GEOTECHNICAL INVESTIGATION
WAIMEA HOMESTEAD AGRICULTURAL PARK
DEPARTMENT OF HAWAIIAN HOME LANDS
PUUKAPU, WAIMEA,
KOHALA WAHO, HAWAII ISLAND
TMK: (3) 6-4-38: 011

for

SSFM INTERNATIONAL, INC.

HIRATA & ASSOCIATES, INC.
W.O. 16-5925
May 13, 2016

Hirata & Associates
Geotechnical Engineering
Hirata & Associates, Inc.
99-1433 Koaha Pl
Aiea, HI 96701
tel 808.486.0787
fax 808.486.0870

May 13, 2016
W.O. 16-5925

Mr. Austen Drake
SSFM International, Inc.
99 Aupuni Street, Suite 202
Hilo, Hawaii 96720

Dear Mr. Drake:

Our report, "Geotechnical Investigation, Waimea Homestead Agricultural Park, Department of Hawaiian Home Lands, Puukapu, Waimea, Kohala Waho, Hawaii Island, TMK: (3) 6-4-38: 011," dated May 13, 2016, our Work Order 16-5925 is enclosed. This investigation was conducted in general conformance with the scope of services presented in our proposal dated February 18, 2016.

Our borings encountered surface soil classified as brown clayey silt with gravel. The clayey silt was in a medium stiff to stiff condition and extended to depths ranging from about 4 to 9 feet below ground surface. Laboratory testing, as well as our past experience near the project area, indicates that the surface clayey silt has a collapsing type structure with the addition of water. This is typical of soils derived from volcanic ash, which is also characterized by poor workability and moderate to high compressibility. Underlying the clayey silt was highly to moderately weathered basalt, extending to the maximum depths drilled. Neither groundwater nor seepage water was encountered.

From a geotechnical viewpoint, it is our opinion that the project site can generally be developed as planned. Due to the collapsing type structure of the onsite clayey silt/volcanic ash, additional site preparation work consisting of placing a minimum 36 inches of imported granular structural fill beneath the tank mat foundations is recommended. Additional geotechnical recommendations for design of the water tanks, underground water lines, gravel roads, and mass grading are included in this report.

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 President

PSM:TS

TABLE OF CONTENTS

APPENDICES

APPENDIX A

APPENDIX B

APPENDIX C

GEOTECHNICAL INVESTIGATION
WAIMEA HOMESTEAD AGRICULTURAL PARK
DEPARTMENT OF HAWAIIAN HOME LANDS
PUUKAPU, WAIMEA, KOHALA WAHO, HAWAII ISLAND
TMK: (3) 6-4-38: 011

INTRODUCTION

This report presents the results of our geotechnical investigation performed for the proposed Waimea Homestead Agricultural Park in Puukapu, Waimea, Hawaii. Our scope of services for this study included the following:

- A visual reconnaissance of the site and its vicinity 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 11 exploratory borings to depths ranging from approximately 8 to 30 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 Plans, Plates A2.2 and A2.3, and the soils encountered in the borings are described on the Boring Logs, Plates A4.1 through A4.11.
- 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 on the Boring Logs (Plates A4.1 through A4.11), 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 site grading, design of foundations, including seismic considerations,

resistance to lateral pressures, concrete walkways, gravel roadway design, flexible pavement design, pipe support, and trench excavation and backfill.

PROJECT CONSIDERATIONS

Information regarding the proposed project was provided by personnel from your office.

The Draft Development Plan indicates that the proposed development will consist of a Community Agricultural Park, Equestrian Center, Golf Facilities, and a cemetery. However, our scope of services was limited to the interior roadways and utilities, a tank farm located on the southeast side of the Community Agricultural Park, and mass grading for the Community Agricultural Park. Mass grading for the remainder of the areas and other proposed structures were not included in our scope of services.

The proposed Community Agricultural Park will encompass a total area of about 30 acres. Mass grading for the agricultural park will consist of about 53,104 cubic yards of cut and approximately 90,753 cubic yards of fill. Grading for the proposed roadways will consist of about 10,406 cubic yards of cut and approximately 9,610 cubic yards of fill.

Approximately 6,500 lineal feet of gravel roadways are currently planned for the proposed site. We understand that AC pavement is also being considered. The main road will extend from the existing gravel road on the west side of the Sandwich Isles Communications facility to the western end of Poliahu Alanui Street. An interior roadway extending from the main road and along the northern boundary of the agricultural park is also planned. Cuts and fills for the roadways will be on the order of 1 to 5 feet.

The proposed waterline alignment will extend from the water storage tank farm, along the southern boundary of the parcel, and continue along the new roadway towards Poliahu Alanui Street. The waterlines will have invert depths of about 3 feet below finish grade.

The proposed tank farm will consist of two water storage tanks, each with a total capacity of 141,016 gallons. The tanks will be about 39 feet in diameter and about 16 feet in height. Fill placement on the order of 4 to 6 feet is planned in the area of the proposed tank farm.

SITE CONDITIONS

The project site is located on the south side of Hiiaku and Ainahui Alanui Street, and west of Uakikumi Alanui Street in Waimea, Hawaii, and is generally surrounded by vacant pasture lands. The Kanu O Ka Aina Learning Ohana Charter School is located to the north of the proposed development.

The parcel occupies about 30 acres of undeveloped land with total relief on the order of 26 feet. Elevations range from about +2772 on the east to about +2746 on the west. At the time of our fieldwork, the site was vacant of structures and covered with a light to moderate growth of vegetation. The site is generally sloped such that drainage flows in a westerly direction.

SOIL CONDITIONS

Our borings encountered surface soil classified as brown clayey silt with gravel. The clayey silt was in a medium stiff to stiff condition and extended to depths ranging from about 4 to 9 feet below ground surface. Laboratory testing, as well as our past experience near the project area, indicates that the clayey silt has a collapsing type structure with the introduction of water. This is typical of soils derived from volcanic ash, which is also characterized as having poor workability characteristics and moderate to high compressibility.

Underlying the clayey silt in all the borings was highly weathered basalt in a medium dense to medium hard condition, extending to the maximum depths drilled in borings B1 through B6, and to depths ranging from about 8 to 24 feet in the remaining borings. The highly weathered basalt in these borings was underlain by moderately weathered basalt in a hard condition, extending to the maximum depths drilled.

Neither groundwater nor seepage water was encountered in the borings.

CONCLUSIONS AND RECOMMENDATIONS

From a geotechnical viewpoint, it is our opinion that the project site can generally be developed as planned. However, due to the poor workability characteristics and collapsing type nature of the onsite clayey silt/volcanic ash, additional site preparation work is recommended.

Ground settlement due to fill placement is anticipated. Our analysis resulted in settlements on the order of 2 inches based on a maximum fill height of 6 feet in the area of the proposed tanks. We believe that settlements of this magnitude could result in distress to the proposed tanks, and therefore recommend that new fills be placed as early as possible during construction. We estimate approximately 90 percent of the consolidation should occur within 2 months of new fill placement. We recommend that a settlement monitoring program be established, and that construction of the new storage tanks be delayed until settlements resulting from fill placement have generally stabilized.

The settlement monitoring program should be initiated prior to fill placement. Settlement gauges should be placed near the corners of each of storage tank pad and within the central portion of each storage tank footprint. Each settlement gauge should consist of 1-inch diameter steel pipe welded to an 18-inch square steel plate, with the plate embedded approximately 6 inches into the existing ground prior to fill placement. A detail of the recommended settlement gauge is shown on Plate C1.1 Elevations of the settlement gauges should be taken weekly, beginning at the onset of fill placement and concluding when settlements have stabilized.

As a precautionary measure, subdrains should be installed in natural drainage ways which will be filled. Due to the collapsing type nature of the onsite clayey silt/volcanic ash, subdrains should also be installed in the uphill side of the tank farm area to minimize surface water runoff from flowing below the newly placed fill of the storage tank pads.

We also recommend that construction of the new waterlines be deferred as long as possible to allow settlements resulting from fill placement to stabilize.

Site Grading

Site Preparation – The project site should be cleared of all vegetation, including large roots, and other deleterious material.

It has been our experience that achieving the standard 90 percent compaction of the onsite surface soils as determined by ASTM D 1557 may be difficult due to the thixotropic properties of volcanic ash. Therefore, as an alternative, a reduced compaction requirement consisting of compacting the onsite clayey silt/volcanic ash to a minimum 100 percent of the maximum wet density determined for the soil at its in-situ moisture content, may be used to facilitate site grading. It has been our experience that achieving this compaction requirement will require approximately the same compaction effort as compacting a normal clay to 90 percent compaction as determined by ASTM D 1557.

As a precautionary measure, subdrains should be installed in natural drainage ways which will be filled. Due to the collapsing type nature of the onsite clayey silt/volcanic ash, subdrains should also be installed in the uphill side of the tank farm area to minimize surface water runoff from flowing below the newly placed fill of the storage tank pads.

Rippability – Based on our exploratory borings, it is our opinion that excavations into the onsite clayey silt can generally be accomplished using conventional excavating equipment. However, excavations into the medium hard to hard basalt will require hydraulic equipment.

Temporary cuts into the onsite clayey silt/volcanic ash 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.

Groundwater – Neither groundwater nor seepage water was encountered in our exploratory borings. As a result, we believe that groundwater will not impact mass grading of the proposed development.

Onsite Fill Material – The onsite clayey silt/volcanic ash will not be acceptable for reuse in compacted fills and backfills, except in the capping layer recommended in the *Water Tank Foundations* section of this report.

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. Imported structural fill should have a CBR expansion value no greater than 1.0 percent and a minimum CBR value of 15 percent, when tested in accordance with ASTM D 1883.

Compaction – Granular structural fill should be placed in horizontal lifts restricted to 8 inches in loose thickness, and 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 – All permanent cut and fill slopes should be stable at gradients of 2H:1V or flatter. Fill placed on slopes should be continually keyed and benched into the existing slope to provide stability for the new fill against sliding. Sliver fills placed on slopes should be avoided. Fill slopes should be constructed by overfilling and cutting back to the design slope gradient to obtain a well-compacted slope face.

All slopes should be planted as soon as practical upon completion of grading to reduce the effects of erosion and weathering.

Water Tank Foundations

Mat foundations may be used to support the proposed water storage tanks. However, due to the collapsing type nature and compressibility characteristics of the onsite clayey silt/volcanic ash, we recommend that foundations be designed for a relatively low allowable bearing value of 1,000 pounds per square foot. The 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 effects of wind and seismic forces.

In addition, to provide more uniform support, we recommend that foundations be underlain by a minimum 36 inches of imported granular structural fill. The granular structural fill section should also extend a minimum 18 inches beyond the edge of foundations. See the *Site Grading* section of this report for imported granular fill requirements.

In areas where the imported granular structural fill is not covered by exterior slabs, pavement, or walkway areas, and is open to the environment, the material should be capped with 12 inches of low permeability soil, such as the onsite clayey silt/volcanic ash. The intent of this recommendation is to reduce the intrusion of surface runoff into the granular fill below footings. The low permeability capping layer should be placed as soon as practical and should be compacted in lifts to a minimum 90 percent compaction as determined by ASTM D 1557, or to *a minimum 100 percent of the maximum wet density determined for the soil at its in-situ moisture content, using ASTM D 1557 procedures*

A modulus of subgrade reaction of 200 pounds per cubic inch may be used to evaluate the required mat foundation thickness.

The bottom of foundation excavations should be thoroughly tamped and cleaned of loose material prior to placement of granular structural fill.

In addition, we recommend that areas adjacent to the storage tanks be graded to allow surface water to drain away from the structures.

Foundations 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 the deep soil conditions in the area, the subsurface soils can be characterized as a rock profile. Therefore, based on the 2012 International Building Code, Site Class B 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 300 pounds per cubic foot with a maximum earth pressure of 3,000 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.

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.

Foundation Settlement

Analyses were performed to provide an estimate of foundation settlement due to storage tank loads, upon stabilization of settlement due to fill placement. Based on an assumed structural load of 1,200 kips, and a mat foundation with plan dimensions of 44 by 44 feet, maximum total and differential settlements on the order of 1/4 inch were computed.

Gravel Roadways

The gravel road section may consist of 3 inches of 3/4-inch minus material over 6 inches of base course and 18 inches of select borrow. Overexcavation of the onsite clayey silt, newly placed fill, or underlying basalt may be required for placement of the gravel road section. If newly placed fill or basalt is encountered during overexcavations, the select borrow section may be reduced as needed.

In addition, we recommend that a nonwoven geotextile fabric (such as Mirafi 170N) be placed between the subgrade soil and the gravel road section. The intent of this recommendation is to provide reinforcement of the roadway and separation between the subgrade soils and overlying gravel roadway section.

Prior to placement of the gravel roadway section, the first 12 inches of select borrow should be compacted to a minimum 90 percent compaction. The top 6 inches of the select borrow and the aggregate base course should be compacted to a minimum 95 percent compaction as determined by ASTM D 1557.

Due to its collapsing type structure and poor workability characteristics associated with soils derived from volcanic ash, compaction of the clayey silt/volcanic ash subgrade to the conventional 90 percent compaction will be difficult to achieve. In lieu of this, we recommend a minimum compaction standard for the subgrade soil, equivalent to 100 percent of the wet density determined at the soil's in-situ moisture content.

Flexible Pavement

We understand that flexible pavement is also being considered in lieu of the planned gravel roadways. We assume that vehicular traffic will generally be limited to passenger vehicles and light trucks. Flexible pavement may be designed based on the following section:

2.0"	Asphalt Concrete
6.0"	Base Course (CBR = 85 minimum)
18.0"	Select Borrow (CBR = 25 minimum)
26.0"	Total Thickness

Overexcavation of the onsite clayey silt, newly placed fill, or underlying basalt may be required for placement of the flexible pavement section. If newly placed fill or basalt is encountered during overexcavations, the select borrow section may be reduced as needed.

Prior to placement of the select borrow and base course, the exposed onsite clayey silt/volcanic ash should be scarified to a minimum depth of 6 inches and compacted to a minimum 90 percent compaction as determined by ASTM D 1557, or to *a minimum 100 percent of the maximum wet density determined for the soil at its in-situ moisture content, using ASTM D 1557 procedures.*

The base course and select borrow should be placed in lifts and compacted to a minimum 95 percent compaction as determined by ASTM D 1557.

Pipe Support

The proposed underground waterlines may be supported on conventional pipe cushion extending to a minimum depth of 6 inches below the pipe invert. The pipe cushion material should conform to, and be placed with accordance with, the Standard Specifications and Details for Public Works Construction and the Water System Standards, State of Hawaii.

Trench Excavation and Backfill

Trench Excavation – Trench excavations into the clayey silt can generally be accomplished using conventional excavating equipment.

Trench excavations for the proposed waterlines should be stable at slopes of 1H:1V for temporary conditions. It should be the Contractor's responsibility to conform to OSHA safety standards during construction.

Trench Backfill – Initial backfill should consist of pipe cushion material. The material should also be placed along the sides of the pipe and up to a minimum 12 inches above the pipe.

Import borrow should conform to specifications in the Standard Specifications for Public Works Construction and Waster System Standards. All backfill should also be placed in accordance with specifications in the Standard Specifications for Public Works Construction and Water System Standards.

Due to its collapsing type structure and poor workability characteristics, the onsite clayey silt will not be acceptable for reuse as backfill.

Unless covered by AC pavement, the upper 12 inches of trench backfill should consist of low permeability soil compacted to a minimum 90 percent compaction as determined by ASTM D 1557. The intent of this recommendation is to reduce the potential for surface water infiltration into the trench backfill material.

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 earthwork and geotechnical design 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 mass grading and fill placement, and perform compaction testing, (2) review and/or perform laboratory testing on import borrow to determine its acceptability for use in compacted fills, (3) observe foundation excavations prior to placement of imported granular fill, reinforcing steel, and concrete, 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 SSFM International, Inc. and their sub-consultants for the design of the proposed Waimea Homestead Agricultural Park in Puukapu, Waimea, 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 judgment. 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 expressed or implied.

Respectfully submitted,

HIRATA & ASSOCIATES, INC.

Teo Samilin, Project Engineer

Rick Yoshida, Project Manager

RICK I.K. YOSHIDA
LICENSED PROFESSIONAL ENGINEER
No. 11118-C
HAWAII, U.S.A.

This work was prepared by me or under my supervision.
Expiration Date of License: April 30, 2018

APPENDIX A

FIELD INVESTIGATION

DESCRIPTION OF FIELD INVESTIGATION

GENERAL

The site was explored from March 1 through 4, 2016, by performing a visual reconnaissance of the site and drilling 11 test borings to depths ranging from about 8 to 30 feet with a CME-55 truck-mounted drill rig.

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 logs. A Boring Log Legend is presented on Plate A3.1, and 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 A4.11.

Borings were located in the field by measuring/taping offsets from existing site features shown on plans provided by your office. The surface elevations at the boring sites were estimated based on the Topographic Survey Map provided by your office on March 9, 2016. The accuracy of the boring locations shown on Plates A2.2 and A2.3, and the boring elevations shown on Plates A4.1 through A4.11 are therefore approximate, in accordance with the field methods used.

SOIL SAMPLING

Representative 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.

Bulk soil samples were also obtained from near borings B2 and B8 at depths of about 1 foot below ground surface. The approximate location of borings B2 and B8 are shown on Plates A2.2 and A2.3.

ROCK SAMPLING

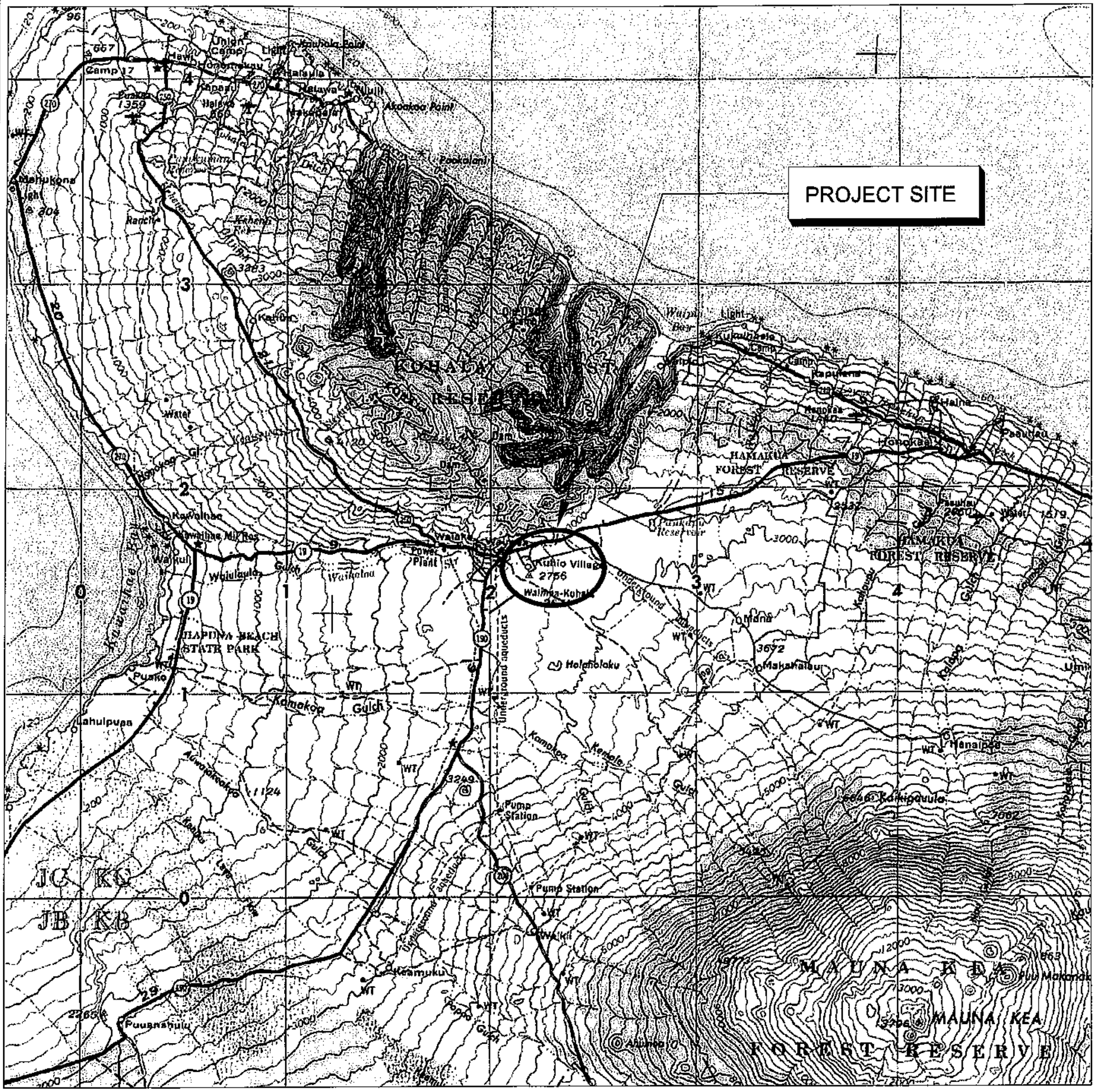
Core samples of basalt were obtained with an NX core barrel having an inside diameter of 2.1 inches. Recovery percentages for each core run are shown on the enclosed Boring Logs.

The rock quality designation (RQD) for the core runs are also shown on the boring logs. This is a modified core recovery percentage that takes into account the number of fractures observed in the core samples. Only pieces of core 4 inches in length or longer, as measured along the centerline, were included in the determination of this modified core recovery percentage. Fractures caused by drilling or handling were ignored.

The following is a general correlation between RQD percentages and rock quality.

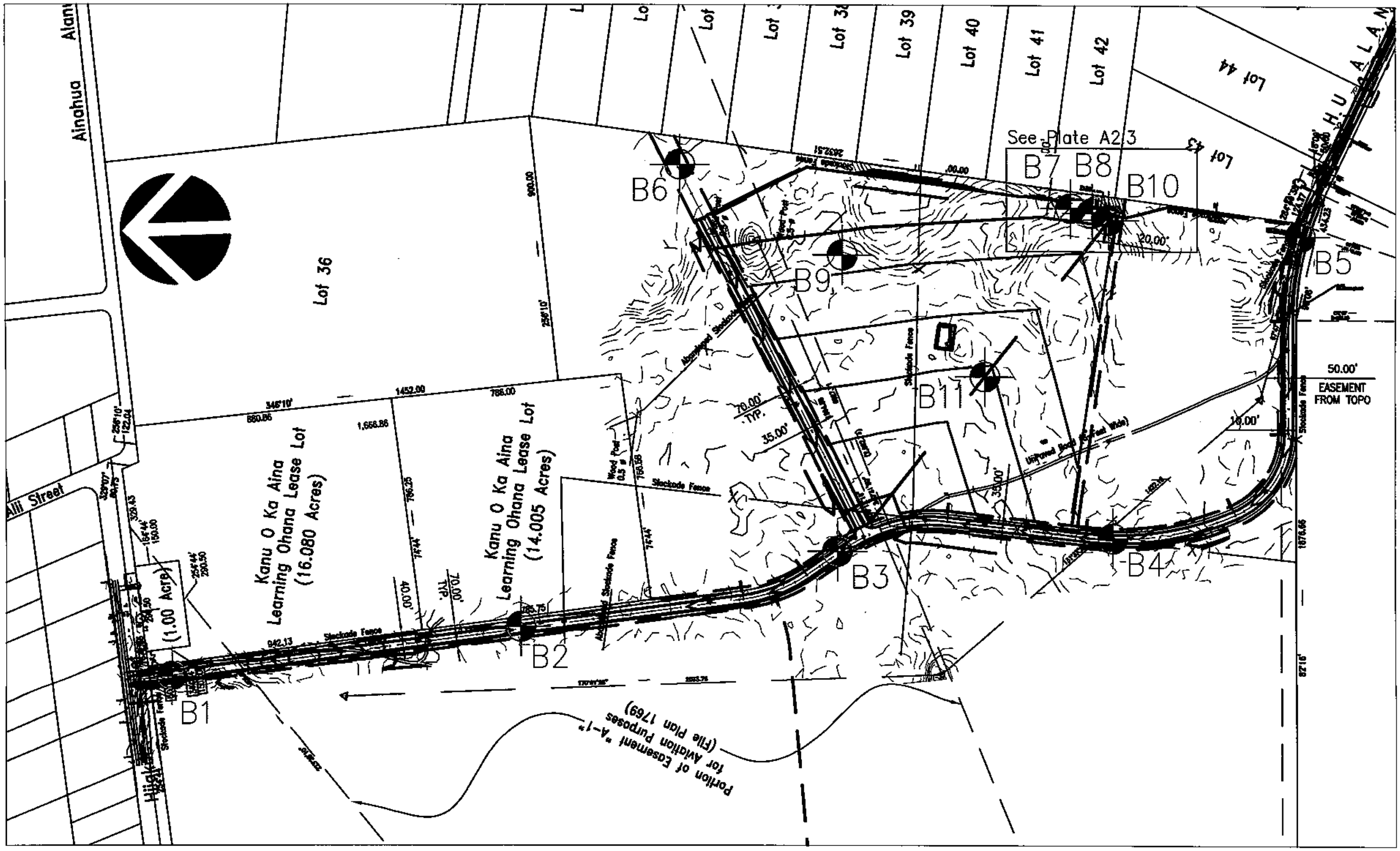
RQD (%)	Description of Rock Quality
0 - 25	Very Poor
25 - 50	Poor
50 - 75	Fair
75 - 90	Good
90 - 100	Excellent

Reference: Tunnel Engineering Handbook, Second Edition, edited by J.O. Bickel, T.R. Kuesel, and E.H. King, 1996



Reference: Topographic Quadrangle Map prepared by the United States Department of the Interior Geologic Survey Hawaii Island, Hawaii. 1975.

Waimea Homestead Agricultural Park		
HIRATA & ASSOCIATES, INC. Geotechnical Engineering	**LOCATION MAP**	Plate A2.1
W.O. 16-5925		



LEGEND

Approximate location of borings

GRAPHIC SCALE:

0 250 500 1,000 FT.

1" = 500'

Reference: Topographic Survey Map provided by SSFM International, Inc. on March 9, 2016.

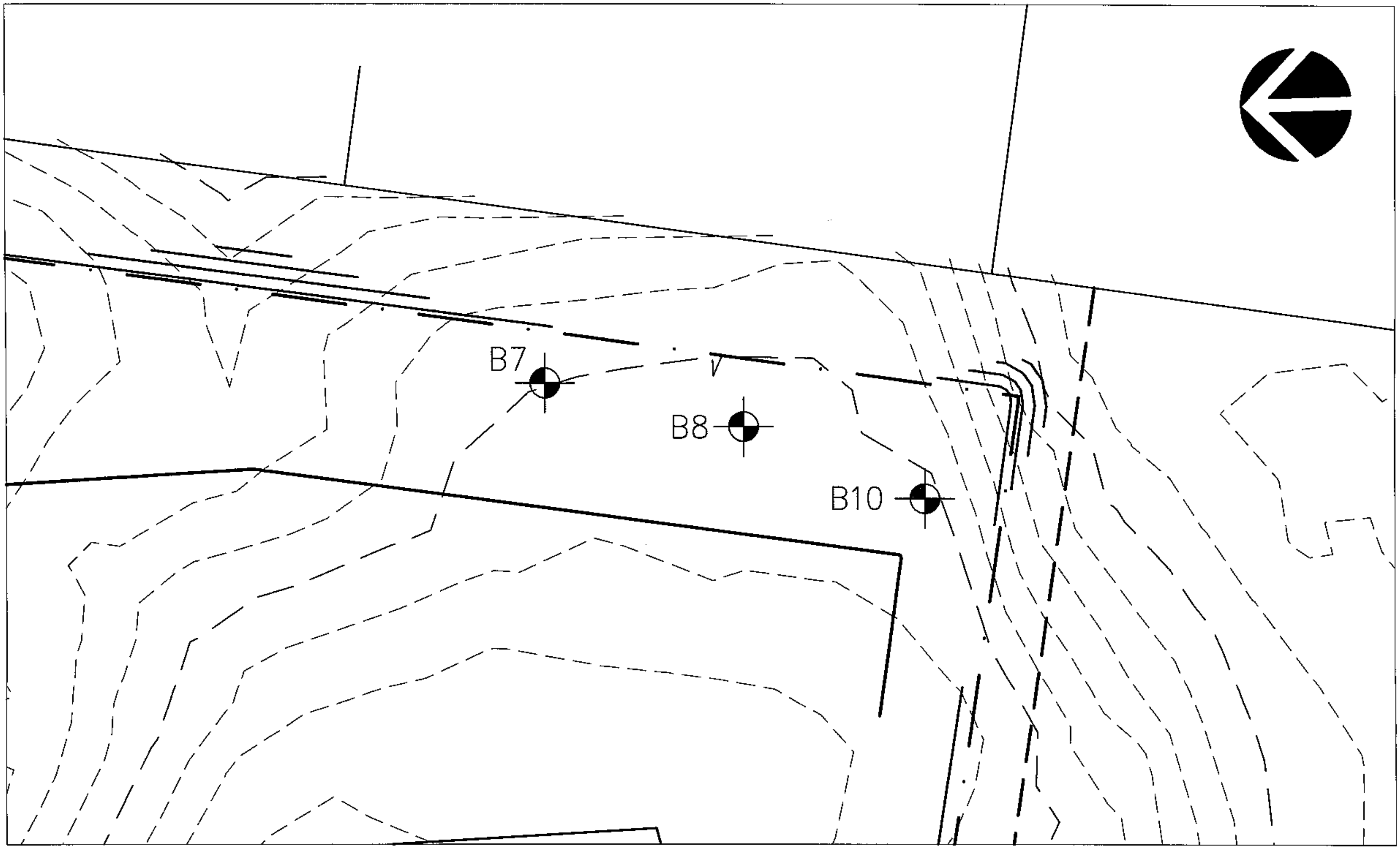
Waimea Homestead Agricultural Park

HIRATA & ASSOCIATES, INC.
Geotechnical Engineering

W.O. 16-5925

BORING LOCATION PLAN

Plate A2.2



LEGEND

Approximate location of borings

GRAPHIC SCALE:

0 25 50 100 FT.

1" = 50'

Reference: Topographic Survey Map provided by SSFM International, Inc. on March 9, 2016.

Waimea Homestead Agricultural Park		
HIRATA & ASSOCIATES, INC. Geotechnical Engineering	**BORING LOCATION PLAN**	Plate A2.3
W.O. 16-5925		

MAJOR DIVISIONS			GROUP DIVISIONS	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 high plasticity, 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 silts.
FORMATIONS				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	Core Sample	Water Table

Waimea Homestead Agricultural Park

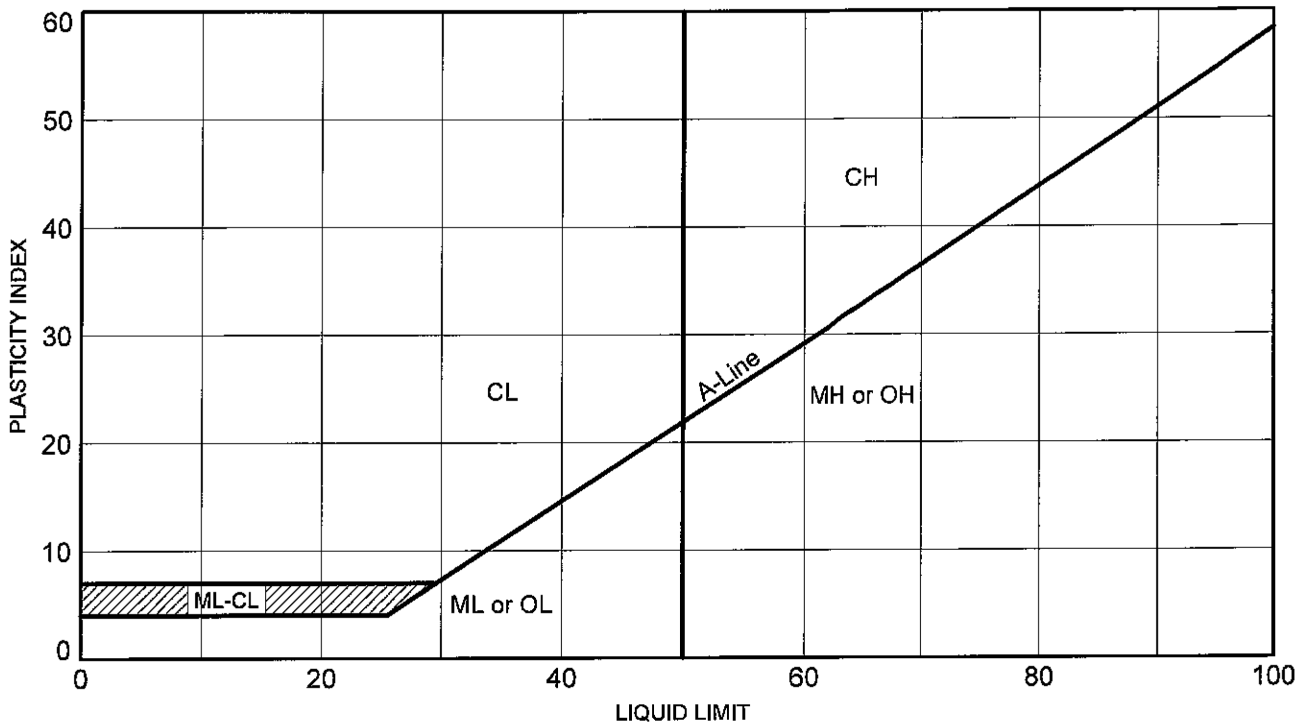
HIRATA & ASSOCIATES, INC.
Geotechnical Engineering

W.O. 16-5925

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	3 in. to 3/4 in.
Fine Gravel	3/4 in. to No. 4 (4.76 mm)
Sand	No. 4 (4.76 mm) to No. 200 (0.074mm)
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)

Grade	Symbol	Description
Fresh	F	No visible signs of decomposition or discoloration. Rings under hammer impact.
Slighly 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	Advance state of decomposition resulting in plastic soils. Rock fabric and structure completely destroyed. Large volume change.

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

ROCK WEATHERING CLASSIFICATION SYSTEM

Hirata & Associates, Inc.
GEOTECHNICAL ENGINEERING

Boring No.
B1

BORING LOG

PROJECT NAME: Waimea Homestead Agricultural Park

WORK ORDER NO.: 16-5925 | DRIVING WT.: 140 lb. | START DATE: 3/4/16

SURFACE ELEV.: 2740 ±* | DROP: 30 in. | END DATE: 3/4/16

REMARKS/ OTHER TESTS	CORE RECOVERY (%)	RQD (%)	BLOWS PER FOOT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	DEPTH (ft)	GRAPHIC LOG	SAMPLE	MATERIAL DESCRIPTION
						0			Clayey SILT (ML) - Brown, moist, stiff, with gravel.
			45	79	19				
			45	83	24				
			61	85	26	5			
			90	90	17	10			BASALT (WH) - Grayish brown, medium hard, highly weathered.
									End boring at 10.5 feet.
									Neither groundwater nor seepage water encountered.
						15			* Elevations based on Topographic Survey Map provided by SSFM International, Inc. on March 9, 2016.
						20			
						25			
						30			
						35			

Hirata & Associates, Inc.
GEOTECHNICAL ENGINEERING

Boring No.
B2

BORING LOG

PROJECT NAME Waimea Homestead Agricultural Park
WORK ORDER NO. 16-5925 DRIVING WT. 140 lb. START DATE 3/4/16
SURFACE ELEV. 2746 ± DROP 30 in. END DATE 3/4/16

REMARKS/ OTHER TESTS	CORE RECOVERY (%)	RQD (%)	BLOWS PER FOOT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	DEPTH (ft)	GRAPHIC LOG	SAMPLE	MATERIAL DESCRIPTION
			77/9"	70	33				Clayey SILT (ML) - Brown, moist, stiff, with gravel.
			10/No penetration 10/No penetration			5			BASALT (WH) - Grayish brown, medium hard, highly weathered.
						10 15 20 25 30 35			End boring at 8.0 feet. Neither groundwater nor seepage water encountered.

Hirata & Associates, Inc.
GEOTECHNICAL ENGINEERING

Boring No.
B3

BORING LOG

PROJECT NAME Waimea Homestead Agricultural Park
WORK ORDER NO. 16-5925 DRIVING WT. 140 lb. START DATE 3/1/16
SURFACE ELEV. 2744 ± DROP 30 in. END DATE 3/1/16

REMARKS/ OTHER TESTS	CORE RECOVERY (%)	RQD (%)	BLOWS PER FOOT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	DEPTH (ft)	GRAPHIC LOG	SAMPLE	MATERIAL DESCRIPTION
									Clayey SILT (ML) - Brown, moist, stiff, with gravel.
Direct Shear Test			30	69	15				
			24	84	11				Medium stiff from 3 feet.
			18	83	14	5			
									BASALT (WH) - Grayish brown, dense to medium hard, highly weathered.
			40	89	9	10			
									End boring at 10.5 feet.
									Neither groundwater nor seepage water encountered.
						15			
						20			
						25			
						30			
						35			

Plate A4.3

Hirata & Associates, Inc.
GEOTECHNICAL ENGINEERING

Boring No.
B4

BORING LOG

PROJECT NAME Waimea Homestead Agricultural Park
WORK ORDER NO. 16-5925 DRIVING WT. 140 lb. START DATE 3/1/16
SURFACE ELEV. 2754 ± DROP 30 in. END DATE 3/1/16

REMARKS/ OTHER TESTS	CORE RECOVERY (%)	RQD (%)	BLOWS PER FOOT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	DEPTH (ft)	GRAPHIC LOG	SAMPLE	MATERIAL DESCRIPTION
									Clayey SILT (ML) - Brown, moist, medium stiff.
			26	56	45				
			28	80	16	5			With gravel from 4 feet.
			50/6"	81	20				BASALT (WH) - Grayish brown, medium hard, highly weathered.
						10			End boring at 9.0 feet.
									Neither groundwater nor seepage water encountered.
						15			
						20			
						25			
						30			
						35			

Hirata & Associates, Inc.
GEOTECHNICAL ENGINEERING

Boring No.
B5

BORING LOG

PROJECT NAME Waimea Homestead Agricultural Park
WORK ORDER NO. 16-5925 DRIVING WT. 140 lb. START DATE 3/1/16
SURFACE ELEV. 2774 ± DROP 30 in. END DATE 3/1/16

REMARKS/ OTHER TESTS	CORE RECOVERY (%)	RQD (%)	BLOWS PER FOOT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	DEPTH (ft)	GRAPHIC LOG	SAMPLE	MATERIAL DESCRIPTION
									Clayey SILT (ML) - Brown, moist, stiff, with gravel.
			10/6" 10/No penetration	73	23				Cobbles at 1.5 feet.
Direct Shear Test			33	70	28				
			29	56	28	5			Medium stiff from 5 feet.
									BASALT (WH) - Grayish brown, medium dense, highly weathered.
			21	71	23	10			
									End boring at 10.5 feet.
									Neither groundwater nor seepage water encountered.
						15			
						20			
						25			
						30			
						35			

Plate A4.5

Hirata & Associates, Inc.
GEOTECHNICAL ENGINEERING

Boring No.
B6

BORING LOG

PROJECT NAME Waimea Homestead Agricultural Park
WORK ORDER NO. 16-5925 DRIVING WT. 140 lb. START DATE 3/1/16
SURFACE ELEV. 2770 ± DROP 30 in. END DATE 3/1/16

REMARKS/ OTHER TESTS	CORE RECOVERY (%)	RQD (%)	BLOWS PER FOOT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	DEPTH (ft)	GRAPHIC LOG	SAMPLE	MATERIAL DESCRIPTION
									Clayey SILT (ML) - Brown, moist, stiff, with gravel.
			37	75	32				
			21	87	23	5			Medium stiff from 4 feet.
			84	89	21				BASALT (WH) - Grayish brown, medium hard, highly weathered.
						10			End boring at 9.5 feet.
									Neither groundwater nor seepage water encountered.
						15			
						20			
						25			
						30			
						35			

Plate A4.6

Hirata & Associates, Inc.
GEOTECHNICAL ENGINEERING

Boring No.
B7

BORING LOG

PROJECT NAME: Waimea Homestead Agricultural Park

WORK ORDER NO.	16-5925	DRIVING WT.	140 lb.	START DATE	3/2/16
SURFACE ELEV.	2764 ±	DROP	30 in.	END DATE	3/3/16

REMARKS/ OTHER TESTS	CORE RECOVERY (%)	RQD (%)	BLOWS PER FOOT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	DEPTH (ft)	GRAPHIC LOG	SAMPLE	MATERIAL DESCRIPTION
						0			Clayey SILT (ML) - Brown, moist, medium stiff.
			12	40	52				
Direct Shear Test			28	47	50				
Consolidation Test			38	78	24	5			Stiff and with gravel from 5 feet.
Consolidation Test			27	71	22	10			BASALT (WH) - Grayish brown, medium dense to dense, highly weathered.
			31	89	19	15			
									BASALT (WM) - Gray, hard, fractured, moderately weathered.
			50/3"						
Begin NX coring at 20 feet						20			
	70	45							
						25			
	100	95							
						30			End boring at 30.0 feet.
									Neither groundwater nor seepage water encountered.
						35			

Hirata & Associates, Inc.
GEOTECHNICAL ENGINEERING

Boring No.
B8

BORING LOG

PROJECT NAME Waimea Homestead Agricultural Park
WORK ORDER NO. 16-5925 DRIVING WT. 140 lb. START DATE 3/2/16
SURFACE ELEV. 2762 ± DROP 30 in. END DATE 3/2/16

REMARKS/ OTHER TESTS	CORE RECOVERY (%)	RQD (%)	BLOWS PER FOOT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	DEPTH (ft)	GRAPHIC LOG	SAMPLE	MATERIAL DESCRIPTION
									Clayey SILT (ML) - Brown, moist, medium stiff.
Consolidation Test			16	42	44				
			37	84	18	5			Stiff and with gravel from 4 feet.
			71/10"	83	17				BASALT (WH) - Grayish brown, dense to medium hard, highly weathered.
						10			
			10/No penetration						BASALT (WM) - Gray, hard, fractured, moderately weathered.
Begin NX coring at 15 feet						15			
	100	100							
						20			
	100	100							
						25			
	100	100							
						30			End boring at 30.0 feet.
									Neither groundwater nor seepage water encountered.
						35			

Hirata & Associates, Inc.
GEOTECHNICAL ENGINEERING

Boring No.
B9

BORING LOG

PROJECT NAME Waimea Homestead Agricultural Park
WORK ORDER NO. 16-5925 DRIVING WT. 140 lb. START DATE 3/3/16
SURFACE ELEV. 2758 ± DROP 30 in. END DATE 3/3/16

REMARKS/ OTHER TESTS	CORE RECOVERY (%)	RQD (%)	BLOWS PER FOOT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	DEPTH (ft)	GRAPHIC LOG	SAMPLE	MATERIAL DESCRIPTION
									Clayey SILT (ML) - Brown, moist, medium stiff, with gravel.
			26	72	24				
			24	72	24	5			
			99	93	12				BASALT (WH) - Grayish brown, medium hard, highly weathered.
						10			
Begin NX coring at 12.5 feet									BASALT (WM) - Gray, hard, fractured, moderately weathered.
	97	87				15			
	100	83				20			
									End boring at 22.5 feet.
						25			Neither groundwater nor seepage water encountered.
						30			
						35			

Plate A4.9

Hirata & Associates, Inc.
GEOTECHNICAL ENGINEERING

Boring No.
B10

BORING LOG

PROJECT NAME: Waimea Homestead Agricultural Park

WORK ORDER NO.: 16-5925 | DRIVING WT.: 140 lb. | START DATE: 3/2/16

SURFACE ELEV.: 2760 ± | DROP: 30 in. | END DATE: 3/2/16

REMARKS/ OTHER TESTS	CORE RECOVERY (%)	RQD (%)	BLOWS PER FOOT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	DEPTH (ft)	GRAPHIC LOG	SAMPLE	MATERIAL DESCRIPTION
									Clayey SILT (ML) - Brown, moist, medium stiff.
			10	41	48				
Direct Shear Test			29	51	39				
			40	82	23	5			Stiff from 5 feet.
			36	80	22	10			BASALT (WH) - Grayish brown, dense to medium hard, highly weathered.
			10/No penetration						
Begin NX coring at 15 feet						15			
	30	8							
			10/No penetration			20			
	58	20							
						25			BASALT (WM) - Gray, hard, fractured, moderately weathered.
	100	100							
						30			End boring at 30.0 feet.
									Neither groundwater nor seepage water encountered.
						35			

Plate A4.10

Hirata & Associates, Inc.
GEOTECHNICAL ENGINEERING

Boring No.
B11

BORING LOG

PROJECT NAME Waimea Homestead Agricultural Park

WORK ORDER NO. 16-5925 DRIVING WT. 140 lb. START DATE 3/3/16

SURFACE ELEV. 2751 ± DROP 30 in. END DATE 3/3/16

REMARKS/ OTHER TESTS	CORE RECOVERY (%)	RQD (%)	BLOWS PER FOOT	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	DEPTH (ft)	MATERIAL DESCRIPTION
						0	Clayey SILT (ML) - Brown, moist, stiff, with gravel.
			33	73	19		
			29	67	28		Medium stiff from 3 feet.
			25	74	27	5	
						8	BASALT (WH) - Grayish brown, medium hard, highly weathered.
			87	91	12	10	
			10/No penetration				
Begin NX coring at 15 feet						15	BASALT (WM) - Gray, hard, fractured, moderately weathered.
	93	92					
						20	
	100	95					
						25	End boring at 25.0 feet.
							Neither groundwater nor seepage water encountered.
						30	
						35	

Plate A4.11

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 A4.11.

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 A4.11.

CONSOLIDATION

Selected representative samples were tested for their consolidation characteristics. The test samples were 2.42 inches in diameter and 1 inch high. Porous stones were placed in contact with the top and bottom of the 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 TEST

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.

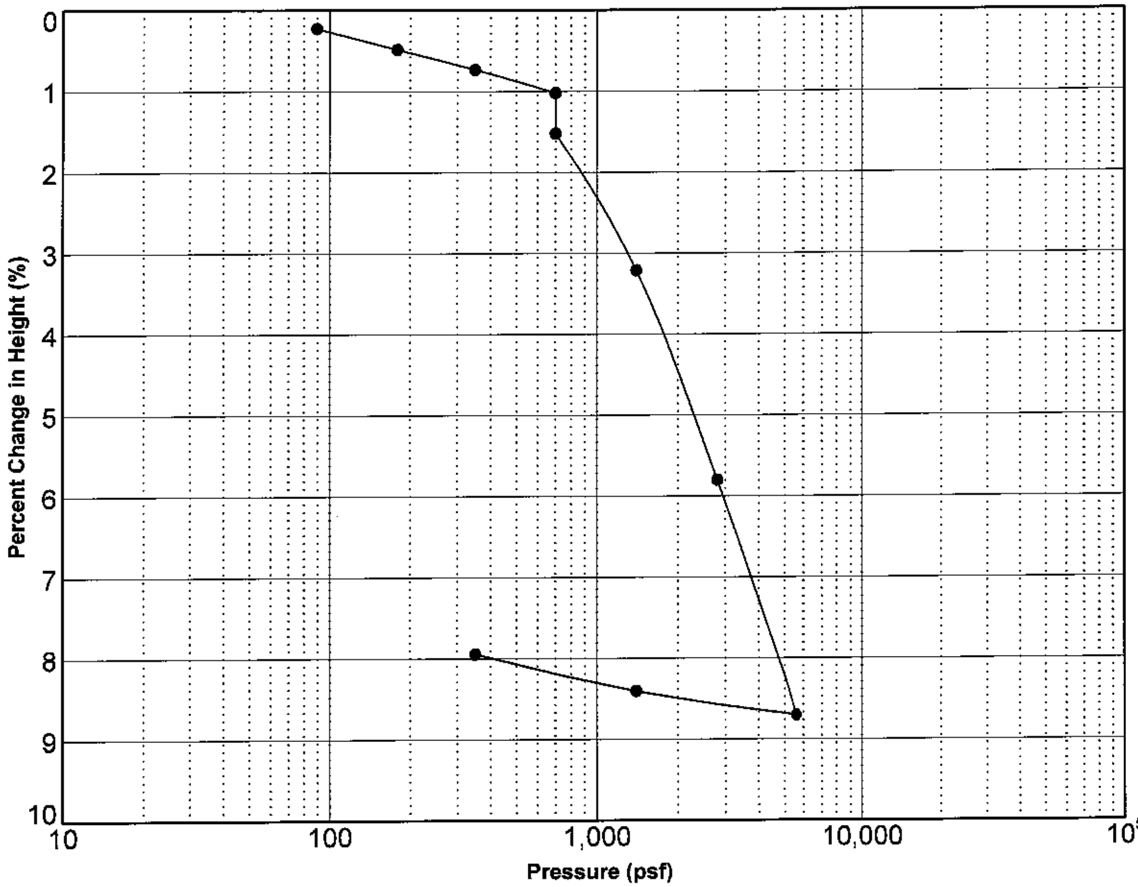
PROCTOR TEST

A Modified Proctor test was performed in general accordance with ASTM D 1557 on a bulk soil sample obtained from near boring B8 at a depth of about 1 foot below ground surface. The test is used to determine the optimum moisture content at which the soil compacts to 100 percent dry density. Results are shown on Plate B4.1.

CALIFORNIA BEARING RATIO TEST

A CBR test was performed on a bulk soil sample obtained from near boring B8 at a depth of about 1 foot below ground surface, in general accordance with ASTM D 1883. The test is used to evaluate the relative quality of subgrade soils to be used in the design of flexible and rigid pavements. Results are shown on Plate B5.1.

Consolidation Test Results



<u>Sample Description</u>

Boring No.: B7 Depth (ft): 5

Soil Description: Brown clayey silt with gravel

	Moisture Content (%)	Dry Density (pcf)
Initial	24.3	78.2
Final	36.6	85.4

Remarks: Water added at 700 psf

Waimea Homestead Agricultural Park

HIRATA & ASSOCIATES, INC.
Geotechnical Engineering

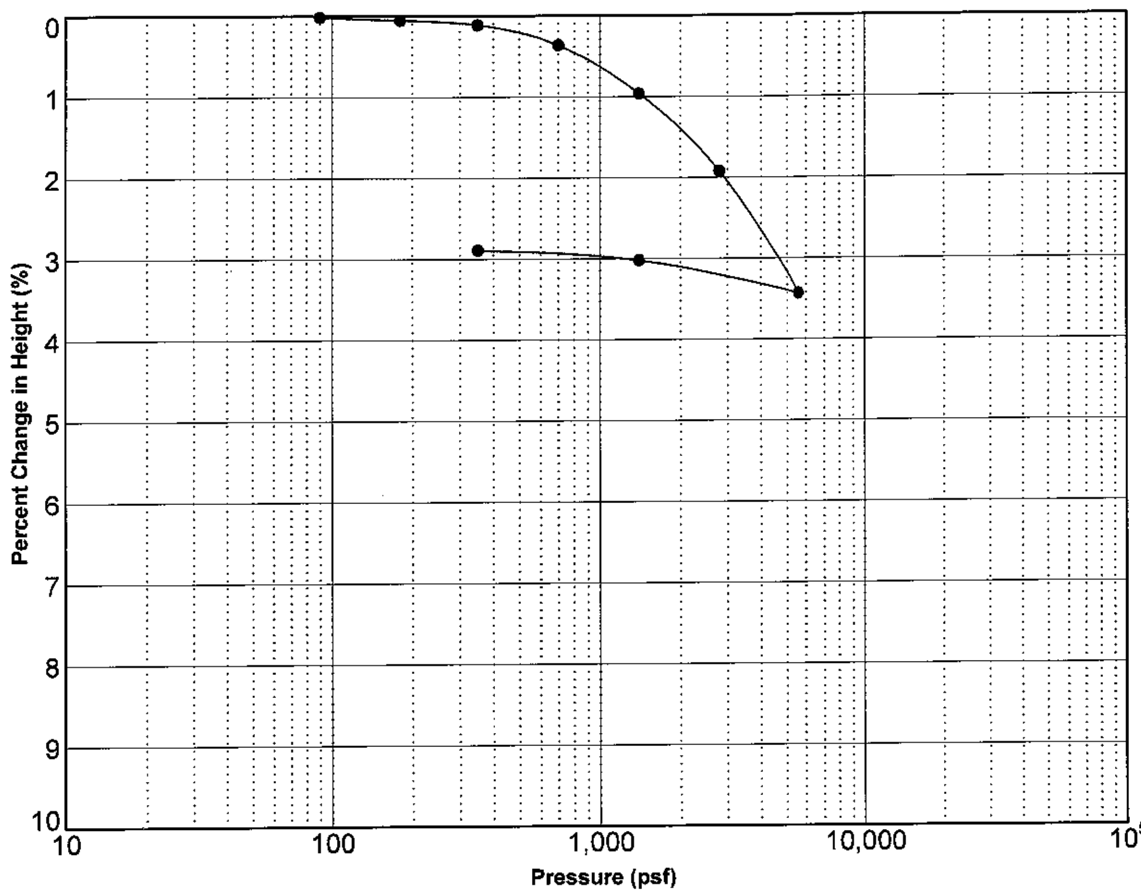
W.O. 16-5925

CONSOLIDATION TEST

ASTM D2435 / D2435M - 11

Plate B2.1

Consolidation Test Results



<u>Sample Description</u>

Boring No.: B7 Depth (ft): 9

Soil Description: Grayish brown highly weathered basalt

	Moisture Content (%)	Dry Density (pcf)
Initial	22	71.2
Final	21	73.3

Waimea Homestead Agricultural Park

HIRATA & ASSOCIATES, INC.
Geotechnical Engineering

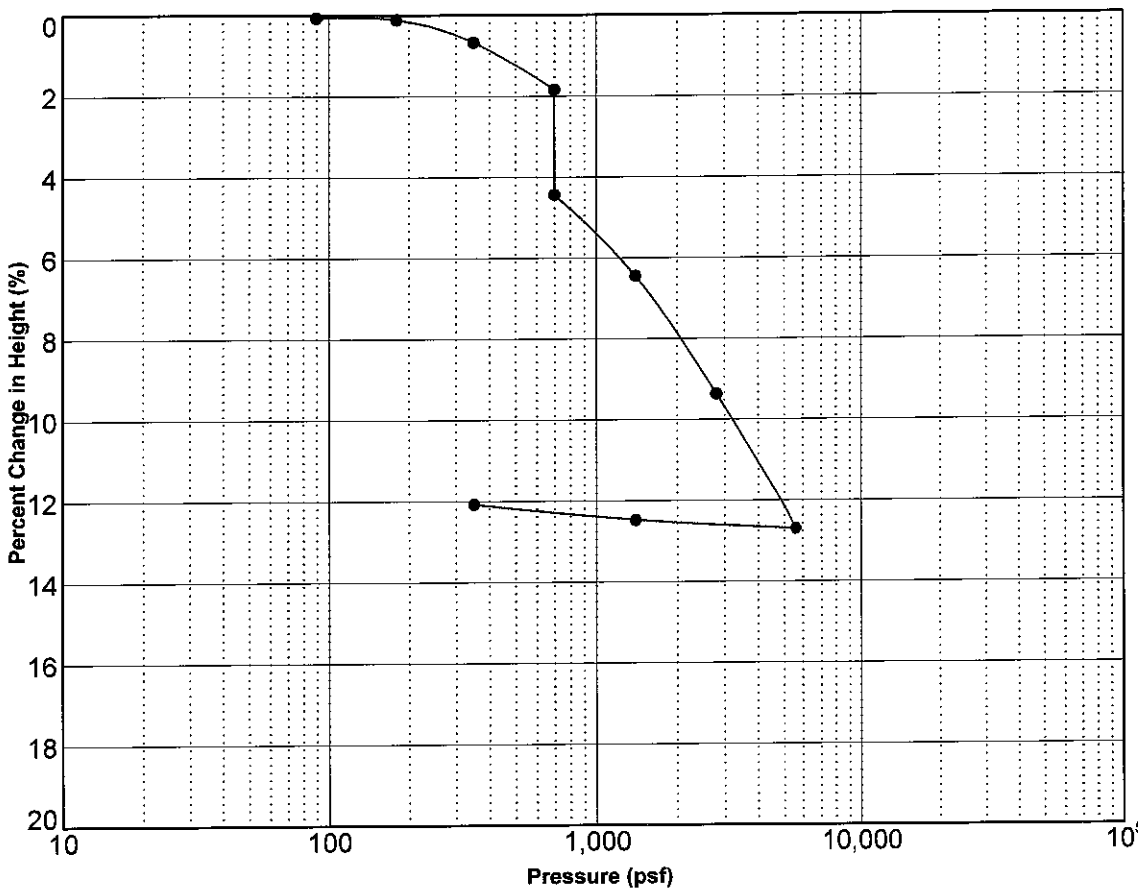
W.O. 16-5925

CONSOLIDATION TEST

ASTM D2435 / D2435M - 11

Plate B2.2

Consolidation Test Results



<u>Sample Description</u>

Boring No.: B8 Depth (ft): 2

Soil Description: Brown clayey silt

	Moisture Content (%)	Dry Density (pcf)
Initial	44.1	42.1
Final	87.6	48.1

Remark: Water added at 700 psf

Waimea Homestead Agricultural Park

HIRATA & ASSOCIATES, INC.
Geotechnical Engineering

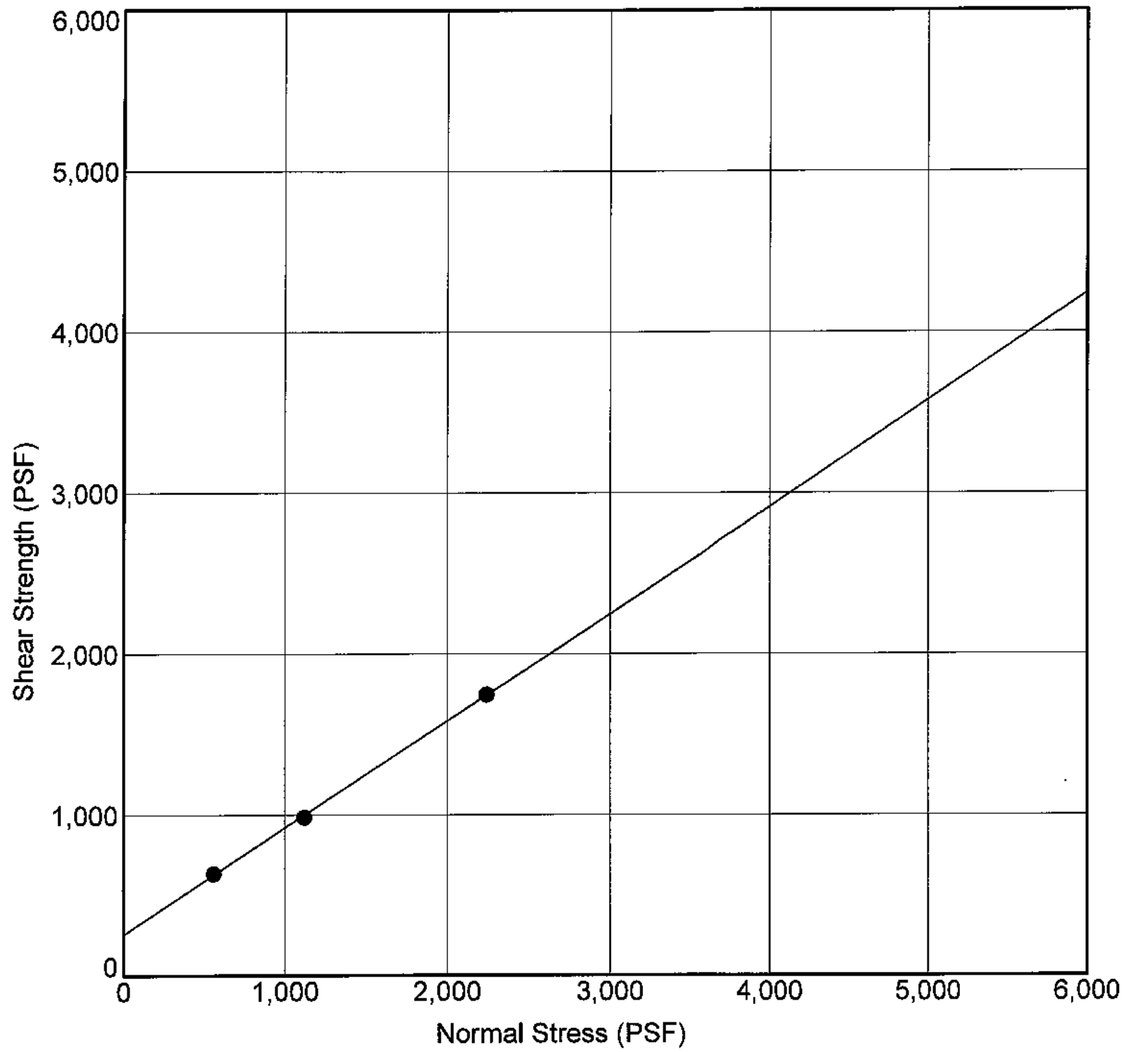
W.O. 16-5925

CONSOLIDATION TEST

ASTM D2435 / D2435M - 11

Plate B2.3

Direct Shear Test Results



Soil Data

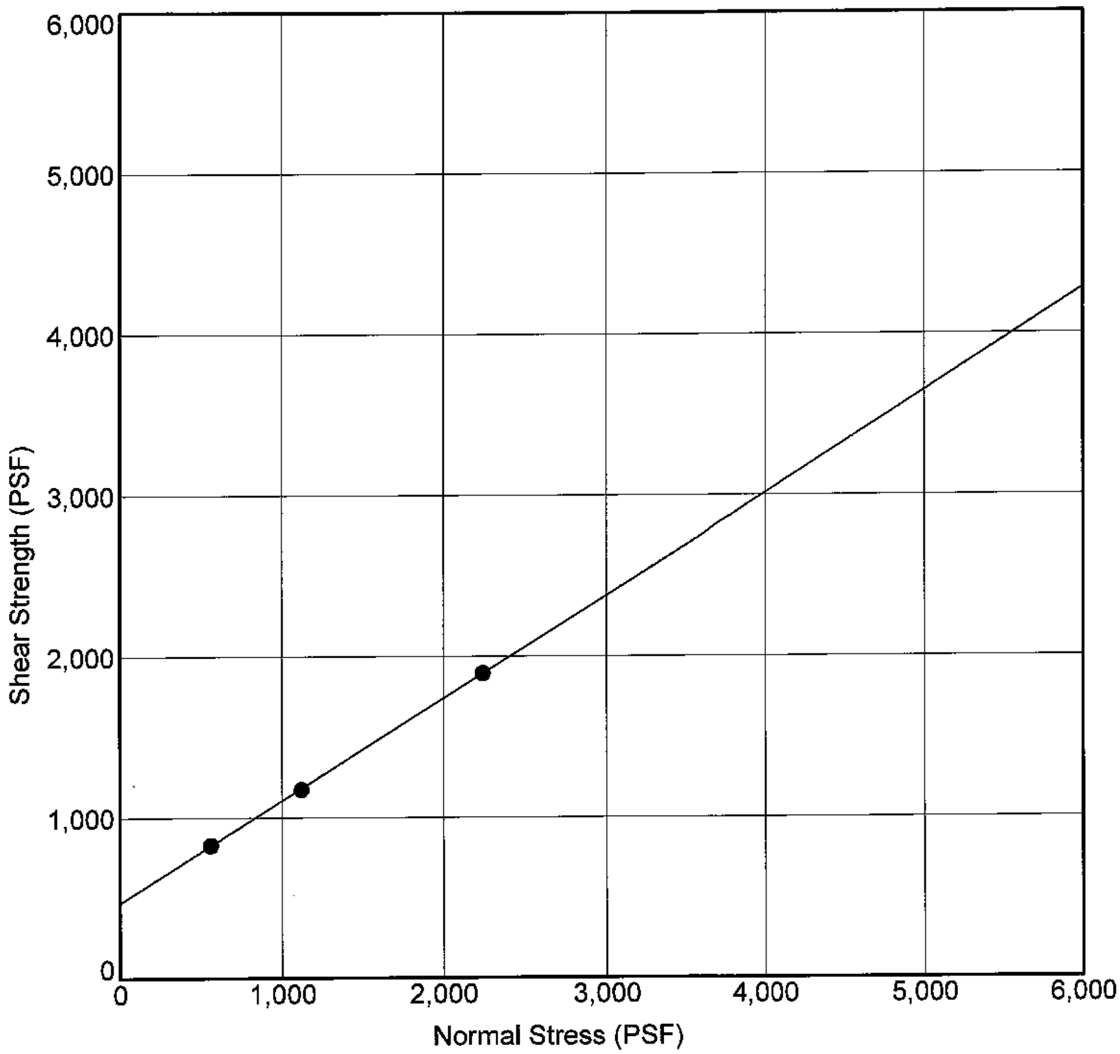
Boring No.: B3 Depth (ft): 1
Soil Description: Brown clayey silt with gravel

Test Results

Strength Intercept (c): 255.6 PSF (Peak Strength)
Friction Angle (phi): 33.6 DEG (Peak Strength)

Waimea Homestead Agricultural Park		
HIRATA & ASSOCIATES, INC. Geotechnical Engineering	**DIRECT SHEAR TEST**	Plate B3.1
W.O. 16-5925	*ASTM D3080*	

Direct Shear Test Results



Soil Data

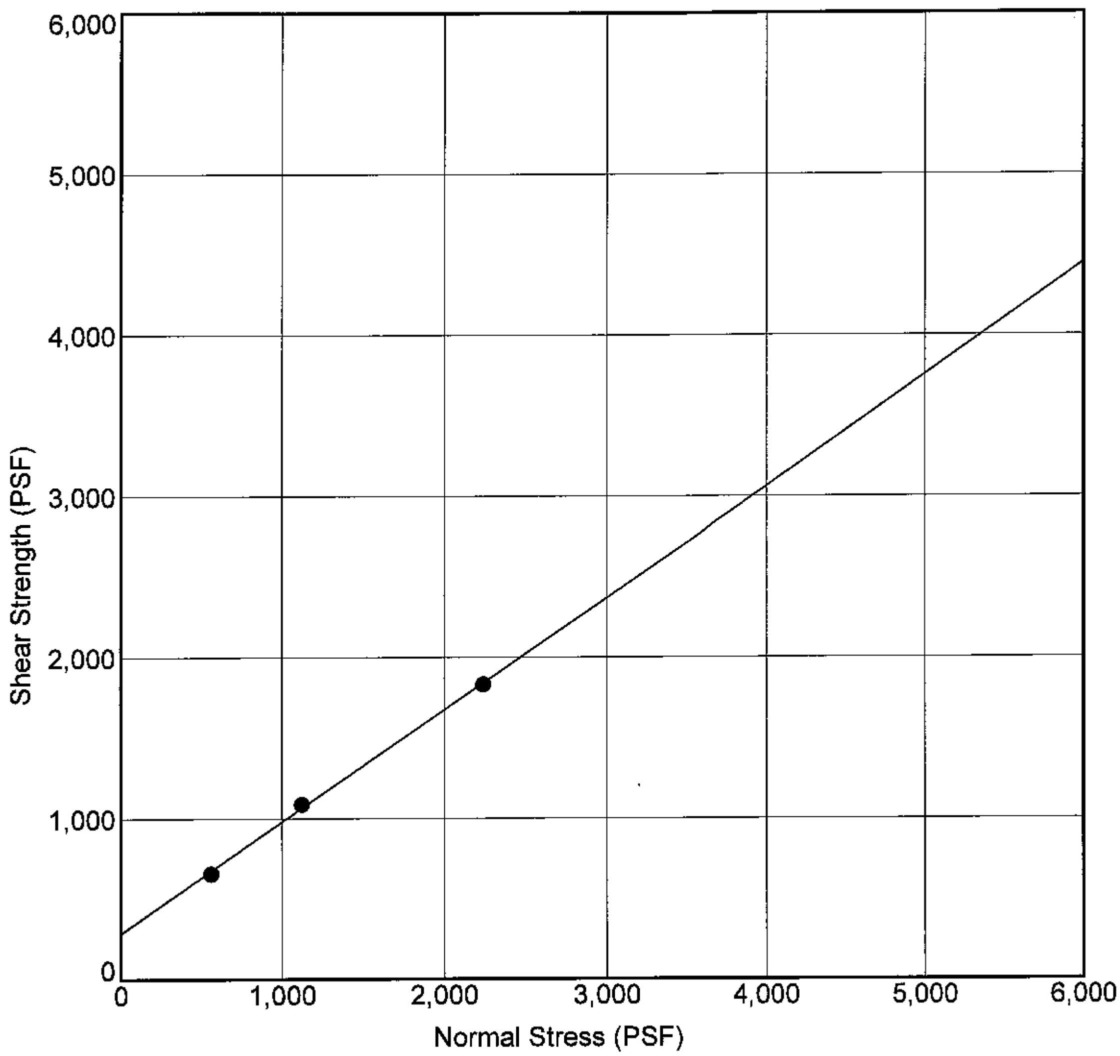
Boring No.: B5 Depth (ft): 3

Soil Description: Brown clayey silt with gravel

Test Results

Strength Intercept (c):	470.2 PSF	(Peak Strength)
Friction Angle (phi):	32.4 DEG	(Peak Strength)

Direct Shear Test Results



<u>Soil Data</u>

Boring No.: B7 Depth (ft): 3
Soil Description: Brown clayey silt

<u>Test Results</u>

Strength Intercept (c):	287.7 PSF	(Peak Strength)
Friction Angle (phi):	34.7 DEG	(Peak Strength)

Waimea Homestead Agricultural Park

HIRATA & ASSOCIATES, INC.
Geotechnical Engineering

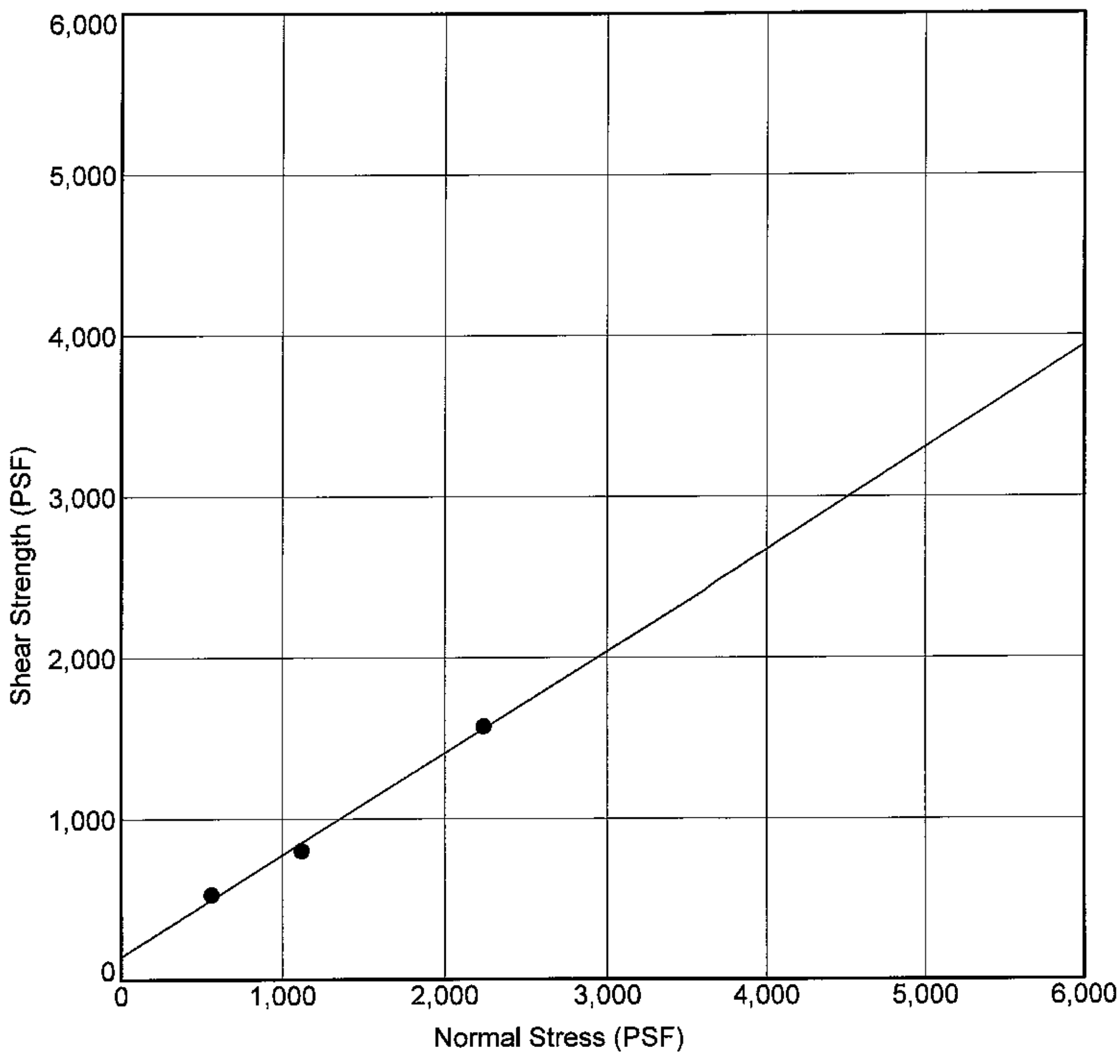
W.O. 16-5925

DIRECT SHEAR TEST

ASTM D3080

Plate B3.3

Direct Shear Test Results



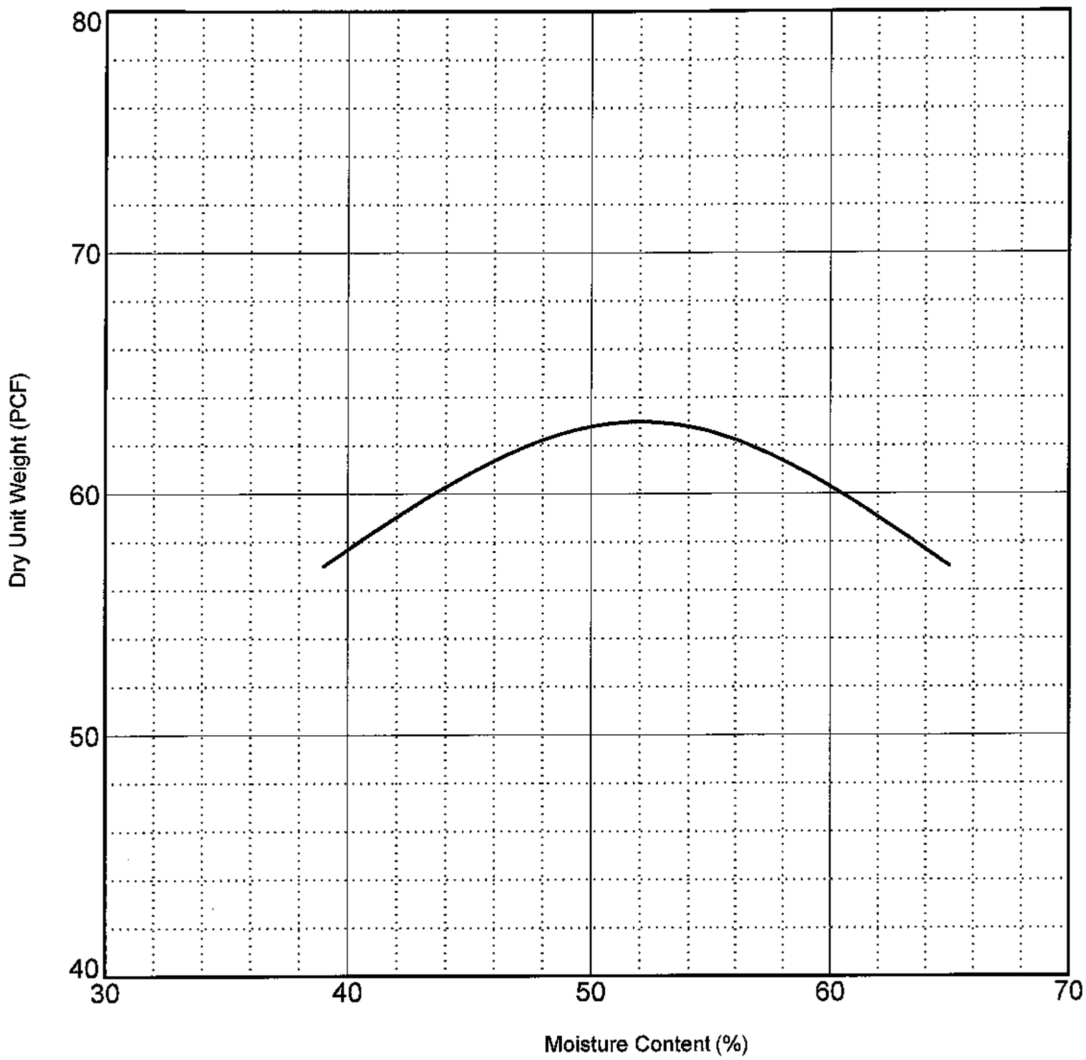
Soil Data

Boring No.: B10 Depth (ft): 3
Soil Description: Brown clayey silt with gravel

Test Results

Strength Intercept (c): 143.7 PSF (Peak Strength)
Friction Angle (phi): 32.3 DEG (Peak Strength)

Waimea Homestead Agricultural Park		
HIRATA & ASSOCIATES, INC. Geotechnical Engineering	**DIRECT SHEAR TEST**	Plate B3.4
W.O. 16-5925	*ASTM D3080*	



Soil Data

Location: Near boring B8 at 1 foot

Description: Brown clayey silt

Test Results

Maximum Dry Density: 63.0 PCF

Optimum Moisture Content: 52.0 %

Waimea Homestead Agricultural Park

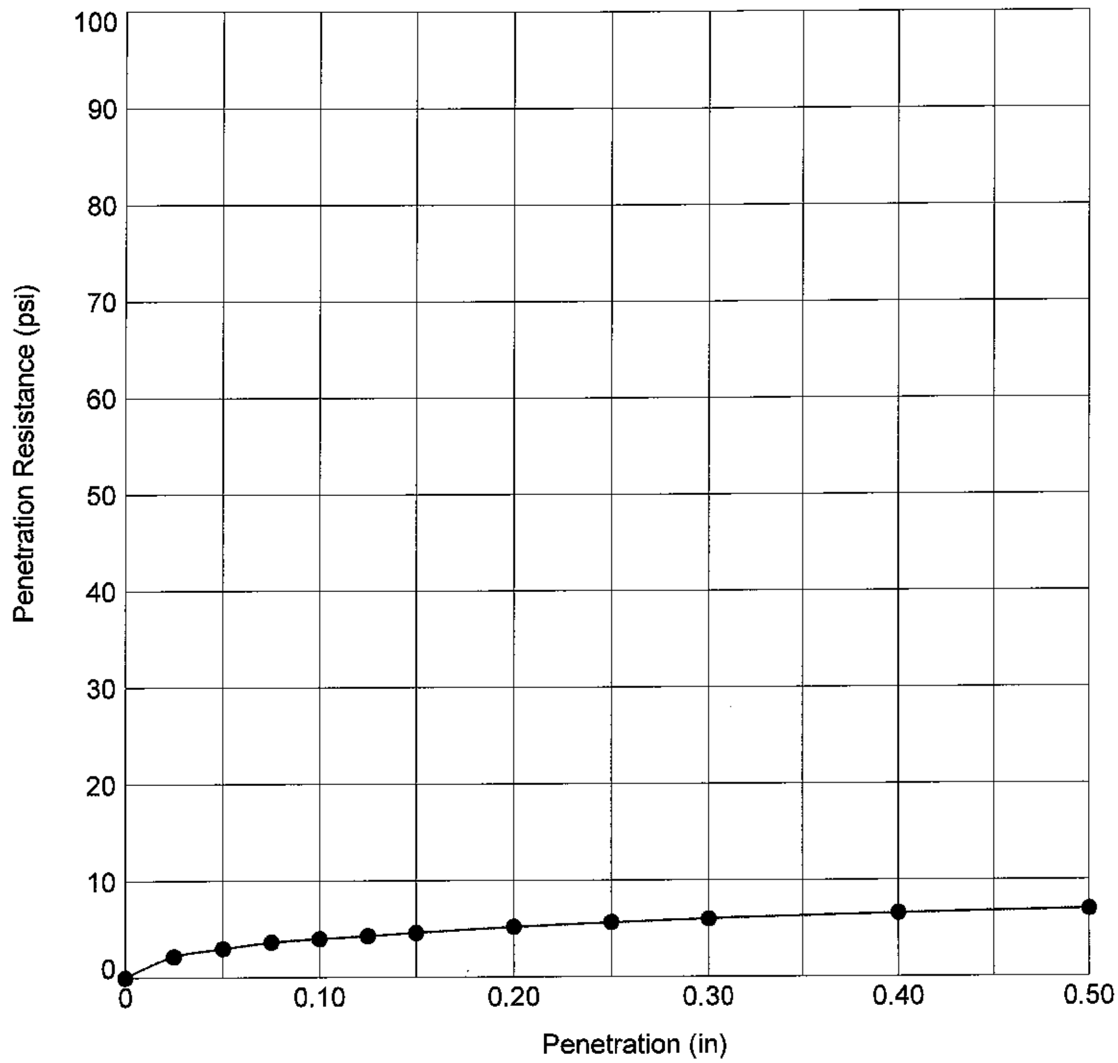
HIRATA & ASSOCIATES, INC.
Geotechnical Engineering

W.O. 16-5925

MODIFIED PROCTOR CURVE

ASTM D1557

Plate B4.1



<u>Soil Data</u>

Location:	Near boring B2 at 0.5 feet
Description:	Brown clayey silt with gravel
Sample Dry Density	63 pcf
Sample Moisture Content	52 %

<u>Test Results</u>

CBR Value:	0.1 %
Expansion:	0 %

Waimea Homestead Agricultural Park

HIRATA & ASSOCIATES, INC.
Geotechnical Engineering
W.O. 16-5925

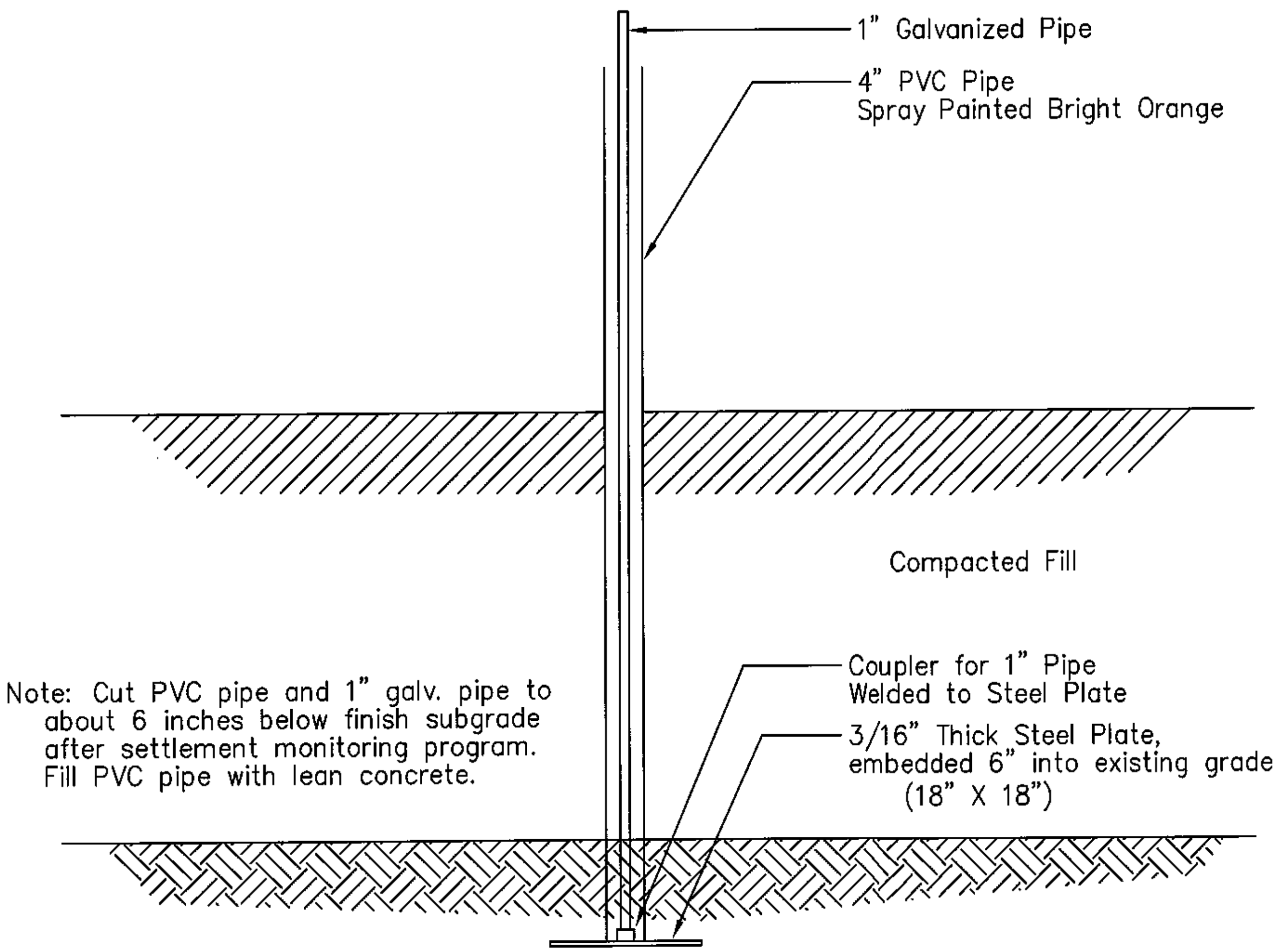
CBR STRESS PENETRATION CURVE

ASTM D1883

Plate
B5.1

APPENDIX C

SETTLEMENT GAUGE DETAIL



(Not to Scale)

Waimea Homestead Agricultural Park		
HIRATA & ASSOCIATES, INC. Geotechnical Engineering	SETTLEMENT GAUGE DETAIL	Plate C1.1
W.O. 16-5925		