Geotechnical Report

Martin Slough Enhancement Project

Prepared for:

Redwood Community Action Agency

SHN Consulting Engineers & Geologists, Inc.

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Prepared for:

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Abbreviations and Acronyms

pcf	pounds per cubic foot
psf	pounds per square foot
ASTM	American Society for Testing and Materials-International
CEQA	California Environmental Quality Act
CPT	cone penetrometer test
H:V	horizontal to vertical (ratio)
HB-#	hand boring designation
HDPE	high-density polyethylene
MLA	Michael Love & Associates
NAVD88	North American Vertical Datum, 19888
NR	no reference
OSHA	United States Occupational Safety and Health Administration
PVC	polyvinyl chloride
RCAA	Redwood Community Action Agency
SCP	standard cone penetrometer
SHN	SHN Consulting Engineers & Geologists, Inc.
USCS	Unified Soil Classification System, where:
	CH high plasticity clays
	CL clay with lower plasticity
	MH high plasticity silts
	ML low plasticity silts
	SM silty sand
	SC clayey sand
USGS	United States Geological Survey

1.0 Introduction

1.1 General

This report provides the results of field and laboratory investigations conducted by SHN Consulting Engineers & Geologists, Inc. (SHN), and includes geotechnical recommendations for design development and construction of the Martin Slough Enhancement project. The Martin Slough Enhancement Project is a restoration project within the Martin Slough Valley in the southwestern portion of Eureka, California (Figure 1). The stated goals of the project are to improve fish habitat and access, to restore and enhance the former tidal salt/brackish marsh and freshwater wetlands in the lower Martin Slough floodplain, and to reduce the duration of flooding in the valley.

Our scope of work was developed from the request for proposals provided by Redwood Community Action Agency (RCAA) and included field and laboratory testing, analysis of results, development of recommendations, and the preparation of this report. A discussion of the project's geologic setting intended to be used in support of the California Environmental Quality Act (CEQA) compliance documentation has been provided under separate cover.

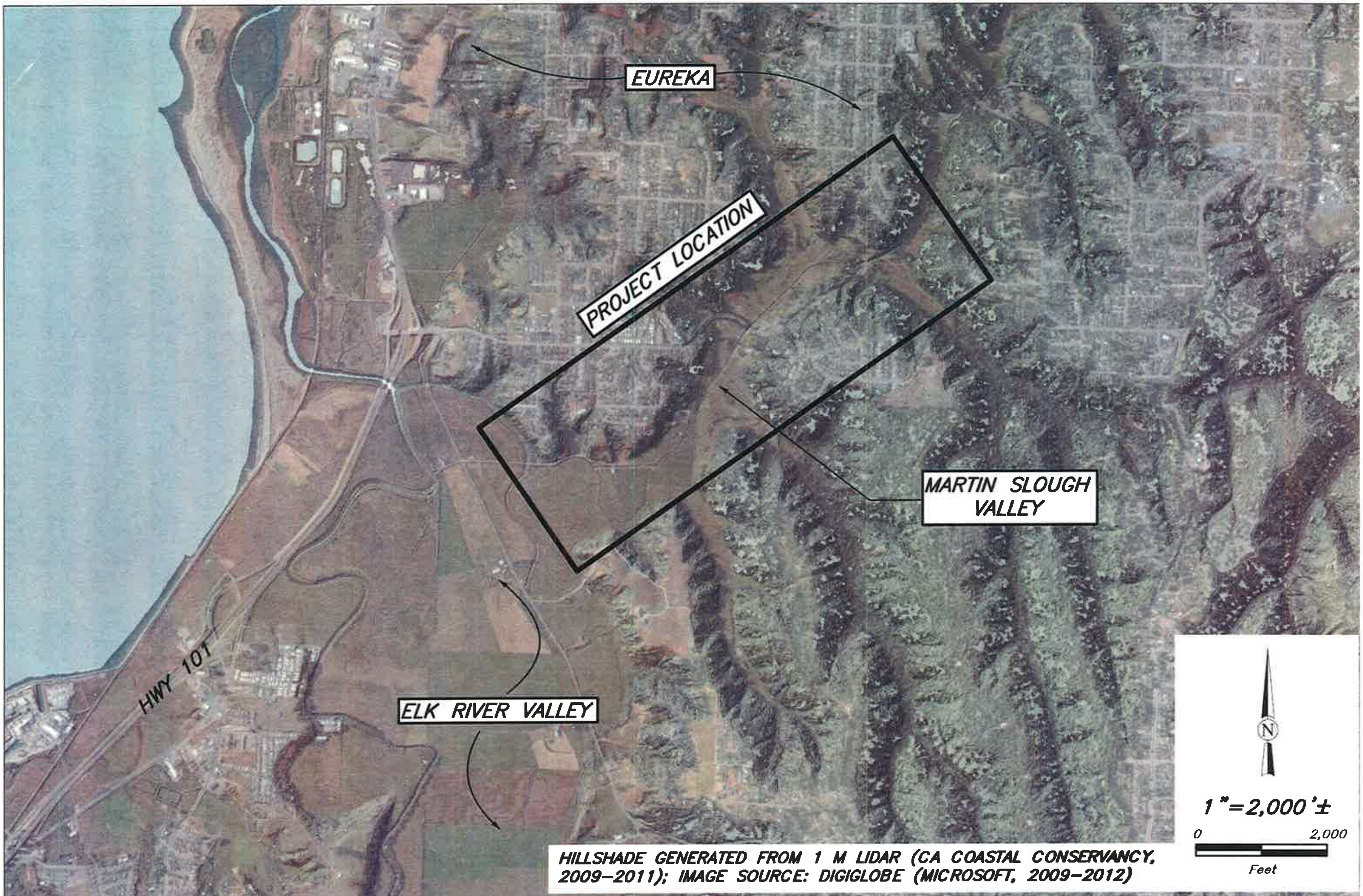
1.2 Project Location

The project is located within the Martin Slough Valley, a coastal drainage that borders the southern part of the City of Eureka (Figure 1). The area is surrounded by unincorporated uplands. Martin Slough flows to Swain Slough downstream of the project area; Swain Slough is a tributary of the Elk River, which subsequently flows to Humboldt Bay west of the project area in southwest Eureka. The project area is within Sections 3, 4, 9 and 10, Township 4N, Range 1W, on the Eureka 7.5-minute United States Geological Survey (USGS) quadrangle.

1.3 Previous Work

SHN's experience going into this study includes previous geotechnical and construction observation projects within the Martin Slough Valley. Of these, one of the most relevant is the Martin Slough Interceptor project, a large sewer improvement project in which a sewer main was installed down the axis of the eastern portion of the valley. Many subsurface investigations were conducted for this project. The findings from our geotechnical studies are included in our 2003 *Geotechnical Study, Proposed Martin Slough Interceptor Sewer Project* (SHN, 2003) and our 2009 *Geotechnical Baseline Report, Phases I and II, Martin Slough Interceptor Project* (SHN, 2009). The excavations for the pipeline and the pump station (just south of the Fairview Drive Bridge) ranged from 8 to 25 feet in depth. SHN's construction observation experience during Phase I of the interceptor project was invaluable. The lessons learned about the limitations of the equipment, the condition of the excavated soils, and the difficulties with excavation are directly applicable to the Martin Slough Enhancement Project.

SHN has also been involved in the geotechnical investigation for the replacement of the Pine Hill Road Bridge over Swain Slough (in process) at the south end of the valley. Our investigation for that project included one boring and four cone penetration tests (CPT) to depths ranging from 60 to 105 feet. The boring for this project was placed very near the proposed new tide gate structure and extended to a total depth of 90 feet below grade.



SHN Consulting Engineers & Geologists, Inc.

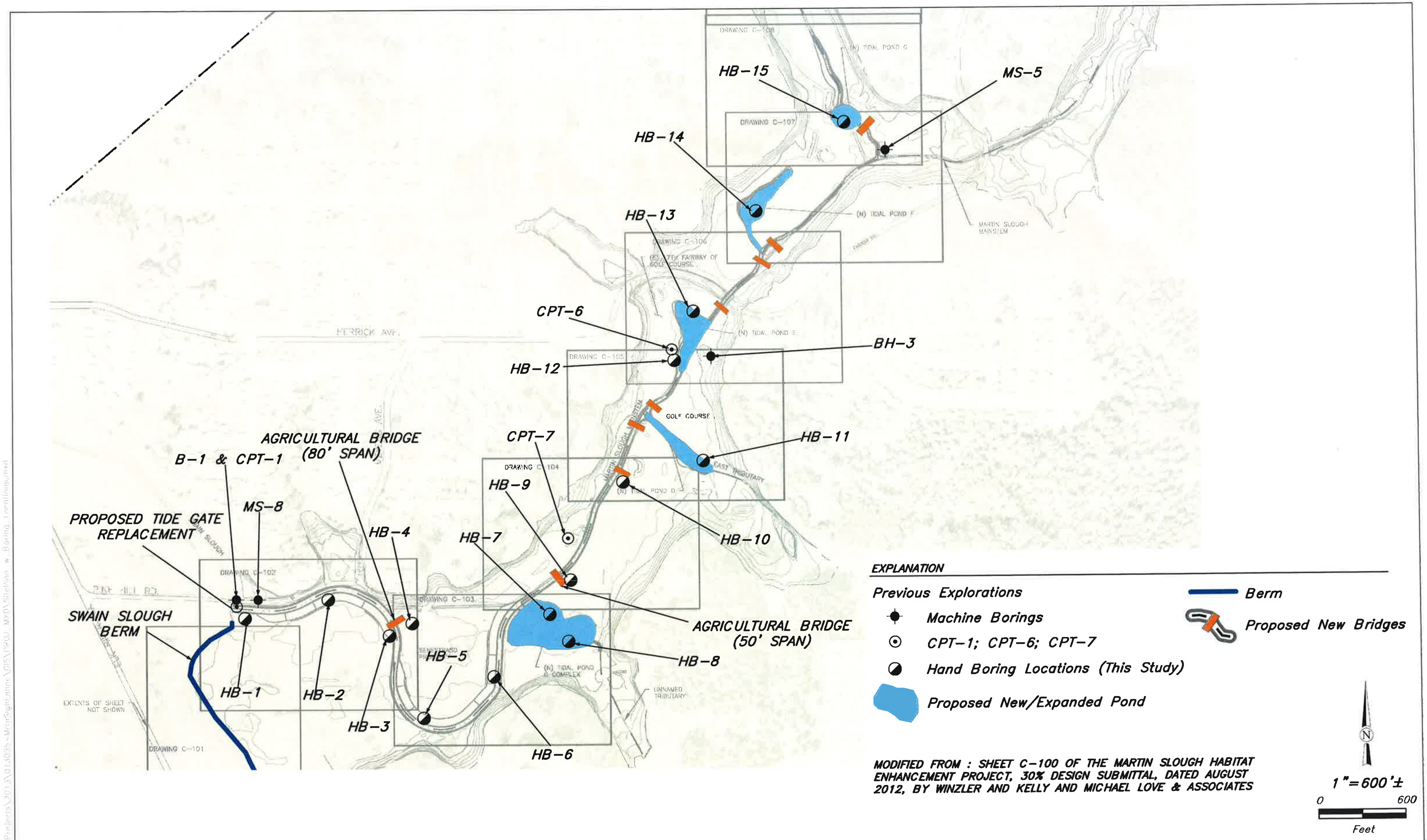
Redwood Community Action Agency
Martin Slough Enhancement Project
Eureka, California

May 2013 | Figure1

Project Location

SHN 013035

Figure 1



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Site Plan Showing Project Elements and Exploration Locations

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SitePlan_w_Boring_Locations

Figure 2

We have included selected exploration logs from previous investigations for reference in Appendix A. Locations of these explorations are noted on Figure 2.

2.0 Project Description

2.1 Project Understanding

Our understanding of the scope of the Martin Slough Enhancement Project is based on information provided in the request for proposals, a pre-bid site walk, our review of the 30% design plans prepared by GHD, Inc. (formerly Winzler & Kelly) and Michael Love & Associates (MLA), dated August 2012, the *Martin Slough Enhancement Feasibility Study* (Winzler & Kelly and MLA, 2006) and our consultation with the design team, RCAA, GHD, and MLA.

2.2 Project Elements

The Martin Slough Enhancement Project consists of enlarging and recontouring the drainage network within the axis of the valley, including the development of a series of ponds, and as proposed will include a substantial amount of earthwork. Between the channel widening and construction of new ponds, the project includes an estimated 123,000 cubic yards of excavation. The project also includes infrastructural improvements (such as, the replacement of the tide gate at the Swain Slough junction and the construction of new agricultural access bridges). The specific project elements that we address in this report are described below. The locations of these project elements are shown on Figure 2.

Channel Widening/Realignment. The Martin Slough mainstem (7,300 lineal feet) and portions of the east tributary (600 lineal feet), the north fork tributary (1,100 lineal feet) and 700 lineal feet of an unnamed tributary will be widened and deepened. The final configuration of the channel varies greatly.

Construction and Expansion of Tidal Ponds. There are five tidal ponds that will be constructed. Some of these are expansions of existing ponds, while others are totally new. The ponds have been designed with variable floor elevations and strategically placed wood structures.

Replacement of Tide Gate. The existing tide gates (48-inch culverts with flap gates) at the confluence of the Martin Slough and Swain Slough are to be removed and replaced with a single concrete tide gate structure. The new tide gate planned for use is a 24-foot by 30-foot concrete box structure with four wing walls extending from each corner. The base of the structure will be founded at a depth of approximately 10 feet below grade.

New Bridges. Many of the existing golf cart bridges will need to be replaced once the channel has been widened. The project also includes the construction of two "agricultural" bridges that will provide access for agricultural equipment and emergency vehicles.

Enhancement of the Existing Berm along Swain Slough. The berm along the east side of Swain Slough is to be raised to an elevation of 9.5 feet (approximately 1.5 to 2 feet above existing grade).

Miscellaneous Grading. The project includes filling abandoned channels and loosely compacted fill areas in various locations on the golf course. Generally, these graded fill areas are broad and are called out to be approximately 1-foot thick.

3.0 Project Geologic Setting

The project is located within Martin Slough, an estuarine stream that drains a coastal valley that opens into the eastern shore of Humboldt Bay at the southern margin of the City of Eureka. The Humboldt Bay region occupies a complex geologic environment characterized by very high rates of active tectonic deformation and seismicity. The geomorphic landscape of the Humboldt Bay region is largely a manifestation of the active tectonic processes and the setting in this dynamic coastal environment.

Martin Slough and other coastal valleys around Humboldt Bay represent sediment-filled estuaries that reflect the late Quaternary history of sea level changes and tectonic deformation (uplift and subsidence). Sea level apparently reached its current high level in the mid-Holocene, about 6,000 years ago. As such, at least the uppermost part of the sediment filling the Martin Slough Valley would be anticipated to be mid-Holocene in age, or younger.

A comprehensive discussion of the geologic setting, including a description of geologic hazards associated with the project location, is provided under separate cover.

4.0 Field Investigation and Laboratory Testing

SHN conducted geotechnical investigations to evaluate representative subsurface soil conditions, and to provide foundation design criteria and site development recommendations for the project elements described above. Our field investigation was limited to reconnaissance of the project site and the drilling and sampling of 15 widely spaced exploratory borings.

The borings were advanced to depths ranging from of 5 to 15 feet below the ground surface. The borings were logged in general accordance with the Unified Soil Classification System (USCS). (See Figure 2 for boring locations, and Appendix A for subsurface exploration logs.) The borings were advanced using hand augers. Samples were collected using a 2.5-inch diameter thin-walled tube, driven using a slide hammer sampler.

Penetration resistance tests were conducted in the field using a static cone penetrometer (SCP). Tests using the SCP were focused on the upper 4 feet of the soil profile and results are shown on the logs.

Selected undisturbed and disturbed samples were collected, and laboratory tests were conducted. Laboratory testing for index properties included in-place moisture content, dry density, unconfined compressive strength (in lab, and using hand-held penetrometer), percent fines, and Atterberg Limits (plasticity). Triaxial tests were also conducted, and the results are presented on plates in Appendix B. Ad hoc testing was done to evaluate the shrinkage potential of selected soil samples.

For characterization of soils for agricultural purposes, selected samples were submitted to A & L Western Agricultural Laboratories, Inc. in Modesto, California. The results of these tests are provided in Appendix C.

See the attached subsurface exploration logs (Appendix A) for detailed soil descriptions, the penetration resistance test results, and laboratory index test results.

5.0 Site Conditions

5.1 Artificial Fill

Artificial fill was not encountered within our borings. Fill is expected to be encountered within the berm alignment, at the tide gate, and at various locations within the golf course area. Fill materials are generally anticipated to be thin and are not expected to be a significant factor in the proposed project.

5.2 Native Soils

Sediment filling Martin Slough is generally fine-grained (silt and clay). The material is primarily derived from alluvial sources (overbank/floodplain deposits) in the upper part of the canyon, and estuarine sources (tidal marine deposits) in the lower reaches of the valley nearest the bay. Evidence of marine influence (deposits with marine shells for example) decreases as you move up the valley. We did not encounter shell fragments within our borings upstream of the Fairway Drive bridge. In this report, we refer to the alluvium and estuarine deposits together as "valley fill sediments." Valley fill sediments are young, unconsolidated materials that contain wood fragments, and other organic materials. Sandy deposits are present, and generally consist of fine sands interbedded with silt. Naturally occurring coarse materials were not encountered during subsurface investigations and are not expected to be encountered during construction operations.

The topsoil within the project area is generally thin with a surficial grass/root mat of 4 to 6 inches and a root zone that extends to 12 to 18 inches below grade. The agricultural characteristics of the upper 2 feet were characterized by A&L Laboratories. The results of the agricultural testing are provided as Appendix C.

Using the USCS system, textures in the valley fill sediments below the topsoil included silt (ML), clay (CL), sandy silt (ML), silty sand (SM), with less common lenses of fat clay (CH), elastic silt (MH) and clayey sand (SC).

From a geotechnical standpoint, the fine-grained valley fill sediments encountered in subsurface excavations are typically soft to very soft, only locally demonstrating higher strength to a level considered to be medium stiff. In previous investigations, blow counts (N-values) in these materials rarely exceeded 10 blows/foot, and were commonly less than 5. Where granular sediments were encountered, consistency ranged from very loose to medium dense. Blow counts in the less frequent granular materials were generally in the 4 to 12 blows/foot range. The upper 2 feet of the soil profile can be the most competent, simply because it has the benefit of the root structures, and the materials are slightly more consolidated from the seasonal wetting and drying cycle. Especially during the dry season, the upper 1 to 2 feet forms a "crust" of more competent soils. Once this crust is removed or disrupted (excavation, vehicle traffic, etc.) the ground strength is significantly reduced. This will be an important consideration in planning excavations and developing haul roads.

In general, fine-grained valley fill sediments within the upper 10 feet are associated with low dry density values (85 pounds per cubic foot [pcf] or less) and high relative moisture (25 to 45%). Shear strength of the soils, based on triaxial shear testing ranges from 200 to 300 pounds per square foot (psf).

5.3 Groundwater Conditions

Subsurface investigations conducted in the Martin Slough Valley bottom and other low-lying areas encountered a uniformly high groundwater table. Many of the subsurface investigations in low-lying areas were conducted, by necessity, near the end of the dry season, and generally encountered groundwater within 6 feet of the ground surface. Groundwater levels adjacent to the mainstem in the lower part of the Martin Slough Valley are influenced by tidal fluctuations, such that the water table rises during high tides. During the rainy season, water frequently ponds at the ground surface throughout the Martin Slough Valley.

Intense and long duration precipitation, modification of topography, and cultural activities, such as irrigation, water well usage, onsite waste disposal systems, and water diversions, can contribute to fluctuations in groundwater levels. Although the depth to groundwater can vary throughout the year and from year to year, a shallow groundwater condition persists throughout the year.

Groundwater elevations encountered within our borings during our field investigation for this project (March 21 and 22, 2013) are provided in the Table 1, below. At four of the boring locations, a slotted polyvinyl chloride (PVC) pipe was installed and left for 5 days to allow groundwater to stabilize. Measurements reported in Table 1 with a piezometer designation were taken on March 26, 2013. All other values within the "Depth of Stabilized Groundwater" column were measured the same day, after the borehole had remained open for a few hours.

Table 1
Groundwater Elevation Data

Location	Depth Groundwater Initially Encountered	Depth of Stabilized Groundwater
HB-1	5.0 feet	6.75 feet
HB-2	3.0 feet	2.36 feet (piezometer)
HB-3	1.75 feet	1.76 feet (piezometer)
HB-4	6.0 feet	-
HB-5	5.5 feet	2.24 feet (piezometer)
HB-6	4.5 feet	-
HB-7	1.25 feet	-
HB-8	-	1.71 feet (piezometer)
HB-9	4.0 feet	-
HB-10	3.5 feet	6.5 feet
HB-11	2.75 feet	1.5 feet
HB-12	3.0 feet	2.5 feet
HB-13	3.0 feet	0.75 feet
HB-14	2.0 feet	1.0 feet
HB-15	not encountered	>7 feet

The groundwater elevation data provided above is specific to the dates on which the measurements were taken. Because of the slow movement of water through the native soils, only the stabilized measurements taken from piezometers should be considered as actual groundwater elevations.

Groundwater should be expected to be encountered within most of the proposed excavations for this project. It should be noted, however, that although groundwater levels are generally shallow, the permeability of the fine-grained soils are typically low. Because of this, groundwater generally seeps into excavations at a relatively low rate. In past excavations associated with the interceptor project, for instance, rapid infiltration of groundwater was generally only observed when lenses of sandy or woody material were encountered.

6.0 Conclusions and Discussion

Based on the results of our field and laboratory investigations, it is our opinion that the project site can be developed as proposed, provided that our recommendations are followed, and that noted conditions and risks are acknowledged.

Soils will be easy to excavate and can be done so with most any equipment. Excavated soils will have over-optimum moisture content and will be difficult to dry out. Groundwater should be anticipated within all but the very shallowest excavations.

The primary geotechnical site consideration is the pervasive, soft, saturated soil conditions. Due to the weak, compressible soils, and the volume of materials planned for excavation and off-hauling, the construction operations will present the greatest geotechnical challenge to the project. Access roads will need to be robust to remain functional and minimize impacts to the natural grounds. We strongly encourage careful planning of the haul roads layout.

Permanent structures (such as, the tide gate and the bridges) that are supported on shallow soils are anticipated to be susceptible to settlement. The risks associated with settlement and the cost/ benefit of mitigation measures should be considered in the design of these structures. We recommend that the tide gate structure implement some form of deeper support beyond what is shown on the 30% design plans. Implementing deep support for the bridges, however, is likely not necessary to meet project objectives and would not be cost effective. We would recommend designing the bridges and their abutments to accommodate some settlement. We provide foundation design criteria recommendations for these structures below.

7.0 Recommendations

7.1 Site Preparation and Grading

A significant part of the enhancement project is associated with grading.

7.1.1 General Fill Areas

The project plans show multiple areas where fill materials will be loosely placed in a thin layer (approximately 1 foot) over broad areas. Abandoned channel segments will be filled in. In these areas, the fill placement methods are not considered critical. If necessary, performance criteria could be developed for fills.

- If possible, we recommend targeting the driest soils for re-use as fill. Stockpiling the upper 1 to 1.5 feet of soil for reuse in these general fill areas would not only ensure that the driest soils are being used, but the existing organics may help with establishing new vegetation.

7.1.2 Temporary Cut Slopes

Temporary cut slopes are anticipated for excavations associated with the installation of the tide gate, construction entrances, cofferdams, and (possibly) other project elements. The stability of a cut slope depends upon the soil type, the groundwater conditions (or soil moisture conditions), and the angle of the cut. Most of the soils encountered in excavations will be silts and clays, which tend to be moderately cohesive, especially under unsaturated conditions, but with seeping groundwater, the stable angle of a cut decreases dramatically.

Relatively small temporary cut slopes (less than 4 feet) where the soil profile has had time to dewater, or where only a minor amount of water is present may hold a 1:1 horizontal to vertical (1H:1V) orientation, for a few days.

- Construction equipment should be excluded from within 5 feet of the edge of temporary cut slopes that are 1H:1V.
- As a general guide we recommend that the angle of temporary cut slopes higher than 4 feet, or where groundwater seepage is present, be limited to a 1.5H:1V cut. However, even some 1.5H:1V cuts in very soft soils may fail within a few hours of excavation. Ultimately, field conditions will dictate the appropriate angle.

7.1.3 Swain Slough Berm

The project includes reconstructing the existing berm along Swain Slough. It is our understanding that the berm will be raised slightly and widened toward the east side. The design elevation shown on the 30% plans is at 9.5 feet, though we understand the final design may be up to 12 feet using the North American Vertical Datum, 1988 (NAVD88). The planned crest width is approximately 6 feet. Currently, the upper surface of the berm is irregular, ranging in elevation from 7 to 8.5 feet.

The berm is to be constructed using soils excavated from other areas of the project. It should be expected that excavated soils will be fine-grained (silt and clay) and have an over-optimum moisture condition. Excavated soils will be slow to dry out and may need to be staged to allow moisture conditioning. Our recommendations provided below assume that the berm is not intended to be a certified flood control structure and that the objectives of the reconstruction are to enhance the ability of the berm to serve as a temporary water barrier and maintaining stable side slopes. Our understanding is that the upper surface of the berm will not be required to serve as a road surface.

- If possible, we recommend targeting the driest soils for re-use in the berm construction. Soils immediately below the organics, but above the groundwater table will most likely be in the best condition for re-use. Soils below the water table will be saturated and difficult to place and compact.
- The berm will be accessed from a single location, so careful consideration of construction methods should be made to minimize the number of trips in and out. Using lightweight equipment should also be considered. Installing a temporary access road may be necessary. Ideally, the footprint of the berm can serve as the access route for importing materials; however, if the soils become too soft for travel, then a temporary road adjacent to the berm may be necessary.
- To prepare the berm for fill placement, the footprint of the new berm should be stripped of the existing organic layer. Just the vegetation and the root system should be removed. If

debris or other deleterious material is encountered, it should also be removed. Care should be taken at this stage to minimize over-excavation. The deeper the excavation extends, the less suitable the operating surface will become. Organic-rich materials should be stockpiled nearby for reuse as the final cover layer.

- Once the organics have been removed from the footprint of the berm, the subgrade surface should be leveled or benched if necessary. If conditions allow, the surface should be rolled with a small sheep's-foot roller or equivalent. The berm should be constructed in lifts no greater than 12 inches. Compaction effort should be made on each lift using track-equipment or a small sheep's-foot roller as soil conditions allow. Side slopes on the Martin Slough side should be constructed at a gradient of 2H:1V. Side slopes on the Swain Slough side should be constructed at a gradient of 3H:1V.
- For poor soil conditions (such as, those at this site), we recommend developing a performance-based criteria for compaction that is feasible, yet meets the objectives of the project. Compaction criteria (such as, a percent of maximum dry density) is not considered appropriate for the type of soils that will be used or necessary for the project objectives.
- Once design grades have been achieved, the stockpiled organic rich materials should be spread over the bare soils and tamped into place so that vegetation can be reestablished. Alternatively, covering the berm with an erosion control blanket and seeding could be used to reestablish vegetation.

7.2 Seismic Design

We recommend that proposed bridges and the tide gate structure be designed and built to withstand strong seismic shaking. As in all of Humboldt County, the site is subject to strong ground motion from seismic sources.

The 2010 California Building Code requires the following information for seismic design. Based on our knowledge of subsurface and geologic conditions, we estimate a Site Class E (soft soil profile) for the project. Based on the Site Class and the latitude and longitude, we calculated the design spectral response acceleration parameters S_S, S_1, F_a, F_v, S_{MS}, S_{M1}, S_{DS} and S_{D1} using the USGS seismic calculator program, "Seismic Hazard Curves, Response Parameters, Design Parameters: Seismic Hazard Curves, and Uniform Hazard Response Spectra", v. 5.1.0, dated February 10, 2011. Calculated values are presented in the following Table 2, Seismic Design Criteria.

Table 2
Seismic Design Criteria

Latitude	40.752144
Longitude	-124.178327
Site Class	E
S_S	2.57
S_1	1.00
F_a	0.9
F_v	2.40
S_{MS}	2.31
S_{M1}	2.40
S_{DS}	1.54
S_{D1}	1.60
Occupancy Category	II
Seismic Design Category	E

7.3 Foundations

7.3.1 General Design for Shallow Foundations

The primary consideration for the design and construction of shallow foundations is the low bearing capacity of the soils which is constrained by the high settlement potential. Some settlement of the structures placed on shallow foundations should be anticipated (2 to 6 inches) over time. Traditional deep foundations for non-critical structures are not considered cost effective because of the significant depths to good "bearing soils."

- Shallow foundations are proposed for supporting the new bridges. Assuming some settlement (2 to 6 inches) is acceptable, the abutments may be constructed on a shallow support system. Minimizing the weight of the foundation and incorporating allowances for settlement are recommended. The use of gravel ramps on the approaches should make adjustments to the transitions easy. If tilting is to be avoided, then adding provisions that allow for re-leveling at a later date would be advised.
- For general design criteria, we recommend that shallow foundations not exceed an allowable bearing capacity of 1,000 psf for dead plus live loads. A horizontal friction coefficient of 0.30 may be used for the footing/soil contact. Frictional resistance may be calculated in conjunction with an allowable lateral passive pressure represented by an equivalent fluid weighing 150 pcf for short-term loadings, such as lateral foundation resistance in response to wind or earthquake loadings. Lateral passive pressure can be calculated where footings bear laterally against undisturbed native subsoils or structural fill.
- Foundation embedment should remain as shallow as feasible. As discussed in Section 5.0, the upper 1 to 2 feet of soils are generally the strongest, so deeper embedment does not equate to stronger soils, as is usually the case. It is only necessary to remove the organics. Also, the deeper the excavation, the more difficult the working conditions will be for establishing a stable subgrade, setting forms for concrete, etc.
- Where new channel banks are constructed on 1.5H:1V slopes adjacent to bridge abutments, the base of the abutment closest to the channel should be constructed on or behind a sloping plane of 2H:1V starting at the edge of the channel bottom.

Below we provide a discussion of the general types of bridges proposed and our foundation design and construction recommendations for each.

7.3.2 Golf Cart Bridges

The existing golf cart bridges will be replaced, in some cases with longer spans, as a consequence of the channel being widened. The new golf cart bridges are anticipated to be similar in design to the existing. Two of the bridges, one on each side of the Fairview Drive bridge, are planned to accommodate heavier traffic, including emergency vehicles.

- Shallow, reinforced concrete abutments like those currently in use should be adequate for both of these bridge types that are less than 30 feet in length, provided they meet the design criteria specified in Section 7.3.1, above.
- For bridges with spans larger than 30 feet, we recommend using bridge abutments similar to those discussed below for the agricultural bridges.
- Ramp fills shall be no thicker than 2 feet considering the design criteria provided in Section 7.3.1.

7.3.3 Agricultural Bridges

There are two free-span steel bridges proposed within the agricultural areas south of the golf course: a 50-foot span and an 80-foot span (Figure 2). It is our understanding that the bridges will only be used for ranch trucks, agricultural equipment, or other light duty use. The anticipated maximum loads on the abutments of the 80-foot-span bridge are assumed to be on the order of 62 kips.

- For bridge spans 30 feet and longer, we recommend the use of a two-part system, which includes a stabilization mat and the bridge footing itself. Figure 3 presents a schematic drawing of this concept.

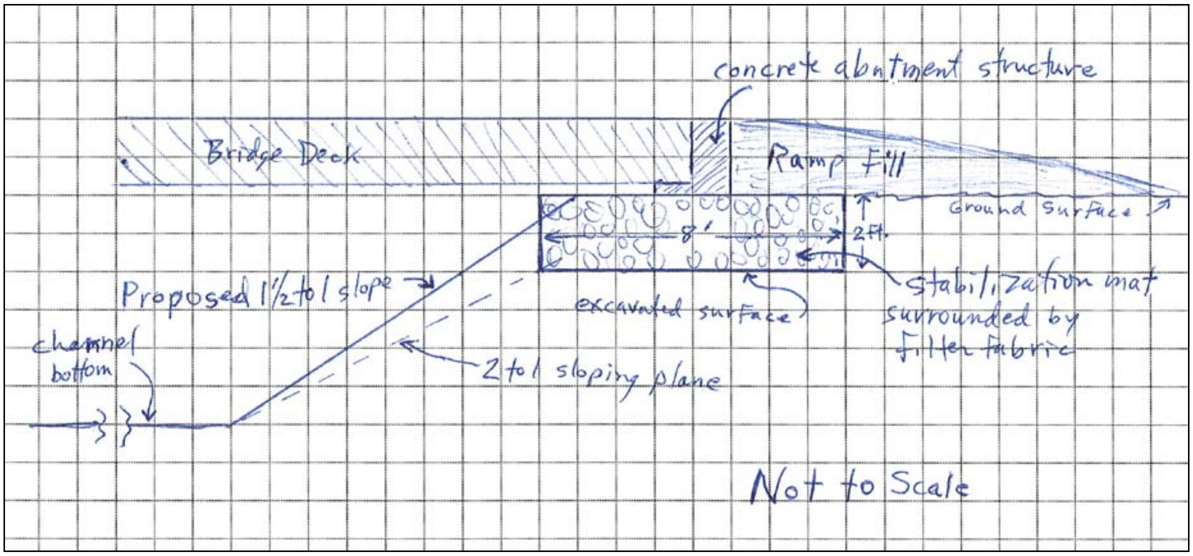

Figure 3. Schematic Drawing of Foundation System for Bridges with Spans Greater Than 30 feet
(actual dimensions will vary)

The purpose of the stabilization mat is to distribute the load of the bridge footing through a flexible, low density, laterally constrained structure that will maintain its integrity while undergoing significant differential settlement.

- We suggest the use of welded wire gabions for this, because it will result in minimal excavation, a relatively easy installation process, and low-cost compared with reinforced concrete. Other alternatives for a stabilization mat may include a laterally constrained multi-layered bed of crushed aggregate and geogrid or interlaced wood beams.
- The stabilization mats should be designed for equivalent basal footing loads of 750 psf or less.
- The bridge footing load should be centered on the stabilization mat structure and should not exceed a footing load of 2,500 psf.
- The thickness of the stabilization mat should be at a ratio of 1:4 with the basal width. For example, an 8-foot basal-width stabilization mat would be at least 2 feet thick. In this example, the overlying concrete abutment footing would need to have a minimum basal width of 2 feet.
- Under no condition should the stabilization mat be less than 6 feet wide or be embedded less than 1.5 feet below original ground surface.
- Where new channel banks are constructed on 1.5H:1V slopes adjacent to bridge abutments, the base of the stabilization mat closest to the channel should be constructed on or behind a sloping plane of 2H:1V starting at the edge of the channel bottom.

- All backfill overlying the bridge abutment footing systems should be low density and provisions should be made to prevent saturation. Ramp fills shall be no thicker than 2.5 feet considering the above design criteria.

7.3.4 Tide Gate Structure

The project includes a 24-foot by 30-foot concrete tide gate with wing walls extending out from each corner. The plans show the structure to have a 1-foot-thick reinforced slab foundation throughout the main part of the structure, with wing walls supported by 4-foot-wide spread footings. As discussed above, the soils at the foundation-bearing depth of this structure are soft, and there is, therefore, a moderate to high settlement potential.

- To minimize differential settlement, we recommend two alternatives for increasing support for the tide gate structure;
  1) sheet piles, and/or
  2) driven piles.

  These options could be used alone or in combination.

Currently, the 30% plans specify sheet piles installed on both the upstream and downstream edges of the structure including along the wing walls.

- Although the purpose of the sheet piles is to provide a groundwater cutoff, if the sheet piles could get extended to a depth of 20 feet below slab grade, then they would also provide support for the structure and reduce the settlement potential.
- Alternatively, or in concert, driven piles could be used to support the slab and wing walls. Driven piles that extend to "solid ground" are not likely cost effective, so piles, if used, should derive their support from friction. Friction piles may need to be extended to 50+ feet below grade, depending upon the loads, and if they are used in combination with the sheet piles. Further evaluation should be conducted to develop specific recommendations.

7.4 Temporary Roads for Construction Access

The temporary roads are a critically important part of the successful completion of the project. As discussed in Section 5.0, the soil conditions in the Martin Slough Valley are soft and saturated at a very shallow depth.

- All heavy equipment and truck traffic should be conducted on temporary roads. Only in rare cases (light vehicles and/or few trips) will vehicles be able to navigate across ground that is not reinforced. Careful consideration of the temporary roads and the layout will be necessary to maintain a functioning access system and minimize the environmental impacts.

Based on the volume of material planned for removal, the highest demand on the temporary road system is likely going to be traffic associated with off hauling the spoils.

- Special attention should be made during laying out the temporary road network and access points in order to minimize disturbance to the project area, maximize the use of temporary materials, and strike the right balance between the number of trips for offhaul and the load of each haul.

Below, we provide recommendations for two types of temporary roads:

1) a mat system, and
2) a geocell system.

Each has its advantages and disadvantages regarding cost/benefit. The specific details of each option may be amended based on the intended use of the particular roadway. In general high volume roadways will require more robust roads than short-term or light duty roads.

7.4.1 Mat System

This option uses interlocking composite road mats placed on a bed of reinforced gravel. The road should be underlain by a medium-weight non-woven filter fabric to act as a separation layer. The bed of gravel should be approximately 2 to 4 inches thick and should consist of crushed rock or equivalent gravel. A medium-grade geogrid should be used at the base of the gravel bed.

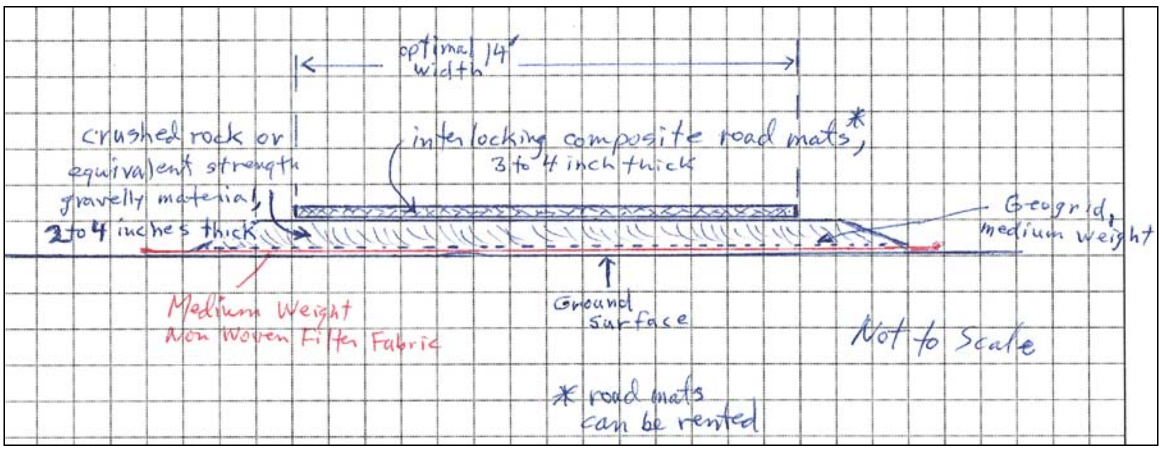

Figure 4. Schematic Drawing of a Temporary Haul Road Using a Mat System
(actual dimensions will vary)

Mats can be rented and will likely drive the cost of using this system. The mats can be pulled and placed with greater ease than some other road systems. Because of the interlocking nature of the mats, curved roads are not easily accommodated with this type of system. From our experience, the optimal width for a road like this is 14 feet.

7.4.2 Geocell System

This option uses a cellular confinement system, also known as geocells. The system is made of an expandable honey-comb-like structure (typically high-density polyethylene [HDPE]) which can be filled with sand and gravel, creating a strong, stiff, cellular mattress. When the soil contained within a geocell is subjected to pressure, it causes lateral stresses on perimeter cell walls. This type of system can be placed directly on the separation layer (woven filter fabric). Figure 5 depicts a schematic drawing of a typical geocell system.

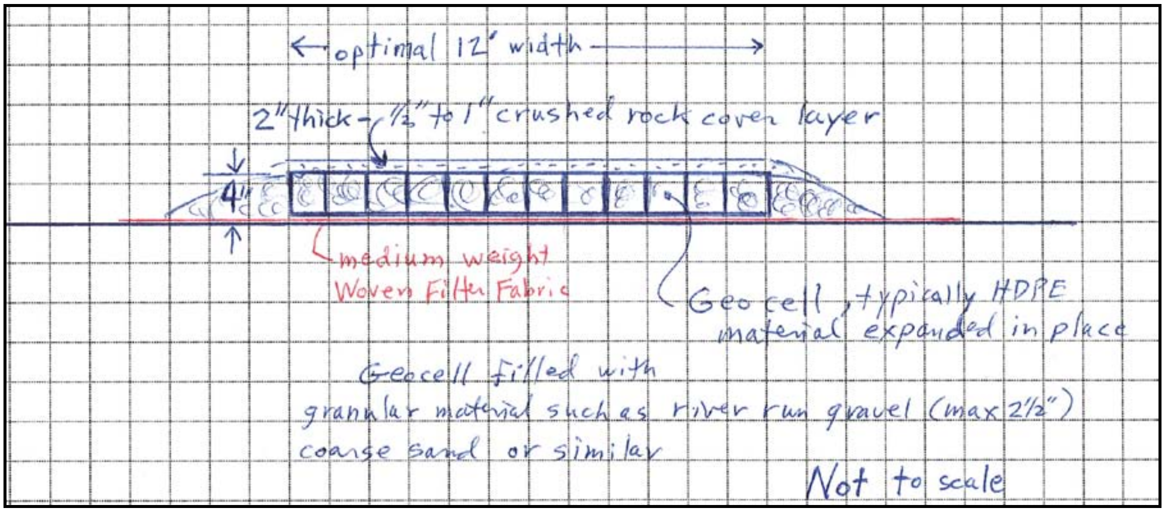

Figure 5. Schematic Drawing of a Temporary Haul Road Using a Geocell System
(actual dimensions will vary)

The material used to fill the cells is not as critical as in other applications, so most any coarse granular material will work. The geocell should be capped with a 2-inch layer of crushed rock. This type of system can more easily accommodate a curved road alignment. Pulling and reuse of this system is more difficult, because the HDPE structure is susceptible to damage.

7.5 Construction-Phase Monitoring

In order to assess construction conformance with the intent of our recommendations, it is important that a representative of our firm review the foundation excavations for the new tide gate and the large-span bridges.

This construction-phase monitoring is important because it provides the owner and SHN the opportunity to verify anticipated site conditions, and recommend appropriate changes in design or construction procedures if site conditions encountered during construction vary from those described in this report. It also allows SHN to recommend appropriate changes in design or construction procedures if construction methods adversely affect the competence of onsite soils to support the structural improvements.

Because of the variable conditions (generally poor) and the large area of the overall project, the project will be a "see as you go" type of endeavor. Various recommendations provided in this report are general, and depend upon the site conditions of the specific project at the time of construction. In many cases, the most appropriate approach cannot be evaluated until the work has begun.

- SHN should be included early on in the various phases of construction to verify the appropriateness of our recommendations and make adjustments if necessary.

8.0 Construction Considerations

This section presents construction considerations that are intended to aid in project planning. These considerations are not intended to be comprehensive; other issues may arise that would require coordination between the owner, the engineer, and the contractor's construction means and methods and capabilities.

Construction considerations for this project include the following:

1. The groundwater is characteristically shallow throughout the year. Based on recent excavation projects in the Martin Slough Valley, groundwater inflow is usually slow and easily managed with pumps. It is important to note, however that even small quantities of persistent seepage may substantially complicate construction operations where excavations extend below areas of saturated soil.
2. Following even minimal site stripping of the upper 1 to 2 feet of soil (the "crust"), exposed soil subgrade will likely be too soft and wet for heavy equipment to traverse. Compaction of the soil subgrade, or achieving a firm soil subgrade surface will be difficult or impractical.
    - If equipment access on excavated areas is necessary, special provisions should be developed, following review of subgrade conditions.
    - To avoid complications with soft subgrade, careful planning of the excavations, particularly those that cover a large area (such as the ponds), is encouraged.
3. We anticipate a vast majority of the excavated soils will be cohesive silty and clayey soils with a moisture content over optimum for compaction. These soils are typically not suitable for use as fill material to be compacted into place, because they will likely be overly wet, slow-drying due to their plasticity, and thus difficult to properly moisture condition and compact.
    - Spreading the soils out and repeatedly turning/disking may be necessary to enhance the usability of the soils.
4. OSHA Type C soils are indicated, requiring excavation side slopes of 1.5H:1V for excavations up to 10 feet in depth, or shoring. However, even at 1.5H:1V some slope failure may occur, particularly where saturated conditions are encountered. Compliance with safety regulations is the responsibility of the contractor.
    - OSHA trench and excavation safety regulations should be acknowledged and followed.

9.0 Plan and Specification Review

- We recommend communications be maintained during the design phase, between the design team and SHN, to optimize compatibility between the design and soil and groundwater conditions.
- We also recommend that we be retained to review those portions of the plans and specifications that pertain to earthwork and foundations. The purpose of this review is to confirm that our earthwork and foundation recommendations have been properly interpreted and implemented during design.

10.0 Closure and Limitations

The analyses, conclusions, and recommendations contained in this report are based on site conditions that we observed at the time of our investigation, data from our subsurface explorations and laboratory tests, our current understanding of proposed project elements, and on our experience with similar projects in similar geotechnical environments. We have assumed that the information obtained from our limited subsurface explorations is representative of subsurface conditions throughout the site.

We recommend that a representative of our firm confirm site conditions during the construction phase. If subsurface conditions differ significantly from those disclosed by our investigation, we should be given the opportunity to re-evaluate the applicability of our conclusions and recommendations. Some alteration of recommendations may be appropriate.

If the scope of the proposed construction, including the proposed loads, grades, or structural locations, changes from that described in this report, our recommendations should also be reviewed.

If there is a substantial lapse of time between the submission of our report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, we should review our report to determine the applicability of the conclusions and recommendations considering the changed conditions and time lapse. This report is applicable only to the project and site studied.

The conclusions and recommendations presented in this report are professional opinions derived in accordance with current standards of professional practice. Our recommendations are tendered on the assumption that design of the improvements will conform to their intent. No representation, express or implied, of warranty or guarantee is included or intended.

The field and laboratory work was conducted to investigate the site characteristics specifically addressed by this report. Assumptions about other site characteristics, such as, hazardous materials contamination, or environmentally sensitive or culturally significant areas, should not be made from this report.

11.0 References

California Building Standards Commission. (2010). *2010 California Building Code–Title 24 Part 2*, Two-Volumes. Based on International Building Code (2009) by the International Code Council. Sacramento, CA:California Building Standards Commission.

SHN Consulting Engineers & Geologists, Inc. (2003). *Geotechnical Study, Proposed Martin Slough Interceptor Sewer Project*. Eureka, CA:SHN.

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Appendix A

Subsurface Exploration Logs

SHN Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Martin Slough Enhancement Project
LOCATION: Tide Gate
GROUND SURFACE ELEVATION: 11 feet
EXCAVATION METHOD: Hand Auger
LOGGED BY: AC, JMA

JOB NUMBER: 013035
DATE DRILLED: 03/21/13
TOTAL DEPTH OF BORING: 15.5 feet
SAMPLER TYPE: 2.5" O.D. brass shelby tube; hand hammer drive

BORING NUMBER HB-1

DEPTH (FT)	USCS	SOIL DESCRIPTION (ASTM D 2488)	% Moisture	Dry Density (pcf)	% Passing 200	Static Cone Pen (tsf)	U.C. (psf)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	% Dry Shrinkage	REMARKS
0.0	ML	Grass, roots to 4".									
-1.0		SILT: Brown, soft, damp.									
-2.5		becomes weakly mottled. grades brown to brownish-gray.									
-4.5		grades bluish-gray and brown. slight increase clay content, very soft, moist to wet.									
-5.5		becomes saturated. grades bluish-gray.									
-6.4			28								Decomposed organic odor
-8.0			35	86				37		3	
-10.0		clamshells observed.									
-11.5		becomes very soft.									
-13.5		sand content increases. becomes soft. clamshells and wood fragments.	40	85			990				
-15.0	SM	SILTY SAND; Bluish-gray, loose, saturated, clam shells.	22	103	25					0	
-15.5		Boring terminated at a depth of 15.5 feet. Groundwater initially encountered at a depth of 5.0 feet; stabalized at a depth of 6.75 feet.									

Depth scale: 0.0, -1.0, -2.0, -3.0, -4.0, -5.0, -6.0, -7.0, -8.0, -9.0, -10.0, -11.0, -12.0, -13.0, -14.0, -15.0, -16.0, -17.0, -18.0, -19.0, -20.0

Columns: BULK SAMPLES, TUBE SAMPLE, USCS, PROFILE

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF BORING

SHN Consulting Engineers & Geologists, Inc.
812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Martin Slough Enhancement Project
LOCATION: South side of slough channel, ~ Sta. 6+00
GROUND SURFACE ELEVATION:
EXCAVATION METHOD: Hand Auger
LOGGED BY: AC, JMA

JOB NUMBER: 013035
DATE DRILLED: 03/21/13
TOTAL DEPTH OF BORING: 7.0 feet
SAMPLER TYPE: Bulk

BORING NUMBER **HB-2**

DEPTH (FT)	BULK SAMPLES	TUBE SAMPLE	USCS	PROFILE	SOIL DESCRIPTION (ASTM D 2488)	% Moisture	Dry Density (pcf)	% Passing 200	Static Cone Pen (tsf)	U.C. (psf)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	% Dry Shrinkage	REMARKS
0.0					Grass, roots to 4".									
			ML		SILT WITH SAND; Brown, soft, damp to moist, minor fine sand.				13					
-1.0									7					
-2.0						26							5	
-3.0									5					
									9.5					
-4.0			ML/ SM		SANDY SILT; Yellowish-brown to grey (weakly mottled), soft, wet, fine sand, occasional wood fragments and decomposed organics.									
-5.0														
-6.0			ML		SILT; Grey, soft, wet, shell fragments.									
-7.0					Boring terminated at a depth of 7.0 feet. Groundwater encountered at a depth of 3 feet. Piezometer installed following completion. Stabilized groundwater elevation at a depth of 2.36 feet on 3/26/13.									
-8.0														
-9.0														
-10.0														

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF BORING

SHN Consulting Engineers & Geologists, Inc.
812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Martin Slough Enhancement Project
LOCATION: 80' Span Agricultural Bridge
GROUND SURFACE ELEVATION: 16 feet
EXCAVATION METHOD: Hand Auger
LOGGED BY: AC, JMA

JOB NUMBER: 013035
DATE DRILLED: 03/21/13
TOTAL DEPTH OF BORING: 10.5 feet
SAMPLER TYPE: 2.5" O.D. brass shelby tube; hand hammer drive

BORING NUMBER HB-3

DEPTH (FT)	USCS	SOIL DESCRIPTION (ASTM D 2488)	% Moisture	Dry Density (pcf)	% Passing 200	Static Cone Pen (tsf)	U.C. (psf)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	% Dry Shrinkage	REMARKS
0.0	ML	Grass, roots to 4".									
-1.0		SILT; Brown to dark brown, medium stiff, moist, trace fine sand.				12					
-2.0	ML	SILT; Yellowish-brown to light olive grey (weak mottles), soft, wet.	49	72							Direct push from 2.25' to 2.75'
-3.0		sand content increases.				18					
-4.0		SANDY SILT; Yellowish-brown to grey (weakly mottled), soft, wet.									
-5.0		SILT; Yellowish-brown to light olive grey (weak mottles), soft, wet.	43	80	79						Direct push from 5.0' to 5.5'
-6.0		decomposed wood and plant and shell fragments									
-7.0											Direct push from 7.0' to 7.5'
-9.0		becomes soft to very soft.									
-10.0			28	83							Direct push from 10' to 10.5'
-11.0		Boring terminated at a depth of 10.5 feet. Groundwater initially encountered at a depth of 1.76 feet. Piezometer installed following completion. Stabilized groundwater elevation measured at a depth of 1.76 feet on 3/26/13.									

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF BORING

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Martin Slough Enhancement Project
LOCATION: 80' Span Agricultural Bridge
GROUND SURFACE ELEVATION: 16 feet
EXCAVATION METHOD: Hand Auger
LOGGED BY: AC, JMA

JOB NUMBER: 013035
DATE DRILLED: 03/21/13
TOTAL DEPTH OF BORING: 10 feet
SAMPLER TYPE: 2.5" O.D. brass shelby tube; hand hammer drive

BORING NUMBER HB-4

DEPTH (FT)	USCS	SOIL DESCRIPTION (ASTM D 2488)	% Moisture	Dry Density (pcf)	% Passing 200	Static Cone Pen (tsf)	U.C. (psf)	Liquid Limit	Plastic Index	% Dry Shrinkage	REMARKS
0.0	ML	Grass, roots to 4".									
-1.0		SILT; Dark brownish-grey to brown (weakly mottled), soft to medium stiff, damp.				20					
-2.0						9					
-3.0						5					
-4.0			36	86							
-5.0		grades grey. wood fragments and decomposed organics.									
-6.0		becomes wet.					760				Direct push from 6.1' to 6.6'
-7.0		becomes soft.									
-9.0			38	80							Direct push from 8.6' to 9.1'
-10.0		Boring terminated at a depth of 10 feet. Groundwater encountered at a depth of 6 feet.									

-11.0 -12.0 -13.0 -14.0 -15.0 -16.0 -17.0 -18.0 -19.0 -20.0

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF BORING

SHN Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Martin Slough Enhancement Project
LOCATION: East of south end of west limb of overflow
GROUND SURFACE ELEVATION: 16 feet
EXCAVATION METHOD: Hand Auger
LOGGED BY: AC, JMA

JOB NUMBER: 013035
DATE DRILLED: 03/21/13
TOTAL DEPTH OF BORING: 7 feet
SAMPLER TYPE: Bulk

BORING NUMBER HB-5

DEPTH (FT)	BULK SAMPLES	TUBE SAMPLE	USCS	PROFILE	SOIL DESCRIPTION (ASTM D 2488)	% Moisture	Dry Density (pcf)	% Passing 200	Static Cone Pen (tsf)	U.C. (psf)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	% Dry Shrinkage	REMARKS
0.0					Grass, roots to 4".									
			ML		SILT; Brown to grey (mottled), soft to medium stiff, moist, contains clay.				11					
-1.0														
									11					
-2.0														
					sandy lens.				3					
-3.0														
			SM		SILTY SAND; Grey to brown (mottled), loose, wet.				17					
-4.0														
						33							9	
-5.0														
			CH/ MH		CLAY; Gray, very soft, wet.									
-6.0														
						36							11	
-7.0					Boring terminated at a depth of 7 feet. Groundwater initially encountered at a depth of 5.5 feet. Piezometer installed following completion. Stabilized groundwater elevation measured at a depth of 2.24 feet on 3/26/13.									
-8.0														
-9.0														
-10.0														

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF BORING

SHN Consulting Engineers & Geologists, Inc.
812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Martin Slough Enhancement Project
LOCATION: East limb of overflow
GROUND SURFACE ELEVATION: 16 feet
EXCAVATION METHOD: Hand Auger
LOGGED BY: AC, JMA

JOB NUMBER: 013035
DATE DRILLED: 03/21/13
TOTAL DEPTH OF BORING: 7 feet
SAMPLER TYPE: Bulk

BORING NUMBER HB-6

DEPTH (FT)	USCS	SOIL DESCRIPTION (ASTM D 2488)	% Moisture	Dry Density (pcf)	% Passing 200	Static Cone Pen (tsf)	U.C. (psf)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	% Dry Shrinkage	REMARKS
0.0		Grass, roots to 4".									
	ML	SILT; Greyish-brown, medium stiff, moist.									
-1.0						10.5					
-2.0											
-3.0											
						4					
-4.0	SM	SILTY SAND; Grey, loose, wet, fine sand.									
	CH/MH	CLAY; Dark grey to brown (mottled), medium stiff, moist.									
-5.0											
	ML	SILTY SAND; Grey, medium dense, moist, decomposed organics, fine to medium grained sand, clam shells and minor organics.									
-6.0			19							4	
			19		28						
-7.0		Boring terminated at a depth of 7.0 feet. Groundwater encountered at a depth of 4.5 feet.									
-8.0											
-9.0											
-10.0											

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF BORING

SHN Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Martin Slough Enhancement Project
LOCATION: Tidal pond C Complex
GROUND SURFACE ELEVATION: 16 feet
EXCAVATION METHOD: Hand Auger
LOGGED BY: AC, JMA

JOB NUMBER: 013035
DATE DRILLED: 03/21/13
TOTAL DEPTH OF BORING: 5 feet
SAMPLER TYPE: Bulk

BORING NUMBER HB-7

DEPTH (FT)	BULK SAMPLES	TUBE SAMPLE	USCS	PROFILE	SOIL DESCRIPTION (ASTM D 2488)	% Moisture	Dry Density (pcf)	% Passing 200	Static Cone Pen (tsf)	U.C. (psf)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	% Dry Shrinkage	REMARKS
0.0					Grass, roots to 4".									
0.0 to -4.0	X (at -2.0 to -2.5)		ML		SILT; Brown to brownish-grey to yellowish-brown (mottled), soft to medium stiff, moist, slightly clayey, some wood fragments.				7, 7.5, 5, 5					
-4.0 to -5.0	X (at -4.0 to -4.5)		ML		SILT; Dark grey to brown (mottled), medium stiff, moist, slightly clayey, minor organics.	30							6	
-5.0					Boring terminated at a depth of 5.0 feet. Groundwater encountered at a depth of 1.25 feet.									

Depth scale: 0.0, -1.0, -2.0, -3.0, -4.0, -5.0, -6.0, -7.0, -8.0, -9.0, -10.0

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF BORING

SHN Consulting Engineers & Geologists, Inc.
812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Martin Slough Enhancement Project
LOCATION: Tidal pond C Complex
GROUND SURFACE ELEVATION: 17 feet
EXCAVATION METHOD: Hand Auger
LOGGED BY: AC, JMA

JOB NUMBER: 013035
DATE DRILLED: 03/21/13
TOTAL DEPTH OF BORING: 5 feet
SAMPLER TYPE: Bulk

BORING NUMBER HB-8

DEPTH (FT)	BULK SAMPLES	TUBE SAMPLE	USCS	PROFILE	SOIL DESCRIPTION (ASTM D 2488)	% Moisture	Dry Density (pcf)	% Passing 200	Static Cone Pen (tsf)	U.C. (psf)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	% Dry Shrinkage	REMARKS
0.0					Grass, roots to 4".									
			CL/ ML		CLAY; Strong brown to brownish-grey (mottled), medium stiff, moist.				9					
-1.0									5					
-2.0			SM/ SC		CLAYEY SAND; Strong brown to brownish-grey (mottled), medium dense, wet.				5					
-3.0			CL/ ML		SILT; Brownish-grey to bluish-grey, medium stiff to stiff, wet, weakly cemented nodules of iron oxide.				7					
-4.0						18							9	
-5.0					Boring terminated at a depth of 5 feet. Piezometer installed following completion. Stabilized groundwater elevation measured at a depth of 1.71 feet.									
-6.0														
-7.0														
-8.0														
-9.0														
-10.0														

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF BORING

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Martin Slough Enhancement Project

LOCATION: 50' Span Agricultural Bridge

GROUND SURFACE ELEVATION: 16 feet

EXCAVATION METHOD: Hand Auger

LOGGED BY: AC, JMA

JOB NUMBER: 013035

DATE DRILLED: 03/21/13

TOTAL DEPTH OF BORING: 10 feet

SAMPLER TYPE: Bulk

BORING NUMBER HB-9

DEPTH (FT)	USCS	SOIL DESCRIPTION (ASTM D 2488)	% Moisture	Dry Density (pcf)	% Passing 200	Static Cone Pen (tsf)	U.C. (psf)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	% Dry Shrinkage	REMARKS
0.0		Grass, roots to 4".									
-1.0	CL	SILTY CLAY; Brownish-grey to strong brown (mottled), medium stiff, moist.				14					
-2.0						16					
-3.0			31	90		8	1350	38	14		
-6.0	SM	SANDY SILT; Greyish-brown, medium stiff, moist, trace fine sand, clamshells.	38	80	76					8.5	
-7.5	SC	CLAYEY SAND; Bluish-grey, medium dense, wet, abundant clamshells.	25	100						14	
-8.0	MH	SILT; Bluish-grey, soft to medium stiff, wet, decomposed organics.	34	86	34		340	57	25		
-11.0			41	80				46	25	2.5	

Boring terminated at a depth of 11.5 feet. Groundwater initially encountered at a depth of 4.0 feet. Piezometer installed following completion. Stabilized groundwater elevation measured at a depth of 1.92 feet on 3/26/13.

Depth scale: 0.0, -1.0, -2.0, -3.0, -4.0, -5.0, -6.0, -7.0, -8.0, -9.0, -10.0, -11.0, -12.0, -13.0, -14.0, -15.0, -16.0, -17.0, -18.0, -19.0, -20.0

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF BORING

SHN Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Martin Slough Enhancement Project
LOCATION: East side of slough channel; ~Sta. 44+00
GROUND SURFACE ELEVATION: 16 feet
EXCAVATION METHOD: Hand Auger
LOGGED BY: AC, JMA

JOB NUMBER: 013035
DATE DRILLED: 03/22/13
TOTAL DEPTH OF BORING: 8 feet
SAMPLER TYPE: Bulk

BORING NUMBER HB-10

DEPTH (FT)	USCS	SOIL DESCRIPTION (ASTM D 2488)	% Moisture	Dry Density (pcf)	% Passing 200	Static Cone Pen (tsf)	U.C. (psf)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	% Dry Shrinkage	REMARKS
0.0		Grass, roots to 4".									
	GW	FILL: SANDY GRAVEL; Grey, rounded, medium dense, damp.									
-1.0	SM	SILTY SAND; Yellowish-brown to grey (mottled), loose to medium dense, damp.									
	ML/SM	SILT WITH SAND; Grey, medium stiff, damp to moist.									
-3.0	SM	SAND; Grey, loose, wet, trace silt, fine sand.									
	ML	SANDY SILT; Grey, very soft, wet, very fine sand.									
-4.0	SM	SILTY SAND; Grey, loose, wet. occasional lense of shells and shell hash.									
-5.0			25		30						
-8.0		Boring terminated at a depth of 8 feet. 8.5'? Groundwater initially encountered at a depth of 3.5 feet. Stabilized groundwater elevation measured at a depth of 6.5 feet.									

Depth scale: 0.0, -1.0, -2.0, -3.0, -4.0, -5.0, -6.0, -7.0, -8.0, -9.0, -10.0

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF BORING

SHN Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Martin Slough Enhancement Project
LOCATION: Tidal Pond D
GROUND SURFACE ELEVATION: 16 feet
EXCAVATION METHOD: Hand Auger
LOGGED BY: AC, JMA

JOB NUMBER: 013035
DATE DRILLED: 03/22/13
TOTAL DEPTH OF BORING: 7 feet
SAMPLER TYPE: Bulk

BORING NUMBER **HB-11**

DEPTH (FT)	BULK SAMPLES	TUBE SAMPLE	USCS	PROFILE	SOIL DESCRIPTION (ASTM D 2488)	% Moisture	Dry Density (pcf)	% Passing 200	Static Cone Pen (tsf)	U.C. (psf)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	% Dry Shrinkage	REMARKS
0.0					Grass, roots to 4".									
			ML		SANDY SILT; Brown to gray (mottled), soft, damp to moist, contains clay.									
-1.0									8.5					
-2.0						46			8				7	
-3.0			CL		SILTY CLAY; Grey to olive brown (weakly mottled), soft, wet.									
-4.0						42							12	
-5.0			ML		SILT; Grey, soft, wet, organics and peat filaments.									
-6.0														
-7.0					Boring terminated at a depth of 7 feet. Ground water initially encountered at a depth of 2.75 feet. Stabilized groundwater elevation measured at a depth of 1.5 feet.									
-8.0														
-9.0														
-10.0														

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF BORING

SHN Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Martin Slough Enhancement Project
LOCATION: Tidal Pond E
GROUND SURFACE ELEVATION: 16 feet
EXCAVATION METHOD: Hand Auger
LOGGED BY: AC, JMA

JOB NUMBER: 013035
DATE DRILLED: 03/22/13
TOTAL DEPTH OF BORING: 8 feet
SAMPLER TYPE: Bulk

BORING NUMBER HB-12

DEPTH (FT)	BULK SAMPLES	TUBE SAMPLE	USCS	PROFILE	SOIL DESCRIPTION (ASTM D 2488)	% Moisture	Dry Density (pcf)	% Passing 200	Static Cone Pen (tsf)	U.C. (psf)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	% Dry Shrinkage	REMARKS
0.0					Grass, roots to 4".									
			ML		SILT; Brown, soft, damp, contains clay.									
-1.0														
-2.0 to -2.5		■				42	75						10	
-3.0														
-4.0														
-5.0 to -5.5		■			grades bluish-grey.	45	73				46	19		
-6.0			SM		SAND; Grey, loose, saturated.									
-7.0			ML		SILT; Grey, soft, wet, few clamshells, trace fine sand.									
-8.0					Boring terminated at a depth of 8 feet. Groundwater initially encountered at a depth of 3.0 feet. Stabilized groundwater elevation measured at a depth of 2.5 feet.									
-9.0														
-10.0														

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF BORING

SHN Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Martin Slough Enhancement Project

LOCATION: Tidal Pond E

GROUND SURFACE ELEVATION: 16 feet

EXCAVATION METHOD: Hand Auger

LOGGED BY: AC, JMA

JOB NUMBER: 013035

DATE DRILLED: 03/22/13

TOTAL DEPTH OF BORING: 7 feet

SAMPLER TYPE: Bulk

BORING NUMBER HB-13

DEPTH (FT)	BULK SAMPLES	TUBE SAMPLE	USCS	PROFILE	SOIL DESCRIPTION (ASTM D 2488)	% Moisture	Dry Density (pcf)	% Passing 200	Static Cone Pen (tsf)	U.C. (psf)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	% Dry Shrinkage	REMARKS
0.0					Grass, roots to 4".									
			CL		SILT; Yellowish-brown to grey (mottled), soft to medium stiff, damp, slightly clayey.									
									28					
						31							5	
									7					
-5.0			ML/ SM		SANDY SILT; Grey, soft, wet, interfingered sandy, clayey, and silty lenses, occasional clam shells.								5	
						23								
-7.0					Boring terminated at a depth of 7 feet. Groundwater initially encountered at a depth of 3.0 feet. Stabilized groundwater elevation measured at a depth of .75 feet.									

Depth scale: 0.0, -1.0, -2.0, -3.0, -4.0, -5.0, -6.0, -7.0, -8.0, -9.0, -10.0

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

LOG OF BORING

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Martin Slough Enhancement Project
JOB NUMBER: 013035
LOCATION: Tidal Pond F
DATE DRILLED: 03/22/13
GROUND SURFACE ELEVATION: 17 feet
TOTAL DEPTH OF BORING: 7 feet
EXCAVATION METHOD: Hand Auger
SAMPLER TYPE: Bulk
LOGGED BY: AC, JMA

BORING NUMBER **HB-14**

DEPTH (FT)	BULK SAMPLES	TUBE SAMPLE	USCS	PROFILE	SOIL DESCRIPTION (ASTM D 2488)	% Moisture	Dry Density (pcf)	% Passing 200	Static Cone Pen (tsf)	U.C. (psf)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	% Dry Shrinkage	REMARKS
0.0					Grass, roots to 4".									
			ML		SILT; Yellowish-brown to gray (mottled), soft, damp to moist.				6					
-1.0									5					
-2.0			SM		SILTY SAND; Brownish-grey, loose, saturated, flowing, fine sand.				5					
-3.0			ML		SILT; Grey, soft, wet, organics, decomposed plant fragments.				14					
-4.0						27							8	
-5.0														
-6.0			SM		SILTY SAND; Grey, loose, wet.									
-7.0					Boring terminated at a depth of 7 feet. Groundwater initially encountered at a depth of 2.0 feet. Stabilized groundwater elevation measured at a depth of 1.0 feet.									
-8.0														
-9.0														
-10.0														

LOG OF BORING

SHN Consulting Engineers & Geologists, Inc.
812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Martin Slough Enhancement Project
LOCATION: Tidal Pond G
GROUND SURFACE ELEVATION: 17 feet
EXCAVATION METHOD: Hand Auger
LOGGED BY: AC, JMA

JOB NUMBER: 013035
DATE DRILLED: 03/22/13
TOTAL DEPTH OF BORING: 7 feet
SAMPLER TYPE: Bulk

BORING NUMBER HB-15

DEPTH (FT)	USCS	SOIL DESCRIPTION (ASTM D 2488)	% Moisture	Dry Density (pcf)	% Passing 200	Static Cone Pen (tsf)	U.C. (psf)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	% Dry Shrinkage	REMARKS
0.0		Grass, roots to 4".									
	CL	CLAY; Brownish-grey to brown (mottled), medium stiff, damp to moist.									
-1.0						245					
						13					
-2.0			78	51			1600				
-3.0			44								
-4.0											
		becomes silty, organic-rich.									
-5.0			80	53			620				
-6.0	Peat	PEAT; Dark brown, soft, moist to wet.	55								
	ML/CL	SILT; Grey, soft, wet, clayey.									
-7.0		Boring terminated at a depth of 7 feet. Groundwater not observed.									
-8.0											
-9.0											
-10.0											

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LOG OF BORING

SHN Consulting Engineers & Geologists, Inc.
812 West Wabash, Eureka, CA ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Martin Slough
LOCATION: Pine Hill Road, Eureka, CA
GROUND SURFACE ELEVATION: --
EXCAVATION METHOD: Solid Stem Flight Auger (4")
LOGGED BY: SMB

JOB NUMBER: 001283.320
DATE DRILLED: 9/25/02
TOTAL DEPTH OF HOLE: 31.5 feet
SAMPLER TYPE: 2.5" I.D. Calif. Split Spoon, 140 lb telescoping hammer, 30" drop

HOLE NUMBER **MS-8**

DEPTH (FT)	SPT BLOWS PER 0.5'	USCS	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Comp. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
0.0		ML-CL	SILT, clayey, very sandy, fine, with few to moderate organics, soft, dry, very dark grey.							
-5.0	1, 2, 2, 1, 2, 2		Becomes wet.	41.6	75			30.5	11	Peak @ 6.5-7.0' C = 0.35 ksf Phi = 30.6 deg. Residual C = 0.20 ksf Phi = 32.8 deg.
-10.0	1, 2, 2		SILT, slightly clayey, slightly sandy, fine to medium, with few to no organics, soft, wet, very dark grey.	43.4	77			40.6	16	
-15.0	1, 2, 2		No organics.							
-20.0	1, 2, 3		SILT, slightly clayey to clayey, few to no organics, medium stiff, moist to wet, very dark grey.							
		ML	SILT, slightly clayey to clayey, very slightly sandy, fine, medium stiff, wet, very dark grey.							ML-CL/ML Contact inferred.
-25.0	3, 4, 5		With shells.							
-30.0	2, 3, 5		Bottom of boring at 31.5 feet.							

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

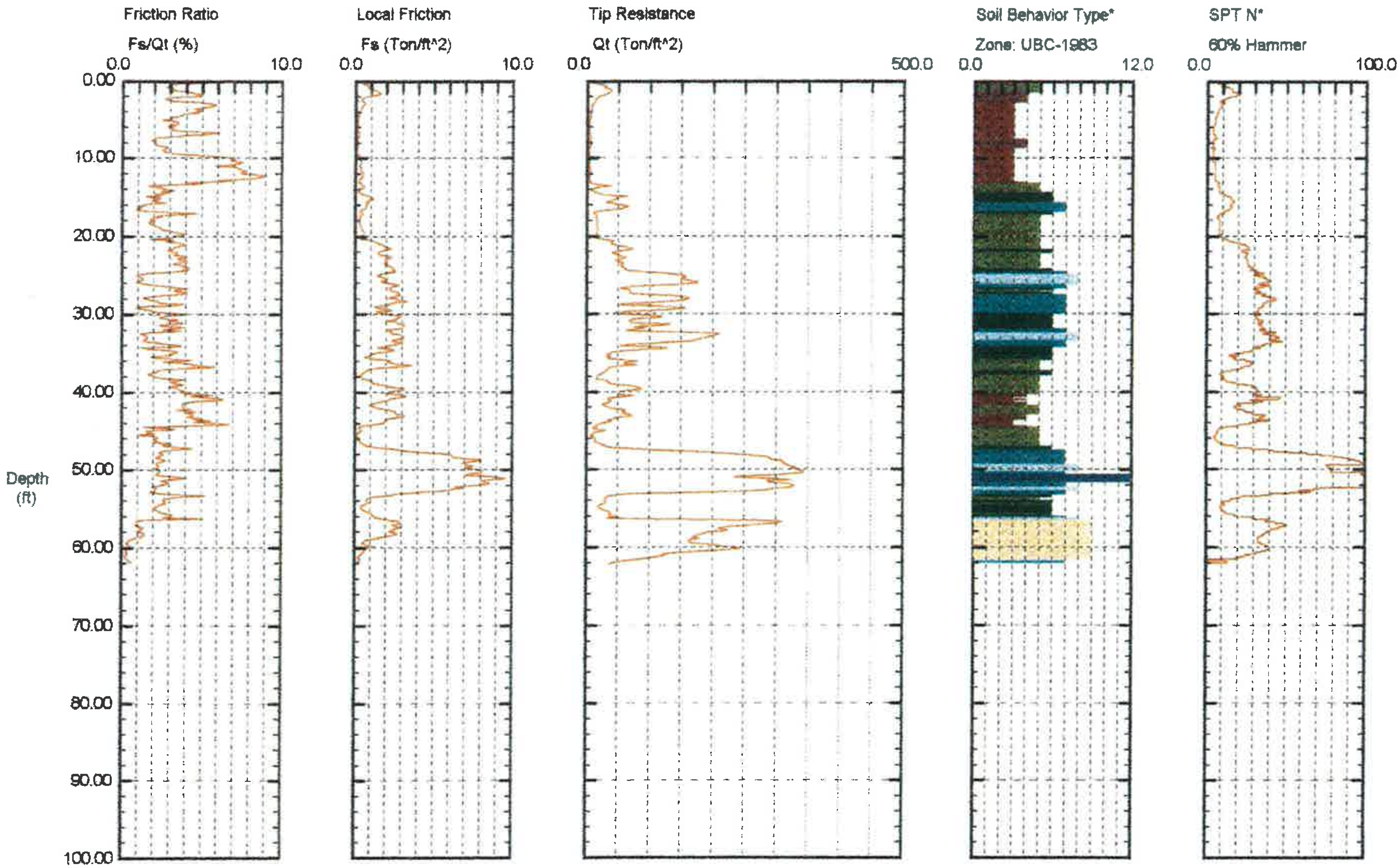
FIELD BORING LOG

behavior type and SPT based on data from UBC-1983

VBI In-Situ Testing

Operator: MIKE JONES
Sounding: 02W324
Cone Used: HO752TC-U2

CPT Date/Time: 09-25-02 09:26
Location: CPT-7
Job Number: MARTIN SLOUGH



Maximum Depth = 62.17 feet

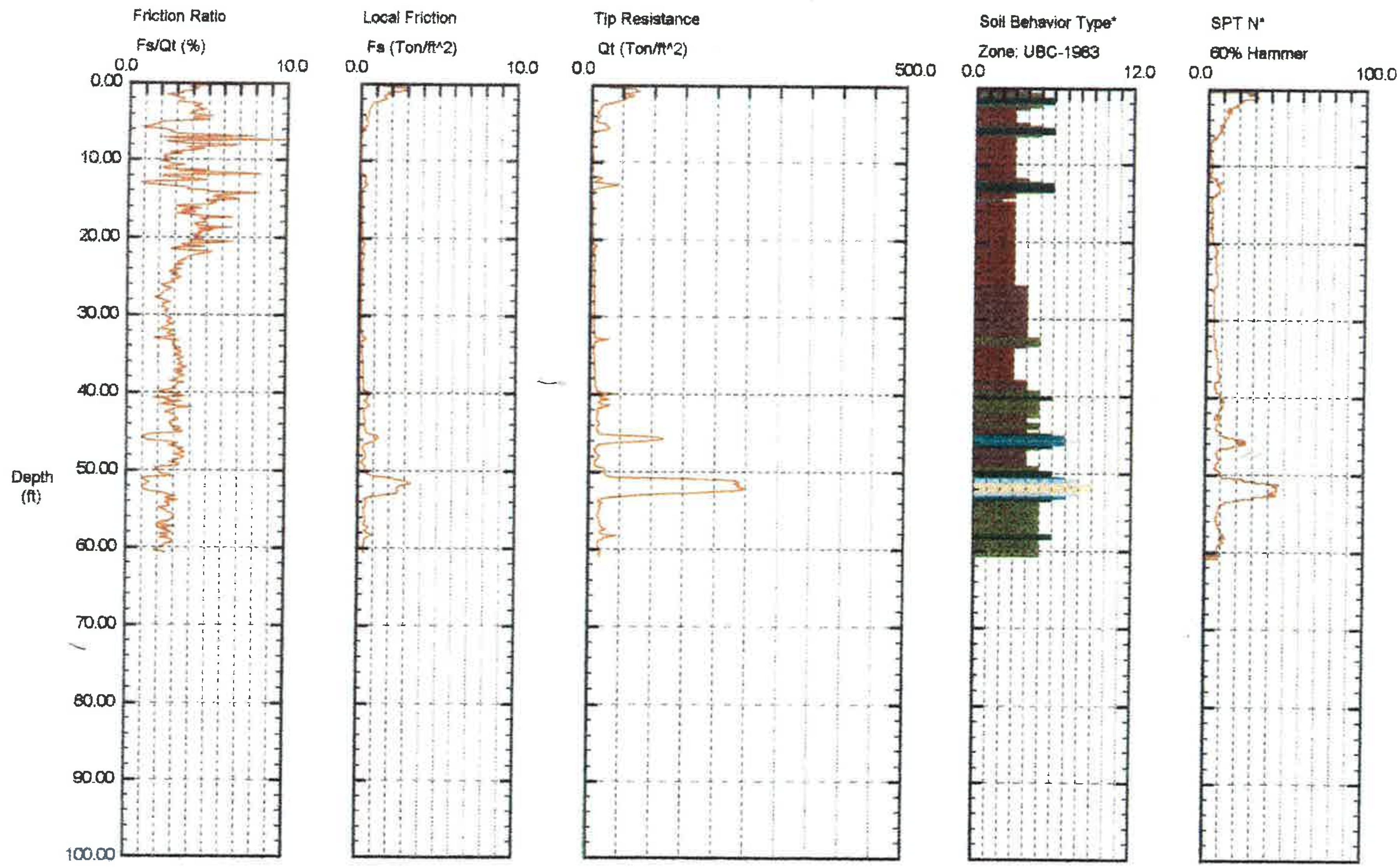
Depth Increment = 0.16 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

VBI In-Situ Testing

Operator: MIKE JONES
Sounding: 02W321
Cone Used: HO752TC-U2

CPT Date/Time: 09-24-02 11:41
Location: CPT-6
Job Number: MARTIN SLOUGH



Maximum Depth = 61.02 feet

Depth Increment = 0.16 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

SHN Consulting Engineers & Geologists, Inc.
812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Martin Slough
LOCATION: Pump House
GROUND SURFACE ELEVATION: --
EXCAVATION METHOD: Rotary Wash 6"
LOGGED BY: SMB

JOB NUMBER: 001283.675
DATE DRILLED: 5/21/08
TOTAL DEPTH OF BORING: 51.5 feet
SAMPLER TYPE: Shelby, SPT

BORING NUMBER BH-3

DEPTH (FT)	BULK SAMPLES	SHELBY TUBE	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
0.0													
-1.0													
-2.0													
-3.0													
-4.0 ▼													
-5.0				SM		FINE SAND, silt, with clay, loose, saturated, grey.	89.0	47.2					Shelby tube encountered wod, no return
-6.0						Gas smell.							
-7.0			4										
			4										Modified Cal. sampler driven through wood fragment
-8.0			4										
-9.0													Loss of drilling fluids due to hydraulic fracture; casing placed to 10 feet
-10.0			2	SM		FINE SAND, silty with clay, wood, loose, saturated, grey							
			3										Sample description based on shoe material
-11.0			3										Drilling fluid lost again due to hydraulic fracture; casing extended to 15 feet
			7	ML/SC		SILT, clay, with trace fine sand, and organics, medium stiff, wet, grey to							
-12.0													

FIELD LOG

SHN Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Martin Slough
LOCATION: Pump House
GROUND SURFACE ELEVATION: --
EXCAVATION METHOD: Rotary Wash 6"
LOGGED BY: SMB

JOB NUMBER: 001283.675
DATE DRILLED: 5/21/08
TOTAL DEPTH OF BORING: 51.5 feet
SAMPLER TYPE: Shelby, SPT

BORING NUMBER BH-3

DEPTH (FT)	BULK SAMPLES	SHELBY TUBE	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-12.0			7, 8			FINE SAND, clayey, with silt and organics, medium dense, wet, grey.							
-13.0													Sampled with CAT
-14.0													
-15.0			5, 6, 8	SC		FINE SAND, clayey, with silt, medium dense, wet, grey.							Cased to 15 feet
-16.0													
-17.0			Push	MH		SILT, clayey, with fine sand, organics, soft, wet, dark grey.				71.3	48	22	
-18.0													
-19.0													
-20.0			Push	ML		SILT, clayey, with sand, soft to medium stiff, wet, dark gray.	33.2	87.7					Direct Shear: Peak @ 20' to 22.5' C = 2.53 psf Phi = 19.8 deg
-21.0													
-22.0													
-23.0													
-24.0													

FIELD LOG

SHN Consulting Engineers & Geologists, Inc.
812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Martin Slough
LOCATION: Pump House
GROUND SURFACE ELEVATION: --
EXCAVATION METHOD: Rotary Wash 6"
LOGGED BY: SMB

JOB NUMBER: 001283.675
DATE DRILLED: 5/21/08
TOTAL DEPTH OF BORING: 51.5 feet
SAMPLER TYPE: Shelby, SPT

BORING NUMBER BH-3

DEPTH (FT)	BULK SAMPLES	SHELBY TUBE	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-24.0													
-25.0			Push	ML		SILT, fine sand, wilt clay, medium stiff, moist to wet, grey.	14.9	117.2	4850				
-26.0													
-27.0													
-28.0													
-29.0													
-30.0			4 6 6	SM		FINE SAND, with silt, medium dense, moist, grey.							
-31.0													
-32.0													
-33.0													
-34.0													
-35.0			4 5	SC		FINE SAND, clay, silt, medium dense, moist, grey.							
-36.0													

FIELD LOG

SHN Consulting Engineers & Geologists, Inc.
812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Martin Slough
LOCATION: Pump House
GROUND SURFACE ELEVATION: --
EXCAVATION METHOD: Rotary Wash 6"
LOGGED BY: SMB

JOB NUMBER: 001283.675
DATE DRILLED: 5/21/08
TOTAL DEPTH OF BORING: 51.5 feet
SAMPLER TYPE: Shelby, SPT

BORING NUMBER BH-3

DEPTH (FT)	BULK SAMPLES	SHELBY TUBE	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-36.0			10										
-40.0 to -41.5			4, 8, 8	SM/SP		FINE SAND, with silt, medium dense, moist, grey.							
-45.0 to -46.5			4, 6, 8	SM/SP		FINE SAND, with silt, medium dense, moist, grey.							

Depth scale: -36.0, -37.0, -38.0, -39.0, -40.0, -41.0, -42.0, -43.0, -44.0, -45.0, -46.0, -47.0, -48.0

FIELD LOG

Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA 95501 ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Martin Slough
LOCATION: Pump House
GROUND SURFACE ELEVATION: --
EXCAVATION METHOD: Rotary Wash 6"
LOGGED BY: SMB

JOB NUMBER: 001283.675
DATE DRILLED: 5/21/08
TOTAL DEPTH OF BORING: 51.5 feet
SAMPLER TYPE: Shelby, SPT

BORING NUMBER BH-3

DEPTH (FT)	BULK SAMPLES	SHELBY TUBE	BLOWS PER 0.5'	USCS	PROFILE	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Com. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
-48.0													
-49.0													
-50.0			12	SM		FINE SAND, with silt, medium dense, moist, grey.							
			12										
-51.0			16										
						Bottom of Boring at 51.5 feet.							
-52.0													
-53.0													
-54.0													
-55.0													
-56.0													
-57.0													
-58.0													
-59.0													
-60.0													

FIELD LOG

SHN Consulting Engineers & Geologists, Inc.

812 West Wabash, Eureka, CA ph. (707) 441-8855 fax. (707) 441-8877

PROJECT: Martin Slough
LOCATION: Golf Course, Eureka, CA
GROUND SURFACE ELEVATION: –
EXCAVATION METHOD: Solid Stem Flight Auger (4")
LOGGED BY: SMB

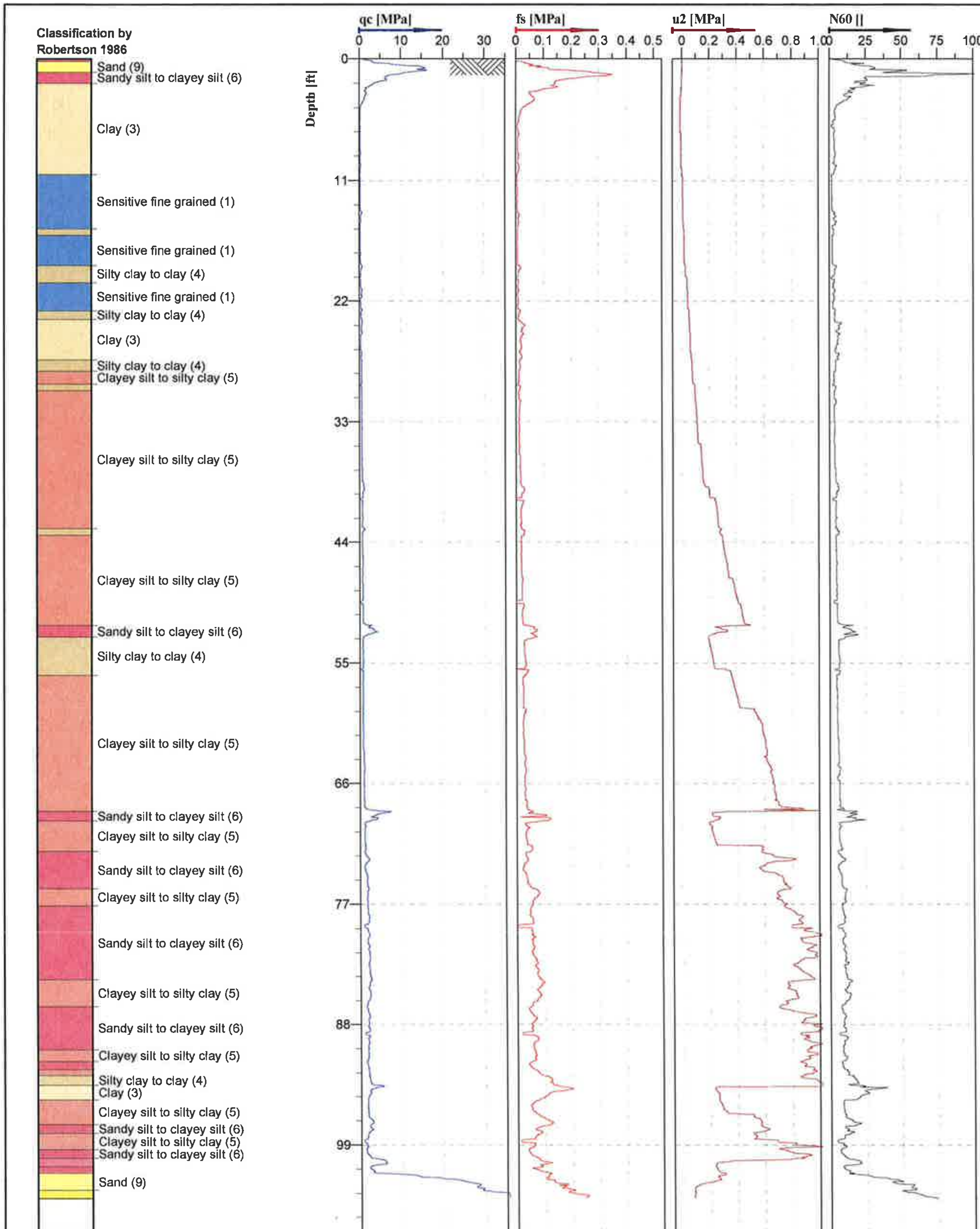
JOB NUMBER: 001283.320
DATE DRILLED: 9/24/02
TOTAL DEPTH OF HOLE: 21.5 feet
SAMPLER TYPE: 2.5" I.D. Calif. Split Spoon, 140 lb telescoping hammer, 30" drop

HOLE NUMBER MS-5

DEPTH (FT)	SPT BLOWS PER 0.5'	USCS	DESCRIPTION	% Moisture	Dry Density (pcf)	Unc. Comp. (psf)	% Passing 200	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Index	REMARKS
0.0		CL	CLAY, silty, medium stiff, dry, yellow brown, with distinct mottles.							
-5.0 (▽)	P, 1, 2, 1, 1, 2		Becomes moist to wet.							
	1, 2, 4	SC	SAND, fine to medium, clayey, slightly silty, with rare organics, medium dense, wet, dark grey.	91.4	52			50.4	26	Peak @ 8.5-9.0' C = 0.44 ksf Phi = 27.2 deg. Residual @ 8.5-9.0' C = 0.15 ksf Phi = 33.9 deg.
-10.0	3, 7, 7	SM	SAND, fine to medium, slightly silty, medium dense, wet, dark yellowish brown.	18.8	112					
		SP-SM	SAND, fine to medium, slightly silty, with few organics, medium dense, wet.							SM/SP-SM Contact inferred
-15.0	5, 10, 6, 1, 2, 2			122.6	42			86.4	39	Woody debris in sampling shoe
		OH	SILT, sl. clayey to clayey, sl.sandy, fine, with many organics, soft, wet, dark yellowish brown.							
		SM-SP	SAND, fine to medium, slightly silty, medium dense, wet, dark yellowish brown.							OH/SM-SP Contact inferred
-20.0	3, 3, 3	ML	SILT, sandy, fine, slightly clayey, with few organics, medium stiff, wet, dark yellowish brown.							
			Bottom of boring at 21.5 feet.							
-25.0										

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

FIELD BORING LOG



Location: Eureka, Ca	Position: X: 0.00 ft, Y: 0.00 ft	Ground level: 0.00	Test no: CPT-1
Project ID: G3904	Client: SHN	Date: 9/28/2012	Scale: 1 : 150
Project: Pine Hill Bridge		Page: 1/1	Fig:
		File: shn pine hill1.cpt	

Fisch Drilling

U2

Cone No: 4057
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Project: Pine Hill Road Bridge Replacement	Log of Boring B-1
Project Location:	Sheet 1 of 1
Project Number: 012163	

Date(s) Drilled	10/16/12	Logged By	JHD	Checked By	
Drilling Method	Hollow-stem auger	Drill Bit Size/Type		Total Depth of Borehole	90.5 feet
Drill Rig Type	0-40' Rotary-wash 40-91'	Drilling Contractor	Taber Drilling	Approximate Surface Elevation	
Groundwater Level and Date Measured		Sampling Method(s)	Shelby Tube	Hammer Data	Automatic
Borehole Backfill	Cement grout	Location	SE corner of bridge 17' east of CPT 1		

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	0				SP		Brown GRAVELLY SAND medium dense, moist	
					CL/OL		Blue Gray Lean CLAY, very soft, wet to saturated, minor sand, minor organics	
	5		NR	2 2 2				
	10		NR	P				
			SHELBY					consol TXCU w=31.4% γ_d=89pcf
	15							
	20						minor decomposing organics	TXCU LL=32, PI=12 w=34.6% γ_d=85pcf
	25							
	30							

Project:		Log of Boring B-1	
Project Location:	SEE PAGE 1	Sheet 2 of 3	
Project Number: 012163			

Date(s) Drilled		Logged By		Checked By	
Drilling Method		Drill Bit Size/Type		Total Depth of Borehole	
Drill Rig Type		Drilling Contractor		Approximate Surface Elevation	
Groundwater Level and Date Measured		Sampling Method(s)		Hammer Data	
Borehole Backfill		Location			

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	30				MH/OH		Grey CLAYEY SILT, soft, saturated, minor organics and clam shells	Consol TXCU W=37.1% γ_d=82pcf
	35							
	40				MH/OH		Grey CLAYEY SILT, soft to medium stiff, saturated, minor sand and organics	TXCU LL=53, PI=24 W=39.7% γ_d=80pcf
	45							
							Brownish-gray SILTY SAND medium dense, saturated, few organics and shell fragments	
	50				SM			TXCU W=42.3% γ_d=77psf
					MH/OH		Gray CLAYEY SILT, soft to medium stiff, saturated, few organics and shell fragments	
	55							
					SM		Brownish-gray SILTY SAND medium dense, saturated	
	60		4				layer of decomposing roots w/ few rounded gravels to 1/2"	

Project:		Log of Boring B-1
Project Location:	SEE PAGE 1	Sheet ~~1~~ of ~~1~~ 3 of 3
Project Number: 012163		

Date(s) Drilled		Logged By		Checked By	
Drilling Method		Drill Bit Size/Type		Total Depth of Borehole	
Drill Rig Type		Drilling Contractor		Approximate Surface Elevation	
Groundwater Level and Date Measured		Sampling Method(s)		Hammer Data	
Borehole Backfill		Location			

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
	60			6 6	CL		layer of Reddish-brown SANDY CLAY w/ few gravels and organics	UC w= 50.3% γ_d= 69 pcf
							Grey SILTY CLAY soft to medium stiff, saturated	
	65							
	70		NR	4 6 9	SC		Grey CLAYEY SAND medium dense, saturated, few organics	Pushed another sample w/ catcher -200 = 45.4%
	75							
					CL		Grey SILTY CLAY very stiff, saturated	
	80			11 18 30	SC		Grey CLAYEY SAND dense, saturated	collected sample using catcher -200 = 27.8%
	85							
				35	SP		SAND, very dense, saturated, medium-grained	collected sample using catcher -200 = 12.9%
	90			50/4"			BOH 90½'	

Appendix B

ASTM Laboratory Test Results

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DENSITY BY DRIVE- CYLINDER METHOD (ASTM D2937)

Project Name:	Martin Slough Enhancement	**Project Number:**	013035
Performed By:	JMA	**Date:**	4/9/2013
Checked By:	DL	**Date:**	4/16/13
Project Manager:	JPB		

Lab Sample Number	13-240	13-241	13-242		
Boring Label	HB9	HB10	HB12		
Sample Depth (ft)	11-11.5	4.5-4.8	2-2.5		
Diameter of Cylinder, in	2.38		2.38		
Total Length of Cylinder, in.	7.45		7.95		
Length of Empty Cylinder A, in.	0.00	disturbed	0.00		
Length of Empty Cylinder B, in.	4.70	sample	5.10		
Length of Cylinder Filled, in	2.75		2.85		
Volume of Sample, in^3	12.23		12.68		
Volume of Sample, cc.	200.48		207.77		
Pan #	s29	ss7	s26		
Weight of Wet Soil and Pan	509.9	477.9	521.1		
Weight of Dry Soil and Pan	405.4	421.5	416.2		
Weight of Water	104.5	56.4	104.9		
Weight of Pan	148.6	193.0	165.5		
Weight of Dry Soil	256.8	228.5	250.7		
Percent Moisture	**40.7**	**24.7**	**41.8**		
Dry Density, g/cc	1.28		1.21		
Dry Density, lb/ft^3	**80.0**		**75.3**		
Shrinkage Percentage	2.5		1		

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DENSITY BY DRIVE- CYLINDER METHOD (ASTM D2937)

Project Name:	Martin Slough Enhancement	**Project Number:**	**013035**
Performed By:	**JMA**	**Date:**	**4/9/2013**
Checked By:	DL	**Date:**	4/16/13
Project Manager:	**JPB**		

Lab Sample Number	13-226	13-228	13-232	13-237	13-238
Boring Label	HB1	HB1	HB3	HB9	HB9
Sample Depth (ft)	7.5-8.0	15-15.5	10-10.5	7-7.5	5.5-6
Diameter of Cylinder, in	2.38	2.38	2.38	2.38	2.38
Total Length of Cylinder, in.	7.93	9.70	7.90	7.92	7.95
Length of Empty Cylinder A, in.	0.00	0.00	0.00	4.90	4.73
Length of Empty Cylinder B, in.	4.52	7.33	2.32	0.38	0.00
Length of Cylinder Filled, in	3.41	2.37	5.58	2.64	3.22
Volume of Sample, in^3	15.17	10.54	24.82	11.74	14.33
Volume of Sample, cc.	248.60	172.78	406.80	192.46	234.75
Pan #	s22	s27	s22	s27	ss12
Weight of Wet Soil and Pan	616.1	502.5	844.3	537.9	609.9
Weight of Dry Soil and Pan	495.7	438.6	694.2	460.2	495.5
Weight of Water	120.4	63.9	150.1	77.7	114.4
Weight of Pan	151.2	152.7	151.3	152.9	194.4
Weight of Dry Soil	344.5	285.9	542.9	307.3	301.1
Percent Moisture	**34.9**	**22.4**	**27.6**	**25.3**	**38.0**
Dry Density, g/cc	1.39	1.65	1.33	1.60	1.28
Dry Density, lb/ft^3	**86.5**	**103.3**	**83.3**	**99.7**	**80.1**
Shrinkage Percentage	2.9	0	3.7	14	8.4

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Moisture Content (ASTM D 2216)

Job Name:	**Martin Slough Enhancment**	**Job Number:**	**013035**
Performed By:	**JMA**	**Date:**	**4/12/2013**
Checked By:	Dh	**Date:**	4/16/13
Project Manager:	**JPB**		

Lab Sample Number	13-224	13-225	13-249	13-255	13-261
Job Sample Number	HB15 @2.8	HB15@ 6.5	HB1@ 6'	HB2 @ 2-3	HB5 @ 4-4.5
A. Pan #	a7	a8	a5	a3	a9
B. Weight of Wet Soil and Pan	241.1	240.6	266.3	266.2	262.1
C. Weight of Dry Soil and Pan	194.2	186.4	227.0	229.0	219.5
D. Weight of Water	46.9	54.2	39.3	37.2	42.6
E. Weight of Pan	86.7	87.5	86.9	85.3	88.9
F. Weight of Dry Soil	107.5	98.9	140.1	143.7	130.6
G. Percent Moisture (D/F)	43.6	54.8	28.1	25.9	32.6

SHRINKAGE CALCULATIONS

Original Dia 2.42"	2.12	2.07	2.31	2.31	2.20
Original Height 1.00"	1.06	0.86	0.99	0.97	0.94
Percent Shrinkage DIA	12.4	14.5	4.5	4.5	9.1
Percent Shrinkage Height	-6.0	14.0	1.0	3.0	6.0

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Moisture Content (ASTM D 2216)

Job Name:	**Martin Slough Enhancment**	**Job Number:**	**013035**
Performed By:	**JMA**	**Date:**	**4/12/2013**
Checked By:	Dh	**Date:**	4/16/13
Project Manager:	**JPB**		

Lab Sample Number	13-281	13-284	13-286	13-290	
Job Sample Number	HB11 @ 4.2-4.	HB13 @ 2-2.5	HB13 @ 6-6.5	HB14 @ 4-4.5	
A. Pan #	s25	s26	s8	s29	
B. Weight of Wet Soil and Pan	302.3	338.5	343.7	329.7	
C. Weight of Dry Soil and Pan	256.4	297.9	309.4	290.8	
D. Weight of Water	45.9	40.6	34.3	38.9	
E. Weight of Pan	146.2	165.9	161.2	148.6	
F. Weight of Dry Soil	110.2	132.0	148.2	142.2	
G. Percent Moisture (D/F)	41.7	30.8	23.1	27.4	

SHRINKAGE CALCULATIONS

Original Dia 2.42"	2.13	2.31	2.30	2.24	
Original Height 1.00	0.89	0.98	0.99	0.98	
Percent Shrinkage DIA	12.0	4.5	5.0	7.4	
Percent Shrinkage Height	11.0	2.0	1.0	2.0	

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PERCENT PASSING # 200 SIEVE (ASTM - D1140)

Project Name:	**Martin Slough Enhancement**	**Project Number:**	**013035**
Performed By:	**JMA**	**Date:**	**4/15/2013**
Checked By:	Jh	**Date:**	4/16/13
Project Manager:	**JPB**		

Lab Sample Number	13-228	13-230	13-238	13-239	13-241
Boring Label	HB1	HB3	HB9	HB9	HB10
Sample Depth (ft)	15-15.5	5-5.5	5.5-6.0	8-8.5	4.5-4.8
Pan Number	ss15	ss11	ss12	ss8	ss7
Dry Weight of Soil & Pan	295.8	303.5	284.2	317.8	300.2
Pan Weight	194.4	192.8	194.4	193.0	193.0
Weight of Dry Soil	101.4	110.7	89.8	124.8	107.2
Soil Weight Retained on #200&Pan	271.0	216.0	216.3	275.7	267.9
Soil Weight Passing #200	24.8	87.5	67.9	42.1	32.3
Percent Passing #200	**24.5**	**79.0**	**75.6**	**33.7**	**30.1**

Lab Sample Number	13-268				
Boring Label	HB6				
Sample Depth (ft)	6.5-7				
Pan Number	ss3				
Dry Weight of Soil & Pan	375.2				
Pan Weight	197.2				
Weight of Dry Soil	178.0				
Soil Weight Retained on #200&Pan	324.7				
Soil Weight Passing #200	50.5				
Percent Passing #200	**28.4**				

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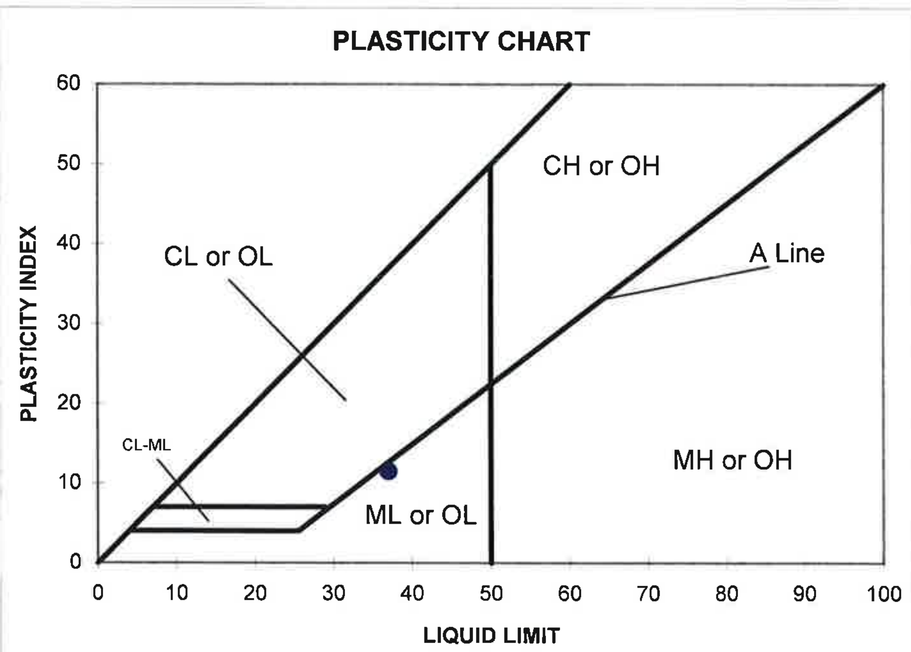
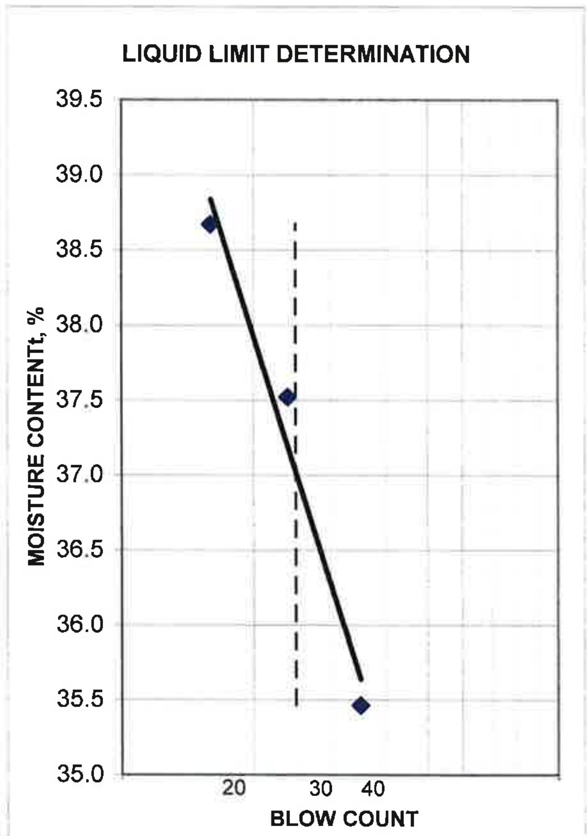
LIQUID LIMIT, PLASTIC LIMIT, and PLASTICITY INDEX (ASTM-D4318)

JOB NAME:	Martin Slough Enhancement	JOB #:	013035	LAB SAMPLE #:	13-226
SAMPLE ID:	HB1 @ 7.5-8.0	PERFORMED BY:	JMA	DATE:	4/15/2013
PROJECT MANGER:	JPB	CHECKED BY:	Dh	DATE:	4/16/13

LINE NO.		TRIAL NO. 1	TRIAL NO. 2	TRIAL NO. 1	TRIAL NO. 2	TRIAL NO. 3
A	PAN #	13	14	7	8	9
B	PAN WT. (g)	22.170	19.950	29.010	29.180	28.740
C	WT. WET SOIL & PAN (g)	28.640	25.950	35.580	37.060	36.270
D	WT. DRY SOIL & PAN (g)	27.330	24.730	33.860	34.910	34.170
E	WT. WATER (C-D)	1.310	1.220	1.720	2.150	2.100
F	WT. DRY SOIL (D-B)	5.160	4.780	4.850	5.730	5.430
G	BLOW COUNT	--	--	35	24	16
H	MOISTURE CONTENT (E/F*100)	25.4	25.5	35.5	37.5	38.7

LIQUID LIMIT	**PLASTIC INDEX**	PLASTIC LIMIT
37	**12**	25





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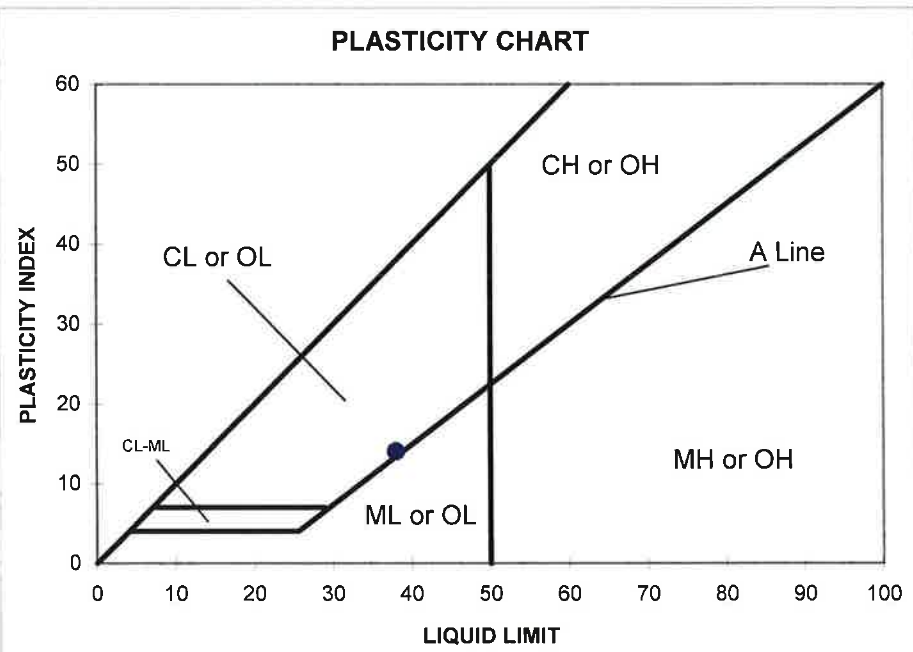
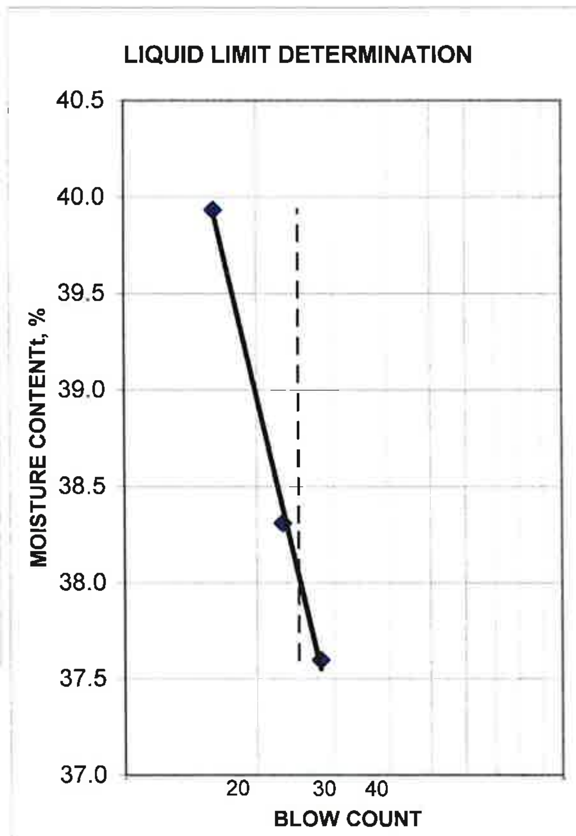
LIQUID LIMIT, PLASTIC LIMIT, and PLASTICITY INDEX (ASTM-D4318)

JOB NAME:	Martin Slough Enhancement	JOB #:	013035	LAB SAMPLE #:	13-236
SAMPLE ID:	HB9 @ 2.5-3.0	PERFORMED BY:	JMA	DATE:	4/15/2013
PROJECT MANGER:	JPB	CHECKED BY:	Dh	DATE:	4/16/13

LINE NO.		TRIAL NO. 1	TRIAL NO. 2	TRIAL NO. 1	TRIAL NO. 2	TRIAL NO. 3
A	PAN #	22	23	a	b	c
B	PAN WT. (g)	17.230	16.960	29.360	29.610	28.700
C	WT. WET SOIL & PAN (g)	23.230	23.480	38.070	37.300	37.320
D	WT. DRY SOIL & PAN (g)	22.070	22.220	35.690	35.170	34.860
E	WT. WATER (C-D)	1.160	1.260	2.380	2.130	2.460
F	WT. DRY SOIL (D-B)	4.840	5.260	6.330	5.560	6.160
G	BLOW COUNT	--	--	28	23	16
H	MOISTURE CONTENT (E/F*100)	24.0	24.0	37.6	38.3	39.9

LIQUID LIMIT	**PLASTIC INDEX**	PLASTIC LIMIT
38	**14**	24





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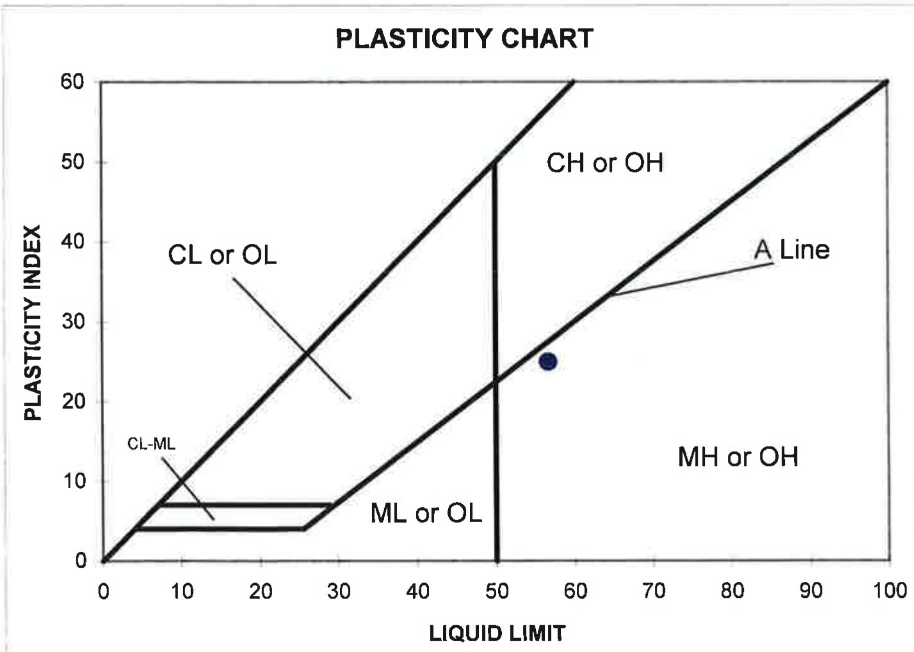
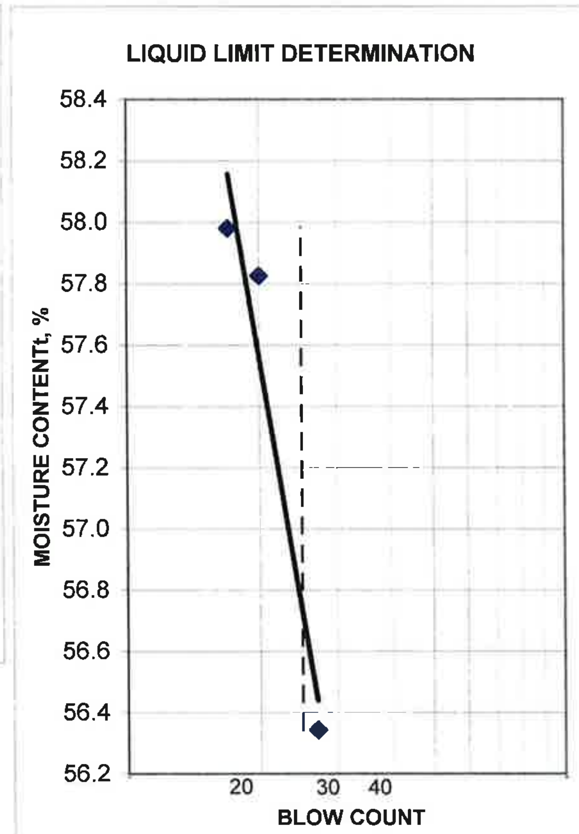
LIQUID LIMIT, PLASTIC LIMIT, and PLASTICITY INDEX (ASTM-D4318)

JOB NAME:	Martin Slough Enhancement	JOB #:	13035	LAB SAMPLE #:	13-239
SAMPLE ID:	HB9 @ 8.5-9	PERFORMED BY:	JMA	DATE:	4/15/2013
PROJECT MANGER:	JPB	CHECKED BY:	Sh	DATE:	4/16/13

LINE NO.		TRIAL NO. 1	TRIAL NO. 2	TRIAL NO. 1	TRIAL NO. 2	TRIAL NO. 3
A	PAN #	17	18	1	2	3
B	PAN WT. (g)	20.300	20.260	29.830	29.130	29.180
C	WT. WET SOIL & PAN (g)	26.840	27.310	37.100	36.390	35.910
D	WT. DRY SOIL & PAN (g)	25.260	25.620	34.480	33.730	33.440
E	WT. WATER (C-D)	1.580	1.690	2.620	2.660	2.470
F	WT. DRY SOIL (D-B)	4.960	5.360	4.650	4.600	4.260
G	BLOW COUNT	--	--	27	20	17
H	MOISTURE CONTENT (E/F*100)	31.9	31.5	56.3	57.8	58.0

LIQUID LIMIT	**PLASTIC INDEX**	PLASTIC LIMIT
57	**25**	32





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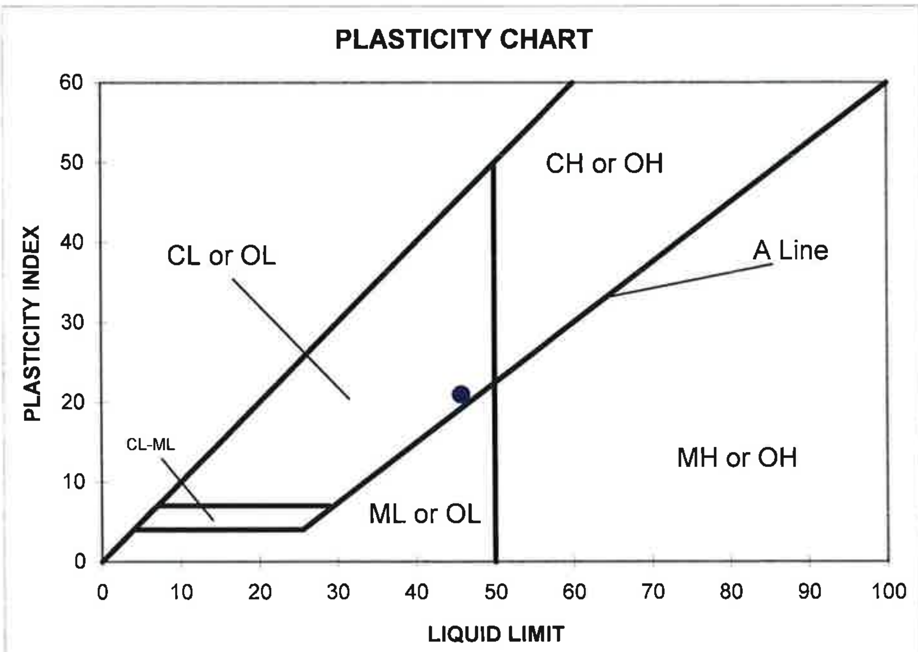
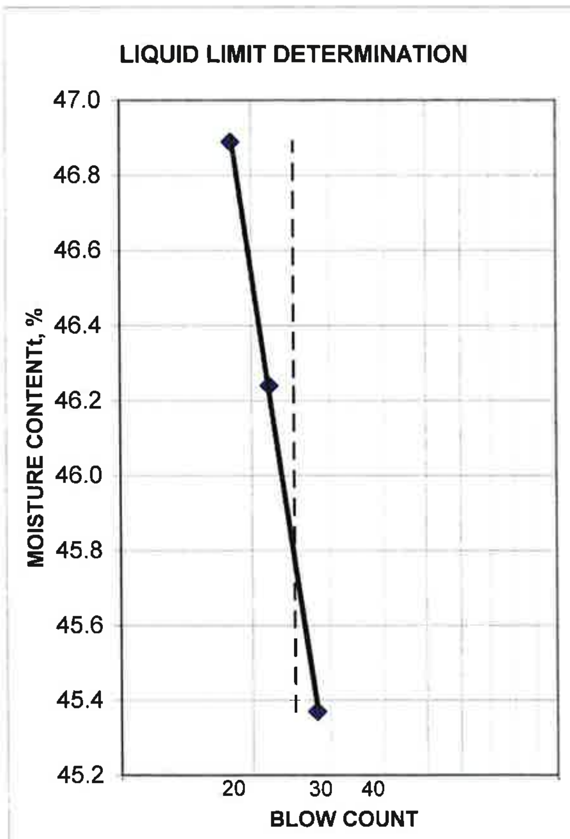
LIQUID LIMIT, PLASTIC LIMIT, and PLASTICITY INDEX (ASTM-D4318)

JOB NAME:	Martin Slough Enhancement	JOB #:	013035	LAB SAMPLE #:	13-240
SAMPLE ID:	HB9 @ 11-11.5	PERFORMED BY:	JMA	DATE:	4/15/2013
PROJECT MANGER:	JPB	CHECKED BY:	Dh	DATE:	4/16/13

LINE NO.		TRIAL NO. 1	TRIAL NO. 2	TRIAL NO. 1	TRIAL NO. 2	TRIAL NO. 3
A	PAN #	23	22	A	B	C
B	PAN WT. (g)	16.960	17.220	29.360	29.610	28.730
C	WT. WET SOIL & PAN (g)	23.050	24.350	38.780	37.390	37.940
D	WT. DRY SOIL & PAN (g)	21.820	22.900	35.840	34.930	35.000
E	WT. WATER (C-D)	1.230	1.450	2.940	2.460	2.940
F	WT. DRY SOIL (D-B)	4.860	5.680	6.480	5.320	6.270
G	BLOW COUNT	--	--	28	22	18
H	MOISTURE CONTENT (E/F*100)	25.3	25.5	45.4	46.2	46.9

LIQUID LIMIT	**PLASTIC INDEX**	PLASTIC LIMIT
46	**21**	25





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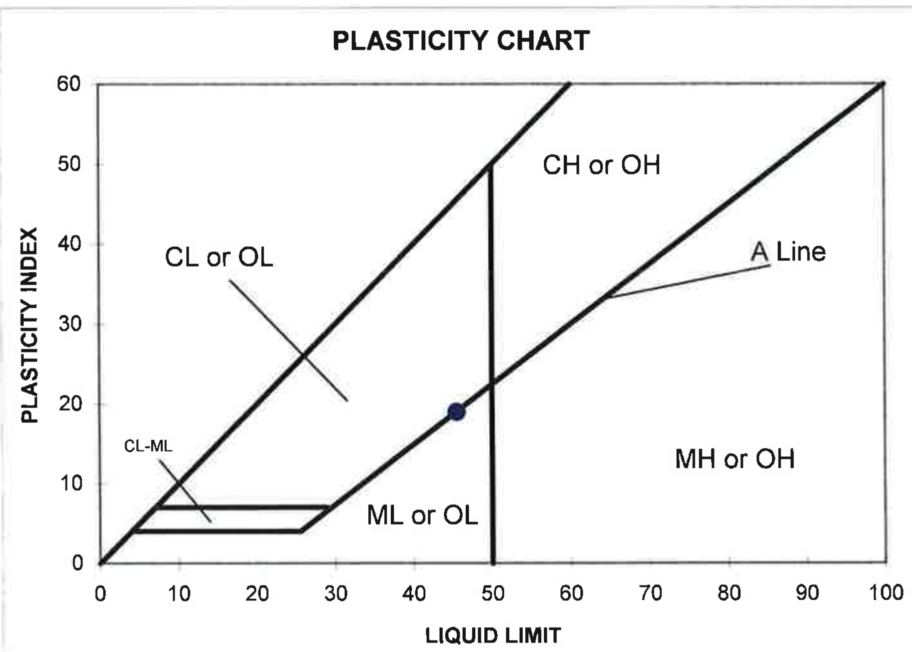
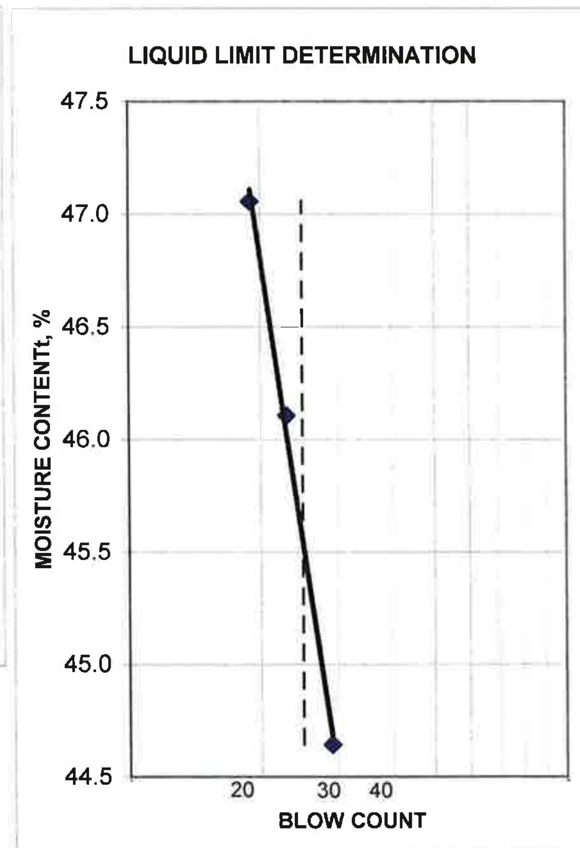
LIQUID LIMIT, PLASTIC LIMIT, and PLASTICITY INDEX (ASTM-D4318)

JOB NAME:	Martin Slough Enhancement	JOB #:	013035	LAB SAMPLE #:	13-243
SAMPLE ID:	HB 12 @ 5-5.5	PERFORMED BY:	JMA	DATE:	4/16/2013
PROJECT MANGER:	JPB	CHECKED BY:	Dh	DATE:	4/16/13

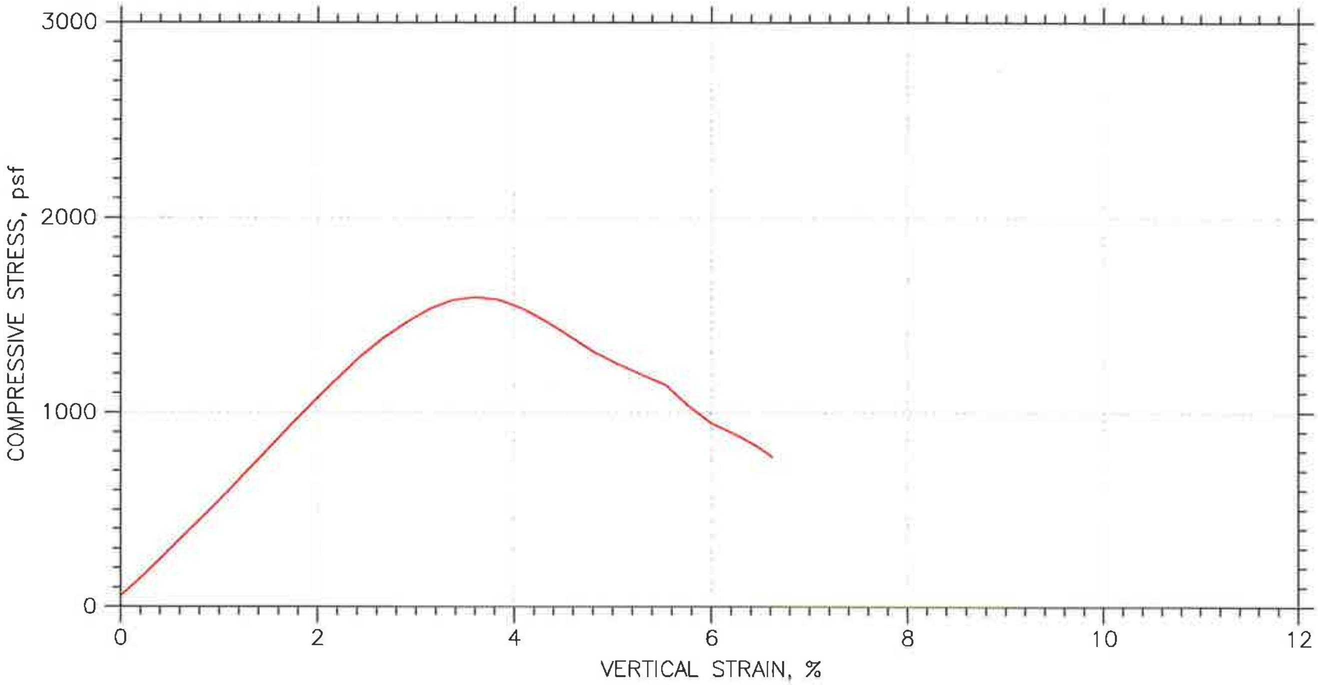
LINE NO.		TRIAL NO. 1	TRIAL NO. 2	TRIAL NO. 1	TRIAL NO. 2	TRIAL NO. 3
A	PAN #	13	14	7	8	9
B	PAN WT. (g)	22.170	19.950	29.000	29.140	28.710
C	WT. WET SOIL & PAN (g)	31.390	26.720	36.290	36.460	34.710
D	WT. DRY SOIL & PAN (g)	29.460	25.300	34.040	34.150	32.790
E	WT. WATER (C-D)	1.930	1.420	2.250	2.310	1.920
F	WT. DRY SOIL (D-B)	7.290	5.350	5.040	5.010	4.080
G	BLOW COUNT	--	--	29	23	19
H	MOISTURE CONTENT (E/F*100)	26.5	26.5	44.6	46.1	47.1

LIQUID LIMIT	PLASTIC INDEX	PLASTIC LIMIT
46	19	27





UNCONFINED COMPRESSION TEST REPORT

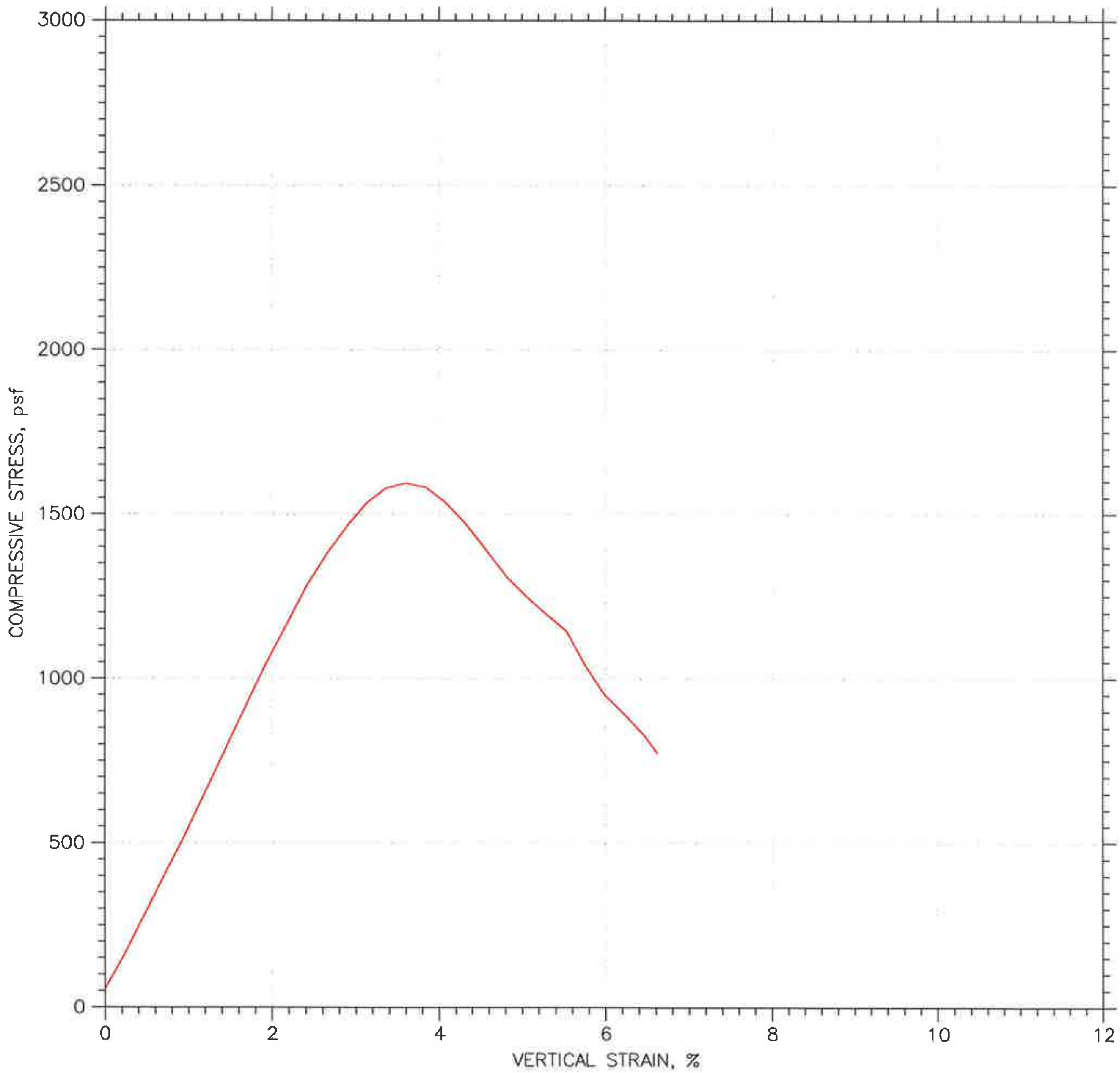


Symbol					
Test No.		13-244			
Initial	Diameter, in	2.38			
	Height, in	5.39			
	Water Content, %	78.04			
	Dry Density, pcf	51.309			
	Saturation, %	92.98			
	Void Ratio	2.2243			
Unconfined Compressive Strength, psf		1595.6			
Undrained Shear Strength, psf		797.81			
Time to Failure, min		3.7539			
Strain Rate, %/min		1			
Specific Gravity		2.65			
Liquid Limit		0			
Plastic Limit		0			
Plasticity Index		0			
Failure Sketch					

Project: Martin Slough Enhancement
Location: Eureka
Project No.: 013035
Boring No.: HB15@2
Sample Type: 2.5"shelby
Description: Strong Brown SILT
Remarks: Organics in specimen

Wed, 10-APR-2013 14:15:46

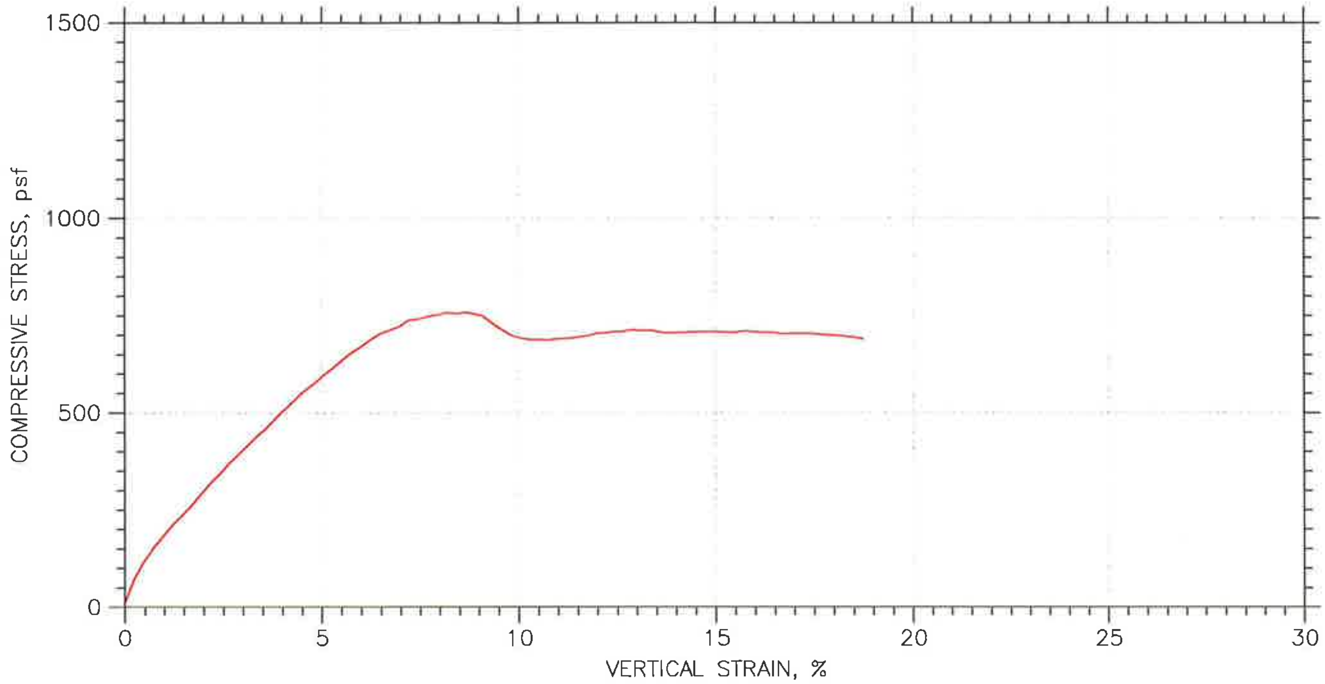
UNCONFINED COMPRESSION TEST REPORT



Project: Martin Slough Enhancement	Location: Eureka	Project No.: 013035
Boring No.: HB15@2	Tested By: JMA	Checked By: DL 4/18/13
Sample No.: 13-244	Test Date: 4/9/12	Depth: 2-2.5
Test No.: 13-244	Sample Type: 2.5"shelby	Elevation:
Description: Strong Brown SILT		
Remarks: Organics in specimen		

Wed, 10-APR-2013 14:15:46

UNCONFINED COMPRESSION TEST REPORT

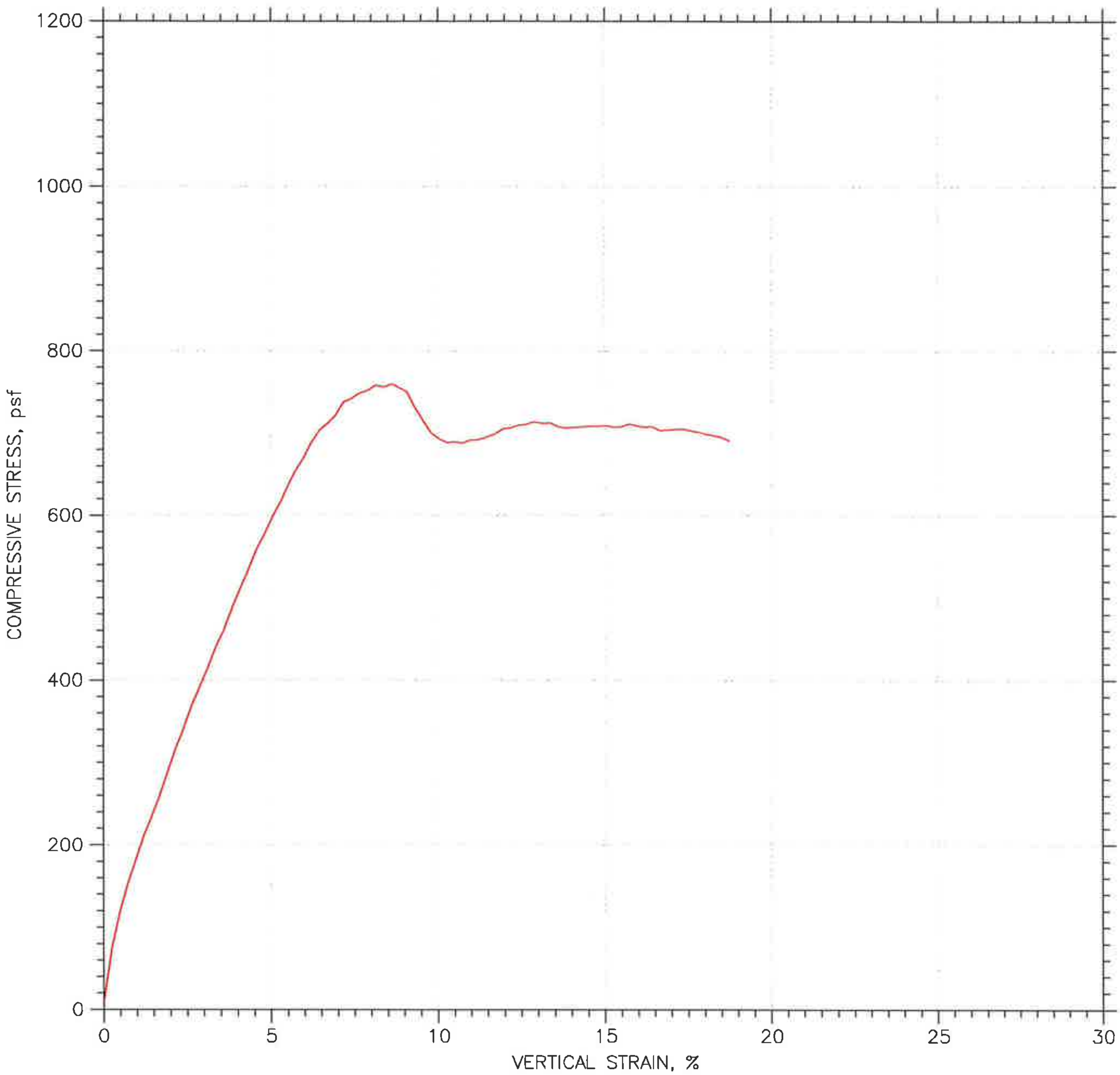


Symbol					
Test No.		13-234			
Initial	Diameter, in	2.38			
	Height, in	5.8			
	Water Content, %	66.67			
	Dry Density, pcf	58.507			
	Saturation, %	96.68			
	Void Ratio	1.8276			
Unconfined Compressive Strength, psf		760.18			
Undrained Shear Strength, psf		380.09			
Time to Failure, min		9.0011			
Strain Rate, %/min		1			
Specific Gravity		2.65			
Liquid Limit		0			
Plastic Limit		0			
Plasticity Index		0			
Failure Sketch					

Project: Martin Slough Enhancement
Location: Eureka
Project No.: 013035
Boring No.: HB4@6.1
Sample Type: 2.5"shelby
Description: Gray SILT
Remarks:

Thu, 18-APR-2013 12:21:05

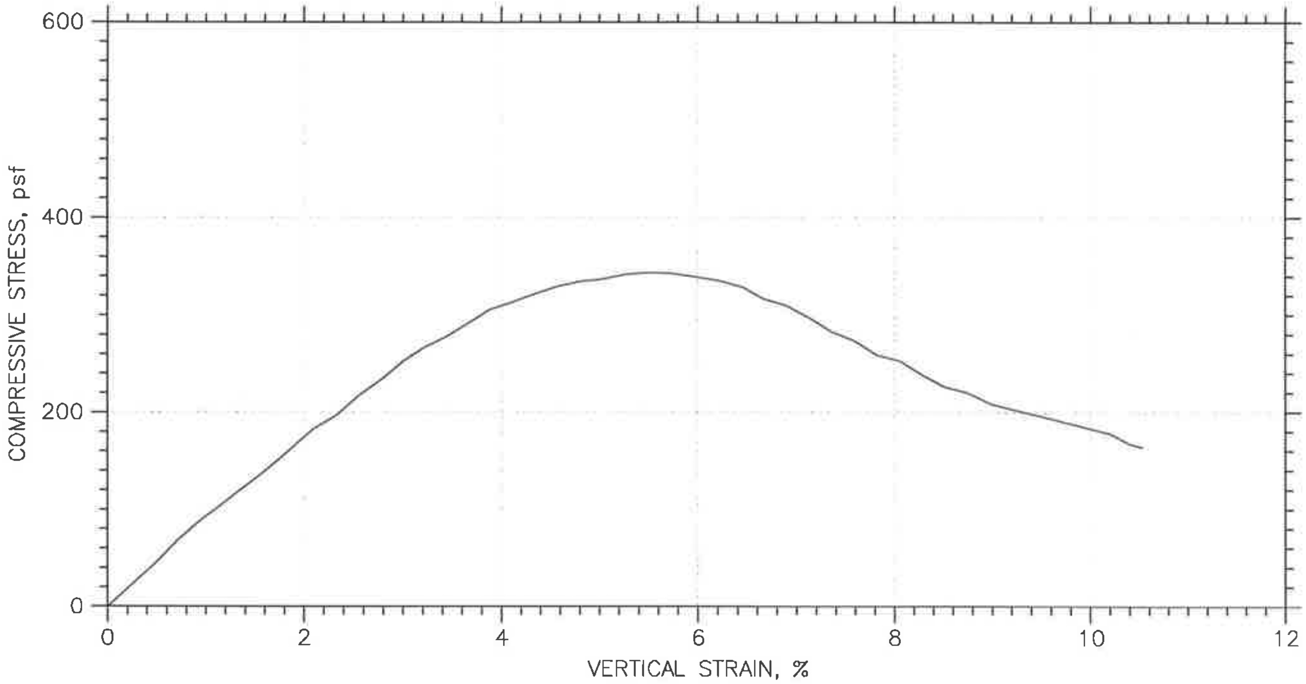
UNCONFINED COMPRESSION TEST REPORT



Project: Martin Slough Enhancement	Location: Eureka	Project No.: 013035
Boring No.: HB4@6.1	Tested By: JMA	Checked By: DL 4/18/13
Sample No.: 13-234	Test Date: 4/9/12	Depth: 6.1-6.6
Test No.: 13-234	Sample Type: 2.5"shelby	Elevation:
Description: Gray SILT		
Remarks:		

Thu, 18-APR-2013 12:21:05

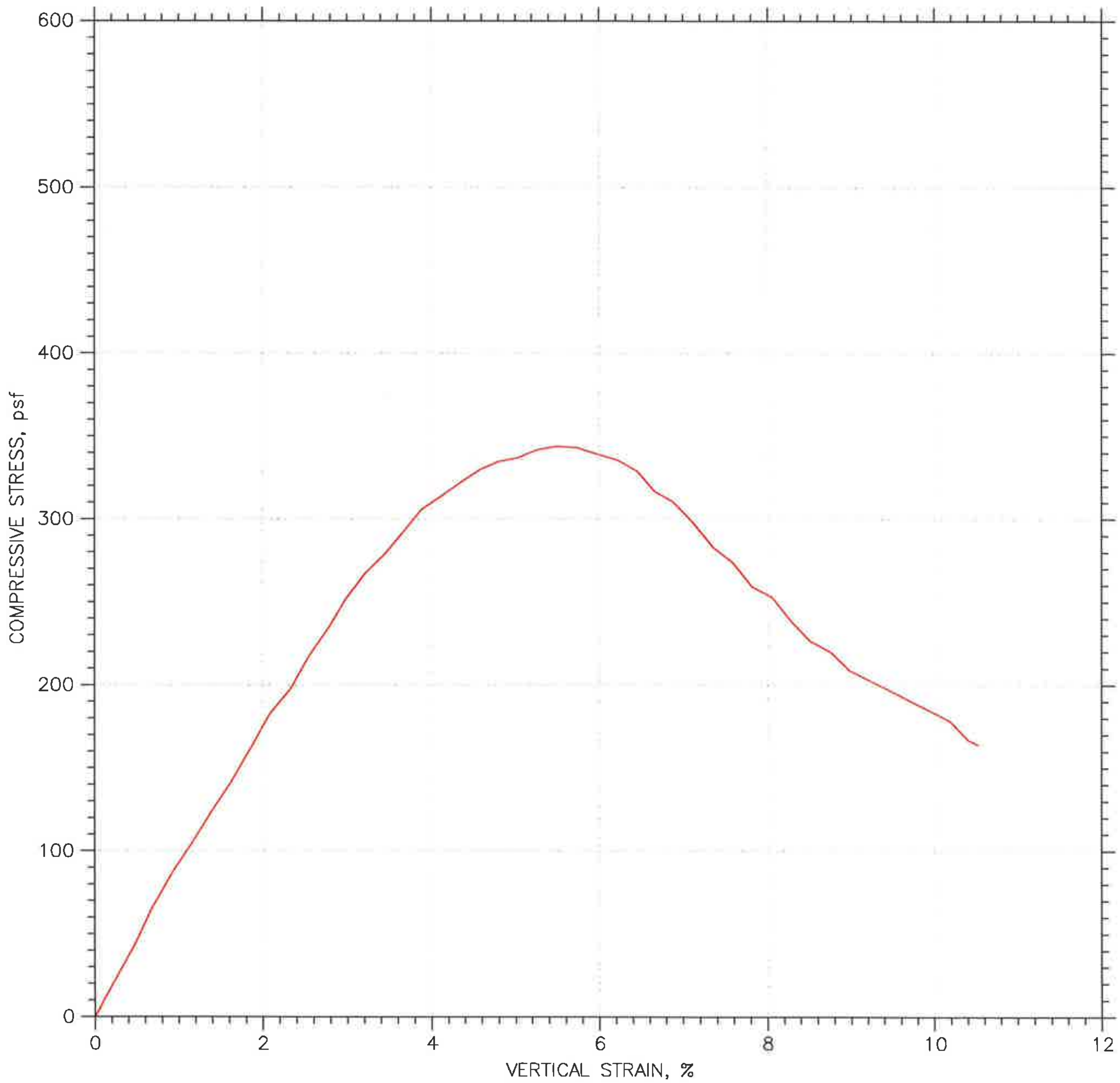
UNCONFINED COMPRESSION TEST REPORT



Symbol					
Test No.		13-239			
Initial	Diameter, in	2.38			
	Height, in	5.09			
	Water Content, %	33.63			
	Dry Density, pcf	86.153			
	Saturation, %	96.83			
	Void Ratio	0.92023			
Unconfined Compressive Strength, psf		344.04			
Undrained Shear Strength, psf		172.02			
Time to Failure, min		6.0021			
Strain Rate, %/min		1			
Specific Gravity		2.65			
Liquid Limit		0			
Plastic Limit		0			
Plasticity Index		0			
Failure Sketch					

Project: Martin Slough Enhancement
Location: Eureka
Project No.: 013035
Boring No.: HB9@8.5
Sample Type: 2.5"shelby
Description: Strong Brown SILT
Remarks:

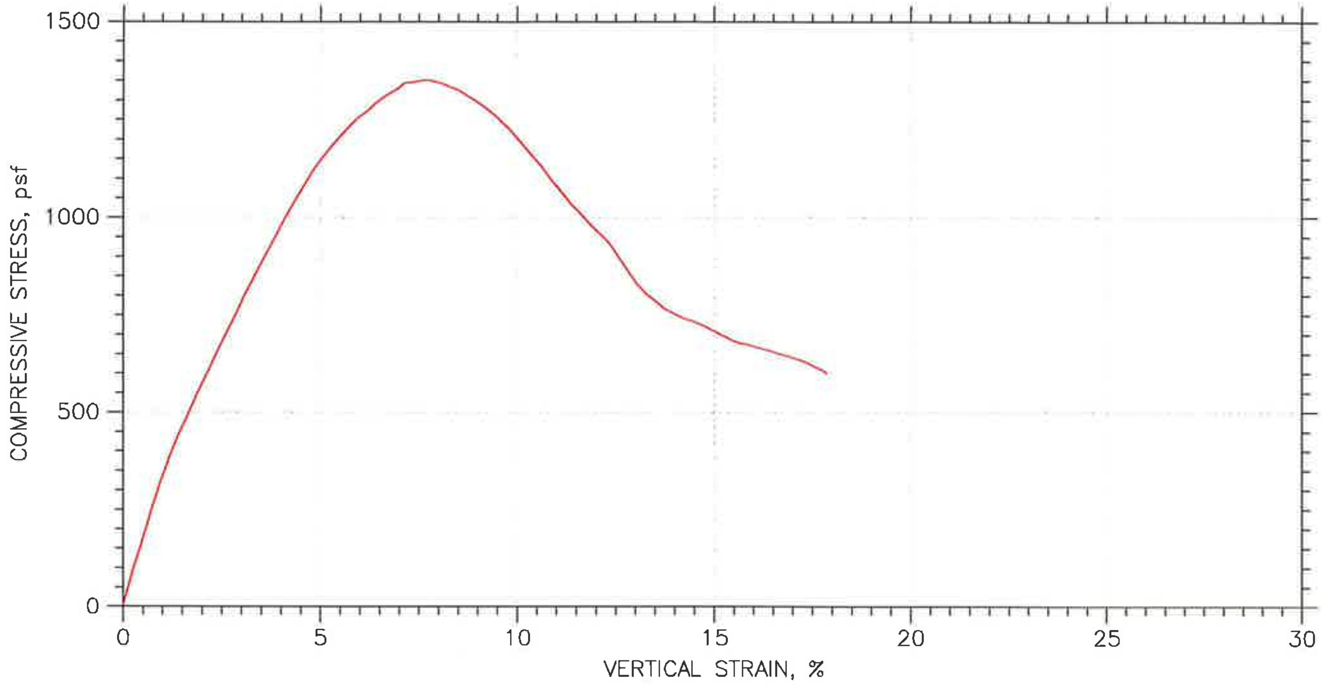
UNCONFINED COMPRESSION TEST REPORT



Project: Martin Slough Enhancement	Location: Eureka	Project No.: 013035
Boring No.: HB9@8.5	Tested By: JMA	Checked By: DL 4/18/13
Sample No.: 13-239	Test Date: 4/9/12	Depth: 8.5-9.0
Test No.: 13-239	Sample Type: 2.5"shelby	Elevation:
Description: Strong Brown SILT		
Remarks:		

Wed, 10-APR-2013 14:05:58

UNCONFINED COMPRESSION TEST REPORT

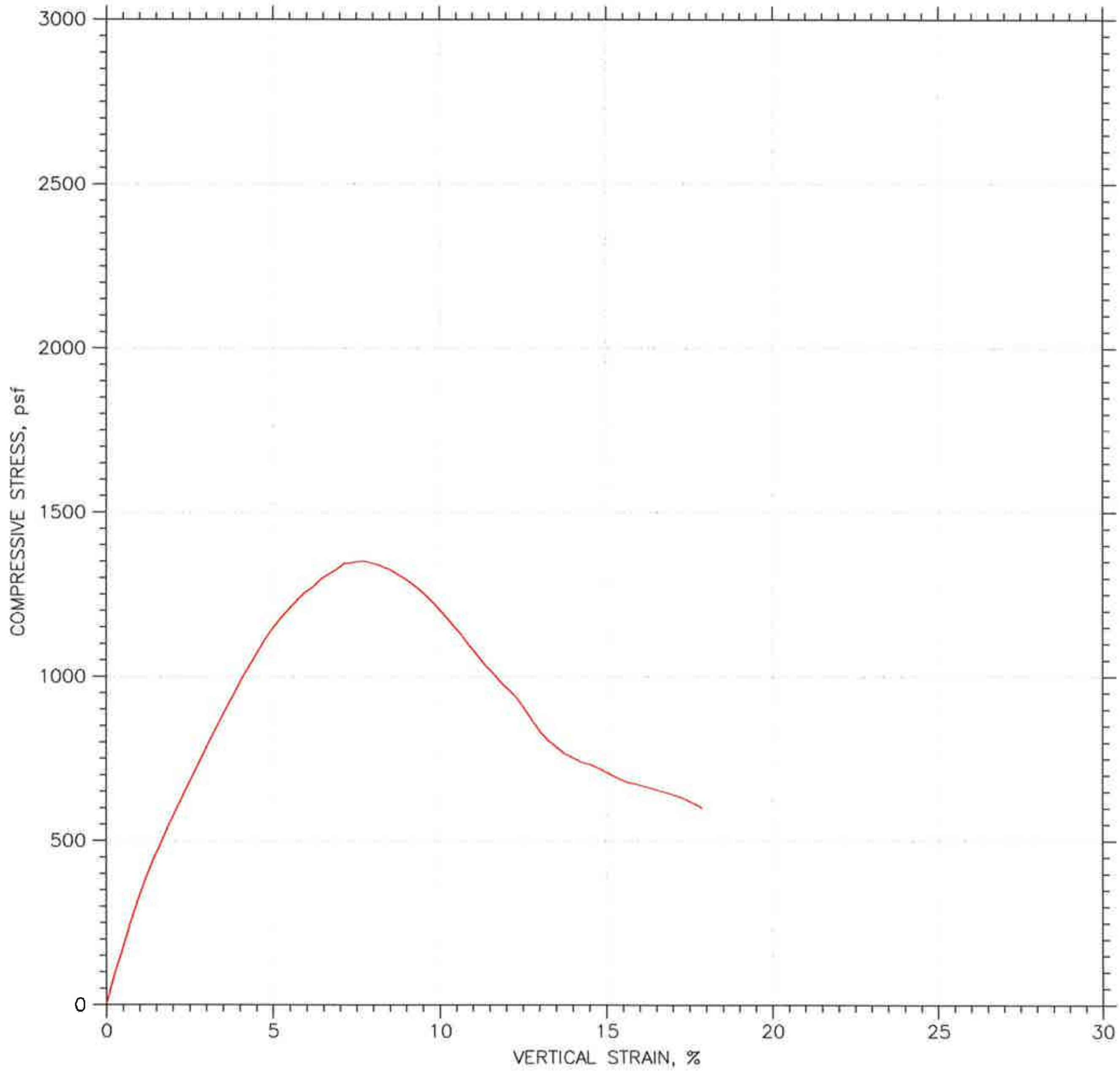


Symbol					
Test No.		13-236			
Initial	Diameter, in	2.38			
	Height, in	5.08			
	Water Content, %	30.82			
	Dry Density, pcf	90.149			
	Saturation, %	97.78			
	Void Ratio	0.83511			
Unconfined Compressive Strength, psf		1351.7			
Undrained Shear Strength, psf		675.84			
Time to Failure, min		8.2505			
Strain Rate, %/min		1			
Specific Gravity		2.65			
Liquid Limit		0			
Plastic Limit		0			
Plasticity Index		0			
Failure Sketch					

Project: Martin Slough Enhancement
Location: Eureka
Project No.: 013035
Boring No.: HB9@2.5
Sample Type: 2.5"shelby
Description: Strong Brown SILT
Remarks:

Wed, 10-APR-2013 13:56:38

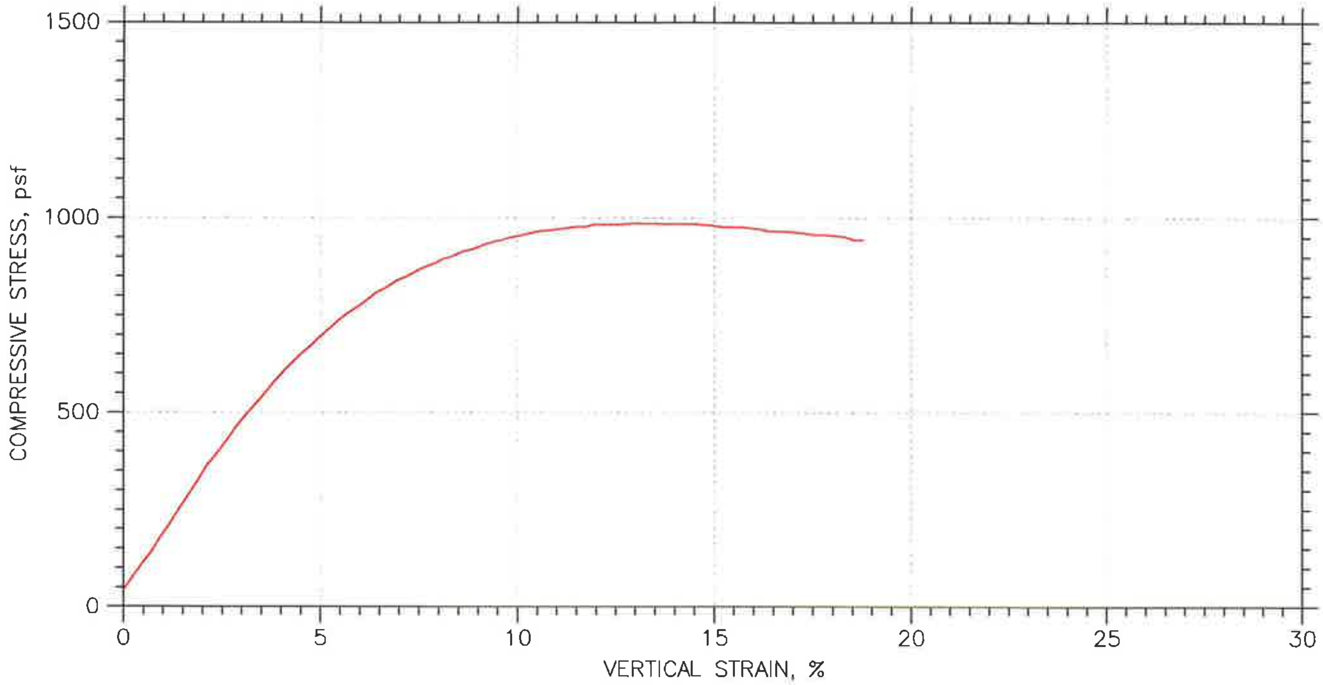
UNCONFINED COMPRESSION TEST REPORT



Project: Martin Slough Enhancement	Location: Eureka	Project No.: 013035
Boring No.: HB9@2.5	Tested By: JMA	Checked By: Dh 4/18/13
Sample No.: 13-236	Test Date: 4/9/12	Depth: 2.5-3.0
Test No.: 13-236	Sample Type: 2.5"shelby	Elevation:
Description: Strong Brown SILT		
Remarks:		

Wed, 10-APR-2013 13:56:38

UNCONFINED COMPRESSION TEST REPORT

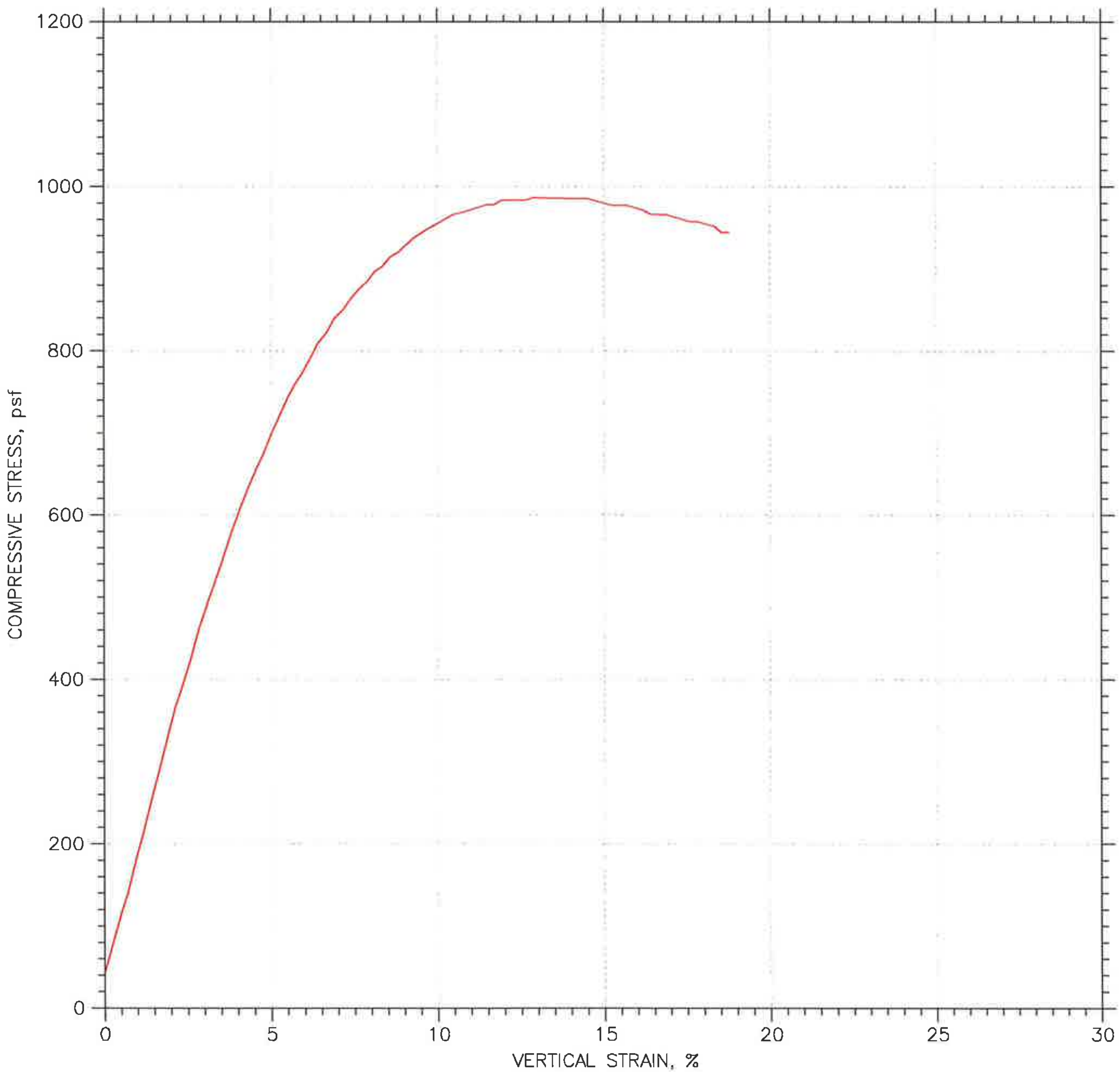


Symbol					
Test No.		13-227			
Initial	Diameter, in	2.38			
	Height, in	5.95			
	Water Content, %	40.10			
	Dry Density, pcf	85.476			
	Saturation, %	113.61			
	Void Ratio	0.93545			
Unconfined Compressive Strength, psf		986.42			
Undrained Shear Strength, psf		493.21			
Time to Failure, min		13.752			
Strain Rate, %/min		1			
Specific Gravity		2.65			
Liquid Limit		0			
Plastic Limit		0			
Plasticity Index		0			
Failure Sketch					

Project: Martin Slough Enhancement
Location: Eureka
Project No.: 013035
Boring No.: HB1@12.75
Sample Type: 2.5"shelby
Description: Gray SILT
Remarks:

Wed, 10-APR-2013 13:45:49

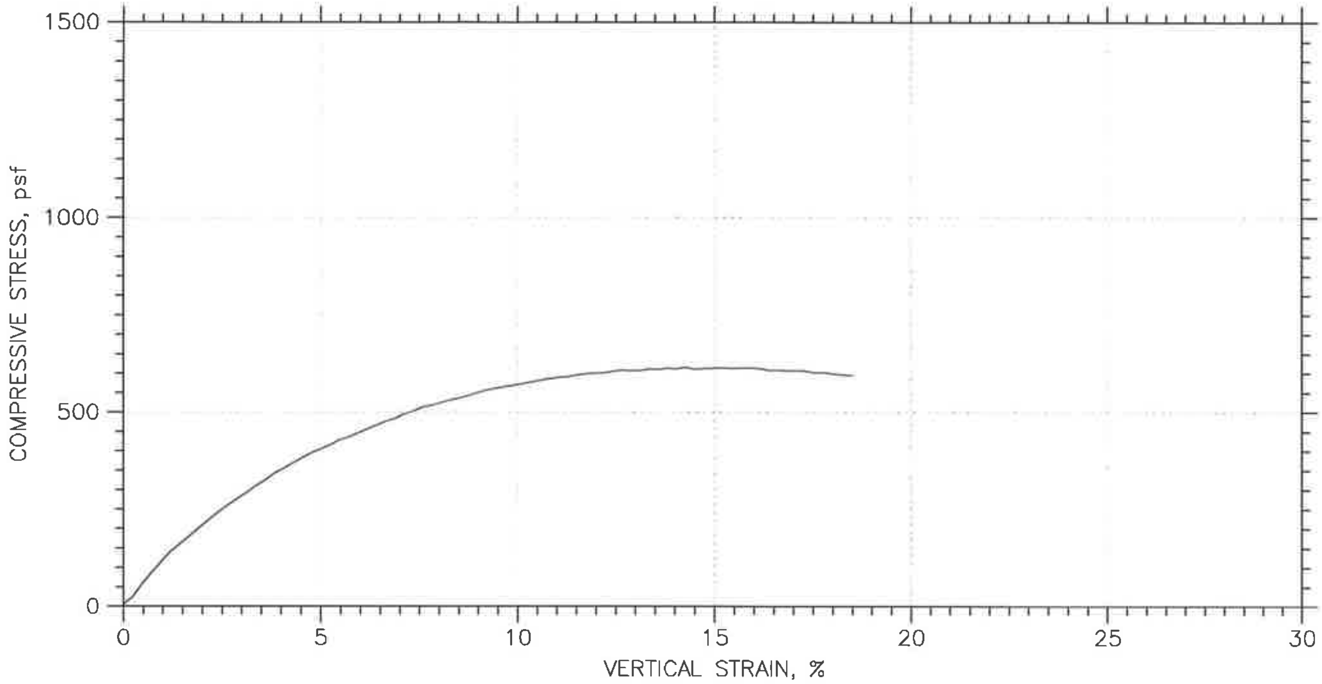
UNCONFINED COMPRESSION TEST REPORT



Project: Martin Slough Enhancement	Location: Eureka	Project No.: 013035
Boring No.: HB1@12.75	Tested By: JMA	Checked By: Dh 4/16/13
Sample No.: 13-227	Test Date: 4/8/12	Depth: 12.75-13.25
Test No.: 13-227	Sample Type: 2.5"shelby	Elevation:
Description: Gray SILT		
Remarks:		

Wed, 10-APR-2013 13:45:50

UNCONFINED COMPRESSION TEST REPORT

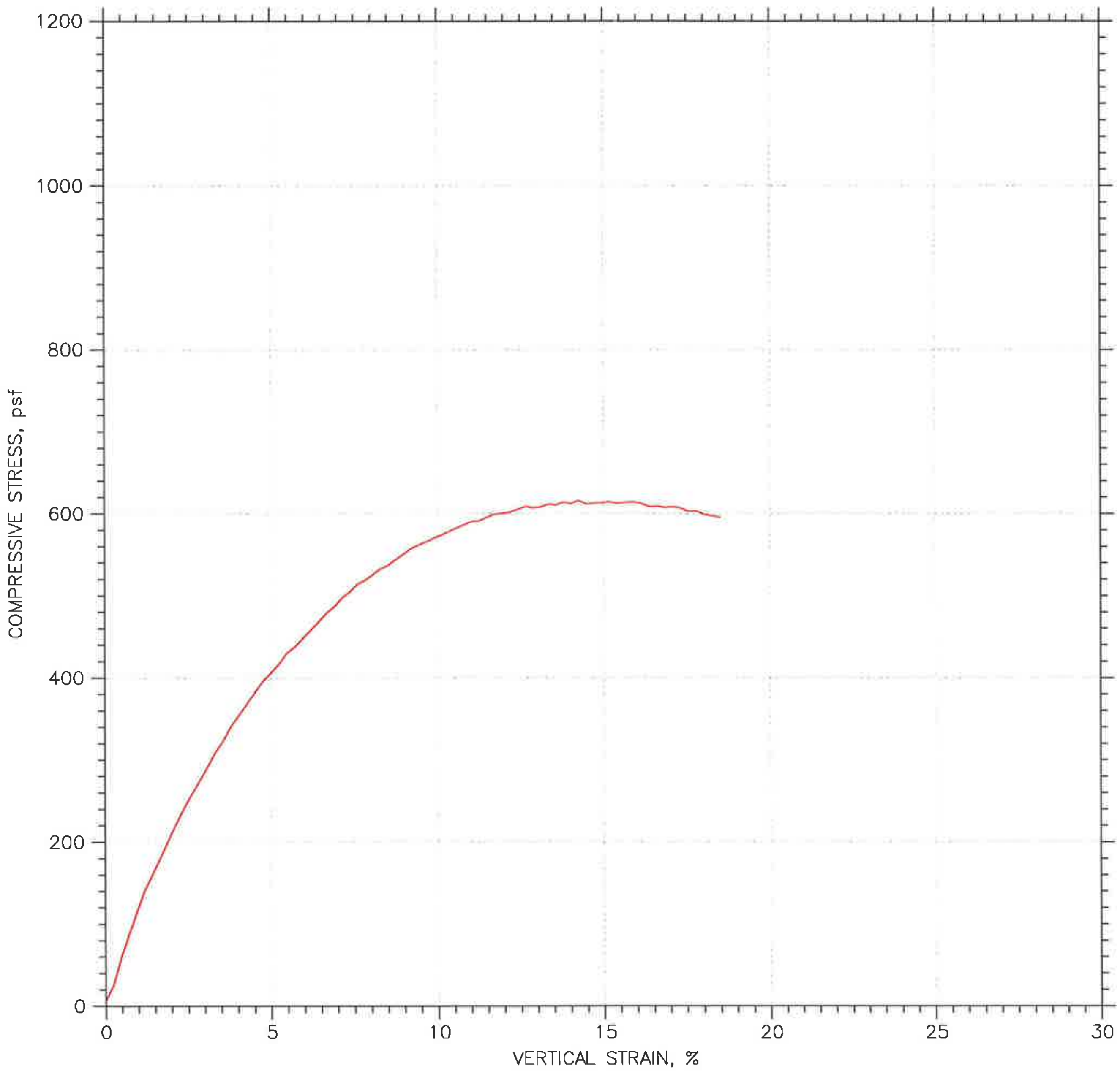


Symbol					
Test No.		13-245			
Initial	Diameter, in	2.38			
	Height, in	5.42			
	Water Content, %	79.99			
	Dry Density, pcf	52.518			
	Saturation, %	98.59			
	Void Ratio	2.15			
Unconfined Compressive Strength, psf		616.41			
Undrained Shear Strength, psf		308.2			
Time to Failure, min		15.253			
Strain Rate, %/min		1			
Specific Gravity		2.65			
Liquid Limit		0			
Plastic Limit		0			
Plasticity Index		0			
Failure Sketch					

Project: Martin Slough Enhancement
Location: Eureka
Project No.: 013035
Boring No.: HB15@5'
Sample Type: 2.5"shelby
Description: Strong Brown SILT
Remarks: Organics in specimen

Thu, 18-APR-2013 12:22:12

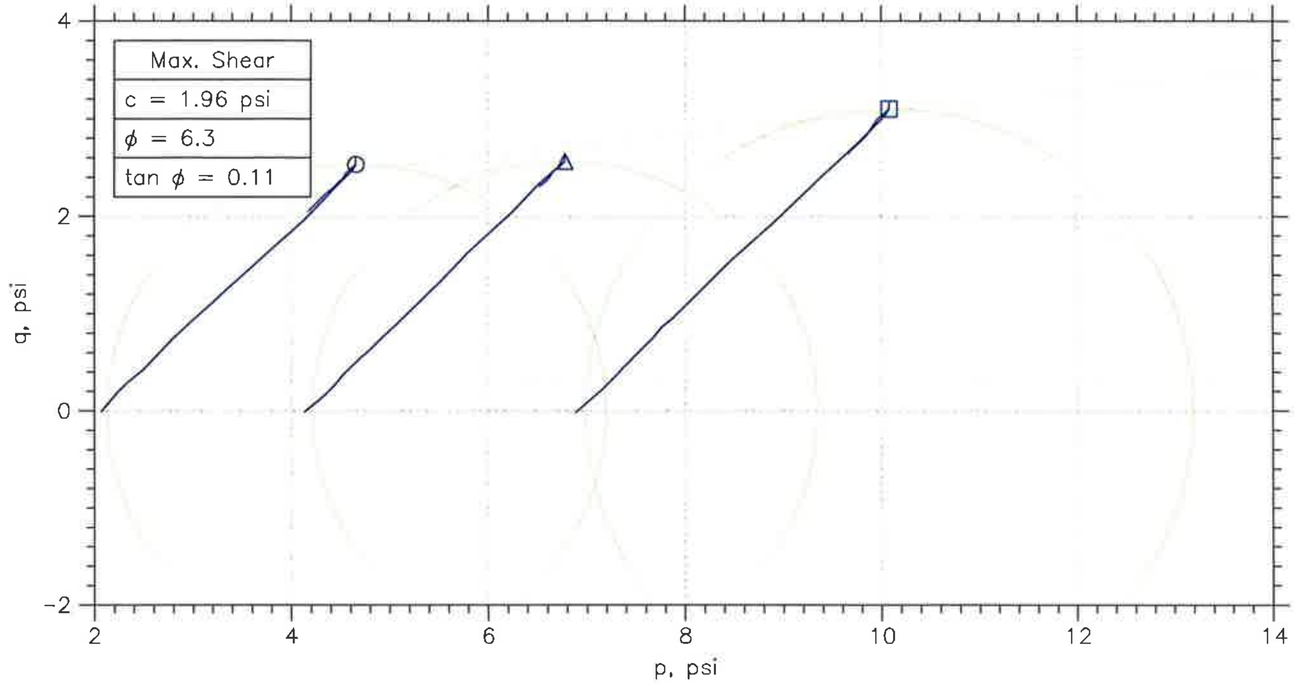
UNCONFINED COMPRESSION TEST REPORT

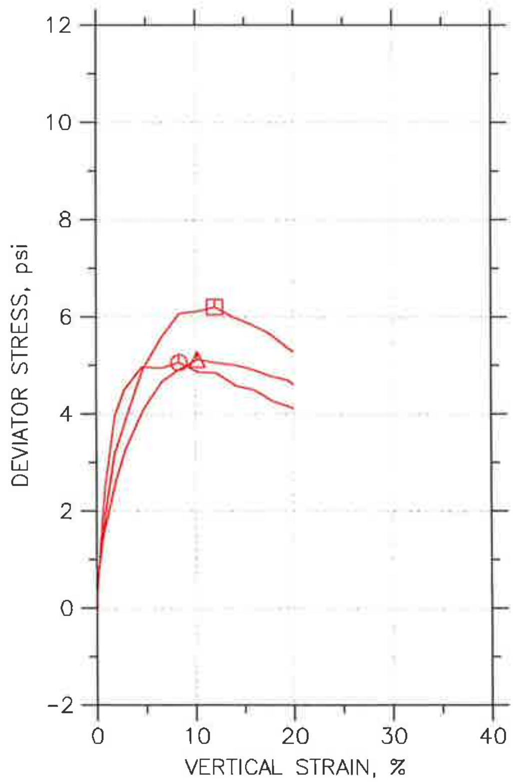


Project: Martin Slough Enhancement	Location: Eureka	Project No.: 013035
Boring No.: HB15@5'	Tested By: JMA	Checked By: DL 4/18/13
Sample No.: 13-245	Test Date: 4/9/12	Depth: 5-5.5
Test No.: 13-245	Sample Type: 2.5"shelby	Elevation:
Description: Strong Brown SILT		
Remarks: Organics in specimen		

Thu, 18-APR-2013 12:22:12

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST





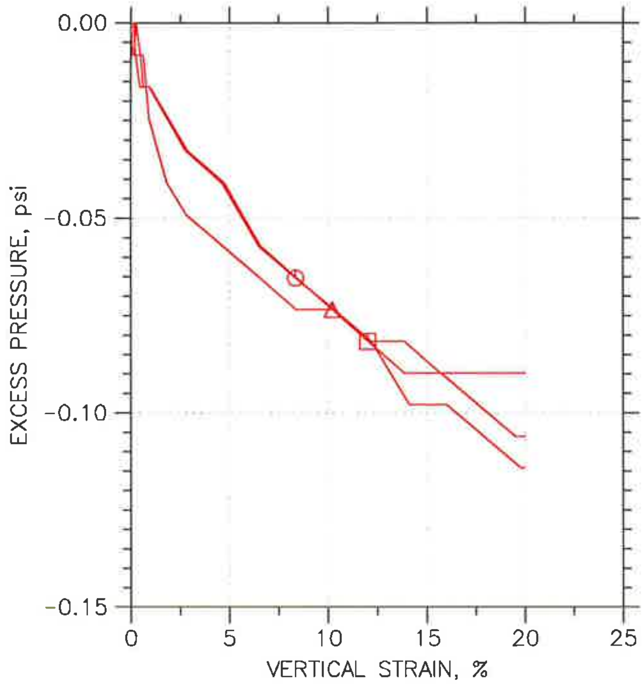
		○	△	□	
Symbol		○	△	□	
Sample No.		HB3@2.75	HB3@5'	HB4@8.6'	
Test No.		13-229	13-230	13-235	
Depth		2.25-2.75	5-5.5	8.6-9.1	
Initial	Diameter, in	2.38	2.38	2.38	
	Height, in	4.79	5.5	5.65	
	Water Content, %	48.5	43.0	38.3	
	Dry Density, pcf	71.94	79.49	79.71	
	Saturation, %	99.9	106.5	95.3	
	Void Ratio	1.27	1.06	1.05	
Before Shear	Water Content, %	48.5	40.3	38.3	
	Dry Density, pcf	72.06	79.58	80.15	
	Saturation*, %	100.0	100.0	96.4	
	Void Ratio	1.27	1.06	1.04	
	Back Press., psi	.E-17	.E-17	.E-17	
Ver. Eff. Cons. Stress, psi		2.075	4.158	6.924	
Shear Strength, psi		2.535	2.564	3.103	
Strain at Failure, %		8.38	10.2	12	
Strain Rate, %/min		1	1	1	
B-Value		---	---	---	
Estimated Specific Gravity		2.62	2.62	2.62	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	

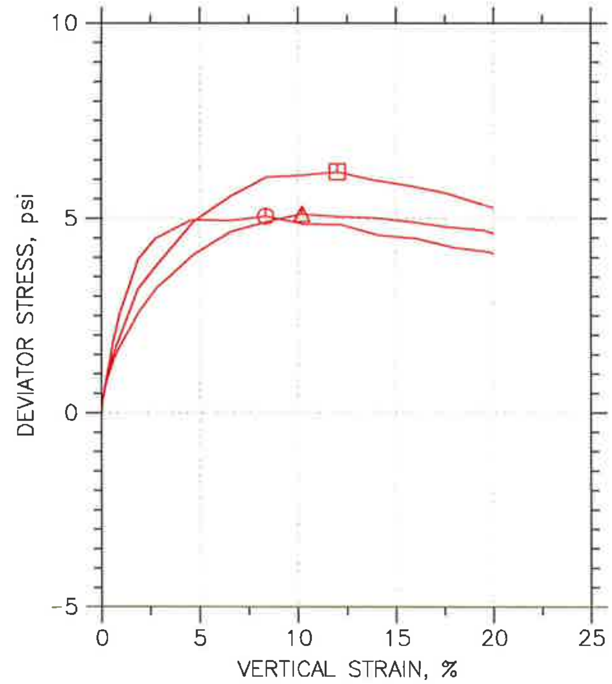
Project: Martin Slough Enhancement
Location: Eureka
Project No.: 013035
Boring No.: HB3 & HB4
Sample Type: 2.5"calbrl
Description: SILT
Remarks: Unconsolidated Undrained

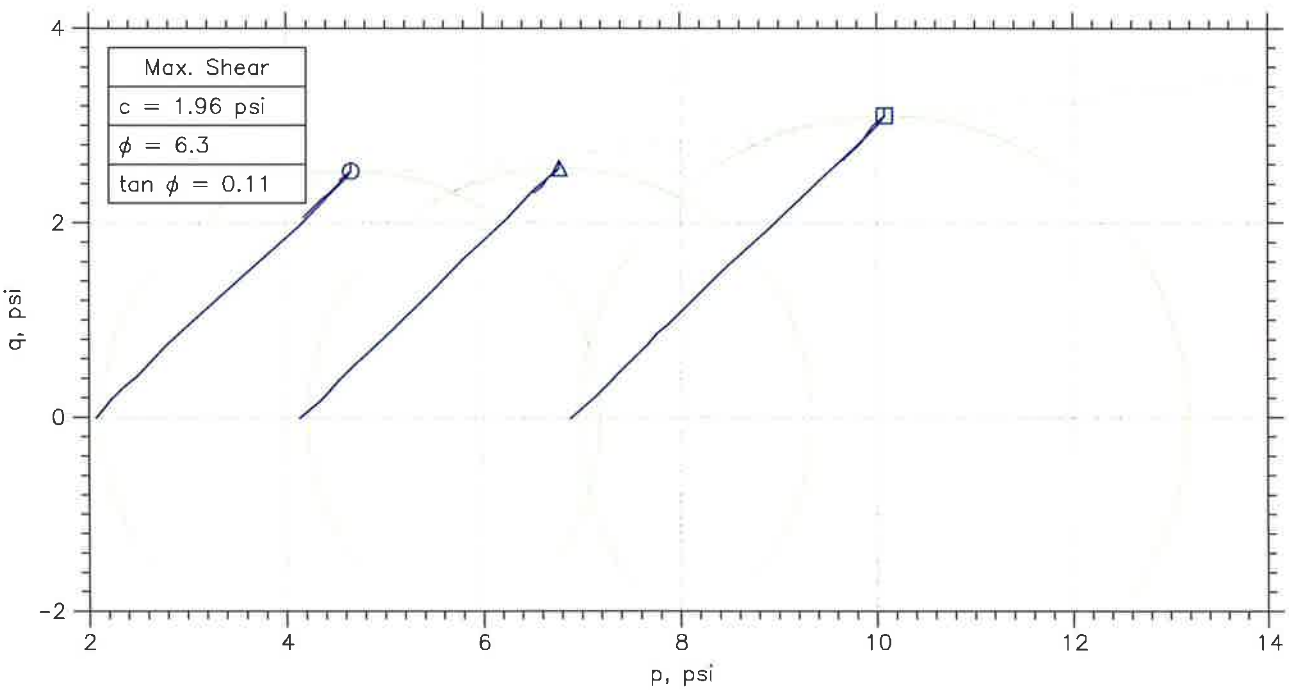
Thu, 18-APR-2013 12:09:29

Phase calculations based on start and end of test.
* Saturation is set to 100% for phase calculations.

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST





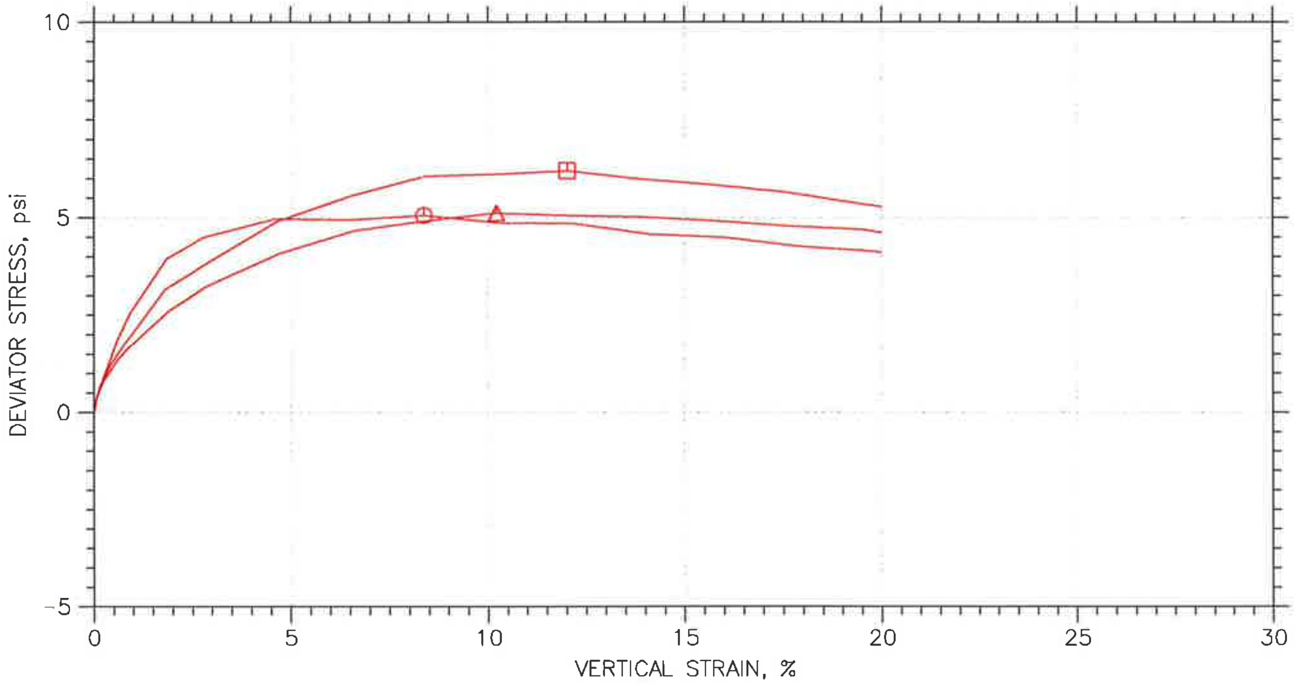


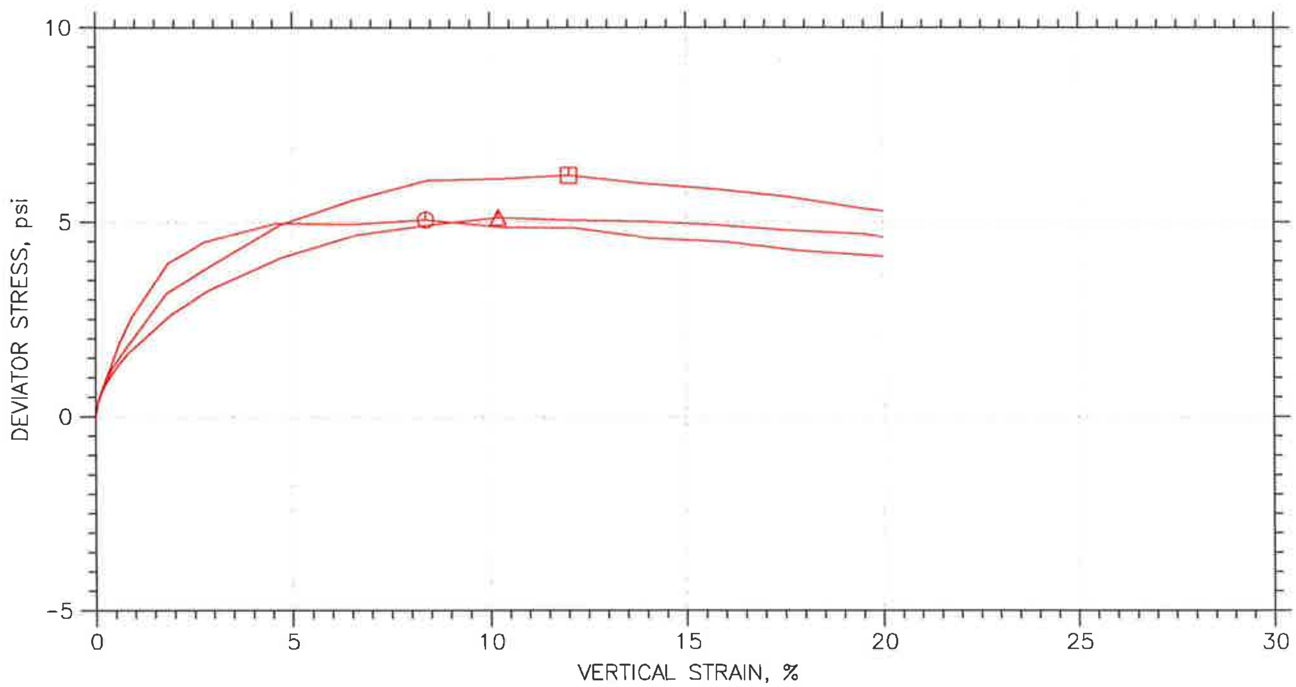
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	HB3@2.75	13-229	2.25-2.75	JMA	4/9/13			13-229 MSE.dat
△	HB3@5'	13-230	5-5.5	JMA	4/10/13			13-230 MSE.dat
□	HB4@8.6'	13-235	8.6-9.1	JMA	4/10/13			13-235 MSE.dat

Project: Martin Slough Enhancement	Location: Eureka	Project No.: 013035
Boring No.: HB3 & HB4	Sample Type: 2.5"calbrl	
Description: SILT		
Remarks: Unconsolidated Undrained		

Thu, 18-APR-2013 12:09:30

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST



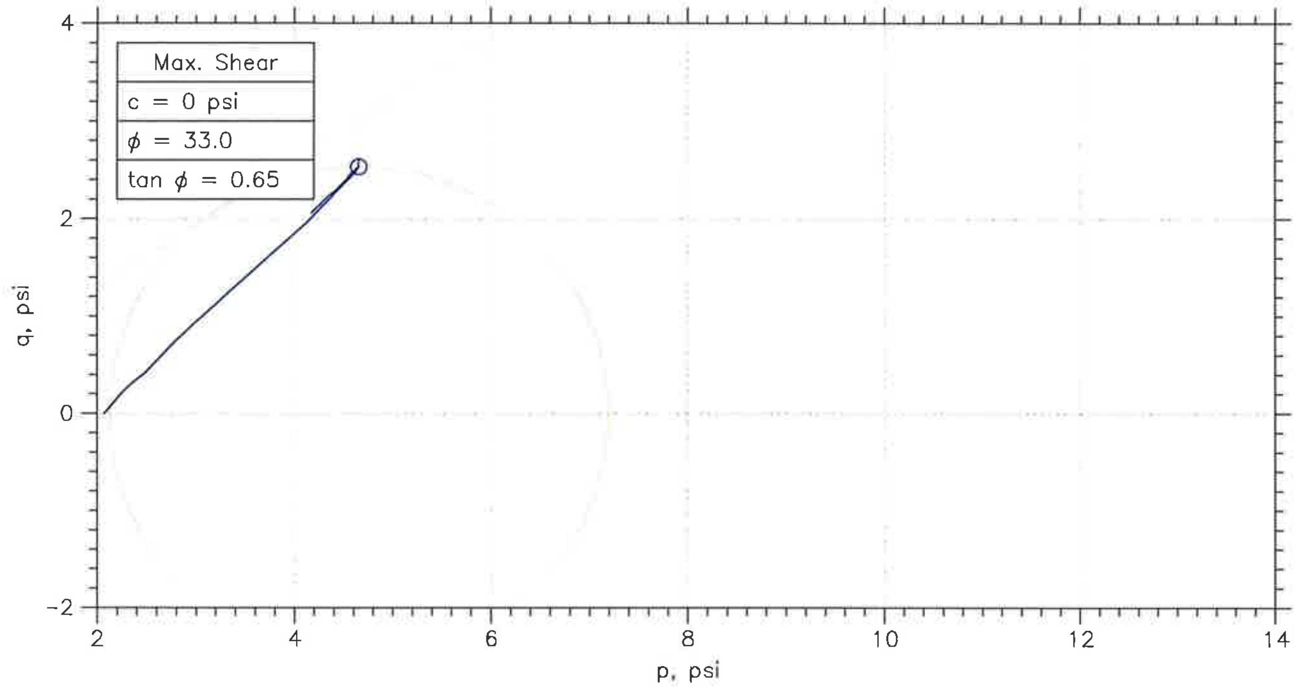


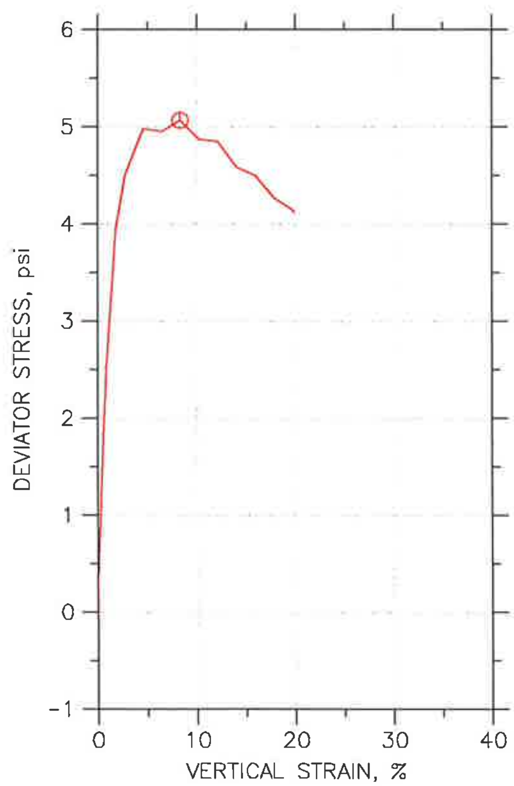
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
⊙	HB3@2.75	13-229	2.25-2.75	JMA	4/9/13			13-229 MSE.dat
△	HB3@5'	13-230	5-5.5	JMA	4/10/13			13-230 MSE.dat
⊡	HB4@8.6'	13-235	8.6-9.1	JMA	4/10/13			13-235 MSE.dat

Project: Martin Slough Enhancement	Location: Eureka	Project No.: 013035
Boring No.: HB3 & HB4	Sample Type: 2.5"calbrl	
Description: SILT		
Remarks: Unconsolidated Undrained		

Thu, 18-APR-2013 12:09:30

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST





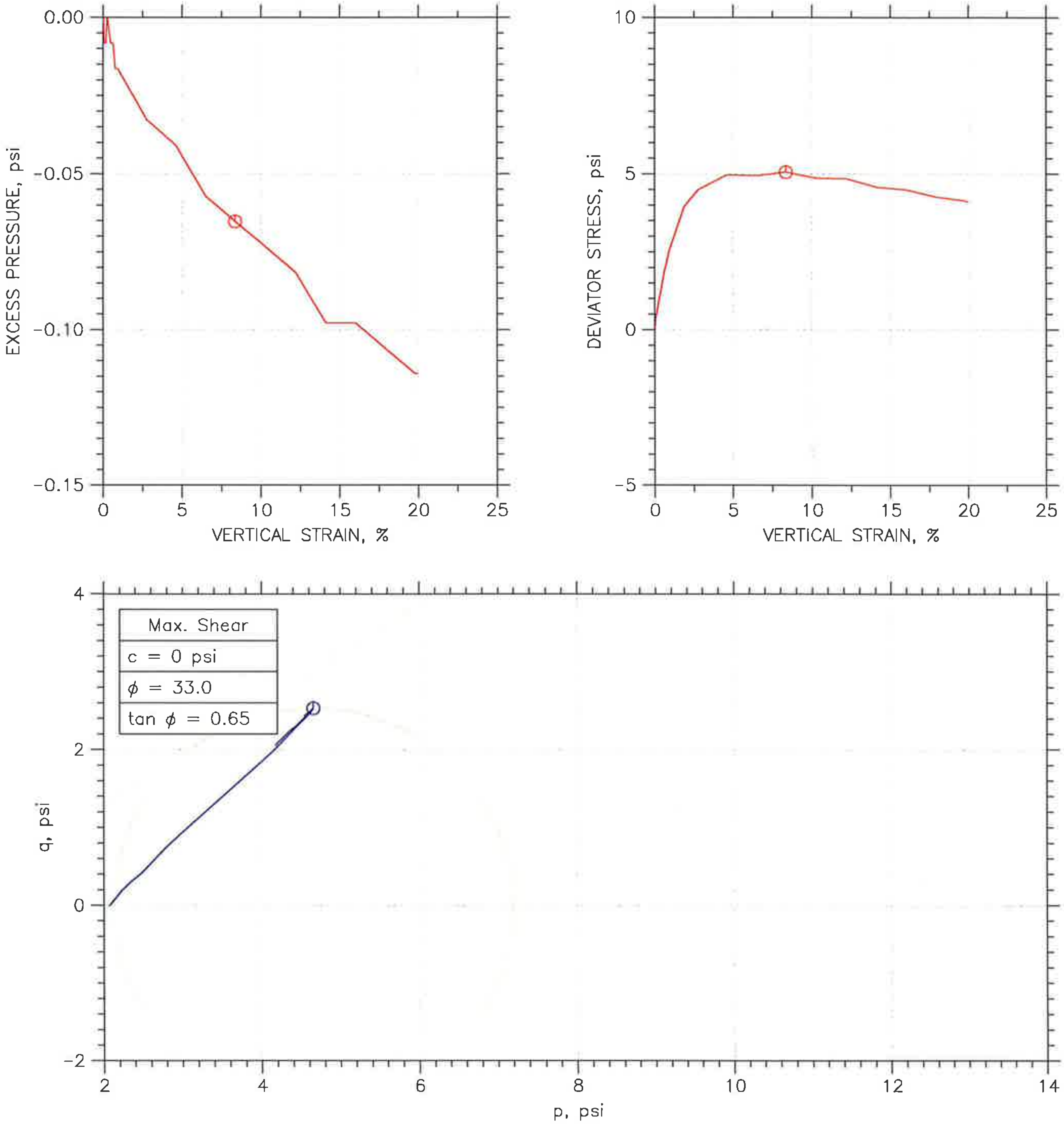
Symbol		⌀			
Sample No.		HB3@2.75			
Test No.		13-229			
Depth		2.25-2.75			
Initial	Diameter, in	2.38			
	Height, in	4.79			
	Water Content, %	48.5			
	Dry Density, pcf	71.94			
	Saturation, %	99.9			
	Void Ratio	1.27			
Before Shear	Water Content, %	48.5			
	Dry Density, pcf	72.06			
	Saturation*, %	100.0			
	Void Ratio	1.27			
	Back Press., psi	.E-17			
Ver. Eff. Cons. Stress, psi		2.075			
Shear Strength, psi		2.535			
Strain at Failure, %		8.38			
Strain Rate, %/min		1			
B-Value		---			
Estimated Specific Gravity		2.62			
Liquid Limit		---			
Plastic Limit		---			

Project: Martin Slough Enhancement
Location: Eureka
Project No.: 013035
Boring No.: HB3@2.25
Sample Type: 2.5"calbrl
Description: SILT
Remarks: Unconsolidated Undrained

Thu, 18-APR-2013 12:15:54

Phase calculations based on start and end of test.
* Saturation is set to 100% for phase calculations.

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST

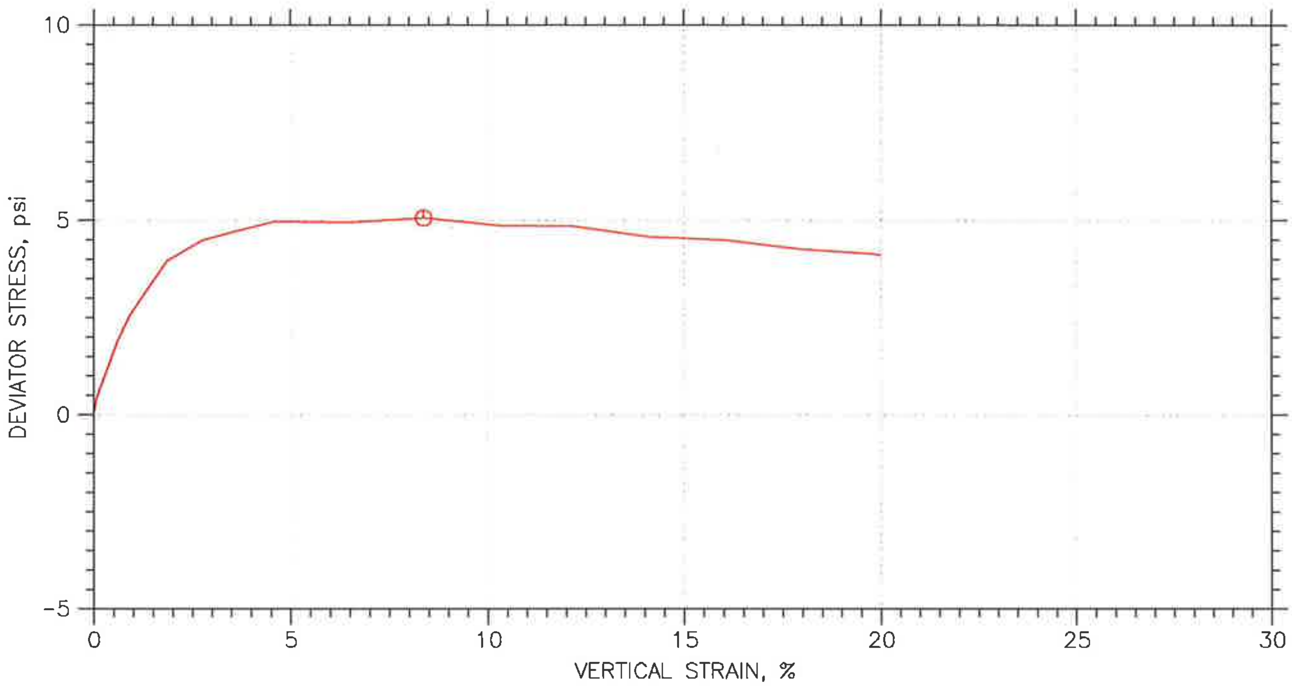


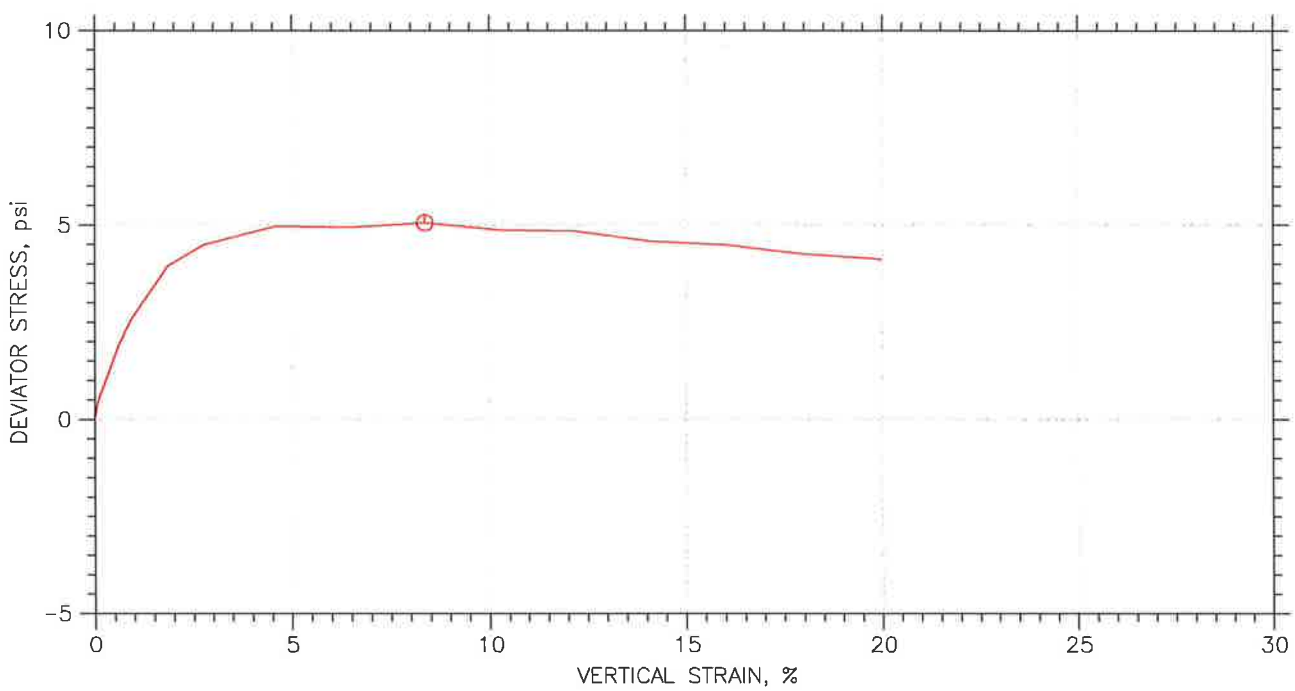
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
①	HB3@2.75	13-229	2.25-2.75	JMA	4/9/13			13-229 MSE.dat

Project: Martin Slough Enhancement	Location: Eureka	Project No.: 013035
Boring No.: HB3@2.25	Sample Type: 2.5"calbrl	
Description: SILT		
Remarks: Unconsolidated Undrained		

Thu, 18-APR-2013 12:15:55

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST



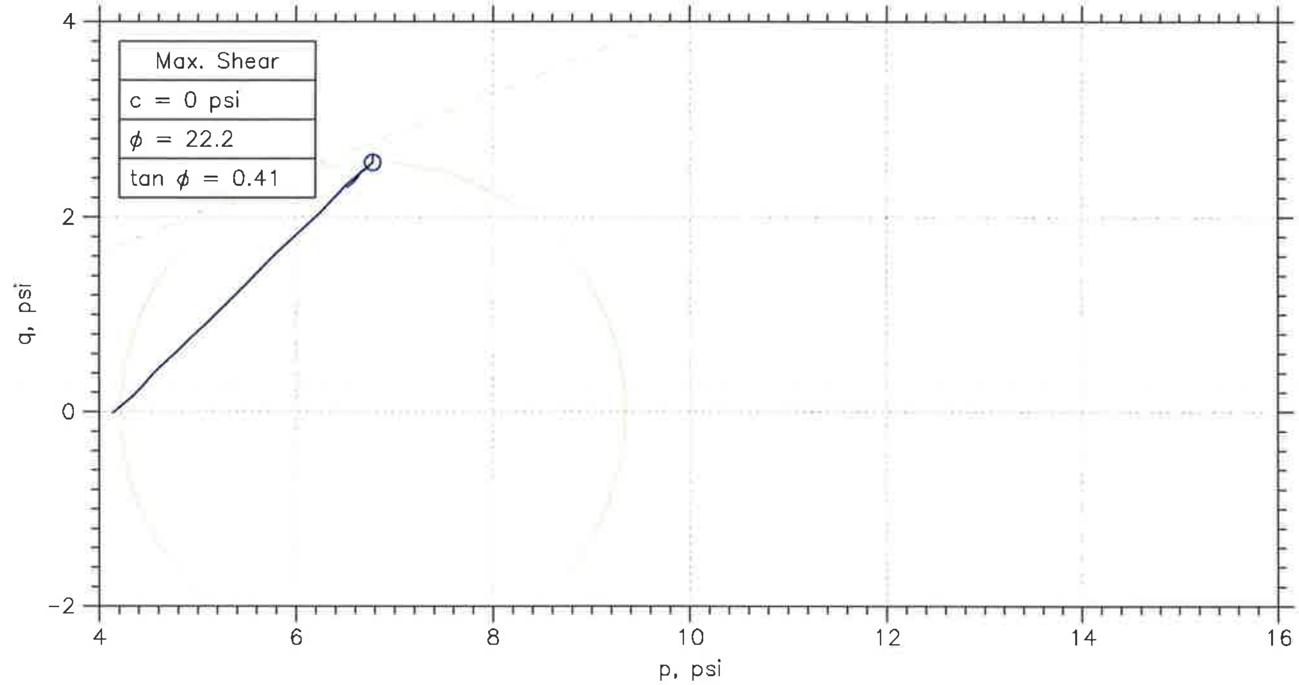


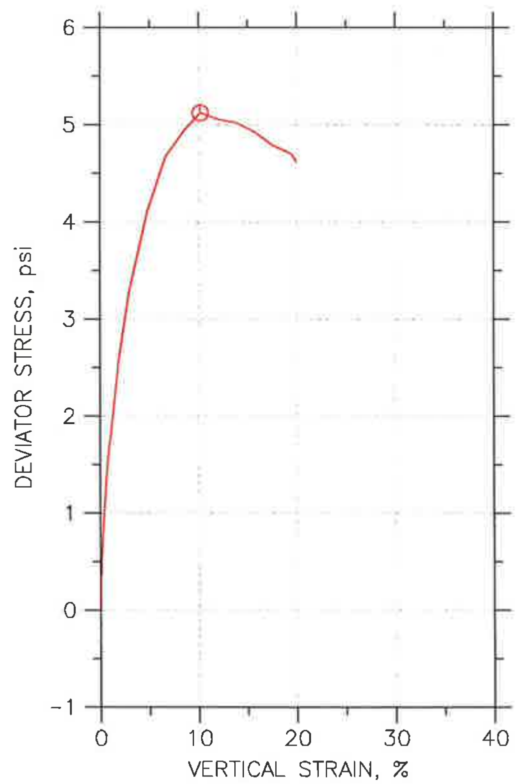
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
	HB3@2.75	13-229	2.25-2.75	JMA	4/9/13			13-229 MSE.dat

Project: Martin Slough Enhancem	Location: Eureka	Project No.: 013035
Boring No.: HB3@2.25	Sample Type: 2.5"calbrl	
Description: SILT		
Remarks: Unconsolidated Undrained		

Thu, 18-APR-2013 12:15:55

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST





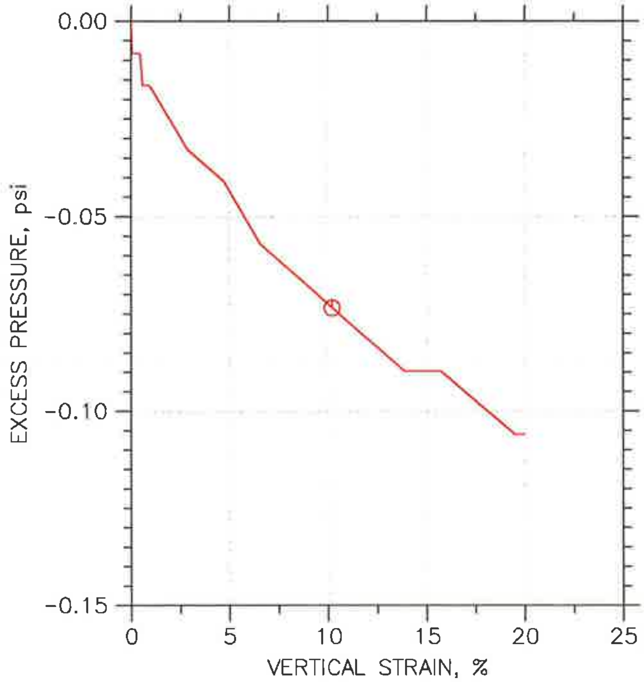
Symbol		⏀			
Sample No.		HB3@5'			
Test No.		13-230			
Depth		5-5.5			
Initial	Diameter, in	2.38			
	Height, in	5.5			
	Water Content, %	43.0			
	Dry Density, pcf	79.49			
	Saturation, %	106.5			
	Void Ratio	1.06			
Before Shear	Water Content, %	40.3			
	Dry Density, pcf	79.58			
	Saturation*, %	100.0			
	Void Ratio	1.06			
	Back Press., psi	.E-17			
Ver. Eff. Cons. Stress, psi		4.158			
Shear Strength, psi		2.564			
Strain at Failure, %		10.2			
Strain Rate, %/min		1			
B-Value		---			
Estimated Specific Gravity		2.62			
Liquid Limit		---			
Plastic Limit		---			

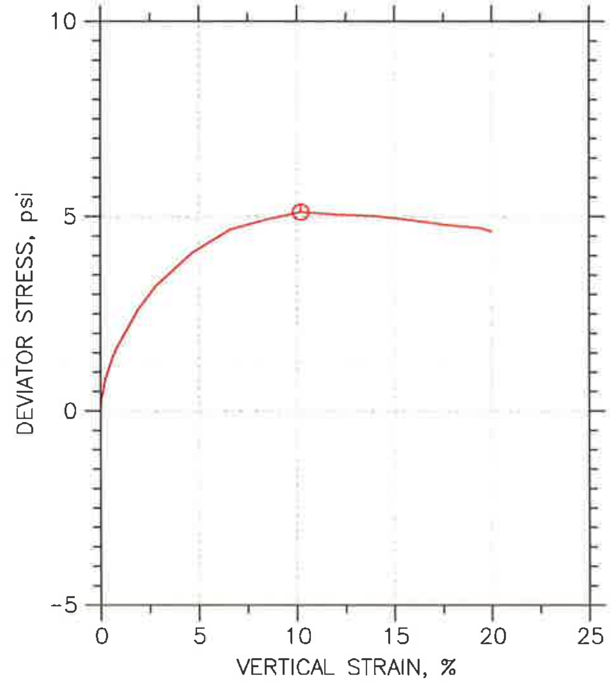
Project: Martin Slough Enhancement
Location: Eureka
Project No.: 013035
Boring No.: HB3@5'
Sample Type: 2.5"calbrl
Description: SILT
Remarks: Unconsolidated Undrained

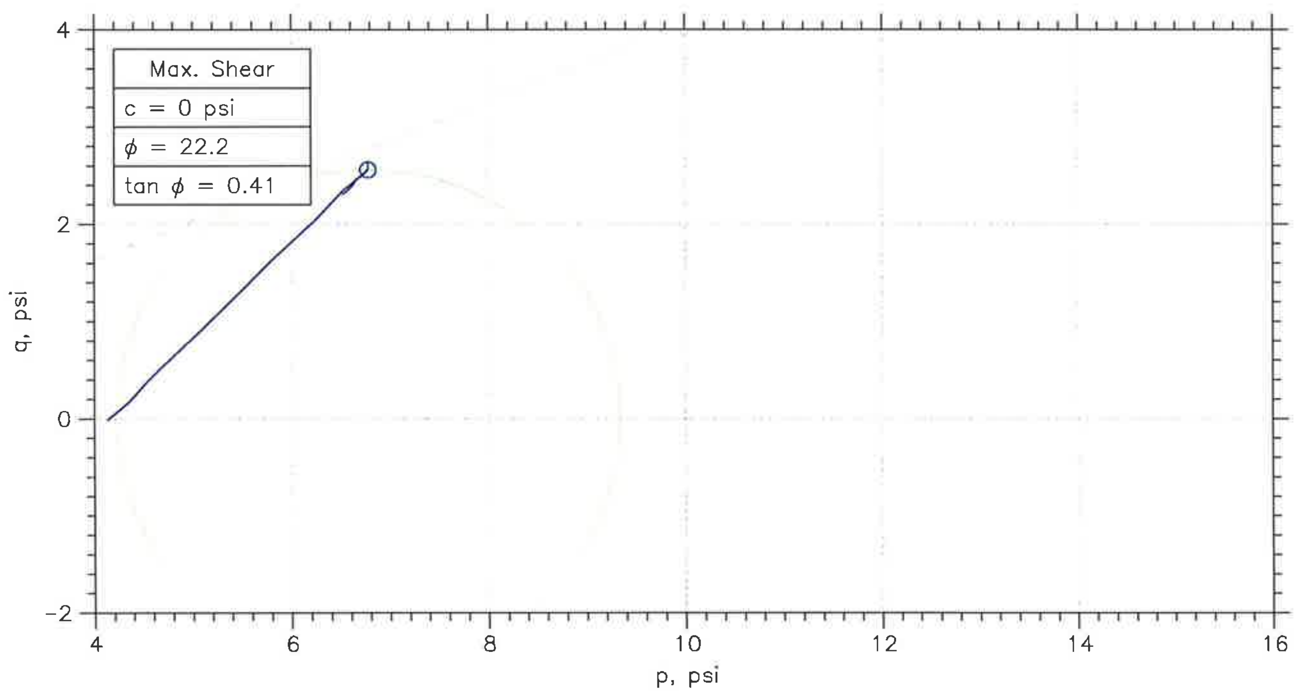
Thu, 18-APR-2013 12:19:50

Phase calculations based on start and end of test.
* Saturation is set to 100% for phase calculations.

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST





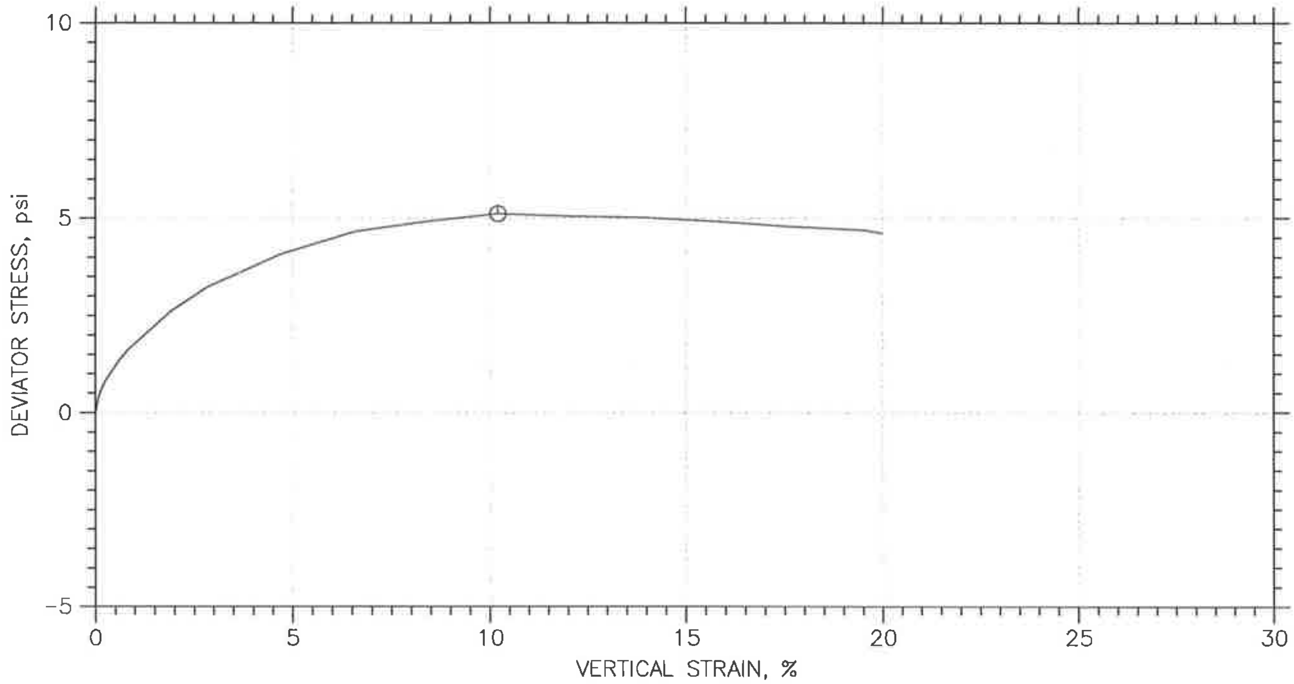


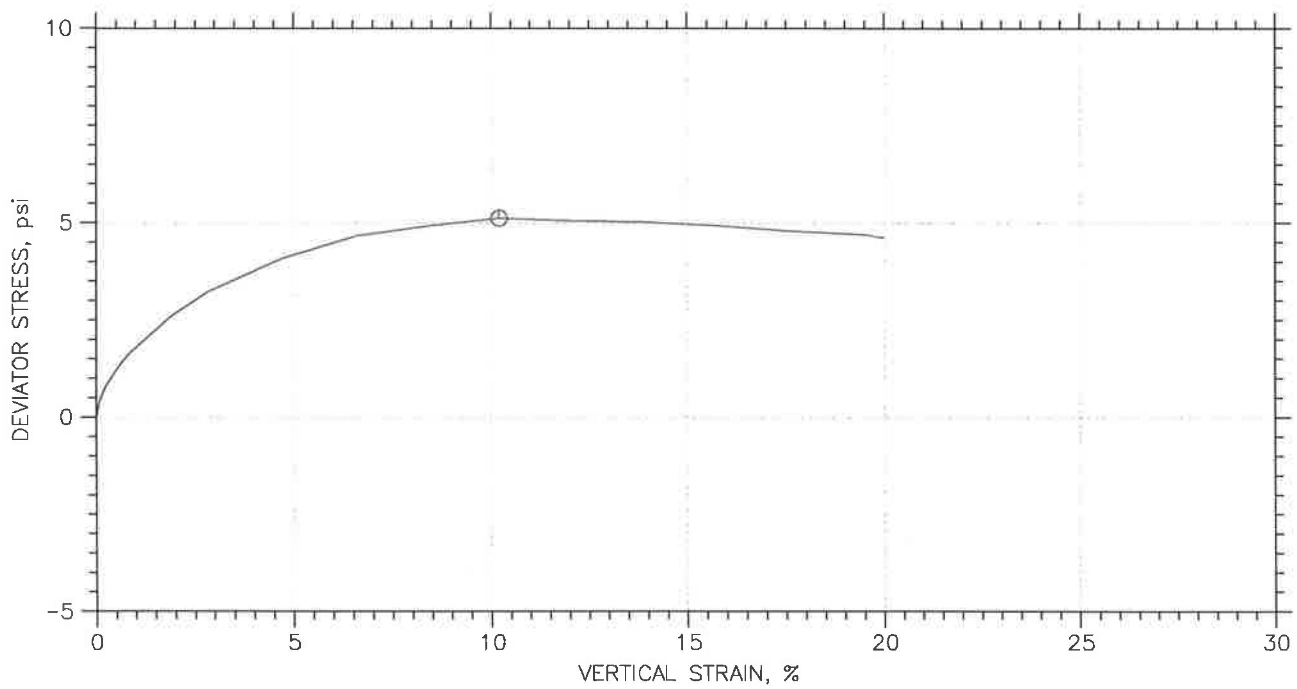
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
①	HB3@5'	13-230	5-5.5	JMA	4/10/13			13-230 MSE.dat

Project: Martin Slough Enhancement	Location: Eureka	Project No.: 013035
Boring No.: HB3@5'	Sample Type: 2.5"calbrl	
Description: SILT		
Remarks: Unconsolidated Undrained		

Thu, 18-APR-2013 12:19:50

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST



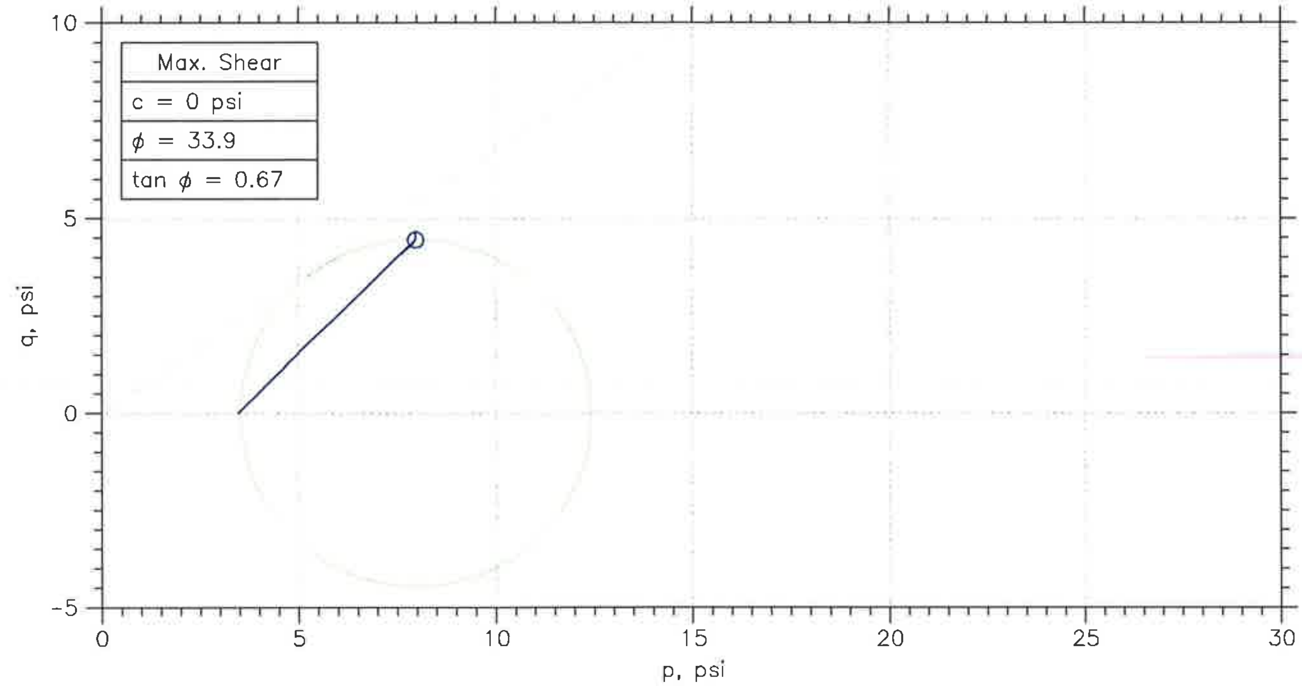


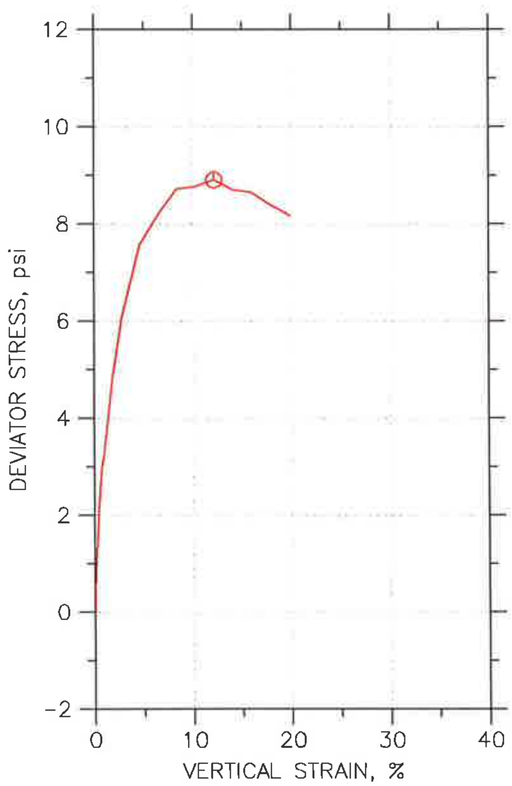
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	HB3@5'	13-230	5-5.5	JMA	4/10/13			13-230 MSE.dat

Project: Martin Slough Enhancement	Location: Eureka	Project No.: 013035
Boring No.: HB3@5'	Sample Type: 2.5"calbrl	
Description: SILT		
Remarks: Unconsolidated Undrained		

Thu, 18-APR-2013 12:19:51

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST





Symbol		⊙				
Sample No.		HB4@3.2				
Test No.		13-233				
Depth		3.2-3.7				
Initial	Diameter, in	2.38				
	Height, in	4.8				
	Water Content, %	36.0				
	Dry Density, pcf	86.22				
	Saturation, %	102.9				
	Void Ratio	0.933				
Before Shear	Water Content, %	34.8				
	Dry Density, pcf	86.42				
	Saturation*, %	100.0				
	Void Ratio	0.929				
	Back Press., psi	.E-17				
Ver. Eff. Cons. Stress, psi		3.474				
Shear Strength, psi		4.456				
Strain at Failure, %		12.2				
Strain Rate, %/min		1				
B-Value		---				
Estimated Specific Gravity		2.67				
Liquid Limit		---				
Plastic Limit		---				

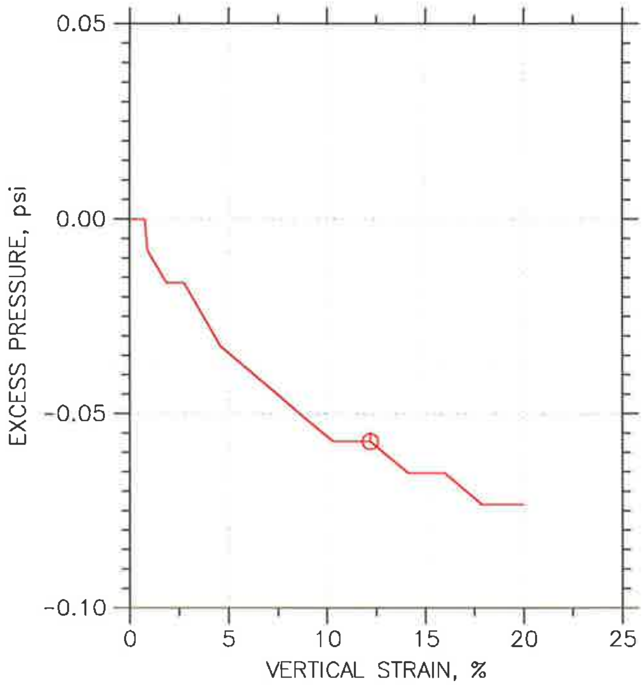
Project: Martin Slough Enhancement	
Location: Eureka	
Project No.: 013035	
Boring No.: HB4@3.2-3.7	
Sample Type: 2.5"calbrl	
Description: SILT	
Remarks: Unconsolidated Undrained	

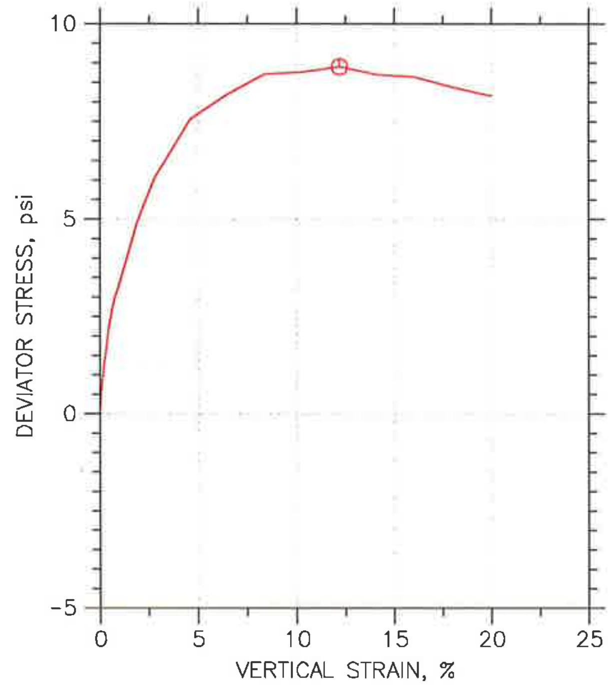
Thu, 18-APR-2013 12:24:31

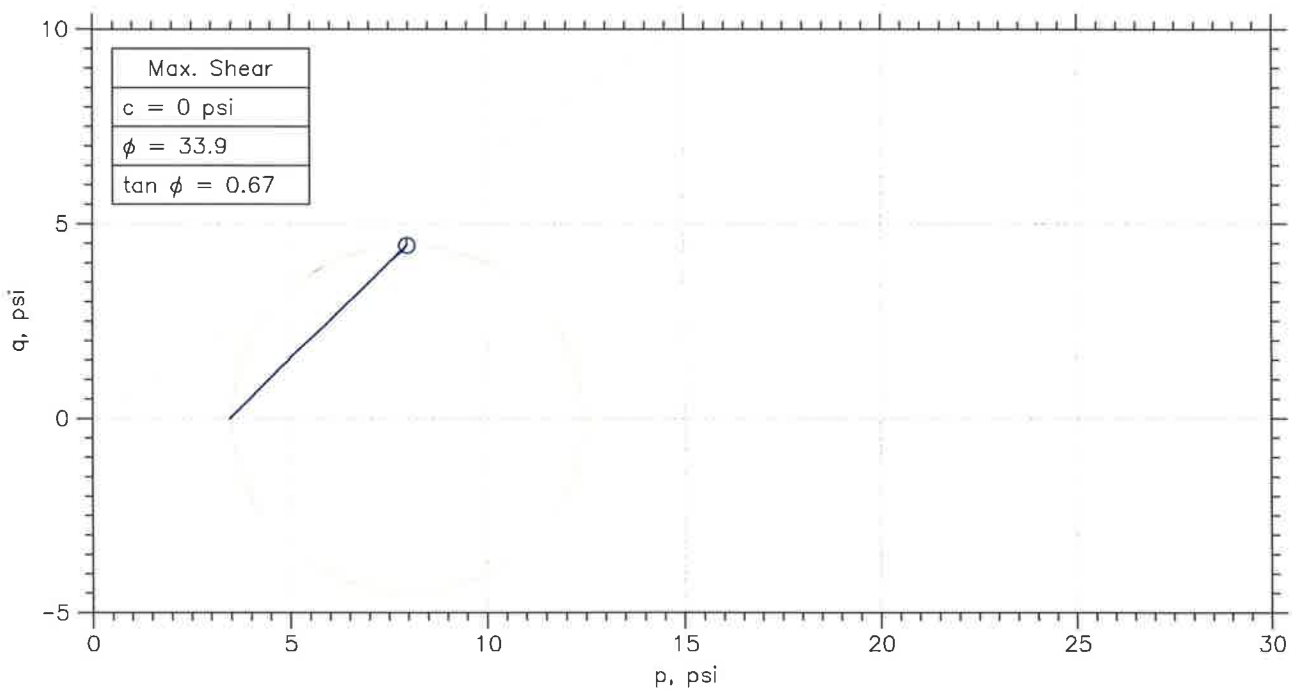
Phase calculations based on start and end of test.

* Saturation is set to 100% for phase calculations.

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST





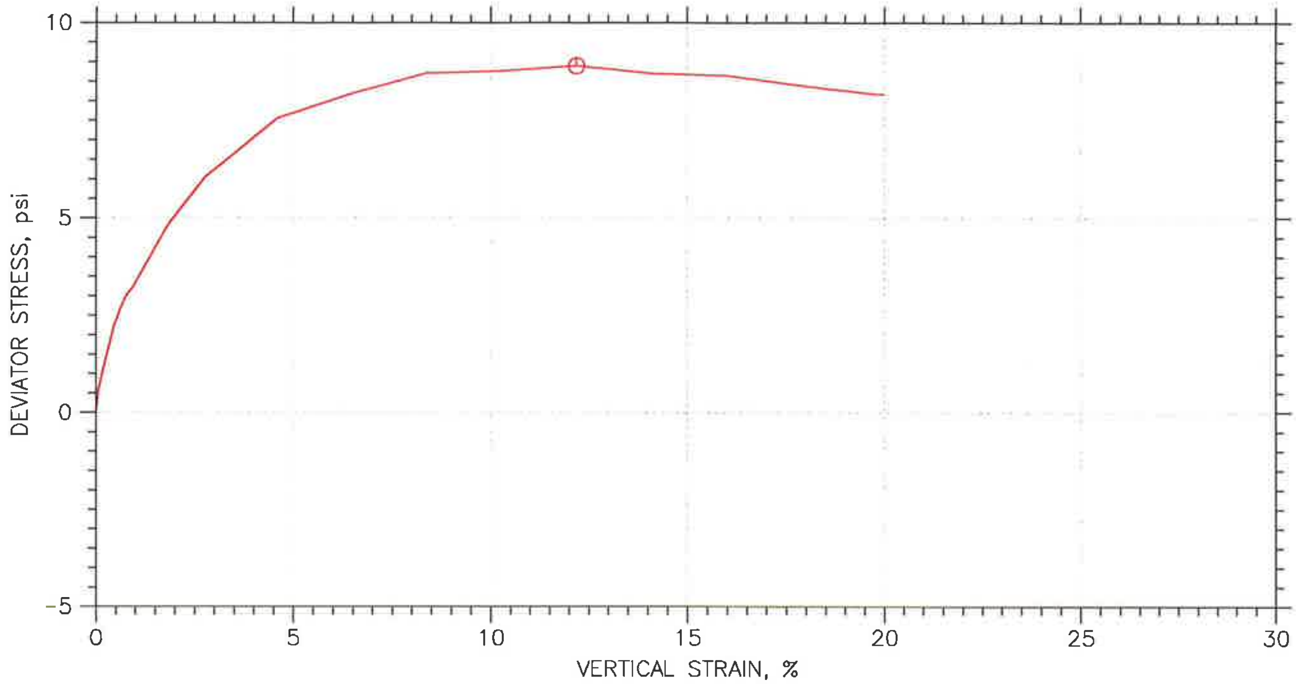


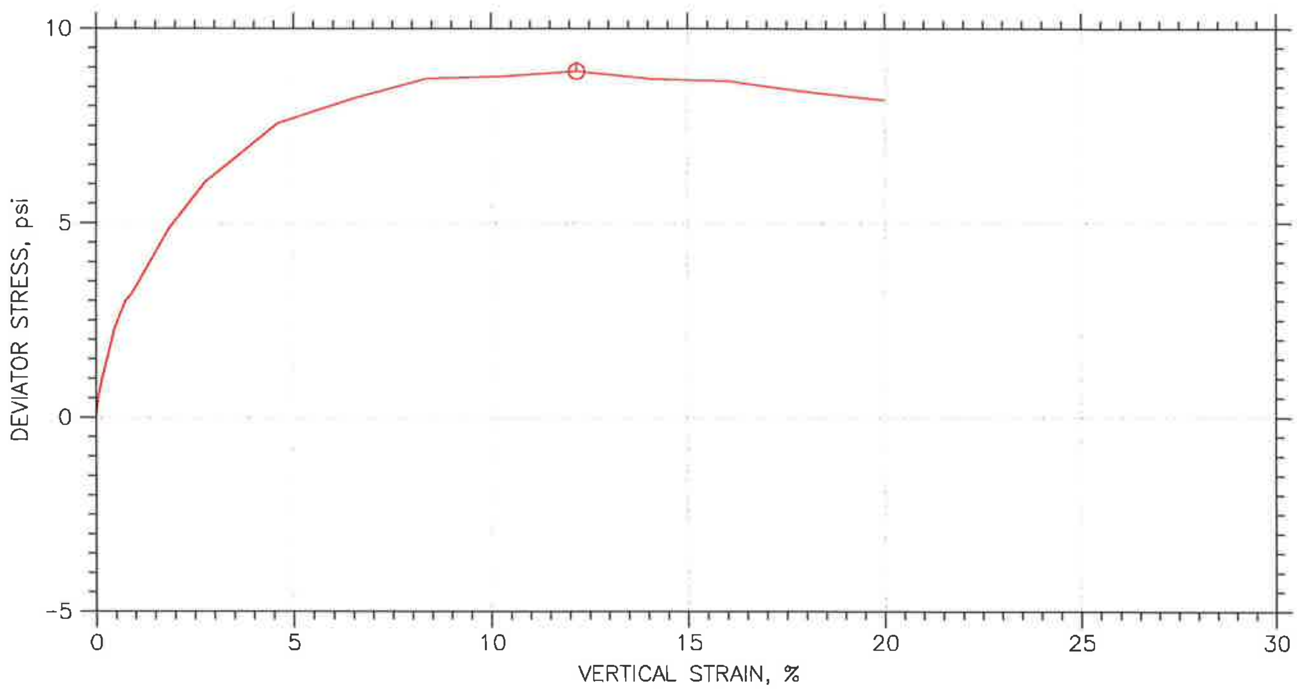
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
⦶	HB4@3.2	13-233	3.2-3.7	JMA	4/10/13			13-233 MSE.dat

Project: Martin Slough Enhancement	Location: Eureka	Project No.: 013035
Boring No.: HB4@3.2-3.7	Sample Type: 2.5"calbrl	
Description: SILT		
Remarks: Unconsolidated Undrained		

Thu, 18-APR-2013 12:24:32

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST



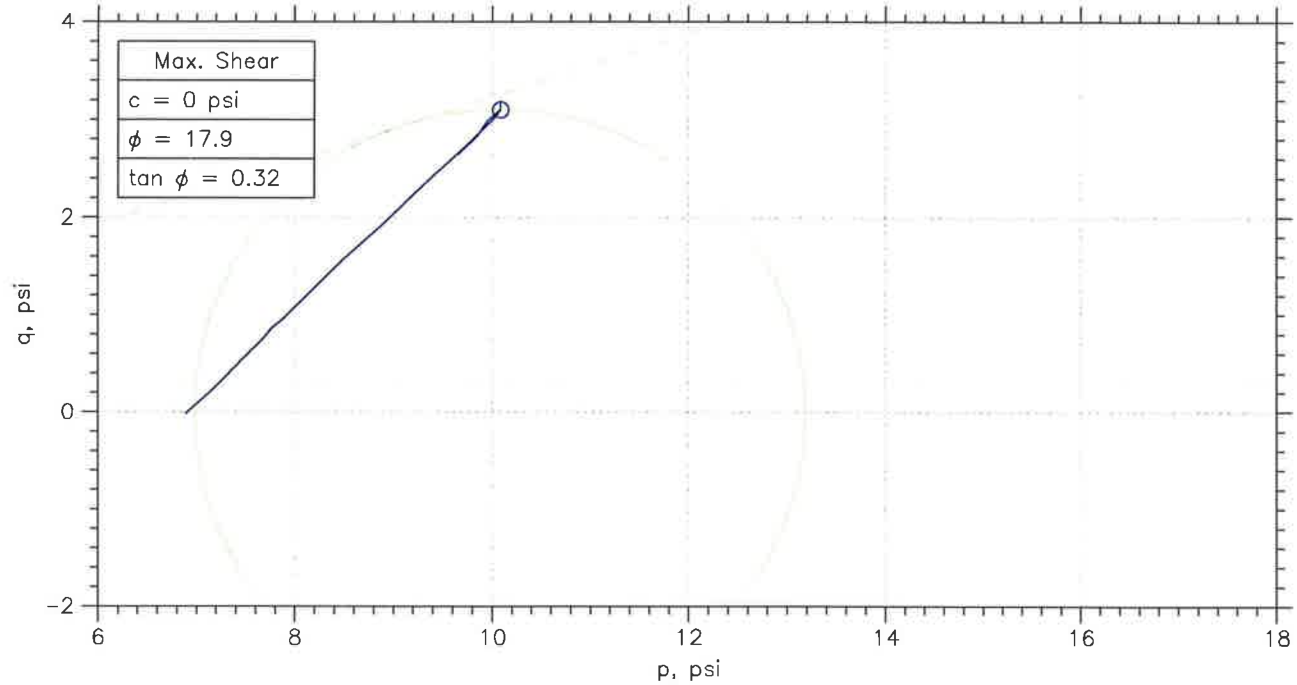


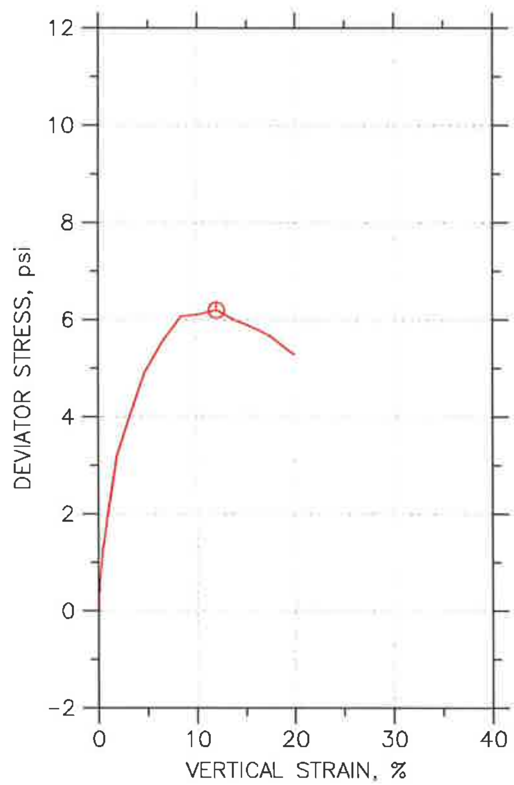
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
○	HB4@3.2	13-233	3.2-3.7	JMA	4/10/13			13-233 MSE.dat

Project: Martin Slough Enhancement	Location: Eureka	Project No.: 013035
Boring No.: HB4@3.2-3.7	Sample Type: 2.5"calbrl	
Description: SILT		
Remarks: Unconsolidated Undrained		

Thu, 18-APR-2013 12:24:32

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST





Symbol		⦶			
Sample No.		HB4@8.6'			
Test No.		13-235			
Depth		8.6-9.1			
Initial	Diameter, in	2.38			
	Height, in	5.65			
	Water Content, %	38.3			
	Dry Density, pcf	79.71			
	Saturation, %	95.3			
	Void Ratio	1.05			
Before Shear	Water Content, %	38.3			
	Dry Density, pcf	80.15			
	Saturation*, %	96.4			
	Void Ratio	1.04			
	Back Press., psi	.E-17			
Ver. Eff. Cons. Stress, psi		6.924			
Shear Strength, psi		3.103			
Strain at Failure, %		12			
Strain Rate, %/min		1			
B-Value		---			
Estimated Specific Gravity		2.62			
Liquid Limit		---			
Plastic Limit		---			

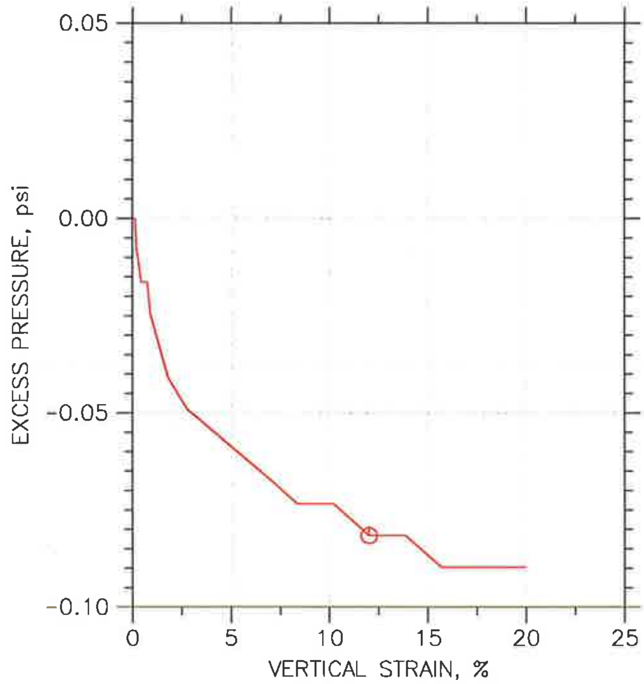
Project: Martin Slough Enhancement
Location: Eureka
Project No.: 013035
Boring No.: HB3
Sample Type: 2.5"calbrl
Description: Blue Gray SILT
Remarks: Unconsolidated Undrained

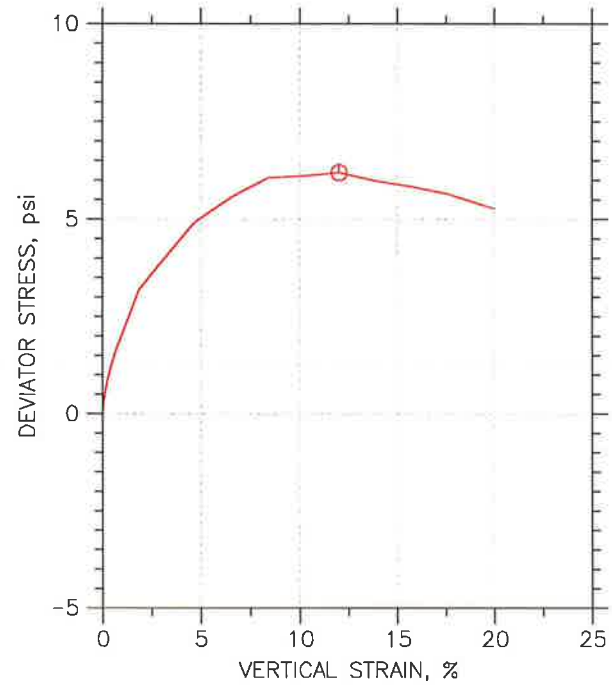
Thu, 18-APR-2013 12:25:52

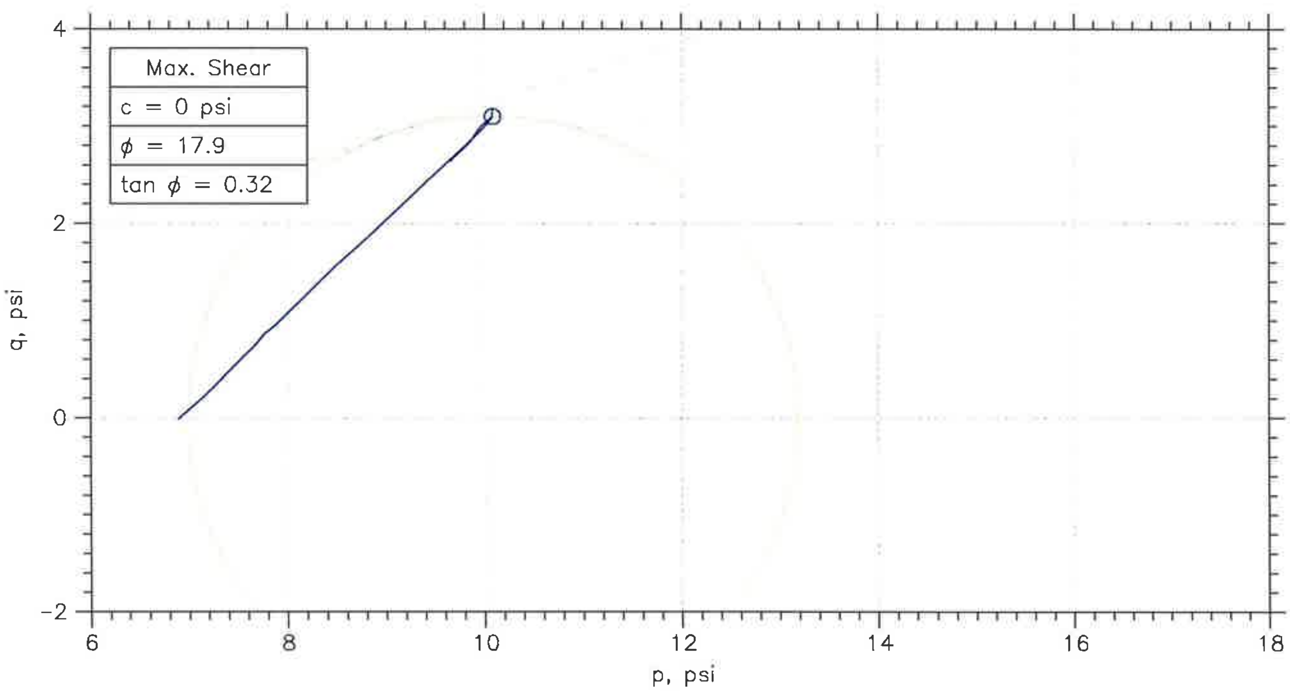
Phase calculations based on start and end of test.

* Saturation is set to 100% for phase calculations.

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST





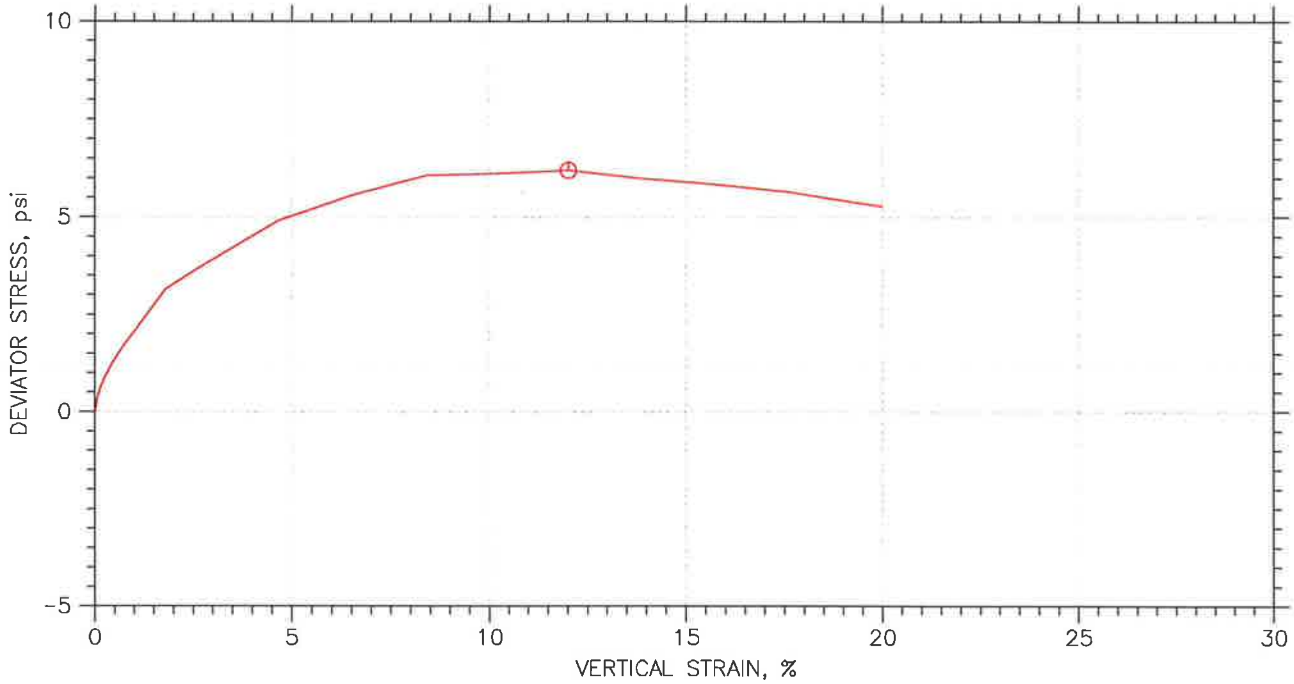


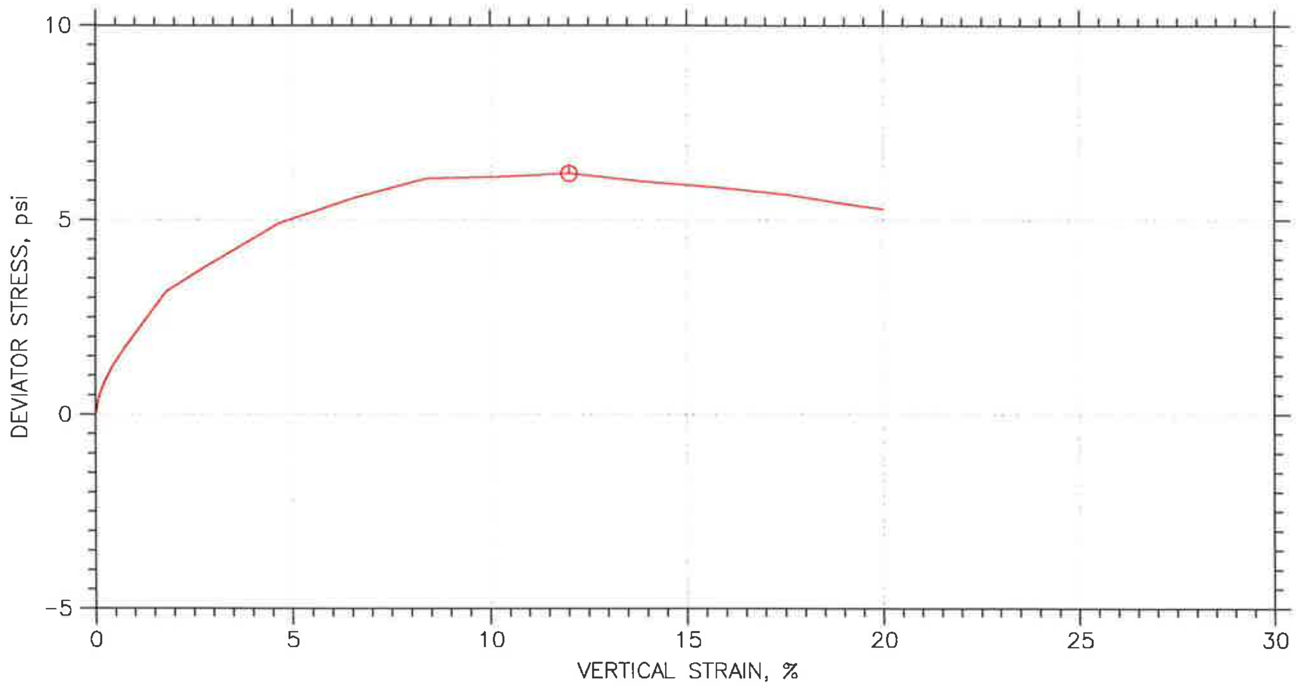
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
ⓘ	HB4@8.6'	13-235	8.6-9.1	JMA	4/10/13			13-235 MSE.dat

Project: Martin Slough Enhanceme	Location: Eureka	Project No.: 013035
Boring No.: HB3	Sample Type: 2.5"calbrl	
Description: Blue Gray SILT		
Remarks: Unconsolidated Undrained		

Thu, 18-APR-2013 12:25:53

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST



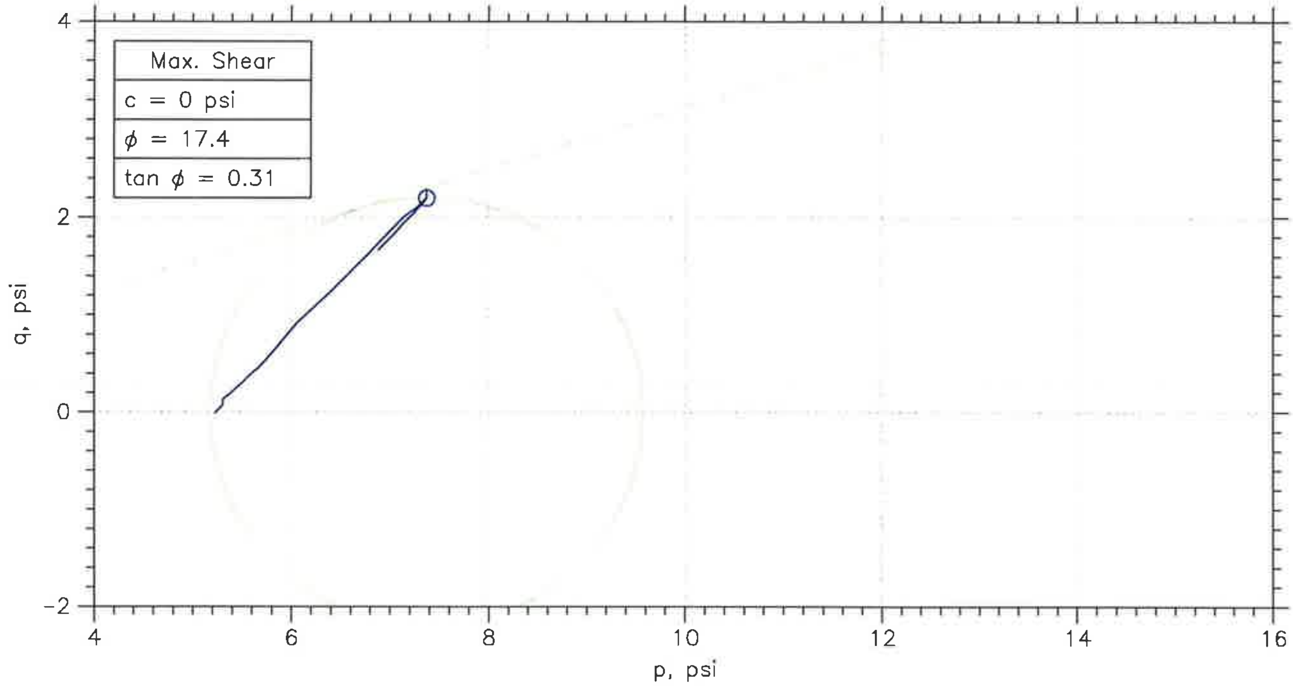


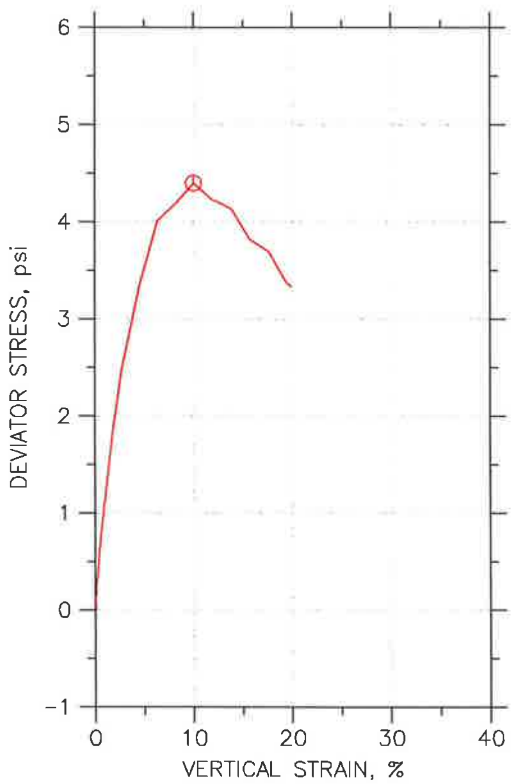
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
⏀	HB4@8.6'	13-235	8.6-9.1	JMA	4/10/13			13-235 MSE.dat

Project: Martin Slough Enhancemelbocation: Eureka		Project No.: 013035
Boring No.: HB3	Sample Type: 2.5"calbrl	
Description: Blue Gray SILT		
Remarks: Unconsolidated Undrained		

Thu, 18-APR-2013 12:25:53

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST





Symbol		O			
Sample No.		HB12@5'			
Test No.		13-243			
Depth		5-5.5			
Initial	Diameter, in	2.38			
	Height, in	5.07			
	Water Content, %	45.3			
	Dry Density, pcf	73.01			
	Saturation, %	95.6			
	Void Ratio	1.24			
Before Shear	Water Content, %	45.3			
	Dry Density, pcf	73.17			
	Saturation*, %	96.1			
	Void Ratio	1.24			
	Back Press., psi	.E-17			
Ver. Eff. Cons. Stress, psi		5.207			
Shear Strength, psi		2.201			
Strain at Failure, %		10.1			
Strain Rate, %/min		1			
B-Value		---			
Estimated Specific Gravity		2.62			
Liquid Limit		---			
Plastic Limit		---			

Project: Martin Slough Enhancement

Location: Eureka

Project No.: 013035

Boring No.: HB12@5-5.5

Sample Type: 2.5"calbrl

Description: Brown SILT

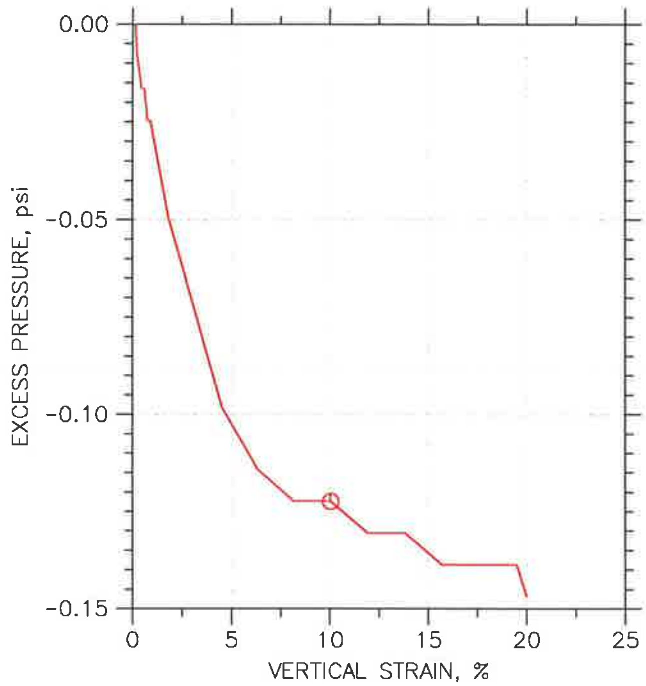
Remarks: Unconsolidated undrained

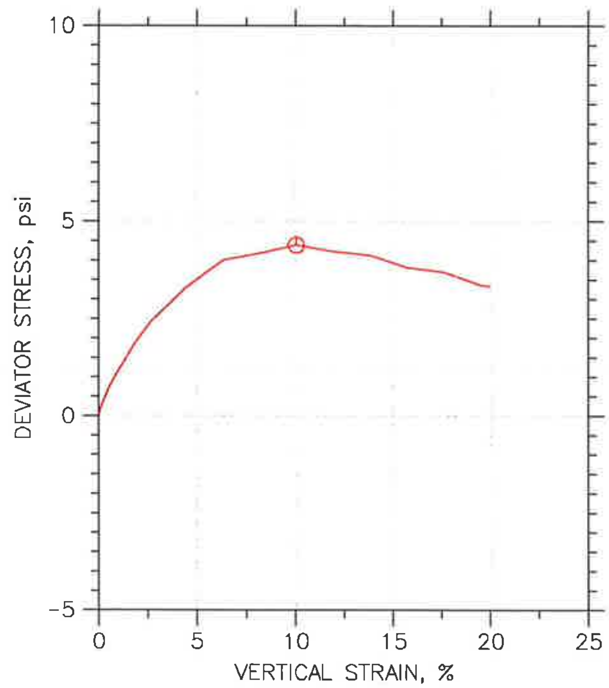
Phase calculations based on start and end of test.

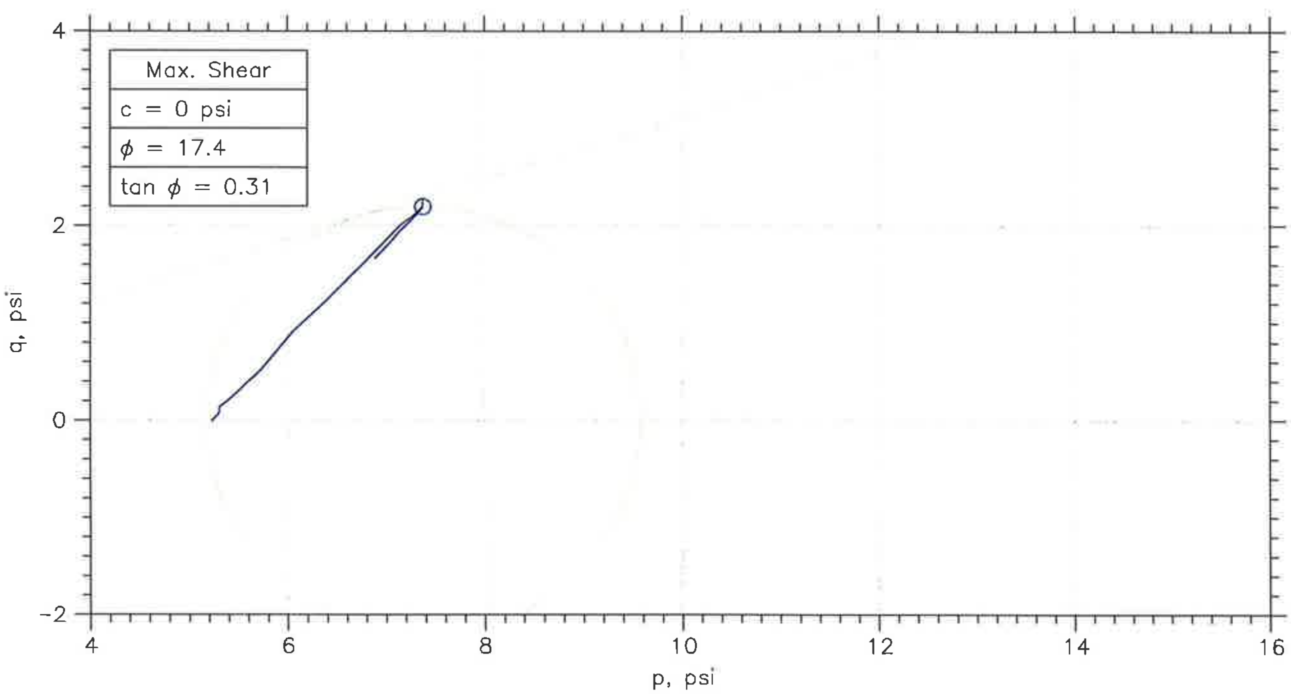
* Saturation is set to 100% for phase calculations.

Thu, 18-APR-2013 12:27:22

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST





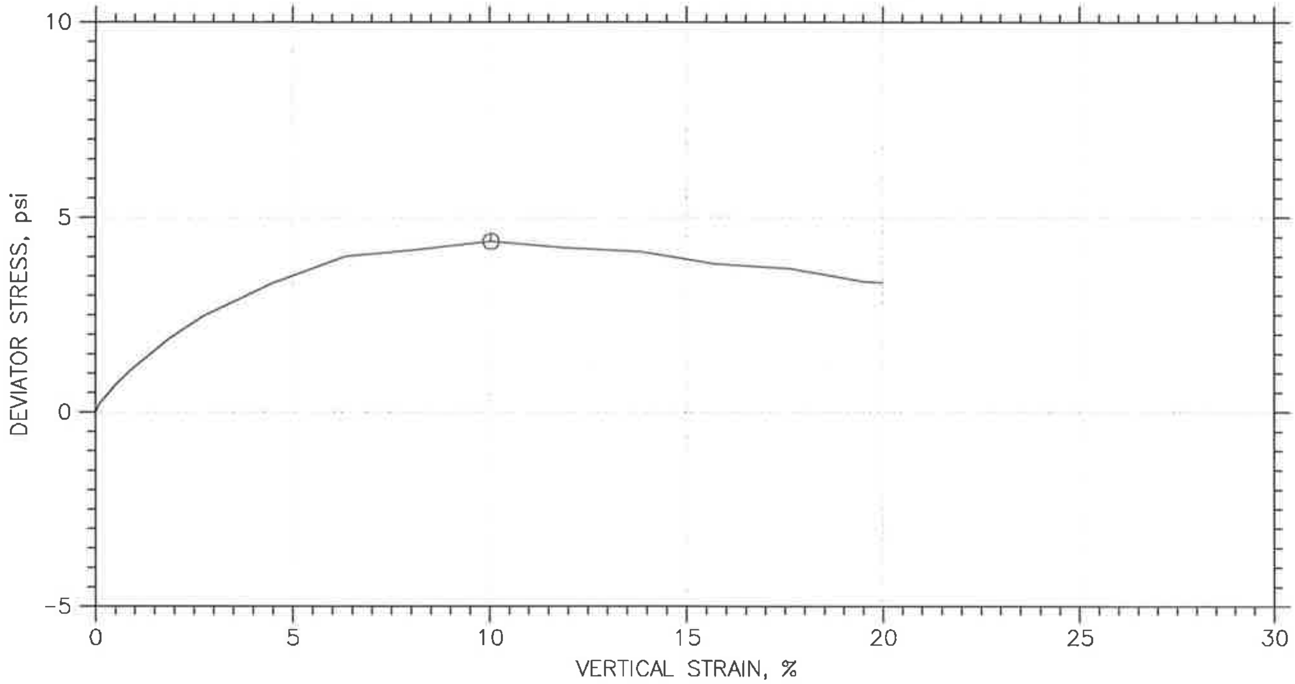


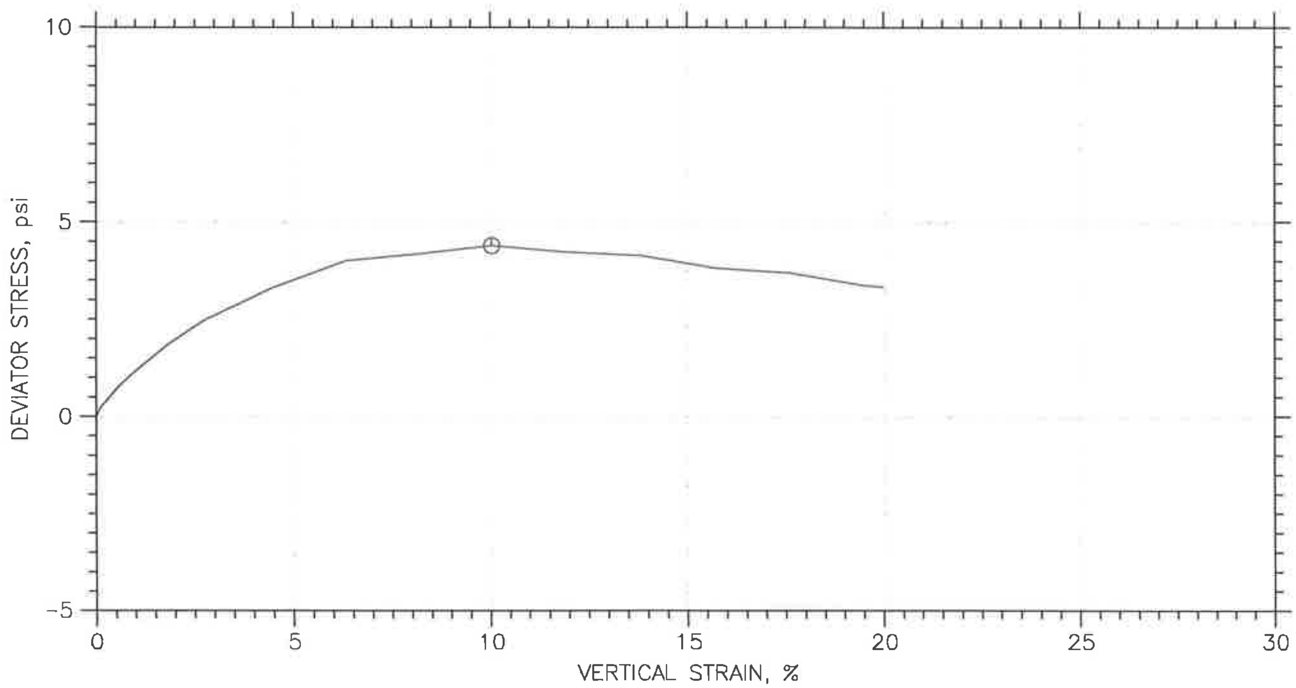
	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
①	HB12@5'	13-243	5-5.5	JMA	4/11/13			13-243 MSE.dat

Project: Martin Slough Enhancem	Location: Eureka	Project No.: 013035
Boring No.: HB12@5-5.5	Sample Type: 2.5"calbrl	
Description: Brown SILT		
Remarks: Unconsolidated undrained		

Thu, 18-APR-2013 12:27:22

UNCONSOLIDATED UNDRAINED TRIAXIAL TEST





	Sample No.	Test No.	Depth	Tested By	Test Date	Checked By	Check Date	Test File
①	HB12@5'	13-243	5-5.5	JMA	4/11/13			13-243 MSE.dat

Project: Martin Slough Enhancement	Location: Eureka	Project No.: 013035
Boring No.: HB12@5-5.5	Sample Type: 2.5"calbrl	
Description: Brown SILT		
Remarks: Unconsolidated undrained		

Thu, 18-APR-2013 12:27:23

Appendix C

USDA Laboratory Test Results

A & L WESTERN AGRICULTURAL LABORATORIES

1311 WOODLAND AVE #1 • MODESTO, CALIFORNIA 95351 • (209) 529-4080 • FAX (209) 529-4736

REPORT NUMBER: 13-101-050

CLIENT NO: 2946-D

SEND TO: SHN CONSULTING ENGINEERS
812 W. WABASH
EUREKA, CA 95501-

SUBMITTED BY: CINDY WILCOX

GROWER: RC4A-013035

DATE OF REPORT: 04/17/13

SOIL ANALYSIS REPORT

SAMPLE ID	LAB NUMBER	Organic Matter * % Rating	Organic Matter ** ENR lbs/A	Phosphorus P1 (Weak Bray) **** * ppm	Phosphorus NaHCO3-P (OlsenMethod) **** * ppm	Potassium K ***** * ppm	Magnesium Mg *** * ppm	Calcium Ca *** * ppm	Sodium Na *** * ppm	pH Soil pH	pH Buffer Index	Hydrogen H meq/100g	Cation Exchange Capacity C.E.C. meq/100g	PERCENT CATION SATURATION (COMPUTED) K %	Mg %	Ca %	H %	Na %
HB-5B	54356	1.3L	57	5VL	9**	129M	355M	276VL	503VH	4.6	6.3	8.0	14.8	2.2	19.7	9.3	54.0	14.8
HB-6	54357	2.6M	82	3VL	19**	42L	276M	300VL	154H	4.4	6.3	7.4	12.0	0.9	19.0	12.5	62.0	5.6
HB-8A	54358	3.9H	108	2VL	11**	45L	495VH	836VL	104M	5.4	6.6	3.5	12.3	0.9	33.0	33.9	28.5	3.7
HB-8B	54359	3.3M	96	1VL	6**	52L	579VH	685VL	177H	5.7	6.7	2.4	11.5	1.1	41.4	29.7	21.0	6.7
HB-11	54360	3.8H	107	1VL	8**	53L	637VH	643VL	128M	5.2	6.5	4.8	13.9	1.0	37.6	23.0	34.5	4.0

** NaHCO3-P unreliable at this soil pH

SAMPLE NUMBER	Nitrogen NO_3-N ppm	Sulfur SO_4-S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Excess Lime Rating	Soluble Salts mmhos/cm	Chloride Cl ppm		PARTICLE SIZE ANALYSIS SAND %	SILT %	CLAY %	SOIL TEXTURE
HB-5B	1VL	67VH						L	1.8M						
HB-6	5L	64VH						L	0.6L						
HB-8A	8L	13M						L	0.3L						
HB-8B	3VL	19M						L	0.4L						
HB-11	4VL	33H						L	0.3L						

* CODE TO RATING: VERY LOW (VL), LOW (L), MEDIUM (M), HIGH (H), AND VERY HIGH (VH).
** ENR - ESTIMATED NITROGEN RELEASE
*** MULTIPLY THE RESULTS IN ppm BY 2 TO CONVERT TO LBS. PER ACRE OF THE ELEMENTAL FORM
**** MULTIPLY THE RESULTS IN ppm BY 4.6 TO CONVERT TO LBS. PER ACRE P_2O_5
***** MULTIPLY THE RESULTS IN ppm BY 2.4 TO CONVERT TO LBS. PER ACRE K_2O
MOST SOILS WEIGH TWO (2) MILLION POUNDS (DRY WEIGHT) FOR AN ACRE OF SOIL 6-2/3 INCHES DEEP

This report applies only to the sample(s) tested. Samples are retained a maximum of thirty days after testing.

M Buttress

Mike Buttress, CPAg
A & L WESTERN LABORATORIES, INC.

A & L WESTERN AGRICULTURAL LABORATORIES

1311 WOODLAND AVE #1 • MODESTO, CALIFORNIA 95351 • (209) 529-4080 • FAX (209) 529-4736

REPORT NUMBER: 13-101-050

CLIENT NO: 2946-D

SEND TO: SHN CONSULTING ENGINEERS
812 W. WABASH
EUREKA, CA 95501-

SUBMITTED BY: CINDY WILCOX

GROWER: RC4A-013035

DATE OF REPORT: 04/17/13

SOIL ANALYSIS REPORT

SAMPLE ID	LAB NUMBER	Organic Matter * % Rating	Organic Matter ** ENR lbs/A	Phosphorus P1 (Weak Bray) **** * ppm	Phosphorus NaHCO₃-P (OlsenMethod) **** * ppm	Potassium K ***** * ppm	Magnesium Mg *** * ppm	Calcium Ca *** * ppm	Sodium Na *** * ppm	pH Soil pH	pH Buffer Index	Hydrogen H meq/100g	Cation Exchange Capacity C.E.C. meq/100g	Percent Cation Saturation (Computed) K %	Mg %	Ca %	H %	Na %
HB-13	54361	1.9L	69	1VL	8**	111L	480H	395VL	315H	4.5	6.1	10.5	18.0	1.6	21.9	10.9	58.0	7.6
HB14A	54362	3.0M	90	1VL	10**	47L	282VH	343VL	160H	4.8	6.6	4.3	9.1	1.3	25.4	18.7	47.0	7.6
HB14B	54363	1.1L	51	1VL	16**	58M	270VH	223VL	321VH	5.4	6.7	1.9	6.8	2.2	32.5	16.3	28.5	20.5
HB-15	54364	3.5M	100	2VL	17**	40L	220H	298VL	73M	4.5	6.5	5.1	8.9	1.1	20.5	16.8	58.0	3.6

** NaHCO3-P unreliable at this soil pH

SAMPLE NUMBER	Nitrogen NO_3-N ppm	Sulfur SO_4-S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Excess Lime Rating	Soluble Salts mmhos/cm	Chloride Cl ppm		Particle Size Analysis SAND %	SILT %	CLAY %	SOIL TEXTURE
HB-13	1VL	228VH						L	1.8M						
HB14A	5L	58VH						L	0.4L						
HB14B	1VL	34H						L	0.5L						
HB-15	3VL	44VH						L	0.2VL						

* CODE TO RATING: VERY LOW (VL), LOW (L), MEDIUM (M), HIGH (H), AND VERY HIGH (VH).
** ENR - ESTIMATED NITROGEN RELEASE
*** MULTIPLY THE RESULTS IN ppm BY 2 TO CONVERT TO LBS. PER ACRE OF THE ELEMENTAL FORM
**** MULTIPLY THE RESULTS IN ppm BY 4.6 TO CONVERT TO LBS. PER ACRE P_2O_5
***** MULTIPLY THE RESULTS IN ppm BY 2.4 TO CONVERT TO LBS. PER ACRE K_2O
MOST SOILS WEIGH TWO (2) MILLION POUNDS (DRY WEIGHT) FOR AN ACRE OF SOIL 6-2/3 INCHES DEEP

This report applies only to the sample(s) tested. Samples are retained a maximum of thirty days after testing.

M Buttress

Mike Buttress, CPAg
A & L WESTERN LABORATORIES, INC.

A & L WESTERN AGRICULTURAL LABORATORIES

1311 WOODLAND AVE #1 • MODESTO, CALIFORNIA 95351 • (209) 529-4080 • FAX (209) 529-4736

REPORT NUMBER: 13-101-049

CLIENT NO: 2946-D

SEND TO: SHN CONSULTING ENGINEERS
812 W. WABASH
EUREKA, CA 95501-

SUBMITTED BY: CINDY WILCOX

GROWER: RC4A-013035

DATE OF REPORT: 04/17/13

SOIL ANALYSIS REPORT

PAGE: 1

SAMPLE ID	LAB NUMBER	Organic Matter * % Rating	Organic Matter ** ENR lbs/A	Phosphorus P1 (Weak Bray) **** * ppm	Phosphorus $NaHCO_3$-P (OlsenMethod) **** * ppm	Potassium K ***** * ppm	Magnesium Mg *** * ppm	Calcium Ca *** * ppm	Sodium Na *** * ppm	pH Soil pH	pH Buffer Index	Hydrogen H meq/100g	Cation Exchange Capacity C.E.C. meq/100g	Percent Cation Saturation (Computed) K %	Mg %	Ca %	H %	Na %
HB-2A	54352	3.4M	99	13L	20**	145M	246H	259VL	258VH	4.9	6.6	3.8	8.6	4.3	23.6	15.0	44.0	13.1
HB-2B	54353	2.7M	83	8L	17**	142M	361H	312VL	521VH	4.9	6.5	5.6	12.8	2.8	23.3	12.2	44.0	17.7
HB-5A	54354	5.7VH	145	14L	39**	86L	184M	175VL	169H	4.2	6.3	7.9	11.3	2.0	13.4	7.7	70.4	6.5
HB-10	54355	1.1L	51	4VL	15**	170M	349H	323VL	222H	4.7	6.4	6.0	11.9	3.7	24.1	13.6	50.5	8.1

** NaHCO3-P unreliable at this soil pH

SAMPLE NUMBER	Nitrogen NO_3-N ppm	Sulfur SO_4-S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Excess Lime Rating	Soluble Salts mmhos/cm	Chloride Cl ppm		Particle Size Analysis SAND %	SILT %	CLAY %	SOIL TEXTURE
HB-2A	7L	33H	1.1M	3M	160VH	1.0M	0.5L	L	0.7M						
HB-2B	5L	45VH	1.1M	2L	158VH	1.8H	0.6M	L	1.4M						
HB-5A	3VL	57VH	0.4VL	2L	141VH	0.9M	0.4L	L	0.9M						
HB-10	1VL	60VH	1.4M	6M	150VH	3.3VH	0.7M	L	1.6M						

* CODE TO RATING: VERY LOW (VL), LOW (L), MEDIUM (M), HIGH (H), AND VERY HIGH (VH).
** ENR - ESTIMATED NITROGEN RELEASE
*** MULTIPLY THE RESULTS IN ppm BY 2 TO CONVERT TO LBS. PER ACRE OF THE ELEMENTAL FORM
**** MULTIPLY THE RESULTS IN ppm BY 4.6 TO CONVERT TO LBS. PER ACRE P_2O_5
***** MULTIPLY THE RESULTS IN ppm BY 2.4 TO CONVERT TO LBS. PER ACRE K_2O
MOST SOILS WEIGH TWO (2) MILLION POUNDS (DRY WEIGHT) FOR AN ACRE OF SOIL 6-2/3 INCHES DEEP

This report applies only to the sample(s) tested. Samples are retained a maximum of thirty days after testing.

M Buttress

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1311 WOODLAND AVE #1 • MODESTO, CALIFORNIA 95351 • (209) 529-4080 • FAX (209) 529-4736

REPORT NUMBER: 13-101-049 **CLIENT:** 2946

SUBMITTED BY: CINDY WILCOX

SEND TO: SHN CONSULTING ENGINEERS
812 W. WABASH
EUREKA, CA 95501-

GROWER: RC4A-013035

DATE OF REPORT: 04/17/13

SOIL SALINITY ANALYSIS REPORT

Sample ID	Lab Number	SAR	ESP	Na meq/L	Ca meq/L	Mg meq/L	pH	CO_3 meq/L	HCO_3 meq/L	E.C. dS/m	Cl meq/L	B ppm	Saturation %
HB-2A	54352	10.4	12.4	6.7	0.5	0.3	4.9	0.0	1.1	0.7	5.0	0.3	54.0
HB-2B	54353	13.8	16.0	13.0	1.0	0.7	4.9	0.0	1.1	1.4	8.0	0.4	52.4
HB-5A	54354	7.0	8.3	6.3	0.8	0.8	4.2	0.0	1.4	0.9	3.6	0.3	59.3
HB-10	54355	6.8	8.1	9.9	1.5	2.7	4.7	0.0	1.1	1.6	7.4	0.7	53.2

NOTES:

MButtress

Mike Buttress, CPAg
A & L WESTERN LABORATORIES, INC.