayey sand	45	5
B-8	9	45-47	silty sand & gravel	64	2
B-8	10	47-105	bedrock-schist/slate	100	58
				100	13.51
			$\check{N} = \sum d_i / \sum (d_i / N_i) =$	7.4018919	Class E

Per ASCE 7-05 Chapter 20- Site Classification Procedure for Seismic Design

**Table 8: Summary of Soil Settlement Values**

location			Properties				Primary Settlement		Immediate Settlement		Secondary Settlement		Total Settlement	
			diameter ft	base ft	length ft	load psf	total S	total S	min	max	total S	total S	min	max
B-1	LPG Tank	edge	202	NA	NA	6,200	0.000	0.000	0.036	0.576	0.000	0.000	0.036	0.576
B-2	LPG Tank	edge	202	NA	NA	6,200	0.000	0.000	0.056	0.726	0.000	0.000	0.056	0.726
B-3	LPG Tank	center	202	NA	NA	6,200	0.000	0.000	0.058	0.769	0.000	0.000	0.058	0.769
B-4	LPG Tank	edge	202	NA	NA	6,200	0.000	0.000	0.078	0.713	0.000	0.000	0.078	0.713
B-5	LPG Tank	edge	202	NA	NA	6,200	0.000	0.000	0.049	0.535	0.000	0.000	0.049	0.535
B-1	LPG Tank	edge	202	NA	NA	3,900	0.085	0.543	0.023	0.363	0.163	0.163	0.270	1.069
B-2	LPG Tank	edge	202	NA	NA	3,900	0.000	0.418	0.035	0.457	0.136	0.136	0.171	1.011
B-3	LPG Tank	center	202	NA	NA	3,900	0.255	0.641	0.037	0.484	0.182	0.182	0.474	1.307
B-4	LPG Tank	edge	202	NA	NA	3,900	0.064	0.390	0.049	0.449	0.183	0.183	0.297	1.023
B-5	LPG Tank	edge	202	NA	NA	3,900	0.117	0.399	0.031	0.336	0.139	0.139	0.287	0.874
B-1	outside LPG tank	0.5 x diameter past B-1	NA	NA	NA	3,900	0.000	0.005	0.000	0.000	0.000	0.000	0.000	0.005
B-2	outside LPG tank	0.5 x diameter past B-2	NA	NA	NA	3,900	0.000	0.011	0.000	0.000	0.000	0.000	0.000	0.011
B-4	outside LPG tank	0.5 x diameter past B-4	NA	NA	NA	3,900	0.000	0.024	0.000	0.000	0.000	0.000	0.000	0.024
B-5	outside LPG tank	0.5 x diameter past B-5	NA	NA	NA	3,900	0.000	0.008	0.000	0.000	0.000	0.000	0.000	0.008
B-7	Firewater Tank	center	40	NA	NA	2,500	0.000	0.226	0.013	0.094	0.016	0.016	0.029	0.335
B-7	Firewater Tank	edge	40	NA	NA	2,500	0.000	0.179	0.013	0.060	0.016	0.016	0.029	0.255
B-8	Bullet Tank	corner	NA	8	15	2,667	0.061	0.066	0.018	0.034	0.031	0.031	0.110	0.131
B-8	Bullet Tank	center	NA	8	15	2,667	0.096	0.126	0.013	0.023	0.031	0.031	0.141	0.180
B-6	Compressors	corner	NA	8	15	83	0.000	0.003	0.000	0.001	0.006	0.006	0.007	0.010
B-6	Compressors	center	NA	8	15	83	0.000	0.006	0.000	0.001	0.006	0.006	0.007	0.014
B-8	Dike Wall	35' maximum elev.	NA	70	125	4,900	0.381	0.414	0.234	0.312	0.170	0.170	0.785	0.896
B-8	Dike Wall	21' minimum elev.	NA	42	273	3,100	0.241	0.260	0.097	0.161	0.170	0.000	0.508	0.421

location			Properties				Total Settlement		Dishing		Planar Tilt		Periphery Settlement	
			diameter ft	base ft	length ft	load psf	total S	total S	min	max	Δ S	Δ S	min	max
B-1	LPG Tank	edge	202	NA	NA	6200	0.036	0.576	0.022	0.193	0.042	0.137	0.020	0.149
B-2	LPG Tank	edge	202	NA	NA	6200	0.056	0.726	0.002	0.044	0.007	0.191	0.018	0.012
B-3	LPG Tank	center	202	NA	NA	6200	0.058	0.769	NA	NA	NA	NA	NA	NA
B-4	LPG Tank	edge	202	NA	NA	6200	0.078	0.713	0.020	0.056	NA	NA	0.010	0.179
B-5	LPG Tank	edge	202	NA	NA	6200	0.049	0.535	0.010	0.235	NA	NA	0.012	0.042
B-1	LPG Tank	edge	202	NA	NA	3900	0.270	1.069	0.203	0.238	0.026	0.046	0.100	0.058
B-2	LPG Tank	edge	202	NA	NA	3900	0.171	1.011	0.303	0.296	0.116	0.136	0.126	0.012
B-3	LPG Tank	center	202	NA	NA	3900	0.474	1.307	NA	NA	NA	NA	NA	NA
B-4	LPG Tank	edge	202	NA	NA	3900	0.297	1.023	0.177	0.284	NA	NA	0.010	0.148
B-5	LPG Tank	edge	202	NA	NA	3900	0.287	0.874	0.187	0.432	NA	NA	0.016	0.194

location			Properties				Total Settlement		Dishing	
			diameter ft	base ft	length ft	load psf	total S	total S	min	max
B-7	Firewater Tank	center	40	NA	NA	2500	0.029	0.335	NA	NA
B-7	Firewater Tank	edge	40	NA	NA	2500	0.029	0.255	0.000	0.081

location			Properties				Total Settlement		
			base ft	length ft	load psf	total S	total S	min	max
B-8	Bullet Tank	corner	8	15	2,667	0.110	0.131		
B-8	Bullet Tank	center	8	15	2,667	0.141	0.180		
B-6	Compressors	corner	8	15	83	0.007	0.010		
B-6	Compressors	center	8	15	83	0.007	0.014		
B-8	Dike Wall	35' maximum elev.	70	125	4,900	0.785	0.896		
B-8	Dike Wall	21' minimum elev.	42	273	3,100	0.508	0.421		

Settlement values were calculated using the following equations:

Primary Settlement:

$$S_C = \sum C_{Re} H_i \log_{10} \frac{\Delta P_{(i)} + P_{o(i)}}{P_{o(i)}}$$

Immediate Settlement:

$$S_{ielastic} = q_n B \frac{(1 - v^2)}{E_{si}} I_f \quad S_{ijanbu} = q_n B \frac{\mu_0 \mu_1}{E_{si}}$$

Secondary Settlement:

$$S_S = C'_{\alpha} H \log_{10} \left( \frac{t_2}{t_1} \right)$$

## **FIGURES**

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DCP Midstream LP  
Proposed LPG Storage Facility  
Searsport, Maine

Geotechnical Investigation  
December 16, 2011  
C&C Project #: 15-605

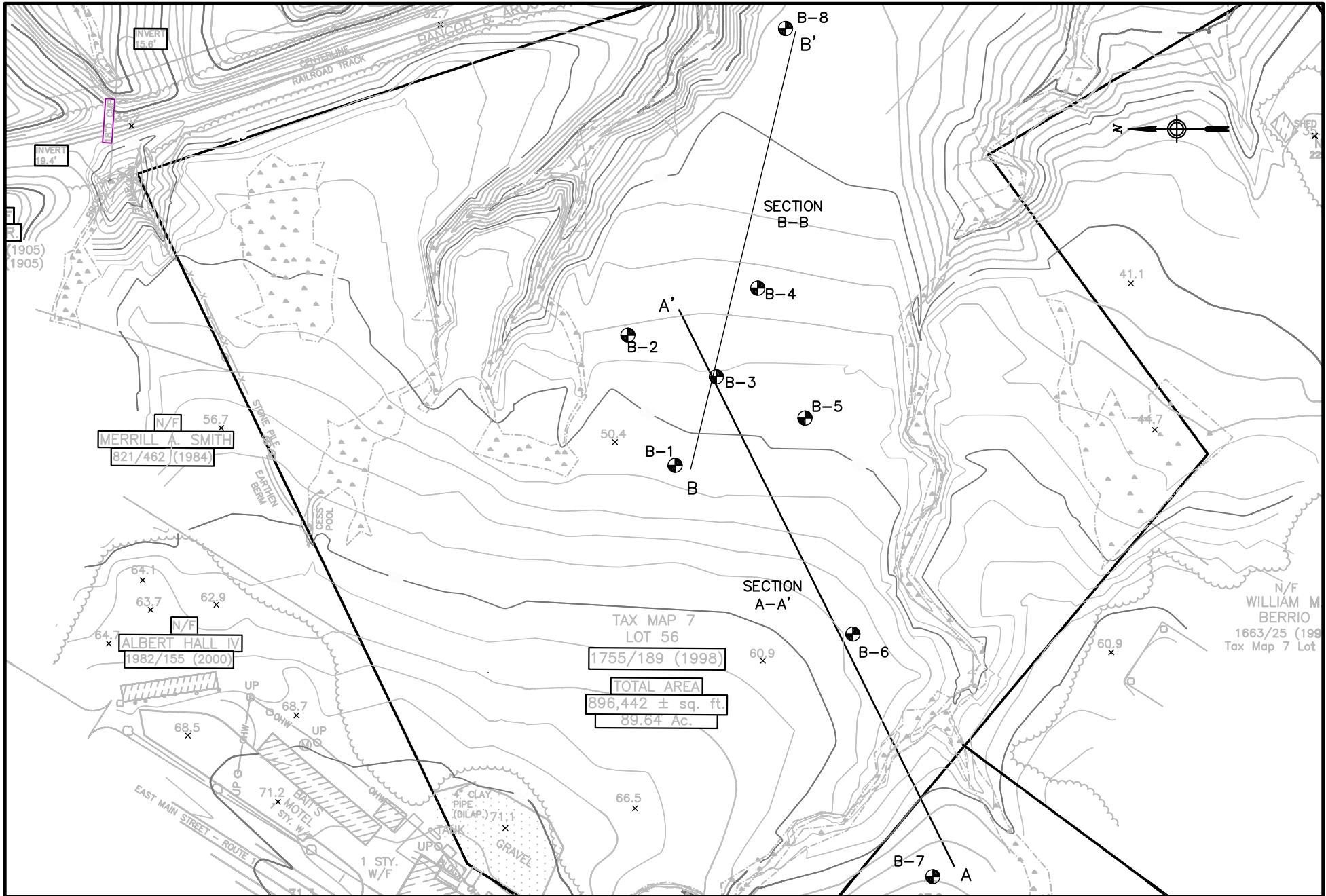
Prepared by Coler & Colantonio, Inc.



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COLANTONIO INC**  
ENGINEERS AND SCIENTISTS

DCP MIDSTREAM LP  
PROPOSED LPG STORAGE FACILITY  
SEARSPORT, MAINE

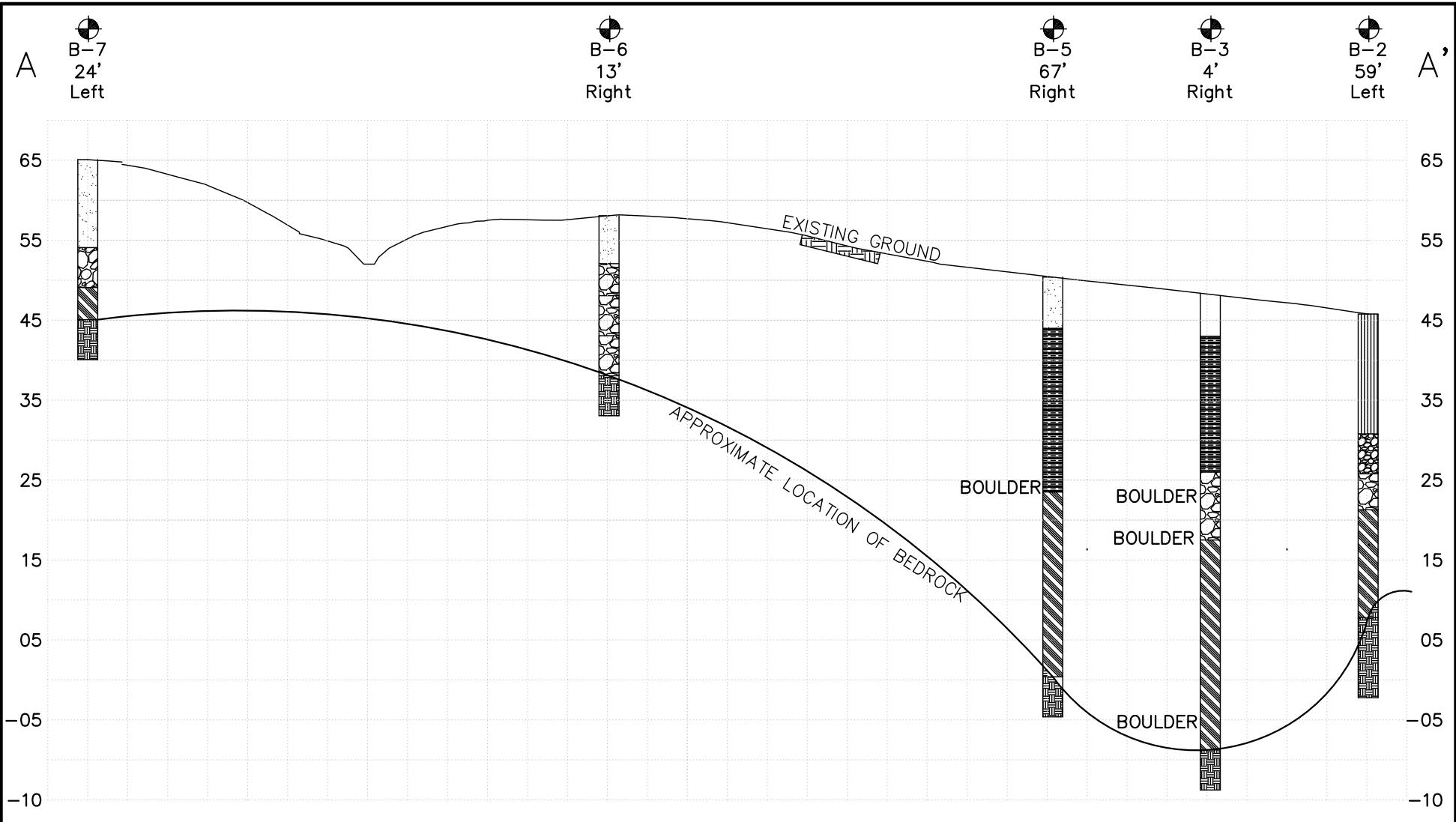
FIGURE 1  
GEOTECHNICAL BORINGS  
LOCUS PLAN



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**DCP MIDSTREAM LP  
PROPOSED LPG STORAGE FACILITY  
SEARSPORT, MAINE**

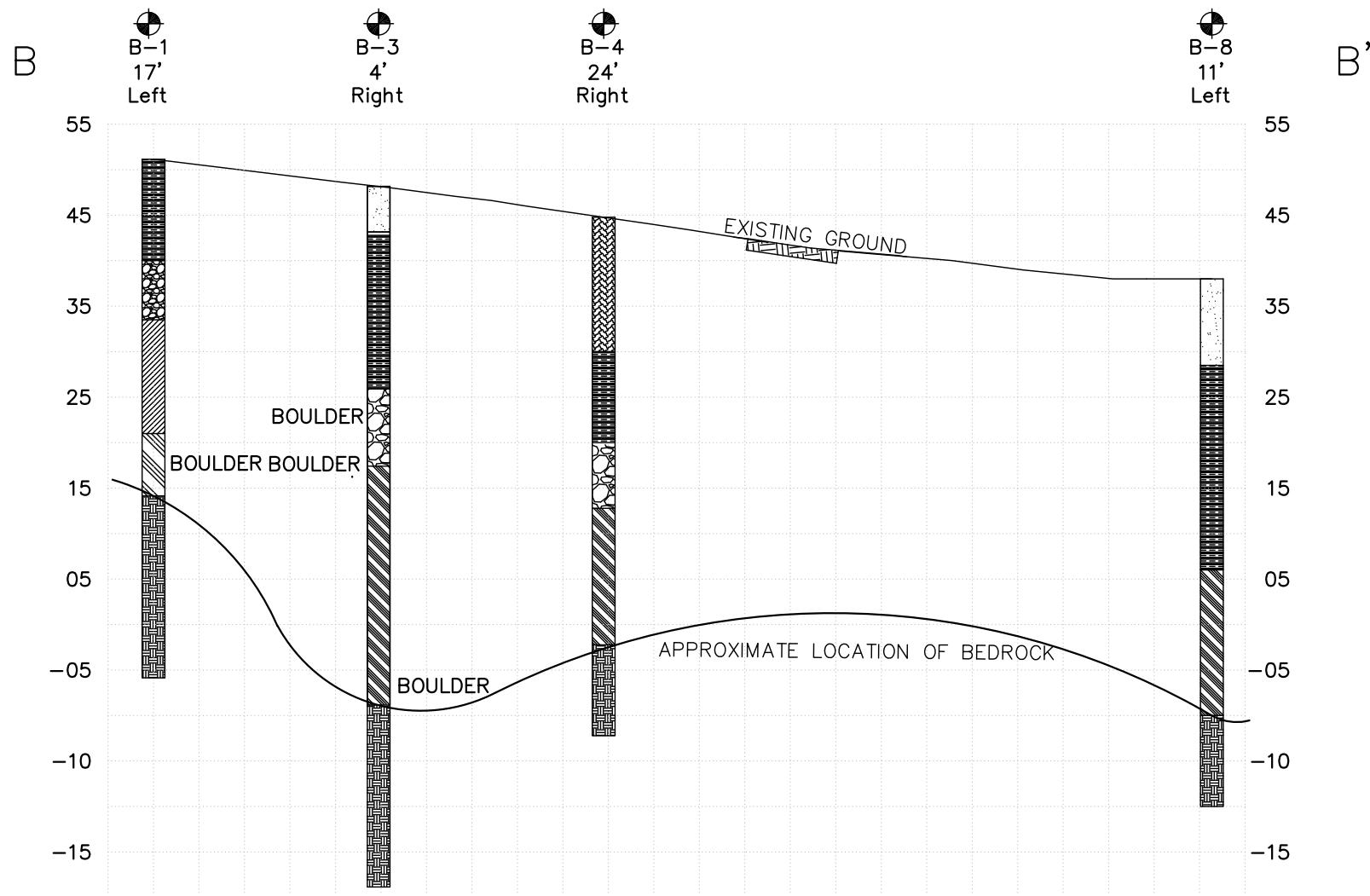
**FIGURE 2  
GEOTECHNICAL BORINGS  
EXPLORATION LOCATION PLAN**

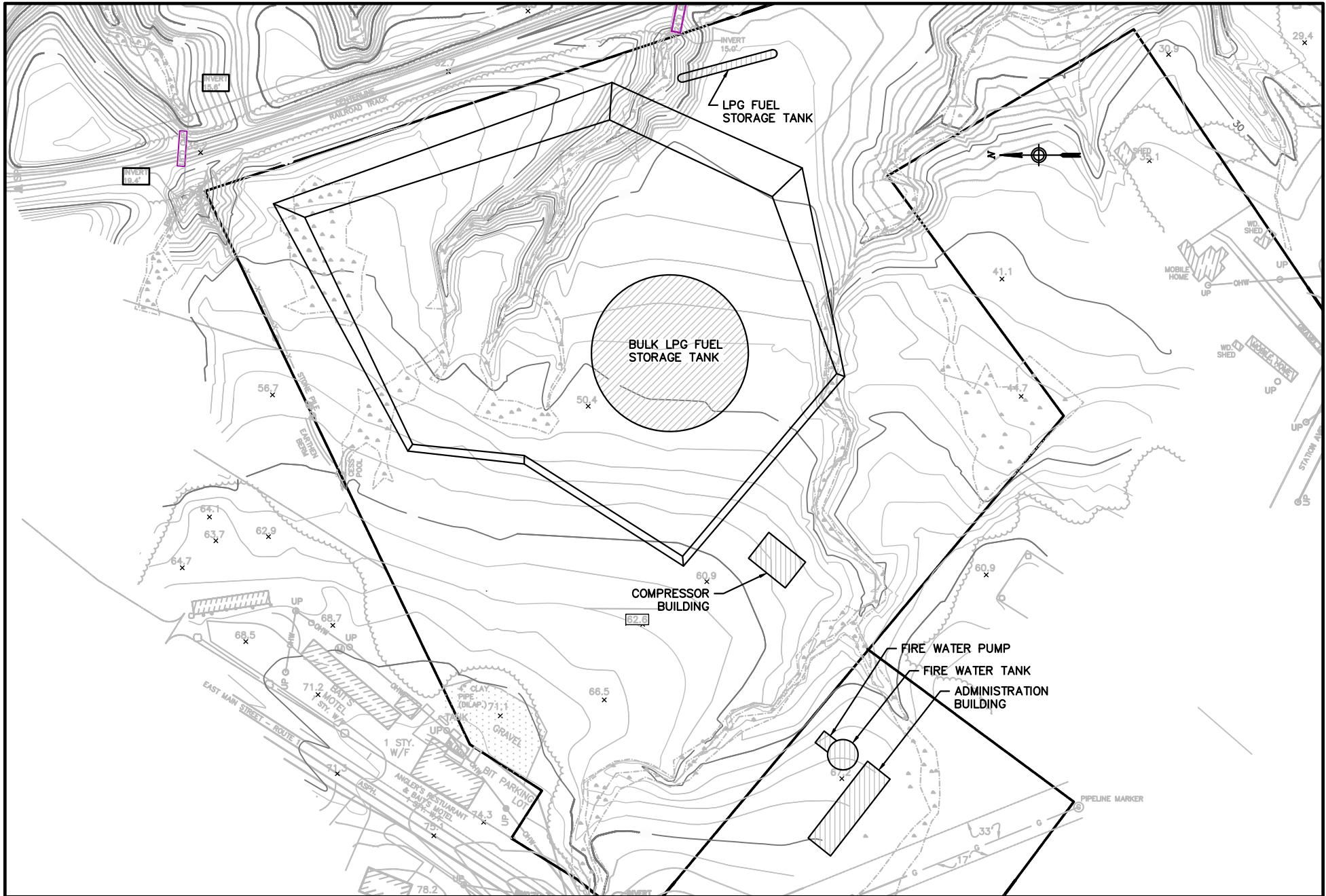


LEGEND\*

SAND	MARINE SAND & GRAVEL	CLAYEY SILT
MARINE CLAY	SAND & GRAVEL	GLACIAL TILL
MARINE SAND & SILT	CLAYEY GRAVEL	BEDROCK

\*FOR DETAILED DESCRIPTION SEE  
THE BORING LOGS AND ROCK  
CORE LOGS





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ENGINEERS AND SCIENTISTS

**DCP MIDSTREAM LP  
PROPOSED LPG STORAGE FACILITY  
SEARSPORT, MAINE**

**FIGURE 5  
MAJOR COMPONENTS  
LOCATION PLAN**

## **Appendix A**

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DCP Midstream LP  
Proposed LPG Storage Facility  
Searsport, Maine

Geotechnical Investigation  
December 16, 2011  
C&C Project #: 15-605

Prepared by Coler & Colantonio, Inc.

**COLER & COLANTONIO**  
ENGINEERS AND SCIENTISTS

PROJECT:	DCP Midstream	BORING NO.:	B-1
LOCATION:	Searsport, ME	SHEET NO.:	1 of 3
FILE NO.:	15-605	DATE:	4/27/2011
FOREMAN:	Maine Test Boring		
ENGINEER:	Lauren Konetzny		
GROUNDWATER READINGS		CASING	SAMPLER
DATE	TIME	DEPTH	TYPE & I.D.
			HAMMER WT.
			HAMMER FALL

D E P T H	C B A L S O I W N S G	SAMPLE					SAMPLE DESCRIPTION	WELL CONSTRUCTION	Visual/Olfactory Observations	STRATUM DESCRIPTION
		NO.	TYPE	PEN./REC.	DEPTH	BLOWS/6"				
5	DP	S-1	SS	24"/14"	0' - 2'	1, 0 1, 2	2" Black organic PEAT, moist (Pt). 4" Grayish brown fine to medium CLAY, moist (CH). 8" Grayish brown fine to medium silty CLAY, moist (CL).		No Odor	CLAY
			A		2' - 5'					
10	15	S-2	SS	24"/20"	5' - 7'	4, 5 5, 7	Grayish brown fine silty CLAY, mottled with red spots, wet (CL).  15-20% silt      10% Sand		No Odor	CLAY
	20									
	21									
	22		RB		7' - 10'					
	25									
15	16	S-3	SS	24"/20"	10' - 12'	2, 3 6, 4	8" Light brown fine CLAY, 10% gravel, wet (CL). 7" light brown fine to medium silty SAND, 30% gravel, wet (SM). 5" Gray fine to medium CLAY, 40% gravel, wet		No Odor	SILTY SAND
	22									
	50									
	62									
	40									
20	34	S-4	SS	24"/8"	15' - 17'	2, 3 3, 3	Gray fine to medium clayey SILT w/ 40% sand, (ML). 10% clay		No Odor	CLAY & GRAVEL
	38									
	38									
	48		RB		17' - 20'					
	46									
25	38	S-5	SS	24"/11"	20' - 22'	4, 6 13, 11	Gray fine to medium SILT, 40% sand, wet (ML)		No Odor	SILT / some gravel
	50									
	65									
	87		RB		22' - 25'					
	120									
30	61	S-6	SS	24"/16"	25' - 27'	8, 11 11, 18	Gray fine to coarse SILT , 30% sand, wet . (ML) 10% clay		No Odor	COBBLES & GRAVEL, little silty sand
	120									
	48									
	42		RB		27' - 30'					
	70									
35	28	S-7	SS	24"/12"	30' - 32'	26, 47 44, 48	40% COBBLES, 40% GRAVEL, 20% gray fine silty sand (SM), wet.		No Odor	BOULDER
	60									
			RB		32' - 35'					

LEGEND  
 SS = split spoon  
 RB = roller bit  
 RC = rock core  
 A = auger  
 DP = direct push

ST= Shelby Tube Sample

REMARKS:  
 4" diameter casing to 32' then continued with 3" casing  
 Water at 4.4' - 4/27/11  
 " RB before advancing casing

B-1

**COLER & COLANTONIO NC**  
ENGINEERS AND SCIENTISTS

PROJECT:	DCP Midstream	BORING NO.:	B-1
LOCATION:	Searsport, ME	SHEET NO.:	2 of 3
FILE NO.:	15-605	DATE:	4/27/2011

FOREMAN:	Maine Test Boring	ENGINEER:	Lauren Konetzny
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GROUNDWATER READINGS			CASING	SAMPLER	G.S. ELEVATION:
DATE	TIME	DEPTH	TYPE & I.D.		51
			HAMMER WT.	4"/3"	DATUM:
			HAMMER FALL	300#	LOCATION: northwest tank edge
				16"	TIME AT COMP.: 4/27/11 8:25 AM - 4/28/11 7:55 AM
				30"	

D E P T H	C B A L S O I W N S G	SAMPLE			SAMPLE DESCRIPTION	WELL CONSTRUCTION	Visual/Olfactory Observations	STRATUM DESCRIPTION
		NO.	TYPE	PEN./REC.	DEPTH	BLOWS/6"		
40	45	7	S-8	SS	14"/8"	35' - 36.2'	24, 50	4" Gray medium to coarse SAND, 50% GRAVEL, wet (GP). 3" Gray fine to coarse SAND, 30% gravel, wet (SP). 1" COBBLE
							50/2"	
		40	RB		36.2'-37.5'			
50	55	RC			37.5' - 57.5'	Rock Core (See Coring Log)	No Odor	BEDROCK
60	65					End of Boring at 57.5'		
70								

LEGEND	REMARKS:	
SS = split spoon	4" diameter casing to 32' then continued with 3" casing	
RB = roller bit	Water at 4.4' - 4/27/11	
RC = rock core	^ RB before advancing casing	
A = auger		
DP = direct push		
ST= Shelby Tube Sample		

B-1

<b>COLER &amp; COLANTONIO</b> <small>ENGINEERS AND SCIENTISTS</small> Start Time: 4/27/11 4:16 PM End Time: 4/28/11 7:55 AM			<b>ROCK CORE BORING LOG</b>						Boring No. B-1 4/27/2011 Sheet No. 3 of 3
			Project Name: DCP Midstream Site Location: Searsport, ME Project No.: 15-605 Drilling Co.: Maine Test Boring						Geologist: Lauren Konetzny Boring Location: northwest tank edge
Depth (ft)	Drilling Rate Min/ft	Recovery Ratio (in)	Recovery RQD		Rock Quality	Weathering	Strata Change	Visual Classification and Remarks	Fractures
			In	%					
37.5' - 42.5'	3, 1, 2, 2, 1	60"/60"	40"	67%	Fair	None to moderate	None	dark gray moderate to heavily metamorphosized slate with moderate amounts of mica & some pyrite visible, 1 mm to 5 mm white feldspar banding & associated 2 cm to 6 cm masses, bedding is mostly vertical	Fractures spaced <1" to 13", fractures to 90° off of horizontal, severe fracturing from 37.8' to 38' & 38.5' to 39'
42.5' - 47.5'	2, 1, 1, 2, 1	60"/60"	32.5"	54%	Fair	None to moderate	None		Fractures spaced <1" to 14", fractures to 90° off of horizontal, severe fracturing from 46.25' to 47'
47.5' - 52.5'	2, 1, 2, 2, 2	60"/60"	9.5"	16%	Very Poor	None to moderate	None		Fractures spaced <1" to 6", fractures to 45° off of horizontal, severe fracturing from 50' to 50.6' & 51.7' to 52'
52.5' - 57.5'	2, 2, 2, 2, 3	54"/60"	7.5"	13%	Very Poor	None to moderate	56.5' - 57': pegmatite zone		Fractures spaced <1" to 8", fractures to 45° off of horizontal, severe fracturing from 56.2' to 56.6' & 57' to 57.2'
Notes:								<b>B-1</b>	

**COLER & COLANTONIO**  
ENGINEERS AND SCIENTISTS

PROJECT:	DCP Midstream	BORING NO.:	B-2
LOCATION:	Searsport, ME	SHEET NO.:	1 of 3
FILE NO.:	15-605	DATE:	4/28/2011
FOREMAN:	Maine Test Boring		
TYPE & I.D.	CASING 4" / 3"	SAMPLER SS / 1.38"	ENGINEER: Lauren Konetzny
HAMMER WT.	300#	140#	
HAMMER FALL	16"	30"	
G.S. ELEVATION:	46		
DATUM:			
LOCATION:	northeast tank edge		
TIME AT COMP.:	4/28/11 10:10 AM - 4/29/11 9:30 AM		

D E P T H	C B A L S O I W N G	SAMPLE					SAMPLE DESCRIPTION	WELL CONSTRUCTION	Visual/Olfactory Observations	STRATUM DESCRIPTION
		NO.	TYPE	PEN./REC.	DEPTH	BLOWS/6"				
5	DP	S-1	SS	24"/16"	0' - 2'	1, 1 3, 6	1" Black organic PEAT, moist (Pt). 12" Light brown fine silty SAND, moist (SM). 3" Light brown fine silty SAND, damp (SM).		No Odor	SILTY SAND
			A		2' - 5'					
		S-2	SS	24"/14"	5' - 7'	7, 11 14, 16			No Odor	
			A		7' - 9'					
10	23	RB			9' - 10'					
15	17	S-3	SS	24"/9"	10' - 12'	6, 6 4, 5	Gray fine to medium silty SAND, 50% GRAVEL, wet (SM). 0-6% clay		No Odor	CLAY & GRAVEL
	21									
	29									
	24									
	22									
20	17	S-4	SS	24"/3"	15' - 17'	3, 2 3, 5	Subangular GRAVEL, 40% gray fine clay, wet (GC).		No Odor	CLAY & GRAVEL
	24									
	42									
	45									
	58									
25	36	S-5	SS	24"/12"	20' - 22'	3, 4 7, 11	Gray fine to medium clayey SAND, 30% gravel, wet (SC). 20% silt  Boulder		No Odor	CLAYEY SAND, some gravel  BOULDER
	58									
	85									
30		S-6	SS	24"/0"	25.2' - 27.2'	15, 18 17, 25	No Recovery. Assume Subangular GRAVEL			SILTY SAND & GRAVEL
	52*									
	30*									
35	55*	S-7	SS	6"/2"	30'-30.5'	65	Subangular GRAVEL, 40% gray fine to medium silty sand, wet (GM).		No Odor	
	57*									
	31*									
	30*									

LEGEND  
 SS = split spoon  
 RB = roller bit  
 RC = rock core  
 A = auger  
 DP = direct push

ST= Shelby Tube Sample

REMARKS:  
 4" diameter casing to 23.4' then continued with 3" casing  
 Water at 3.6' - 4/29/11 7:00 AM  
 " RB before advancing casing

B-2

**COLER & COLANTONIO INC**  
ENGINEERS AND SCIENTISTS

PROJECT:	DCP Midstream	BORING NO.:	B-2
LOCATION:	Searsport, ME	SHEET NO.:	2 of 3
FILE NO.:	15-605	DATE:	4/28/2011
FOREMAN:	Maine Test Boring	ENGINEER:	Lauren Konetzny
GROUNDWATER READINGS		CASING	G.S. ELEVATION: 46
DATE	TIME	DEPTH	TYPE & I.D.
			HAMMER WT.
			HAMMER FALL

D E P T H	C B A L S O I W N S G	SAMPLE				SAMPLE DESCRIPTION	WELL CONSTRUCTION	Visual/Olfactory Observations	STRATUM DESCRIPTION
		NO.	TYPE	PEN./REC.	DEPTH				
		S-8	SS	6"/3"	35' - 35.5'	90	2" GRAVEL, 40% grayish brown fine to medium silty SAND, wet (GM). 1" COBBLE	No Odor	SILTY SAND & GRAVEL
			RB		35.5'-39.5'		weathered rock		WEATHERED BEDROCK
40							competent rock		
45			RC		40' - 59.2'		Rock Core (See Coring Log)		BEDROCK
50									
55									
60									
65									
70									
							End of Boring at 59.2'		

LEGEND  
 SS = split spoon  
 RB = roller bit  
 RC = rock core  
 A = auger  
 DP = direct push

ST= Shelby Tube Sample

REMARKS:  
 4" diameter casing to 23.4' then continued with 3" casing  
 Water at 3.6' - 4/29/11 7:00 AM  
 ^ RB before advancing casing

B-2

COLER & COLANTONIO ENGINEERS AND SCIENTISTS			ROCK CORE BORING LOG						Boring No. B-2 4/29/2011 Sheet No. 3 of 3
									Geologist: Lauren Konetzny Boring Location: northeast tank edge
Depth (ft)	Drilling Rate Min/ft	Recovery Ratio (in)	Recovery RQD In %	Rock Quality	Weathering	Strata Change	Visual Classification and Remarks	Fractures	
40' - 45'	2, 3, 2, 2, 2	60"/60"	30"	50%	Poor	None to moderate	None	gray low to moderately metamorphosized slate with moderate amounts of mica & some pyrite visible, 1 mm to 5 mm white feldspar banding, bedding is mostly vertical, deformed sedimentary layering visible	
45' - 49.6'	2, 1, 2, 1, 2	55"/55"	22"	40%	Poor	None to moderate	None		
49.6' - 54.2'	1, 2, 1, 2, 1	55"/55"	18"	33%	Poor	None to moderate	None		
54.2' - 59.2	1, 2, 2, 2, 2	55"/60"	36"	60%	Fair	None to moderate	None		
Notes:								<b>B-2</b>	

**COLER & COLANTONIO**  
ENGINEERS AND SCIENTISTS

PROJECT:	DCP Midstream	BORING NO.:	B-3
LOCATION:	Searsport, ME	SHEET NO.:	1 of 3
FILE NO.:	15-605	DATE:	4/29/2011
FOREMAN:	Maine Test Boring	ENGINEER:	Lauren Konetzny
GROUNDWATER READINGS	CASING	G.S. ELEVATION:	48
DATE	TIME	DEPTH	TYPE & I.D.
			4"3"
			SS/1.38"
			HAMMER WT.
			300#
			140#
			HAMMER FALL
			16"
			30"
			TIME AT COMP.:
			4/29/11 11:32 AM - 5/2/11 8:37 AM

D E P T H	C B A L S O I W N S G	SAMPLE					SAMPLE DESCRIPTION	WELL CONSTRUCTION	Visual/Olfactory Observations	STRATUM DESCRIPTION	
		NO.	TYPE	PEN./REC.	DEPTH	BLOWS/6"					
5	DP	S-1	SS	24"/20"	0' - 2'	1, 1 2, 4	1" Brown fine to medium clayey SAND, moist (SC). 19" Light brown fine to medium clayey SAND with orange and brown striations, moist (SC).		No Odor	CLAYEY SAND	
			A		2' - 5'						
10	RB	9	S-2	SS	24"/24"	5' - 7'	4, 5 6, 6		No Odor	CLAY, little gravel	
		20									
		19									
		20			7' - 10'						
		24									
15	RB	18	S-3	SS	24"/20"	10' - 12 '	1, 1 3, 5		No Odor	SILTY SAND, little gravel	
		22									
		26			12' - 15'						
		26									
		27									
		15*	ST		15' - 17'		Shelby Tube Sample				
		14*									
20	RB	14*			17' - 20'						
		45*									
		48*									
		18	S-4	SS	24"/9"	20' - 22'	7, 12 19, 13		No Odor	CLAY & GRAVEL	
		20									
		22		RB		22' - 26'				SILTY SAND, little gravel	
		18									
		25									
25	RB	25					Boulder			COBBLES	
		18	S-5	SS	24"/12"	26' - 28'	10, 7 6, 11				
		10									
		16		RB		28' - 29.8'				BOULDER	
		30									
		30									
30	RB					29.8'-31'	Boulder Subangular GRAVEL, 30% gray fine to coarse silty sand, wet (GM).		No Odor	CLAYEY SAND & GRAVEL	
			S-6	SS	10"/7"	31'-31.8'					
						32, 50/4"					
						31.8' - 35'					
35										BOULDER	

LEGEND  
 SS = split spoon  
 RB = roller bit  
 RC = rock core  
 A = auger  
 DP = direct push

ST= Shelby Tube Sample

REMARKS:  
 4" diameter casing to 29.8' then continued with 3" casing  
 Water at 3.6' - 5/2/11 7:00 AM  
 ^ RB before advancing casing

B-3

**COLER & COLANTONIO**  
ENGINEERS AND SCIENTISTS

						PROJECT: DCP Midstream	BORING NO.: B-3		
						LOCATION: Searsport, ME	SHEET NO.: 2 of 3		
						FILE NO.: 15-605	DATE: 4/29/2011		
						FOREMAN: Maine Test Boring	ENGINEER: Lauren Konetzny		
GROUNDWATER READINGS			CASING	SAMPLER	G.S. ELEVATION:	48			
DATE	TIME	DEPTH	TYPE & I.D.	4"3"	SS/1.38"	DATUM:			
			HAMMER WT.	300#	140#	LOCATION:	tank center		
			HAMMER FALL	16"	30"	TIME AT COMP.:	4/29/11 11:32 AM - 5/2/11 8:37 AM		
D E P T H	C B A L S O I W N S G	SAMPLE				SAMPLE DESCRIPTION	WELL CONSTRUCTION	Visual/Olfactory Observations	STRATUM DESCRIPTION
NO.	TYPE	PEN./REC.	DEPTH	BLOWS/6"					
40	15	S-7	SS	9"/5"	35'-35.8'	43, 50/3"	Gray fine to medium silty SAND, 50% GRAVEL, wet (SM).	No Odor	SILTY SAND & GRAVEL
	25								
	117								
	80								
	110								
45	20*	S-8	SS	18"/12"	40' - 41.5'	40, 47	Gray fine to medium silty SAND, 20% subangular gravel, wet 30% clay and silt. (SM)	No Odor	SILTY SAND, little to some gravel
	38*					60			
	87*								
	32*								
	27*								
50	24	S-9	SS	16"/14"	45' - 46.3'	36, 52	Grayish brown fine to medium silty SAND, 10% gravel, wet (SM).	No Odor	GRAVEL, some sand
	24					50/4"			
	32								
	84*								
	35*								
55	27	S-10	SS	9"/5"	50'-50.8'	45, 50/3"	GRAVEL, 30% grayish brown fine to coarse sand, wet (GP).  Boulder at 53.5	No Odor	GRAVEL, some sand
	30								
	29								
	44								
60		S-11	SS	14"/6"	55' - 56.2'	25, 35	2" Reddish & grayish brown fine to medium silty SAND, wet (SM). 4" Gray fine to medium silty SAND, 40% gravel, wet (SM).	No Odor	SITLY SAND
			RB		56.2'-56.5'	50/2"			
			RC						
							Rock Core (See Coring Log)	BEDROCK	
							End of Boring at 76.1'		

LEGEND  
 SS = split spoon  
 RB = roller bit  
 RC = rock core  
 A = auger  
 DP = direct push

ST= Shelby Tube Sample

REMARKS:  
 4" diameter casing to 29.8' then continued with 3" casing  
 Water at 3.6' - 5/2/11 7:00 AM  
 ^ RB before advancing casing

B-3

<b>COLER &amp; COLANTONIO</b> <small>ENGINEERS AND SCIENTISTS</small> Start Time: 5/2/11 3:52 PM End Time: 5/3/11 8:37 AM			<b>ROCK CORE BORING LOG</b>						Boring No. B-3 5/2/2011 Sheet No. 3 of 3
			Project Name: DCP Midstream Site Location: Searsport, ME Project No.: 15-605 Drilling Co.: Maine Test Boring						Geologist: Lauren Konetzny Boring Location: tank center
Depth (ft)	Drilling Rate Min/ft	Recovery Ratio (in)	Recovery RQD		Rock Quality	Weathering	Strata Change	Visual Classification and Remarks	Fractures
			In	%					
56.5' - 61.5'	2, 1, 2, 2, 1	60"/60"	53"	88%	Good	None to slight	None	gray low to moderately metamorphosized slate with moderate amounts of mica & some pyrite visible, 1 mm to 5 mm white feldspar banding, bedding is mostly vertical, deformed sedimentary layering visible	Fractures spaced 10" to 18", fractures to 90° off of horizontal
61.5' - 66.5'	2, 2, 1, 2, 2	60"/60"	46.5"	78%	Good	None to slight	None		Fractures spaced <1" to 22", fractures to 70° off of horizontal
66.5' - 71.5'	2, 1, 2, 2, 2	60"/60"	38.5"	64%	Fair	None to slight	None		Fractures spaced <1" to 14", fractures to 70° off of horizontal, severe fracturing from 71.1' to 71.5'
71.5' - 76.1'	2, 2, 1, 1, 2	55"/55"	20"	36%	Poor	None to moderate	None		Fractures spaced <1" to 9", fractures to 70° off of horizontal, severe fracturing from 73.5' to 73.8' & 75' to 75.3'
Notes:								<b>B-3</b>	

**COLER & COLANTONIO**  
ENGINEERS AND SCIENTISTS

PROJECT:	DCP Midstream	BORING NO.:	B-4
LOCATION:	Searsport, ME	SHEET NO.:	1 of 3
FILE NO.:	15-605	DATE:	5/3/2011
FOREMAN:	Maine Test Boring	ENGINEER:	Lauren Konetzny
GROUNDWATER READINGS	CASING	G.S. ELEVATION:	45
DATE	TIME	DEPTH	TYPE & I.D.
			4"3"
			SS/1.38"
			HAMMER WT.
			300#
			140#
			HAMMER FALL
			16"
			30"

D E P T H	C B A L S O I W N G	SAMPLE					SAMPLE DESCRIPTION	WELL CONSTRUCTION	Visual/Olfactory Observations	STRATUM DESCRIPTION	
		NO.	TYPE	PEN/J REC.	DEPTH	BLOWS/6"					
5	DP	S-1	SS	24"/16"	0' - 2'	1, 1 1, 4	1" Black organic PEAT, damp (Pt). 8" Grayish brown fine to medium clayey SILT, damp (ML). 7" Light brown, reddish brown & gray striated fine clayey SILT, moist (ML).		No Odor	Clayey SILT	
			A		2' - 5'						
10	DP	S-2	SS	24"/24"	5' - 7'	3, 4 5, 5	8" Light brown & gray striated fine clayey SILT, with red mottles, damp (ML). 16" Light brown with some gray striations fine clayey SILT, wet (ML).		No Odor		
			A		7' - 10'						
15	DP	ST			10' - 12'		Shelby Tube Sample				
			RB		12' - 15'						
20	RB	12	S-3	SS	24"/3"	15' - 17'	1, 2 3, 5	Gray fine silty CLAY, 25% sand and 20% gravel, wet (CL). Cobble in tip.		No Odor	Silty CLAY
		16									
		21									
		27									
25	RB	36									
		24	S-4	SS	24"/10"	20' - 22'	2, 3 5, 5	Gray fine silty CLAY, 25% sand and 20% silt gravel, wet (CL). Cobble in tip.	No Odor		
		42									
		50									
30	RB	76				22'-25'				CLAYEY SAND & GRAVEL	
		72									
		55	S-5	SS	24"/10"	25' - 27'	6, 7 8, 8	Gray fine to medium clayey SAND, 40% gravel, wet (SC).	No Odor		
		75									
35	RB	105								COBBLES	
		170				27' - 30'					
		90*									
		70	S-6	SS	24"/8"	30' - 32'	32, 16 14, 15	3" Gray fine to medium silty SAND, 40% gravel, wet (SM). 5" Gray COBBLES, wet.	No Odor		
35	RB	72									
		78									
		95				32' - 35'					
		140									

LEGEND  
 SS = split spoon  
 RB = roller bit  
 RC = rock core  
 A = auger  
 DP = direct push

ST= Shelby Tube Sample

REMARKS:  
 4" diameter casing to 40' then continued with 3" casing  
 Water at 4.4' - 5/4/11 7:00 AM  
 ^ RB before advancing casing

B-4

PROJECT:	DCP Midstream	BORING NO.:	B-4
LOCATION:	Searsport, ME	SHEET NO.:	2 of 3
FILE NO.:	15-605	DATE:	5/3/2011

FOREMAN:	Maine Test Boring	ENGINEER:	Lauren Konetzny
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GROUNDWATER READINGS			CASING	SAMPLER	G.S. ELEVATION:
DATE	TIME	DEPTH	TYPE & I.D.	4"3"	SS/1.38"
			HAMMER WT.	300#	140#
			HAMMER FALL	16"	30"

D E P T H	C B A L S O I W N S G	SAMPLE				SAMPLE DESCRIPTION	WELL CONSTRUCTION	Visual/Olfactory Observations	STRATUM DESCRIPTION	
		NO.	TYPE	PEN./REC.	DEPTH					
40	95*	S-7	SS	10"5"	35' - 35.8'	45, 50/4"	Subangular GRAVEL, 40% gray fine to coarse silty sand, wet (GM).		No Odor	SILTY SAND & GRAVEL
	78*									
	67*									
	69*									
	65*									
		S-8	SS	24"12"	40' - 42'	22, 35				
45						46, 50	Alternating 1" to 2" layers of brown and reddish brown medium to coarse SAND, wet (SP).		No Odor	SAND
50	25	S-9	SS	18"12"	45' - 46.5'	33, 35	Orange brown medium to coarse SAND, 20% gravel, wet (SP).		No Odor	SAND, little gravel
	75					55				
55							Rock Core (See Coring Log)			BEDROCK
60							End of Boring at 58'			
65										
70										

LEGEND  
 SS = split spoon  
 RB = roller bit  
 RC = rock core  
 A = auger  
 DP = direct push

ST= Shelby Tube Sample

REMARKS:  
 4" diameter casing to 40' then continued with 3" casing  
 Water at 4.4' - 5/4/11 7:00 AM  
 " RB before advancing casing

B-4

<b>COLER &amp; COLANTONIO</b> <small>ENGINEERS AND SCIENTISTS</small> Start Time: 5/4/11 8:38 AM End Time: 5/4/11 9:11 AM			<b>ROCK CORE BORING LOG</b>						Boring No. B-4 5/4/2011 Sheet No. 3 of 3
			Project Name: DCP Midstream Site Location: Searsport, ME Project No.: 15-605 Drilling Co.: Maine Test Boring						Geologist: Lauren Konetzny Boring Location: southeast tank edge
Depth (ft)	Drilling Rate Min/ft	Recovery Ratio (in)	Recovery RQD		Rock Quality	Weathering	Strata Change	Visual Classification and Remarks	Fractures
			In	%					
48' - 53'	2, 2, 1, 2, 2	57"/60"	37"	62%	Fair	None to moderate	None	gray moderate to highly metamorphosized slate with moderate amounts of mica & some pyrite visible, 1 mm to 5 mm white feldspar banding & associated 3 cm to 6 cm masses, bedding is mostly vertical, deformed sedimentary layering visible	Fractures spaced <1" to 13", fractures to 70° off of horizontal
53' - 58'	1, 2, 1, 2, 2	58"/60"	17.5"	29%	Poor	None to moderate	None		Fractures spaced <1" to 12", fractures to 90° off of horizontal, severe fracturing from 57.3' to 58'
Notes:								<b>B-4</b>	



PROJECT:	DCP Midstream	BORING NO.:	B-5
LOCATION:	Searsport, ME	SHEET NO.:	1 of 3
FILE NO.:	15-605	DATE:	5/5/2011
FOREMAN:	Maine Test Boring	ENGINEER:	Lauren Konetzny
GROUNDWATER READINGS	CASING	SAMPLER	G.S. ELEVATION: 49
DATE	TIME	DEPTH	TYPE & I.D.
			HAMMER WT.
			HAMMER FALL

D E P T H	C B A L S O I W N G	SAMPLE					SAMPLE DESCRIPTION	WELL CONSTRUCTION	Visual/Olfactory Observations	STRATUM DESCRIPTION	
		NO.	TYPE	PEN./REC.	DEPTH	BLOWS/6"					
5	DP	S-1	SS	24"/18"	0' - 2'	0, 1 4, 5	1" Black organic PEAT, wet (Pt). 12" Light brown fine clayey SAND, damp (SC). 5" Grayish brown with reddish brown striations fine silty SAND, moist (SM).		No Odor	CLAYEY SAND	
										SILTY SAND	
		S-2	SS	24"/24"	5' - 7'	5, 5 9, 8			No Odor	CLAY	
					7' - 10'						
10	DP				10' - 12'		Shelby Tube Sample- moist grey CLAY (CL)				
					12' - 15'						
15	DP		ST							CLAY	
			RB								
20	DP	18	S-3	SS	24"/18"	15' - 17'	4, 3 3, 4	gray clayey SILT (ML) with 30% sand, 10% gravel		No Odor	Clayey SILT
		20									
		23									
		20									
25	DP	21								CLAY & GRAVEL	
		10	S-4	SS	24"/12"	20' - 22'	1, 1 2, 2				
		21									
		24									
30	DP	32				22'-24.9'		Gray fine to medium CLAY, 40% gravel, wet (CH).			BOULDER
		50									
		27*				24.9'-26.1'					
		54*									
35	DP	49*				26.1' - 30'		Boulder			BOULDER
		59*									
		95*									
		43*	S-5	SS	12"/5"	30' - 31'	38, 50				
35	DP	48*						3" Gray fine to medium silty SAND, 40% subangular gravel, wet (SM). 2" COBBLES, wet.		No Odor	SILTY SAND & GRAVEL
		108*									
		33*									
		71*									

LEGEND  
 SS = split spoon  
 RB = roller bit  
 RC = rock core  
 A = auger  
 DP = direct push

ST= Shelby Tube Sample

REMARKS:  
 4" diameter casing to 40' then continued with 3" casing  
 Water at 5.1' - 5/6/11 7:00 AM  
 " RB before advancing casing

B-5

**COLER & COLANTONIO**  
ENGINEERS AND SCIENTISTS

						PROJECT: DCP Midstream	BORING NO.: B-5
						LOCATION: Searsport, ME	SHEET NO.: 2 of 3
						FILE NO.: 15-605	DATE: 5/5/2011
						FOREMAN: Maine Test Boring	ENGINEER: Lauren Konetzny
GROUNDWATER READINGS			CASING	SAMPLER	G.S. ELEVATION: 49		
DATE	TIME	DEPTH	TYPE & I.D.	4"3"	SS/1.38"	DATUM:	
			HAMMER WT.	300#	140#	LOCATION:	southwest tank edge
			HAMMER FALL	16"	30"	TIME AT COMP.:	5/5/11 1:15 PM - 5/6/11 1:42 PM
D E P T H	C B A L S O I W N S G	SAMPLE				WELL CONSTRUCTION	STRATUM DESCRIPTION
NO.	TYPE	PEN./REC.	DEPTH	BLOWS/6"	SAMPLE DESCRIPTION		
40	52*	S-6	SS	10'5"	35' -35.8'	56, 50/4"	SILTY SAND, little gravel
	31*						
	30*						
	43*						
	58*						
45		S-7	SS	24"/22"	40' - 42'	18, 36	CLAYEY SAND
						25, 40	
50	5*	S-8	SS	21"/18"	45' - 46.8'	23, 35	SAND
	7*					36, 50/3"	
	8*						
	10*						
	72*						
55							BEDROCK
60							BEDROCK
65							
70							

LEGEND  
 SS = split spoon  
 RB = roller bit  
 RC = rock core  
 A = auger  
 DP = direct push

ST= Shelby Tube Sample

REMARKS:  
 4" diameter casing to 40' then continued with 3" casing  
 Water at 5.1' - 5/6/11 7:00 AM  
 ^ RB before advancing casing

B-5



**COLER & COLANTONIO**  
ENGINEERS AND SCIENTISTS

PROJECT:	DCP Midstream	BORING NO.:	B-6
LOCATION:	Searsport, ME	SHEET NO.:	1 of 2
FILE NO.:	15-605	DATE:	5/9/2011
FOREMAN:	Maine Test Boring	ENGINEER:	Lauren Konetzny

GROUNDWATER READINGS				CASING	SAMPLER	G.S. ELEVATION:	57						
DATE	TIME	DEPTH	TYPE & I.D.	4"3"	SS/1.38"	DATUM:							
			HAMMER WT.	300#	140#	LOCATION:	western most boring on Map 7 Lot 56						
			HAMMER FALL	16"	30"	TIME AT COMP.:	5/9/11 9:45 AM - 5/9/11 1:18 PM						
D E P T H	C B A L S O I W N G	NO.	TYPE	PEN/J REC.	DEPTH	BLOWS/6"	SAMPLE DESCRIPTION	WELL CONSTRUCTION					
5	DP	S-1	SS	24"/15"	0' - 2'	0, 1 3, 6	10" Light brown fine clayey SAND, damp (SC). 5" Grayish brown fine SAND, dry (SW).	Visual/Olfactory Observations	No Odor	CLAYEY SAND			
10	DP	S-2	SS	24"/22"	5' - 7'	5, 6 7, 7	16" Light brown and gray striated fine clayey SAND with reddish brown mottles, moist (SC). 6" Light brown fine CLAY, damp (CL).			No Odor	CLAYEY SAND		
15	RB	5*	ST		10' - 12'		Shelby Tube Sample						
15	RB	5*											
15	RB	7											
15	RB	12											
15	RB	12											
20	RB	10	S-3	24"/2"	15' - 17'	2, 2 3, 2	GRAVEL, 50% brown fine CLAY, saturated (GC).		Well Construction	No Odor	CLAY & GRAVEL		
20	RB	10											
20	RB	15											
20	RB	19											
20	RB	27											
25	RC				19.9'-21'		Bedrock				BEDROCK		
30	RC				21' - 30.7'		Rock Core (See Coring Log)						
35	RC						End of Boring at 30.7'						

LEGEND  
 SS = split spoon  
 RB = roller bit  
 RC = rock core  
 A = auger  
 DP = direct push

ST= Shelby Tube Sample

REMARKS:  
 4" diameter casing to 20' then continued with 3" casing  
 Water estimated at approximately 6' bsg based on soil water content  
 " RB before advancing casing

B-6

<b>COLER &amp; COLANTONIO</b> <small>ENGINEERS AND SCIENTISTS</small> Start Time: 5/9/11 12:27 PM End Time: 5/9/11 1:18 PM			<b>ROCK CORE BORING LOG</b>						Boring No. B-6 5/9/2011 Sheet No. 2 of 2
			Project Name: DCP Midstream Site Location: Searsport, ME Project No.: 15-605 Drilling Co.: Maine Test Boring						Geologist: Lauren Konetzny Boring Location: western most boring on Map 7 Lot 56
Depth (ft)	Drilling Rate Min/ft	Recovery Ratio (in)	Recovery RQD		Rock Quality	Weathering	Strata Change	Visual Classification and Remarks	Fractures
			In	%					
21' - 26'	2, 2, 2, 3, 3	54"/60"	6"	10%	Very Poor	Moderate to high	None	gray moderate to highly metamorphosized slate with moderate amounts of mica & some pyrite visible, 1 mm to 25 mm white feldspar banding, deformed sedimentary layering visible	Fractures spaced <1" to 6", fractures to 90° off of horizontal, severe fracturing from 21' to 24'
26' - 30.7'	2, 2, 2, 2, 2	56"/56"	35.5"	63%	Fair	Moderate to high	None		Fractures spaced <1" to 22", fractures to 90° off of horizontal, severe fracturing from 29' to 29.5'
Notes:								<b>B-6</b>	

**COLER & COLANTONIO**  
ENGINEERS AND SCIENTISTS

PROJECT:	DCP Midstream	BORING NO.:	B-7
LOCATION:	Searsport, ME	SHEET NO.:	1 of 2
FILE NO.:	15-605	DATE:	5/10/2011

FOREMAN: Maine Test Boring

ENGINEER: Lauren Konetzny

GROUNDWATER READINGS				CASING	SAMPLER	G.S. ELEVATION:	64				
DATE	TIME	DEPTH	TYPE & I.D.	HAMMER WT.	4"/3"	SS/1.38"	DATUM:				
				HAMMER FALL	300#	140#	LOCATION:				
					16"	30"	TIME AT COMP.:				
D E P T H	C B A L S O I W N G	SAMPLE				SAMPLE DESCRIPTION	WELL CONSTRUCTION	Visual/Olfactory Observations	STRATUM DESCRIPTION		
5	DP	S-1	SS	24"/12"	0' - 2'	1, 1		No Odor	CLAYEY SAND interbedded with layers of fine to medium SAND		
						4, 5					
10	DP	S-2	SS	24"/18"	5' - 7'	5, 8		No Odor	CLAYEY SILT & GRAVEL, trace cobble		
						9, 20					
15		S-3	SS	24"/8"	10' - 12'	9, 7		No Odor	WEATHERED BEDROCK		
						8, 8					
20		RB			12' - 15.5'	7, 7		No Odor	BEDROCK		
						13, 18					
25		S-4	SS	24"/8"	15.5' - 17.5'	3" Gray charcoal SILT with 20-30% sand (ML) 10-50% clays, varved. 5" Silvery gray, soft friable COBBLE/weathered bedrock, wet					
						17.5' - 20'					
30		RC		20' - 30'	Rock Core (See Coring Log)						
					End of Boring at 30'						
35											

LEGEND

SS = split spoon

RB = roller bit

RC = rock core

A = auger

DP = direct push

ST= Shelby Tube Sample

REMARKS:

4" diameter casing to 15' then continued with 3" casing

Water estimated at approximately 3' bsg based on soil water content

^ RB before advancing casing

B-7



PROJECT:	DCP Midstream	BORING NO.:	B-8
LOCATION:	Searsport, ME	SHEET NO.:	1 of 3
FILE NO.:	15-605	DATE:	5/4/2011
FOREMAN:	Maine Test Boring	ENGINEER:	Lauren Konetzny
GROUNDWATER READINGS		CASING	SAMPLER
DATE	TIME	DEPTH	TYPE & I.D.
			HAMMER WT.
			HAMMER FALL

D E P T H	C B A L S O I W N G	SAMPLE				SAMPLE DESCRIPTION	WELL CONSTRUCTION	Visual/Olfactory Observations	STRATUM DESCRIPTION	
		NO.	TYPE	PEN/J REC.	DEPTH	BLOWS/6"				
5	DP	S-1	SS	24"/5"	0' - 2'	1, 1 3, 6	1" Black organic PEAT, damp (Pt). 1" Brown fine silty SAND, damp (SM). 1" Cobble. 2" Grayish brown fine silty SAND, damp (SM).	No Odor	SILTY SAND, trace cobbles	
			A		2' - 5'					
10	DP	S-2	SS	24"/22"	5' - 7'	4, 7 7, 10	Grayish brown fine clayey SAND with red mottles, damp (SC).  Shelby Tube Sample	No Odor	CLAYEY SAND	
			A		7' - 8'					
			ST		8' - 10'					
15	DP	S-3	SS	24"/24"	10' - 12'	3, 2 4, 4	Grayish brown fine CLAY with red mottles, wet (CL).	No Odor	CLAY	
			RB		12' - 15'					
20	DP	S-4	SS	24"/24"	15' - 17'	3, 3 3, 3	20" Gray fine to medium clayey SAND with a reddish brown vertical stripe, wet (SC). 4" Gray fine CLAY, wet (CH).	No Odor	CLAYEY SAND	
			RB		17' - 20'					
25	DP	S-5	SS	24"/24"	20' - 22'	0, 0 0, 0	Gray fine CLAY, wet (CL).	No Odor	CLAY	
			RB		22'-25'					
30	DP	24 25 35 47 47	S-6	SS	24"/24"	25' - 27'	0, 0 1, 5	Gray fine CLAY, trace gravel, wet (CL).	No Odor	CLAY, trace gravel
			RB		27' - 30'					
35	DP	44 57 70 78 110	S-7	SS	24"/0"	30' - 32'	3, 4 6, 11	No Recovery		
			RB		32' - 35'					

LEGEND  
 SS = split spoon  
 RB = roller bit  
 RC = rock core  
 A = auger  
 DP = direct push

ST= Shelby Tube Sample

REMARKS:  
 4" diameter casing to 40' then continued with 3" casing  
 Water at 9.4' - 5/5/11 7:00 AM  
 " RB before advancing casing

B-8

<b>COLER &amp; COLANTONIO</b> <b>ENGINEERS AND SCIENTISTS</b>								PROJECT: DCP Midstream	BORING NO.: B-8				
								LOCATION: Searsport, ME	SHEET NO.: 2 of 3				
								FILE NO.: 15-605	DATE: 5/4/2011				
								FOREMAN: Maine Test Boring	ENGINEER: Lauren Konetzny				
GROUNDWATER READINGS				CASING	SAMPLER	G.S. ELEVATION:	39						
DATE	TIME	DEPTH	TYPE & I.D.	4"3"	SS/1.38"	DATUM:							
			HAMMER WT.	300#	140#	LOCATION:	eastern most boring						
			HAMMER FALL	16"	30"	TIME AT COMP.:	5/4/11 12:15 PM - 5/5/11 10:08 AM						
D E P T H	C B A L S O I W N S G	SAMPLE				SAMPLE DESCRIPTION	WELL CONSTRUCTION	Visual/Olfactory Observations	STRATUM DESCRIPTION				
		NO.	TYPE	PEN./REC.	DEPTH	BLOWS/6"							
40	48*	S-8	SS	24"/12"	35' - 37'	9, 9 15, 16	Cobbles	No Odor	CLAYEY SAND, some gravel, trace cobbles				
									COBBLES				
45	50*	S-9	SS	24"/9"	40' - 42'	9, 14 31, 34	Subangular GRAVEL, 50% gray fine to medium clayey SAND, wet (SC).	No Odor	CLAYEY SAND & GRAVEL				
50	72*	S-10	SS	24"/16"	45' - 47'	19, 34 30, 35	Gray fine to medium silty SAND, 40% gravel, 5% cobbles, wet (SM).	No Odor	SILTY SAND & GRAVEL, trace cobbles				
55	65*						Rock Core (See Coring Log)		BEDROCK				
60								End of Boring at 58'					
65													
70													
LEGEND				REMARKS:									
SS = split spoon				4" diameter casing to 40' then continued with 3" casing									
RB = roller bit				Water at 9.4' - 5/5/11 7:00 AM									
RC = rock core				~ RB before advancing casing									
A = auger													
DP = direct push													
								B-8					

<b>COLER &amp; COLANTONIO</b> <small>ENGINEERS AND SCIENTISTS</small> Start Time: 5/5/11 9:31 AM End Time: 5/5/11 10:08 AM			<b>ROCK CORE BORING LOG</b>						Boring No. B-8 5/5/2011 Sheet No. 3 of 3
			Project Name: DCP Midstream Site Location: Searsport, ME Project No.: 15-605 Drilling Co.: Maine Test Boring						Geologist: Lauren Konetzny Boring Location: eastern most boring
Depth (ft)	Drilling Rate Min/ft	Recovery Ratio (in)	Recovery RQD		Rock Quality	Weathering	Strata Change	Visual Classification and Remarks	Fractures
			In	%					
48' - 53'	2, 2, 2, 2, 2	60"/60"	14"	23%	Very Poor	None to moderate	None	gray low to moderately metamorphosized slate with moderate amounts of mica & some pyrite visible, 1 mm to 5 mm white feldspar banding, bedding is mostly vertical, deformed sedimentary layering visible	Fractures spaced <1" to 6", fractures to 90° off of horizontal, severe fracturing from 51' to 51.5'
53' - 58'	1, 2, 2, 1, 2	58"/60"	28"	47%	Poor	None to moderate	None		Fractures spaced 2" to 11", fractures to 90° off of horizontal
Notes:								<b>B-8</b>	

## **Appendix B**

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DCP Midstream LP  
Proposed LPG Storage Facility  
Searsport, Maine

Geotechnical Investigation  
December 16, 2011  
C&C Project #: 15-605

Prepared by Coler & Colantonio, Inc.



125 Nagog Park  
Acton, MA 01720  
978 635 0424 Tel  
978 635 0266 Fax

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## Transmittal

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TO:

Lauren Konetzny  
Coler & Colantonio, Inc.  
101 Accord Park Drive  
Norwell, MA 02061

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DATE: 6/8/2011	GTX NO: 10738
RE: DCP Searsport	

COPIES	DATE	DESCRIPTION
	6/8/2011	May 2011 Laboratory Test Report

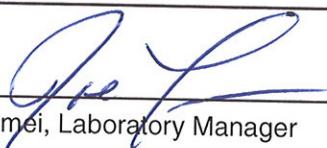
REMARKS:

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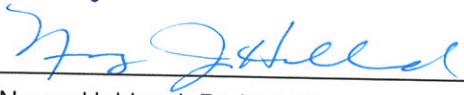
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CC:

SIGNED:

  
Joe Tomei, Laboratory Manager

APPROVED BY:

  
Nancy Hubbard, Project Manager

June 8, 2011

Lauren Konetzny  
Coler & Colantonio, Inc.  
101 Accord Park Drive  
Norwell, MA 02061

RE: DCP Searsport, Maine (GTX-10738)

Dear Lauren:

Enclosed are the test results you requested for the above referenced project. GeoTesting Express, Inc. (GTX) received 10 samples from you between 5/12/2011 and 5/18/2011. These samples were labeled as follows:

Boring Number	Depth
B-1	0-2 ft
B-1	15-17 ft
B-1	25-27 ft
B-2	5-7 ft
B-4	0-2 ft
B-5	10-12 ft
B-5	5-7 ft
B-8	10-12 ft
B-8	20-22 ft
B-8	5-7 ft

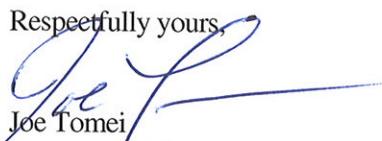
GTX performed the following tests on these samples:

- 1 ASTM D 2216 - Moisture Content test
- 5 ASTM D 422 - Grain Size Analyses with Hydrometer
- 1 ASTM D 4318 - Atterberg Limits test
- 1 ASTM D 2937 - Density of Soil test
- 1 ASTM D 4186 - CRC Consolidation test

GTX also subcontracted Braun Intertec Corporation of Minneapolis, MN to perform ASTM C 1580 Soluble Sulfates in Soil on samples B-1 (0-2 ft) and B-4 (0-2 ft). See the attached Braun Intertec report for results. A copy of your test request is attached.

The results presented in this report apply only to the items tested. This report shall not be reproduced except in full, without written approval from GeoTesting Express. The remainder of these samples will be retained for a period of sixty (60) days and will then be discarded unless otherwise notified by you. Please call me if you have any questions or require additional information. Thank you for allowing GeoTesting Express the opportunity of providing you with testing services. We look forward to working with you again in the future.

Respectfully yours,



Joe Tomei  
Laboratory Manager



125 Nagog Park  
Acton, MA 01720  
978 635 0424 Tel  
978 635 0266 Fax

---

## **Geotechnical Test Report**

**6/8/2011**

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**GTX-10738**  
**DCP Searsport**  
**Maine**  
**Client Project No.: 15-605**

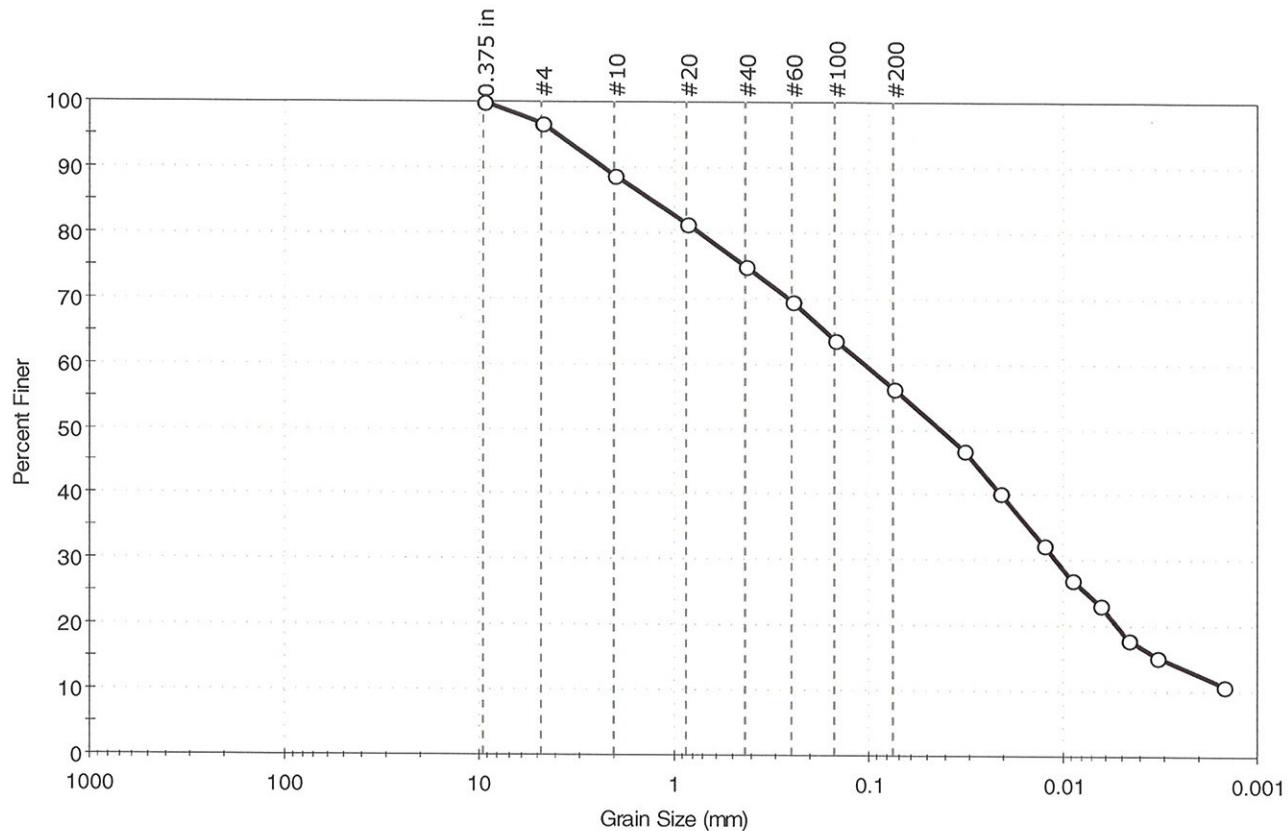
Prepared for:

**Coler & Colantonio, Inc.**

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Client:	Coler & Colantonio, Inc.	Project No:	GTX-10738
Project:	DCP Searsport	Tested By:	jbr
Location:	Maine	Test Date:	05/19/11
Boring ID:	B-1	Sample Type:	tube
Sample ID:	---	Checked By:	jdt
Depth :	15-17 ft	Test Id:	208615
Test Comment:	---		
Sample Description:	Moist, olive green sandy silt		
Sample Comment:	---		

## Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	3.3	40.4	56.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	97		
#10	2.00	89		
#20	0.85	81		
#40	0.42	75		
#60	0.25	70		
#100	0.15	64		
#200	0.075	56		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0323	47		
---	0.0210	41		
---	0.0124	32		
---	0.0089	27		
---	0.0064	23		
---	0.0046	18		
---	0.0033	15		
---	0.0015	11		

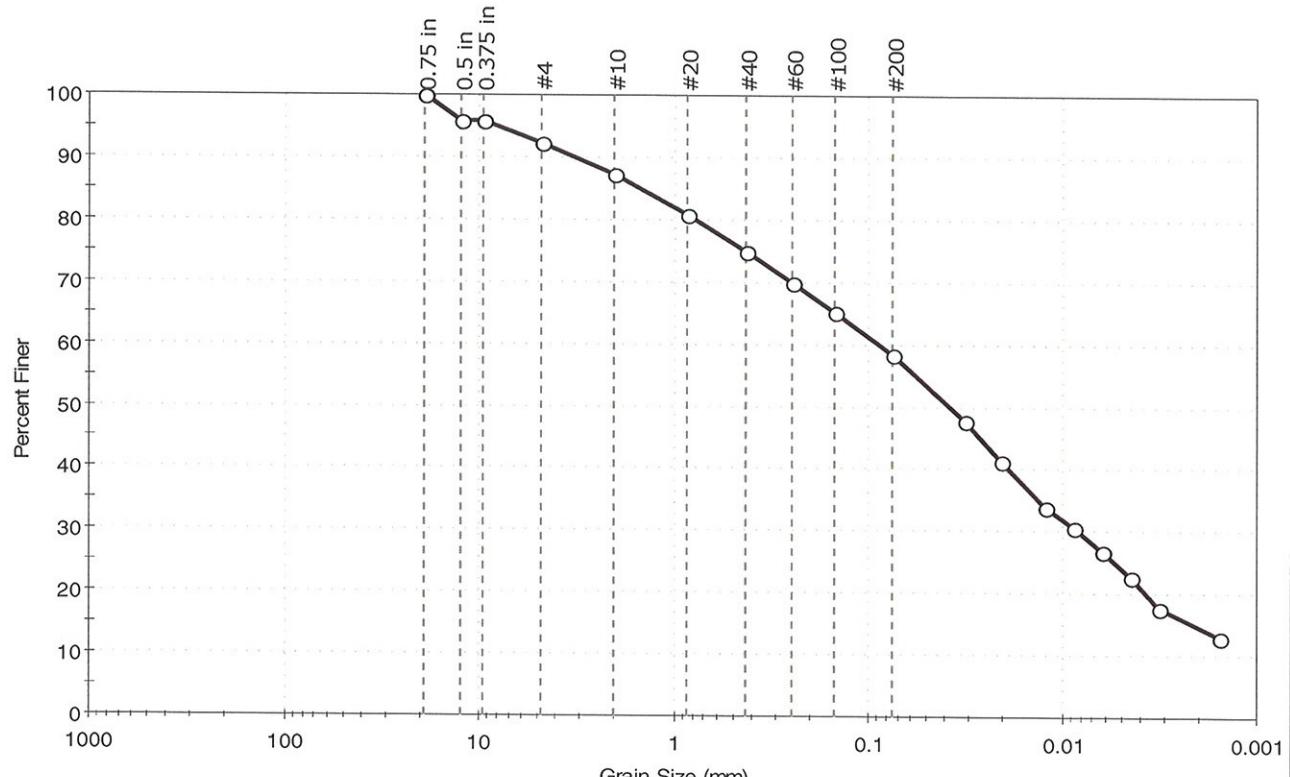
Coefficients	
D <sub>85</sub> = 1.2942 mm	D <sub>30</sub> = 0.0107 mm
D <sub>60</sub> = 0.1059 mm	D <sub>15</sub> = 0.0031 mm
D <sub>50</sub> = 0.0428 mm	D <sub>10</sub> = 0.0013 mm
C <sub>u</sub> = N/A	C <sub>c</sub> = N/A

Classification	
ASTM	N/A
AASHTO	Silty Soils (A-4 (0))

Sample/Test Description	
Sand/Gravel Particle Shape :	ROUNDED
Sand/Gravel Hardness :	HARD

Client:	Coler & Colantonio, Inc.	Project No:	GTX-10738
Project:	DCP Searsport	Tested By:	jbr
Location:	Maine	Test Date:	05/13/11
Boring ID:	B-1	Sample Type:	jar
Sample ID:	---	Checked By:	jdt
Depth :	25-27 ft	Test Id:	207948
Test Comment:	---		
Sample Description:	Moist, olive sandy silt		
Sample Comment:	---		

## Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	7.6	34.0	58.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	96		
0.375 in	9.50	96		
#4	4.75	92		
#10	2.00	87		
#20	0.85	81		
#40	0.42	75		
#60	0.25	70		
#100	0.15	65		
#200	0.075	58		
0.0318		48		
0.0206		41		
0.0122		34		
0.0087		31		
0.0063		27		
0.0045		23		
0.0032		18		
0.0016		13		

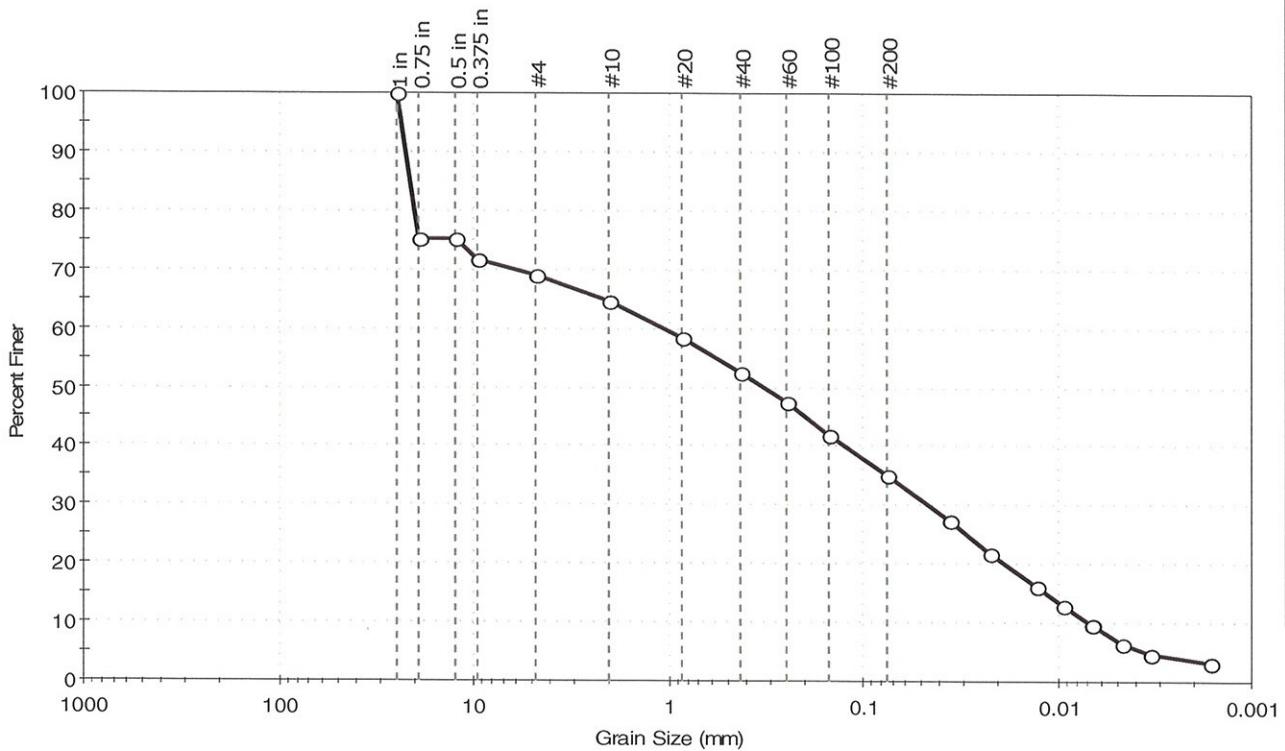
**Coefficients**  
 $D_{85} = 1.4828 \text{ mm}$        $D_{30} = 0.0082 \text{ mm}$   
 $D_{60} = 0.0878 \text{ mm}$        $D_{15} = 0.0021 \text{ mm}$   
 $D_{50} = 0.0382 \text{ mm}$        $D_{10} = 0.0010 \text{ mm}$   
 $C_u = N/A$        $C_c = N/A$

**Classification**  
ASTM      N/A  
AASHTO      Silty Soils (A-4 (0))

**Sample/Test Description**  
 Sand/Gravel Particle Shape : ROUNDED  
 Sand/Gravel Hardness : HARD

Client:	Coler & Colantonio, Inc.	Project No:	GTX-10738
Project:	DCP Searsport	Tested By:	jbr
Location:	Maine	Test Date:	05/13/11
Boring ID:	B-2	Sample Type:	jar
Sample ID:	---	Checked By:	jdt
Depth :	5-7 ft	Test Id:	207949
Test Comment:	---		
Sample Description:	Moist, olive silty sand with gravel		
Sample Comment:	---		

## Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	30.9	33.9	35.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 in	25.00	100		
0.75 in	19.00	75		
0.5 in	12.50	75		
0.375 in	9.50	72		
#4	4.75	69		
#10	2.00	64		
#20	0.85	58		
#40	0.42	53		
#60	0.25	48		
#100	0.15	42		
#200	0.075	35		
---	0.0355	27		
---	0.0224	22		
---	0.0130	16		
---	0.0093	13		
---	0.0067	10		
---	0.0048	6		
---	0.0034	5		
---	0.0016	3		

**Coefficients**  
 $D_{85} = 21.1646 \text{ mm}$        $D_{30} = 0.0456 \text{ mm}$   
 $D_{60} = 1.0722 \text{ mm}$        $D_{15} = 0.0116 \text{ mm}$   
 $D_{50} = 0.3238 \text{ mm}$        $D_{10} = 0.0069 \text{ mm}$   
 $C_u = N/A$        $C_c = N/A$

**Classification**  
ASTM      N/A  
AASHTO      Silty Soils (A-4 (0))

**Sample/Test Description**  
Sand/Gravel Particle Shape : ROUNDED  
Sand/Gravel Hardness : HARD



Client:	Coler & Colantonio, Inc.	Project No:	GTX-10738
Project:	DCP Searsport		
Location:	Maine		
Boring ID:	B-5	Sample Type:	tube
Sample ID:	---	Test Date:	06/09/11
Depth :	10-12 ft	Sample Id:	99408
Test Comment:	---	Tested By:	jef
Sample Description:	Moist, gray clay	Checked By:	jdt
Sample Comment:	---		

## Moisture Content of Soil - ASTM D 2216-05

Boring ID	Sample ID	Depth	Description	Moisture Content,%
B-5	---	10-12 ft	Moist, gray clay	32.8

Notes: Temperature of Drying : 110° Celsius



Client:	Coler & Colantonio, Inc.	Project No:	GTX-10738
Project:	DCP Searsport	Tested By:	md
Location:	Maine	Test Date:	06/09/11
Boring ID:	B-5	Sample Type:	tube
Sample ID:	---	Checked By:	jdt
Depth :	10-12 ft	Test Id:	207953
Test Comment:	---		
Sample Description:	Moist, gray clay		
Sample Comment:	---		

## Density of Soil In Place by the Drive Cylinder Method - ASTM D 2937-04

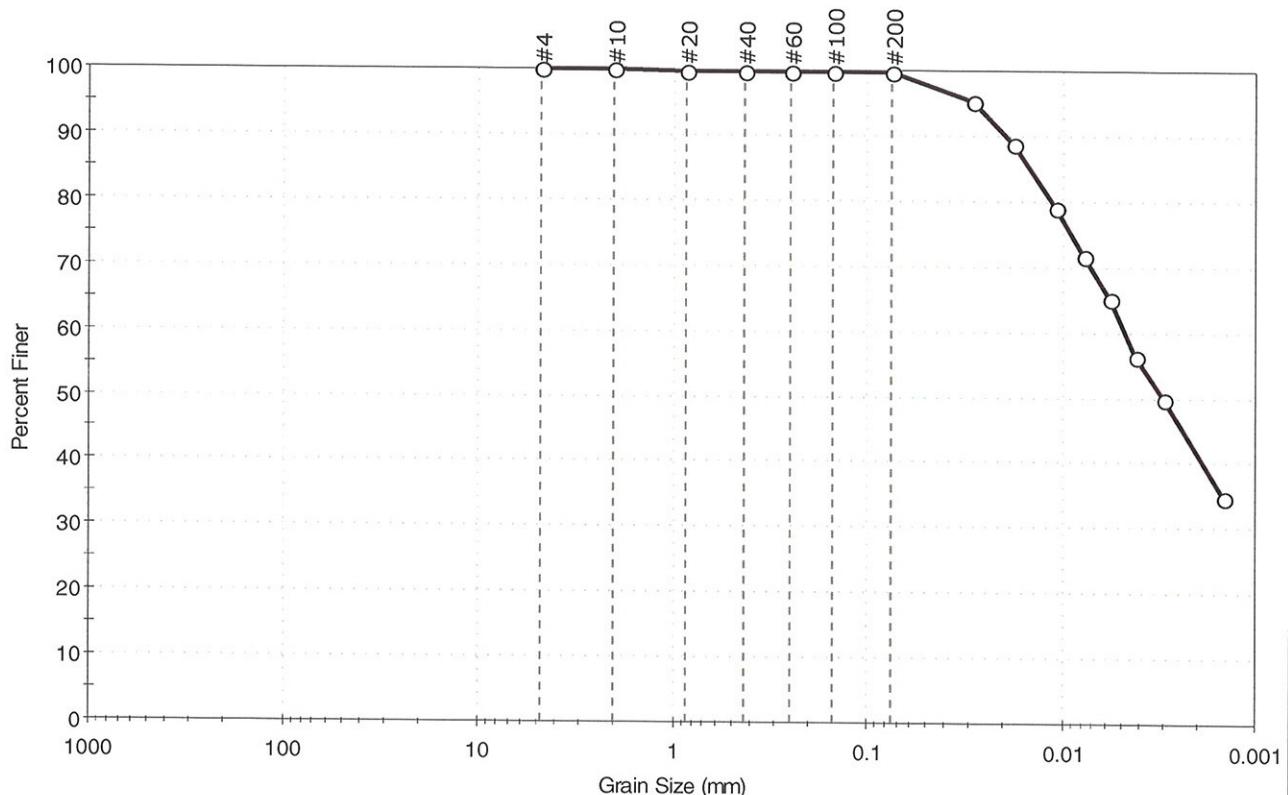
Boring ID	Sample ID	Depth	Visual Description	Sample Diameter, in	Sample Height, in	Bulk Density, pcf	Moisture Content, %	Dry Density, pcf
B-5	---	10-12 ft	Moist, gray clay	2.87	3.34	118	32.8	89.0

Notes: Density determined on undisturbed samples provided to GeoTesting Express.

Moisture Content determined by ASTM D 2216.

Client:	Coler & Colantonio, Inc.	Project No:	GTX-10738
Project:	DCP Searsport	Tested By:	jbr
Location:	Maine	Test Date:	05/17/11
Boring ID:	B-5	Checked By:	jdt
Sample ID:	---	Test Id:	207947
Depth :	10-12 ft		
Test Comment:	---		
Sample Description:	Moist, gray clay		
Sample Comment:	Post CRC test specimen used for grain size test		

## Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



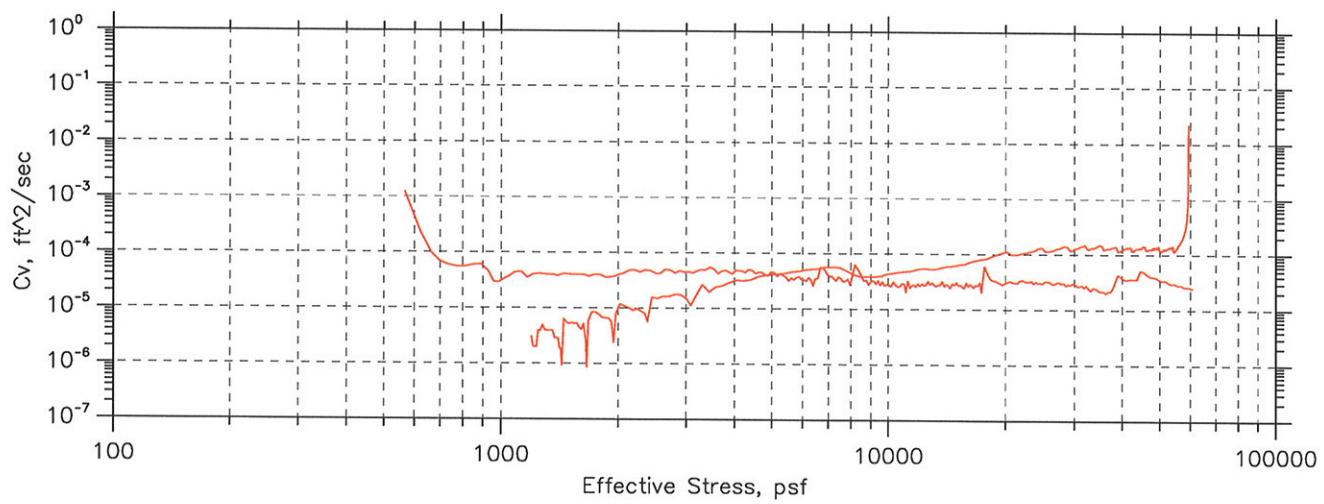
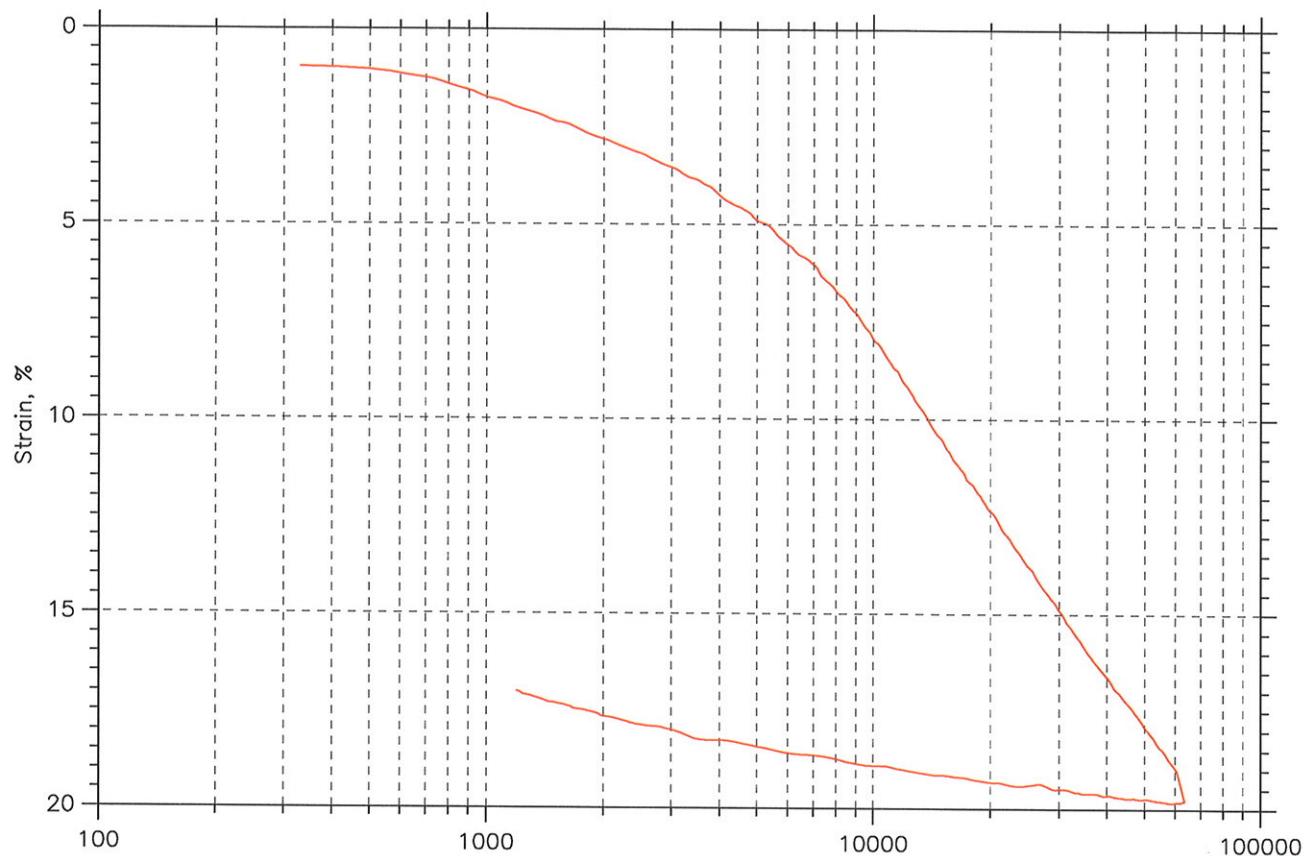
Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	100		
#100	0.15	100		
#200	0.075	100		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0286	95		
---	0.0181	89		
---	0.0108	79		
---	0.0078	72		
---	0.0057	65		
---	0.0041	56		
---	0.0030	50		
---	0.0015	35		

**Coefficients**  
 $D_{85} = 0.0147 \text{ mm}$     $D_{30} = \text{N/A}$   
 $D_{60} = 0.0047 \text{ mm}$     $D_{15} = \text{N/A}$   
 $D_{50} = 0.0030 \text{ mm}$     $D_{10} = \text{N/A}$   
 $C_u = \text{N/A}$     $C_c = \text{N/A}$

**Classification**  
ASTM N/A  
AASHTO Silty Soils (A-4 (0))

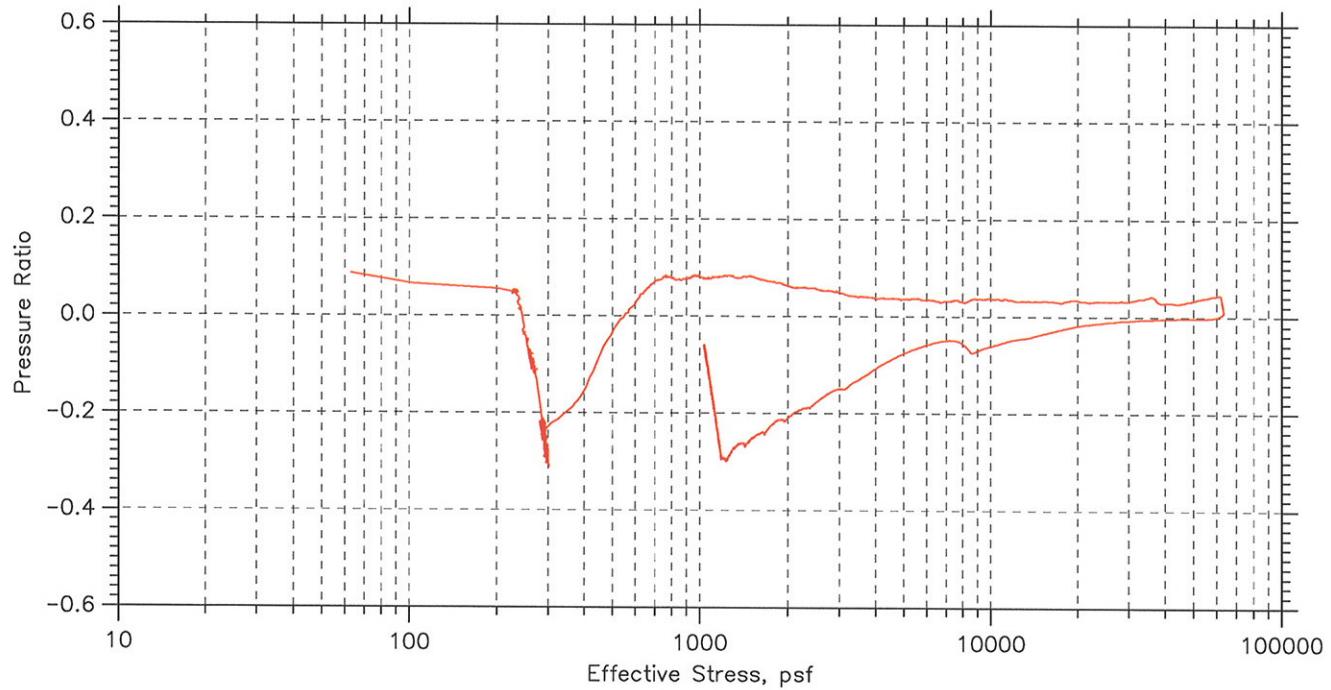
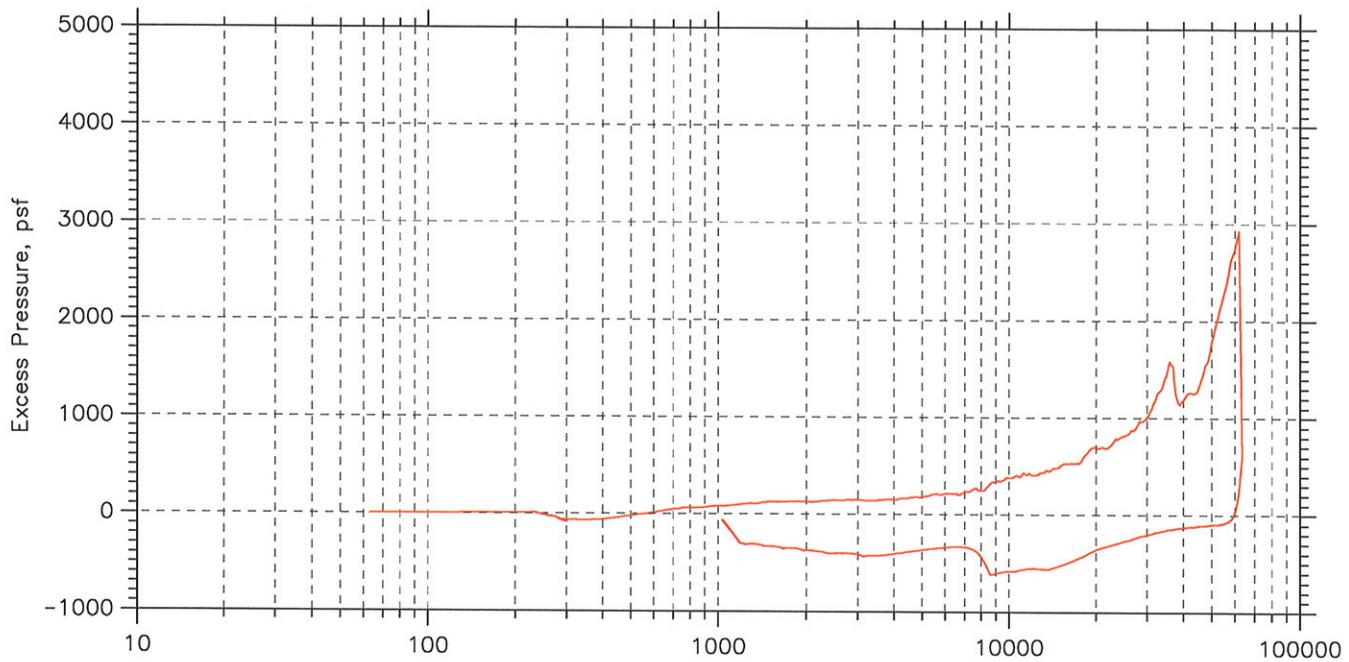
**Sample/Test Description**  
Sand/Gravel Particle Shape : ---  
Sand/Gravel Hardness : ---

**Constant Rate of Consolidation**  
**Constant Strain Rate by ASTM D4186**  
**Summary Report**



Project: CDP Searsport	Location: Maine	Project No.: GTX-10738
Boring No.: B-5	Tested By: md	Checked By: jdt
Sample No.: ---	Test Date: 5/13/11	Depth: 10-12 ft
Test No.: CRC-1	Sample Type: tube	Elevation: ---
Description: Moist, gray clay		
Remarks: System S		

**Constant Rate of Consolidation**  
**Constant Strain Rate by ASTM D4186**  
**Pressure Curves**



Project: CDP Searsport	Location: Maine	Project No.: GTX-10738
Boring No.: B-5	Tested By: md	Checked By: jdt
Sample No.: ---	Test Date: 5/13/11	Depth: 10-12 ft
Test No.: CRC-1	Sample Type: tube	Elevation: ---
Description: Moist, gray clay		
Remarks: System S		

CRC TEST DATA

Project: CDP Searsport  
 Boring No.: B-5  
 Sample No.: ---  
 Test No.: CRC-1

Soil Description: Moist, gray clay  
 Remarks: System S

Estimated Specific Gravity: 2.89  
 Initial Void Ratio: 1.01  
 Final Void Ratio: 0.68

Location: Maine  
 Tested By: md  
 Test Date: 5/13/11  
 Sample Type: tube

Project No.: GTX-10738  
 Checked By: jdt  
 Depth: 10-12 ft  
 Elevation: ---

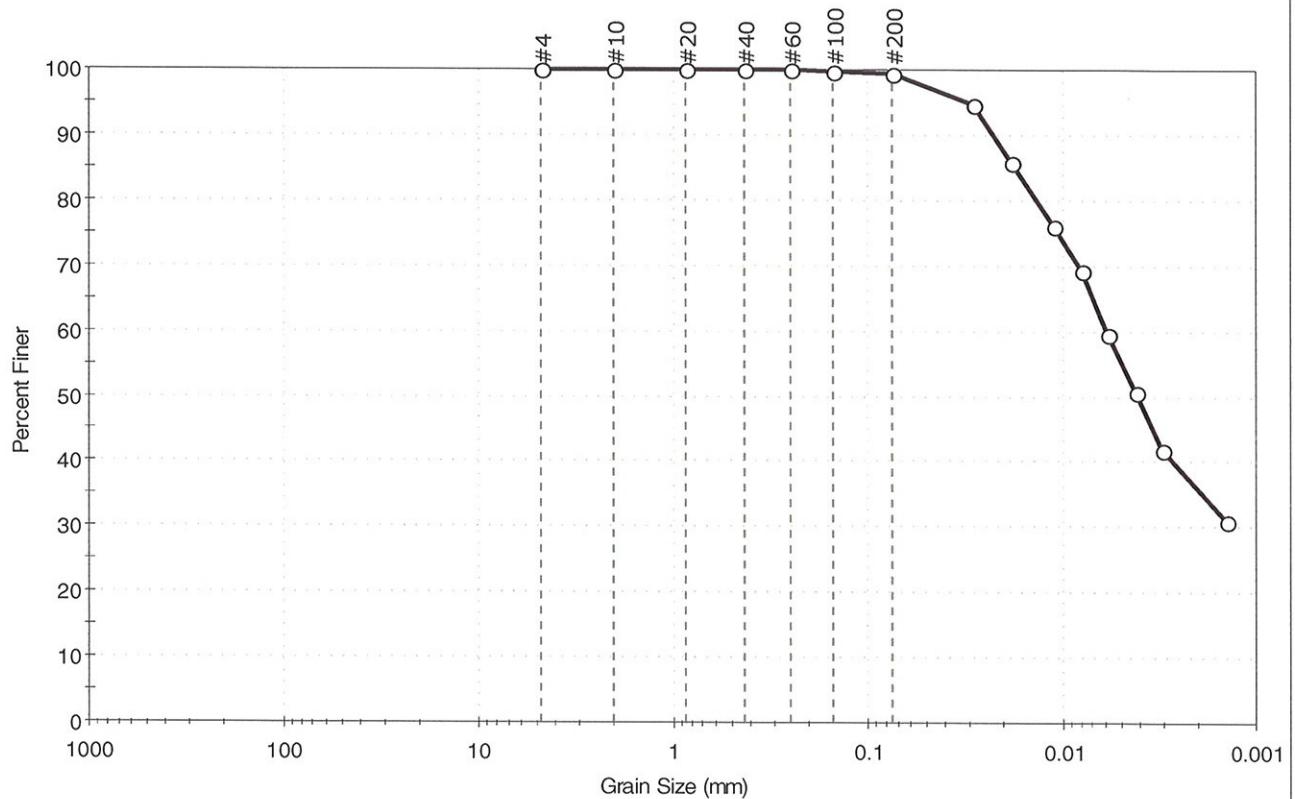
Initial Height: 1.00 in  
 Specimen Diameter: 2.50 in

	Before Consolidation	After Consolidation	
	Trimmings	Specimen+Ring	Specimen+Ring
Container ID	7119	RING	7893
Wt. Container + Wet Soil, gm	480.11	265.1	252.04
Wt. Container + Dry Soil, gm	363.57	224.99	224.99
Wt. Container, gm	8.41	109.55	109.55
Wt. Dry Soil, gm	355.16	115.44	115.44
Water Content, %	32.81	34.75	23.43
Void Ratio	---	1.01	0.68
Degree of Saturation, %	---	99.11	100.00
Dry Unit Weight, pcf	---	89.59	107.53

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

Client:	Coler & Colantonio, Inc.	Project No:	GTX-10738
Project:	DCP Searsport	Tested By:	jbr
Location:	Maine	Test Date:	05/19/11
Boring ID:	B-8	Sample Type:	tube
Sample ID:	---	Checked By:	jdt
Depth :	10-12 ft	Test Id:	208614
Test Comment:	---		
Sample Description:	Moist, olive green silty clay		
Sample Comment:	---		

## Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	0.0	0.6	99.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	100		
#100	0.15	100		
#200	0.075	99		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0287	95		
---	0.0184	86		
---	0.0110	76		
---	0.0080	69		
---	0.0058	59		
---	0.0042	51		
---	0.0031	42		
---	0.0014	31		

<u>Coefficients</u>	
D <sub>85</sub> = 0.0175 mm	D <sub>30</sub> = N/A
D <sub>60</sub> = 0.0059 mm	D <sub>15</sub> = N/A
D <sub>50</sub> = 0.0041 mm	D <sub>10</sub> = N/A
C <sub>u</sub> = N/A	C <sub>c</sub> = N/A

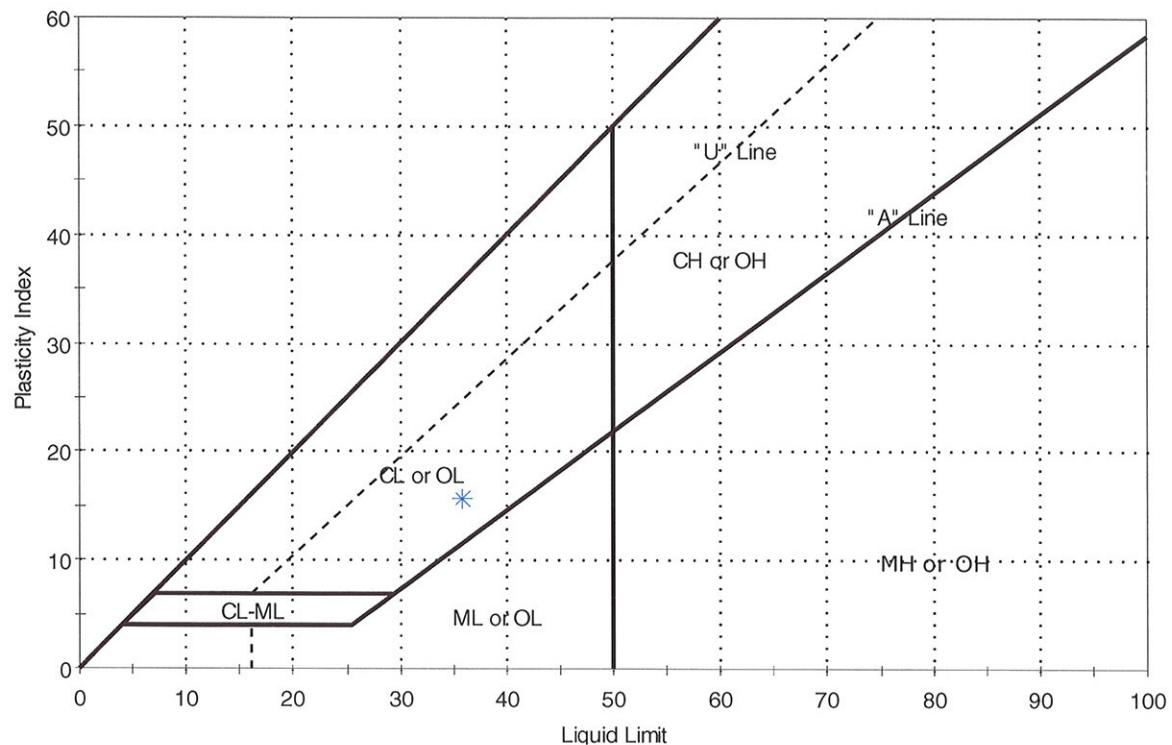
ASTM	Classification
N/A	AASHTO Silty Soils (A-4 (0))

<u>Sample/Test Description</u>	
Sand/Gravel Particle Shape :	---
Sand/Gravel Hardness :	---

Client:	Coler & Colantonio, Inc.	Project No:	GTX-10738
Project:	DCP Searsport	Tested By:	cam
Location:	Maine	Test Date:	05/16/11
Boring ID:	B-8	Sample Type:	jar
Sample ID:	---	Checked By:	jdt
Depth :	20-22 ft	Test Id:	207946
Test Comment:	---		
Sample Description:	Moist, dark olive gray clay		
Sample Comment:	---		

## Atterberg Limits - ASTM D 4318-05

Plasticity Chart



Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	---	B-8	20-22 ft	34	36	20	16	1	

Sample Prepared using the WET method

Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW



Braun Intertec Corporation  
11001 Hampshire Avenue S.  
Minneapolis, MN 55438

Phone: 952.995.2000  
Fax: 952.995.2020  
Web: braunintertec.com

Mr. Michael Dagher  
Geotesting Express, Inc.  
125 Nagog Park  
Acton, MA 01720

May 26, 2011

Report #: 1102501

RE: GTX10738  
GTX10738

Dear Michael Dagher:

Braun Intertec Corporation received samples for the project identified above on May 16, 2011. Analytical results are summarized in the following report.

All routine quality assurance procedures were followed, unless otherwise noted.

Analytical results are reported on an "as received" basis unless otherwise noted. Where possible, the samples will be retained by the laboratory for 14 days following issuance of the initial final report. The samples will be disposed of or returned at that time. Arrangements can be made for extended storage by contacting me at this time.

We appreciate your decision to use Braun Intertec Corporation for this project. We are committed to being your vendor of choice to meet your analytical chemistry needs.

If you have any questions please contact me at the above phone number.

Sincerely,

Steven J. Albrecht  
Project Manager

Providing engineering and environmental solutions since 1957



11001 Hampshire Ave. S.  
Minneapolis, MN 55438  
952.995.2000 Phone  
952.995.2020 Fax

Geotesting Express, Inc.  
125 Nagog Park  
Acton, MA 01720

Client Ref: GTX10738  
Client Contact: Mr. Michael Dagher  
PO Number: GTX10738

Report #: 1102501  
Project Mgr: Steven J. Albrecht  
Account ID:

### Qualifiers and Abbreviations

COC	Chain of Custody
dry	Sample results reported on a dry weight basis
MRL	Method Reporting Limit
NA	Not Applicable
ND	Analyte NOT DETECTED
NR	Not Reported
%Rec	Percent Recovery
RPD	Relative Percent Difference
VOC	Volatile Organic Compound



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952.995.2020 Fax

Geotesting Express, Inc.  
125 Nagog Park  
Acton, MA 01720

Client Ref: GTX10738  
Client Contact: Mr. Michael Dagher  
PO Number: GTX10738

Report #: 1102501  
Project Mgr: Steven J. Albrecht  
Account ID:

### Sample Summary

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
B-1	1102501-01	Soil	05/13/11 00:00	05/16/11 11:32
B-4	1102501-02	Soil	05/13/11 00:00	05/16/11 11:32



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952.995.2000 Phone  
952.995.2020 Fax

Geotesting Express, Inc.  
125 Nagog Park  
Acton, MA 01720

Client Ref: GTX10738  
Client Contact: Mr. Michael Dagher  
PO Number: GTX10738

Report #: 1102501  
Project Mgr: Steven J. Albrecht  
Account ID:

#### Conditions Upon Receipt

**Cooler:** Cooler 1

Temperature: 21.0 °C	COC Included: Yes	Custody Seals Used: No
Temperature Blank: No	COC Complete: Yes	Custody Seals Intact: NA
Received on Ice: No	COC & Labels Agree: Yes	Hand Delivered by Client: No
Preservation Confirmed: No	Sufficient Sample Provided: Yes	Headspace Present (VOC): No



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952.995.2020 Fax

Geotesting Express, Inc.  
125 Nagog Park  
Acton, MA 01720

Client Ref: GTX10738  
Client Contact: Mr. Michael Dagher  
PO Number: GTX10738

Report #: 1102501  
Project Mgr: Steven J. Albrecht  
Account ID:

**B-1**

**1102501-01 (Soil)**

**5/13/11 0:00**

**Classical Chemistry Parameters**

Analyte	Result	MRL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Sulfate, water soluble	< 0.020	0.020	% Wt	1	B1E0479	5/24/11	5/26/11	ASTM C1580	



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952.995.2020 Fax

Geotesting Express, Inc.  
125 Nagog Park  
Acton, MA 01720

Client Ref: GTX10738  
Client Contact: Mr. Michael Dagher  
PO Number: GTX10738

Report #: 1102501  
Project Mgr: Steven J. Albrecht  
Account ID:

**B-4**

**1102501-02 (Soil)**

**5/13/11 0:00**

**Classical Chemistry Parameters**

Analyte	Result	MRL	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Sulfate, water soluble	<0.020	0.020	% Wt	1	B1E0479	5/24/11	5/26/11	ASTM C1580	



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Geotesting Express, Inc.  
125 Nagog Park  
Acton, MA 01720

Client Ref: GTX10738  
Client Contact: Mr. Michael Dagher  
PO Number: GTX10738

Report #: 1102501  
Project Mgr: Steven J. Albrecht  
Account ID:

### Classical Chemistry Parameters - Quality Control

#### Batch B1E0479 - Method-specified preparation

Method Blank (B1E0479-BLK1)    Prepared: 05/24/11 Analyzed: 05/26/11

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Sulfate, water soluble	< 0.020	0.020	% Wt	NA	NA	NA	NA	NA	NA	

#### Standard Reference Material (B1E0479-SRM1)

Prepared: 05/24/11 Analyzed: 05/26/11

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Sulfate, water soluble	0.585		% Wt	0.560	NA	104	70-130	NA	NA	

# BRAUN INTERTEC

11001 Hampshire Ave. S.  
Minneapolis, MN 55438  
952.995.2000 Phone  
952.995.2020 Fax

Geotesting Express, Inc.  
125 Nagog Park  
Acton, MA 01720

Client Ref: GTX10738  
Client Contact: Mr. Michael Dagher  
PO Number: GTX10738

Report #: 1102501  
Project Mgr: Steven J. Albrecht  
Account ID:

{102501}



Brooklyn  
Atlanta  
New York  
[www.geotesting.com](http://www.geotesting.com)

May 12, 2011

Braun Intertec  
Attn: Steve Albrecht  
11001 Hampshire Avenue  
Minneapolis, MN

RE:

Dear Steve:

Enclosed are two (2) samples:

Boring Number	Depth
13-1	0-2 ft
13-2	0-2 ft

GTX would like to have the following test performed on this sample:

ASTM D 1880 - Soluble Salts in Soil

When applicable, the project name and number shall be recorded on reports and correspondence as:

GTX10738

The expected date of completion for this testing is **JUNE 1<sup>ST</sup>, 2011**. Upon completion of testing please forward the results to [jdt@geotesting.com](mailto:jdt@geotesting.com) referencing the project name and number.

If you have any questions or concerns regarding our testing program please feel free to contact our office.

Respectfully yours,

Michael Dagher  
Project Coordinator

Custody Seal intact Yes No   
 Chain destroyed by client  
Dryer: Yes  No   
Temp. Blank: Yes  No   
Temp:  °C  °F  
  
Steve Albrecht

Geotesting Express, Inc. | 125 Nagog Park | Acton, MA 01720 | Toll Free: 800.343.3000 | Fax: 978.345.0000

PROJECT NO	CALC BY
SUBJECT	DATE
	CHECKED BY
LOCATION	DATE

a) B-5 (10'-12') - Shelby Tube

- ① Constant Rate-of-Strain Consolidation  
ASTM D 4186
- ② Density (unit weight)  
ASTM D 2937
- ③ Grain Size Analysis - sieve & hydrometer ✓  
ASTM D 422
- ④ Moisture Content  
ASTM D 2216

b) B-8 (20'-22')

- ① Atterberg Limits ✓  
ASTM D 4318

c) B-1 (0'-2')

- ① Sulfate Content ASTM C 1580

d) B-4 (0'-2')

- ① Sulfate Content ASTM C 1580

continued on next page

PROJECT NO \_\_\_\_\_  
SUBJECT \_\_\_\_\_  
CHECKED BY \_\_\_\_\_  
LOCATION \_\_\_\_\_  
CALC BY \_\_\_\_\_  
DATE \_\_\_\_\_

e) B-1 (25' - 27')

① Grain Size Analysis - S & H ✓  
ASTM D 422

f) B-2 (5' - 7')

① Grain Size Analysis - S & H ✓  
ASTM D 422

g) B-5 (5' - 7')

① Grain Size Analysis - S & H ✓  
ASTM D 422

h) B-8 (5' - 7')

① Grain Size Analysis - S & H ✓  
ASTM D 422

## WARRANTY and LIABILITY

GeoTesting Express (GTX) warrants that all tests it performs are run in general accordance with the specified test procedures and accepted industry practice. GTX will correct or repeat any test that does not comply with this warranty. GTX has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material.

GTX may report engineering parameters that require us to interpret the test data. Such parameters are determined using accepted engineering procedures. However, GTX does not warrant that these parameters accurately reflect the true engineering properties of the *in situ* material. Responsibility for interpretation and use of the test data and these parameters for engineering and/or construction purposes rests solely with the user and not with GTX or any of its employees.

GTX's liability will be limited to correcting or repeating a test which fails our warranty. GTX's liability for damages to the Purchaser of testing services for any cause whatsoever shall be limited to the amount GTX received for the testing services. GTX will not be liable for any damages, or for any lost benefits or other consequential damages resulting from the use of these test results, even if GTX has been advised of the possibility of such damages. GTX will not be responsible for any liability of the Purchaser to any third party.

## Commonly Used Symbols

A	pore pressure parameter for $\Delta\sigma_1 - \Delta\sigma_3$	T	temperature
B	pore pressure parameter for $\Delta\sigma_3$	t	time
CIU	isotropically consolidated undrained triaxial shear test	U, UC	unconfined compression test
CR	compression ratio for one dimensional consolidation	UU, Q	unconsolidated undrained triaxial test
$C_c$	coefficient of curvature, $(D_{30})^2 / (D_{10} \times D_{60})$	$u_a$	pore gas pressure
$C_u$	coefficient of uniformity, $D_{60}/D_{10}$	$u_e$	excess pore water pressure
$C_c$	compression index for one dimensional consolidation	$u, u_w$	pore water pressure
$C_a$	coefficient of secondary compression	V	total volume
$c_v$	coefficient of consolidation	$V_g$	volume of gas
c	cohesion intercept for total stresses	$V_s$	volume of solids
$c'$	cohesion intercept for effective stresses	$V_v$	volume of voids
D	diameter of specimen	$V_w$	volume of water
$D_{10}$	diameter at which 10% of soil is finer	$V_o$	initial volume
$D_{15}$	diameter at which 15% of soil is finer	v	velocity
$D_{30}$	diameter at which 30% of soil is finer	W	total weight
$D_{50}$	diameter at which 50% of soil is finer	$W_s$	weight of solids
$D_{60}$	diameter at which 60% of soil is finer	$W_w$	weight of water
$D_{85}$	diameter at which 85% of soil is finer	w	water content
$d_{50}$	displacement for 50% consolidation	$w_c$	water content at consolidation
$d_{90}$	displacement for 90% consolidation	$w_f$	final water content
$d_{100}$	displacement for 100% consolidation	$w_l$	liquid limit
E	Young's modulus	$w_n$	natural water content
e	void ratio	$w_p$	plastic limit
$e_c$	void ratio after consolidation	$w_s$	shrinkage limit
$e_o$	initial void ratio	$w_o, w_i$	initial water content
G	shear modulus	$\alpha$	slope of $q_f$ versus $p_f$
$G_s$	specific gravity of soil particles	$\alpha'$	slope of $q_f$ versus $p_f'$
H	height of specimen	$\gamma_t$	total unit weight
PI	plasticity index	$\gamma_d$	dry unit weight
i	gradient	$\gamma_s$	unit weight of solids
$K_o$	lateral stress ratio for one dimensional strain	$\gamma_w$	unit weight of water
k	permeability	$\epsilon$	strain
LI	Liquidity Index	$\epsilon_{vol}$	volume strain
$m_v$	coefficient of volume change	$\epsilon_h, \epsilon_v$	horizontal strain, vertical strain
n	porosity	$\mu$	Poisson's ratio, also viscosity
PI	plasticity index	$\sigma$	normal stress
$P_c$	preconsolidation pressure	$\sigma'$	effective normal stress
p	$(\sigma_1 + \sigma_3)/2, (\sigma_v + \sigma_h)/2$	$\sigma_c, \sigma'_c$	consolidation stress in isotropic stress system
$p'$	$(\sigma'_1 + \sigma'_3)/2, (\sigma'_v + \sigma'_h)/2$	$\sigma_h, \sigma'_h$	horizontal normal stress
$p'_c$	$p'$ at consolidation	$\sigma_v, \sigma'_v$	vertical normal stress
Q	quantity of flow	$\sigma_1$	major principal stress
q	$(\sigma_1 - \sigma_3)/2$	$\sigma_2$	intermediate principal stress
$q_f$	q at failure	$\sigma_3$	minor principal stress
$q_o, q_i$	initial q	$\tau$	shear stress
$q_c$	q at consolidation	$\phi$	friction angle based on total stresses
S	degree of saturation	$\phi'$	friction angle based on effective stresses
SL	shrinkage limit	$\phi_r$	residual friction angle
$s_u$	undrained shear strength	$\phi_{ult}$	$\phi$ for ultimate strength
T	time factor for consolidation		



125 Nagog Park  
Acton, MA 01720  
978 635 0424 Tel  
978 635 0266 Fax

---

## Transmittal

---

TO:

Lauren Konetzny  
Coler & Colantonio, Inc.  
101 Accord Park Drive  
Norwell, MA 02061

---

---

---

DATE: 10/5/2011	GTX NO: 10738
RE: DCP Searsport	

COPIES	DATE	DESCRIPTION
	10/5/2011	September 2011 Laboratory Test Report

REMARKS:

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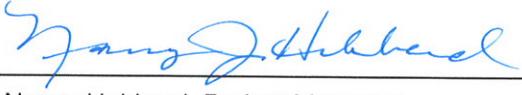
---

CC:

SIGNED:

  
Joe Tomei, Laboratory Manager

APPROVED BY:

  
Nancy Hubbard, Project Manager

October 5, 2011

Lauren Konetzny  
Coler & Colantonio, Inc.  
101 Accord Park Drive  
Norwell, MA 02061

RE: DCP Searsport, Maine (GTX-10738)

Dear Lauren:

Enclosed are the test results you requested for the above referenced project. GeoTesting Express, Inc. (GTX) received five samples from you on 9/13/2011. These samples were labeled as follows:

Boring Number	Sample Number	Depth
B-1	---	20-22 ft
B-3	Shelby	15-17 ft
B-4	Shelby	10-12 ft
B-5	---	15-17 ft
B-7	---	5-7 ft

GTX performed the following tests on these samples:

- 5 ASTM D 422 - Grain Size Analyses with Hydrometer
- 5 ASTM D 4318 - Atterberg Limits
- 1 ASTM D 2435 - Incremental Consolidation

The results presented in this report apply only to the items tested. This report shall not be reproduced except in full, without written approval from GeoTesting Express. The remainder of these samples will be retained for a period of sixty (60) days and will then be discarded unless otherwise notified by you. Please call me if you have any questions or require additional information. Thank you for allowing GeoTesting Express the opportunity of providing you with testing services. We look forward to working with you again in the future.

Respectfully yours,



Joe Tomei  
Laboratory Manager



125 Nagog Park  
Acton, MA 01720  
978 635 0424 Tel  
978 635 0266 Fax

---

## **Geotechnical Test Report**

**10/5/2011**

---

# **GTX-10738**

## **DCP Searsport**

**Maine**

**Client Project No.: 15-605**

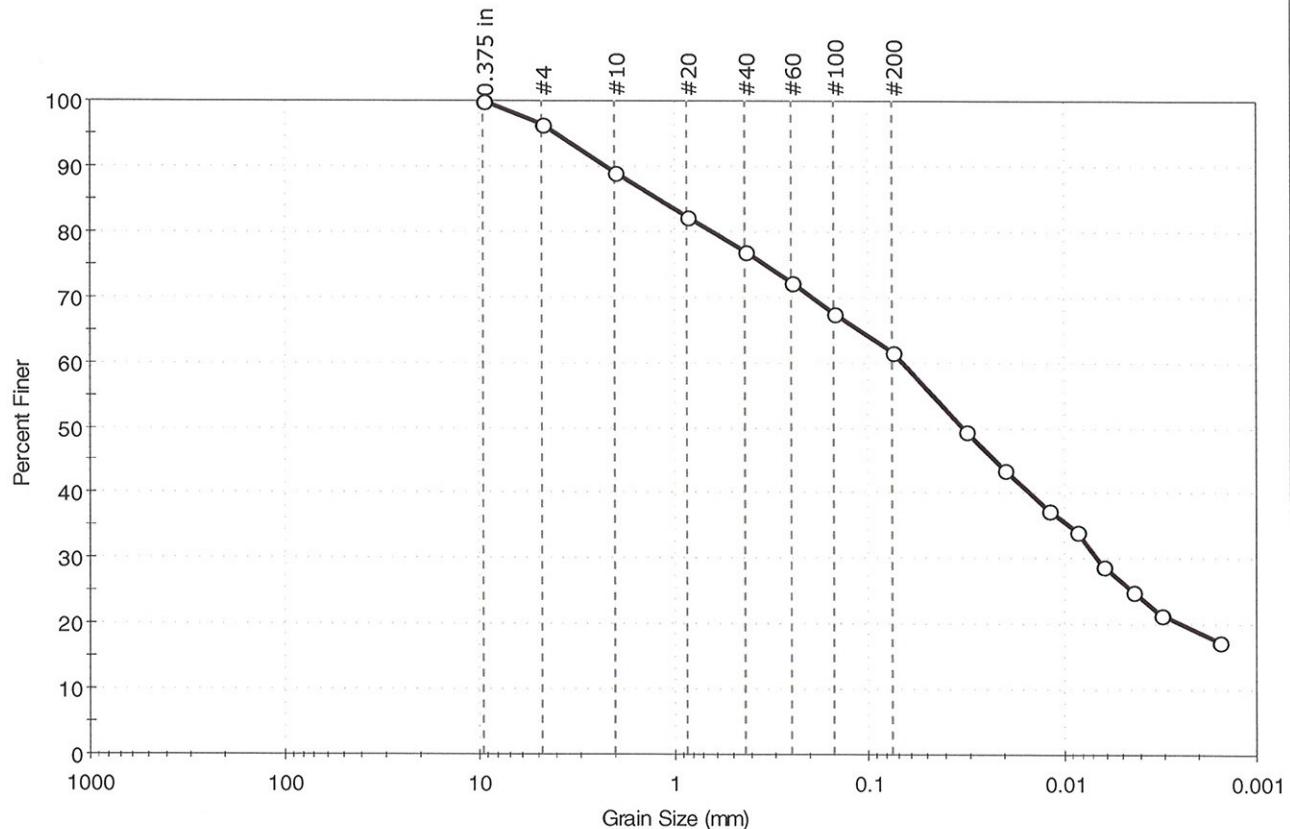
Prepared for:

**Coler & Colantonio, Inc.**

---

Client:	Coler & Colantonio, Inc.	Project No:	GTX-10738
Project:	DCP Searsport	Tested By:	jbr
Location:	Maine	Test Date:	09/15/11
Boring ID:	B-1	Sample Type:	jar
Sample ID:	---	Checked By:	jdt
Depth :	20-22 ft	Test Id:	217421
Test Comment:	---		
Sample Description:	Moist, dark greenish gray sandy clay		
Sample Comment:	---		

## Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	3.6	34.7	61.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	96		
#10	2.00	89		
#20	0.85	82		
#40	0.42	77		
#60	0.25	72		
#100	0.15	68		
#200	0.075	62		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0315	50		
---	0.0201	44		
---	0.0121	38		
---	0.0086	34		
---	0.0062	29		
---	0.0044	25		
---	0.0032	22		
---	0.0016	17		

Coefficients	
D <sub>85</sub> = 1.1954 mm	D <sub>30</sub> = 0.0066 mm
D <sub>60</sub> = 0.0665 mm	D <sub>15</sub> = N/A
D <sub>50</sub> = 0.0322 mm	D <sub>10</sub> = N/A
C <sub>u</sub> = N/A	C <sub>c</sub> = N/A

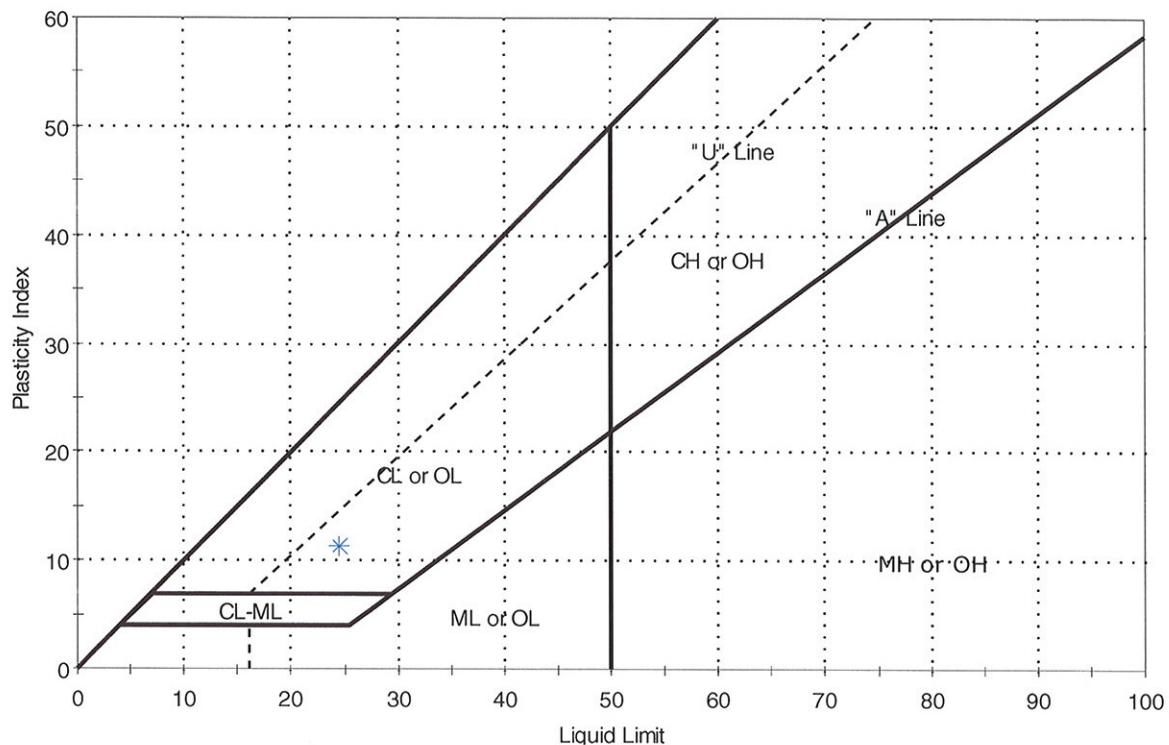
Classification	
ASTM	Sandy lean clay (CL)
AASHTO	Clayey Soils (A-6 (4))

Sample/Test Description	
Sand/Gravel Particle Shape :	ROUNDED
Sand/Gravel Hardness :	HARD

Client:	Coler & Colantonio, Inc.	Project No:	GTX-10738
Project:	DCP Searsport	Tested By:	cam
Location:	Maine	Test Date:	09/22/11
Boring ID:	B-1	Sample Type:	jar
Sample ID:	---	Checked By:	jdt
Depth :	20-22 ft	Test Id:	217416
Test Comment:	---		
Sample Description:	Moist, dark greenish gray sandy clay		
Sample Comment:	---		

## Atterberg Limits - ASTM D 4318-05

Plasticity Chart



Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	---	B-1	20-22 ft	11	25	13	12	0	Sandy lean clay (CL)

Sample Prepared using the WET method

23% Retained on #40 Sieve

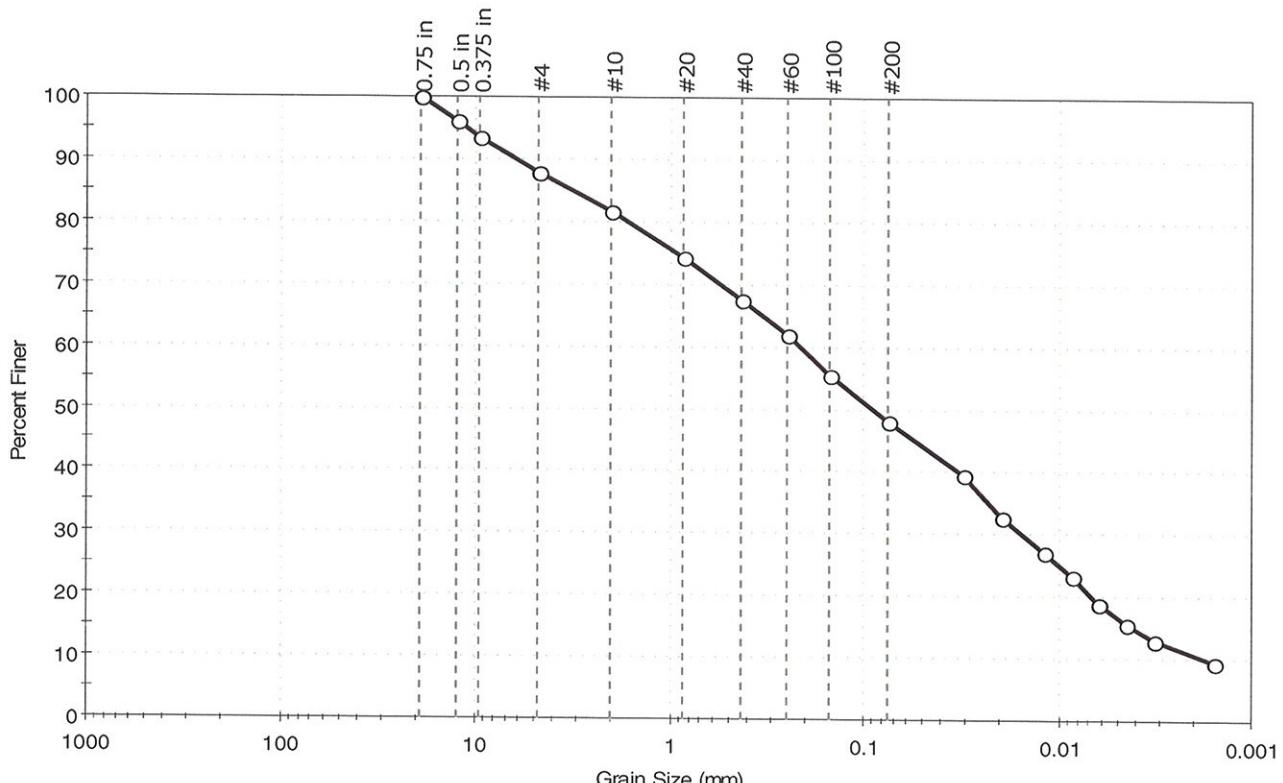
Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

Client:	Coler & Colantonio, Inc.	Project No:	GTX-10738
Project:	DCP Searsport	Tested By:	jbr
Location:	Maine	Test Date:	09/19/11
Boring ID:	B-3	Sample Type:	tube
Sample ID:	Shelby	Checked By:	jdt
Depth :	15-17 ft	Test Id:	217420
Test Comment:	---		
Sample Description:	Moist, dark olive gray silty, clayey sand		
Sample Comment:	---		

## Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	96		
0.375 in	9.50	94		
#4	4.75	88		
#10	2.00	82		
#20	0.85	74		
#40	0.42	68		
#60	0.25	62		
#100	0.15	55		
#200	0.075	48		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0309	40		
---	0.0198	33		
---	0.0119	27		
---	0.0086	23		
---	0.0062	19		
---	0.0044	16		
---	0.0032	13		
---	0.0016	10		

Coefficients	
D85 = 3.1401 mm	D30 = 0.0154 mm
D60 = 0.2164 mm	D15 = 0.0041 mm
D50 = 0.0893 mm	D10 = 0.0017 mm
Cu = N/A	Cc = N/A

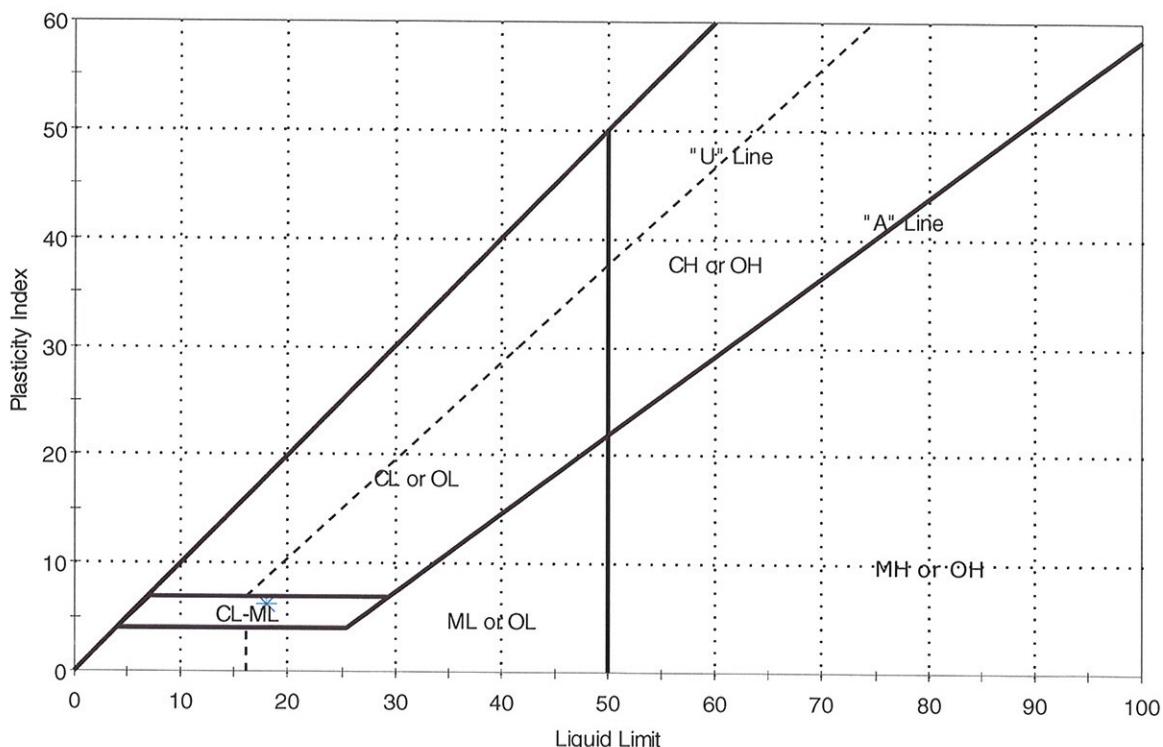
ASTM	Silty, clayey sand (SC-SM)
AASHTO	Silty Soils (A-4 (0))

Sample/Test Description	
Sand/Gravel Particle Shape :	ROUNDED
Sand/Gravel Hardness :	HARD

Client:	Coler & Colantonio, Inc.	Project No:	GTX-10738
Project:	DCP Searsport	Tested By:	cam
Location:	Maine	Test Date:	09/19/11
Boring ID:	B-3	Sample Type:	tube
Sample ID:	Shelby	Checked By:	jdt
Depth :	15-17 ft	Test Id:	217415
Test Comment:	---		
Sample Description:	Moist, dark olive gray silty, clayey sand		
Sample Comment:	---		

## Atterberg Limits - ASTM D 4318-05

Plasticity Chart



Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	Shelby	B-3	15-17 ft	12	18	12	6	0	Silty, clayey sand (SC-SM)

Sample Prepared using the WET method

32% Retained on #40 Sieve

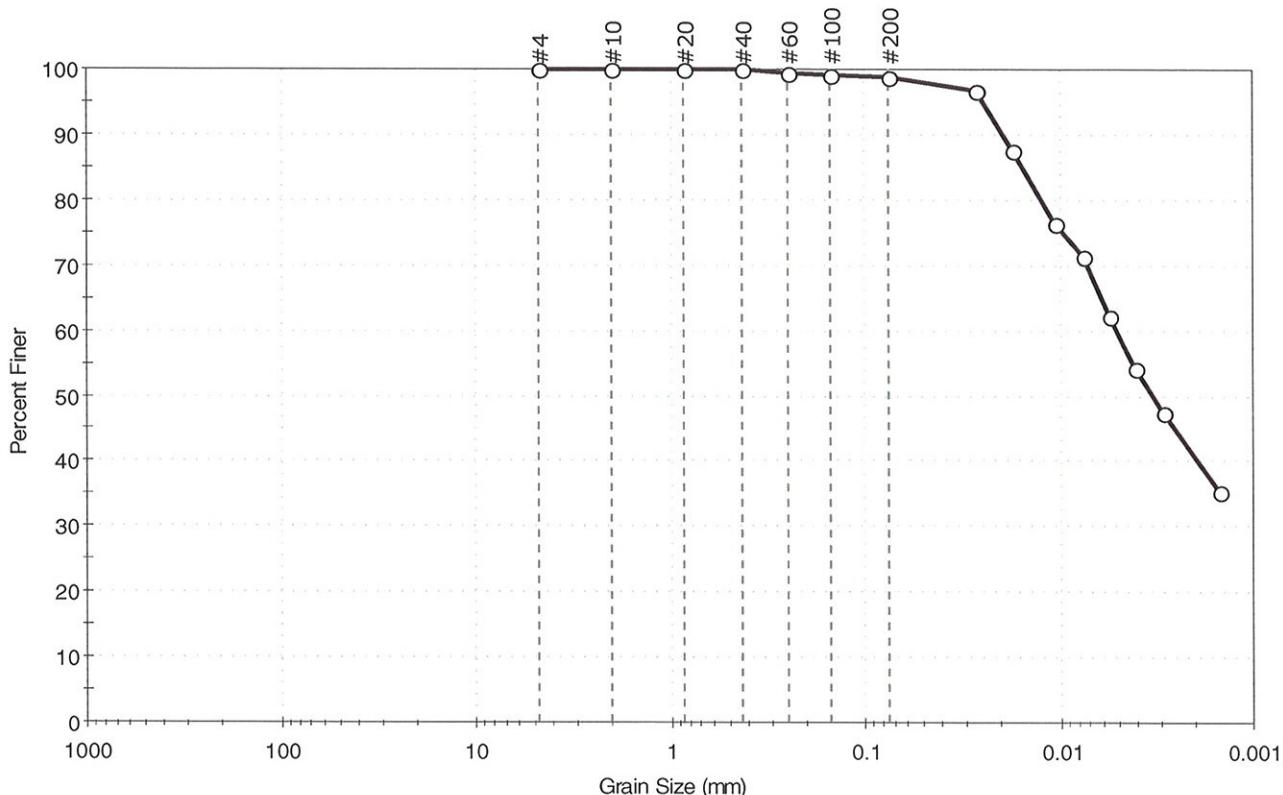
Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

Client:	Coler & Colantonio, Inc.	Project No:	GTX-10738
Project:	DCP Searsport	Tested By:	jbr
Location:	Maine	Test Date:	09/20/11
Boring ID:	B-4	Sample Type:	tube
Sample ID:	Shelby	Checked By:	jdt
Depth :	10-12 ft	Test Id:	217419
Test Comment:	---		
Sample Description:	Moist, dark greenish gray clay		
Sample Comment:	---		

## Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	0.0	1.1	98.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.85	100		
#40	0.42	100		
#60	0.25	99		
#100	0.15	99		
#200	0.075	99		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0268	97		
---	0.0174	88		
---	0.0107	77		
---	0.0077	71		
---	0.0056	62		
---	0.0041	54		
---	0.0030	48		
---	0.0015	35		

Coefficients	
D <sub>85</sub> = 0.0155 mm	D <sub>30</sub> = N/A
D <sub>60</sub> = 0.0051 mm	D <sub>15</sub> = N/A
D <sub>50</sub> = 0.0033 mm	D <sub>10</sub> = N/A
C <sub>u</sub> = N/A	C <sub>c</sub> = N/A

Classification	
ASTM	lean clay (CL)

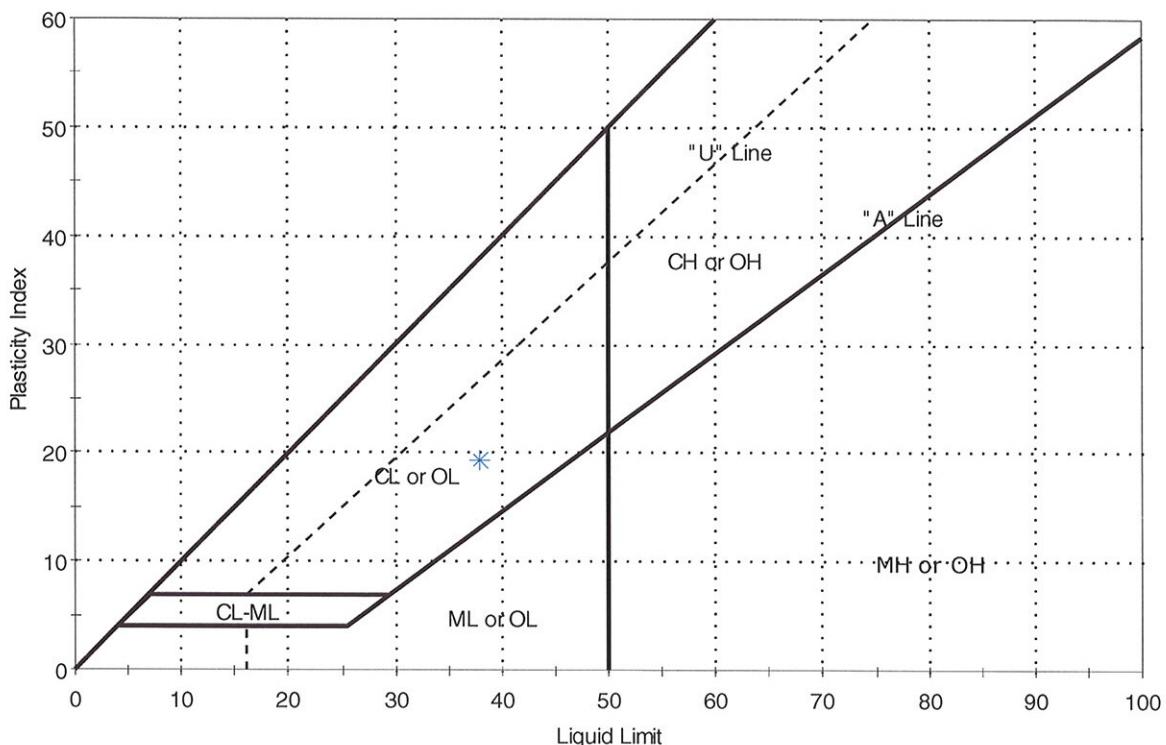
AASHTO	Clayey Soils (A-6 (21))
--------	-------------------------

Sample/Test Description	
Sand/Gravel Particle Shape :	---
Sand/Gravel Hardness :	---

Client:	Coler & Colantonio, Inc.	Project No:	GTX-10738
Project:	DCP Searsport	Tested By:	cam
Location:	Maine	Test Date:	09/20/11
Boring ID:	B-4	Sample Type:	tube
Sample ID:	Shelby	Checked By:	jdt
Depth :	10-12 ft	Test Id:	217414
Test Comment:	---		
Sample Description:	Moist, dark greenish gray clay		
Sample Comment:	---		

## Atterberg Limits - ASTM D 4318-05

Plasticity Chart



Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	Shelby	B-4	10-12 ft	34	38	19	19	1	lean clay (CL)

Sample Prepared using the WET method

0% Retained on #40 Sieve

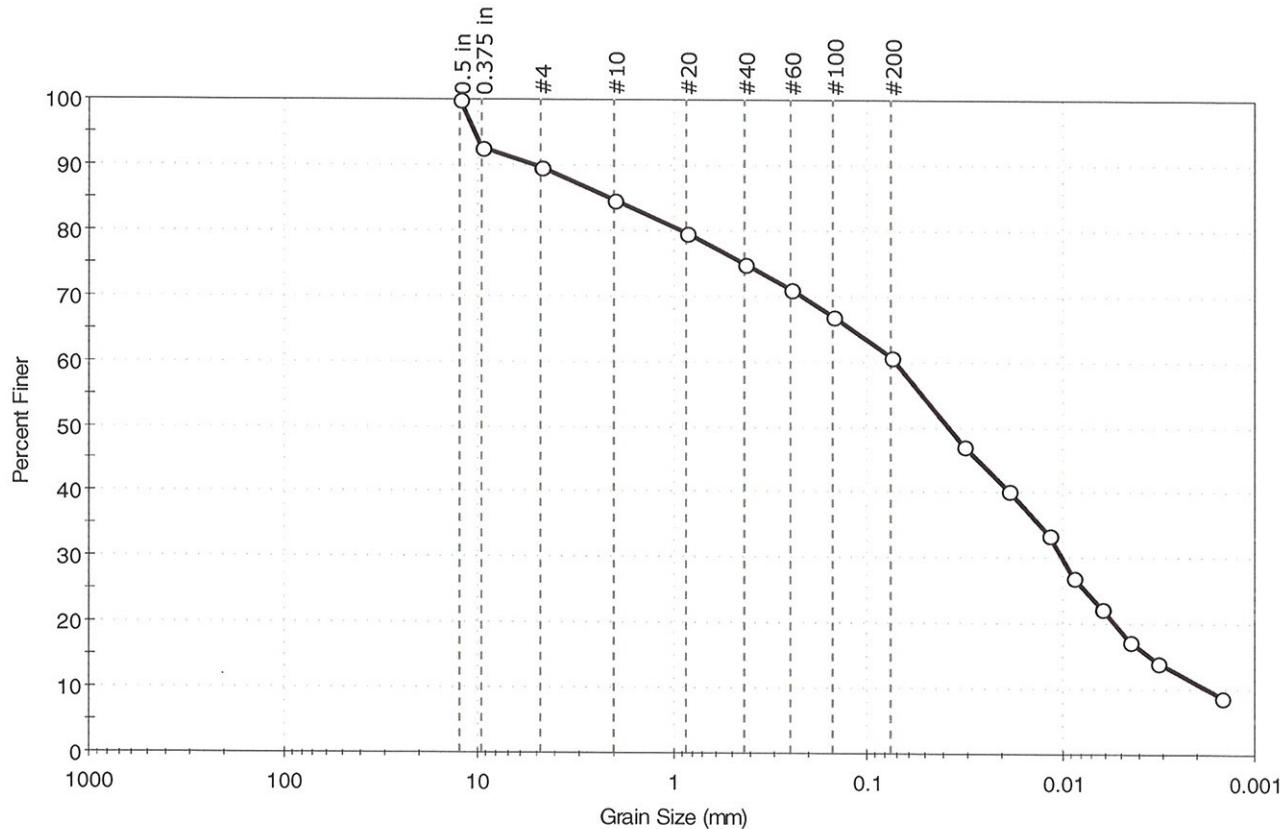
Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

Client:	Coler & Colantonio, Inc.	Project No:	GTX-10738
Project:	DCP Searsport	Tested By:	jbr
Location:	Maine	Test Date:	09/15/11
Boring ID:	B-5	Sample Type:	jar
Sample ID:	---	Checked By:	jdt
Depth :	15-17 ft	Test Id:	217457
Test Comment:	---		
Sample Description:	moist, olive sandy clay		
Sample Comment:	---		

## Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	10.4	28.8	60.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.5 in	12.50	100		
0.375 in	9.50	93		
#4	4.75	90		
#10	2.00	85		
#20	0.85	80		
#40	0.42	75		
#60	0.25	71		
#100	0.15	67		
#200	0.075	61		
---	0.0317	47		
---	0.0189	40		
---	0.0118	34		
---	0.0088	27		
---	0.0063	22		
---	0.0045	17		
---	0.0033	14		
---	0.0015	9		

**Coefficients**  
 $D_{85} = 2.1182 \text{ mm}$        $D_{30} = 0.0100 \text{ mm}$   
 $D_{60} = 0.0714 \text{ mm}$        $D_{15} = 0.0035 \text{ mm}$   
 $D_{50} = 0.0381 \text{ mm}$        $D_{10} = 0.0018 \text{ mm}$   
 $C_u = N/A$        $C_c = N/A$

**Classification**  
ASTM Sandy lean clay (CL)

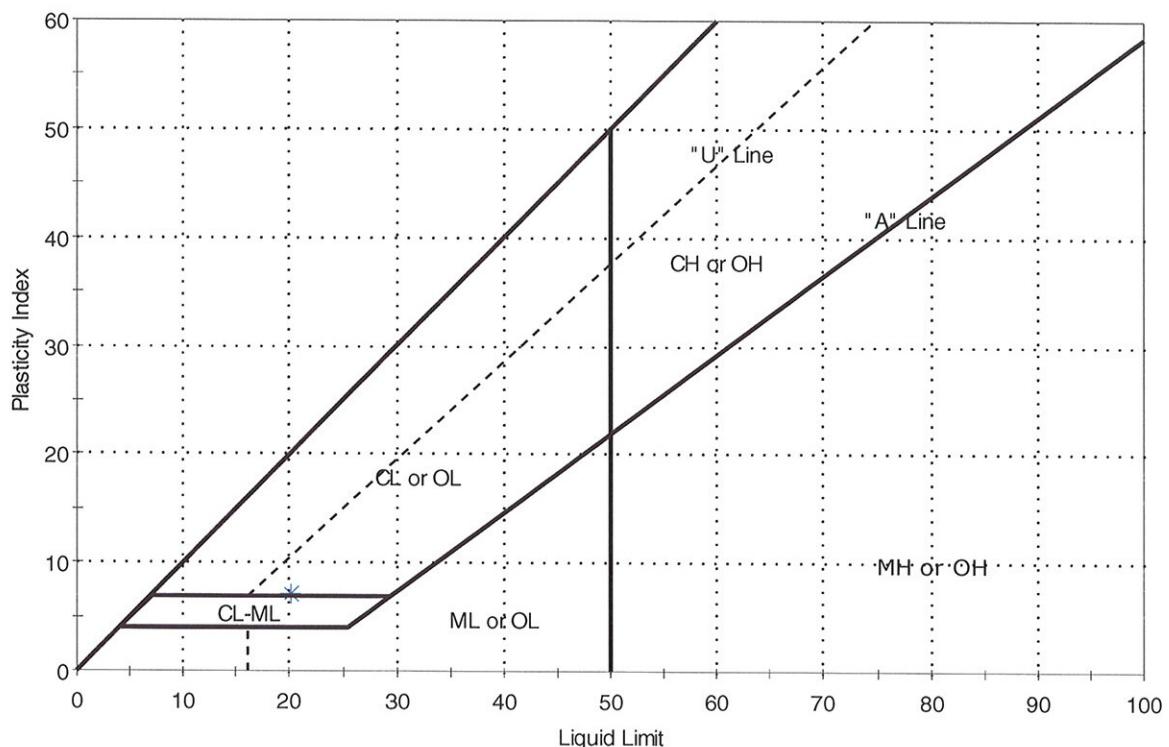
AASHTO Silty Soils (A-4 (1))

**Sample/Test Description**  
Sand/Gravel Particle Shape : ROUNDED  
Sand/Gravel Hardness : HARD

Client:	Coler & Colantonio, Inc.	Project No:	GTX-10738
Project:	DCP Searsport	Tested By:	cam
Location:	Maine	Test Date:	09/22/11
Boring ID:	B-5	Sample Type:	jar
Sample ID:	---	Checked By:	jdt
Depth :	15-17 ft	Test Id:	217417
Test Comment:	---		
Sample Description:	moist, olive sandy clay		
Sample Comment:	---		

## Atterberg Limits - ASTM D 4318-05

Plasticity Chart



Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	---	B-5	15-17 ft	13	20	13	7	0	Sandy lean clay (CL)

Sample Prepared using the WET method

25% Retained on #40 Sieve

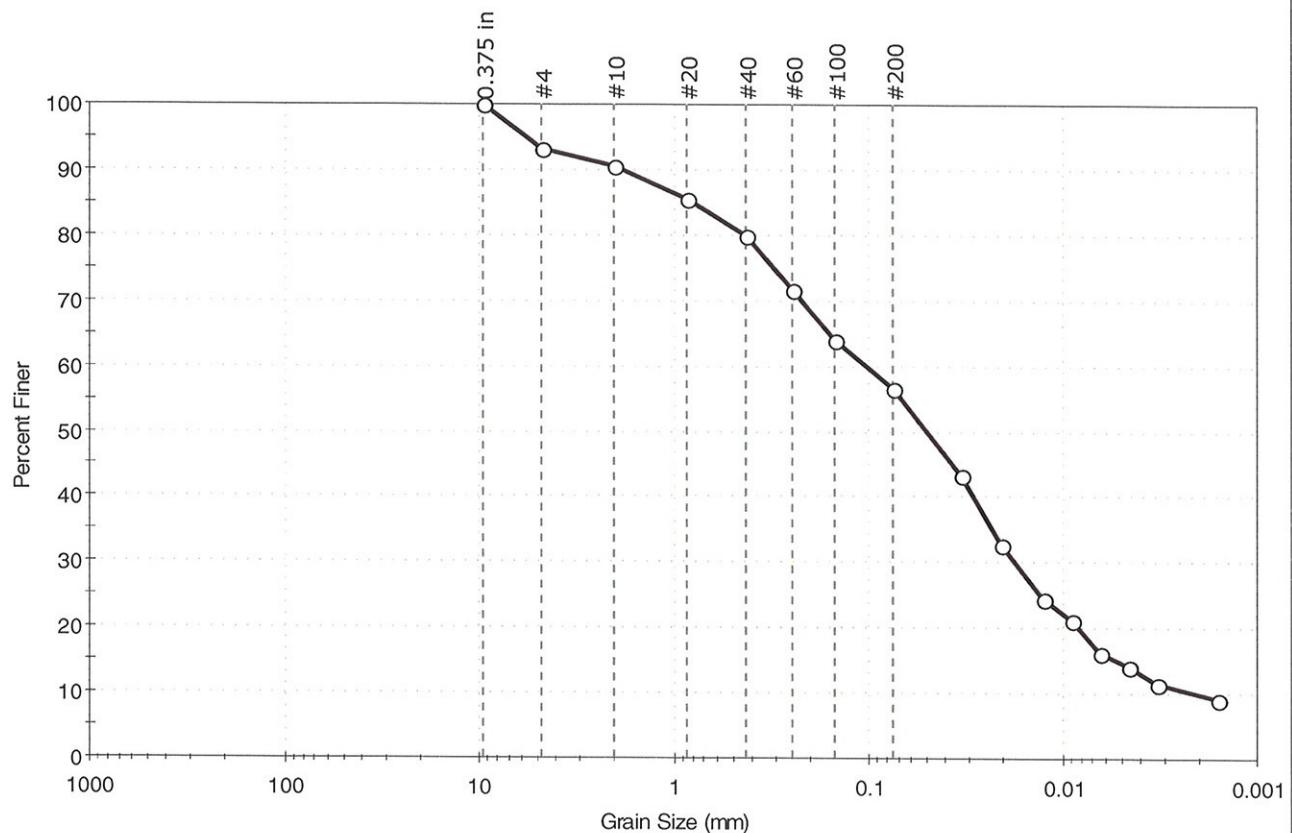
Dry Strength: VERY HIGH

Dilatancy: SLOW

Toughness: LOW

Client:	Coler & Colantonio, Inc.	Project No:	GTX-10738
Project:	DCP Searsport	Tested By:	jbr
Location:	Maine	Test Date:	09/15/11
Boring ID:	B-7	Sample Type:	jar
Sample ID:	---	Checked By:	jdt
Depth :	5-7 ft	Test Id:	217422
Test Comment:	---		
Sample Description:	Moist, olive sandy silty clay		
Sample Comment:	---		

## Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	6.8	36.6	56.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	93		
#10	2.00	91		
#20	0.85	85		
#40	0.42	80		
#60	0.25	72		
#100	0.15	64		
#200	0.075	57		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0332	43		
---	0.0209	33		
---	0.0126	24		
---	0.0090	21		
---	0.0065	16		
---	0.0046	14		
---	0.0033	12		
---	0.0016	9		

**Coefficients**  
 $D_{85} = 0.8013 \text{ mm}$        $D_{30} = 0.0178 \text{ mm}$   
 $D_{60} = 0.1033 \text{ mm}$        $D_{15} = 0.0054 \text{ mm}$   
 $D_{50} = 0.0498 \text{ mm}$        $D_{10} = 0.0021 \text{ mm}$   
 $C_u = N/A$        $C_c = N/A$

**Classification**  
ASTM Sandy silty clay (CL-ML)

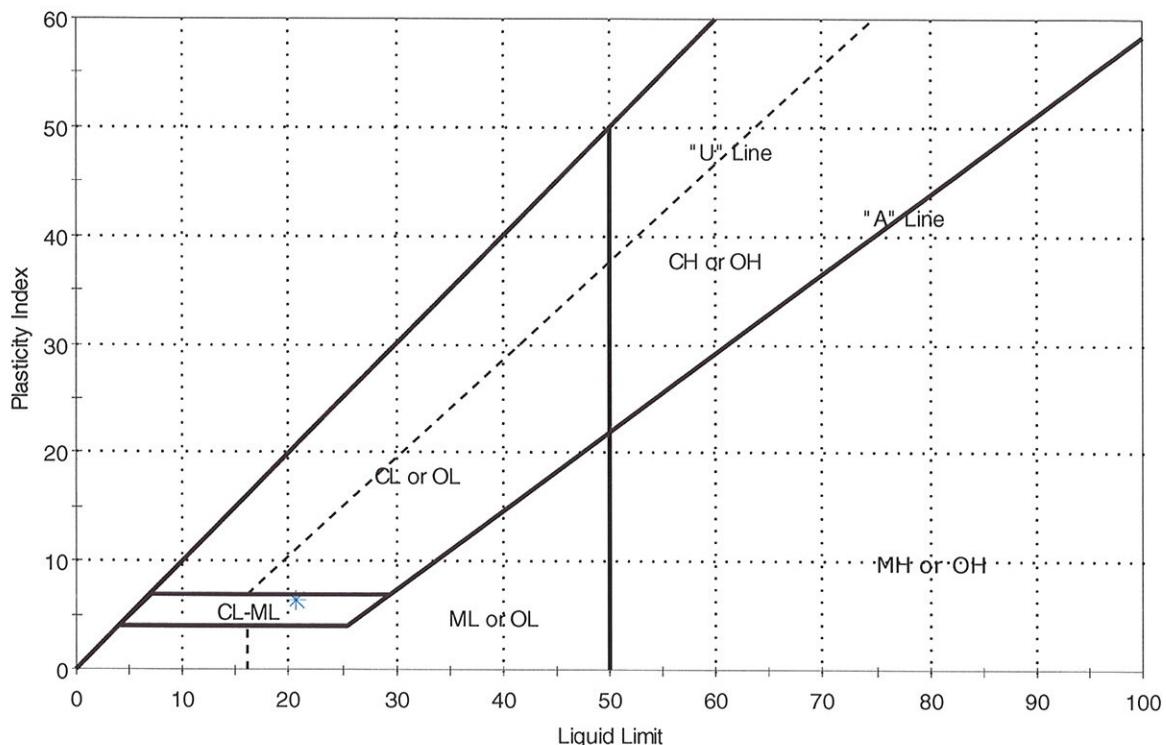
AASHTO Silty Soils (A-4 (0))

**Sample/Test Description**  
Sand/Gravel Particle Shape : ROUNDED  
Sand/Gravel Hardness : HARD

Client:	Coler & Colantonio, Inc.	Project No:	GTX-10738
Project:	DCP Searsport	Tested By:	cam
Location:	Maine	Test Date:	09/21/11
Boring ID:	B-7	Sample Type:	jar
Sample ID:	---	Checked By:	jdt
Depth :	5-7 ft	Test Id:	217418
Test Comment:	---		
Sample Description:	Moist, olive sandy silty clay		
Sample Comment:	---		

## Atterberg Limits - ASTM D 4318-05

Plasticity Chart



Symbol	Sample ID	Boring	Depth	Natural Moisture Content, %	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index	Soil Classification
*	---	B-7	5-7 ft	12	21	14	7	0	Sandy silty clay (CL-ML)

Sample Prepared using the WET method

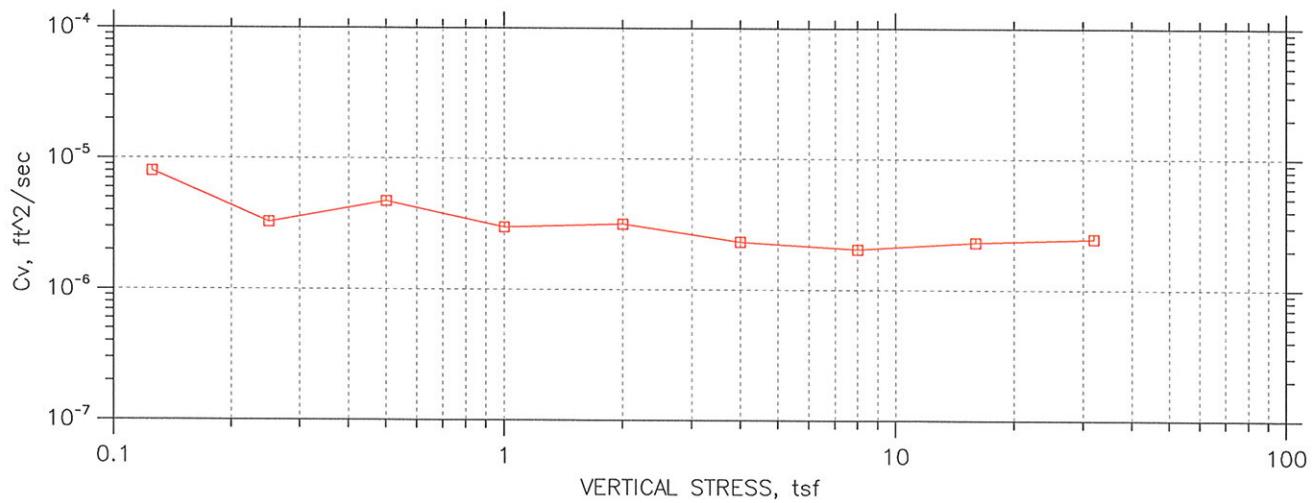
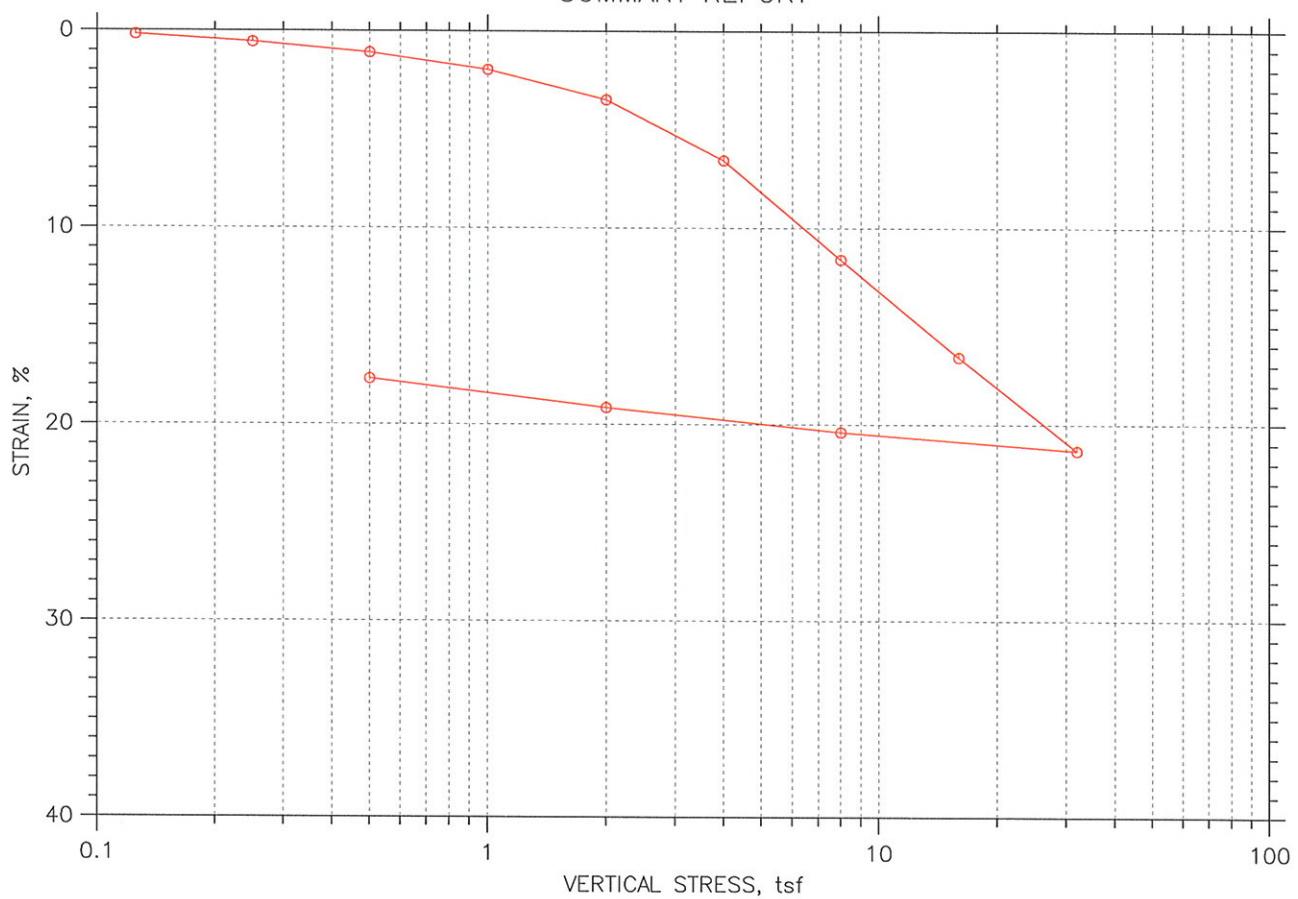
20% Retained on #40 Sieve

Dry Strength: VERY HIGH

Dilatancy: SLOW

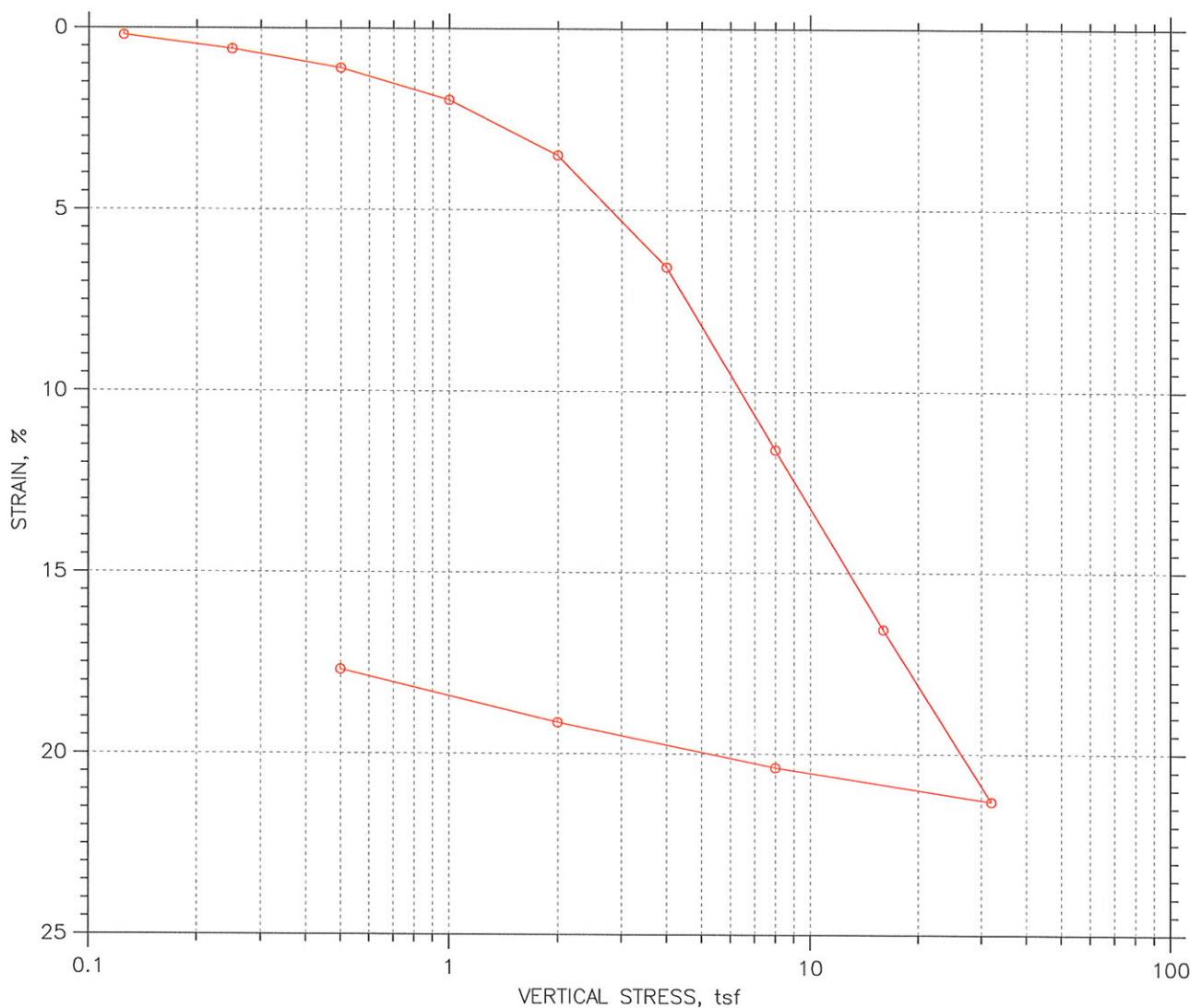
Toughness: LOW

**One-Dimensional Consolidation by ASTM D 2435 ⇔ Method B**  
**SUMMARY REPORT**



	Project: DCP Searsport	Location: Maine	Project No.: GTX-10738
	Boring No.: B-4	Tested By: md	Checked By: jdt
	Sample No.: Shelby	Test Date: 9/14/11	Test No.: IconP-1
	Depth: 10-12 ft	Sample Type: tube	Elevation: ---
	Description: Moist, dark greenish gray clay		
	Remarks: System X, Cell A-1		
	Displacement at End of Increment		

**One-Dimensional Consolidation by ASTM D 2435 ⇔ Method B**  
**SUMMARY REPORT**



				Before Test	After Test
Overburden Pressure: ---			Water Content, %	39.28	26.30
Preconsolidation Pressure: ---			Dry Unit Weight, pcf	83.728	101.71
Compression Index: ---			Saturation, %	99.47	100.00
Diameter: 2.5 in	Height: 1.001 in		Void Ratio	1.13	0.75
LL: 38	PL: 19	PI: 19	GS: 2.85		

	Project: DCP Searsport		Location: Maine	Project No.: GTX-10738
	Boring No.: B-4		Tested By: md	Checked By: jdt
	Sample No.: Shelby		Test Date: 9/14/11	Test No.: IconP-1
	Depth: 10-12 ft		Sample Type: tube	Elevation: ---
	Description: Moist, dark greenish gray clay			
	Remarks: System X, Cell A-1			
	Displacement at End of Increment			

## One-Dimensional Consolidation by ASTM D 2435 - Method B

Project: DCP Searsport  
 Boring No.: B-4  
 Sample No.: Shelby  
 Test No.: IconP-1

Location: Maine  
 Tested By: md  
 Test Date: 9/14/11  
 Sample Type: tube

Project No.: GTX-10738  
 Checked By: jdt  
 Depth: 10-12 ft  
 Elevation: ----

Soil Description: Moist, dark greenish gray clay  
 Remarks: System X, Cell A-1

Estimated Specific Gravity: 2.85  
 Initial Void Ratio: 1.13  
 Final Void Ratio: 0.750

Liquid Limit: 38  
 Plastic Limit: 19  
 Plasticity Index: 19

Initial Height: 1.00 in  
 Specimen Diameter: 2.50 in

Container ID	Before Consolidation		After Consolidation	
	Trimmings	Specimen+Ring	Specimen+Ring	Trimmings
8188	RING			8025
Wt. Container + Wet Soil, gm	98.320	259.16	245.15	144.55
Wt. Container + Dry Soil, gm	73.410	216.74	216.74	116.17
Wt. Container, gm	8.3400	108.75	108.75	8.2800
Wt. Dry Soil, gm	65.070	107.99	107.99	107.89
Water Content, %	38.28	39.28	26.30	26.30
Void Ratio	---	1.13	0.750	---
Degree of Saturation, %	---	99.47	100.00	---
Dry Unit Weight,pcf	---	83.728	101.71	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

## One-Dimensional Consolidation by ASTM D 2435 - Method B

Project: DCP Searsport  
 Boring No.: B-4  
 Sample No.: Shelby  
 Test No.: IconP-1

Location: Maine  
 Tested By: md  
 Test Date: 9/14/11  
 Sample Type: tube

Project No.: GTX-10738  
 Checked By: jdt  
 Depth: 10-12 ft  
 Elevation: ---

Soil Description: Moist, dark greenish gray clay

Remarks: System X, Cell A-1  
 Displacement at End of Increment

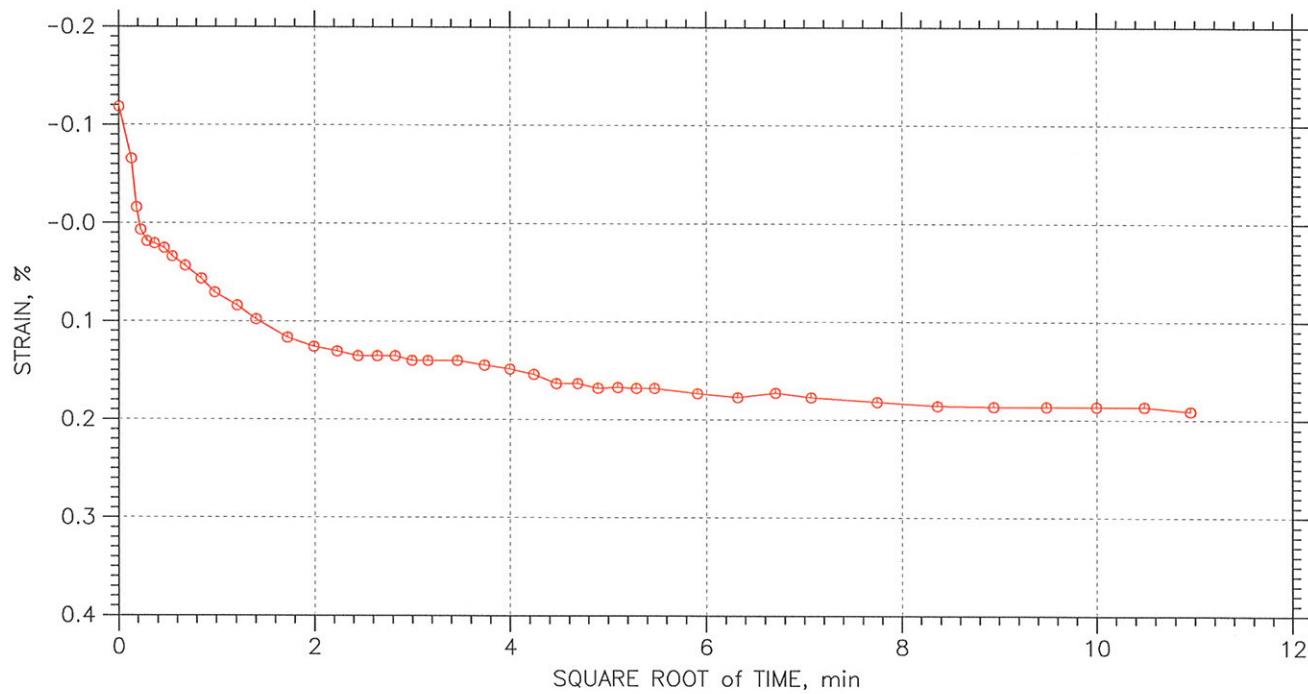
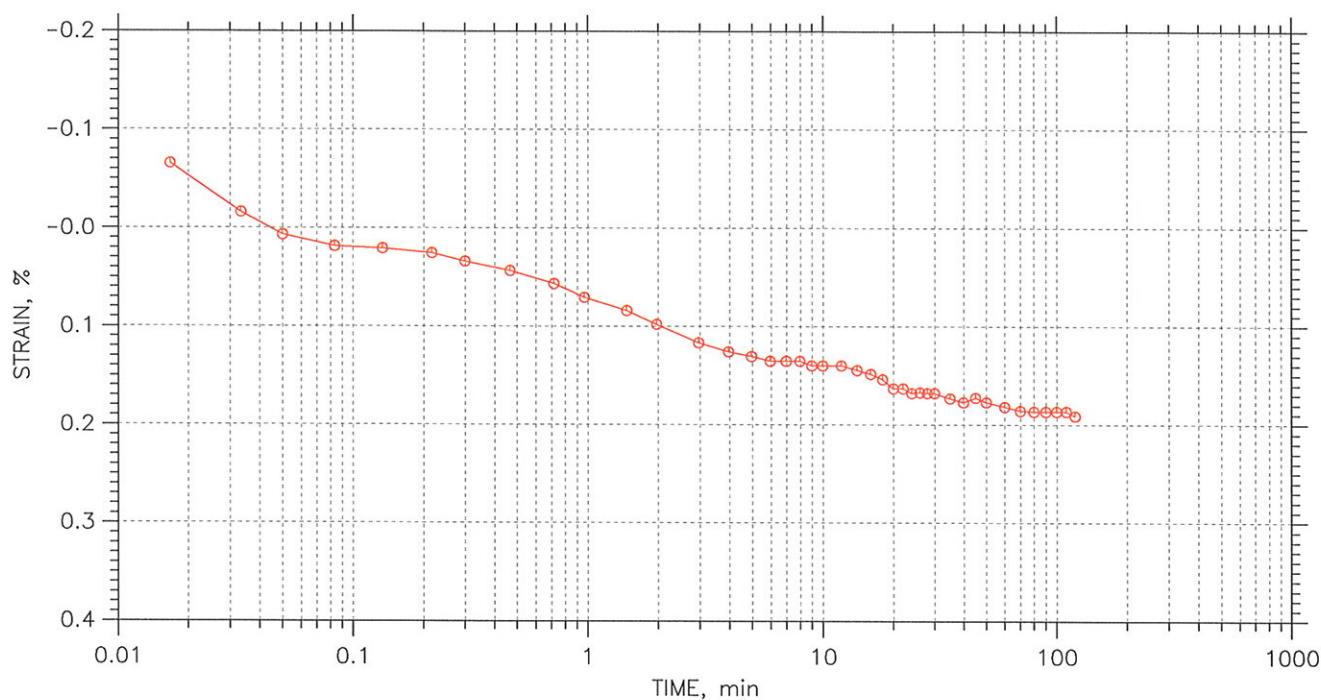
	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt T90 min	Cv ft^2/sec	Mv 1/tsf	k ft/day	
1	0.125	0.001913	1.12	0.191	2.520	9.74e-006	1.53e-002	4.02e-004	
2	0.250	0.005737	1.11	0.573	4.441	5.49e-006	3.06e-002	4.53e-004	
3	0.500	0.01100	1.10	1.10	5.961	4.06e-006	2.11e-002	2.30e-004	
4	1.00	0.01972	1.08	1.97	8.016	2.97e-006	1.74e-002	1.40e-004	
5	2.00	0.03493	1.05	3.49	6.460	3.60e-006	1.52e-002	1.47e-004	
6	4.00	0.06575	0.986	6.57	7.950	2.79e-006	1.54e-002	1.16e-004	
7	8.00	0.1162	0.879	11.6	8.217	2.47e-006	1.26e-002	8.40e-005	
8	16.0	0.1658	0.774	16.6	6.181	2.94e-006	6.20e-003	4.91e-005	
9	32.0	0.2133	0.673	21.3	5.738	2.82e-006	2.97e-003	2.25e-005	
10	8.00	0.2040	0.693	20.4	1.461	1.05e-005	3.88e-004	1.10e-005	
11	2.00	0.1916	0.719	19.1	6.374	2.48e-006	2.07e-003	1.38e-005	
12	0.500	0.1770	0.750	17.7	25.622	6.39e-007	9.72e-003	1.67e-005	
	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Log T50 min	Cv ft^2/sec	Mv 1/tsf	k ft/day	Ca %
1	0.125	0.001913	1.12	0.191	0.000	0.00e+000	1.53e-002	0.00e+000	0.00e+000
2	0.250	0.005737	1.11	0.573	2.236	2.53e-006	3.06e-002	2.09e-004	0.00e+000
3	0.500	0.01100	1.10	1.10	1.137	4.94e-006	2.11e-002	2.80e-004	0.00e+000
4	1.00	0.01972	1.08	1.97	0.000	0.00e+000	1.74e-002	0.00e+000	0.00e+000
5	2.00	0.03493	1.05	3.49	1.812	2.98e-006	1.52e-002	1.22e-004	0.00e+000
6	4.00	0.06575	0.986	6.57	2.441	2.11e-006	1.54e-002	8.76e-005	0.00e+000
7	8.00	0.1162	0.879	11.6	2.636	1.79e-006	1.26e-002	6.08e-005	0.00e+000
8	16.0	0.1658	0.774	16.6	2.120	1.99e-006	6.20e-003	3.32e-005	0.00e+000
9	32.0	0.2133	0.673	21.3	1.739	2.16e-006	2.97e-003	1.73e-005	0.00e+000
10	8.00	0.2040	0.693	20.4	0.413	8.67e-006	3.88e-004	9.08e-006	0.00e+000
11	2.00	0.1916	0.719	19.1	2.376	1.55e-006	2.07e-003	8.62e-006	0.00e+000
12	0.500	0.1770	0.750	17.7	0.000	0.00e+000	9.72e-003	0.00e+000	0.00e+000

# One-Dimensional Consolidation by ASTM D 2435 ⇔ Method B

TIME CURVES

Constant Load Step 1 of 12

Stress: 0.125 tsf



Project: DCP Searsport	Location: Maine	Project No.: GTX-10738
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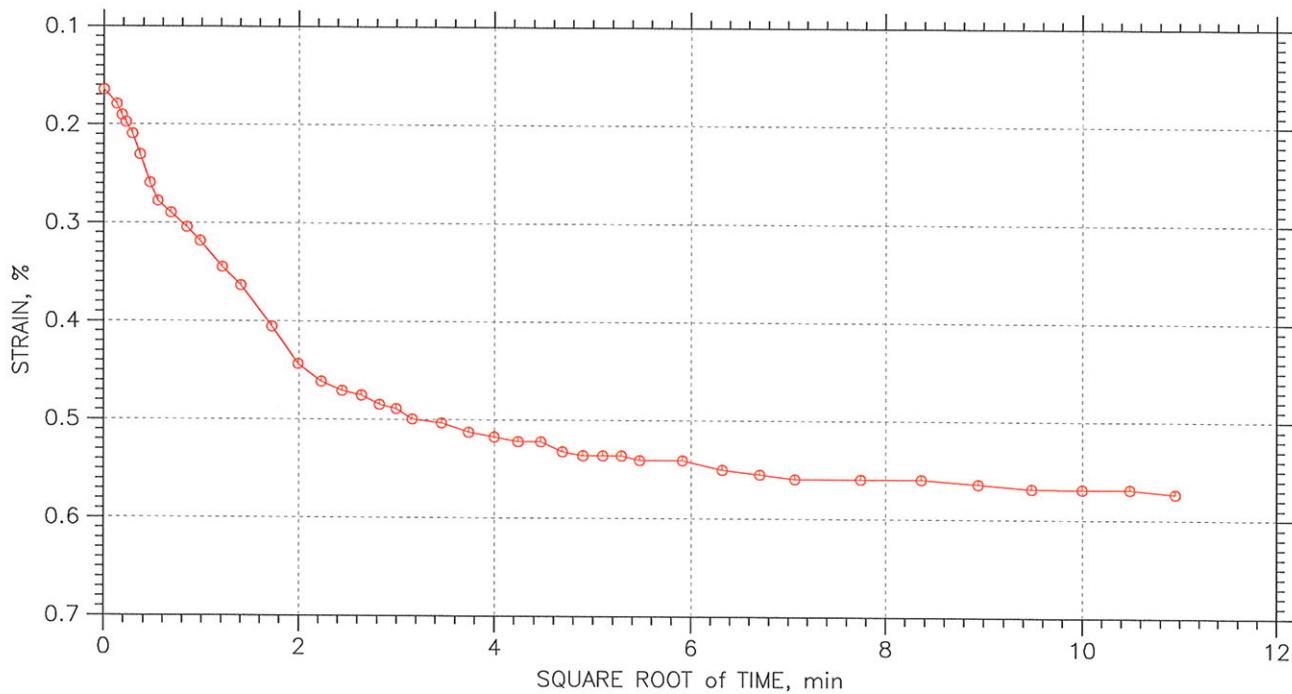
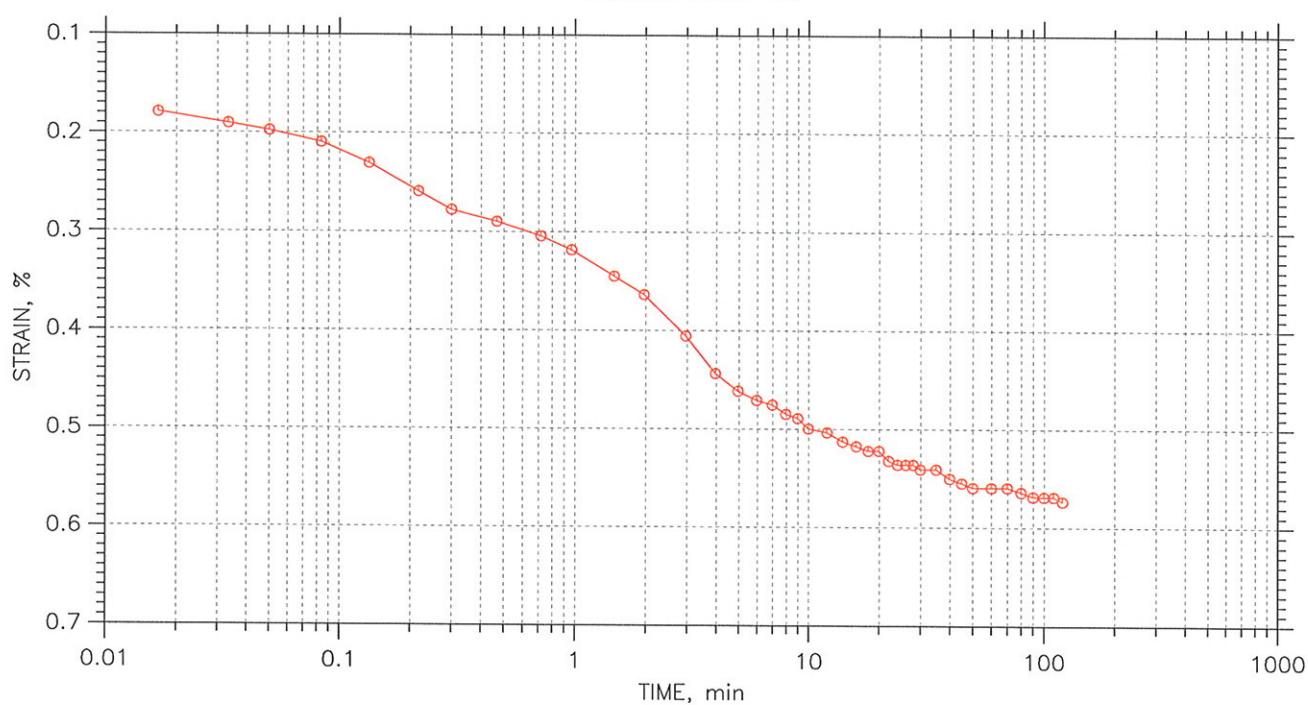
Boring No.: B-4	Tested By: md	Checked By: jdt
Sample No.: Shelby	Test Date: 9/14/11	Test No.: IconP-1
Depth: 10-12 ft	Sample Type: tube	Elevation: ---
Description: Moist, dark greenish gray clay		
Remarks: System X, Cell A-1		

# One-Dimensional Consolidation by ASTM D 2435 ⇔ Method B

## TIME CURVES

Constant Load Step 2 of 12

Stress: 0.25 tsf



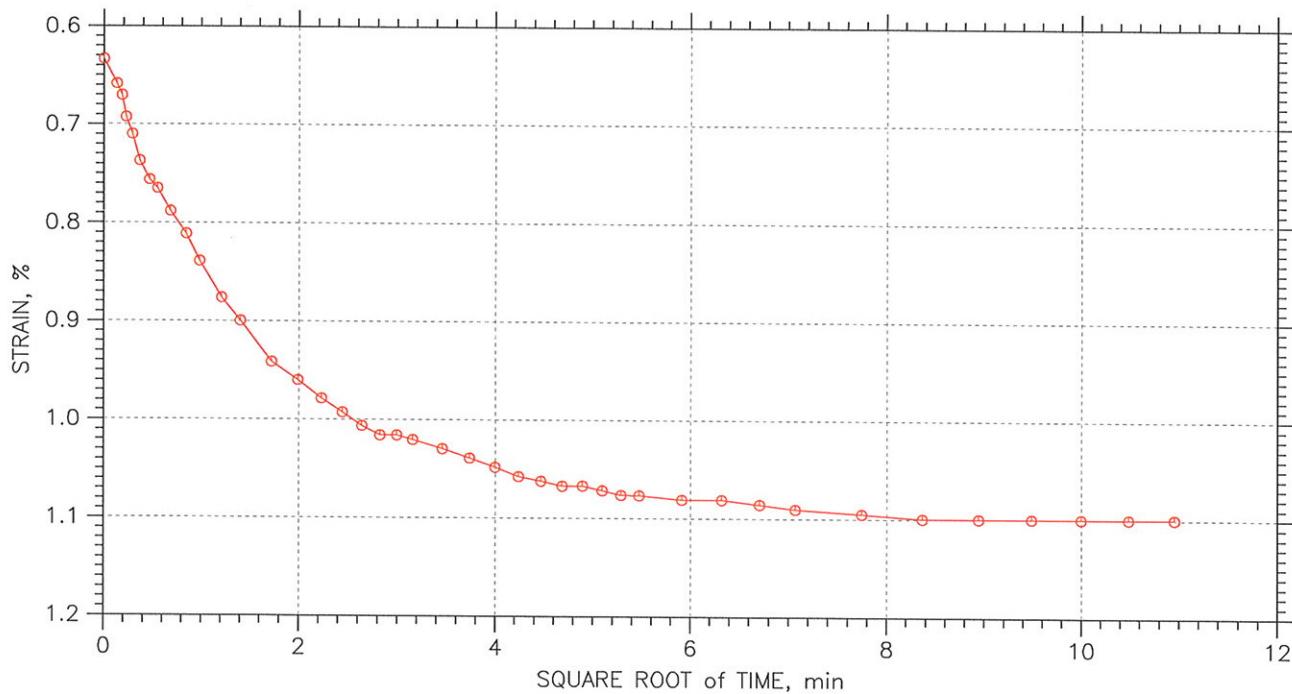
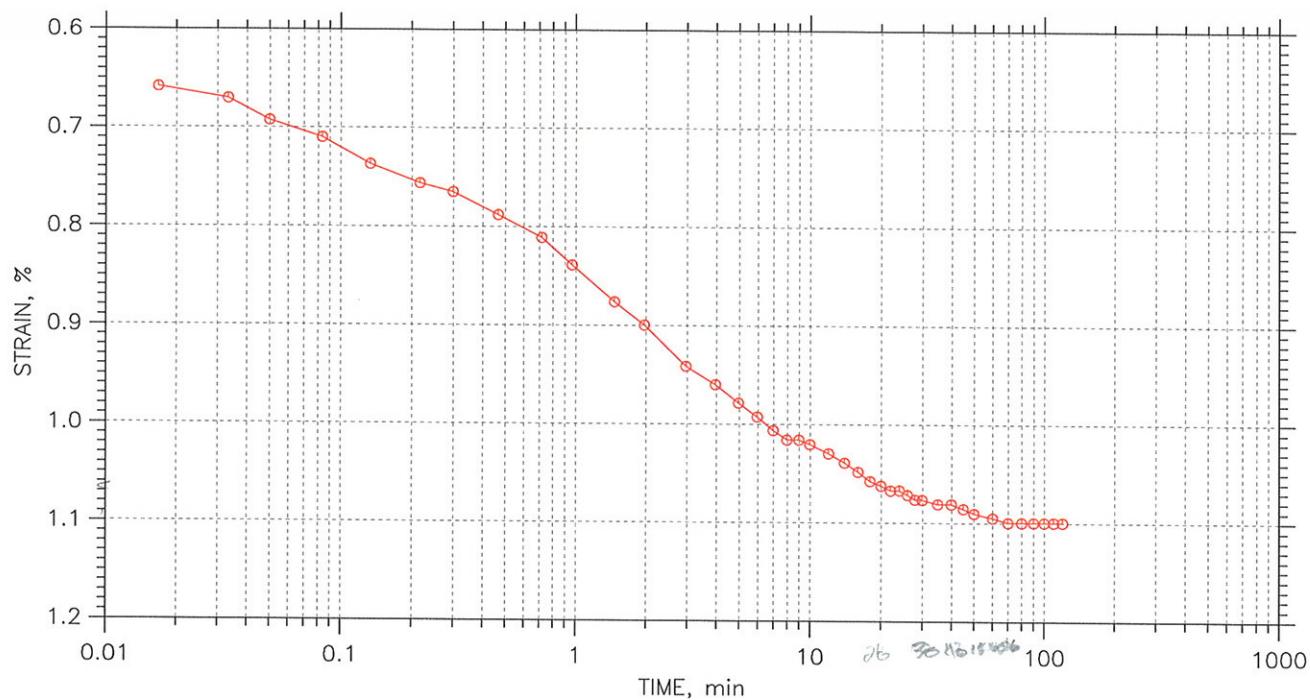
<b>GeoTesting</b> EXPRESS	Project: DCP Searsport	Location: Maine	Project No.: GTX-10738
	Boring No.: B-4	Tested By: md	Checked By: jdt
	Sample No.: Shelby	Test Date: 9/14/11	Test No.: IconP-1
	Depth: 10-12 ft	Sample Type: tube	Elevation: ---
	Description: Moist, dark greenish gray clay		
	Remarks: System X, Cell A-1		

# One-Dimensional Consolidation by ASTM D 2435 ⇔ Method B

## TIME CURVES

Constant Load Step 3 of 12

Stress: 0.5 tsf



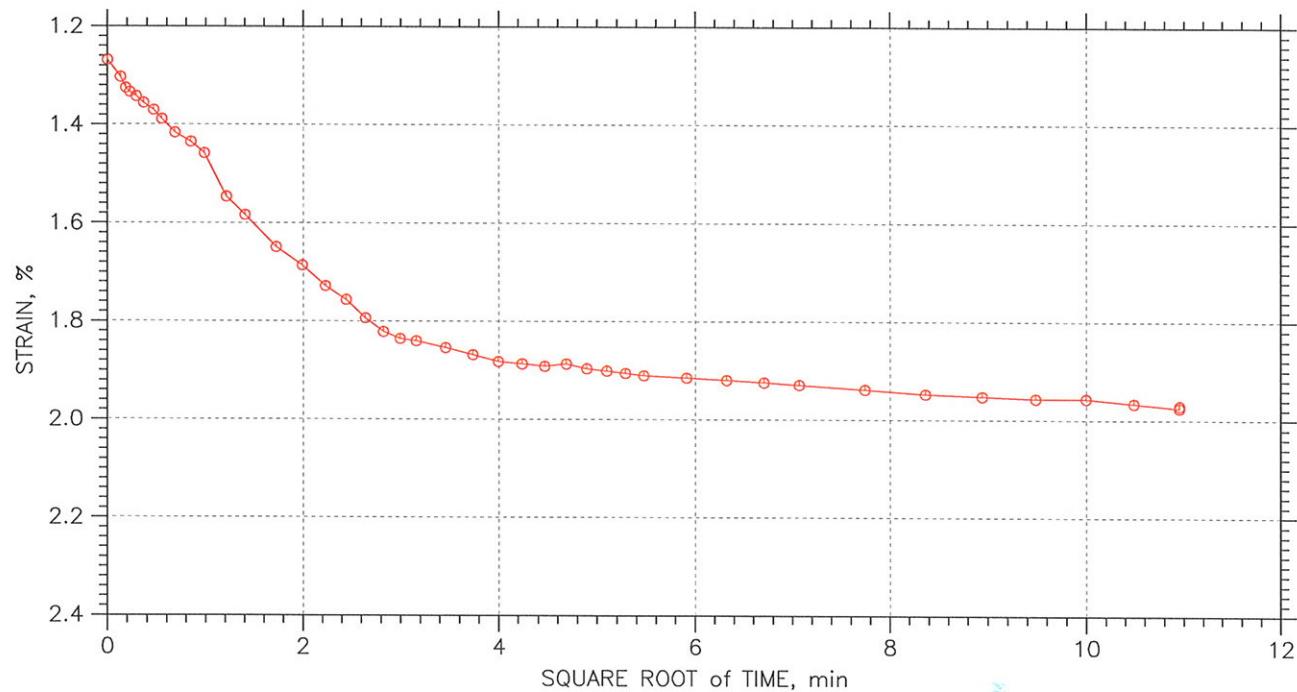
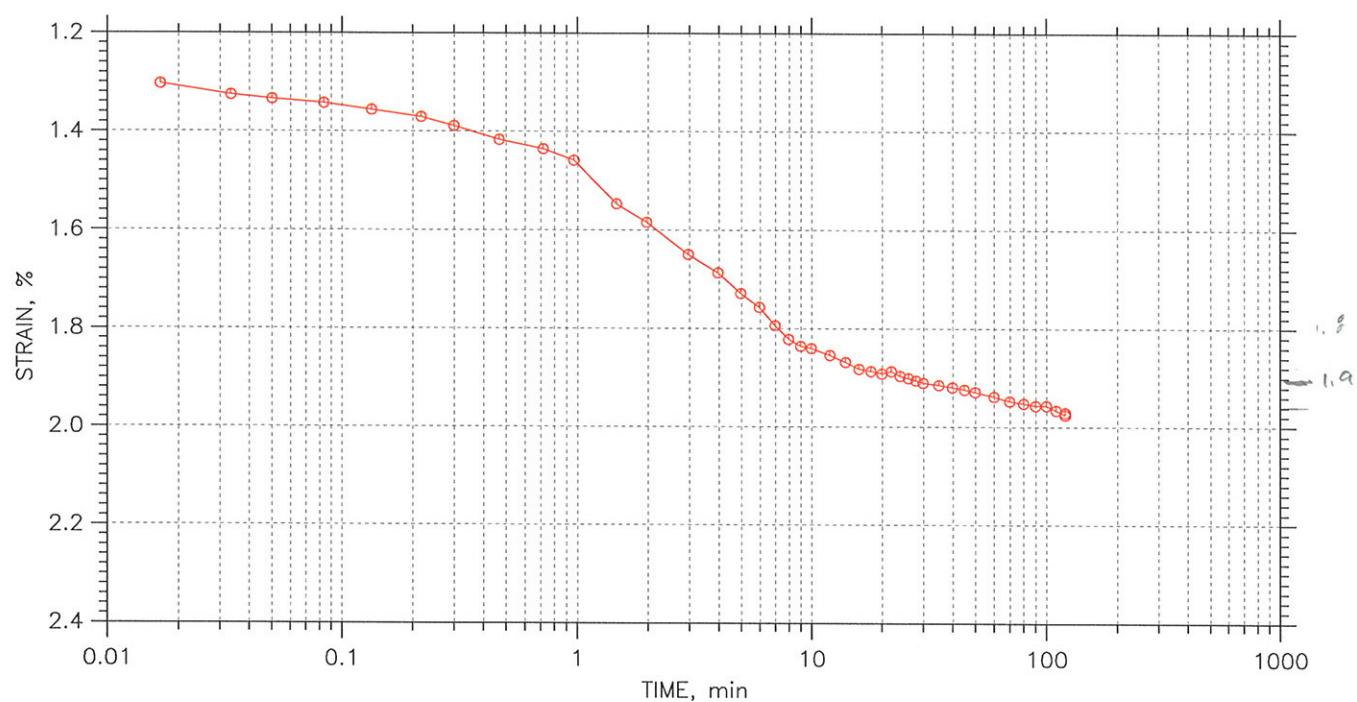
<b>GeoTesting</b> <small>EXPRESS</small>	Project: DCP Searsport	Location: Maine	Project No.: GTX-10738
	Boring No.: B-4	Tested By: md	Checked By: jdt
	Sample No.: Shelby	Test Date: 9/14/11	Test No.: IconP-1
	Depth: 10-12 ft	Sample Type: tube	Elevation: ---
	Description: Moist, dark greenish gray clay		
	Remarks: System X, Cell A-1		

# One-Dimensional Consolidation by ASTM D 2435 ⇔ Method B

## TIME CURVES

Constant Load Step 4 of 12

Stress: 1 tsf



Project: DCP Searsport      Location: Maine      Project No.: GTX-10738

Boring No.: B-4      Tested By: md      Checked By: jdt

Sample No.: Shelby      Test Date: 9/14/11      Test No.: IconP-1

Depth: 10-12 ft      Sample Type: tube      Elevation: ----

Description: Moist, dark greenish gray clay

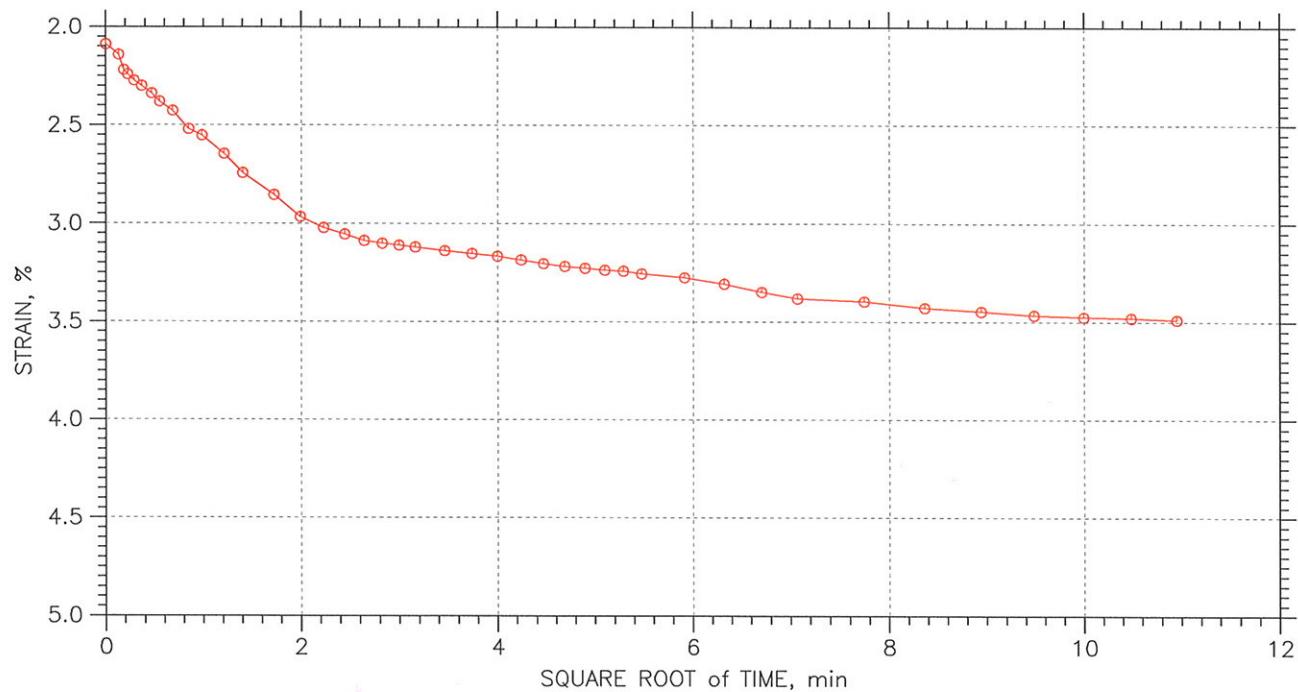
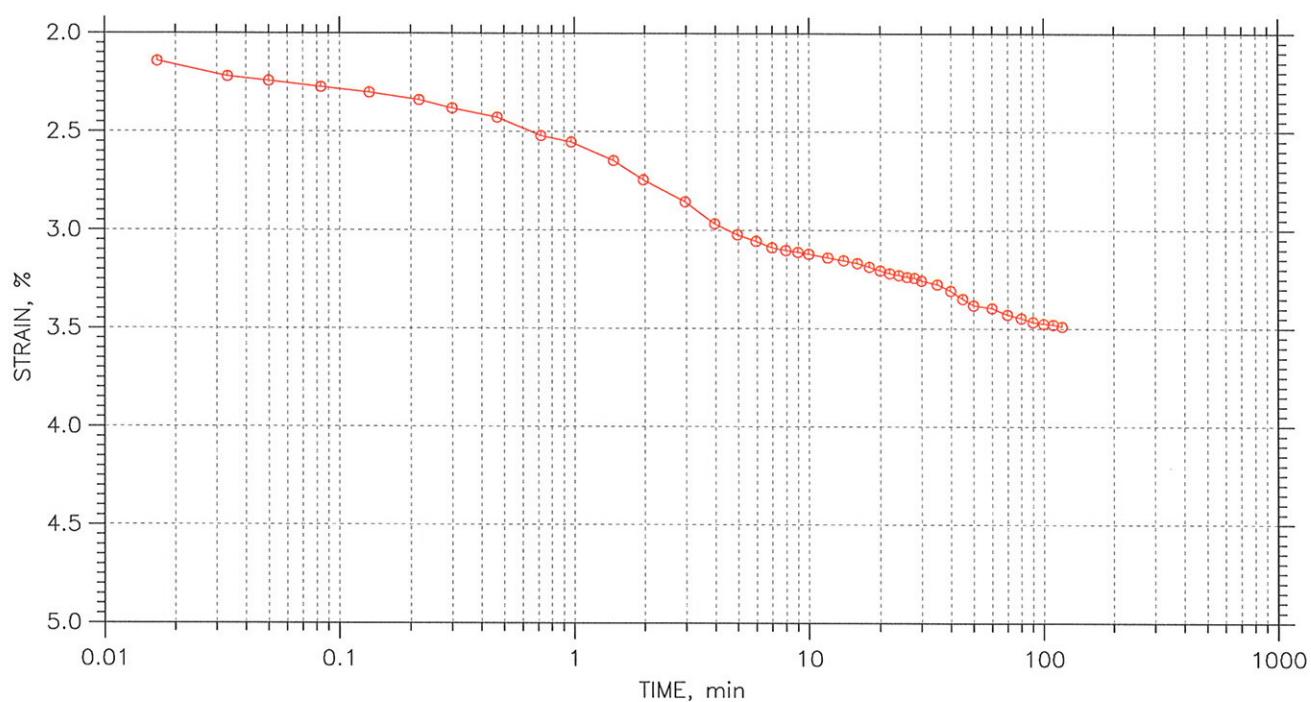
Remarks: System X, Cell A-1

# One-Dimensional Consolidation by ASTM D 2435 ⇔ Method B

## TIME CURVES

Constant Load Step 5 of 12

Stress: 2 tsf



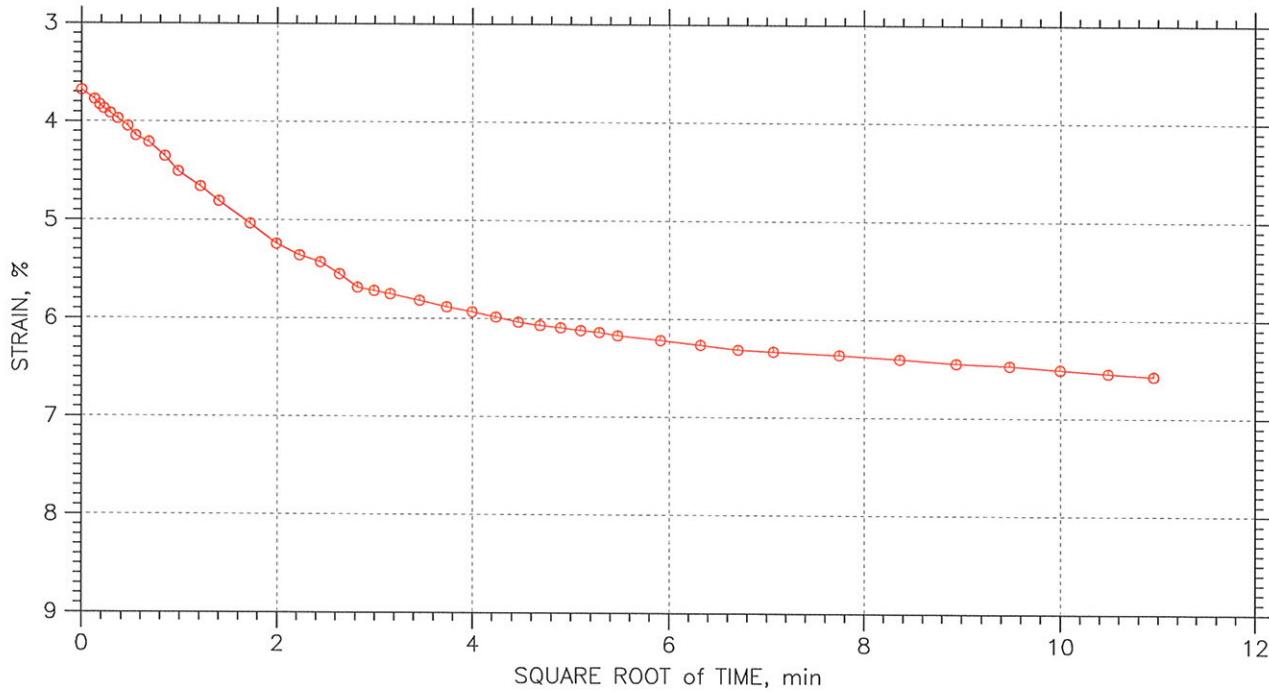
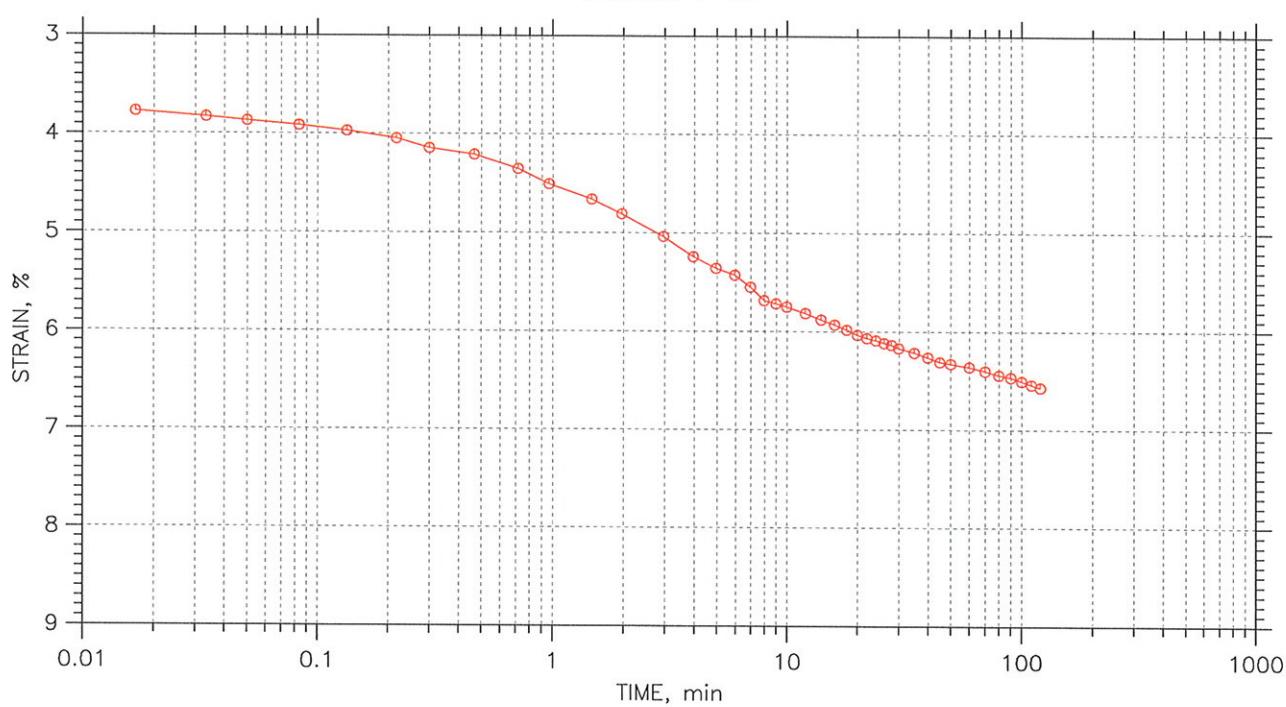
<b>GeoTesting</b> EXPRESS	Project: DCP Searsport	Location: Maine	Project No.: GTX-10738
	Boring No.: B-4	Tested By: md	Checked By: jdt
	Sample No.: Shelby	Test Date: 9/14/11	Test No.: IconP-1
	Depth: 10-12 ft	Sample Type: tube	Elevation: ---
	Description: Moist, dark greenish gray clay		
	Remarks: System X, Cell A-1		

# One-Dimensional Consolidation by ASTM D 2435 ⇔ Method B

## TIME CURVES

Constant Load Step 6 of 12

Stress: 4 tsf



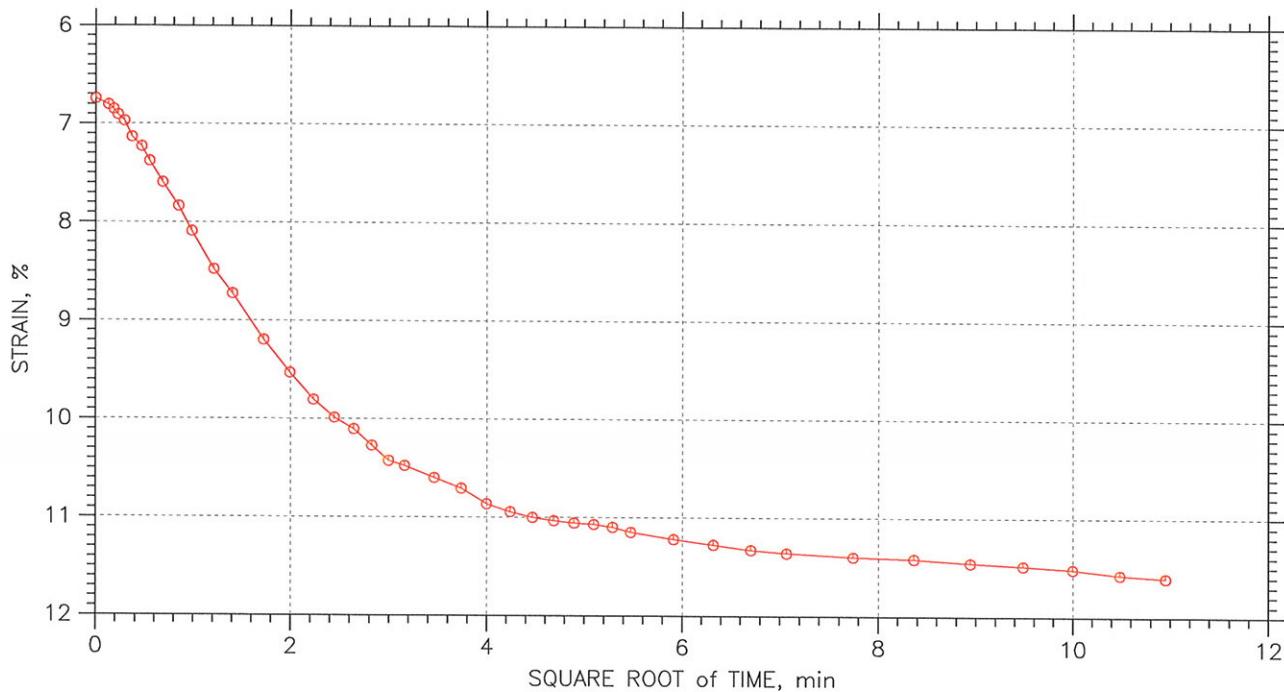
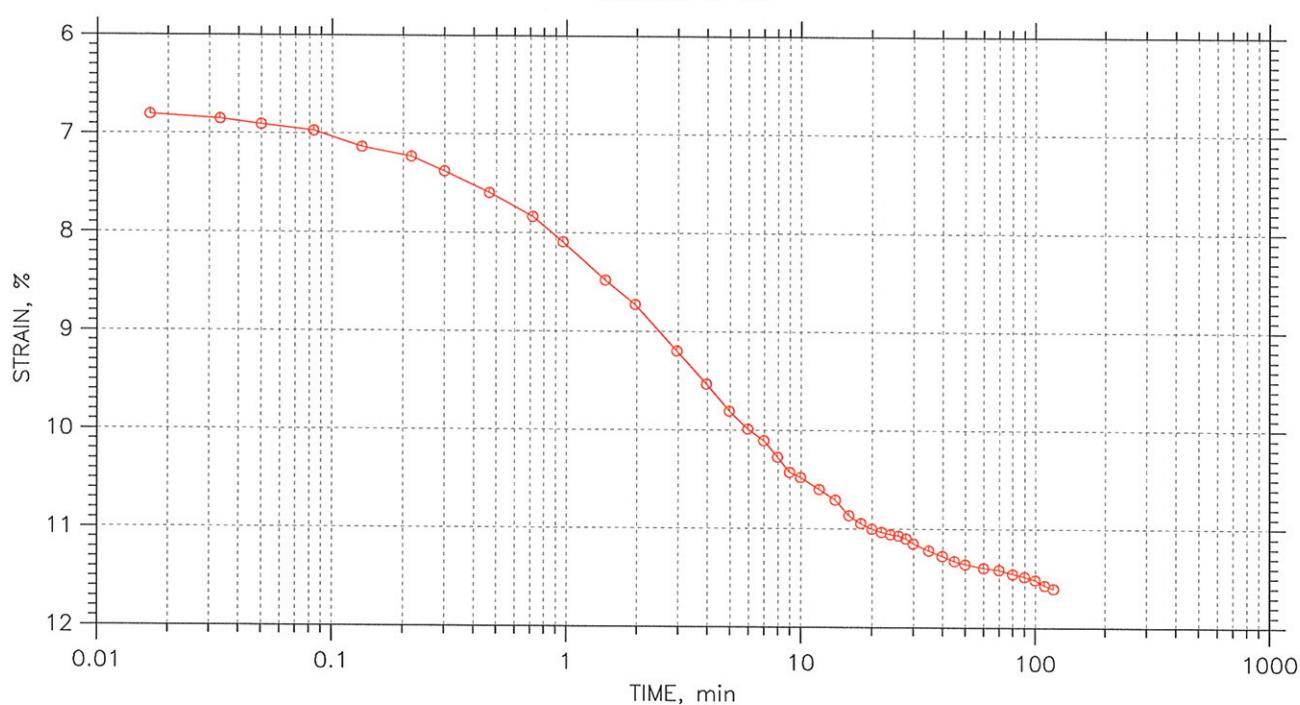
<b>GeoTesting</b> EXPRESS	Project: DCP Searsport	Location: Maine	Project No.: GTX-10738
	Boring No.: B-4	Tested By: md	Checked By: jdt
	Sample No.: Shelby	Test Date: 9/14/11	Test No.: IconP-1
	Depth: 10-12 ft	Sample Type: tube	Elevation: ---
	Description: Moist, dark greenish gray clay		
	Remarks: System X, Cell A-1		

# One-Dimensional Consolidation by ASTM D 2435 ⇔ Method B

## TIME CURVES

Constant Load Step 7 of 12

Stress: 8 tsf



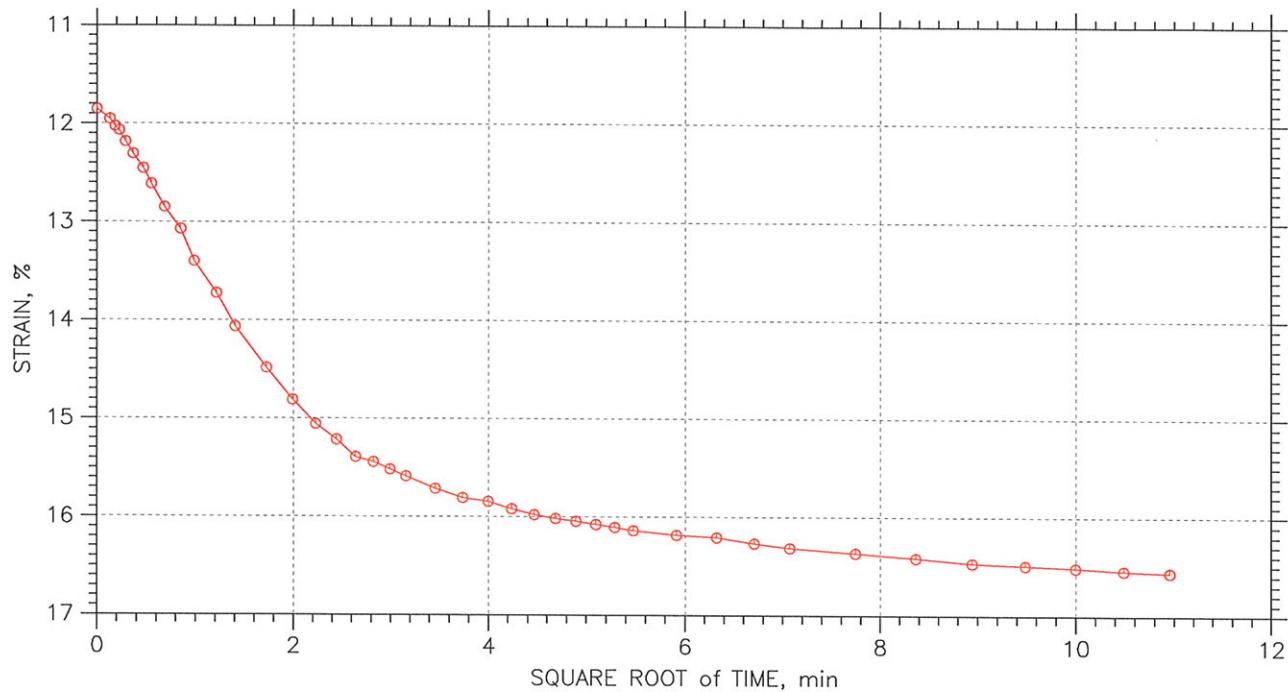
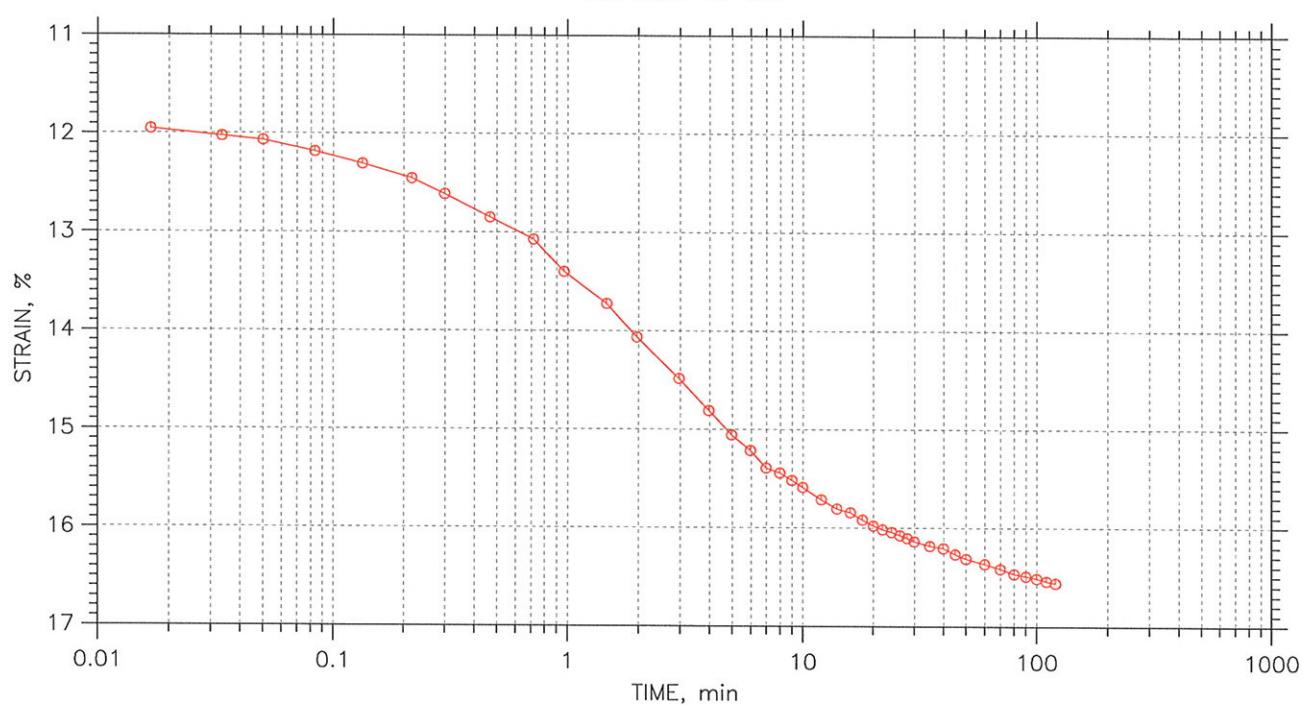
<b>GeoTesting</b> EXPRESS	Project: DCP Searsport	Location: Maine	Project No.: GTX-10738
	Boring No.: B-4	Tested By: md	Checked By: jdt
	Sample No.: Shelby	Test Date: 9/14/11	Test No.: IconP-1
	Depth: 10-12 ft	Sample Type: tube	Elevation: ---
	Description: Moist, dark greenish gray clay		
	Remarks: System X, Cell A-1		

# One-Dimensional Consolidation by ASTM D 2435 ⇔ Method B

## TIME CURVES

Constant Load Step 8 of 12

Stress: 16 tsf



Project: DCP Searsport	Location: Maine	Project No.: GTX-10738
------------------------	-----------------	------------------------

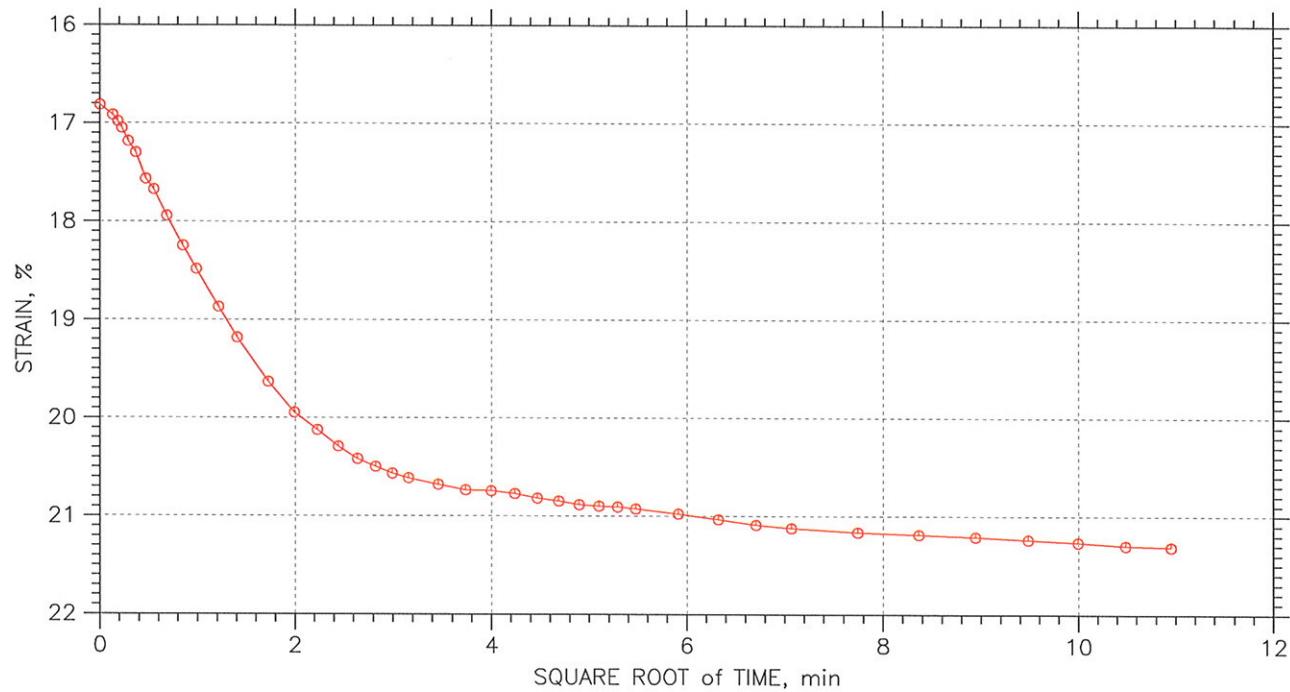
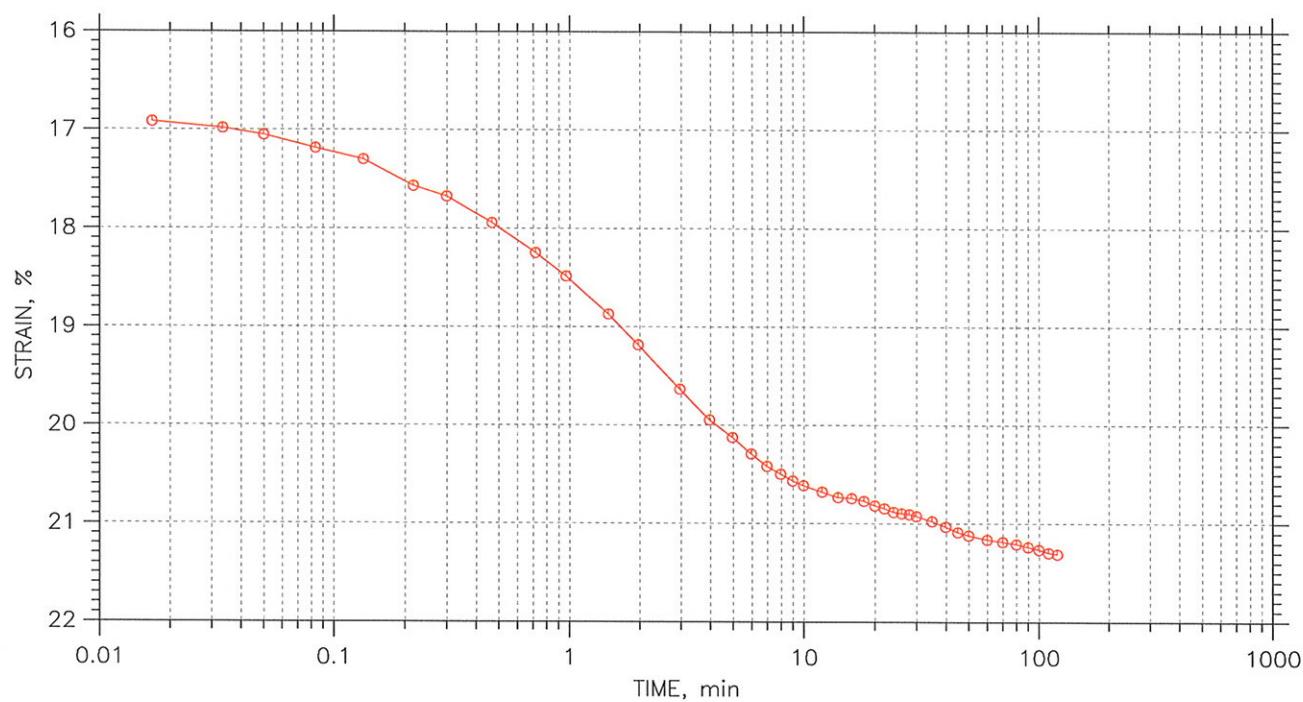
Boring No.: B-4	Tested By: md	Checked By: jdt
Sample No.: Shelby	Test Date: 9/14/11	Test No.: IconP-1
Depth: 10-12 ft	Sample Type: tube	Elevation: ---
Description: Moist, dark greenish gray clay		
Remarks: System X, Cell A-1		

# One-Dimensional Consolidation by ASTM D 2435 ⇔ Method B

## TIME CURVES

Constant Load Step 9 of 12

Stress: 32 tsf



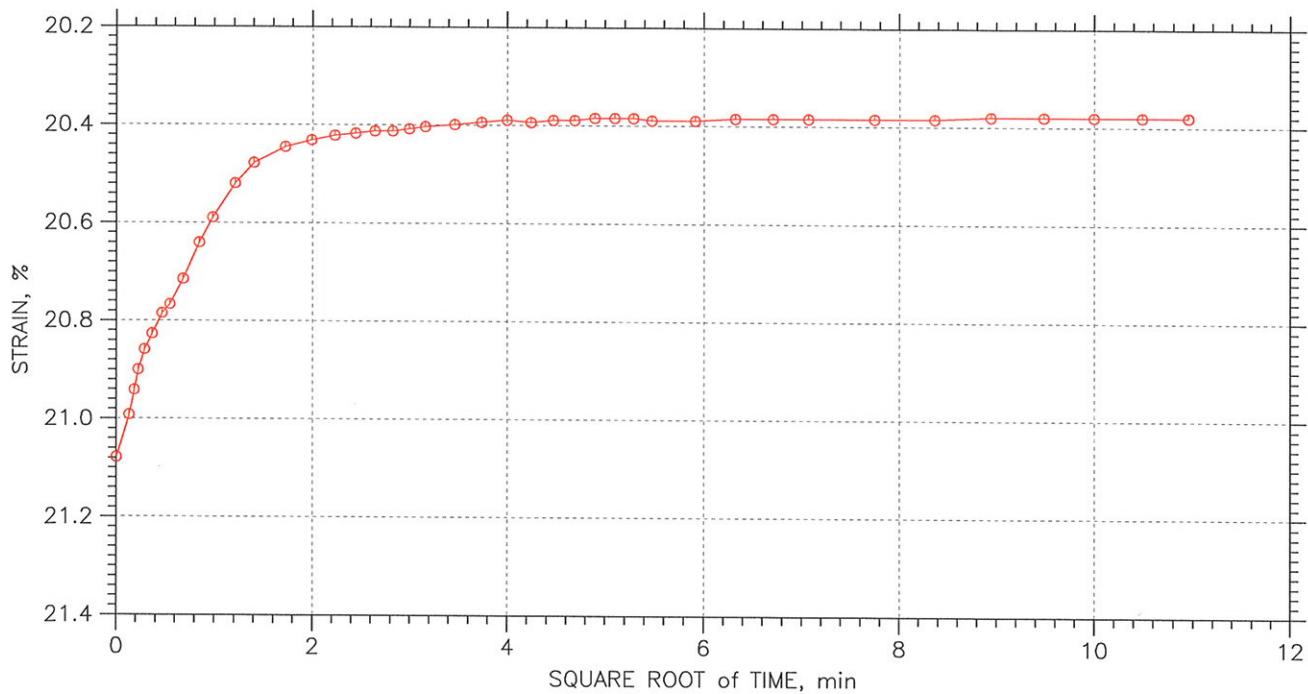
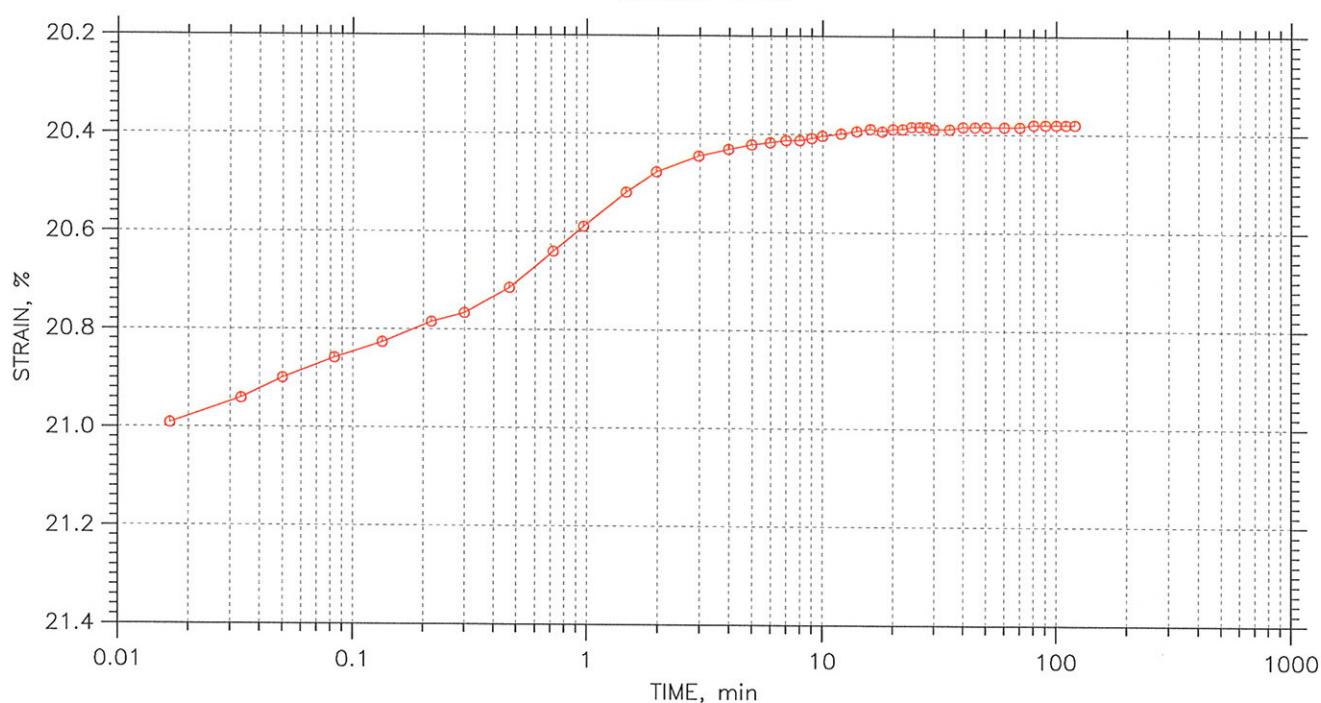
	Project: DCP Searsport	Location: Maine	Project No.: GTX-10738
	Boring No.: B-4	Tested By: md	Checked By: jdt
	Sample No.: Shelby	Test Date: 9/14/11	Test No.: IconP-1
	Depth: 10-12 ft	Sample Type: tube	Elevation: ---
	Description: Moist, dark greenish gray clay		
	Remarks: System X, Cell A-1		

# One-Dimensional Consolidation by ASTM D 2435 ⇔ Method B

## TIME CURVES

Constant Load Step 10 of 12

Stress: 8 tsf



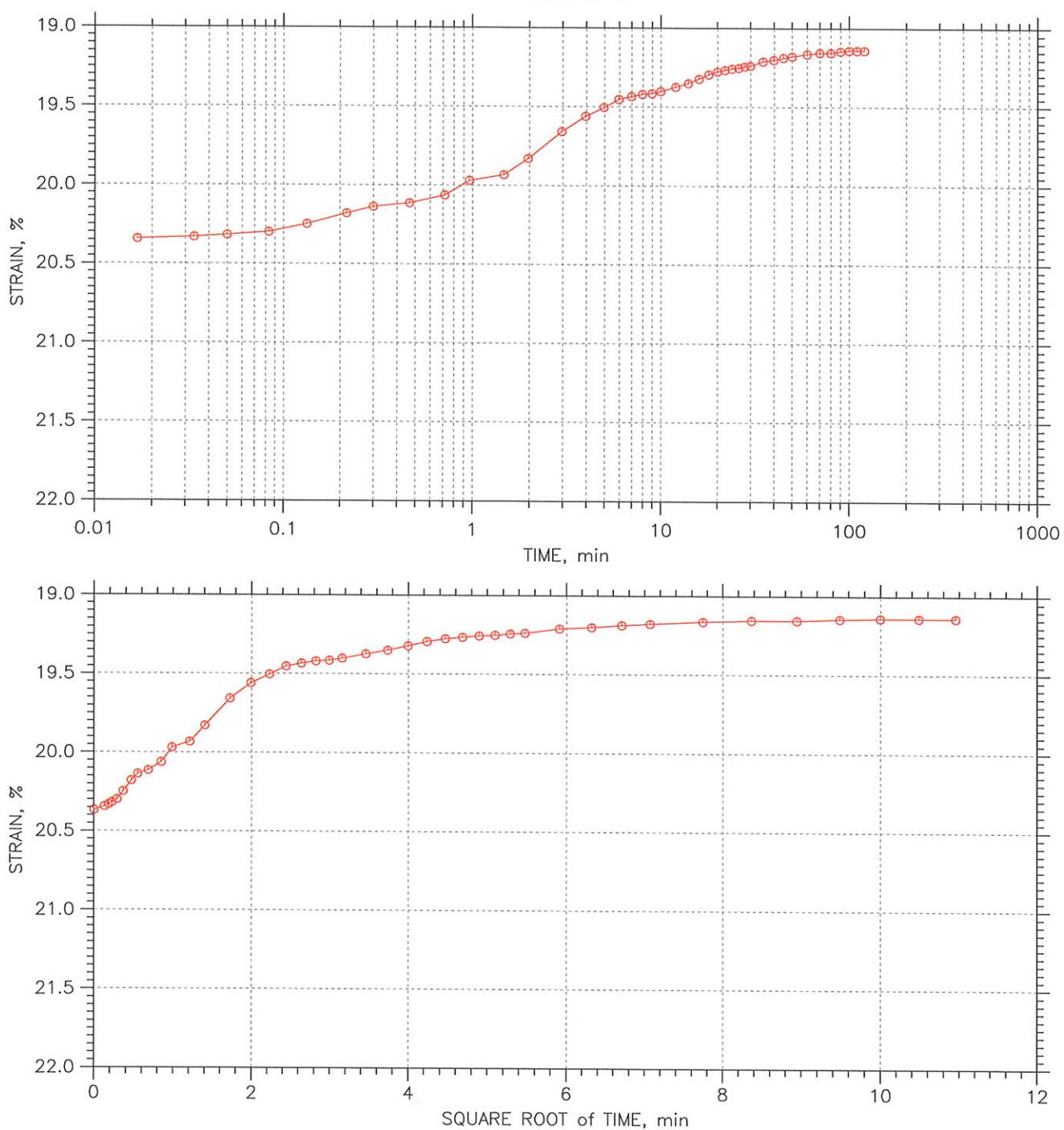
	Project: DCP Searsport	Location: Maine	Project No.: GTX-10738
	Boring No.: B-4	Tested By: md	Checked By: jdt
	Sample No.: Shelby	Test Date: 9/14/11	Test No.: IconP-1
	Depth: 10-12 ft	Sample Type: tube	Elevation: ---
	Description: Moist, dark greenish gray clay		
	Remarks: System X, Cell A-1		

# One-Dimensional Consolidation by ASTM D 2435 ⇔ Method B

## TIME CURVES

Constant Load Step 11 of 12

Stress: 2 tsf



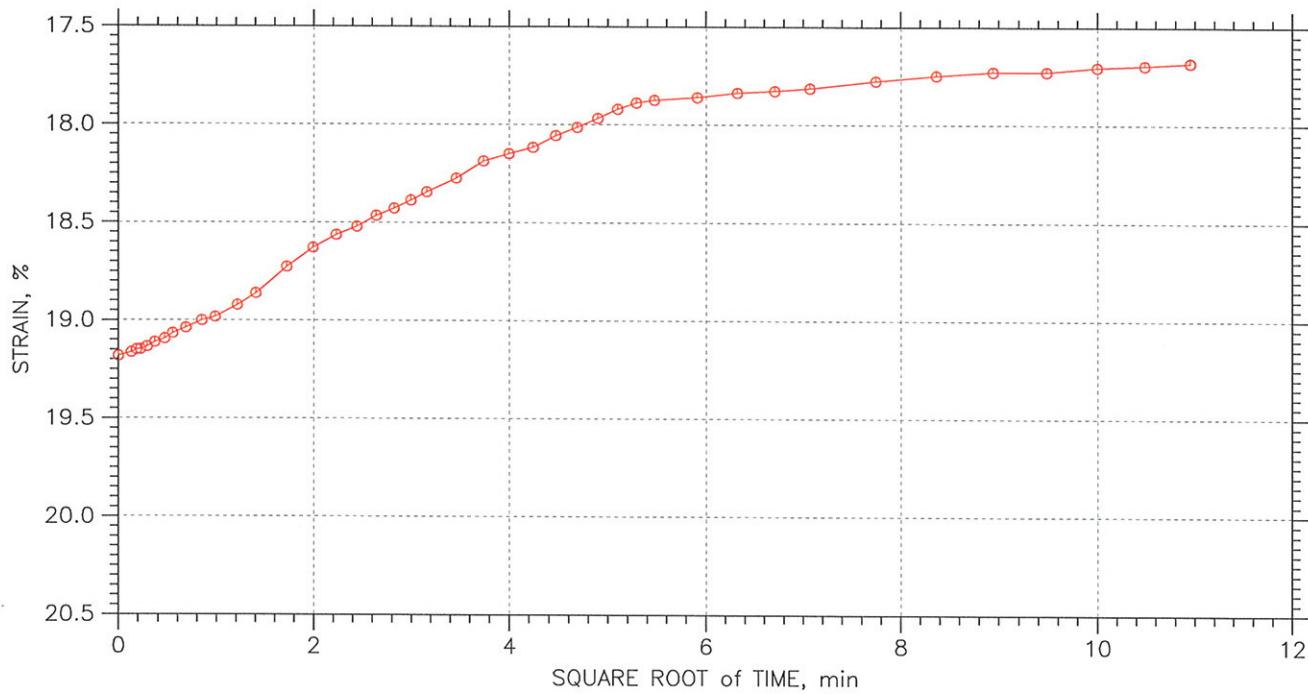
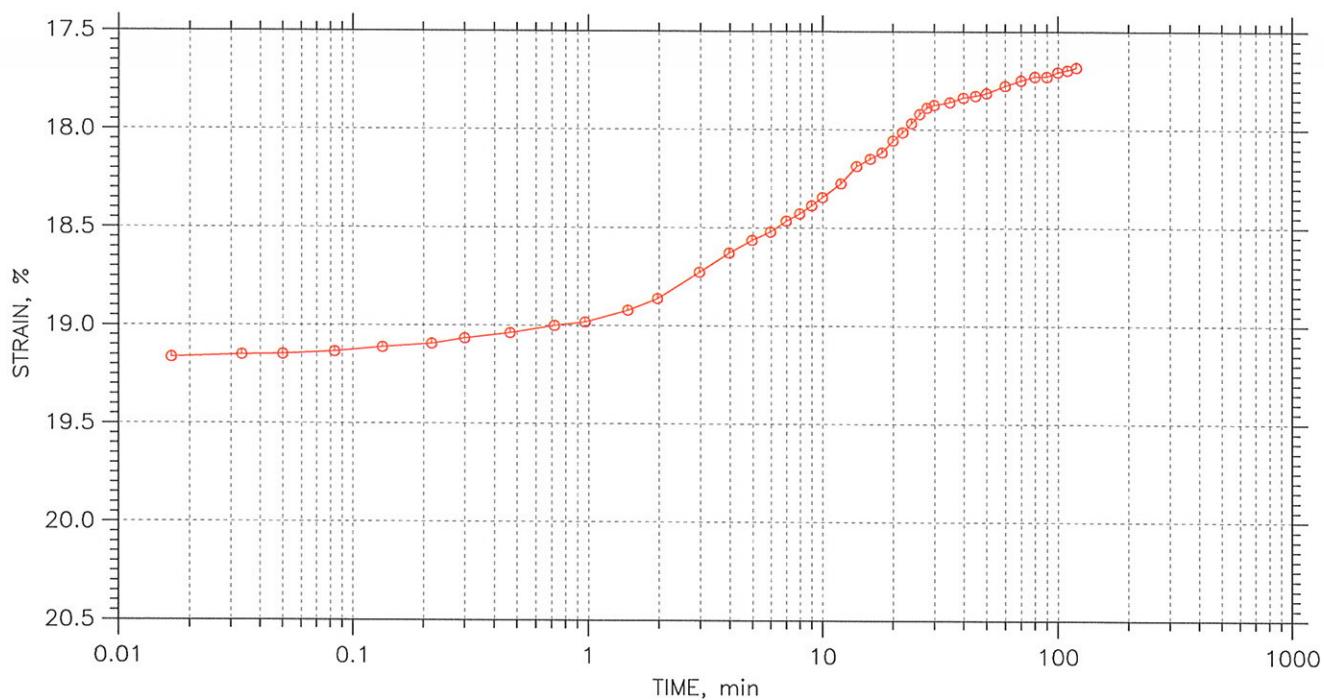
<b>GeoTesting</b> EXPRESS	Project: DCP Searsport	Location: Maine	Project No.: GTX-10738
	Boring No.: B-4	Tested By: md	Checked By: jdt
	Sample No.: Shelby	Test Date: 9/14/11	Test No.: IconP-1
	Depth: 10-12 ft	Sample Type: tube	Elevation: ---
	Description: Moist, dark greenish gray clay		
	Remarks: System X, Cell A-1		

# One-Dimensional Consolidation by ASTM D 2435 ⇔ Method B

TIME CURVES

Constant Load Step 12 of 12

Stress: 0.5 tsf



<b>GeoTesting</b> EXPRESS	Project: DCP Searsport	Location: Maine	Project No.: GTX-10738
	Boring No.: B-4	Tested By: md	Checked By: jdt
	Sample No.: Shelby	Test Date: 9/14/11	Test No.: IconP-1
	Depth: 10-12 ft	Sample Type: tube	Elevation: ---
	Description: Moist, dark greenish gray clay		
	Remarks: System X, Cell A-1		

## WARRANTY and LIABILITY

GeoTesting Express (GTX) warrants that all tests it performs are run in general accordance with the specified test procedures and accepted industry practice. GTX will correct or repeat any test that does not comply with this warranty. GTX has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material.

GTX may report engineering parameters that require us to interpret the test data. Such parameters are determined using accepted engineering procedures. However, GTX does not warrant that these parameters accurately reflect the true engineering properties of the *in situ* material. Responsibility for interpretation and use of the test data and these parameters for engineering and/or construction purposes rests solely with the user and not with GTX or any of its employees.

GTX's liability will be limited to correcting or repeating a test which fails our warranty. GTX's liability for damages to the Purchaser of testing services for any cause whatsoever shall be limited to the amount GTX received for the testing services. GTX will not be liable for any damages, or for any lost benefits or other consequential damages resulting from the use of these test results, even if GTX has been advised of the possibility of such damages. GTX will not be responsible for any liability of the Purchaser to any third party.

### Commonly Used Symbols

A	pore pressure parameter for $\Delta\sigma_1 - \Delta\sigma_3$	T	temperature
B	pore pressure parameter for $\Delta\sigma_3$	t	time
CIU	isotropically consolidated undrained triaxial shear test	U, UC	unconfined compression test
CR	compression ratio for one dimensional consolidation	UU, Q	unconsolidated undrained triaxial test
$C_c$	coefficient of curvature, $(D_{30})^2 / (D_{10} \times D_{60})$	$u_a$	pore gas pressure
$C_u$	coefficient of uniformity, $D_{60}/D_{10}$	$u_e$	excess pore water pressure
$C_c$	compression index for one dimensional consolidation	$u, u_w$	pore water pressure
$C_a$	coefficient of secondary compression	V	total volume
$c_v$	coefficient of consolidation	$V_g$	volume of gas
c	cohesion intercept for total stresses	$V_s$	volume of solids
$c'$	cohesion intercept for effective stresses	$V_v$	volume of voids
D	diameter of specimen	$V_w$	volume of water
$D_{10}$	diameter at which 10% of soil is finer	$V_o$	initial volume
$D_{15}$	diameter at which 15% of soil is finer	v	velocity
$D_{30}$	diameter at which 30% of soil is finer	W	total weight
$D_{50}$	diameter at which 50% of soil is finer	$W_s$	weight of solids
$D_{60}$	diameter at which 60% of soil is finer	$W_w$	weight of water
$D_{85}$	diameter at which 85% of soil is finer	w	water content
$d_{50}$	displacement for 50% consolidation	$w_c$	water content at consolidation
$d_{90}$	displacement for 90% consolidation	$w_f$	final water content
$d_{100}$	displacement for 100% consolidation	$w_l$	liquid limit
E	Young's modulus	$w_n$	natural water content
e	void ratio	$w_p$	plastic limit
$e_c$	void ratio after consolidation	$w_s$	shrinkage limit
$e_o$	initial void ratio	$w_o, w_i$	initial water content
G	shear modulus	$\alpha$	slope of $q_f$ versus $p_f$
$G_s$	specific gravity of soil particles	$\alpha'$	slope of $q_f$ versus $p'_f$
H	height of specimen	$\gamma_t$	total unit weight
PI	plasticity index	$\gamma_d$	dry unit weight
i	gradient	$\gamma_s$	unit weight of solids
$K_o$	lateral stress ratio for one dimensional strain	$\gamma_w$	unit weight of water
k	permeability	$\epsilon$	strain
LI	Liquidity Index	$\epsilon_{vol}$	volume strain
$m_v$	coefficient of volume change	$\epsilon_h, \epsilon_v$	horizontal strain, vertical strain
n	porosity	$\mu$	Poisson's ratio, also viscosity
PI	plasticity index	$\sigma$	normal stress
$P_c$	preconsolidation pressure	$\sigma'$	effective normal stress
p	$(\sigma_1 + \sigma_3) / 2, (\sigma_v + \sigma_h) / 2$	$\sigma_c, \sigma'_c$	consolidation stress in isotropic stress system
$p'$	$(\sigma'_1 + \sigma'_3) / 2, (\sigma'_v + \sigma'_h) / 2$	$\sigma_h, \sigma'_h$	horizontal normal stress
$p'_c$	$p'$ at consolidation	$\sigma_v, \sigma'_v$	vertical normal stress
Q	quantity of flow	$\sigma_1$	major principal stress
q	$(\sigma_1 - \sigma_3) / 2$	$\sigma_2$	intermediate principal stress
$q_f$	q at failure	$\sigma_3$	minor principal stress
$q_o, q_i$	initial q	$\tau$	shear stress
$q_c$	q at consolidation	$\phi$	friction angle based on total stresses
S	degree of saturation	$\phi'$	friction angle based on effective stresses
SL	shrinkage limit	$\phi'_r$	residual friction angle
$s_u$	undrained shear strength	$\phi_{ult}$	$\phi$ for ultimate strength
T	time factor for consolidation		

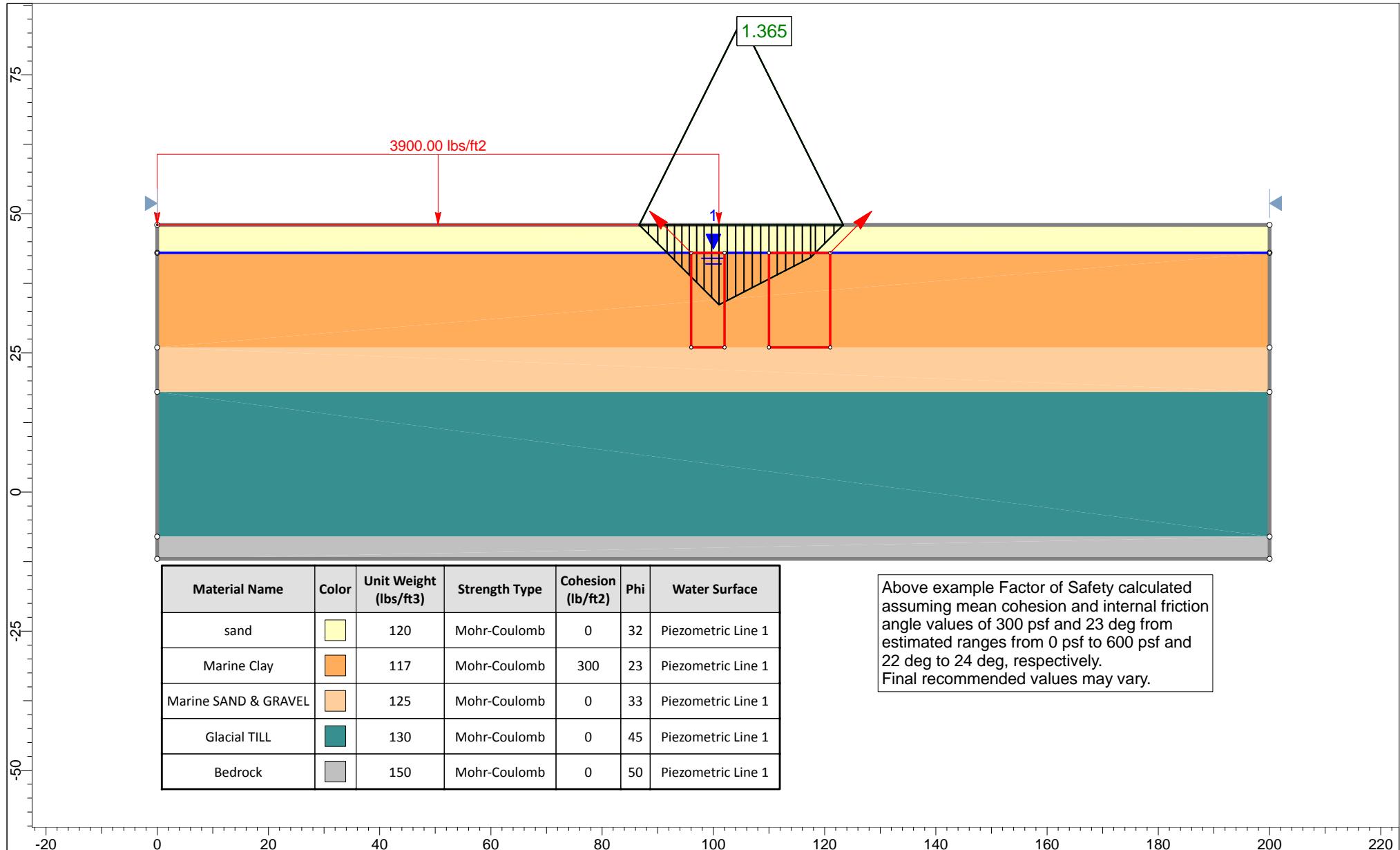
## **Appendix C**

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DCP Midstream LP  
Proposed LPG Storage Facility  
Searsport, Maine

Geotechnical Investigation  
December 16, 2011  
C&C Project #: 15-605

Prepared by Coler & Colantonio, Inc.

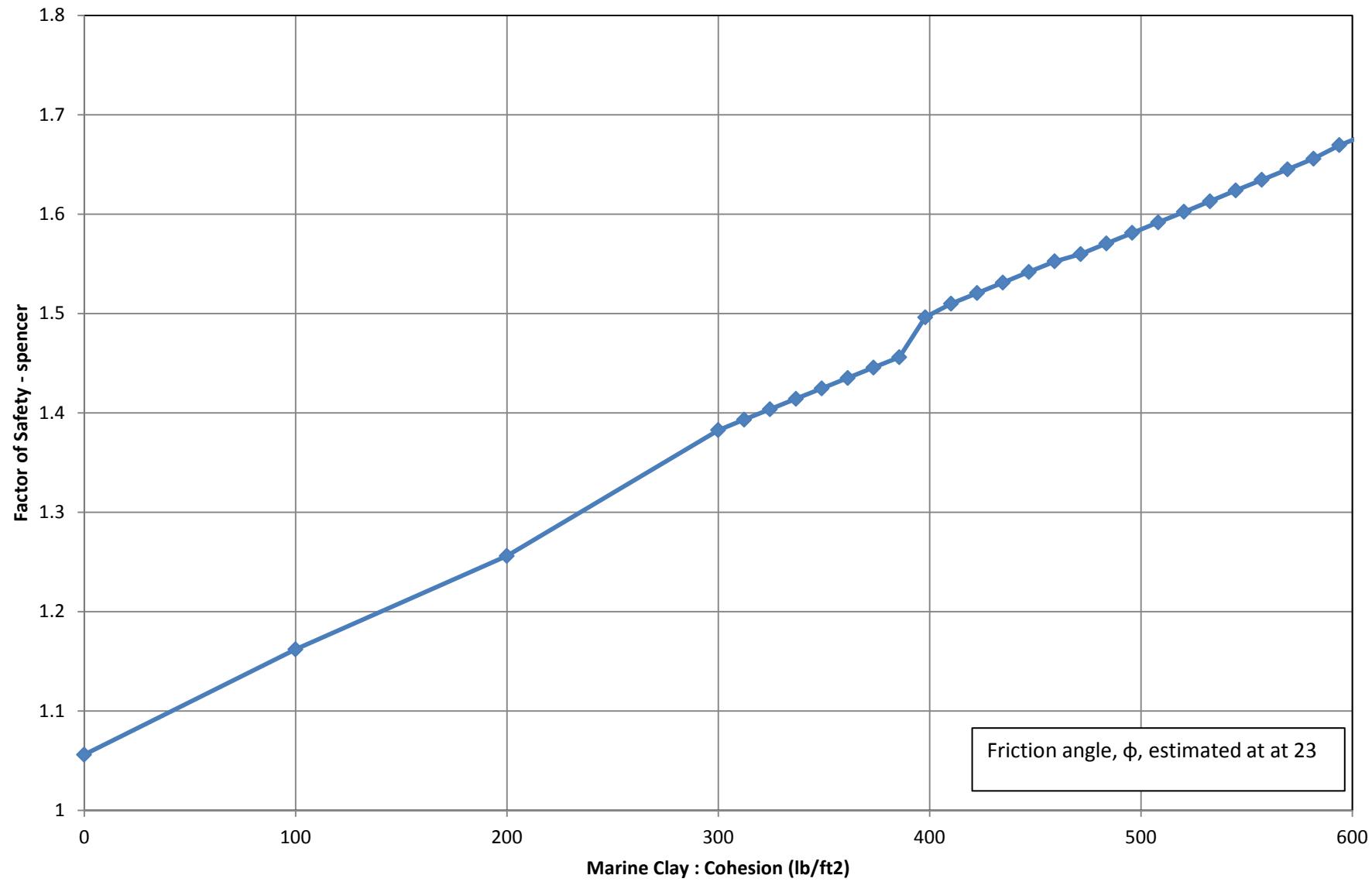


Material Name	Color	Unit Weight (lbs/ft <sup>3</sup> )	Strength Type	Cohesion (lb/ft <sup>2</sup> )	Phi	Water Surface
sand	Yellow	120	Mohr-Coulomb	0	32	Piezometric Line 1
Marine Clay	Orange	117	Mohr-Coulomb	300	23	Piezometric Line 1
Marine SAND & GRAVEL	Light Orange	125	Mohr-Coulomb	0	33	Piezometric Line 1
Glacial TILL	Teal	130	Mohr-Coulomb	0	45	Piezometric Line 1
Bedrock	Grey	150	Mohr-Coulomb	0	50	Piezometric Line 1

Above example Factor of Safety calculated assuming mean cohesion and internal friction angle values of 300 psf and 23 deg from estimated ranges from 0 psf to 600 psf and 22 deg to 24 deg, respectively. Final recommended values may vary.

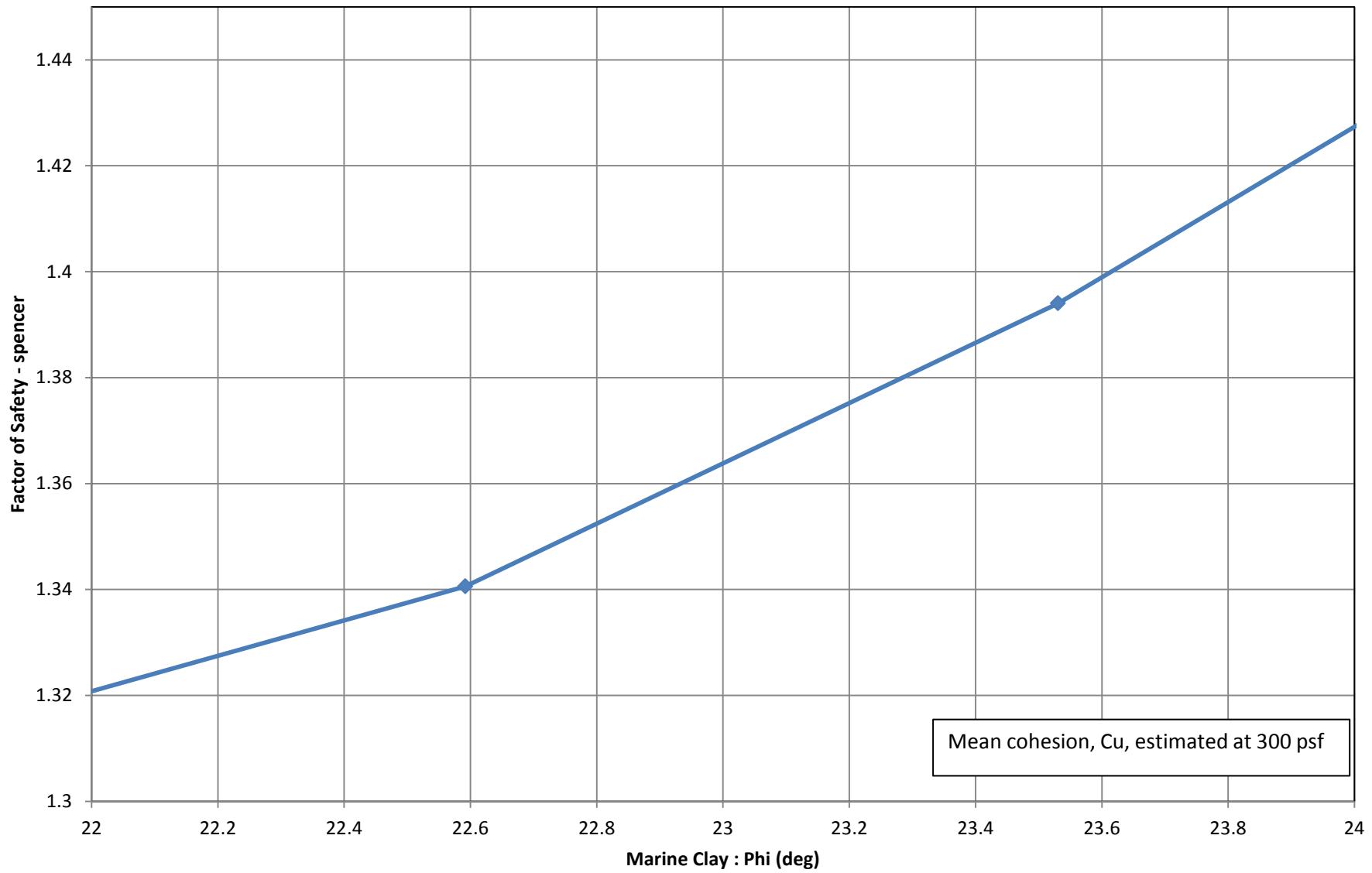
 <b>Geocomp</b> CONSULTING, INC. Technologies to manage risk for infrastructure SLIDEINTERPRET 6.013	Project	
	Searsport LPG Tank and Ancillary Structures	
	Analysis Description	
	LPG Tank - Normal Operation Conditions - Drained Conditions	
	Drawn By	Nicolas Betancur
	Company	Geocomp Consulting
	Date	11/8/2011, 1:39:01 PM
	File Name	Normal_Block_Drained_Sensitivity(c-phi).slim

## Sensitivity Plot - LPG Tank - Normal Loading Condition - Drained Condition (Long Term)



## Sensitivity Plot - LPG Tank - Normal Operating Conditions

### Drained Condition (Long Term)



# *Slide Analysis Information*

## *Searsport LPG Tank and Ancillary Structures*

### ***Project Summary***

---

File Name: Normal\_Block\_Drained\_Sensitivity(c-phi)  
Slide Modeler Version: 6.013  
Project Title: Searsport LPG Tank and Ancillary Structures  
Analysis: LPG Tank - Normal Operation Conditions - Drained Conditions  
Author: Nicolas Betancur  
Company: Geocomp Consulting  
Date Created: 11/8/2011, 1:39:01 PM

### ***General Settings***

---

Units of Measurement: Imperial Units  
Time Units: days  
Permeability Units: feet/second  
Failure Direction: Left to Right  
Data Output: Standard  
Maximum Material Properties: 20  
Maximum Support Properties: 20

### ***Analysis Options***

---

#### ***Analysis Methods Used***

Spencer  
Number of slices: 25  
Tolerance: 0.005  
Maximum number of iterations: 50  
Check malpha < 0.2: Yes  
Initial trial value of FS: 1  
Steffensen Iteration: Yes

### ***Groundwater Analysis***

---

Groundwater Method: Water Surfaces  
Pore Fluid Unit Weight: 62.4 lbs/ft<sup>3</sup>  
Advanced Groundwater Method: None

### ***Random Numbers***

---

Pseudo-random Seed: 10116  
Random Number Generation Method: Park and Miller v.3

## Surface Options

---

Surface Type: Non-Circular Block Search  
Number of Surfaces: 5000

Pseudo-Random Surfaces: Enabled

Convex Surfaces Only: Disabled

Left Projection Angle (Start Angle): 135

Left Projection Angle (End Angle): 135

Right Projection Angle (Start Angle): 45

Right Projection Angle (End Angle): 45

Minimum Elevation: Not Defined

Minimum Depth: Not Defined

## Loading

---

1 Distributed Load present

### Distributed Load 1

Distribution: Constant

Magnitude [lbs/ft<sup>2</sup>]: 3900

Orientation: Normal to boundary

## Material Properties

---

Property	sand	Marine Clay	Marine SAND & GRAVEL	Glacial TILL	Bedrock
Color					
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft <sup>3</sup> ]	120	117	125	130	150
Cohesion [psf]	0	300	0	0	0
Friction Angle [deg]	32	23	33	45	50
Water Surface	Piezometric Line 1	Piezometric Line 1	Piezometric Line 1	Piezometric Line 1	Piezometric Line 1
Hu Value	1	1	1	1	1

## Probabilistic Analysis Input

---

### General Settings

Sensitivity Analysis: On

Probabilistic Analysis: Off

### Variables

Material	Property	Distribution	Mean	Min	Max
Marine Clay	Cohesion	Normal	300	0	600
Marine Clay	Phi	Normal	23	22	24

## Global Minimum

---

### Method: spencer

FS: 1.365030  
Axis Location: 105.006, 84.681  
Left Slip Surface Endpoint: 86.665, 48.000  
Right Slip Surface Endpoint: 123.346, 48.000  
Resisting Moment=2.19587e+006 lb-ft  
Driving Moment=1.60866e+006 lb-ft  
Resisting Horizontal Force=41562.3 lb  
Driving Horizontal Force=30448 lb

### Global Minimum Coordinates

---

### Method: spencer

X	Y
86.665	48
101.009	33.6562
117.483	42.1368
123.346	48

### Valid / Invalid Surfaces

---

### Method: spencer

Number of Valid Surfaces: 4832  
Number of Invalid Surfaces: 168

#### Error Codes:

Error Code -108 reported for 83 surfaces  
Error Code -111 reported for 85 surfaces

#### Error Codes

The following errors were encountered during the computation:

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).  
-111 = safety factor equation did not converge

### Slice Data

---

#### Global Minimum Query (spencer) - Safety Factor: 1.36503

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]

1	1.66667	166.667	sand	0	32	1233.45	1683.7	2694.48	0	2694.48
2	1.66667	500	sand	0	32	1295.12	1767.88	2829.2	0	2829.2
3	1.66667	833.333	sand	0	32	1356.8	1852.07	2963.93	0	2963.93
4	1.33483	905.132	Marine Clay	300	23	1219.55	1664.72	3256.72	41.6467	3215.08
5	1.33483	1113.6	Marine Clay	300	23	1235.39	1686.35	3390.98	124.94	3266.04
6	1.33483	1322.07	Marine Clay	300	23	1251.25	1707.99	3525.25	208.234	3317.01
7	1.33483	1530.53	Marine Clay	300	23	1267.09	1729.62	3659.51	291.527	3367.99
8	1.33483	1739	Marine Clay	300	23	1282.95	1751.26	3793.77	374.82	3418.95
9	1.33483	1947.47	Marine Clay	300	23	1298.79	1772.89	3928.04	458.114	3469.92
10	1.33483	2155.94	Marine Clay	300	23	1308.7	1786.42	4043.18	541.407	3501.78
11	1.49767	2468.35	Marine Clay	300	23	698.478	953.443	2098.41	559	1539.41
12	1.49767	2333.26	Marine Clay	300	23	681.573	930.368	1995.95	510.891	1485.06
13	1.49767	2198.16	Marine Clay	300	23	664.669	907.293	1893.47	462.783	1430.69
14	1.49767	2063.07	Marine Clay	300	23	647.764	884.217	1791	414.674	1376.33
15	1.49767	1927.97	Marine Clay	300	23	630.859	861.142	1688.53	366.566	1321.97
16	1.49767	1792.88	Marine Clay	300	23	613.955	838.067	1586.07	318.457	1267.61
17	1.49767	1657.78	Marine Clay	300	23	597.05	814.991	1483.59	270.349	1213.24
18	1.49767	1522.69	Marine Clay	300	23	580.145	791.916	1381.12	222.24	1158.88
19	1.49767	1387.59	Marine Clay	300	23	563.241	768.841	1278.65	174.132	1104.52
20	1.49767	1252.5	Marine Clay	300	23	546.336	745.765	1176.18	126.024	1050.15
21	1.49767	1117.4	Marine Clay	300	23	529.432	722.69	1073.71	77.9152	995.797
22	0.863156	561.478	Marine Clay	300	23	647.125	883.345	1401.2	26.9305	1374.27
23	1.66667	833.333	sand	0	32	488.181	666.382	1066.43	0	1066.43
24	1.66667	500	sand	0	32	292.909	399.829	639.862	0	639.862
25	1.66667	166.667	sand	0	32	99.4696	135.779	217.292	0	217.292

## Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.36503

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]

1	86.665	48	0	0	0
2	88.3317	46.3333	2440.62	125.914	2.95333
3	89.9983	44.6667	5003.28	258.124	2.95333
4	91.665	43	7687.96	396.629	2.95332
5	92.9998	41.6652	10411.7	537.148	2.95332
6	94.3347	40.3303	13293.5	685.824	2.95332
7	95.6695	38.9955	16333.4	842.657	2.95333
8	97.0043	37.6607	19531.5	1007.65	2.95333
9	98.3391	36.3258	22887.7	1180.8	2.95333
10	99.674	34.991	26401.9	1362.1	2.95333
11	101.009	33.6562	30056.8	1550.66	2.95333
12	102.506	34.4272	27395.7	1413.37	2.95332
13	104.004	35.1981	24838.9	1281.46	2.95332
14	105.502	35.9691	22386.3	1154.93	2.95332
15	106.999	36.7401	20038	1033.78	2.95333
16	108.497	37.511	17793.9	918.006	2.95333
17	109.995	38.282	15654.1	807.611	2.95333
18	111.493	39.053	13618.6	702.594	2.95331
19	112.99	39.8239	11687.2	602.956	2.95334
20	114.488	40.5949	9860.18	508.696	2.95333
21	115.986	41.3659	8137.37	419.815	2.95333
22	117.483	42.1368	6518.81	336.312	2.95333
23	118.346	43	4752.29	245.175	2.95332
24	120.013	44.6667	2163.48	111.616	2.95333
25	121.68	46.3333	610.186	31.4801	2.95333
26	123.346	48	0	0	0

## List Of Coordinates

---

### Piezoline

X	Y
0	43
200	43

### Line Load

X	Y
101	48
0	48

### Block Search Window

X	Y
96	43
96	26
102	26
102	43

## Block Search Window

X	Y
110	43
110	26
121	26
121	43

## External Boundary

X	Y
200	-12
200	-8
200	18
200	26
200	43
200	48
0	48
0	43
0	26
0	18
0	-8
0	-12

## Material Boundary

X	Y
0	43
200	43

## Material Boundary

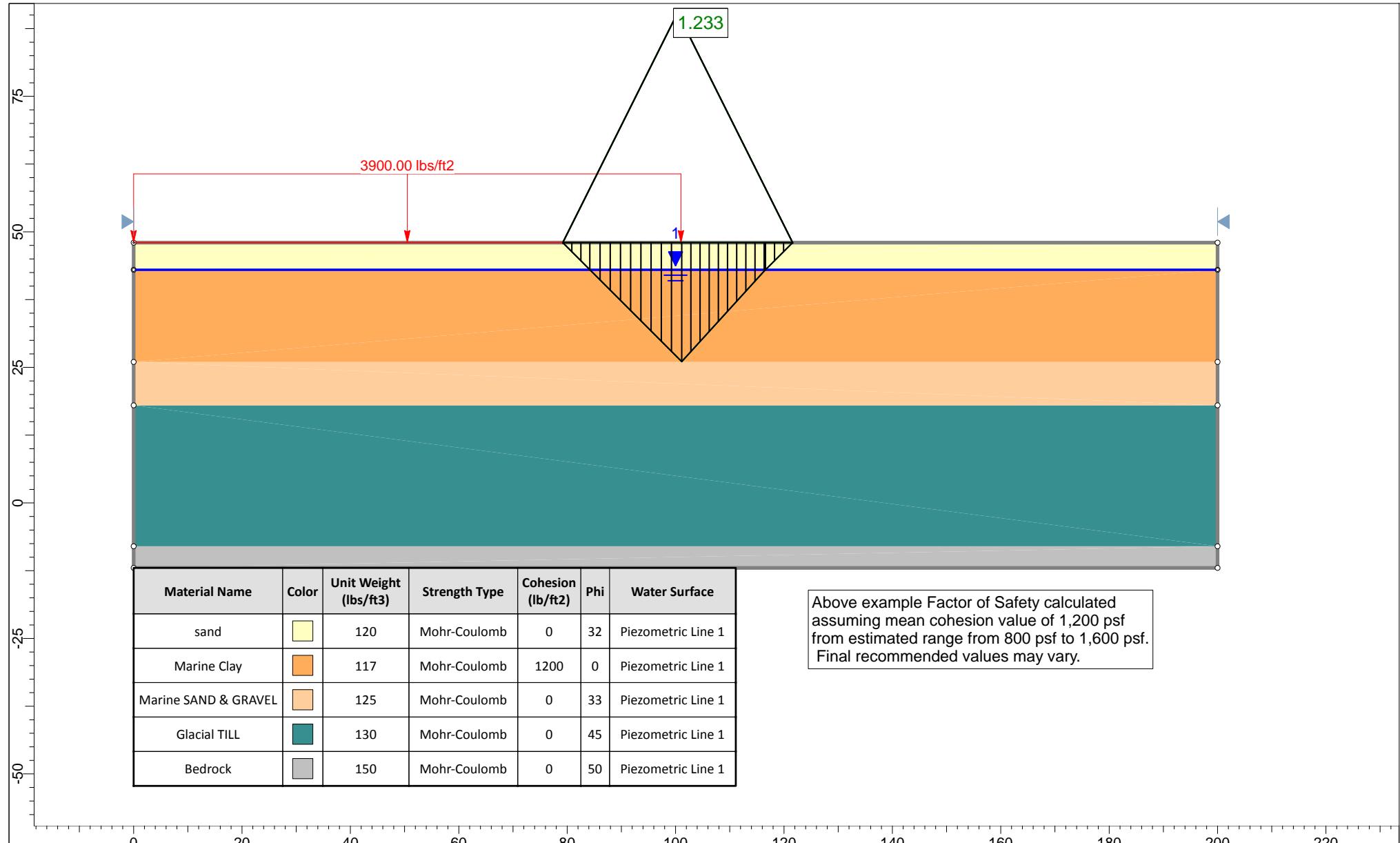
X	Y
0	26
200	26

## Material Boundary

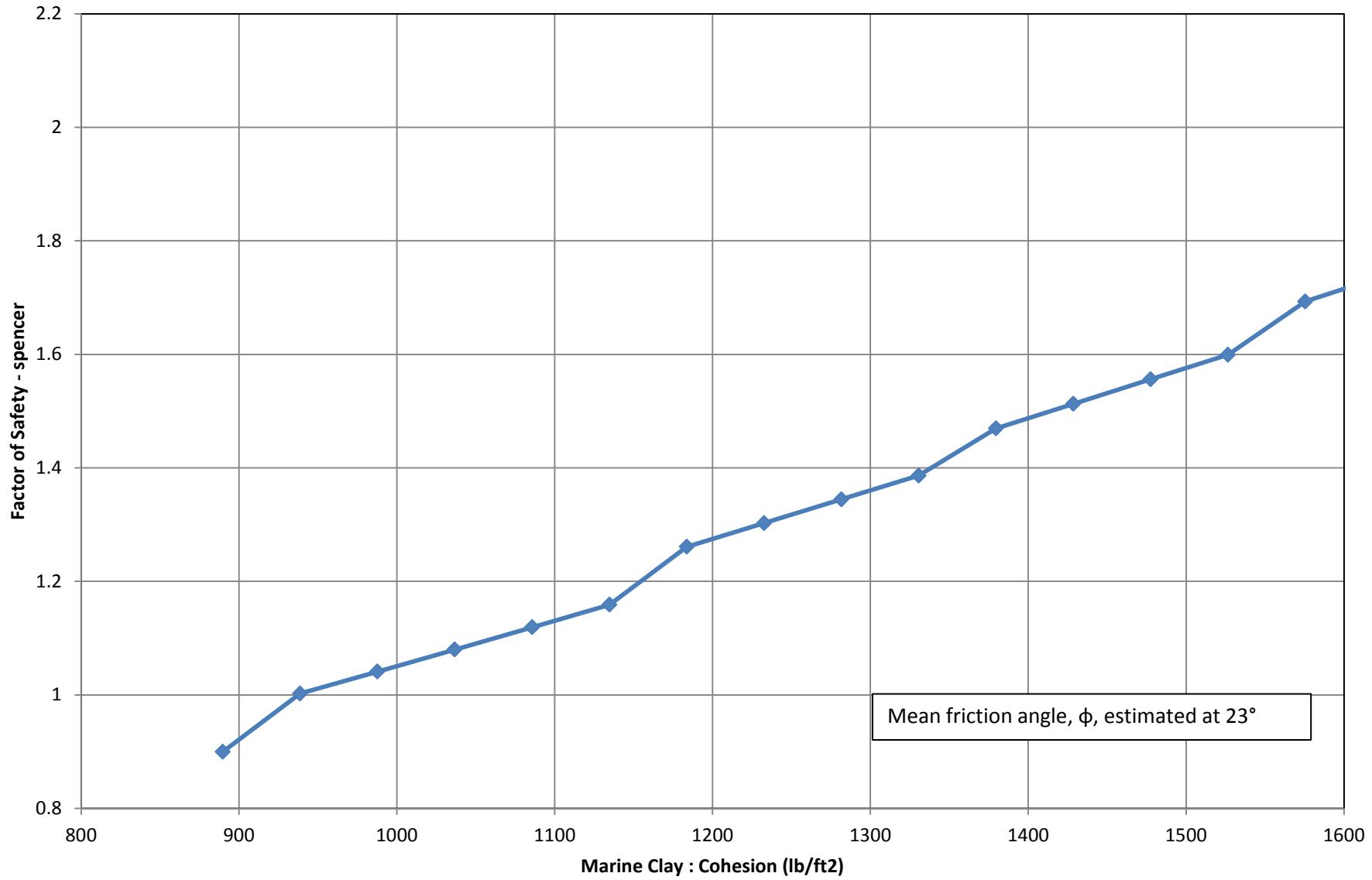
X	Y
0	18
200	18

## Material Boundary

X	Y
0	-8
200	-8



## Sensitivity Plot - LPG Tank - Normal Operation Conditions - Undrained (Short Term)



# *Slide Analysis Information*

## *Searsport LPG Tank & Ancillary Structures*

### ***Project Summary***

---

File Name: Normal\_Block\_Sensitivity(800-1600)  
Slide Modeler Version: 6.013  
Project Title: Searsport LPG Tank & Ancillary Structures  
Analysis: LPG Tank Normal Operation Conditions - Undrained  
Author: Nicolas Betancur  
Company: Geocomp Consulting  
Date Created: 11/8/2011, 1:39:01 PM

### ***General Settings***

---

Units of Measurement: Imperial Units  
Time Units: days  
Permeability Units: feet/second  
Failure Direction: Left to Right  
Data Output: Standard  
Maximum Material Properties: 20  
Maximum Support Properties: 20

### ***Analysis Options***

---

#### ***Analysis Methods Used***

Spencer  
Number of slices: 25  
Tolerance: 0.005  
Maximum number of iterations: 50  
Check malpha < 0.2: Yes  
Initial trial value of FS: 1  
Steffensen Iteration: Yes

### ***Groundwater Analysis***

---

Groundwater Method: Water Surfaces  
Pore Fluid Unit Weight: 62.4 lbs/ft<sup>3</sup>  
Advanced Groundwater Method: None

### ***Random Numbers***

---

Pseudo-random Seed: 10116  
Random Number Generation Method: Park and Miller v.3

## Surface Options

---

Surface Type: Non-Circular Block Search  
Number of Surfaces: 5000

Pseudo-Random Surfaces: Enabled

Convex Surfaces Only: Disabled

Left Projection Angle (Start Angle): 135

Left Projection Angle (End Angle): 135

Right Projection Angle (Start Angle): 45

Right Projection Angle (End Angle): 45

Minimum Elevation: Not Defined

Minimum Depth: Not Defined

## Loading

---

1 Distributed Load present

### Distributed Load 1

Distribution: Constant

Magnitude [lbs/ft<sup>2</sup>]: 3900

Orientation: Normal to boundary

## Material Properties

---

Property	sand	Marine Clay	Marine SAND & GRAVEL	Glacial TILL	Bedrock
Color					
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft <sup>3</sup> ]	120	117	125	130	150
Cohesion [psf]	0	1200	0	0	0
Friction Angle [deg]	32	0	33	45	50
Water Surface	Piezometric Line 1	Piezometric Line 1	Piezometric Line 1	Piezometric Line 1	Piezometric Line 1
Hu Value	1	1	1	1	1

## Probabilistic Analysis Input

---

### General Settings

Sensitivity Analysis: On

Probabilistic Analysis: Off

### Variables

Material	Property	Distribution	Mean	Min	Max
Marine Clay	Cohesion	Normal	1200	800	1600

## Global Minimum

---

### Method: spencer

FS: 1.232700  
Axis Location: 100.384, 90.405  
Left Slip Surface Endpoint: 79.182, 48.000  
Right Slip Surface Endpoint: 121.587, 48.000  
Resisting Moment=3.16994e+006 lb-ft  
Driving Moment=2.57154e+006 lb-ft  
Resisting Horizontal Force=49531.9 lb  
Driving Horizontal Force=40181.6 lb

### Global Minimum Coordinates

---

### Method: spencer

X	Y
79.1821	48
101.129	26.0527
116.341	42.7546
121.587	48

### Valid / Invalid Surfaces

---

### Method: spencer

Number of Valid Surfaces: 4881  
Number of Invalid Surfaces: 120

#### Error Codes:

Error Code -108 reported for 55 surfaces  
Error Code -111 reported for 65 surfaces

#### Error Codes

The following errors were encountered during the computation:

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).  
-111 = safety factor equation did not converge

### Slice Data

---

#### Global Minimum Query (spencer) - Safety Factor: 1.2327

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]

1	1.66667	166.667	sand	0	32	1339.82	1651.6	2643.12	0	2643.12
2	1.66667	500	sand	0	32	1406.81	1734.18	2775.27	0	2775.27
3	1.66667	833.333	sand	0	32	1473.81	1816.76	2907.43	0	2907.43
4	1.88303	1337.25	Marine Clay	1200	0	973.473	1200	3604.25	58.7505	3545.5
5	1.88303	1752.11	Marine Clay	1200	0	973.473	1200	3821.96	176.252	3645.71
6	1.88303	2166.97	Marine Clay	1200	0	973.473	1200	4039.68	293.753	3745.93
7	1.88303	2581.82	Marine Clay	1200	0	973.473	1200	4257.41	411.254	3846.15
8	1.88303	2996.68	Marine Clay	1200	0	973.473	1200	4475.17	528.755	3946.41
9	1.88303	3411.54	Marine Clay	1200	0	973.473	1200	4692.89	646.256	4046.64
10	1.88303	3826.4	Marine Clay	1200	0	973.473	1200	4910.61	763.757	4146.86
11	1.88303	4241.26	Marine Clay	1200	0	973.473	1200	5128.34	881.258	4247.08
12	1.88303	4656.12	Marine Clay	1200	0	973.473	1200	5081.29	998.759	4082.53
13	1.69021	4182.02	Marine Clay	1200	0	973.473	1200	3602.96	999.61	2603.35
14	1.69021	3815.04	Marine Clay	1200	0	973.473	1200	3382.96	883.81	2499.15
15	1.69021	3448.05	Marine Clay	1200	0	973.473	1200	3162.96	768.011	2394.95
16	1.69021	3081.07	Marine Clay	1200	0	973.473	1200	2942.97	652.211	2290.76
17	1.69021	2714.08	Marine Clay	1200	0	973.473	1200	2722.97	536.411	2186.56
18	1.69021	2347.1	Marine Clay	1200	0	973.473	1200	2502.97	420.612	2082.36
19	1.69021	1980.11	Marine Clay	1200	0	973.473	1200	2282.97	304.812	1978.16
20	1.69021	1613.13	Marine Clay	1200	0	973.473	1200	2062.98	189.012	1873.97
21	1.69021	1246.14	Marine Clay	1200	0	973.473	1200	1842.98	73.2128	1769.77
22	0.245401	150.763	Marine Clay	1200	0	973.473	1200	1619.8	7.6565	1612.14
23	1.66667	833.333	sand	0	32	534.042	658.314	1053.52	0	1053.52
24	1.66667	500	sand	0	32	320.426	394.989	632.115	0	632.115
25	1.66667	166.667	sand	0	32	107.104	132.027	211.288	0	211.288

Query 1 (spencer) - Safety Factor: 1.2327

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	1.66667	166.667	sand	0	32	1339.82	1651.6	2643.12	0	2643.12
2	1.66667	500	sand	0	32	1406.81	1734.18	2775.27	0	2775.27

3	1.66667	833.333	sand	0	32	1473.81	1816.76	2907.43	0	2907.43
4	1.88303	1337.25	Marine Clay	1200	0	973.473	1200	3604.25	58.7505	3545.5
5	1.88303	1752.11	Marine Clay	1200	0	973.473	1200	3821.96	176.252	3645.71
6	1.88303	2166.97	Marine Clay	1200	0	973.473	1200	4039.68	293.753	3745.93
7	1.88303	2581.82	Marine Clay	1200	0	973.473	1200	4257.41	411.254	3846.15
8	1.88303	2996.68	Marine Clay	1200	0	973.473	1200	4475.17	528.755	3946.41
9	1.88303	3411.54	Marine Clay	1200	0	973.473	1200	4692.89	646.256	4046.64
10	1.88303	3826.4	Marine Clay	1200	0	973.473	1200	4910.61	763.757	4146.86
11	1.88303	4241.26	Marine Clay	1200	0	973.473	1200	5128.34	881.258	4247.08
12	1.88303	4656.12	Marine Clay	1200	0	973.473	1200	5081.29	998.759	4082.53
13	1.69021	4182.02	Marine Clay	1200	0	973.473	1200	3602.96	999.61	2603.35
14	1.69021	3815.04	Marine Clay	1200	0	973.473	1200	3382.96	883.81	2499.15
15	1.69021	3448.05	Marine Clay	1200	0	973.473	1200	3162.96	768.011	2394.95
16	1.69021	3081.07	Marine Clay	1200	0	973.473	1200	2942.97	652.211	2290.76
17	1.69021	2714.08	Marine Clay	1200	0	973.473	1200	2722.97	536.411	2186.56
18	1.69021	2347.1	Marine Clay	1200	0	973.473	1200	2502.97	420.612	2082.36
19	1.69021	1980.11	Marine Clay	1200	0	973.473	1200	2282.97	304.812	1978.16
20	1.69021	1613.13	Marine Clay	1200	0	973.473	1200	2062.98	189.012	1873.97
21	1.69021	1246.14	Marine Clay	1200	0	973.473	1200	1842.98	73.2128	1769.77
22	0.245401	150.763	Marine Clay	1200	0	973.473	1200	1619.8	7.6565	1612.14
23	1.66667	833.333	sand	0	32	534.042	658.314	1053.52	0	1053.52
24	1.66667	500	sand	0	32	320.426	394.989	632.115	0	632.115
25	1.66667	166.667	sand	0	32	107.104	132.027	211.288	0	211.288

## Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.2327

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	79.1821	48	0	0	0
2	80.8488	46.3333	2169.57	25.8111	0.681608

3	82.5154	44.6667	4447.62	52.9128	0.681609
4	84.1821	43	6834.15	81.305	0.681608
5	86.0651	41.117	11785.9	140.215	0.681607
6	87.9481	39.2339	17147.6	204.002	0.681606
7	89.8312	37.3509	22919.2	272.667	0.681609
8	91.7142	35.4679	29100.9	346.21	0.681609
9	93.5972	33.5848	35692.5	424.629	0.681608
10	95.4803	31.7018	42694.2	507.927	0.681608
11	97.3633	29.8188	50105.8	596.102	0.681608
12	99.2463	27.9358	57927.4	689.154	0.681608
13	101.129	26.0527	65660.4	781.153	0.681608
14	102.82	27.9085	57326.8	682.01	0.681609
15	104.51	29.7643	49401.6	587.724	0.681608
16	106.2	31.62	41884.6	498.296	0.681609
17	107.89	33.4758	34775.9	413.724	0.681608
18	109.58	35.3315	28075.4	334.01	0.68161
19	111.271	37.1873	21783.3	259.152	0.681605
20	112.961	39.0431	15899.3	189.152	0.681609
21	114.651	40.8988	10423.7	124.009	0.681606
22	116.341	42.7546	5356.25	63.7226	0.681608
23	116.587	43	4719.59	56.1483	0.681608
24	118.253	44.6667	2072.61	24.6576	0.681609
25	119.92	46.3333	484.431	5.76321	0.681608
26	121.587	48	0	0	0

Query 1 (spencer) - Safety Factor: 1.2327

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	79.1821	48	0	0	0
2	80.8488	46.3333	2169.57	25.8111	0.681608
3	82.5154	44.6667	4447.62	52.9128	0.681609
4	84.1821	43	6834.15	81.305	0.681608
5	86.0651	41.117	11785.9	140.215	0.681607
6	87.9481	39.2339	17147.6	204.002	0.681606
7	89.8312	37.3509	22919.2	272.667	0.681609
8	91.7142	35.4679	29100.9	346.21	0.681609
9	93.5972	33.5848	35692.5	424.629	0.681608
10	95.4803	31.7018	42694.2	507.927	0.681608
11	97.3633	29.8188	50105.8	596.102	0.681608
12	99.2463	27.9358	57927.4	689.154	0.681608
13	101.129	26.0527	65660.4	781.153	0.681608
14	102.82	27.9085	57326.8	682.01	0.681609
15	104.51	29.7643	49401.6	587.724	0.681608
16	106.2	31.62	41884.6	498.296	0.681609
17	107.89	33.4758	34775.9	413.724	0.681608
18	109.58	35.3315	28075.4	334.01	0.68161
19	111.271	37.1873	21783.3	259.152	0.681605
20	112.961	39.0431	15899.3	189.152	0.681609

21	114.651	40.8988	10423.7	124.009	0.681606
22	116.341	42.7546	5356.25	63.7226	0.681608
23	116.587	43	4719.59	56.1483	0.681608
24	118.253	44.6667	2072.61	24.6576	0.681609
25	119.92	46.3333	484.431	5.76321	0.681608
26	121.587	48	0	0	0

## List Of Coordinates

---

### Piezoline

X	Y
0	43
200	43

### Line Load

X	Y
101	48
0	48

### Block Search Window

X	Y
96	43
96	26
102	26
102	43

### Block Search Window

X	Y
110	43
110	26
121	26
121	43

### External Boundary

X	Y
200	-12
200	-8
200	18
200	26
200	43
200	48
0	48
0	43

0	26
0	18
0	-8
0	-12

#### Material Boundary

X	Y
0	43
200	43

#### Material Boundary

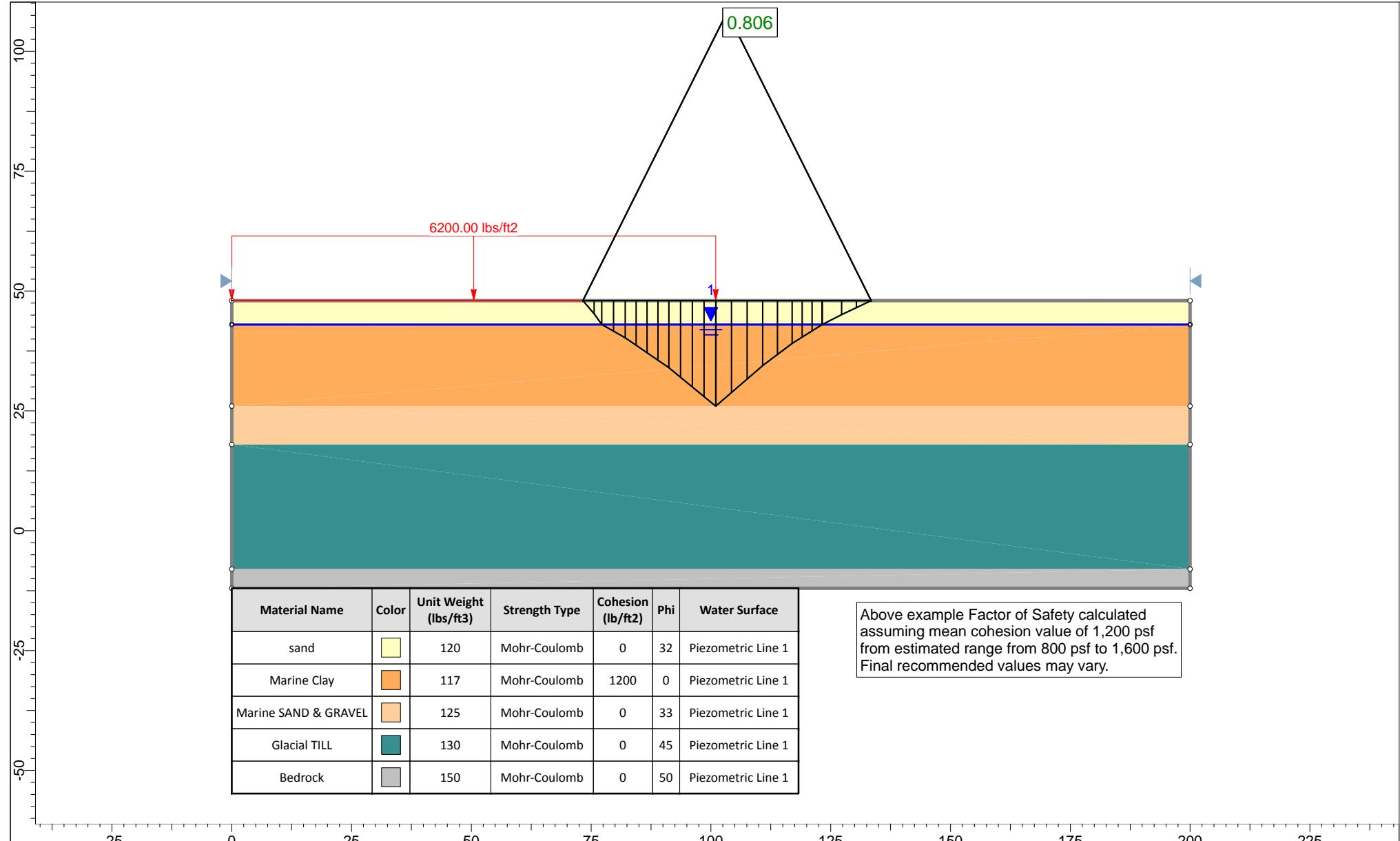
X	Y
0	26
200	26

#### Material Boundary

X	Y
0	18
200	18

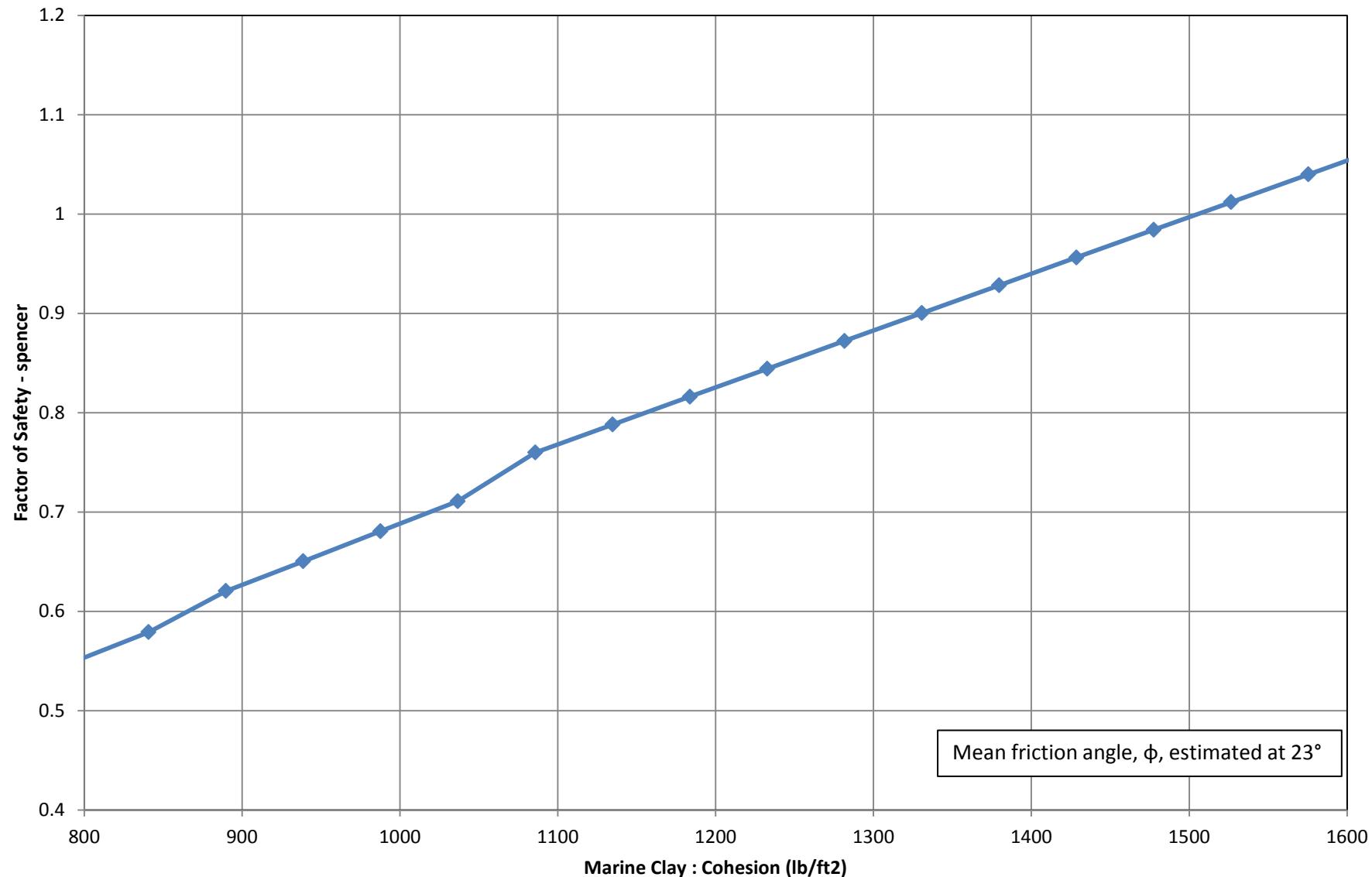
#### Material Boundary

X	Y
0	-8
200	-8



## Sensitivity Plot - LPG Tank - Hydrotest Conditions

### Undrained Condition (Short Term)



# *Slide Analysis Information*

## *Searsport LPG Tank & Ancillary Structures*

### ***Project Summary***

---

File Name: Hydrotest\_AutoBlock\_Sensitivity(800-1600)

Slide Modeler Version: 6.013

Project Title: Searsport LPG Tank & Ancillary Structures

Analysis: LPG Tank - Hydrotest Conditions - Undrained

Author: Nicolas Betancur

Company: Geocomp Consulting

Date Created: 11/8/2011, 1:39:01 PM

### ***General Settings***

---

Units of Measurement: Imperial Units

Time Units: days

Permeability Units: feet/second

Failure Direction: Left to Right

Data Output: Standard

Maximum Material Properties: 20

Maximum Support Properties: 20

### ***Analysis Options***

---

#### ***Analysis Methods Used***

Spencer

Number of slices: 25

Tolerance: 0.005

Maximum number of iterations: 50

Check malpha < 0.2: Yes

Initial trial value of FS: 1

Steffensen Iteration: Yes

### ***Groundwater Analysis***

---

Groundwater Method: Water Surfaces

Pore Fluid Unit Weight: 62.4 lbs/ft<sup>3</sup>

Advanced Groundwater Method: None

### ***Random Numbers***

---

Pseudo-random Seed: 10116

Random Number Generation Method: Park and Miller v.3

## Surface Options

---

Search Method: Auto Refine Search  
Divisions along slope: 10  
Circles per division: 10  
Number of iterations: 10  
Divisions to use in next iteration: 50%  
Number of vertices per surface: 12  
Minimum Elevation: Not Defined  
Minimum Depth: Not Defined

## Loading

---

1 Distributed Load present

### Distributed Load 1

Distribution: Constant  
Magnitude [lbs/ft<sup>2</sup>]: 6200  
Orientation: Normal to boundary

## Material Properties

---

Property	sand	Marine Clay	Marine SAND & GRAVEL	Glacial TILL	Bedrock
Color					
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft <sup>3</sup> ]	120	117	125	130	150
Cohesion [psf]	0	1200	0	0	0
Friction Angle [deg]	32	0	33	45	50
Water Surface	Piezometric Line 1	Piezometric Line 1	Piezometric Line 1	Piezometric Line 1	Piezometric Line 1
Hu Value	1	1	1	1	1

## Probabilistic Analysis Input

---

### General Settings

Sensitivity Analysis: On  
Probabilistic Analysis: Off

### Variables

Material	Property	Distribution	Mean	Min	Max
Marine Clay	Cohesion	Normal	1200	800	1600

## Global Minimums

---

## Method: spencer

FS: 0.805673  
Axis Location: 103.367, 108.158  
Left Slip Surface Endpoint: 73.288, 48.000  
Right Slip Surface Endpoint: 133.446, 48.000  
Resisting Moment=5.48798e+006 lb·ft  
Driving Moment=6.81167e+006 lb·ft  
Resisting Horizontal Force=66303.8 lb  
Driving Horizontal Force=82296.2 lb

## Global Minimum Coordinates

---

### Method: spencer

X	Y
73.2882	48
75.6244	45.2532
77.2149	43.0137
82.1146	40.2337
91.2316	33.997
101	25.9803
101.044	26.0198
110.812	34.4434
116.952	39.0686
123.188	42.9636
127.267	45.0679
133.446	48

## Valid / Invalid Surfaces

---

### Method: spencer

Number of Valid Surfaces: 1676  
Number of Invalid Surfaces: 2825

#### Error Codes:

Error Code -105 reported for 11 surfaces  
Error Code -106 reported for 550 surfaces  
Error Code -107 reported for 32 surfaces  
Error Code -108 reported for 1550 surfaces  
Error Code -112 reported for 682 surfaces

#### Error Codes

The following errors were encountered during the computation:

- 105 = More than two surface / slope intersections with no valid slip surface.
- 106 = Average slice width is less than 0.0001 \* (maximum horizontal extent of soil region). This limitation is imposed to avoid numerical errors which may result from too many slices, or too small a slip region.
- 107 = Total driving moment or total driving force is negative. This will occur if the wrong failure direction is specified, or if

high external or anchor loads are applied against the failure direction.

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-112 = The coefficient M-Alpha =  $\cos(\alpha)(1+\tan(\alpha)\tan(\phi))/F < 0.2$  for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

## Slice Data

Global Minimum Query (spencer) - Safety Factor: 0.805673

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	2.33619	385.024	sand	0	32	2586.42	2083.81	3334.78	0	3334.78
2	1.59046	737.958	sand	0	32	2476.65	1995.37	3193.26	0	3193.26
3	2.44984	1665.2	Marine Clay	1200	0	1489.44	1200	6050.68	42.5154	6008.16
4	2.44984	2063.61	Marine Clay	1200	0	1489.44	1200	6214.06	129.25	6084.81
5	2.27926	2313.15	Marine Clay	1200	0	1489.44	1200	6218.79	221.264	5997.53
6	2.27926	2728.94	Marine Clay	1200	0	1489.44	1200	6402.24	318.557	6083.68
7	2.27926	3144.74	Marine Clay	1200	0	1489.44	1200	6585.69	415.85	6169.84
8	2.27926	3560.53	Marine Clay	1200	0	1489.44	1200	6769.14	513.143	6255.99
9	2.4421	4323.97	Marine Clay	1200	0	1489.44	1200	6781.87	624.32	6157.55
10	2.4421	4896.62	Marine Clay	1200	0	1489.44	1200	7017.94	749.38	6268.56
11	2.4421	5469.26	Marine Clay	1200	0	1489.44	1200	7254.01	874.441	6379.57
12	2.4421	6041.91	Marine Clay	1200	0	1489.44	1200	7490.12	999.502	6490.62
13	0.0440661	114.089	Marine Clay	1200	0	1489.44	1200	3884.06	1060.8	2823.26
14	3.25601	7887.44	Marine Clay	1200	0	1489.44	1200	3668.51	971.959	2696.55
15	3.25601	6817.77	Marine Clay	1200	0	1489.44	1200	3342.31	796.747	2545.56
16	3.25601	5748.09	Marine Clay	1200	0	1489.44	1200	3016.11	621.535	2394.57
17	3.07001	4500.12	Marine Clay	1200	0	1489.44	1200	2559.62	461.777	2097.84
18	3.07001	3669.47	Marine Clay	1200	0	1489.44	1200	2290.71	317.473	1973.24
19	2.07852	2045.31	Marine Clay	1200	0	1489.44	1200	1892.38	204.812	1687.56
20	2.07852	1729.57	Marine Clay	1200	0	1489.44	1200	1741.25	123.795	1617.45

21	2.07852	1413.83	Marine Clay	1200	0	1489.44	1200	1590.12	42.7782	1547.34
22	0.070508	42.4549	Marine Clay	1200	0	1489.44	1200	1352.47	1.13488	1351.34
23	4.00838	1907.7	sand	0	32	604.593	487.104	779.528	0	779.528
24	3.08991	815.401	sand	0	32	318.645	256.724	410.845	0	410.845
25	3.08991	271.8	sand	0	32	106.215	85.5747	136.948	0	136.948

Query 1 (spencer) - Safety Factor: 0.805673

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	2.33619	385.024	sand	0	32	2586.42	2083.81	3334.78	0	3334.78
2	1.59046	737.958	sand	0	32	2476.65	1995.37	3193.26	0	3193.26
3	2.44984	1665.2	Marine Clay	1200	0	1489.44	1200	6050.68	42.5154	6008.16
4	2.44984	2063.61	Marine Clay	1200	0	1489.44	1200	6214.06	129.25	6084.81
5	2.27926	2313.15	Marine Clay	1200	0	1489.44	1200	6218.79	221.264	5997.53
6	2.27926	2728.94	Marine Clay	1200	0	1489.44	1200	6402.24	318.557	6083.68
7	2.27926	3144.74	Marine Clay	1200	0	1489.44	1200	6585.69	415.85	6169.84
8	2.27926	3560.53	Marine Clay	1200	0	1489.44	1200	6769.14	513.143	6255.99
9	2.4421	4323.97	Marine Clay	1200	0	1489.44	1200	6781.87	624.32	6157.55
10	2.4421	4896.62	Marine Clay	1200	0	1489.44	1200	7017.94	749.38	6268.56
11	2.4421	5469.26	Marine Clay	1200	0	1489.44	1200	7254.01	874.441	6379.57
12	2.4421	6041.91	Marine Clay	1200	0	1489.44	1200	7490.12	999.502	6490.62
13	0.0440661	114.089	Marine Clay	1200	0	1489.44	1200	3884.06	1060.8	2823.26
14	3.25601	7887.44	Marine Clay	1200	0	1489.44	1200	3668.51	971.959	2696.55
15	3.25601	6817.77	Marine Clay	1200	0	1489.44	1200	3342.31	796.747	2545.56
16	3.25601	5748.09	Marine Clay	1200	0	1489.44	1200	3016.11	621.535	2394.57
17	3.07001	4500.12	Marine Clay	1200	0	1489.44	1200	2559.62	461.777	2097.84
18	3.07001	3669.47	Marine Clay	1200	0	1489.44	1200	2290.71	317.473	1973.24
19	2.07852	2045.31	Marine Clay	1200	0	1489.44	1200	1892.38	204.812	1687.56
20	2.07852	1729.57	Marine Clay	1200	0	1489.44	1200	1741.25	123.795	1617.45
21	2.07852	1413.83	Marine Clay	1200	0	1489.44	1200	1590.12	42.7782	1547.34

22	0.070508	42.4549	Marine Clay	1200	0	1489.44	1200	1352.47	1.13488	1351.34
23	4.00838	1907.7	sand	0	32	604.593	487.104	779.528	0	779.528
24	3.08991	815.401	sand	0	32	318.645	256.724	410.845	0	410.845
25	3.08991	271.8	sand	0	32	106.215	85.5747	136.948	0	136.948

## Interslice Data

Global Minimum Query (spencer) - Safety Factor: 0.805673

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	73.2882	48	0	0	0
2	75.6244	45.2532	3117.69	-25.7043	-0.472374
3	77.2149	43.0137	6330.08	-52.1895	-0.472375
4	79.6647	41.6237	11091.5	-91.446	-0.472375
5	82.1146	40.2337	16080	-132.575	-0.472377
6	84.3938	38.6745	22381.4	-184.528	-0.472376
7	86.6731	37.1153	28968.9	-238.839	-0.472374
8	88.9524	35.5561	35842.3	-295.509	-0.472376
9	91.2316	33.997	43001.9	-354.537	-0.472375
10	93.6737	31.9928	52956.6	-436.61	-0.472374
11	96.1158	29.9886	63384.4	-522.585	-0.472375
12	98.5579	27.9844	74285.4	-612.46	-0.472375
13	101	25.9803	85659.6	-706.236	-0.472375
14	101.044	26.0198	85440.4	-704.429	-0.472375
15	104.3	28.8277	70290.1	-579.519	-0.472374
16	107.556	31.6356	56055.6	-462.161	-0.472375
17	110.812	34.4434	42737.1	-352.354	-0.472375
18	113.882	36.756	32245.2	-265.852	-0.472376
19	116.952	39.0686	22375.2	-184.476	-0.472374
20	119.031	40.3669	16822.4	-138.696	-0.472377
21	121.109	41.6653	11465.8	-94.5323	-0.472377
22	123.188	42.9636	6305.5	-51.9868	-0.472374
23	123.258	43	6151.28	-50.7154	-0.472375
24	127.267	45.0679	2115.88	-17.4448	-0.472376
25	130.356	46.5339	528.97	-4.36119	-0.472375
26	133.446	48	0	0	0

Query 1 (spencer) - Safety Factor: 0.805673

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	73.2882	48	0	0	0
2	75.6244	45.2532	3117.69	-25.7043	-0.472374
3	77.2149	43.0137	6330.08	-52.1895	-0.472375
4	79.6647	41.6237	11091.5	-91.446	-0.472375
5	82.1146	40.2337	16080	-132.575	-0.472377

6	84.3938	38.6745	22381.4	-184.528	-0.472376
7	86.6731	37.1153	28968.9	-238.839	-0.472374
8	88.9524	35.5561	35842.3	-295.509	-0.472376
9	91.2316	33.997	43001.9	-354.537	-0.472375
10	93.6737	31.9928	52956.6	-436.61	-0.472374
11	96.1158	29.9886	63384.4	-522.585	-0.472375
12	98.5579	27.9844	74285.4	-612.46	-0.472375
13	101	25.9803	85659.6	-706.236	-0.472375
14	101.044	26.0198	85440.4	-704.429	-0.472375
15	104.3	28.8277	70290.1	-579.519	-0.472374
16	107.556	31.6356	56055.6	-462.161	-0.472375
17	110.812	34.4434	42737.1	-352.354	-0.472375
18	113.882	36.756	32245.2	-265.852	-0.472376
19	116.952	39.0686	22375.2	-184.476	-0.472374
20	119.031	40.3669	16822.4	-138.696	-0.472377
21	121.109	41.6653	11465.8	-94.5323	-0.472377
22	123.188	42.9636	6305.5	-51.9868	-0.472374
23	123.258	43	6151.28	-50.7154	-0.472375
24	127.267	45.0679	2115.88	-17.4448	-0.472376
25	130.356	46.5339	528.97	-4.36119	-0.472375
26	133.446	48	0	0	0

## List Of Coordinates

---

### Piezoline

X	Y
0	43
200	43

### Line Load

X	Y
101	48
0	48

### External Boundary

X	Y
200	-12
200	-8
200	18
200	26
200	43
200	48
0	48
0	43
0	26

0	18
0	-8
0	-12

### Material Boundary

X	Y
0	43
200	43

### Material Boundary

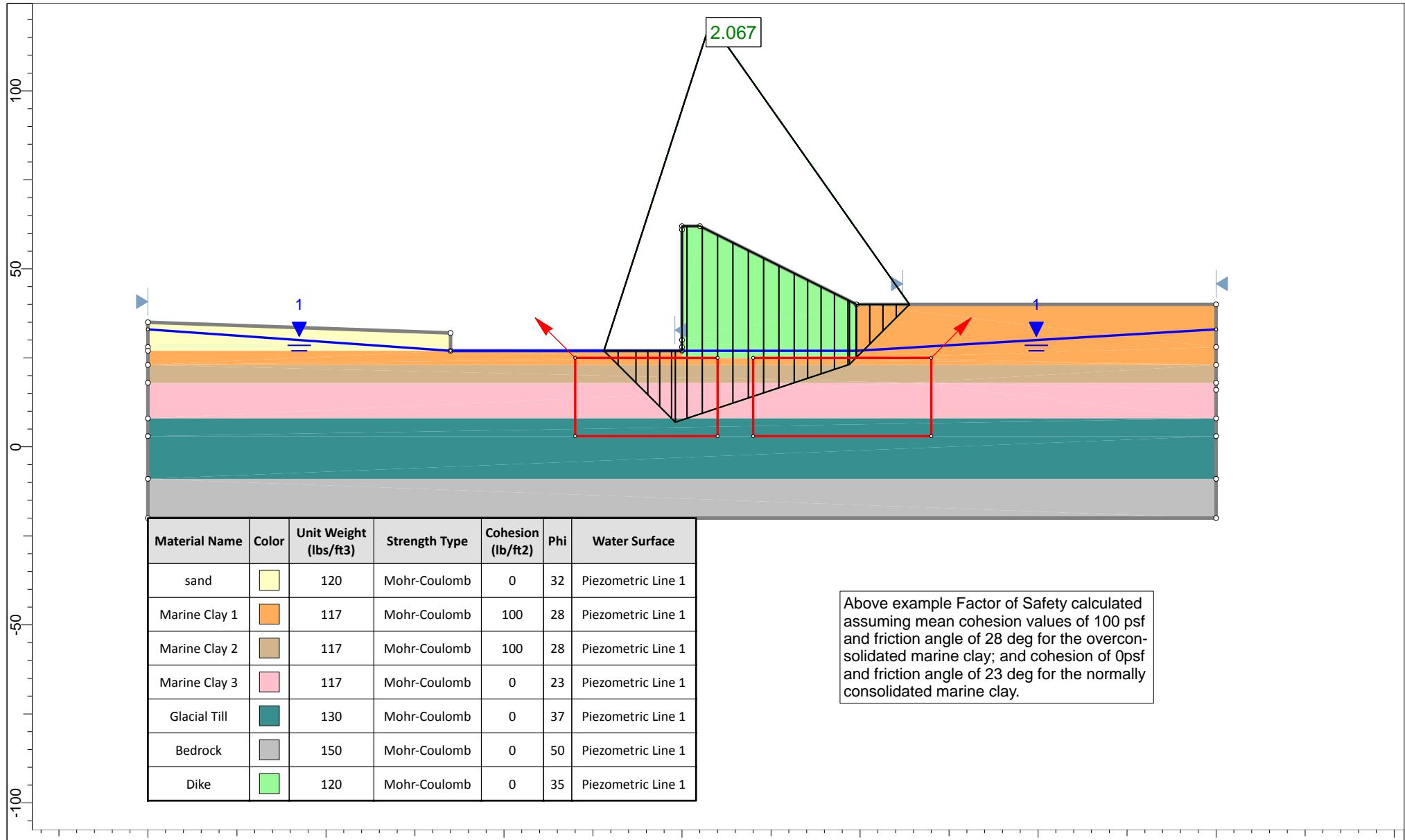
X	Y
0	26
200	26

### Material Boundary

X	Y
0	18
200	18

### Material Boundary

X	Y
0	-8
200	-8



## *Slide Analysis Information*

# **Searsport LPG Tank & Ancillary Structures - Containment Dike - Normal Condition - Drained**

### **Project Summary**

---

File Name: Dike\_Normal\_Drained

Slide Modeler Version: 6.013

Project Title: Searsport LPG Tank & Ancillary Structures - Containment Dike - Normal Condition - Drained

Analysis: Containment Dike - Normal Condition - Drained

Author: Nicolas Betancur

Company: Geocomp Consulting

Date Created: 11/8/2011, 1:39:01 PM

### **General Settings**

---

Units of Measurement: Imperial Units

Time Units: days

Permeability Units: feet/second

Failure Direction: Right to Left

Data Output: Standard

Maximum Material Properties: 20

Maximum Support Properties: 20

### **Analysis Options**

---

#### **Analysis Methods Used**

Spencer

Number of slices: 25

Tolerance: 0.005

Maximum number of iterations: 50

Check malpha < 0.2: Yes

Initial trial value of FS: 1

Steffensen Iteration: Yes

### **Groundwater Analysis**

---

Groundwater Method: Water Surfaces

Pore Fluid Unit Weight: 62.4 lbs/ft<sup>3</sup>

Advanced Groundwater Method: None

### **Random Numbers**

---

Pseudo-random Seed: 10116

Random Number Generation Method: Park and Miller v.3

## Surface Options

---

Surface Type: Non-Circular Block Search

Number of Surfaces: 5000

Pseudo-Random Surfaces: Enabled

Convex Surfaces Only: Disabled

Left Projection Angle (Start Angle): 135

Left Projection Angle (End Angle): 135

Right Projection Angle (Start Angle): 45

Right Projection Angle (End Angle): 45

Minimum Elevation: Not Defined

Minimum Depth: Not Defined

## Material Properties

---

Property	sand	Marine Clay 1	Marine Clay 2	Marine Clay 3	Glacial Till	Bedrock	Dike
Color							
Strength Type	Mohr-Coulomb						
Unit Weight [lbs/ft <sup>3</sup> ]	120	117	117	117	130	150	120
Cohesion [psf]	0	100	100	0	0	0	0
Friction Angle [deg]	32	28	28	23	37	50	35
Water Surface	Piezometric Line 1						
Hu Value	1	1	1	1	1	1	1

## Probabilistic Analysis Input

---

### General Settings

Sensitivity Analysis: On

Probabilistic Analysis: Off

### Variables

Material	Property	Distribution	Mean	Min	Max
Marine Clay 1	Cohesion	Normal	100	0	500
Marine Clay 1	Phi	Normal	28	23	30
Marine Clay 20	Cohesion	Normal	100	0	500
Marine Clay 20	Phi	Normal	28	23	30
Marine Clay 30	Phi	Normal	23	21	28

## Global Minimums

---

## Method: spencer

FS: 2.066650  
Axis Location: 157.967, 119.323  
Left Slip Surface Endpoint: 128.055, 27.000  
Right Slip Surface Endpoint: 213.878, 40.000  
Resisting Moment=1.07553e+007 lb·ft  
Driving Moment=5.20423e+006 lb·ft  
Resisting Horizontal Force=95172.4 lb  
Driving Horizontal Force=46051.6 lb

## Global Minimum Coordinates

---

### Method: spencer

X	Y
128.055	27
148.135	6.92017
197.027	23.1494
213.878	40

## Valid / Invalid Surfaces

---

### Method: spencer

Number of Valid Surfaces: 3889  
Number of Invalid Surfaces: 1111

#### Error Codes:

Error Code -108 reported for 589 surfaces  
Error Code -111 reported for 522 surfaces

#### Error Codes

The following errors were encountered during the computation:

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).  
-111 = safety factor equation did not converge

## Slice Data

---

### Global Minimum Query (spencer) - Safety Factor: 2.06665

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4	936	Marine Clay 1	100	28	119.208	246.361	400.065	124.8	275.265
2	5	3802.5	Marine Clay 2	100	28	229.942	475.209	1111.27	405.6	705.666

3	3.33333	4160	Marine Clay 3	0	23	192.266	397.347	1601.69	665.6	936.092
4	3.33333	5460	Marine Clay 3	0	23	252.35	521.519	2102.22	873.6	1228.62
5	3.33333	6760	Marine Clay 3	0	23	312.433	645.69	2602.75	1081.6	1521.15
6	1.07983	2476.26	Glacial Till	0	37	841.894	1739.9	3528.22	1219.29	2308.93
7	3.25313	13297.6	Glacial Till	0	37	923.417	1908.38	3751.79	1219.29	2532.5
8	4.30376	27294.8	Marine Clay 3	0	23	982.982	2031.48	5926.9	1141.03	4785.87
9	4.30376	25855.6	Marine Clay 3	0	23	936.825	1936.09	5613.03	1051.89	4561.14
10	4.30376	24024.9	Marine Clay 3	0	23	873.37	1804.95	5214.92	962.743	4252.18
11	4.30376	22194.2	Marine Clay 3	0	23	809.91	1673.8	4816.83	873.6	3943.23
12	4.30376	20363.5	Marine Clay 3	0	23	746.45	1542.65	4418.72	784.457	3634.26
13	4.30376	18532.8	Marine Clay 3	0	23	682.994	1411.51	4020.63	695.314	3325.32
14	4.30376	16702.2	Marine Clay 3	0	23	619.534	1280.36	3622.52	606.171	3016.35
15	3.76579	13112.7	Marine Clay 2	100	28	739.075	1527.41	3207.17	522.6	2684.57
16	3.76579	11711	Marine Clay 2	100	28	670.322	1385.32	2861.94	444.6	2417.34
17	3.76579	10309.4	Marine Clay 2	100	28	601.568	1243.23	2516.71	366.6	2150.11
18	3.76579	8907.81	Marine Clay 2	100	28	532.819	1101.15	2171.48	288.6	1882.88
19	0.450095	970.907	Marine Clay 1	100	28	494.332	1021.61	1978.24	244.939	1733.3
20	1.8506	3647.7	Marine Clay 1	100	28	384.062	793.721	1487.24	182.539	1304.7
21	0.121924	219.017	Dike	0	35	403.167	833.205	1310.94	120.996	1189.94
22	3.71952	5665.36	Marine Clay 1	100	28	333.992	690.245	1118.13	8.03695	1110.09
23	3.71952	4046.69	Marine Clay 1	100	28	251.159	519.057	788.131	0	788.131
24	3.71952	2428.01	Marine Clay 1	100	28	166.623	344.351	459.559	0	459.559
25	3.71952	809.337	Marine Clay 1	100	28	82.0783	169.627	130.95	0	130.95

## Interslice Data

Global Minimum Query (spencer) - Safety Factor: 2.06665

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	128.055	27	0	0	0

2	132.055	23	2077.84	186.871	5.13908
3	137.055	18	8785.7	790.144	5.13908
4	140.388	14.6667	14766.6	1328.03	5.13905
5	143.722	11.3333	22616.5	2034.02	5.13908
6	147.055	8	32335.4	2908.09	5.13908
7	148.135	6.92017	37055.8	3332.62	5.13908
8	151.388	8	36013.3	3238.86	5.13908
9	155.692	9.42857	31783.5	2858.45	5.13907
10	159.995	10.8571	27803.1	2500.48	5.13909
11	164.299	12.2857	24117.9	2169.05	5.13909
12	168.603	13.7143	20727.9	1864.17	5.13909
13	172.907	15.1429	17633.1	1585.83	5.13906
14	177.21	16.5714	14833.4	1334.05	5.1391
15	181.514	18	12329	1108.81	5.13908
16	185.28	19.25	11107.6	998.964	5.13908
17	189.046	20.5	10058.5	904.61	5.13906
18	192.812	21.75	9181.55	825.744	5.13908
19	196.577	23	8476.85	762.367	5.13908
20	197.027	23.1494	8404.14	755.828	5.13908
21	198.878	25	6363.73	572.323	5.13908
22	199	25.1219	6253.13	562.376	5.13908
23	202.72	28.8414	3338.49	300.248	5.13909
24	206.439	32.561	1342.69	120.755	5.13908
25	210.159	36.2805	254.09	22.8516	5.13907
26	213.878	40	0	0	0

## List Of Coordinates

---

### Piezoline

X	Y
0	33
85	27
150	27
199	27
300	33

### Block Search Window

X	Y
170	25
170	3
220	3
220	25

### Block Search Window

X	Y

120	3
160	3
160	25
120	25

### External Boundary

X	Y
300	-20
300	-9
300	3
300	8
300	16
300	18
300	23
300	28
300	40
199	40
155	62
150	62
150	61
150	30
150	28
150	27
85	27
85	32
0	35
0	28
0	27
0	23
0	18
0	8
0	3
0	-9
0	-20

### Material Boundary

X	Y
0	8
300	8

### Material Boundary

X	Y
0	-9
300	-9

### Material Boundary

X	Y
0	27
85	27

### Material Boundary

X	Y
0	18
214.248	18
300	18

### Material Boundary

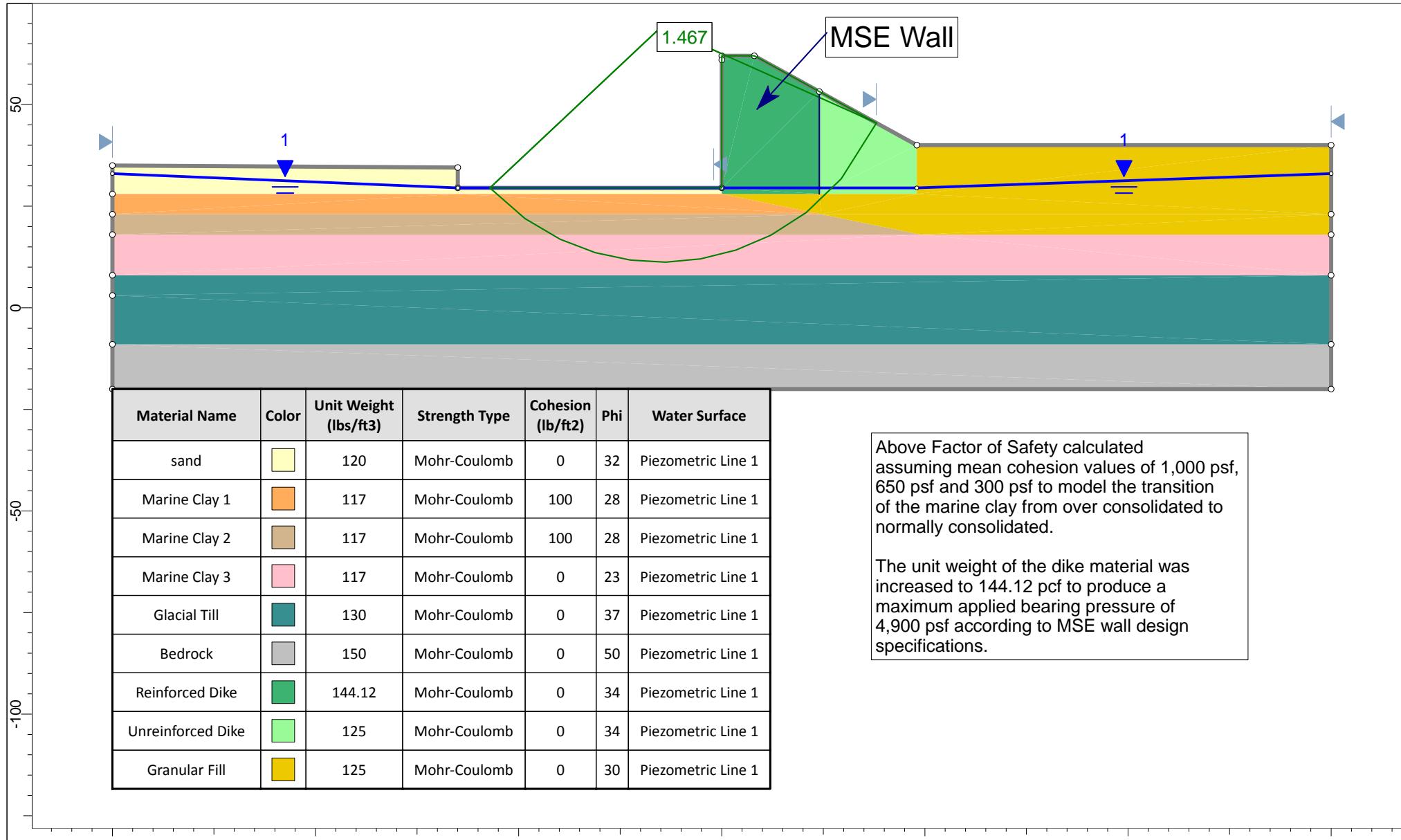
X	Y
0	23
300	23

### Material Boundary

X	Y
150	25
150	27

### Material Boundary

X	Y
150	25
199	25
199	40



## *Slide Analysis Information*

# **Searsport LPG Tank & Ancillary Structures - Containment Dike - Normal Condition - Drained**

### **Project Summary**

---

File Name: Dike\_Normal\_Drained  
Slide Modeler Version: 6.014  
Project Title: Searsport LPG Tank & Ancillary Structures - Containment Dike - Normal Condition - Drained  
Analysis: Containment Dike - Normal Condition - Drained  
Author: Nicolas Betancur  
Company: Geocomp Consulting  
Date Created: 12/16/2011

### **General Settings**

---

Units of Measurement: Imperial Units  
Time Units: days  
Permeability Units: feet/second  
Failure Direction: Right to Left  
Data Output: Standard  
Maximum Material Properties: 20  
Maximum Support Properties: 20

### **Analysis Options**

---

#### **Analysis Methods Used**

Spencer  
Number of slices: 25  
Tolerance: 0.005  
Maximum number of iterations: 50  
Check malpha < 0.2: Yes  
Initial trial value of FS: 1  
Steffensen Iteration: Yes

### **Groundwater Analysis**

---

Groundwater Method: Water Surfaces  
Pore Fluid Unit Weight: 62.4 lbs/ft<sup>3</sup>  
Advanced Groundwater Method: None

### **Random Numbers**

---

Pseudo-random Seed: 10116  
Random Number Generation Method: Park and Miller v.3

### **Surface Options**

---

Search Method: Auto Refine Search  
Divisions along slope: 10  
Circles per division: 10

Number of iterations: 10  
 Divisions to use in next iteration: 50%  
 Number of vertices per surface: 12  
 Minimum Elevation: Not Defined  
 Minimum Depth: Not Defined

## Material Properties

Property	sand	Marine Clay 1	Marine Clay 2	Marine Clay 3	Glacial Till	Bedrock	Reinforced Dike	Unreinforced Dike
Color								
Strength Type	Mohr-Coulomb							
Unit Weight [lbs/ft <sup>3</sup> ]	120	117	117	117	130	150	144.12	125
Cohesion [psf]	0	100	100	0	0	0	0	0
Friction Angle [deg]	32	28	28	23	37	50	34	34
Water Surface	Piezometric Line 1							
Hu Value	1	1	1	1	1	1	1	1

Property	Granular Fill
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft <sup>3</sup> ]	125
Cohesion [psf]	0
Friction Angle [deg]	30
Water Surface	Piezometric Line 1
Hu Value	1

## Global Minimum

### Method: spencer

FS: 1.467010  
 Axis Location: 135.160, 69.177  
 Left Slip Surface Endpoint: 92.909, 29.500  
 Right Slip Surface Endpoint: 188.052, 45.472  
 Resisting Moment=5.55993e+006 lb-ft  
 Driving Moment=3.78997e+006 lb-ft  
 Resisting Horizontal Force=81805.3 lb  
 Driving Horizontal Force=55763.3 lb

## Global Minimum Coordinates

### Method: spencer

X	Y
92.9088	29.5
101.558	21.9504
110.208	16.8624
118.857	13.5563
127.506	11.7237
136.156	11.2246
144.805	12.0241

153.454	14.1788
162.104	17.8591
170.753	23.4318
179.402	31.7324
188.052	45.4715

## Valid / Invalid Surfaces

---

### Method: spencer

Number of Valid Surfaces: 1315

Number of Invalid Surfaces: 3185

#### Error Codes:

- Error Code -105 reported for 507 surfaces
- Error Code -107 reported for 21 surfaces
- Error Code -108 reported for 3 surfaces
- Error Code -113 reported for 2654 surfaces

#### Error Codes

The following errors were encountered during the computation:

- 105 = More than two surface / slope intersections with no valid slip surface.
- 107 = Total driving moment or total driving force is negative. This will occur if the wrong failure direction is specified, or if high external or anchor loads are applied against the failure direction.
- 108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
- 113 = Surface intersects outside slope limits.

## Slice Data

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### Global Minimum Query (spencer) - Safety Factor: 1.46701

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	1.7185	154.665	sand	0	32	41.1609	60.3834	143.434	46.8	96.6338
2	5.72832	2706.63	Marine Clay 1	100	28	272.922	400.379	814.531	249.6	564.931
3	1.20254	993.781	Marine Clay 2	100	28	392.453	575.732	1333.07	438.349	894.721
4	6.71541	7513.9	Marine Clay 2	100	28	389.723	571.728	1481.54	594.349	887.19
5	1.93394	2739.53	Marine Clay 3	0	23	278.861	409.092	1716.85	753.095	963.759
6	4.32468	6832.16	Marine Clay 3	0	23	273.524	401.263	1785.48	840.164	945.316
7	4.32468	7668.58	Marine Clay 3	0	23	306.911	450.241	2004.02	943.314	1060.7
8	4.32468	8318.6	Marine Clay 3	0	23	301.533	442.352	2065.59	1023.48	1042.11
9	4.32468	8782.24	Marine Clay 3	0	23	318.296	466.944	2180.71	1080.65	1100.06
10	4.32468	9077.19	Marine Clay 3	0	23	302.215	443.353	2161.5	1117.03	1044.47
11	4.32468	9203.45	Marine Clay 3	0	23	306.409	449.505	2191.57	1132.6	1058.97
12	4.32468	9165.44	Marine Clay 3	0	23	281.992	413.685	2102.49	1127.91	974.581
13	4.32468	8963.17	Marine Clay 3	0	23	275.784	404.578	2056.09	1102.97	953.121
14	4.32468	8589.47	Marine Clay 3	0	23	244.239	358.301	1900.99	1056.88	844.106
15	4.32468	24358.8	Marine Clay 3	0	23	1250.88	1835.06	5312.79	989.655	4323.13
16	8.64936	53949.4	Marine Clay 3	0	23	1362.8	1999.24	5551.14	841.216	4709.92
17	0.218649	1260.36	Marine Clay 3	0	23	1180.17	1731.32	4800.74	721.995	4078.75
18	3.88026	21150.2	Marine Clay 2	100	28	1425.1	2090.64	4383.45	639.6	3743.85
19	3.88026	18846.3	Marine Clay 2	100	28	1302.6	1910.92	3889.43	483.6	3405.83
20	0.670181	3021.74	Marine Clay 1	100	28	1230.76	1805.54	3599.78	392.128	3207.65

21	0.286053	1267.33	Marine Clay 1	100	28	1086.22	1593.49	3178.93	370.091	2808.84
22	4.4741	16989.6	Granular Fill	0	30	970.648	1423.95	2693.92	227.563	2466.35
23	3.8892	10419.2	Unreinforced Dike	0	34	824.112	1208.98	1792.38	0	1792.38
24	4.32468	7499.12	Unreinforced Dike	0	34	430.809	632.001	936.981	0	936.981
25	4.32468	2499.71	Unreinforced Dike	0	34	144.201	211.544	313.627	0	313.627

## Interslice Data

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Global Minimum Query (spencer) - Safety Factor: 1.46701

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	92.9088	29.5	0	0	0
2	94.6273	28	285.968	30.2254	6.03348
3	100.356	23	5923.84	626.12	6.03347
4	101.558	21.9504	7795.58	823.954	6.03348
5	108.274	18	16268.4	1719.49	6.03348
6	110.208	16.8624	18761.5	1983	6.03349
7	114.532	15.2093	22897.3	2420.13	6.03348
8	118.857	13.5563	27538.8	2910.72	6.03349
9	123.182	12.64	30737.1	3248.76	6.03348
10	127.506	11.7237	34113.4	3605.62	6.03348
11	131.831	11.4741	35961.3	3800.93	6.03348
12	136.156	11.2246	37834.8	3998.95	6.03348
13	140.48	11.6244	38215.3	4039.17	6.03348
14	144.805	12.0241	38587.5	4078.5	6.03347
15	149.13	13.1015	37596.9	3973.81	6.03348
16	153.454	14.1788	37289.2	3941.28	6.03347
17	162.104	17.8591	28660.5	3029.27	6.03347
18	162.322	18	28242.5	2985.09	6.03347
19	166.203	20.5	22820.2	2411.98	6.03347
20	170.083	23	18156.9	1919.09	6.03347
21	170.753	23.4318	17428.3	1842.09	6.0335
22	171.039	23.7063	16866.7	1782.73	6.03349
23	175.513	28	9647.76	1019.72	6.03348
24	179.402	31.7324	6166.81	651.8	6.03347
25	183.727	38.602	1595.44	168.63	6.03348
26	188.052	45.4715	0	0	0

## List Of Coordinates

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### Piezoline

X	Y
0	33
85	29.5
150	29.5
198	29.5
300	33

### External Boundary

X	Y

300	-20
300	-9
300	8
300	18
300	23
300	40
198	40
174.001	53.1996
158	62
150	62
150	61
150	29.5
85	29.5
85	34.5
0	35
0	28
0	23
0	18
0	8
0	3
0	-9
0	-20

#### Material Boundary

X	Y
0	8
300	8

#### Material Boundary

X	Y
0	-9
300	-9

#### Material Boundary

X	Y
0	18
199	18

#### Material Boundary

X	Y
0	23
174.5	23
300	23

#### Material Boundary

X	Y
0	28
85	28
150	28

### Material Boundary

X	Y
150	28
150	29.5

### Material Boundary

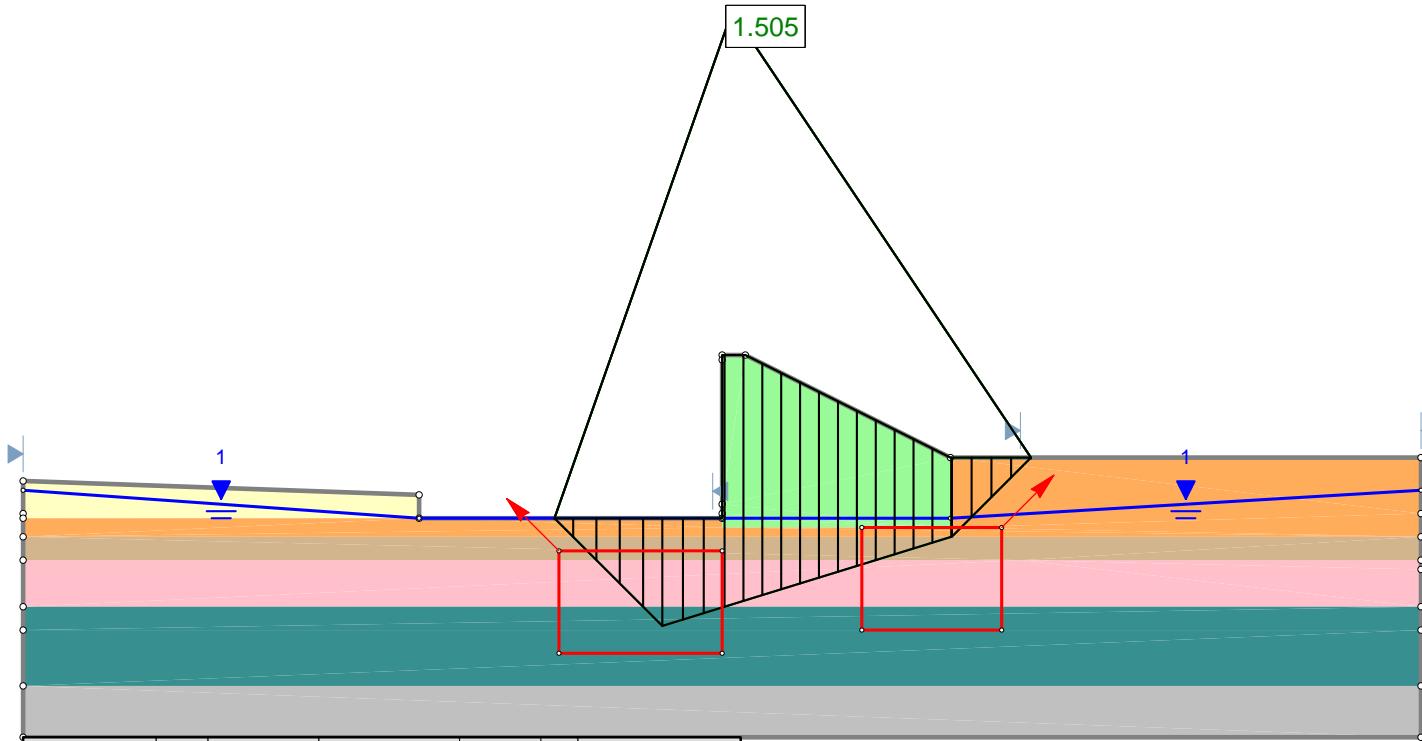
X	Y
150	28
174.5	23
199	18
300	18

### Material Boundary

X	Y
150	28
174	28

### Material Boundary

X	Y
174.001	53.1996
174	28
198	28
198	40



Material Name	Color	Unit Weight (lbs/ft³)	Strength Type	Cohesion (lb/ft²)	Phi	Water Surface
sand	[Yellow]	120	Mohr-Coulomb	0	32	Piezometric Line 1
Marine Clay 1	[Orange]	117	Mohr-Coulomb	1000	0	Piezometric Line 1
Marine Clay 2	[Brown]	117	Mohr-Coulomb	650	0	Piezometric Line 1
Marine Clay 3	[Pink]	117	Mohr-Coulomb	300	0	Piezometric Line 1
Glacial Till	[Teal]	130	Mohr-Coulomb	0	37	Piezometric Line 1
Bedrock	[Grey]	150	Mohr-Coulomb	0	50	Piezometric Line 1
Dike	[Green]	120	Mohr-Coulomb	0	35	Piezometric Line 1

Above example Factor of Safety calculated assuming mean cohesion values of 1,000 psf, 650 psf and 300 psf to model the transition of the marine clay from over consolidated to normally consolidated.

## *Slide Analysis Information*

### **Searsport LPG Tank & Ancillary Structures - Containment Dike - Normal Condition - Undrained**

#### **Project Summary**

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File Name: Dike\_Normal\_Undrained

Slide Modeler Version: 6.013

Project Title: Searsport LPG Tank & Ancillary Structures - Containment Dike - Normal Condition - Undrained

Analysis: Containment Dike - Normal Condition - Undrained

Author: Nicolas Betancur

Company: Geocomp Consulting

Date Created: 11/8/2011, 1:39:01 PM

#### **General Settings**

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Units of Measurement: Imperial Units

Time Units: days

Permeability Units: feet/second

Failure Direction: Right to Left

Data Output: Standard

Maximum Material Properties: 20

Maximum Support Properties: 20

#### **Analysis Options**

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##### **Analysis Methods Used**

Spencer

Number of slices: 25

Tolerance: 0.005

Maximum number of iterations: 50

Check malpha < 0.2: Yes

Initial trial value of FS: 1

Steffensen Iteration: Yes

#### **Groundwater Analysis**

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Groundwater Method: Water Surfaces

Pore Fluid Unit Weight: 62.4 lbs/ft<sup>3</sup>

Advanced Groundwater Method: None

#### **Random Numbers**

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Pseudo-random Seed: 10116

Random Number Generation Method: Park and Miller v.3

## Surface Options

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Surface Type: Non-Circular Block Search

Number of Surfaces: 5000

Pseudo-Random Surfaces: Enabled

Convex Surfaces Only: Disabled

Left Projection Angle (Start Angle): 135

Left Projection Angle (End Angle): 135

Right Projection Angle (Start Angle): 45

Right Projection Angle (End Angle): 45

Minimum Elevation: Not Defined

Minimum Depth: Not Defined

## Material Properties

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Property	sand	Marine Clay 1	Marine Clay 2	Marine Clay 3	Glacial Till	Bedrock	Dike
Color							
Strength Type	Mohr-Coulomb						
Unit Weight [lbs/ft³]	120	117	117	117	130	150	120
Cohesion [psf]	0	1000	650	300	0	0	0
Friction Angle [deg]	32	0	0	0	37	50	35
Water Surface	Piezometric Line 1						
Hu Value	1	1	1	1	1	1	1

## Probabilistic Analysis Input

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### General Settings

Sensitivity Analysis: On

Probabilistic Analysis: Off

### Variables

Material	Property	Distribution	Mean	Min	Max
Marine Clay 1	Cohesion	Normal	1000	600	1400
Marine Clay 20	Cohesion	Normal	650	450	850
Marine Clay 30	Cohesion	Normal	300	100	500

## Global Minimum

---

Method: spencer

FS: 1.505080

Axis Location: 152.155, 135.737  
 Left Slip Surface Endpoint: 114.036, 27.000  
 Right Slip Surface Endpoint: 216.273, 40.000  
 Resisting Moment=9.12927e+006 lb-ft  
 Driving Moment=6.06566e+006 lb-ft  
 Resisting Horizontal Force=64762.4 lb  
 Driving Horizontal Force=43029.3 lb

## Global Minimum Coordinates

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### Method: spencer

X	Y
114.036	27
137.159	3.8771
199.317	23.0432
216.273	40

## Valid / Invalid Surfaces

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### Method: spencer

Number of Valid Surfaces: 4419  
 Number of Invalid Surfaces: 581

### Error Codes:

Error Code -108 reported for 106 surfaces  
 Error Code -111 reported for 475 surfaces

### Error Codes

The following errors were encountered during the computation:

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).  
 -111 = safety factor equation did not converge

## Slice Data

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### Global Minimum Query (spencer) - Safety Factor: 1.50508

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4	936	Marine Clay 1	1000	0	664.417	1000	776.518	124.8	651.718
2	5	3802.5	Marine Clay 2	650	0	431.871	650	1066.19	405.6	660.588
3	5	6727.5	Marine Clay 3	300	0	199.325	300	1409.85	717.6	692.246

4	5	9652.5	Marine Clay 3	300	0	199.325	300	1949.71	1029.6	920.106
5	4.1229	10270.1	Glacial Till	0	37	851.47	1281.53	3014.89	1314.23	1700.66
6	4.45698	11898.6	Glacial Till	0	37	558.802	841.041	2516.09	1399.99	1116.1
7	4.45698	11102.3	Glacial Till	0	37	518.097	779.778	2349.03	1314.23	1034.8
8	4.45698	12535.5	Glacial Till	0	37	691.472	1040.72	2609.55	1228.48	1381.07
9	4.05387	25765.9	Marine Clay 3	300	0	199.325	300	6444	1146.6	5297.4
10	4.05387	24776	Marine Clay 3	300	0	199.325	300	6193.38	1068.6	5124.78
11	4.05387	23202.3	Marine Clay 3	300	0	199.325	300	5794.91	990.6	4804.31
12	4.05387	21623.4	Marine Clay 3	300	0	199.325	300	5395.11	912.6	4482.51
13	4.05387	20044.4	Marine Clay 3	300	0	199.325	300	4995.32	834.6	4160.72
14	4.05387	18465.5	Marine Clay 3	300	0	199.325	300	4595.55	756.6	3838.95
15	4.05387	16886.6	Marine Clay 3	300	0	199.325	300	4195.76	678.6	3517.16
16	4.05387	15307.7	Marine Clay 3	300	0	199.325	300	3795.99	600.6	3195.39
17	4.05387	13728.8	Marine Clay 2	650	0	431.871	650	3302.9	522.6	2780.3
18	4.05387	12149.9	Marine Clay 2	650	0	431.871	650	2903.11	444.6	2458.51
19	4.05387	10571	Marine Clay 2	650	0	431.871	650	2503.34	366.6	2136.74
20	4.05387	8985.09	Marine Clay 2	650	0	431.871	650	2101.78	288.6	1813.18
21	0.140197	278.498	Marine Clay 1	1000	0	664.417	1000	1772.45	249.165	1523.29
22	4.23919	7359.02	Marine Clay 1	1000	0	664.417	1000	1110.73	123.671	987.063
23	4.23919	5256.45	Marine Clay 1	1000	0	664.417	1000	569.55	0	569.55
24	4.23919	3153.87	Marine Clay 1	1000	0	664.417	1000	28.3634	0	28.3634
25	4.23919	1051.29	Marine Clay 1	1000	0	664.417	1000	-512.989	0	-512.989

Query 1 (spencer) - Safety Factor: 1.50508

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4	936	Marine Clay 1	1000	0	664.417	1000	776.518	124.8	651.718
2	5	3802.5	Marine Clay 2	650	0	431.871	650	1066.19	405.6	660.588
3	5	6727.5	Marine Clay 3	300	0	199.325	300	1409.85	717.6	692.246
			Marine Clay							

				3								
5	4.1229	10270.1	Glacial Till	0	37	851.47	1281.53	3014.89	1314.23	1700.66		
6	4.45698	11898.6	Glacial Till	0	37	558.802	841.041	2516.09	1399.99	1116.1		
7	4.45698	11102.3	Glacial Till	0	37	518.097	779.778	2349.03	1314.23	1034.8		
8	4.45698	12535.5	Glacial Till	0	37	691.472	1040.72	2609.55	1228.48	1381.07		
9	4.05387	25765.9	Marine Clay 3	300	0	199.325	300	6444	1146.6	5297.4		
10	4.05387	24776	Marine Clay 3	300	0	199.325	300	6193.38	1068.6	5124.78		
11	4.05387	23202.3	Marine Clay 3	300	0	199.325	300	5794.91	990.6	4804.31		
12	4.05387	21623.4	Marine Clay 3	300	0	199.325	300	5395.11	912.6	4482.51		
13	4.05387	20044.4	Marine Clay 3	300	0	199.325	300	4995.32	834.6	4160.72		
14	4.05387	18465.5	Marine Clay 3	300	0	199.325	300	4595.55	756.6	3838.95		
15	4.05387	16886.6	Marine Clay 3	300	0	199.325	300	4195.76	678.6	3517.16		
16	4.05387	15307.7	Marine Clay 3	300	0	199.325	300	3795.99	600.6	3195.39		
17	4.05387	13728.8	Marine Clay 2	650	0	431.871	650	3302.9	522.6	2780.3		
18	4.05387	12149.9	Marine Clay 2	650	0	431.871	650	2903.11	444.6	2458.51		
19	4.05387	10571	Marine Clay 2	650	0	431.871	650	2503.34	366.6	2136.74		
20	4.05387	8985.09	Marine Clay 2	650	0	431.871	650	2101.78	288.6	1813.18		
21	0.140197	278.498	Marine Clay 1	1000	0	664.417	1000	1772.45	249.165	1523.29		
22	4.23919	7359.02	Marine Clay 1	1000	0	664.417	1000	1110.73	123.671	987.063		
23	4.23919	5256.45	Marine Clay 1	1000	0	664.417	1000	569.55	0	569.55		
24	4.23919	3153.87	Marine Clay 1	1000	0	664.417	1000	28.3634	0	28.3634		
25	4.23919	1051.29	Marine Clay 1	1000	0	664.417	1000	-512.989	0	-512.989		

## Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.50508

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	114.036	27	0	0	0
2	118.036	23	5756.52	-481.045	-4.77684
3	123.036	18	13241	-1106.48	-4.77681
4	128.036	13	21284.1	-1778.61	-4.77683
5	133.036	8	32026.5	-2676.31	-4.77685

6	137.159	3.8771	47957.6	-4007.59	-4.77684
7	141.616	5.2514	46983.6	-3926.19	-4.77683
8	146.073	6.6257	46058.2	-3848.86	-4.77683
9	150.53	8	45545.4	-3806.01	-4.77683
10	154.584	9.25	38296.2	-3200.23	-4.77684
11	158.638	10.5	31360.3	-2620.63	-4.77684
12	162.692	11.75	24922.6	-2082.66	-4.77683
13	166.746	13	18984.5	-1586.45	-4.77685
14	170.799	14.25	13546.2	-1131.99	-4.77683
15	174.853	15.5	8607.59	-719.296	-4.77684
16	178.907	16.75	4168.73	-348.361	-4.77684
17	182.961	18	229.595	-19.1861	-4.77682
18	187.015	19.25	-2153.04	179.919	-4.77683
19	191.069	20.5	-4035.95	337.265	-4.77684
20	195.123	21.75	-5419.13	452.851	-4.77684
21	199.176	23	-6300.36	526.491	-4.77684
22	199.317	23.0432	-6284.08	525.131	-4.77684
23	203.556	27.2824	-8183.76	683.878	-4.77684
24	207.795	31.5216	-7789.24	650.91	-4.77684
25	212.034	35.7608	-5100.53	426.227	-4.77684
26	216.273	40	0	0	0

Query 1 (spencer) - Safety Factor: 1.50508

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	114.036	27	0	0	0
2	118.036	23	5756.52	-481.045	-4.77684
3	123.036	18	13241	-1106.48	-4.77681
4	128.036	13	21284.1	-1778.61	-4.77683
5	133.036	8	32026.5	-2676.31	-4.77685
6	137.159	3.8771	47957.6	-4007.59	-4.77684
7	141.616	5.2514	46983.6	-3926.19	-4.77683
8	146.073	6.6257	46058.2	-3848.86	-4.77683
9	150.53	8	45545.4	-3806.01	-4.77683
10	154.584	9.25	38296.2	-3200.23	-4.77684
11	158.638	10.5	31360.3	-2620.63	-4.77684
12	162.692	11.75	24922.6	-2082.66	-4.77683
13	166.746	13	18984.5	-1586.45	-4.77685
14	170.799	14.25	13546.2	-1131.99	-4.77683
15	174.853	15.5	8607.59	-719.296	-4.77684
16	178.907	16.75	4168.73	-348.361	-4.77684
17	182.961	18	229.595	-19.1861	-4.77682
18	187.015	19.25	-2153.04	179.919	-4.77683
19	191.069	20.5	-4035.95	337.265	-4.77684
20	195.123	21.75	-5419.13	452.851	-4.77684
21	199.176	23	-6300.36	526.491	-4.77684
22	199.317	23.0432	-6284.08	525.131	-4.77684
23	203.556	27.2824	-8183.76	683.878	-4.77684

24	207.795	31.5216	-7789.24	650.91	-4.77684
25	212.034	35.7608	-5100.53	426.227	-4.77684
26	216.273	40	0	0	0

## List Of Coordinates

---

### Piezoline

X	Y
0	33
85	27
150	27
199	27
300	33

### Block Search Window

X	Y
180	25
180	3
210	3
210	25

### Block Search Window

X	Y
115	-2
150	-2
150	20
115	20

### External Boundary

X	Y
300	-20
300	-9
300	3
300	8
300	16
300	18
300	23
300	28
300	40
199	40
155	62
150	62
150	61
150	30

150	28
150	27
85	27
85	32
0	35
0	28
0	27
0	23
0	18
0	8
0	3
0	-9
0	-20

### Material Boundary

X	Y
0	8
300	8

### Material Boundary

X	Y
0	-9
300	-9

### Material Boundary

X	Y
0	27
85	27

### Material Boundary

X	Y
0	18
214.248	18
300	18

### Material Boundary

X	Y
0	23
300	23

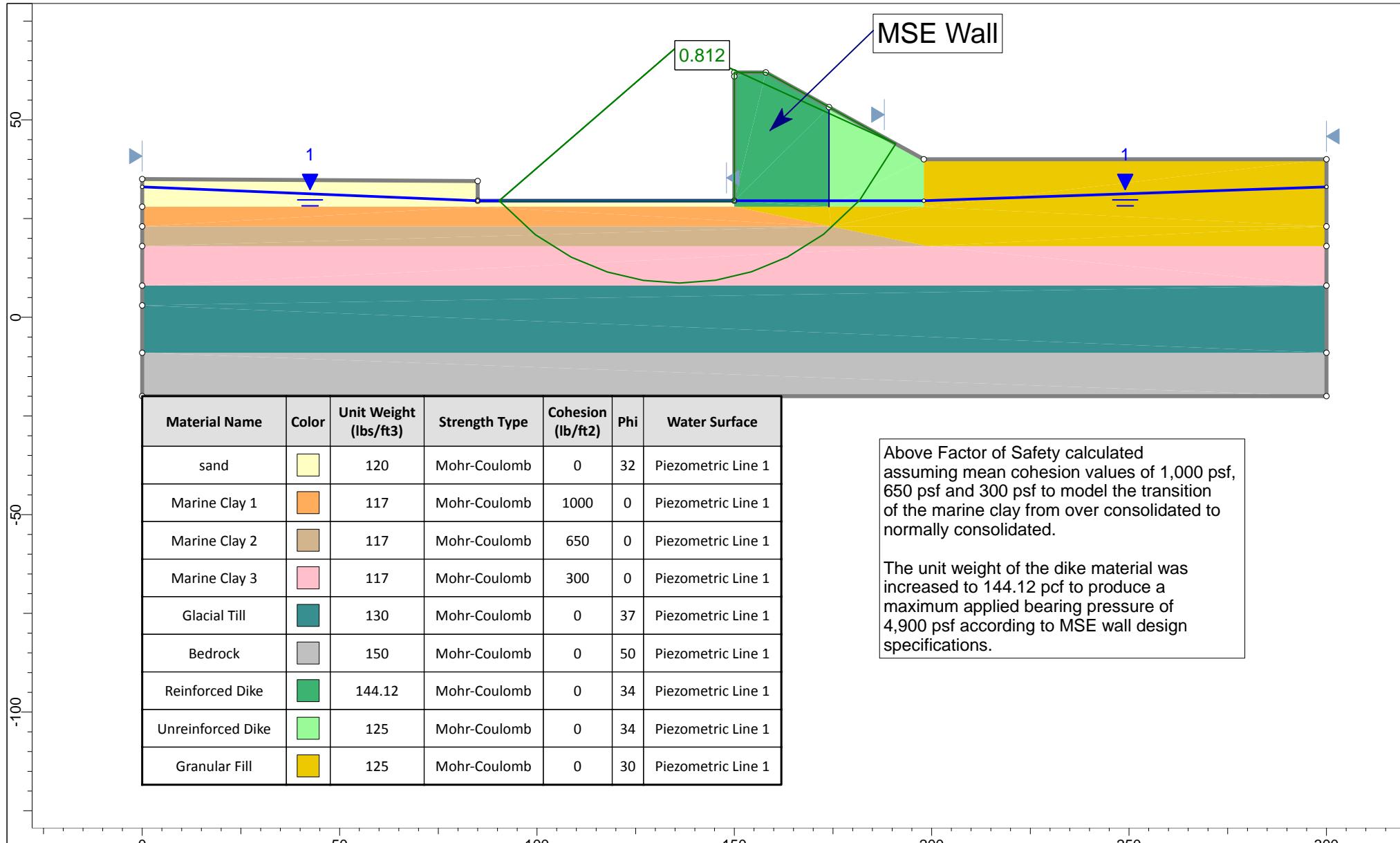
### Material Boundary

X	Y

150	25
150	27

### Material Boundary

X	Y
150	25
199	25
199	40



## *Slide Analysis Information*

### **Searsport LPG Tank & Ancillary Structures - Containment Dike - Normal Condition - Undrained**

#### **Project Summary**

---

File Name: Dike\_Normal\_Undrained  
Slide Modeler Version: 6.014  
Project Title: Searsport LPG Tank & Ancillary Structures - Containment Dike - Normal Condition - Undrained  
Analysis: Containment Dike - Normal Condition - Undrained  
Author: Nicolas Betancur  
Company: Geocomp Consulting  
Date Created: 12/15/2011

#### **General Settings**

---

Units of Measurement: Imperial Units  
Time Units: days  
Permeability Units: feet/second  
Failure Direction: Right to Left  
Data Output: Standard  
Maximum Material Properties: 20  
Maximum Support Properties: 20

#### **Analysis Options**

---

##### **Analysis Methods Used**

Spencer  
Number of slices: 25  
Tolerance: 0.005  
Maximum number of iterations: 50  
Check malpha < 0.2: Yes  
Initial trial value of FS: 1  
Steffensen Iteration: Yes

#### **Groundwater Analysis**

---

Groundwater Method: Water Surfaces  
Pore Fluid Unit Weight: 62.4 lbs/ft<sup>3</sup>  
Advanced Groundwater Method: None

#### **Random Numbers**

---

Pseudo-random Seed: 10116  
Random Number Generation Method: Park and Miller v.3

#### **Surface Options**

---

Search Method: Auto Refine Search  
Divisions along slope: 10  
Circles per division: 10

Number of iterations: 10  
 Divisions to use in next iteration: 50%  
 Number of vertices per surface: 12  
 Minimum Elevation: Not Defined  
 Minimum Depth: Not Defined

## Material Properties

Property	sand	Marine Clay 1	Marine Clay 2	Marine Clay 3	Glacial Till	Bedrock	Reinforced Dike	Unreinforced Dike
Color								
Strength Type	Mohr-Coulomb							
Unit Weight [lbs/ft <sup>3</sup> ]	120	117	117	117	130	150	144.12	125
Cohesion [psf]	0	1000	650	300	0	0	0	0
Friction Angle [deg]	32	0	0	0	37	50	34	34
Water Surface	Piezometric Line 1							
Hu Value	1	1	1	1	1	1	1	1

Property	Granular Fill
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft <sup>3</sup> ]	125
Cohesion [psf]	0
Friction Angle [deg]	30
Water Surface	Piezometric Line 1
Hu Value	1

## Global Minimum

### Method: spencer

FS: 0.812119  
 Axis Location: 136.029, 68.972  
 Left Slip Surface Endpoint: 90.412, 29.500  
 Right Slip Surface Endpoint: 190.898, 43.906  
 Resisting Moment=3.28413e+006 lb-ft  
 Driving Moment=4.0439e+006 lb-ft  
 Resisting Horizontal Force=43876.5 lb  
 Driving Horizontal Force=54027.1 lb

## Global Minimum Coordinates

### Method: spencer

X	Y
90.4119	29.5
99.5471	20.9301
108.682	15.203
117.817	11.4629
126.952	9.33498
136.088	8.64825
145.223	9.35293

154.358	11.5002
163.493	15.2627
172.628	21.0193
181.763	29.6358
190.898	43.9059

## Valid / Invalid Surfaces

---

### Method: spencer

Number of Valid Surfaces: 1558

Number of Invalid Surfaces: 2942

#### Error Codes:

- Error Code -105 reported for 554 surfaces
- Error Code -107 reported for 27 surfaces
- Error Code -108 reported for 1 surface
- Error Code -112 reported for 76 surfaces
- Error Code -113 reported for 2284 surfaces

#### Error Codes

The following errors were encountered during the computation:

- 105 = More than two surface / slope intersections with no valid slip surface.
- 107 = Total driving moment or total driving force is negative. This will occur if the wrong failure direction is specified, or if high external or anchor loads are applied against the failure direction.
- 108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
- 112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.
- 113 = Surface intersects outside slope limits.

## Slice Data

---

### Global Minimum Query (spencer) - Safety Factor: 0.812119

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	1.59893	143.904	sand	0	32	122.423	99.4221	205.909	46.8	159.109
2	5.32978	2518.32	Marine Clay 1	1000	0	1231.35	1000	1637.65	249.6	1388.05
3	2.20642	1955.09	Marine Clay 2	650	0	800.375	650	1644.49	470.181	1174.31
4	4.67369	5508.36	Marine Clay 2	650	0	800.375	650	1685.98	626.181	1059.8
5	4.46144	6752.96	Marine Clay 3	300	0	369.404	300	1748.98	804.867	944.113
6	4.56757	8160.64	Marine Clay 3	300	0	369.404	300	1940.74	950.479	990.263
7	4.56757	9159.98	Marine Clay 3	300	0	369.404	300	2159.7	1067.17	1092.53
8	4.56757	9943.95	Marine Clay 3	300	0	369.404	300	2265.21	1158.71	1106.5
9	4.56757	10512.5	Marine Clay 3	300	0	369.404	300	2389.76	1225.1	1164.66
10	4.56757	10888.6	Marine Clay 3	300	0	369.404	300	2412.84	1269.01	1143.83
11	4.56757	11072.1	Marine Clay 3	300	0	369.404	300	2453.01	1290.44	1162.57
12	4.56757	11069.7	Marine Clay 3	300	0	369.404	300	2395.28	1290.16	1105.12
13	4.56757	10881.4	Marine Clay 3	300	0	369.404	300	2354.07	1268.17	1085.9
14	4.56757	10500.4	Marine Clay 3	300	0	369.404	300	2211.42	1223.68	987.742
15	4.56757	30511.7	Marine Clay 3	300	0	369.404	300	6590.62	1156.69	5433.93
16	3.04504	20605.2	Marine Clay 3	300	0	369.404	300	6609.47	1084.06	5525.41

17	3.04504	19936	Marine Clay 3	300	0	369.404	300	6389.9	1005.8	5384.1
18	3.04504	18783.5	Marine Clay 3	300	0	369.404	300	6011.69	927.538	5084.16
19	4.34383	24534.9	Marine Clay 3	300	0	369.404	300	5408.62	803.004	4605.62
20	4.7913	23749.8	Marine Clay 2	650	0	800.375	650	4446.58	623.399	3823.18
21	2.05937	8734.03	Marine Clay 2	650	0	800.375	650	3478.32	468.593	3009.73
22	5.34152	17274.5	Granular Fill	0	30	1266.93	1028.9	2032.9	250.794	1782.11
23	1.73424	4463.34	Unreinforced Dike	0	34	1176.49	955.449	1459.07	42.5635	1416.51
24	4.56757	8262.05	Unreinforced Dike	0	34	652.036	529.531	785.061	0	785.061
25	4.56757	2754.02	Unreinforced Dike	0	34	217.383	176.541	261.733	0	261.733

## Interslice Data

---

Global Minimum Query (spencer) - Safety Factor: 0.812119

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	90.4119	29.5	0	0	0
2	92.0109	28	505.402	0.974877	0.110518
3	97.3407	23	15283.1	29.4797	0.110518
4	99.5471	20.9301	20460.1	39.4658	0.110519
5	104.221	18	29156	56.2395	0.110519
6	108.682	15.203	35702.7	68.8675	0.110519
7	113.25	13.333	41026.1	79.1357	0.110518
8	117.817	11.4629	46758.9	90.1938	0.110518
9	122.385	10.399	50863.1	98.1105	0.110518
10	126.952	9.33498	55099.8	106.283	0.110519
11	131.52	8.99162	57622.4	111.149	0.110519
12	136.088	8.64825	60158.8	116.041	0.110518
13	140.655	9.00059	61009	117.681	0.110518
14	145.223	9.35293	61873.7	119.349	0.110518
15	149.79	10.4265	61193.6	118.037	0.110518
16	154.358	11.5002	55811.9	107.656	0.110518
17	157.403	12.7543	48651.8	93.8451	0.110518
18	160.448	14.0085	41767.1	80.5652	0.110519
19	163.493	15.2627	35356.8	68.2002	0.110518
20	167.837	18	22162.9	42.7503	0.110518
21	172.628	21.0193	12587.8	24.2808	0.110519
22	174.688	22.9617	7486.25	14.4403	0.110518
23	180.029	28	4038.69	7.79029	0.110519
24	181.763	29.6358	3700.54	7.13802	0.110518
25	186.331	36.7708	1089.37	2.1013	0.110518
26	190.898	43.9059	0	0	0

## List Of Coordinates

---

### Piezoline

X	Y
0	33
85	29.5
150	29.5
198	29.5
300	33

### External Boundary

X	Y
300	-20
300	-9
300	8
300	18
300	23
300	40
198	40
174.001	53.1996
158	62
150	62
150	61
150	29.5
85	29.5
85	34.5
0	35
0	28
0	23
0	18
0	8
0	3
0	-9
0	-20

### Material Boundary

X	Y
0	8
300	8

### Material Boundary

X	Y
0	-9
300	-9

### Material Boundary

X	Y
0	18
199	18

### Material Boundary

X	Y
0	23
174.5	23
300	23

### Material Boundary

X	Y

0	28
85	28
150	28

### Material Boundary

X	Y
150	28
150	29.5

### Material Boundary

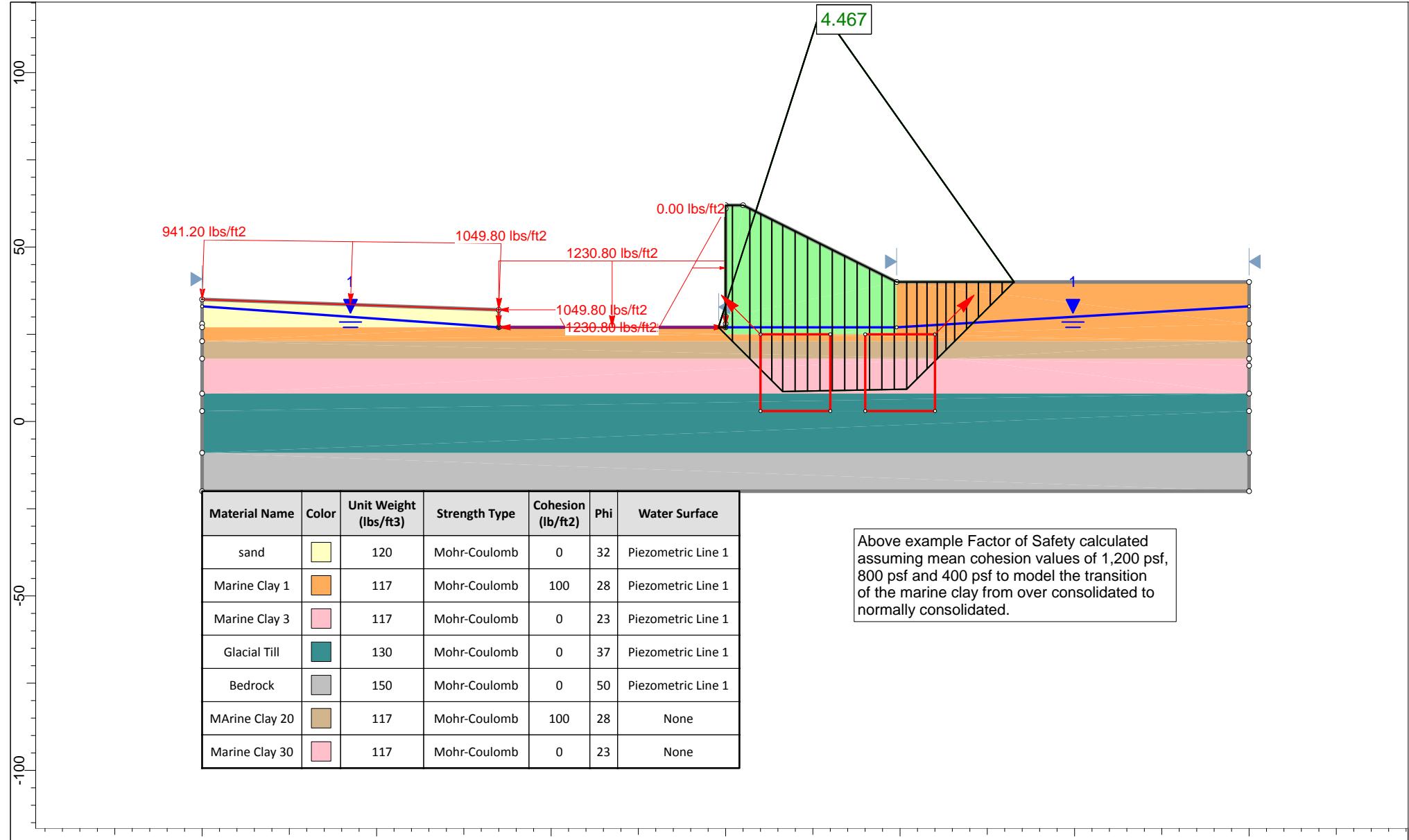
X	Y
150	28
174.5	23
199	18
300	18

### Material Boundary

X	Y
150	28
174	28

### Material Boundary

X	Y
174.001	53.1996
174	28
198	28
198	40



<b>Geocomp</b> <b>CONSULTING, INC.</b> <i>Technologies to manage risk for infrastructure</i> SLIDEINTERPRET 6.013	<i>Project</i> <b>Searsport LPG Tank &amp; Ancillary Structures - Containment Dike - Spill Condition - Drained</b>	
	<i>Analysis Description</i> <b>Containment Dike - Spill Condition - Drained</b>	
	<i>Drawn By</i> Nicolas Betancur	<i>Company</i> Geocomp Consulting
	<i>Date</i> 11/8/2011, 1:39:01 PM	<i>File Name</i> Dike_Spill_Drained.slim

## *Slide Analysis Information*

### **Searsport LPG Tank & Ancillary Structures - Containment Dike - Spill Condition - Drained**

#### **Project Summary**

---

File Name: Dike\_Spill\_Drained

Slide Modeler Version: 6.013

Project Title: Searsport LPG Tank & Ancillary Structures - Containment Dike - Spill Condition - Drained

Analysis: Containment Dike - Spill Condition - Drained

Author: Nicolas Betancur

Company: Geocomp Consulting

Date Created: 11/8/2011, 1:39:01 PM

#### **General Settings**

---

Units of Measurement: Imperial Units

Time Units: days

Permeability Units: feet/second

Failure Direction: Left to Right

Data Output: Standard

Maximum Material Properties: 20

Maximum Support Properties: 20

#### **Analysis Options**

---

##### **Analysis Methods Used**

Spencer

Number of slices: 25

Tolerance: 0.005

Maximum number of iterations: 50

Check malpha < 0.2: Yes

Initial trial value of FS: 1

Steffensen Iteration: Yes

#### **Groundwater Analysis**

---

Groundwater Method: Water Surfaces

Pore Fluid Unit Weight: 62.4 lbs/ft<sup>3</sup>

Advanced Groundwater Method: None

#### **Random Numbers**

---

Pseudo-random Seed: 10116

Random Number Generation Method: Park and Miller v.3

## **Surface Options**

---

Surface Type: Non-Circular Block Search

Number of Surfaces: 5000

Pseudo-Random Surfaces: Enabled

Convex Surfaces Only: Disabled

Left Projection Angle (Start Angle): 135

Left Projection Angle (End Angle): 135

Right Projection Angle (Start Angle): 45

Right Projection Angle (End Angle): 45

Minimum Elevation: Not Defined

Minimum Depth: Not Defined

## **Loading**

---

4 Distributed Loads present

### **Distributed Load 1**

Distribution: Triangular

Magnitude 1 [lbs/ft<sup>2</sup>]: 0

Magnitude 2 [lbs/ft<sup>2</sup>]: 1230.8

Orientation: Normal to boundary

### **Distributed Load 2**

Distribution: Triangular

Magnitude 1 [lbs/ft<sup>2</sup>]: 1049.8

Magnitude 2 [lbs/ft<sup>2</sup>]: 941.2

Orientation: Normal to boundary

### **Distributed Load 3**

Distribution: Triangular

Magnitude 1 [lbs/ft<sup>2</sup>]: 1230.8

Magnitude 2 [lbs/ft<sup>2</sup>]: 1049.8

Orientation: Normal to boundary

### **Distributed Load 4**

Distribution: Constant

Magnitude [lbs/ft<sup>2</sup>]: 1230.8

Orientation: Normal to boundary

## **Material Properties**

---

Property	sand	Marine Clay 1	Marine Clay 2	Marine Clay 3	Glacial Till	Bedrock	Dike
Color							
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight							

[lbs/ft <sup>3</sup> ]								
Cohesion [psf]	0	100	100	0	0	0	0	0
Friction Angle [deg]	32	28	28	23	37	50	35	
Water Surface	Piezometric Line 1							
Hu Value	1	1	1	1	1	1	1	1

## Probabilistic Analysis Input

---

### General Settings

Sensitivity Analysis: On

Probabilistic Analysis: Off

### Variables

Material	Property	Distribution	Mean	Min	Max
Marine Clay 1	Cohesion	Normal	100	0	500
Marine Clay 1	Phi	Normal	28	23	30
MArine Clay 20	Cohesion	Normal	100	0	500
MArine Clay 20	Phi	Normal	28	23	30
Marine Clay 30	Phi	Normal	23	21	25

## Global Minimum

---

### Method: spencer

FS: 4.466910

Axis Location: 177.297, 118.194

Left Slip Surface Endpoint: 147.950, 27.000

Right Slip Surface Endpoint: 232.644, 40.000

Resisting Moment=1.34081e+007 lb-ft

Driving Moment=3.00165e+006 lb-ft

Resisting Horizontal Force=113019 lb

Driving Horizontal Force=25301.3 lb

## Global Minimum Coordinates

---

### Method: spencer

X	Y
147.95	27
166.367	8.58306
201.886	9.24282
232.644	40

## Valid / Invalid Surfaces

### Method: spencer

Number of Valid Surfaces: 3878  
Number of Invalid Surfaces: 1122

#### Error Codes:

Error Code -107 reported for 993 surfaces  
Error Code -108 reported for 104 surfaces  
Error Code -111 reported for 25 surfaces

#### Error Codes

The following errors were encountered during the computation:

-107 = Total driving moment or total driving force is negative. This will occur if the wrong failure direction is specified, or if high external or anchor loads are applied against the failure direction.  
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).  
-111 = safety factor equation did not converge

## Slice Data

Global Minimum Query (spencer) - Safety Factor: 4.46691

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4	9137.12	Marine Clay 1	100	28	265.224	1184.73	2164.88	124.8	2040.08
2	5	24718.4	Marine Clay 2	100	28	475.664	2124.75	4213.61	405.6	3808.01
3	3.13898	16421.5	Marine Clay 3	0	23	371.942	1661.43	4573.63	659.536	3914.09
4	3.13898	16983.1	Marine Clay 3	0	23	369.454	1650.32	4743.32	855.409	3887.91
5	3.13898	17544.7	Marine Clay 3	0	23	366.967	1639.21	4913.04	1051.28	3861.76
6	3.55196	19778.6	Marine Clay 3	0	23	424.298	1895.3	5612.21	1147.16	4465.05
7	3.55196	18994.2	Marine Clay 3	0	23	403.505	1802.42	5389.27	1143.04	4246.23
8	3.55196	18209.8	Marine Clay 3	0	23	382.712	1709.54	5166.36	1138.92	4027.44
9	3.55196	17425.4	Marine Clay 3	0	23	361.921	1616.67	4943.43	1134.81	3808.62
10	3.55196	16641	Marine Clay 3	0	23	341.128	1523.79	4720.52	1130.69	3589.83
11	3.55196	15856.6	Marine Clay 3	0	23	320.336	1430.91	4497.61	1126.57	3371.04
			Marine Clay							

				3							
13	3.55196	14287.8	Marine Clay 3	0	23	278.752	1245.16	4051.76	1118.34	2933.42	
14	3.55196	13503.4	Marine Clay 3	0	23	257.961	1152.29	3828.83	1114.22	2714.61	
15	3.55196	12839	Marine Clay 3	0	23	240.016	1072.13	3640.01	1114.22	2525.79	
16	2.91906	10006	Marine Clay 3	0	23	282.05	1259.89	4001.21	1033.08	2968.13	
17	2.91906	9009.07	Marine Clay 3	0	23	261.243	1166.95	3610.92	861.755	2749.17	
18	2.91906	8012.13	Marine Clay 3	0	23	240.435	1074	3220.63	690.426	2530.2	
19	2.5	6069.37	Marine Clay 2	100	28	311.739	1392.51	2962.27	531.396	2430.87	
20	2.5	5338.13	Marine Clay 2	100	28	288.705	1289.62	2622.02	384.663	2237.36	
21	3.4	6086.34	Marine Clay 1	100	28	261.525	1168.21	2220.54	211.519	2009.03	
22	3.4	4733.82	Marine Clay 1	100	28	230.2	1028.28	1757.81	11.9621	1745.85	
23	3.4	3381.3	Marine Clay 1	100	28	173.014	772.838	1265.42	0	1265.42	
24	3.4	2028.78	Marine Clay 1	100	28	114.179	510.027	771.148	0	771.148	
25	3.4	676.26	Marine Clay 1	100	28	55.3459	247.225	276.888	0	276.888	

Query 1 (spencer) - Safety Factor: 4.46691

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4	9137.12	Marine Clay 1	100	28	265.224	1184.73	2164.88	124.8	2040.08
2	5	24718.4	Marine Clay 2	100	28	475.664	2124.75	4213.61	405.6	3808.01
3	3.13898	16421.5	Marine Clay 3	0	23	371.942	1661.43	4573.63	659.536	3914.09
4	3.13898	16983.1	Marine Clay 3	0	23	369.454	1650.32	4743.32	855.409	3887.91
5	3.13898	17544.7	Marine Clay 3	0	23	366.967	1639.21	4913.04	1051.28	3861.76
6	3.55196	19778.6	Marine Clay 3	0	23	424.298	1895.3	5612.21	1147.16	4465.05
7	3.55196	18994.2	Marine Clay 3	0	23	403.505	1802.42	5389.27	1143.04	4246.23
8	3.55196	18209.8	Marine Clay 3	0	23	382.712	1709.54	5166.36	1138.92	4027.44
9	3.55196	17425.4	Marine Clay 3	0	23	361.921	1616.67	4943.43	1134.81	3808.62
10	3.55196	16641	Marine Clay 3	0	23	341.128	1523.79	4720.52	1130.69	3589.83

11	3.55196	15856.6	Marine Clay 3	0	23	320.336	1430.91	4497.61	1126.57	3371.04
12	3.55196	15072.2	Marine Clay 3	0	23	299.545	1338.04	4274.67	1122.46	3152.21
13	3.55196	14287.8	Marine Clay 3	0	23	278.752	1245.16	4051.76	1118.34	2933.42
14	3.55196	13503.4	Marine Clay 3	0	23	257.961	1152.29	3828.83	1114.22	2714.61
15	3.55196	12839	Marine Clay 3	0	23	240.016	1072.13	3640.01	1114.22	2525.79
16	2.91906	10006	Marine Clay 3	0	23	282.05	1259.89	4001.21	1033.08	2968.13
17	2.91906	9009.07	Marine Clay 3	0	23	261.243	1166.95	3610.92	861.755	2749.17
18	2.91906	8012.13	Marine Clay 3	0	23	240.435	1074	3220.63	690.426	2530.2
19	2.5	6069.37	Marine Clay 2	100	28	311.739	1392.51	2962.27	531.396	2430.87
20	2.5	5338.13	Marine Clay 2	100	28	288.705	1289.62	2622.02	384.663	2237.36
21	3.4	6086.34	Marine Clay 1	100	28	261.525	1168.21	2220.54	211.519	2009.03
22	3.4	4733.82	Marine Clay 1	100	28	230.2	1028.28	1757.81	11.9621	1745.85
23	3.4	3381.3	Marine Clay 1	100	28	173.014	772.838	1265.42	0	1265.42
24	3.4	2028.78	Marine Clay 1	100	28	114.179	510.027	771.148	0	771.148
25	3.4	676.26	Marine Clay 1	100	28	55.3459	247.225	276.888	0	276.888

## Interslice Data

Global Minimum Query (spencer) - Safety Factor: 4.46691

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	147.95	27	0	0	0
2	151.95	23	28521.5	1939.19	3.88958
3	156.95	18	47209.8	3209.81	3.88957
4	160.089	14.861	60398.1	4106.49	3.88958
5	163.228	11.722	74126.9	5039.92	3.88958
6	166.367	8.58306	88396.1	6010.09	3.88958
7	169.919	8.64903	86517.9	5882.39	3.88958
8	173.471	8.71501	84728.2	5760.71	3.88958
9	177.023	8.78099	83027.1	5645.05	3.88958
10	180.575	8.84696	81414.6	5535.42	3.88958
11	184.127	8.91294	79890.7	5431.81	3.88958
12	187.679	8.97892	78455.5	5334.22	3.88958
13	191.231	9.04489	77108.8	5242.66	3.88958

14	194.783	9.11087	75850.8	5157.13	3.88958
15	198.334	9.17685	74681.3	5077.62	3.88958
16	201.886	9.24282	73588.1	5003.29	3.88958
17	204.805	12.1619	61084.5	4153.16	3.88958
18	207.725	15.0809	49781	3384.63	3.88958
19	210.644	18	39677.5	2697.69	3.88958
20	213.144	20.5	31492.1	2141.16	3.88958
21	215.644	23	24214.8	1646.37	3.88957
22	219.044	26.4	15775.2	1072.56	3.88957
23	222.444	29.8	9015.51	612.969	3.88958
24	225.844	33.2	4124.46	280.424	3.88958
25	229.244	36.6	1114.1	75.7484	3.88959
26	232.644	40	0	0	0

Query 1 (spencer) - Safety Factor: 4.46691

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	147.95	27	0	0	0
2	151.95	23	28521.5	1939.19	3.88958
3	156.95	18	47209.8	3209.81	3.88957
4	160.089	14.861	60398.1	4106.49	3.88958
5	163.228	11.722	74126.9	5039.92	3.88958
6	166.367	8.58306	88396.1	6010.09	3.88958
7	169.919	8.64903	86517.9	5882.39	3.88958
8	173.471	8.71501	84728.2	5760.71	3.88958
9	177.023	8.78099	83027.1	5645.05	3.88958
10	180.575	8.84696	81414.6	5535.42	3.88958
11	184.127	8.91294	79890.7	5431.81	3.88958
12	187.679	8.97892	78455.5	5334.22	3.88958
13	191.231	9.04489	77108.8	5242.66	3.88958
14	194.783	9.11087	75850.8	5157.13	3.88958
15	198.334	9.17685	74681.3	5077.62	3.88958
16	201.886	9.24282	73588.1	5003.29	3.88958
17	204.805	12.1619	61084.5	4153.16	3.88958
18	207.725	15.0809	49781	3384.63	3.88958
19	210.644	18	39677.5	2697.69	3.88958
20	213.144	20.5	31492.1	2141.16	3.88958
21	215.644	23	24214.8	1646.37	3.88957
22	219.044	26.4	15775.2	1072.56	3.88957
23	222.444	29.8	9015.51	612.969	3.88958
24	225.844	33.2	4124.46	280.424	3.88958
25	229.244	36.6	1114.1	75.7484	3.88959
26	232.644	40	0	0	0

## List Of Coordinates

---

### Piezoline

---

X	Y
0	33
85	27
150	27
199	27
300	33

### Line Load

X	Y
150	61
150	30
150	28
150	27

### Line Load

X	Y
85	32
0	35

### Line Load

X	Y
85	27
85	32

### Line Load

X	Y
150	27
85	27

### Block Search Window

X	Y
190	25
190	3
210	3
210	25

### Block Search Window

X	Y
160	3
180	3
180	25
160	25

### **External Boundary**

X	Y
300	-20
300	-9
300	3
300	8
300	16
300	18
300	23
300	28
300	40
199	40
155	62
150	62
150	61
150	30
150	28
150	27
85	27
85	32
0	35
0	28
0	27
0	23
0	18
0	8
0	3
0	-9
0	-20

### **Material Boundary**

X	Y
0	8
300	8

### **Material Boundary**

X	Y
0	-9
300	-9

### **Material Boundary**

X	Y
0	27

**Material Boundary**

X	Y
0	18
214.248	18
300	18

**Material Boundary**

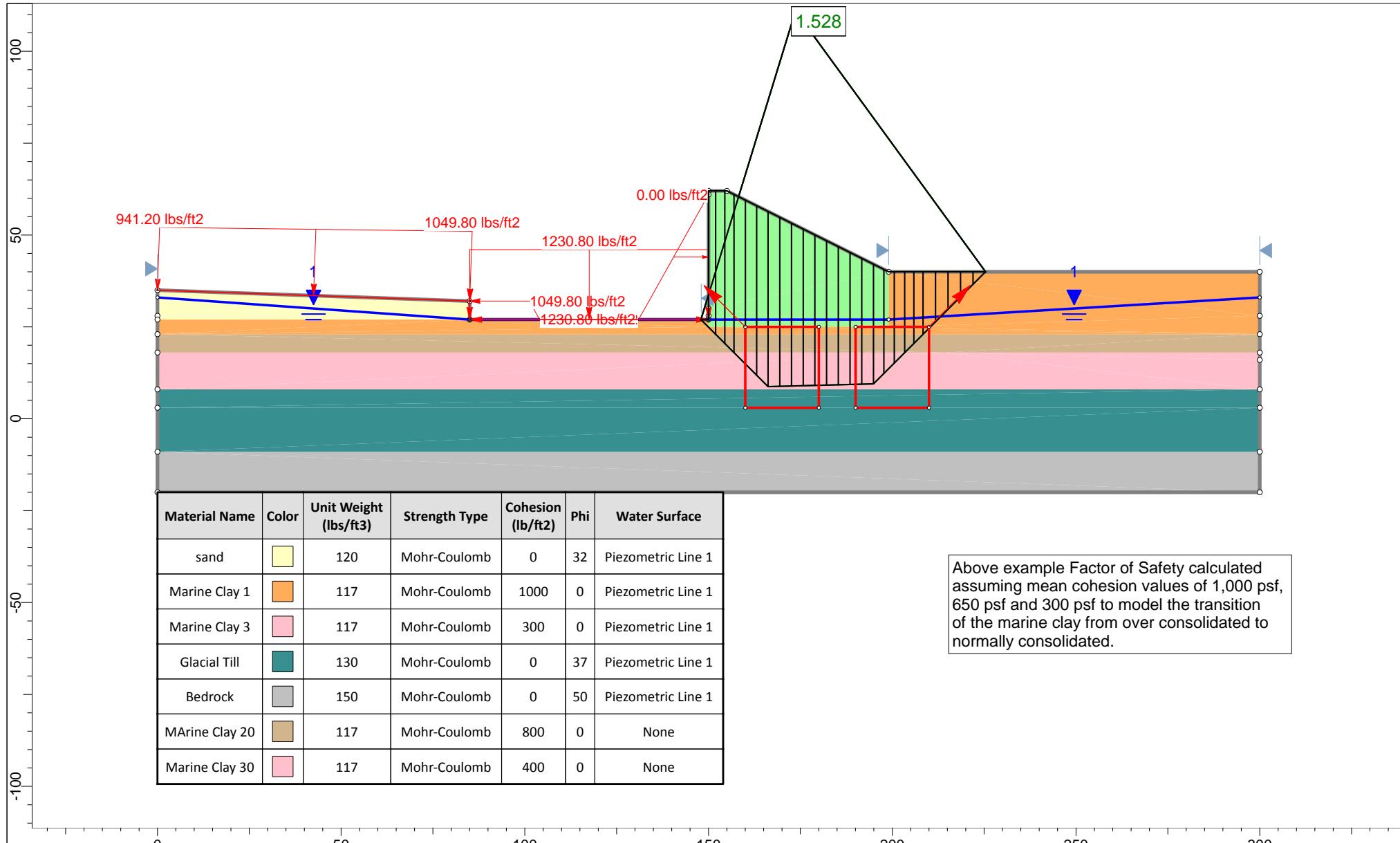
X	Y
0	23
300	23

**Material Boundary**

X	Y
150	25
150	27

**Material Boundary**

X	Y
150	25
199	25
199	40



Above example Factor of Safety calculated assuming mean cohesion values of 1,000 psf, 650 psf and 300 psf to model the transition of the marine clay from over consolidated to normally consolidated.

<b>Geocomp</b> <b>CONSULTING, INC.</b> <i>Technologies to manage risk for infrastructure</i> SLIDEINTERPRET 6.013	<i>Project</i> <b>Searsport LPG Tank &amp; Ancillary Structures - Containment Dike - Spill Condition - Undrained</b>	
	<i>Analysis Description</i> <b>Containment Dike - Spill Condition - Undrained</b>	
	<i>Drawn By</i> Nicolas Betancur	<i>Company</i> Geocomp Consulting
	<i>Date</i> 11/8/2011, 1:39:01 PM	<i>File Name</i> Dike_Spill_Undrained.slim

## *Slide Analysis Information*

### **Searsport LPG Tank & Ancillary Structures - Containment Dike - Spill Condition - Undrained**

#### **Project Summary**

---

File Name: Dike\_Spill\_Undrained

Slide Modeler Version: 6.013

Project Title: Searsport LPG Tank & Ancillary Structures - Containment Dike - Spill Condition - Undrained

Analysis: Containment Dike - Spill Condition - Undrained

Author: Nicolas Betancur

Company: Geocomp Consulting

Date Created: 11/8/2011, 1:39:01 PM

#### **General Settings**

---

Units of Measurement: Imperial Units

Time Units: days

Permeability Units: feet/second

Failure Direction: Left to Right

Data Output: Standard

Maximum Material Properties: 20

Maximum Support Properties: 20

#### **Analysis Options**

---

##### **Analysis Methods Used**

Spencer

Number of slices: 25

Tolerance: 0.005

Maximum number of iterations: 50

Check malpha < 0.2: Yes

Initial trial value of FS: 1

Steffensen Iteration: Yes

#### **Groundwater Analysis**

---

Groundwater Method: Water Surfaces

Pore Fluid Unit Weight: 62.4 lbs/ft<sup>3</sup>

Advanced Groundwater Method: None

#### **Random Numbers**

---

Pseudo-random Seed: 10116

Random Number Generation Method: Park and Miller v.3

## Surface Options

---

Surface Type: Non-Circular Block Search

Number of Surfaces: 5000

Pseudo-Random Surfaces: Enabled

Convex Surfaces Only: Disabled

Left Projection Angle (Start Angle): 135

Left Projection Angle (End Angle): 135

Right Projection Angle (Start Angle): 45

Right Projection Angle (End Angle): 45

Minimum Elevation: Not Defined

Minimum Depth: Not Defined

## Loading

---

4 Distributed Loads present

### Distributed Load 1

Distribution: Triangular

Magnitude 1 [lbs/ft<sup>2</sup>]: 0

Magnitude 2 [lbs/ft<sup>2</sup>]: 1230.8

Orientation: Normal to boundary

### Distributed Load 2

Distribution: Triangular

Magnitude 1 [lbs/ft<sup>2</sup>]: 1049.8

Magnitude 2 [lbs/ft<sup>2</sup>]: 941.2

Orientation: Normal to boundary

### Distributed Load 3

Distribution: Triangular

Magnitude 1 [lbs/ft<sup>2</sup>]: 1230.8

Magnitude 2 [lbs/ft<sup>2</sup>]: 1049.8

Orientation: Normal to boundary

### Distributed Load 4

Distribution: Constant

Magnitude [lbs/ft<sup>2</sup>]: 1230.8

Orientation: Normal to boundary

## Material Properties

---

Property	sand	Marine Clay 1	Marine Clay 2	Marine Clay 3	Glacial Till	Bedrock	Dike
Color							
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight							

[lbs/ft <sup>3</sup> ]								
Cohesion [psf]	0	1000	650	300	0	0	0	0
Friction Angle [deg]	32	0	0	0	37	50	35	
Water Surface	Piezometric Line 1							
Hu Value	1	1	1	1	1	1	1	1

## Probabilistic Analysis Input

---

### General Settings

Sensitivity Analysis: On  
Probabilistic Analysis: Off

### Variables

Material	Property	Distribution	Mean	Min	Max
Marine Clay 1	Cohesion	Normal	1000	600	1400
MArine Clay 20	Cohesion	Normal	800	600	1000
Marine Clay 30	Cohesion	Normal	400	200	600

## Global Minimum

---

### Method: spencer

FS: 1.527670  
Axis Location: 173.652, 110.938  
Left Slip Surface Endpoint: 147.933, 27.000  
Right Slip Surface Endpoint: 225.371, 40.000  
Resisting Moment=4.78104e+006 lb-ft  
Driving Moment=3.12963e+006 lb-ft  
Resisting Horizontal Force=41431.4 lb  
Driving Horizontal Force=27120.6 lb

## Global Minimum Coordinates

---

### Method: spencer

X	Y
147.933	27
166.186	8.74701
194.88	9.50967
225.371	40

## Valid / Invalid Surfaces

---

## Method: spencer

Number of Valid Surfaces: 3891  
Number of Invalid Surfaces: 1109

### Error Codes:

Error Code -107 reported for 993 surfaces  
Error Code -108 reported for 86 surfaces  
Error Code -111 reported for 30 surfaces

### Error Codes

The following errors were encountered during the computation:

- 107 = Total driving moment or total driving force is negative. This will occur if the wrong failure direction is specified, or if high external or anchor loads are applied against the failure direction.
- 108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
- 111 = safety factor equation did not converge

## Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.52767

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4	9064.38	Marine Clay 1	1000	0	654.592	1000	2249.7	124.8	2124.9
2	2.5	12050.6	Marine Clay 2	650	0	425.485	650	4395.83	327.6	4068.23
3	2.5	12669.8	Marine Clay 2	650	0	425.485	650	4643.66	483.6	4160.06
4	3.08433	16134	Marine Clay 3	300	0	196.377	300	5036.72	657.831	4378.89
5	3.08433	16676.2	Marine Clay 3	300	0	196.377	300	5212.61	850.293	4362.32
6	3.08433	17218.5	Marine Clay 3	300	0	196.377	300	5388.52	1042.76	4345.76
7	3.1883	17758.4	Marine Clay 3	300	0	196.377	300	5574.91	1136.34	4438.57
8	3.1883	17116.9	Marine Clay 3	300	0	196.377	300	5373.69	1131.06	4242.63
9	3.1883	16475.4	Marine Clay 3	300	0	196.377	300	5172.49	1125.77	4046.72
10	3.1883	15833.8	Marine Clay 3	300	0	196.377	300	4971.26	1120.48	3850.78
11	3.1883	15192.3	Marine Clay 3	300	0	196.377	300	4770.07	1115.19	3654.88
12	3.1883	14550.8	Marine Clay 3	300	0	196.377	300	4568.84	1109.9	3458.94
13	3.1883	13909.2	Marine Clay 3	300	0	196.377	300	4367.64	1104.62	3263.02

14	3.1883	13267.7	Marine Clay 3	300	0	196.377	300	4166.45	1099.33	3067.12
15	3.1883	12626.2	Marine Clay 3	300	0	196.377	300	3965.22	1094.04	2871.18
16	2.83011	10214.1	Marine Clay 3	300	0	196.377	300	3803.79	1003.1	2800.69
17	2.83011	8798.29	Marine Clay 3	300	0	196.377	300	3303.79	826.963	2476.82
18	2.83011	7753.26	Marine Clay 3	300	0	196.377	300	2934.73	660.856	2273.87
19	2.5	6069.38	Marine Clay 2	650	0	425.485	650	2852.55	504.435	2348.12
20	2.5	5338.12	Marine Clay 2	650	0	425.485	650	2560.21	357.703	2202.5
21	3.4	6086.34	Marine Clay 1	1000	0	654.592	1000	2444.7	184.558	2260.14
22	3.4	4733.82	Marine Clay 1	1000	0	654.592	1000	2047.12	0	2047.12
23	3.4	3381.3	Marine Clay 1	1000	0	654.592	1000	1649.54	0	1649.54
24	3.4	2028.78	Marine Clay 1	1000	0	654.592	1000	1251.96	0	1251.96
25	3.4	676.26	Marine Clay 1	1000	0	654.592	1000	854.372	0	854.372

Query 1 (spencer) - Safety Factor: 1.52767

Slice Number	Width [ft]	Weight [lbs]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]
1	4	9064.38	Marine Clay 1	1000	0	654.592	1000	2249.7	124.8	2124.9
2	2.5	12050.6	Marine Clay 2	650	0	425.485	650	4395.83	327.6	4068.23
3	2.5	12669.8	Marine Clay 2	650	0	425.485	650	4643.66	483.6	4160.06
4	3.08433	16134	Marine Clay 3	300	0	196.377	300	5036.72	657.831	4378.89
5	3.08433	16676.2	Marine Clay 3	300	0	196.377	300	5212.61	850.293	4362.32
6	3.08433	17218.5	Marine Clay 3	300	0	196.377	300	5388.52	1042.76	4345.76
7	3.1883	17758.4	Marine Clay 3	300	0	196.377	300	5574.91	1136.34	4438.57
8	3.1883	17116.9	Marine Clay 3	300	0	196.377	300	5373.69	1131.06	4242.63
9	3.1883	16475.4	Marine Clay 3	300	0	196.377	300	5172.49	1125.77	4046.72
10	3.1883	15833.8	Marine Clay 3	300	0	196.377	300	4971.26	1120.48	3850.78
11	3.1883	15192.3	Marine Clay 3	300	0	196.377	300	4770.07	1115.19	3654.88
			Marine Clay							

				3							
13	3.1883	13909.2	Marine Clay 3	300	0	196.377	300	4367.64	1104.62	3263.02	
14	3.1883	13267.7	Marine Clay 3	300	0	196.377	300	4166.45	1099.33	3067.12	
15	3.1883	12626.2	Marine Clay 3	300	0	196.377	300	3965.22	1094.04	2871.18	
16	2.83011	10214.1	Marine Clay 3	300	0	196.377	300	3803.79	1003.1	2800.69	
17	2.83011	8798.29	Marine Clay 3	300	0	196.377	300	3303.79	826.963	2476.82	
18	2.83011	7753.26	Marine Clay 3	300	0	196.377	300	2934.73	660.856	2273.87	
19	2.5	6069.38	Marine Clay 2	650	0	425.485	650	2852.55	504.435	2348.12	
20	2.5	5338.12	Marine Clay 2	650	0	425.485	650	2560.21	357.703	2202.5	
21	3.4	6086.34	Marine Clay 1	1000	0	654.592	1000	2444.7	184.558	2260.14	
22	3.4	4733.82	Marine Clay 1	1000	0	654.592	1000	2047.12	0	2047.12	
23	3.4	3381.3	Marine Clay 1	1000	0	654.592	1000	1649.54	0	1649.54	
24	3.4	2028.78	Marine Clay 1	1000	0	654.592	1000	1251.96	0	1251.96	
25	3.4	676.26	Marine Clay 1	1000	0	654.592	1000	854.372	0	854.372	

## Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.52767

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	147.933	27	0	0	0
2	151.933	23	27297.2	-14.9842	-0.0314513
3	154.433	20.5	37220.3	-20.4313	-0.0314513
4	156.933	18	47762.9	-26.2184	-0.0314513
5	160.017	14.9157	62690.5	-34.4126	-0.0314513
6	163.101	11.8313	78160.7	-42.9047	-0.0314513
7	166.186	8.74701	94173.4	-51.6945	-0.0314513
8	169.374	8.83175	93073.2	-51.0906	-0.0314513
9	172.562	8.91649	91990.1	-50.496	-0.0314513
10	175.75	9.00123	90924.1	-49.9108	-0.0314513
11	178.939	9.08597	89875	-49.335	-0.0314513
12	182.127	9.17071	88843.1	-48.7685	-0.0314513
13	185.315	9.25545	87828.2	-48.2114	-0.0314513
14	188.504	9.34019	86830.3	-47.6637	-0.0314513
15	191.692	9.42493	85849.5	-47.1253	-0.0314513
16	194.88	9.50967	84885.7	-46.5962	-0.0314513

17	197.71	12.3398	73563.4	-40.3811	-0.0314513
18	200.541	15.1699	63656.1	-34.9427	-0.0314513
19	203.371	18	54793.3	-30.0776	-0.0314513
20	205.871	20.5	46595.4	-25.5776	-0.0314514
21	208.371	23	39128.4	-21.4787	-0.0314513
22	211.771	26.4	28585	-15.6911	-0.0314512
23	215.171	29.8	19393.4	-10.6456	-0.0314513
24	218.571	33.2	11553.5	-6.34207	-0.0314514
25	221.971	36.6	5065.48	-2.78059	-0.0314513
26	225.371	40	0	0	0

Query 1 (spencer) - Safety Factor: 1.52767

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	147.933	27	0	0	0
2	151.933	23	27297.2	-14.9842	-0.0314513
3	154.433	20.5	37220.3	-20.4313	-0.0314513
4	156.933	18	47762.9	-26.2184	-0.0314513
5	160.017	14.9157	62690.5	-34.4126	-0.0314513
6	163.101	11.8313	78160.7	-42.9047	-0.0314513
7	166.186	8.74701	94173.4	-51.6945	-0.0314513
8	169.374	8.83175	93073.2	-51.0906	-0.0314513
9	172.562	8.91649	91990.1	-50.496	-0.0314513
10	175.75	9.00123	90924.1	-49.9108	-0.0314513
11	178.939	9.08597	89875	-49.335	-0.0314513
12	182.127	9.17071	88843.1	-48.7685	-0.0314513
13	185.315	9.25545	87828.2	-48.2114	-0.0314513
14	188.504	9.34019	86830.3	-47.6637	-0.0314513
15	191.692	9.42493	85849.5	-47.1253	-0.0314513
16	194.88	9.50967	84885.7	-46.5962	-0.0314513
17	197.71	12.3398	73563.4	-40.3811	-0.0314513
18	200.541	15.1699	63656.1	-34.9427	-0.0314513
19	203.371	18	54793.3	-30.0776	-0.0314513
20	205.871	20.5	46595.4	-25.5776	-0.0314514
21	208.371	23	39128.4	-21.4787	-0.0314513
22	211.771	26.4	28585	-15.6911	-0.0314512
23	215.171	29.8	19393.4	-10.6456	-0.0314513
24	218.571	33.2	11553.5	-6.34207	-0.0314514
25	221.971	36.6	5065.48	-2.78059	-0.0314513
26	225.371	40	0	0	0

## List Of Coordinates

### Piezoline

X	Y
0	33

85	27
150	27
199	27
300	33

### Line Load

X	Y
150	61
150	30
150	28
150	27

### Line Load

X	Y
85	32
0	35

### Line Load

X	Y
85	27
85	32

### Line Load

X	Y
150	27
85	27

### Block Search Window

X	Y
190	25
190	3
210	3
210	25

### Block Search Window

X	Y
160	3
180	3
180	25
160	25

### External Boundary

X	Y
300	-20
300	-9
300	3
300	8
300	16
300	18
300	23
300	28
300	40
199	40
155	62
150	62
150	61
150	30
150	28
150	27
85	27
85	32
0	35
0	28
0	27
0	23
0	18
0	8
0	3
0	-9
0	-20

### Material Boundary

X	Y
0	8
300	8

### Material Boundary

X	Y
0	-9
300	-9

### Material Boundary

X	Y
0	27
85	27

### **Material Boundary**

X	Y
0	18
214.248	18
300	18

### **Material Boundary**

X	Y
0	23
300	23

### **Material Boundary**

X	Y
150	25
150	27

### **Material Boundary**

X	Y
150	25
199	25
199	40

## **Appendix D**

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DCP Midstream LP  
Proposed LPG Storage Facility  
Searsport, Maine

Geotechnical Investigation  
December 16, 2011  
C&C Project #: 15-605

Prepared by Coler & Colantonio, Inc.

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*Liquefaction Potential of Cohesionless Soils*

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## **Appendix E**

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DCP Midstream LP  
Proposed LPG Storage Facility  
Searsport, Maine

Geotechnical Investigation  
December 16, 2011  
C&C Project #: 15-605

Prepared by Coler & Colantonio, Inc.

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Observations were made of the site and of structures on the site only on those dates as indicated within this report. Where access to portions of the site was unavailable or limited, Coler & Colantonio, Inc. renders no opinion as to the presence of hazardous material or oil, or to the presence of indirect evidence relating to hazardous material or oil, in that portion of the site.

The conclusions contained in this report are based in part upon the data obtained from a limited number of soil and/or groundwater samples obtained from the site. The nature and extent of variations between these samples may not become evident without further exploration. If variations or other latent conditions then appear evident, it will be necessary to reevaluate the conclusions of this report. Where quantitative laboratory testing was performed as part of the site assessment, such analyses have been conducted by an independent laboratory. Coler & Colantonio, Inc. has relied upon the data provided. Chemical analyses have been performed for specific parameters during the course of this investigation, as described in the text. However, additional chemical constituents not searched for during the current study may be present in soil and/or groundwater at the site.

The conclusions and recommendations contained in this report are based in part upon various types of chemical data and are contingent upon their validity. These data have been reviewed and interpretations made in the report. Moreover, it should be noted that variations in the types and concentrations of contaminants and variations in their flow paths may occur due to seasonal water table fluctuations, past disposal practices, the passage of time, and other factors. Coler & Colantonio, Inc. should review additional chemical data become available in the future, these data and the conclusions or recommendations presented herein modified accordingly.