Job No. 02-06
Appendix N
Foundation Investigation

FOUNDATION INVESTIGATION
1.0 MG WATER TANK
KILAUEA, KAUAI, HAWAII
TMK: 5-1-005: 131

for

KODANI & ASSOCIATES, INC.

HIRATA & ASSOCIATES, INC.
W.O. 12-5271
March 19, 2012

Hirata & Associates
Geotechnical Engineering
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March 19, 2012
W.O. 12-5271

Mr. Clyde Kodani
Kodani & Associates, Inc.
3126 Akahi Street
Lihue, Hawaii 96766

Dear Mr. Kodani:

Our report, "Foundation Investigation, 1.0 MG Water Tank, Kilauea, Kauai, Hawaii, TMK: 5-1-005: 131", dated March 19, 2012, our Work Order 12-5271 is enclosed. This investigation was conducted in general conformance with the scope of services presented in our proposal dated April 21, 2010.

Borings B3 and B4, drilled above the slopes surrounding the existing tank, encountered surface soils consisting of reddish brown and brown clayey silt. The clayey silt was in a medium stiff condition, and extended to depths of about 5 and 18 feet. Underlying the pavement section in borings B1 and B2, and the surface clayey silt in borings B3 and B4, was a stratum of completely weathered basalt. The completely weathered basalt was in a firm to medium stiff condition and extended to the maximum depths drilled. Seepage water was encountered in borings B1, B2, and B4 at depths ranging from about 23.8 to 29.8 feet.

Conventional shallow foundations may be used to support the proposed water tank. However, to provide more uniform support for structure, we recommend that all footings and concrete slabs-on-grade be underlain by a minimum 24 inches of imported granular structural fill.

The following is a summary of our geotechnical recommendations. This summary is not intended to be a substitute for our report which includes more detailed explanations of our recommendations, as well as additional requirements.

- Allowable bearing value = 2,000 psf
- Coefficient of friction = 0.4
- Passive earth pressure = 200 pcf

We appreciate this opportunity to be of service. Should you have any questions concerning this report, please feel free to call on us.

Very truly yours,

HIRATA & ASSOCIATES, INC.

Paul S. Morimoto

Paul S. Morimoto President

PSM:SJ

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FOUNDATION INVESTIGATION
1.0 MG WATER TANK
KILAUEA, KAUAI, HAWAII
TMK: 5-1-005: 131

INTRODUCTION

This report presents the results of our foundation investigation performed for the proposed 1.0 MG Water Tank in Kilauea, Kauai, Hawaii. Our scope of services for this study included the following:

- A visual reconnaissance of the site to observe existing conditions which may affect the project. The general location of the project site is shown on the enclosed Location Map, Plate A2.1.

- A review of available in-house soils information pertinent to the site and the proposed project.

- Drilling and sampling four exploratory borings to depths ranging from about 25.5 to 44.5 feet. A description of our field investigation is summarized on Plates A1.1 and A1.2. The approximate exploratory boring locations are shown on the enclosed Boring Location Plan, Plate A2.2, and the soils encountered in the borings are described on the Boring Logs, Plates A4.1 through A4.6.

- Laboratory testing of selected soil samples. Testing procedures are presented in the Description of Laboratory Testing, Plates B1.1 and B1.2. Test results are presented in the Description of Laboratory Testing, and on the Boring Logs (Plates A4.1 through A4.6), Consolidation Test reports (Plates B2.1 through B2.3), Direct Shear Test reports (Plates B3.1 through B3.4), Modified Proctor Test report (Plate B4.1), and CBR Test report (Plate B5.1).

- Engineering analyses of the field and laboratory data.

- Preparation of this report presenting geotechnical recommendations for the design of foundations, including seismic considerations, resistance to lateral pressures, retaining wall, slabs-on-grade, flexible pavement, and site grading.

PROJECT CONSIDERATIONS

Information regarding the proposed project was provided by personnel from your office and KAI Hawaii, Inc., Structural Engineers.

The proposed project will consist of demolishing the existing 100,000 gallon water tank and constructing a new 1.0 million gallon (MG) water storage tank. The new concrete tank will have a diameter of about 95 feet.

Based on the existing topography and the proposed finish floor elevation of +447, grading will primarily consist of excavation, with maximum cut depths of about 10 feet. Preliminary plans show an approximate 1.5H:1V cut slope gradient. Retaining walls are planned along the northwest, northeast and southeast of the property line to accommodate grade changes.

The project will also include an AC paved perimeter road, extending around the new tank. We expect that the perimeter road will be about 10 to 12 feet wide.

SITE CONDITIONS

The project site is located on the south side of Kuhio Highway, southeast of its intersection with Puu Pane Road in Kilauea, Kauai. The central portion of the parcel is occupied by the existing water tank and service road. The remainder of the site is covered by low to moderate vegetation. Vacant land borders the site on the north and west.

Slopes ranging from about 4 to 10 feet in height surround the tank. The slopes are moderately to heavily overgrown, and the topographic survey indicates an approximate 2H:1V gradient. A 6-foot high chain-link fence extends around the existing tank site.

SOIL CONDITIONS

Borings B1 and B2 were drilled through the existing AC pavement which consisted of about 2 to 2.5 inches of asphaltic concrete over about 7 to 8 inches of base material. Borings B3 and B4, drilled from elevations about 10 and 5 feet higher than the existing service road, encountered reddish brown and brown clayey silt in a medium stiff condition.

Underlying the pavement section in borings B1 and B2, and the surface clayey silt in borings B3 and B4 at depths of about 5 and 18 feet, respectively, was a stratum of completely weathered basalt. Completely weathered basalt, also known as saprolite, is rock which has completely decomposed to soil, but with its structure preserved. The weathered basalt was in a firm to medium stiff condition, and extended to the maximum depths drilled. Laboratory testing on the completely weathered basalt indicated a low expansion potential.

Seepage water was encountered in borings B1, B2, and B4 at depths ranging from about 23.8 to 29.8 feet. Neither groundwater nor seepage water was encountered in boring B3.

CONCLUSIONS AND RECOMMENDATIONS

Based on the proposed finish floor elevation and the existing topography of the site, grading within the proposed tank footprint will consist primarily of excavation. In the northern portion of the tank footprint, cut depths will range from about 1 to 7 feet, while in the southern portion, cut depths will extend to depths of about 3 to 10 feet.

Conventional shallow foundations may be used to support the proposed 1.0 MG water tank. However, due to the firm to medium stiff condition of the completely weathered basalt and to provide more uniform support, we recommend that all footings and concrete slabs-on-grade be underlain by a minimum 24 inches of imported granular structural fill.

Foundations

Conventional shallow foundations, such as spread footings or thickened slab foundations, founded on a minimum 24 inches of imported granular structural fill may be used to support the proposed water tank. The granular structural fill should also extend laterally, a minimum 12 inches beyond the edge of footings. Imported granular structural fill should conform to and be placed in accordance with recommendations presented in the *Site Grading* section of this report.

Foundations may be designed for an allowable bearing value of 2,000 pounds per square foot. The recommended allowable bearing value is for the total of dead and frequently applied live loads, and may be increased by one-third for short duration loading which includes the effect of wind and seismic forces.

Foundations should be a minimum 16 inches in width, and embedded at least 18 inches below finish adjacent grade. The bottom of all footing excavations should be cleaned of loose or deleterious material prior to placement of reinforcing steel and concrete.

Footings located on, or near the top of slopes should be embedded such that a minimum horizontal distance of 5 feet is maintained between the bottom edge of footing and slope face.

Seismic Design

Based on the borings drilled as part of this study and our knowledge of deep soil conditions in the area, the subsurface soils can be characterized as a stiff soil profile. Therefore, based on the 2003 International Building Code, Site Class D is recommended for this site.

Lateral Design

Resistance to lateral loading may be provided by friction acting at the base of foundations, and by passive earth pressure acting on the buried portions of foundations.

A coefficient of friction of 0.4 may be used with the dead load forces. Passive earth pressure may be computed as an equivalent fluid having a density of 200 pounds per cubic foot with a maximum earth pressure of 2,000 pounds per square foot. Unless covered by pavement or concrete slabs, the upper 12 inches of soil should not be considered in computing lateral resistance.

Retaining Walls

Retaining wall foundations may be designed using recommendations presented in the *Foundations, Seismic Design,* and *Lateral Design* sections of this report.

For active earth pressure considerations, equivalent fluid pressures of 40 and 50 pounds per cubic foot may be used for level and sloping backfill conditions, respectively. An equivalent fluid pressure of 55 pounds per cubic foot may be used for restrained conditions.

Both the onsite soils and imported structural fill may be used for backfill behind new retaining walls. Backfill should be compacted in lifts to between 90 and 95 percent compaction as determined by ASTM D 1557. Overcompaction of the backfill material should be avoided.

To prevent buildup of hydrostatic pressures, retaining walls should be well-drained. The standard of practice consists of placing a minimum 12-inch thick layer of free-draining gravel at the back of the wall. The gravel should extend from the base of the wall, around subdrains or weepholes, and up to within 12 inches of finish grade.

Alternatively, prefabricated drainage geocomposites, such as Miradrain or J-drain, may be used in lieu of the free-draining gravel. As with the free-draining gravel, the drainage geocomposites should be placed at the back of the wall, be connected with the weepholes and/or subdrains (in accordance with manufacturers specifications), and extend to within 12 inches of finish grade. For freestanding walls, the drainage system should be covered by at least 12 inches of low permeability soil, such as the onsite clayey silt. If the backfill is covered by interior or exterior concrete slabs, the gravel fill should extend to the bottom of slab cushion elevation.

Foundation Settlement

Maximum column loads of about 88 kips are anticipated. Based on the estimated structural loads, maximum settlements of less than ½ inch were computed for foundations bearing on a minimum 24 inches of compacted granular structural fill. Differential settlement is not expected to exceed 1/4 inch.

Slabs-on-Grade

Due to the firm to medium stiff condition of the completely weathered basalt and to provide more uniform support, we recommend that the tank slab be underlain by a minimum 24 inches of imported granular fill. The upper six inches of the granular

fill should consist of aggregate base course. The remainder of the fill section should consist of granular structural fill. The tank slab should also be protected by a vapor barrier.

Prior to placement of granular structural fill, the subgrade soil should be scarified to a minimum depth of 6 inches, moisture conditioned to about 2 percent above optimum moisture content, and compacted to between 90 and 95 percent compaction as determined by ASTM D 1557. The overlying granular structural fill and aggregate base course should be compacted to a minimum 95 percent compaction as determined by ASTM D 1557.

Pavement Design

Flexible pavement for the perimeter road may be designed based on the following section:

2.0"	Asphaltic Concrete
6.0"	Base Course (minimum CBR = 85)
6.0"	Select Borrow (minimum CBR = 25)
14.0"	Total Thickness

Prior to placement of the select borrow, the exposed subgrade soil should be scarified to a minimum depth of 6 inches, moisture conditioned to about 2 percent above optimum moisture content, and compacted to between 90 and 95 percent compaction as determined by ASTM D 1557. The select borrow and base course should be compacted to a minimum 95 percent compaction as determined by ASTM D 1557.

Site Grading

Site Preparation - The project site should be cleared of all vegetation, AC pavement, concrete footings and slabs, and other deleterious material. In areas requiring fill placement, the exposed subgrade should first be scarified to a minimum depth of 6 inches, moisture conditioned to about 2 percent above optimum moisture content,

and compacted to between 90 and 95 percent compaction as determined by ASTM D 1557.

Structural Excavations - Based on our exploratory borings, we believe that excavations into the surface clayey silt and completely weathered basalt can be accomplished using conventional excavating equipment.

Temporary shallow cuts into the near surface soils should be stable at slope gradients of 1H:1V or flatter. However, it should be the Contractor's responsibility to conform to all OSHA safety standards for excavations.

Onsite Fill Material - The onsite soils will be acceptable for reuse in compacted fills and backfills, except in the imported granular fill section recommended below foundations and slabs-on-grade. All rock fragments larger than 3 inches in maximum dimension should be removed from the onsite soils prior to reuse.

Imported Fill Material - Imported structural fill should be well-graded, non-expansive granular material. Specifications for imported granular structural fill should indicate a maximum particle size of 3 inches, and state that between 8 and 20 percent of soil by weight shall pass the #200 sieve. In addition, the plasticity index (P.I.) of that portion of the soil passing the #40 sieve shall not be greater than 10. Granular structural fill should also have a minimum CBR value of 15 and a CBR expansion value less than 1.0 percent when tested in accordance with ASTM D 1883.

Compaction - The onsite soils should be placed in horizontal lifts restricted to eight inches in loose thickness and compacted to between 90 and 95 percent compaction as determined by ASTM D 1557. Imported granular structural fill, should also be placed in horizontal lifts restricted to eight inches in loose thickness, but compacted to a minimum 95 percent compaction as determined by ASTM D 1557.

Fill placed in areas which slope steeper than 5H:1V should be continually benched as the fill is brought up in lifts.

Slope Gradients - Permanent cut slopes should be stable at gradients of 1.5H:1V or flatter. All slopes should be planted as soon as practical upon completion of grading to reduce the effects of erosion and weathering.

ADDITIONAL SERVICES

We recommend that we perform a general review of the final design plans and specifications. This will allow us to verify that the foundation design and earthwork recommendations have been properly interpreted and implemented in the design plans and construction specifications.

For continuity, we recommend that we be retained during construction to (1) observe footing excavations prior to placement of imported granular fill, reinforcing steel and concrete, (2) review and/or perform laboratory testing on import borrow to determine its acceptability for use in compacted fills, (3) observe structural fill placement and perform compaction testing, and (4) provide geotechnical consultation as required. Our services during construction will allow us to verify that our recommendations are properly interpreted and included in construction, and if necessary, to make modifications to those recommendations, thereby reducing construction delays in the event subsurface conditions differ from those anticipated.

LIMITATIONS

The boring logs indicate the approximate subsurface soil conditions encountered only at those times and locations where our borings were made, and may not represent conditions at other times and locations.

This report was prepared specifically for Kodani & Associates, Inc. and their sub-consultants for design of the proposed 1.0 MG Water Tank in Kilauea, Kauai,

Hawaii. The boring logs, laboratory test results, and recommendations presented in this report are for design purposes only, and are not intended for use in developing cost estimates by the contractor.

During construction, should subsurface conditions differ from those encountered in our borings, we should be advised immediately in order to re-evaluate our recommendations, and to revise or verify them in writing before proceeding with construction.

Our recommendations and conclusions are based upon the site materials observed, the preliminary design information made available, the data obtained from our site exploration, our engineering analyses, and our experience and engineering judgement. The conclusions and recommendations in this report are professional opinions which we have strived to develop in a manner consistent with that level of care, skill, and competence ordinarily exercised by members of the profession in good standing, currently practicing under similar conditions in the same locality. We will be responsible for those recommendations and conclusions, but will not be responsible for the interpretation by others of the information developed. No warranty is made regarding the services performed, either express or implied.

Respectfully submitted,

HIRATA & ASSOCIATES, INC.

Stephen Jo, Project Engineer

Rick Yoshida, Project Manager

This work was prepared by
me or under my supervision
Expiration Date of License:
April 30, 2012

APPENDIX A

FIELD INVESTIGATION

DESCRIPTION OF FIELD INVESTIGATION

GENERAL

The site was explored on February 1, 6 and 7, 2012, by performing a visual reconnaissance of the site and drilling four test borings to depths ranging from about 25.5 to 44.5 feet with a Mobile B40-L12 truck-mounted drill rig and a portable Concore drilling equipment.

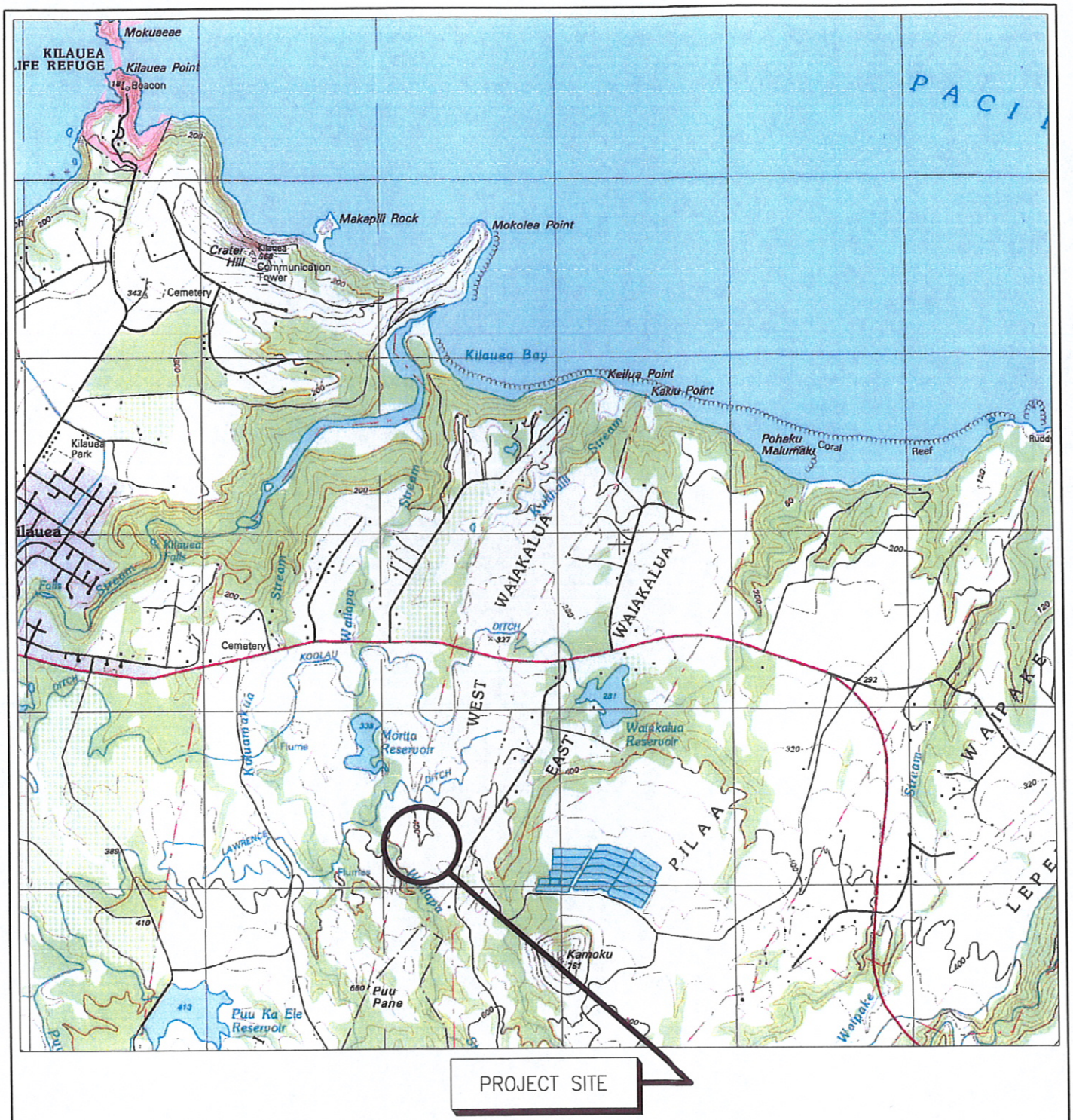
During drilling operations, the soils were continuously logged by our field engineer and classified by visual examination in accordance with the Unified Soil Classification System. The boring logs indicate the depths at which the soils or their characteristics change, although the change could actually be gradual. If the change occurred between sample locations, the depth was interpreted based on field observations. Classifications and sampling intervals are shown on the boring log. A Boring Log Legend is presented on Plate A3.1. The Unified Soil Classification and Rock Weathering Classification Systems are shown on Plates A3.2 and A3.3, respectively. The soils encountered are logged on Plates A4.1 through A4.6.

Borings were located in the field by measuring/taping offsets from existing site features shown on the plans. Surface elevations at boring locations were estimated based on the Site Plan provided by Kodani & Associates, Inc. The accuracy of the boring locations shown on Plate A2.2 and the boring elevations shown on Plates A4.1 through A4.6 are therefore approximate, in accordance with the field methods used.

SOIL SAMPLING

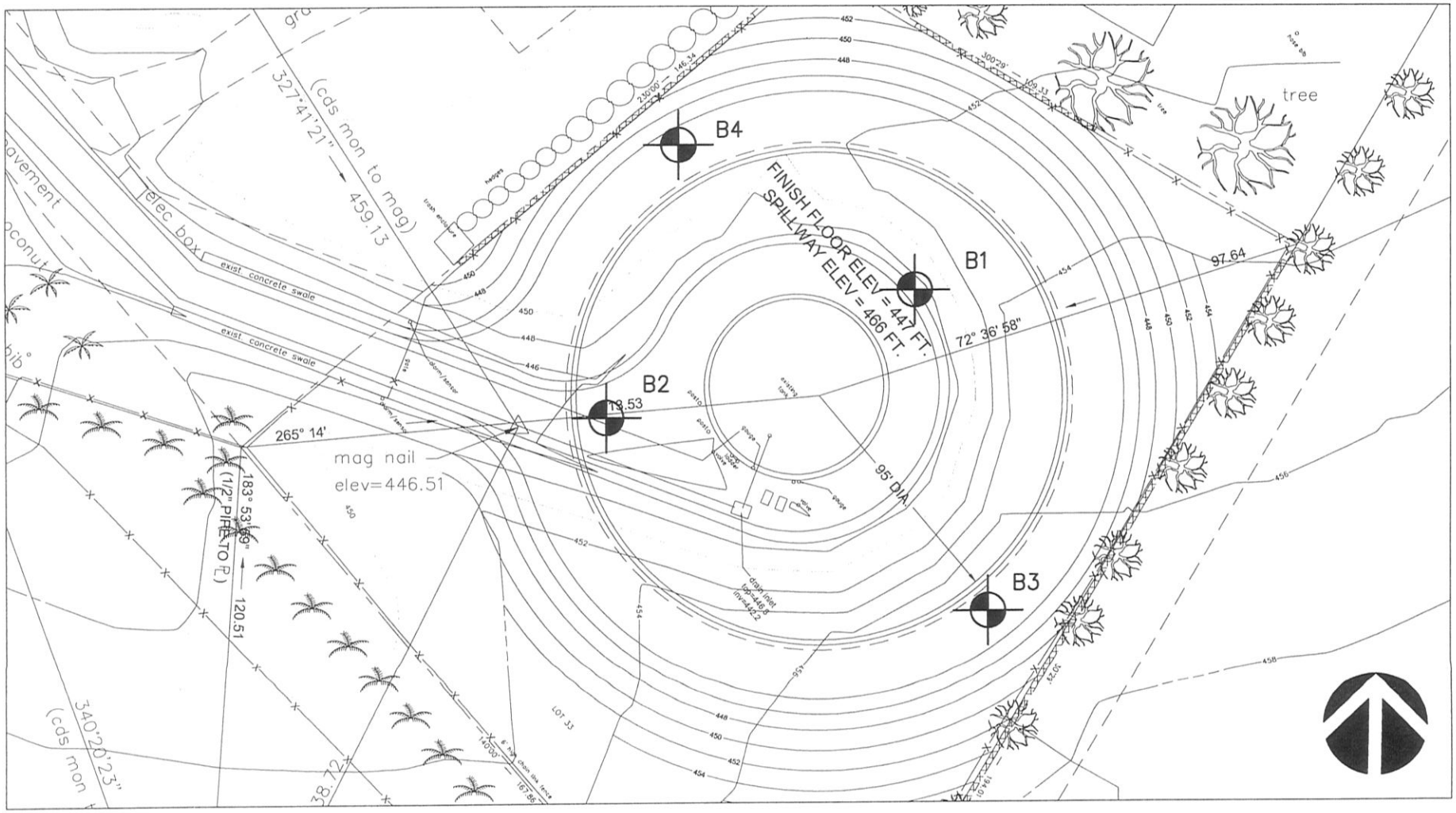
Representative and bulk soil samples were recovered from the borings for selected laboratory testing and analyses. Representative samples were recovered by driving a 3-inch O.D. split tube sampler a total of 18 inches with a 140-pound hammer

dropped from a height of 30 inches. The number of blows required to drive the sampler the final 12 inches are recorded at the appropriate depths on the boring logs, unless noted otherwise. A bulk soil sample was recovered from near boring B2 at a depth of about 2 feet below ground surface.



Reference: U.S.G.S. Anahola Quadrangle, Hawaii–Kauai Co.
7.5–Minute Series, Topographic, 1996

W.O. 12-5271	1.0 MG Water Tank – Kilauea, Kauai
Hirata & Associates, Inc.	LOCATION MAP Plate A2.1



GRAPHIC SCALE:

0 15 30 60 FT.

1" = 30'

LEGEND:

Approximate location of borings

Reference: Topographic Survey Map provided by Kodani & Associates, Inc., on 2/01/2012.

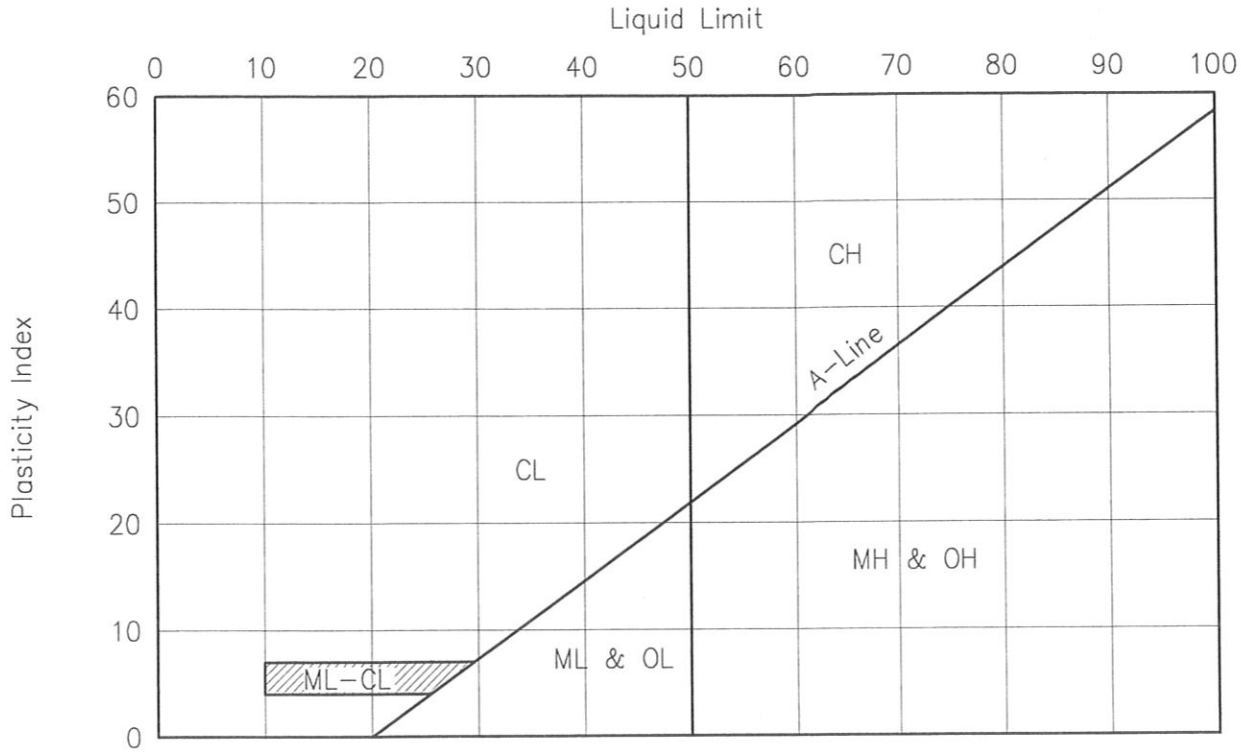
W.O. 12-5271	1.0 MG Water Tank - Kilauea, Kauai
Hirata & Associates, Inc.	BORING LOCATION PLAN Plate A2.2

MAJOR DIVISIONS			GROUP SYMBOLS		TYPICAL NAMES
COARSE GRAINED SOILS (More than 50% of the material is LARGER than No. 200 sieve size.)	GRAVELS (More than 50% of coarse fraction is LARGER than the No. 4 sieve size.)	CLEAN GRAVELS (Little or no fines.)		GW	Well graded gravels, gravel–sand mixtures, little or no fines.
				GP	Poorly graded gravels or gravel–sand mixtures, little or no fines.
		GRAVELS WITH FINES (Appreciable amt. of fines.)		GM	Silty gravels, gravel–sand–silt mixtures.
				GC	Clayey gravels, gravel–sand–clay mixtures.
	SANDS (More than 50% of coarse fraction is SMALLER than the No. 4 sieve size.)	CLEAN SANDS (Little or no fines.)		SW	Well graded sands, gravelly sands, little or no fines.
				SP	Poorly graded sands or gravelly sands, little or no fines.
		SANDS WITH FINES (Appreciable amt. of fines.)		SM	Silty sands, sand–silt mixtures.
				SC	Clayey sands, sand–clay mixtures.
FINE GRAINED SOILS (More than 50% of the material is SMALLER than No. 200 sieve size.)	SILTS AND CLAYS (Liquid limit LESS than 50.)			ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
				CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
				OL	Organic silts and organic silty clays of low plasticity.
	SILTS AND CLAYS (Liquid limit GREATER than 50.)			MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
				CH	Inorganic clays of high plasticity, fat clays.
				OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS				PT	Peat and other highly organic soils.
					FRESH TO MODERATELY WEATHERED BASALT
					VOLCANIC TUFF / HIGHLY TO COMPLETELY WEATHERED BASALT
					CORAL

SAMPLE DEFINITION		
2" O.D. Standard Split Spoon Sampler	Shelby Tube	RQD Rock Quality Designation
3" O.D. Split Tube Sampler	NX / 4" Coring	Water Level

W.O. 12-5271	1.0 MG Water Tank – Kilauea, Kauai
Hirata & Associates, Inc.	BORING LOG LEGEND Plate A3.1

PLASTICITY CHART



GRADATION CHART

COMPONENT DEFINITIONS BY GRADATION	
COMPONENT	SIZE RANGE
Boulders	Above 12 in.
Cobbles	3 in. to 12 in.
Gravel	3 in. to No. 4 (4.76 mm)
Coarse gravel	3 in. to 3/4 in.
Fine gravel	3/4 in. to No. 4 (4.76 mm)
	No. 4 (4.76 mm) to No. 200 (0.074 mm)
Coarse sand	No. 4 (4.76 mm) to No. 10 (2.0 mm)
Medium sand	No. 10 (2.0 mm) to No. 40 (0.42 mm)
Fine sand	No. 40 (0.42 mm) to No. 200 (0.074 mm)
Silt and clay	Smaller than No. 200 (0.074 mm)

W.O. 12-5271	1.0 MG Water Tank - Kilauea, Kauai
Hirata & Associates, Inc.	UNIFIED SOIL CLASSIFICATION SYSTEM Plate A3.2

Grade	Symbol	Description
Fresh	F	No visible signs of decomposition or discoloration. Rings under hammer impact.
Slightly Weathered	WS	Slight discoloration inwards from open fractures, otherwise similar to F.
Moderately Weathered	WM	Discoloration throughout. Weaker minerals such as feldspar decomposed. Strength somewhat less than fresh rock but cores cannot be broken by hand or scraped by knife. Texture preserved.
Highly Weathered	WH	Most minerals somewhat decomposed. Specimens can be broken by hand with effort or shaved with knife. Core stones present in rock mass. Texture becoming indistinct but fabric preserved.
Completely Weathered	WC	Minerals decomposed to soil but fabric and structure preserved (Saprolite). Specimens easily crumbled or penetrated.
Residual Soil	RS	Advanced state of decomposition resulting in plastic soils. Rock fabric and structure completely destroyed. Large volume change.

Reference: Soils Mechanics, NAVFAC DM-7.1, Department of the Navy, Naval Facilities Engineering Command, September, 1986.

W.O. 12-5271	1.0 MG Water Tank - Kilauea, Kauai
Hirata & Associates, Inc.	ROCK WEATHERING CLASSIFICATION SYSTEM Plate A3.3

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BORING LOG

W.O. 12-5271

BORING NO. B1 DRIVING WT. 140 lb. START DATE 2/1/2012

SURFACE ELEV. 446±* DROP 30 in. END DATE 2/1/2012

DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						COMPLETELY WEATHERED BASALT (WC) – Reddish brown and brown, moist, firm. Covered by 2 inches of AC over 7 inches of base material.
			10	79	36	
			8	Sample Disturbed	44	
5			5	69	43	
10			12	69	40	Medium stiff from 9 feet.
15			12	70	51	
20			17	64	59	
▽						Seepage water encountered at 23.8 feet on 2/1/2012 at 4:55 p.m.
25			20	61	59	
						End boring at 25.5 feet.
30						* Elevations based on Tophographic Survey Map provided by Kodani & Associates.

Plate A4.1

HIRATA & ASSOCIATES, INC.

Geotechnical Engineering

BORING LOG

W.O. 12-5271

BORING NO. B2 DRIVING WT. 140 lb. START DATE 2/1/2012

SURFACE ELEV. 446± DROP 30 in. END DATE 2/7/2012

DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						COMPLETELY WEATHERED BASALT (WC) – Reddish brown and brown, moist, firm. Covered by 2.5 inches of AC over 8 inches of base material.
			5	63	47	
5			6	68	46	
			7	67	52	
10						
			12	64	59	Medium stiff from 13 feet.
15						
			20	71	50	
20						
			24	66	60	
25						Seepage water encountered at 25.2 feet on 2/7/2012 at 11:00 a.m.
			14	63	65	
30						

Plate A4.2

HIRATA & ASSOCIATES, INC.

Geotechnical Engineering

BORING LOG

W.O. 12-5271

BORING NO. B2 (continued) DRIVING WT. 140 lb. START DATE 2/1/2012

SURFACE ELEV. 446± DROP 30 in. END DATE 2/7/2012

DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
30						
		□	5	55	77	Firm at 33 feet.
35						
		□	14	57	74	
40						End boring at 39.5 feet.
45						
50						
55						
60						

Plate A4.3

HIRATA & ASSOCIATES, INC.

Geotechnical Engineering

BORING LOG

W.O. 12-5271

BORING NO. B3 DRIVING WT. 140 lb. START DATE 2/1/2012

SURFACE ELEV. 456.3± DROP 30 in. END DATE 2/1/2012

DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						
			18	77	43	Clayey SILT (MH) – Reddish brown, moist, medium stiff. Covered by 3 inches of gravel.
			21	82	43	
5			11	83	40	COMPLETELY WEATHERED BASALT (WC) – Reddish brown and brown, moist, medium stiff.
10			16	78	46	
15			11	80	41	
20			28	84	38	Stiff from 19 feet.
25			27	64	59	
30			49	68	52	End boring at 30.5 feet.

Plate A4.4

HIRATA & ASSOCIATES, INC.

Geotechnical Engineering

BORING LOG

W.O. 12-5271

BORING NO. B4 DRIVING WT. 140 lb. START DATE 2/06/2012

SURFACE ELEV. 450± DROP 30 in. END DATE 2/06/2012

DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
0						Clayey SILT (MH) – Brown, moist, medium stiff.
5			32	Sample Disturbed	34	Stiff at 4 feet.
10			12	68	59	Slightly wet at 8 feet.
15						
20			27	75	44	COMPLETELY WEATHERED BASALT (WC) – Reddish and brown, moist, medium stiff.
25			13	65	60	Slightly wet from 23 feet.
30 ▽			20	68	59	Seepage water encountered at 29.8 feet on 2/06/2012 at 8:45 a.m.

Plate A4.5

HIRATA & ASSOCIATES, INC.

Geotechnical Engineering

BORING LOG

W.O. 12-5271

BORING NO. B4 (continued) DRIVING WT. 140 lb. START DATE 2/06/2012

SURFACE ELEV. 250± DROP 30 in. END DATE 2/06/2012

DEPTH	GRAPH	SAMPLE	BLOWS PER FOOT	DRY DENSITY (PCF)	MOIST. CONT. (%)	DESCRIPTION
30						
		☐	5	60	72	Firm from 33 feet.
35						
		☐	7	60	71	
40						
		☐	7	54	70	
45						End boring at 44.5 feet.
50						
55						
60						

Plate A4.6

APPENDIX B

LABORATORY TESTING

DESCRIPTION OF LABORATORY TESTING

CLASSIFICATION

Field classification was verified in the laboratory in accordance with the Unified Soil Classification System. Laboratory classification was determined by visual examination. The final classifications are shown at the appropriate locations on the Boring Logs, Plates A4.1 through A4.6.

MOISTURE-DENSITY

Representative samples were tested for field moisture content and dry unit weight. The dry unit weight was determined in pounds per cubic foot while the moisture content was determined as a percentage of dry weight. Samples were obtained using a 3-inch O.D. split tube sampler. Test results are shown at the appropriate depths on the Boring Logs, Plates A4.1 through A4.6.

CONSOLIDATION

Selected representative samples were tested for their consolidation characteristics. Test samples were 2.42 inches in diameter and 1 inch high. Porous stones were placed in contact with the top and bottom of test samples to permit addition and release of pore fluid. Loads were then applied in several increments in a geometric progression, and the resulting deformations recorded at selected time intervals. Test results are plotted on the Consolidation Test Reports, Plates B2.1 through B2.3.

SHEAR TESTS

Shear tests were performed in the Direct Shear Machine which is of the strain control type. Each sample was sheared under varying confining loads in order to determine the Coulomb shear strength parameters, cohesion and angle of internal friction. Test results are presented on Plates B3.1 through B3.4.

SWELL TESTS

Swell tests were performed on representative soil samples by placing a 90 psf surcharge load on one-inch high specimens. The samples were inundated with water, and total expansion recorded after a period of at least 24 hours. Test results were recorded as a percentage of original height. Test results are summarized in the following table:

Sample	Sample Type	Recorded Expansion	Moisture Content Prior to Test
B1 @ 1'	Representative	0.1%	36%
B2 @ 2'	Representative	0.1%	47%

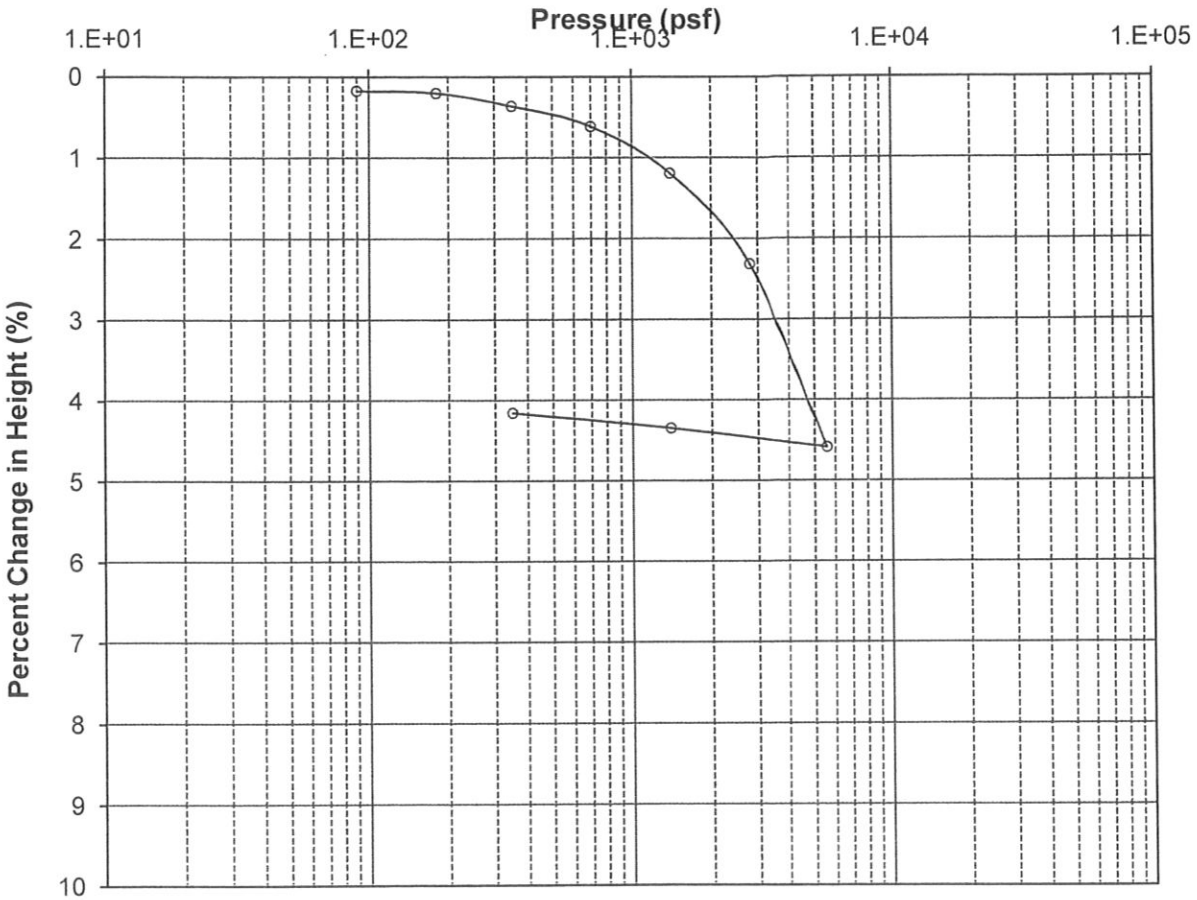
PROCTOR TESTS

A Modified Proctor test was performed in general accordance with ASTM D 1557 on a bulk soil sample obtained from near boring B2 at a depth of about 2 feet below existing grade. The test is used to determine the optimum moisture content at which the soil compacts to 100 percent density. Results are shown on Plate B4.1.

CALIFORNIA BEARING RATIO TEST

A CBR test was performed in general accordance with ASTM D 1883 on a bulk soil sample obtained from near boring B2 at a depth of about 2 feet below existing grade. The test is used to evaluate the relative quality of subgrade soils to be used in the design of flexible pavements. Results are shown on Plate B5.1.

Consolidation Test Results



Sample Description

Boring No.: B1 Depth (ft): 5

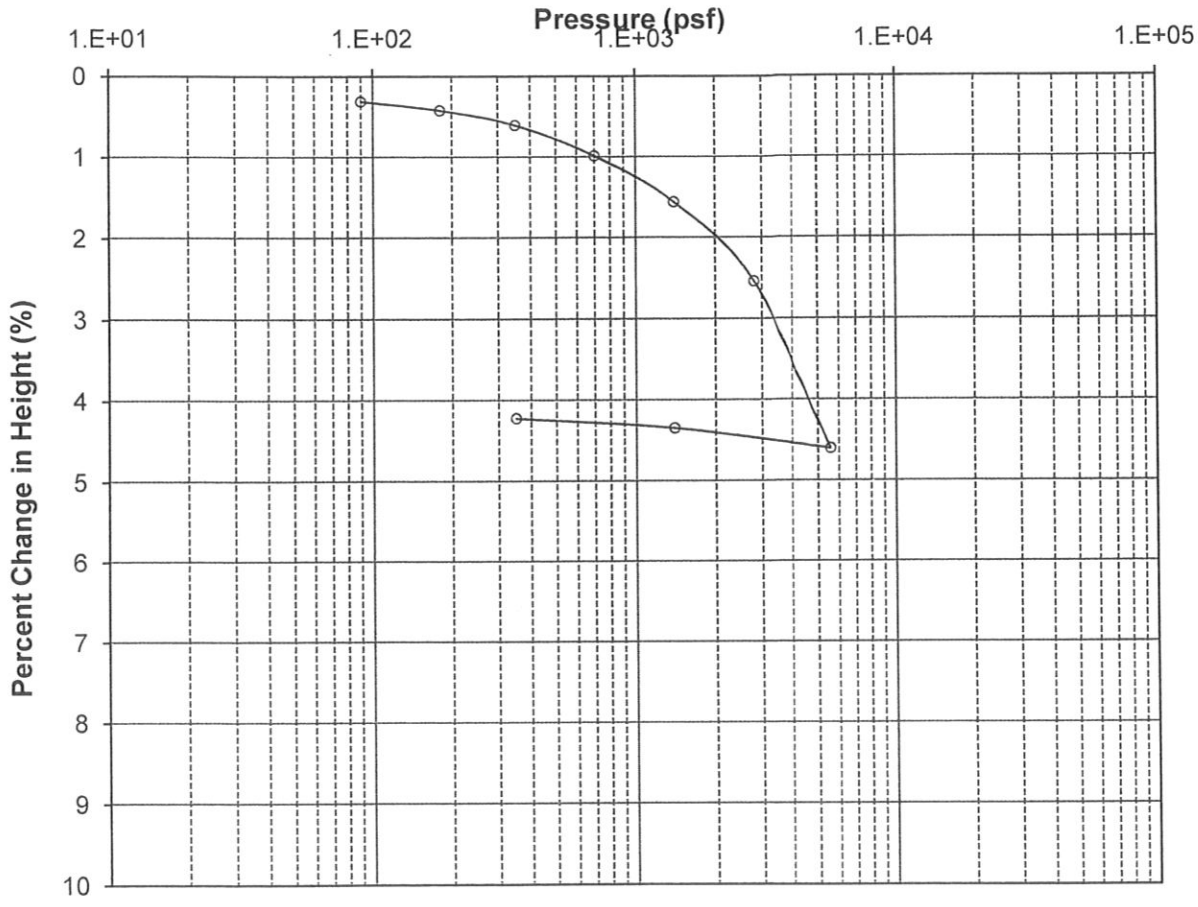
Soil Description: Reddish brown clayey silt

	Moisture Content (%)	Dry Density (pcf)
Initial	43.3	68.6
Final	41.2	71.6

Remark: 2/9/12

W.O. 12-5271	1.0 MG Water Tank - Kilauea, Kauai
Hirata & Associates, Inc.	CONSOLIDATION TEST Plate B2.1

Consolidation Test Results



Sample Description

Boring No.: B2 Depth (ft): 8

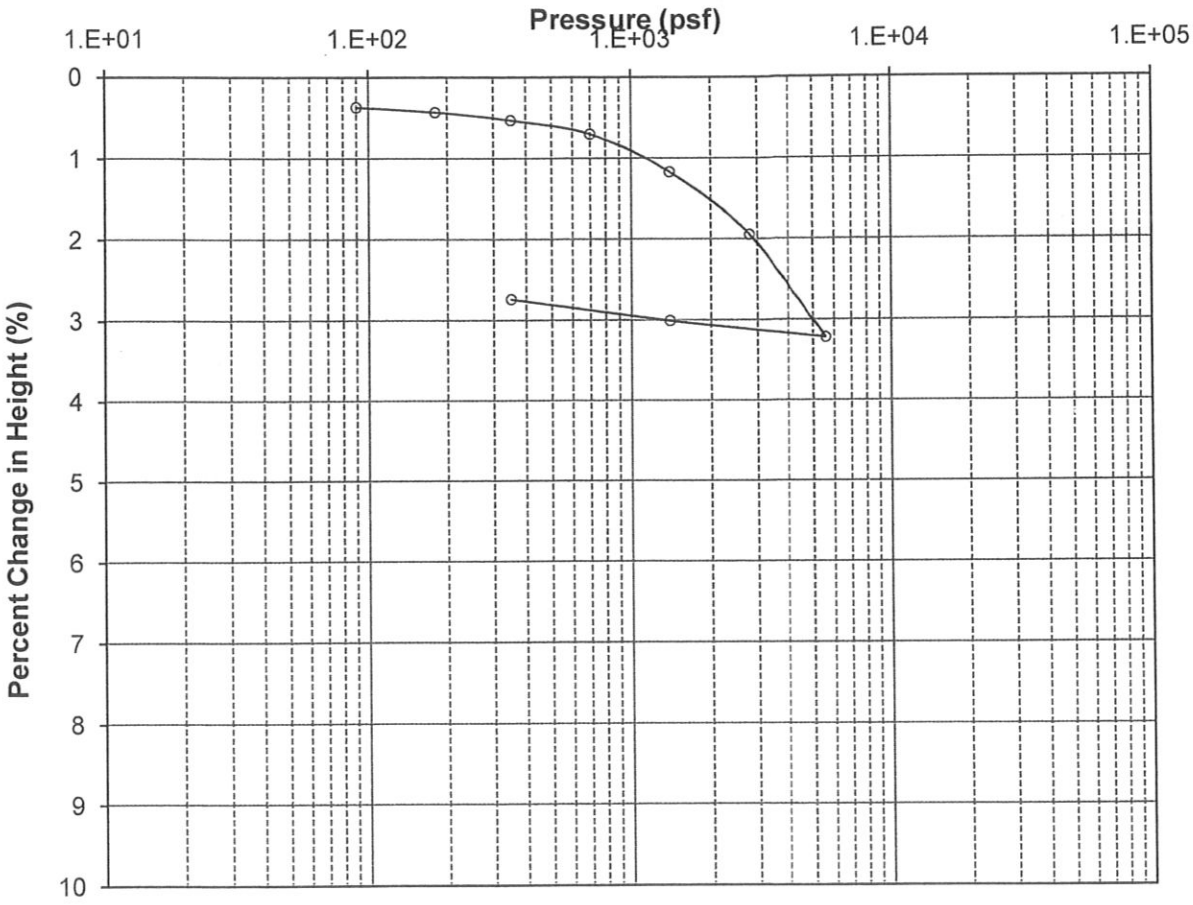
Soil Description: Reddish brown clayey silt

	Moisture Content (%)	Dry Density (pcf)
Initial	51.6	67.2
Final	49.8	70.2

Remark: 2/10/12

W.O. 12-5271	1.0 MG Water Tank - Kilauea, Kauai
Hirata & Associates, Inc.	**CONSOLIDATION TEST** Plate B2.2

Consolidation Test Results



Sample Description

Boring No.: B4 Depth (ft): 18

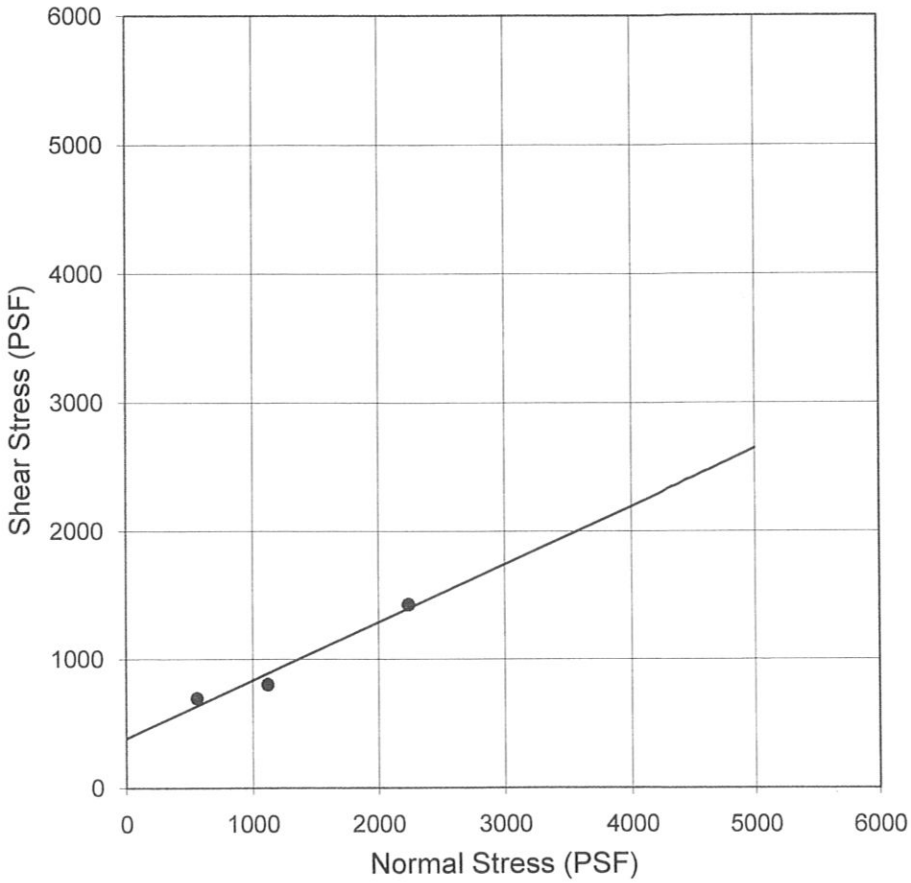
Soil Description: Reddish brown clayey silt

	Moisture Content (%)	Dry Density (pcf)
Initial	44.4	75.0
Final	44.2	77.1

Remark: 2/10/12

W.O. 12-5271	1.0 MG Water Tank - Kilauea, Kauai
Hirata & Associates, Inc.	**CONSOLIDATION TEST** Plate B2.3

Direct Shear Test Results



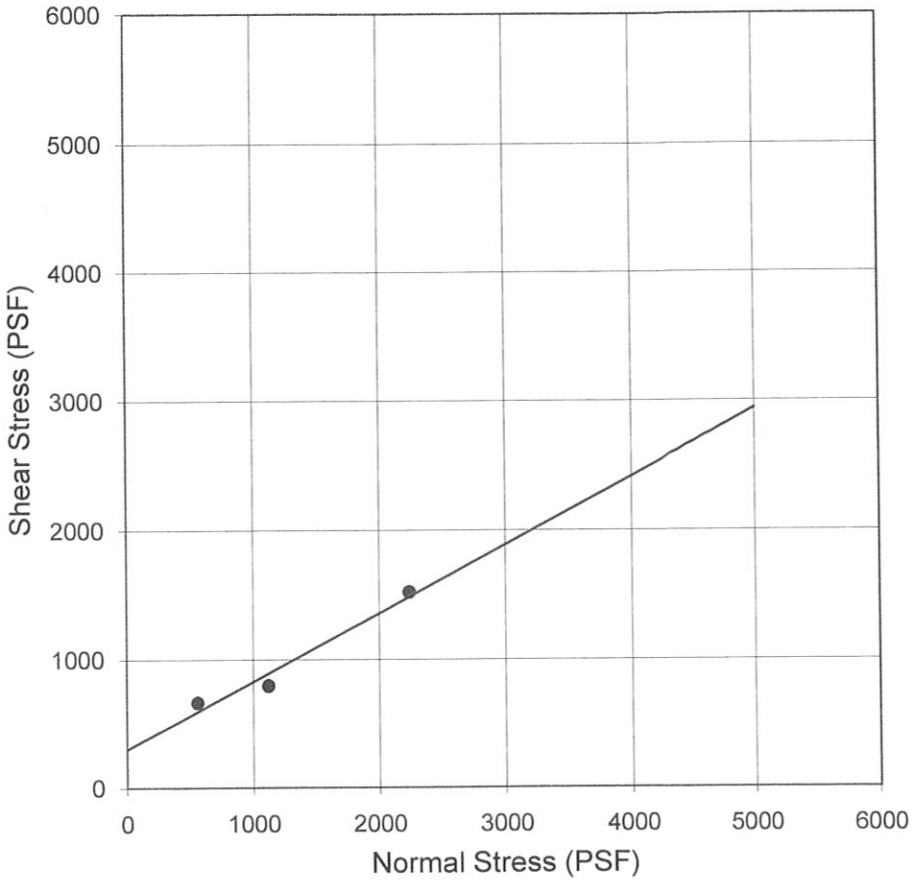
Sample Description

Boring No.: B1 Depth (ft): 5
Soil Description: Reddish brown clayey silt
Strength Intercept (C): 385.0 PSF
Friction Angle (ϕ): 24.4 DEG

Remark: 2/11/2012

W.O. 12-5271	1.0 MG Water Tank - Kilauea, Kauai
Hirata & Associates, Inc.	DIRECT SHEAR TEST Plate B3.1

Direct Shear Test Results



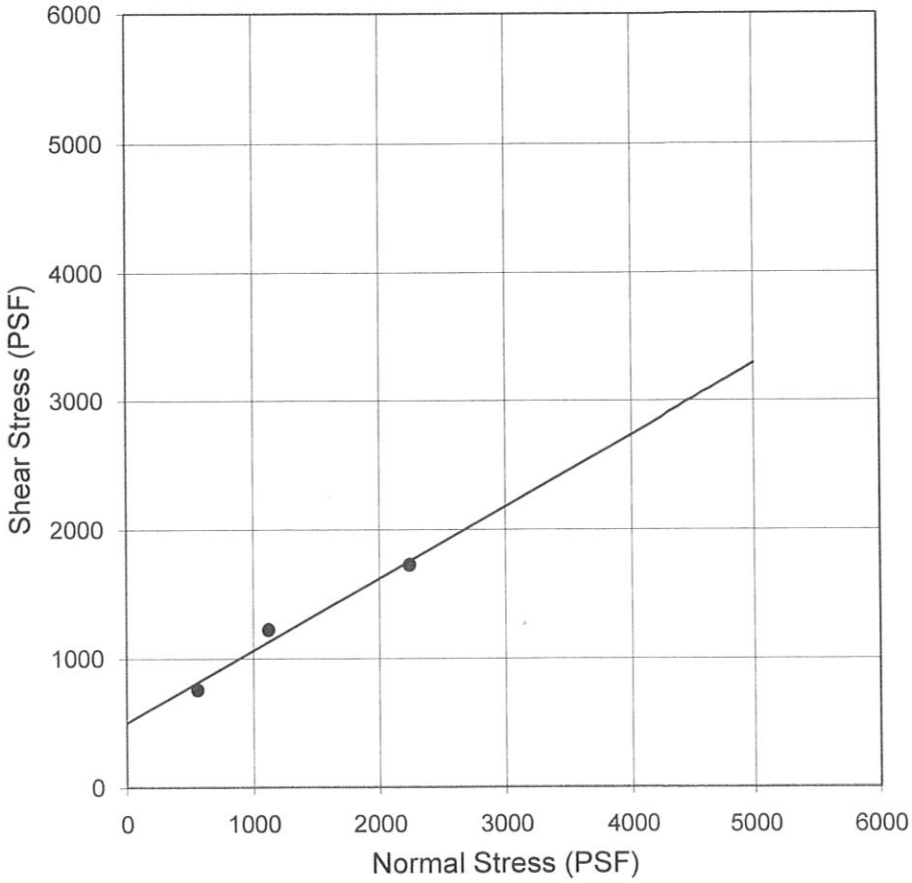
Sample Description

Boring No.: B2 Depth (ft): 4
Soil Description: Reddish brown clayey silt
Strength Intercept (C): 305.1 PSF
Friction Angle (ϕ): 27.8 DEG

Remark: 2/27/2012

W.O. 12-5271	1.0 MG Water Tank - Kilauea, Kauai
Hirata & Associates, Inc.	**DIRECT SHEAR TEST** Plate B3.2

Direct Shear Test Results



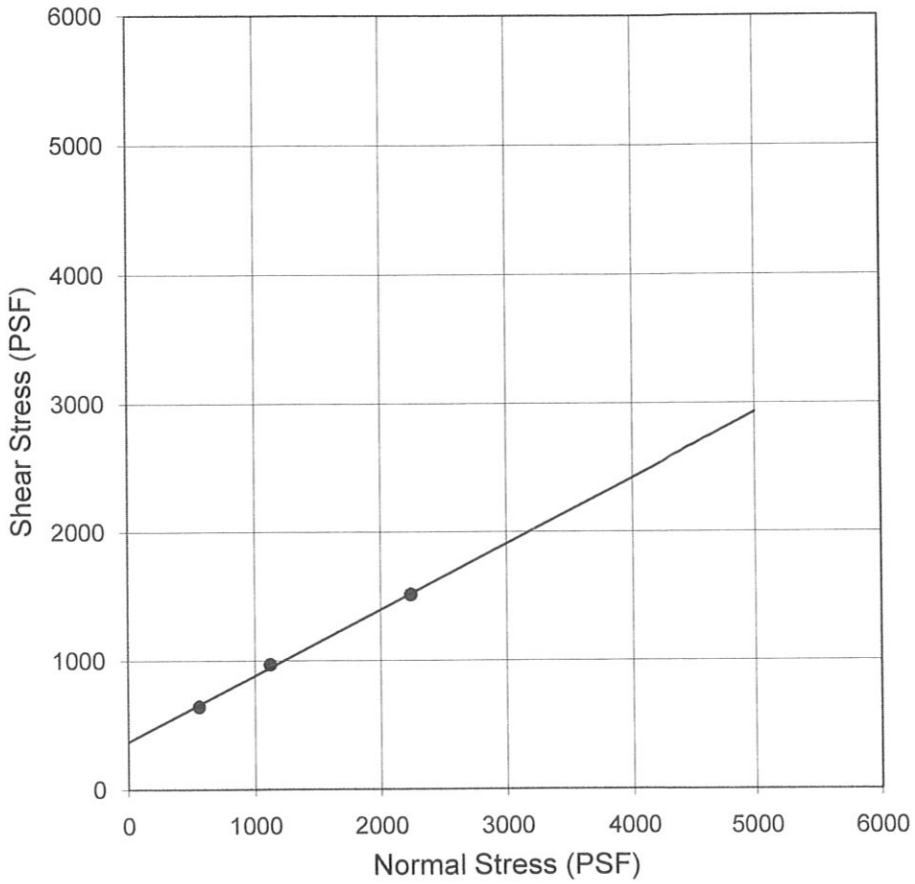
Sample Description

Boring No.: B3 Depth (ft): 14
Soil Description: Reddish brown clayey silt
Strength Intercept (C): 506.9 PSF
Friction Angle (ϕ): 29.1 DEG

Remark: 2/27/2012

W.O. 12-5271	1.0 MG Water Tank - Kilauea, Kauai
Hirata & Associates, Inc.	**DIRECT SHEAR TEST** Plate B3.3

Direct Shear Test Results

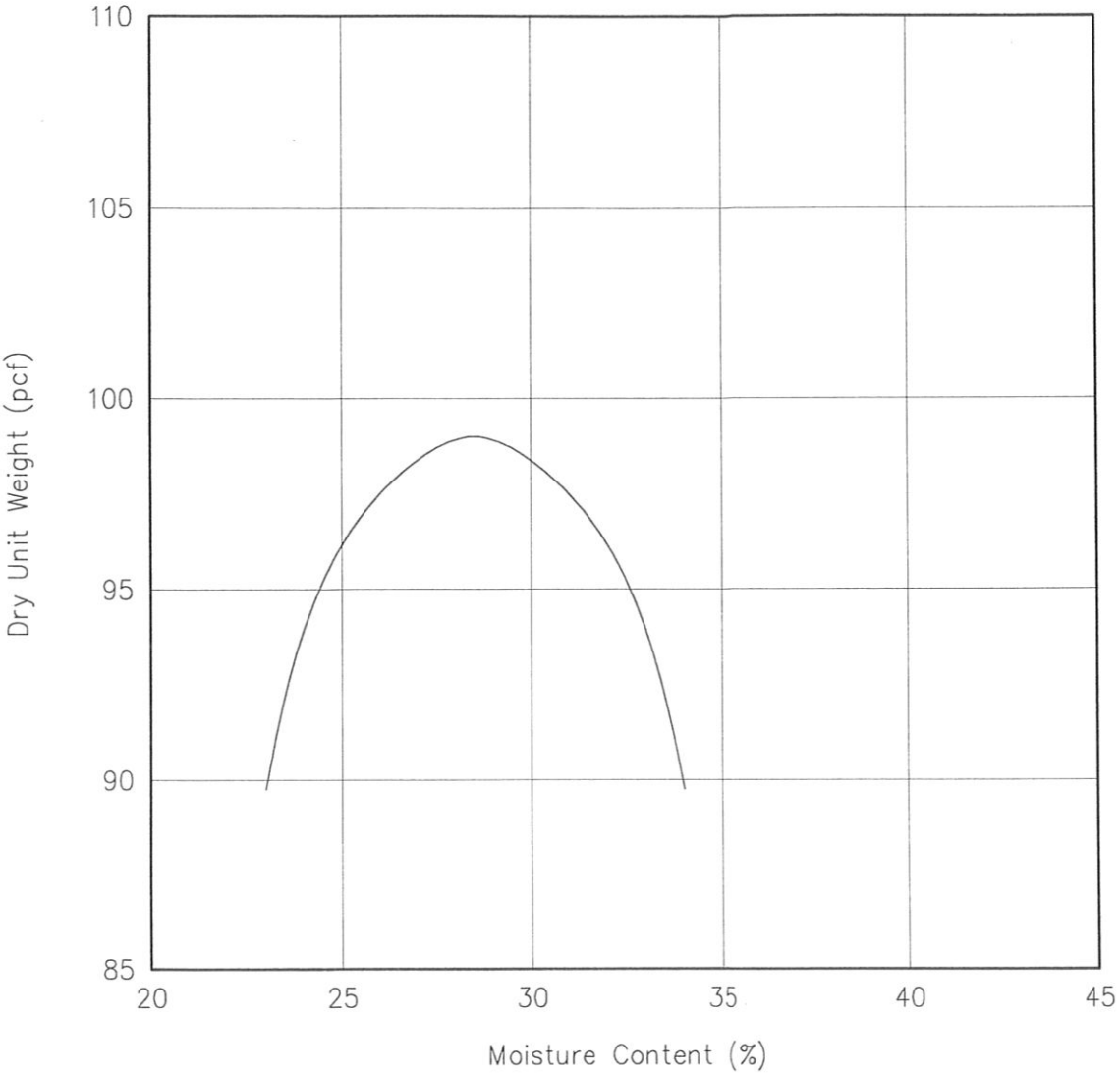


Sample Description

Boring No.: B4 Depth (ft): 4
Soil Description: Reddish brown clayey silt
Strength Intercept (C): 373.6 PSF
Friction Angle (ϕ): 27.1 DEG

Remark: 2/27/2012

W.O. 12-5271	1.0 MG Water Tank - Kilauea, Kauai
Hirata & Associates, Inc.	DIRECT SHEAR TEST Plate B3.4



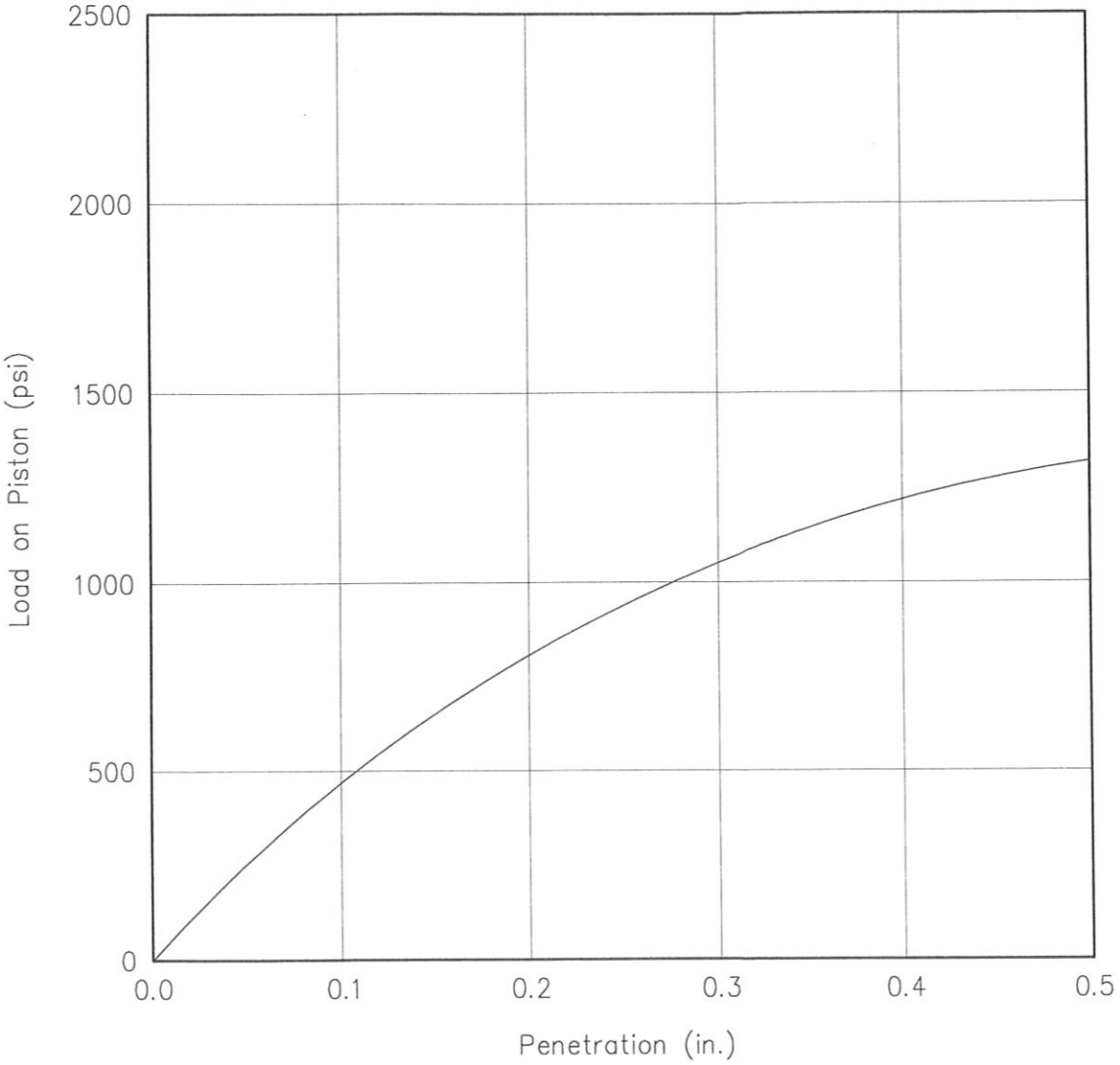
Soil Data

Location: Near boring B2 at 2 feet
Description: Reddish brown clayey silt

Test Results

Maximum Dry Density: 99 pcf
Optimum Moisture Content: 28.5%

W.O. 12-5271	1.0 MG Water Tank - Kilauea, Kauai
Hirata & Associates, Inc.	MODIFIED PROCTOR CURVE Plate B4.1



Soil Data

Location:	Near boring B2 at 2 feet
Description:	Reddish brown clayey silt
Sample Dry Density:	97.5 pcf
Sample Moisture Content:	31%

Test Results

CBR Value:	46%
Expansion:	0.2%

W.O. 12-5271	1.0 MG Water Tank - Kilauea, Kauai
Hirata & Associates, Inc.	CBR STRESS PENETRATION CURVE Plate B5.1