SOIL REPORT

KAI HAWAII

STRUCTURAL & FORENSIC ENGINEERS

GEOTECHNICAL ENGINEERING EXPLORATION
NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

W.O. 6826-00 OCTOBER 27, 2016

Prepared for

R.M. TOWILL CORPORATION

and

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
HARBORS DIVISION

GEOLABS, INC.
Geotechnical Engineering and Drilling Services

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LICENSED PROFESSIONAL ENGINEER
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THIS WORK WAS PREPARED BY
ME OR UNDER MY SUPERVISION.

John Chen 4-30-18

SIGNATURE EXPIRATION DATE OF THE LICENSE

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GEOLABS, INC.
Geotechnical Engineering and Drilling Services

October 27, 2016
W.O. 6826-00

Mr. Craig Luke
R.M. Towill Corporation
2024 N. King Street, Suite 200
Honolulu, HI 96819

Dear **Mr. Luke:**

Geolabs, Inc. is pleased to submit our revised report entitled "Geotechnical Engineering Exploration, New Kapalama Terminal, Honolulu, Oahu, Hawaii" prepared for the design and construction of the proposed project. The revision reflects updates for site preparation and grading procedures.

Our work was performed in general accordance with the scope of services outlined in our revised fee proposal dated January 11, 2013.

Please note that the soil samples recovered during our field exploration (remaining after testing) will be stored for a period of two months from the date of this report. The samples will be discarded after that date unless arrangements are made for a longer sample storage period. Please contact our office for alternative sample storage requirements, if appropriate.

Detailed discussion and specific design recommendations are contained in the body of this report. If there is any point that is not clear, please contact our office.

Very truly yours,

GEOLABS, INC.

John Chen

John Y.L. Chen, P.E.
Vice President

JC:as

GEOTECHNICAL ENGINEERING EXPLORATION
NEW KAPALAMA TERMINAL
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SUMMARY OF FINDINGS AND RECOMMENDATIONS

Our field exploration indicated that the project site generally is underlain by dense/stiff surface fills and soft/loose lagoonal materials over variable coralline deposits. Lagoonal material about 4 to 12.5 feet thick, was encountered in a majority of the borings drilled for the project, except those that were drilled generally along the northern and southern boundary of the property. A layer of landfill material about 3 to 4 feet thick was encountered at depths of 4 to 13 feet below the existing ground surface near the northwestern corner of the site. Groundwater levels were encountered from depths of about 4.5 to 10.3 feet below the existing ground surface, corresponding to Elevations -0.9 to +3.7 feet MLLW.

The project site was divided into five pavement zones subject to various types of vehicles and repetitions. The pavement design was based on typical container handler forklift (Hyster H1050-1150HD-CH) and trailer truck (HS20-44) used in Hawaii with 25 and 50 years of design life. To optimize the concrete pavement design, we recommend using 750 pounds per square inch (psi) concrete flexural strength, which is higher than 650 psi traditionally used in Hawaii concrete pavement industry, to design the container yard concrete pavement. The design pavement sections are summarized in the following table. For comparison, the thickness of Portland cement concrete (PCC) may be increased from about 15 to 16.5 inches if using the lower flexural strength of 650 psi in Pavement Areas A, C and D.

SUMMARY OF PAVEMENT STRUCTURAL SECTION

Container Pavement Area	Recommended Pavement Sections	
	50-Year Design Life	25-Year Design Life
A	15.0-inch PCC + 6.0-inch AB	14.5-inch PCC + 6.0-inch AB
C	15.0-inch PCC + 6.0-inch AB	14.0-inch PCC + 6.0-inch AB
D	14.0-inch PCC + 6.0-inch AB	13.5-inch PCC + 6.0-inch AB
B	8.0-inch PCC + 6.0-inch AB or 4.5-inch AC + 10.0-inch ACB	7.5-inch PCC + 6.0-inch AB or 4.0-inch AC + 9.0-inch ACB
E	2.0-inch AC + 6.0 AB	

We recommend proof-rolling the subgrade soils at the bottom of the pavement structural sections, to obtain a firm and unyielding surface. We recommend a minimum of 12-inch over-excavation if yielding/pumping condition is encountered during the proof-rolling operation. We recommend using select granular material to backfill the over-excavation compacted to a minimum of 95 percent relative compaction, with a layer of geotextile fabric, such as Mirafi 180N or equivalent, placed at the bottom of the over-excavation.

Within the identified landfill areas, we recommend over-excavating a minimum of 12 inches below the existing ground surface (in fill area) or below finished subgrade (in cut area), and proof-rolling with a 20-ton roller at the bottom of the over-excavation. The over-excavation should be backfilled with select granular material, compacted to a minimum of 95 percent relative compaction. A layer of triaxial geogrid, such as Tensar TX-160 or equivalent, should be placed at the bottom of the pavement section over the entire identified landfill areas.

Soft/loose lagoonal deposits were encountered below the limits of the old fish ponds. To reduce potential pavement depression due to consolidation settlement induced by the new fills, we recommend the following grading sequence.

1. Demolish and remove all existing buildings and utilities on site;
2. In the identified landfill areas, over-excavation a minimum of 12 inches below existing ground surface (in fill areas) or below finished subgrade (in cut areas) and backfill with select granular material;
3. In other grading areas, grade to subgrade with 8 inches of scarification
4. Proof-roll with 20-ton vibratory compactor at existing grade in fill areas and at finished subgrade in cut areas;
5. In yielding areas (except the identified landfill areas), over-excavate a minimum of 12 inches and place a layer of geotextile fabric, and survey location of yielding areas;
6. Backfill over-excavation with select granular material with a minimum of 95% relative compaction;
7. Install settlement gauges for 2 to 3 months of settlement monitoring;
8. Surcharge the fill areas if the new fill is greater than 3 feet thick;
9. Once consolidation of fill areas is complete, fine grade entire site to finished subgrade elevation;
10. Install drainage and utilities (pipes and structures);
11. Place a layer of triaxial geogrid over entire landfill areas;
12. Place aggregate base course;
13. Construct concrete pavements.

The surcharge fill may consist of stockpiling 4 feet of materials for a period of 2 to 3 months. The settlement monitoring should be conducted optically by a qualified surveyor and reviewed by Geolabs.

We recommend an allowable bearing pressure of 1,500 psf for design of below-grade structures, such as drainage inlets, supported on a stabilization layer. The stabilization layer may consist of 2 feet of 3B Fine gravel (ASTM C33, No. 67 gradation) wrapped in a filter fabric, such as Mirafi 180N or equivalent. We also recommend an allowable bearing pressure of 3,000 psf for design of shallow foundations supporting the compacted granular material for the new comfort station and retaining walls.

We recommend using 48-inch diameter drilled shafts with an embedment depth of at least 25 feet below the pavement surface to support the new container yard light poles. The text of this report should be referred to for detailed discussion and specific design recommendations.

END OF SUMMARY OF FINDINGS AND RECOMMENDATIONS

SECTION 1. GENERAL

1.1 Introduction

This report presents the results of our geotechnical engineering exploration performed for the proposed *New Kapalama Terminal* project in Honolulu on the Island of Oahu, Hawaii. The project location and general vicinity are shown on the Project Location Map, Plate 1.

This report summarizes the findings from our field exploration and laboratory testing and presents our geotechnical recommendations derived from our analyses for the project. These recommendations are intended for the design of pavements, below-grade structures, shallow foundation, light pole foundations, underground utility lines, and site grading only. The findings and recommendations presented herein are subject to the limitations noted at the end of this report.

1.2 Project Considerations

The proposed Kapalama Terminal project is part of the Harbor Modernization program, to increase the container storage capacity of Honolulu Harbor by about 1 million TEUs (Twenty Foot Equivalent Units) per year. We understand that the total project area encompasses approximately 90 acres within the existing Kapalama Military Reservation near the western end of Honolulu Harbor, adjacent to Pier 41 to the east and Sand Island Access Bridge to the south.

We understand that Kapalama Terminal development includes construction of new wharves/piers and container terminal. The new wharves/piers will consist of 1,840 feet of berthing to Pier 42 and Pier 43 (designed by others). The container terminal developments include on-site and off-site work. Off-site work includes a weight station, roadway improvements and other infrastructure. The scope of work presented in this report is for the on-site container terminal development, including container yard concrete pavements supporting industrial heavy container forklift loads (such as Hyster-H1050-1150HD-CH or equivalent) during storage, toplift, and transportation loading.

The project also involves lighting system development within the new container yard. We envision that containers will be stacked up to four high, requiring the construction of new 80-foot light poles. Details for the new light poles were not available at the time of this report preparation. The following preliminary structural loading information was provided for our foundation analysis by the project structural engineer, KAI Hawaii, Inc.

80-FOOT TALL LIGHT POLE LOADS		
Axial (kips)	**Shear** (kips)	**Overturning Moment** (ft-kips)
9.5	7.7	377

We envision drilled shaft foundations will be required for foundation support of the new light poles to resist the high overturning moment demands. Due to the presence of shallow groundwater conditions, concrete placement for the drilled shaft foundations will require placement by tremie methods.

In addition, the new infrastructures such as underground structures, storm drain inlets/manholes, comfort station, water, sanitary and others are also required as part of the container terminal development. Two three-story buildings are planned as new terminal offices, designed by others.

Based on the topographic map provided, the existing grades at the project site vary from about +5 to +10 feet Mean Lower Low Water (MLLW). We anticipate that site grading consisting of cuts and fills up to about 4 to 5 feet will be needed to achieve the design finished grades for the proposed project. In addition, we anticipate that some deep excavations of up to about 6 to 10 feet deep may be required for construction of the waterlines and/or drainage structures.

Based on the information presented on the U.S. Geological Survey map published by the International Archaeological Research Institute, Inc., dated July 2002, the project site was previously occupied by two large fish ponds (Ananaho Pond and Auiki Pond) prior to WWII. Based on the project EA study report, portions of the site were used as a municipal dump during the 1930s and 1940s. Therefore, our field exploration focused on identification and quantification of the soft/loose soil and delineating dump site limits for design of the site grading.

Based on the information provided, portions of the site were expected to be contaminated with petroleum-based hydrocarbons and potential chlordane by-product may be encountered under the existing warehouse concrete slab. The drilling equipment was prepared to be decontaminated under environmental protocol, if contaminated soil was encountered in the boring. In addition, environmental samples were collected by others for the environmental assessment.

1.3 Purpose and Scope

The purpose of our geotechnical engineering exploration was to obtain a general overview of the surface and subsurface conditions to formulate a summary of the soil and/or rock conditions for design of the pavements, below-grade structures, shallow foundations, light pole foundations, underground utility lines, and site grading. In order to accomplish these objectives, we conducted an exploration program generally consisting of the following tasks and work efforts:

1. Review of in-house boring logs and geology information in the project vicinity.
2. Preparation of an Accident Prevention Plan specific to the work being performed by Geolabs personnel for the project, with consideration of potential contamination encountered in the borings and environmental protocol.
3. Application of the necessary excavation permits and One-Call application and coordinating with existing warehouse tenants for clearance of boring access.
4. Mobilization and demobilization of a truck-mounted drill rig for the borings located outside of the existing warehouses and a track-mounted drill rig for the borings located inside of the warehouses, and two operators to the project site and back.
5. Drilling and sampling of 20 borings extending to depths of about 30 to 123.5 feet below the existing ground surface for a total of approximately 848.6 lineal feet of exploration.
6. Conducting decontamination and environmental protocol for the upper 10 to 15 feet of drilling by installing 6-inch diameter PVC casing and grouting with cement-bentonite grout.
7. Performance of three percolation tests to evaluate in-situ soil permeability characteristics.

8. Coordination of the field exploration, boring stakeout, and logging of the borings by our geologist.
9. Laboratory testing of selected soil samples obtained during the field exploration as an aid in classifying the materials and evaluating their engineering properties.
10. Analyses of the field and laboratory data to develop geotechnical recommendations for the design of pavements, below-grade structures, shallow foundations, light pole foundations, underground utility lines, and site grading.
11. Preparation of this report summarizing our work on the project and presenting our findings and geotechnical recommendations.
12. Coordination of our work on the project by our engineer.
13. Quality assurance of our overall work on the project and client/design team consultation by our principal engineer.
14. Miscellaneous work efforts such as drafting, word processing, clerical support, and reproductions.

Detailed descriptions of our field exploration and Logs of Borings are presented in Appendix A. Results of the laboratory tests performed on selected soil samples are presented in Appendix B. Results of the in-situ permeability tests performed at selected locations and depths are presented in Appendix C.

END OF GENERAL

SECTION 2. SITE CHARACTERIZATION

2.1 Regional Geology

The Island of Oahu was built by the extrusion of basaltic lavas from the Waianae and Koolau shield volcanoes. The older Waianae Volcano is estimated to be middle to late Pliocene in age and forms the bulk of the western third of the island. The younger Koolau Volcano is estimated to be late Pliocene to early Pleistocene (Ice Age) in age and forms the majority of the eastern two-thirds of the island. Waianae became extinct while Koolau Volcano was still active, and its eastern flank was partially buried below Koolau lavas banking against its eastern flank. After a long period of volcanic inactivity, during which time erosion incised deep valleys into the Koolau Shield, volcanic activity returned with a series of lava flows followed by cinder and tuff cone formations. These series are referred to as the Honolulu Volcanic Series.

The project site is on the coastal plain of Southern Oahu. The coastal plain was built on the eroded flanks of the Koolau Volcano, which forms the eastern two-thirds of the Island of Oahu. The coastal plain was built by extensive accumulation of alluvium derived from erosion of the volcano, interbedded with coral reefs and associated deposits.

During the Pleistocene Epoch (Ice Age), sea levels fluctuated in response to the cycles of continental glaciation. Most of the coastal plains were developed during the Pleistocene Epoch when the sea levels fluctuated significantly. As the glaciers grew and advanced, less water was available to fill the oceanic basins such that sea levels fell below the present stands of the sea. When the glaciers melted and receded, an excess of water became available such that the sea levels rose to above the present sea.

The processes of erosion and deposition were affected by these glacio-eustatic sea level fluctuations. When the sea level was low, the erosional base level was correspondingly lower, and valleys were carved to depths below the present sea level. When the sea level was high, the erosional base level was raised such that sediments accumulated at higher elevations.

The project site generally is underlain by deposits of calcareous sediments and alluvium. The deposition of soils at the site is likely associated with the nearby Kapalama

Stream/Basin, lagoonal deposits from old fishponds and from Honolulu Harbor, and coralline formation. A surface layer of man-made fill was placed over these deposits to extend the shoreline for the development of Honolulu Harbor within the last century.

2.2 Site Description

The Kapalama Terminal project site is near the western end of the existing Honolulu Harbor in the District of Honolulu on the Island of Oahu, Hawaii. It is adjacent to Keehi Lagoon and Kapalama Basin. The project site is bounded by Pier 41 to the east, Auiki Street to the north, Sand Island Access Road to the west, and Honolulu Harbor to the south, as shown on the Site Plan, Plate 2.

The project site was previously owned by the U.S. Navy as the Kapalama Military Reservation and was turned over to the State of Hawaii under the jurisdiction of Department of Transportation – Harbors Division. Currently, the warehouses on site are rented by various venders, including University Marine Research Center, Island Movers, Pacific Shipyard, Pacific Commercial Services, and other small venders. Majority of the project site is covered by either asphaltic concrete pavement or gravel for industrial access and parking. Most of the existing warehouses were built about 3 to 4 feet above the adjacent ground surface.

Based on the topographic map provided, the project site is relatively level. The existing ground elevations at the project site range from approximately +5 to +10 feet MLLW.

2.3 Subsurface Conditions

Our field exploration at the project site consisted of drilling and sampling 20 borings, designated as Boring Nos. 101 through 118, 201 and 202, extending to depths of about 30 to 123.5 feet below the existing ground surface. The approximate boring locations are shown on the Site Plan, Plate 2.

In general, the project site is underlain by surface fill and lagoonal deposits overlying coralline deposits. Granular surface fill materials were encountered with the consistency of dense to medium dense, extending to depths varying from 2.5 to 14 feet below the existing ground surface. The granular surface fills were underlain by soft/loose lagoonal deposits extending to a depth of up to about 22 feet deep. Coralline deposits consisting of dense coral formation, sandstone, and medium dense coralline detritus with localized loose/soft pockets with variable consistency extended to the maximum depth explored of about 123.5 feet below the existing ground surface.

Two large fish ponds (Ananaho Pond and Auiki Pond) located in the project site prior to WWII were documented on the U.S. Geological Survey map published by the International Archaeological Research Institute, Inc., dated July 2002. Some of the soft/loose lagoonal deposits may be from the old fish ponds. Based on the vicinity where the soft/loose lagoonal deposits were encountered, the approximate fish pond limits were delineated as presented on the Site Plan, Plate 2. Thickness of the soft/loose lagoonal deposits ranged from about 4 to 12.5 feet in the borings within the approximate fish pond limits.

In addition, landfill materials consisting of metal, glass and other debris were encountered in Boring Nos. 105, 107, 111 and 112 at depths of 4 to 10 feet below the existing ground surface. The landfill materials may be from a documented dump site during the 1930s and 1940s. An approximate landfill limit was estimated in the vicinity where the landfill materials were encountered in the borings, as also presented on the Site Plan, Plate 2. Thickness of the landfill materials varied from 3 to 4 feet in the borings drilled within the approximate landfill limit.

Four sets of California Bearing Ratio (CBR) tests were performed on bulk samples of the near-surface soils to evaluate the strength characteristics for pavement subgrade support. Each set of CBR tests were conducted with two compaction densities, to simulate various compaction efforts ranging from 90 to 100 percent relative compaction.

We encountered groundwater at depths of about 4.5 to 10.3 feet below the existing ground surface, corresponding to elevations from -0.9 to +3.7 feet MLLW, at the time of our field exploration. Due to the proximity of the project site to the Pacific Ocean, groundwater levels are expected to change with tidal fluctuations. Seasonal precipitation, storm surge condition, surface water runoff, and other factors may also influence the groundwater levels at the project site.

Detailed descriptions of the materials encountered from our field exploration are presented on the Logs of Borings, Plates A-1.1 through A-20 of Appendix A. Laboratory tests were performed on selected soil samples, and the test results are presented in Appendix B.

2.4 In-Situ Permeability Testing

Three in-situ permeability tests were conducted at Boring Nos. 106, 115 and 201 to evaluate the infiltration characteristics of the subsurface materials encountered at the project site. The locations are shown on the Site Plan, Plate 2.

The permeability tests were typically performed at a depth of about 15 feet below the existing ground surface. Depending on rate of percolation, either constant head tests or falling head permeability tests were performed to determine the average hydraulic conductivity of the underlying subsurface materials. Water was introduced into the boring and the stabilized water level under a constant injection rate was measured in the boring for the constant head test, while the drop of the water level in the boring was measured along with time for the falling head test until reaching equilibrium steady state.

FIELD PERMEABILITY TEST RESULTS

Test Location	**Test Depth** (feet)	**Test Soil**	**Hydraulic Conductivity** (centimeters/second)
B-106	14	Coral	1.2×10^{-2}
B-115	16	Coralline Detritus	1.4×10^{-5}
B-201	16	Coralline Detritus	3.0×10^{-5}

Based on the in-situ permeability test results, the calculated hydraulic conductivity (k-value) at each test location is summarized in the above table. It should be noted that the permeability of the subsurface soils may range broadly and also vary locally in terms of orders of magnitude. The results of our permeability tests are presented on Plates C-1 through C-3 of Appendix C.

END OF SITE CHARACTERIZATION

SECTION 3. DISCUSSION AND RECOMMENDATIONS

Our field exploration indicated that the project site is generally underlain by surface fills and lagoonal materials over coralline deposits. The surface fills consisted of granular coralline gravel and sand with occasional silty or clayey soils, extending to depths of about 4 to 14 feet below existing ground surface. The lagoonal materials were comprised of soft/loose silty or sandy soils with thickness varying from 4 to 12.5 feet. It should be noted that the lagoonal material was not encountered in the borings drilled generally along the northern and southern boundary of the property. The coralline deposits primarily consisted of hard coral formation/sandstone and variable coralline detritus extending to the maximum depth drilled of approximately 123.5 feet below the existing ground surface. Groundwater levels were encountered from depths of about 4.5 to 10.3 feet below the existing ground surface.

Based on the traffic loading information provided and the pavement subgrade conditions anticipated, the pavement design was divided into five container pavement areas, designated as Areas A through E, for both 50 and 25 years of design life. Due to the heavy industrial container handler forklift loads, we believe that a rigid pavement section consisting of 13.5 to 15.0 inches of Portland cement concrete over 6 inches of aggregate base course may be used for the container yard pavement at Pavement Areas A, C and D. A higher concrete flexural strength of 750 psi was used to optimize the above concrete pavement design. However, the thickness of concrete pavement sections would increase to 15 to 16.5 inches of Portland cement concrete over 6 inches of aggregate base course, if the lower conventional flexural strength of 650 psi is used. Pavement Area B will be primarily subjected to trailer truck vehicles. Therefore, either rigid pavement section or flexible pavement section may be considered in the channelized entry and exit for the container trucks. Light-duty flexible pavement section may be designed for Pavement Area E to support primarily passenger cars and pickup trucks with occasional heavy trucks.

In order to provide a stable subgrade for the pavement structural section, we recommend proof-rolling the subgrade soils (at finished subgrade in cut areas and at existing ground surface in fill areas). If yielding or pumping condition is encountered during the proof-rolling, we recommend over-excavating a minimum of 12 inches and replacing with select granular material with a layer of geotextile fabric, such as Mirafi 180N or equivalent, placed at the bottom of the over-excavation.

Within the identified landfill areas, we recommend over-excavating a minimum of 12 inches below the subgrade soils (finished subgrade in cut areas, and existing ground surface in fill areas) with subsequent proof-rolling using 20-ton vibratory roller at the bottom of the over-excavation. The over-excavation should be backfilled with select granular material. The select granular material should be compacted to at least 95 percent relative compaction. In addition, a layer of triaxial geogrid, such as Tensar TX-160 or equivalent, should be placed at the bottom of the pavement section over the entire identified landfill areas.

To reduce risk of potential pavement depression due to consolidation settlement caused by the new fills over the soft/loose lagoonal soils in the old fish pond areas, we recommend a surcharge and settlement monitoring program. The surcharge should consist of 4 feet of material placed for a period of 2 to 3 months in the fill areas where the fill thickness is greater than 3 feet. Where the fill thickness is less than 3 feet, the surcharge may be eliminated, but a waiting period should be implemented. The waiting period may consist of placing select granular material to design finished subgrade with settlement monitoring for a period of 2 to 3 months. The settlement monitoring should be conducted optically by a qualified surveyor and reviewed by Geolabs.

In addition, we recommend using 48-inch diameter drilled shafts with an embedment depth of at least 25 feet below the pavement surface to support the new container yard light poles. Detailed discussions of these items and our geotechnical recommendations for design are presented in the following sections.

3.1 Pavement Design

It is desired to construct concrete pavement to support the heavy container handler forklift at the container yard in the new Kapalama Terminal. The design procedures used in determining the new rigid pavement sections are based on the "Design of Heavy Industrial Concrete Pavements" developed by the Portland Cement Association.

3.1.1 Design Traffic Loading Conditions

We envision the new concrete pavement sections at the new container yard will be subjected to traffic loads from various types of container handlers similar to Hyster H1050-1150HD-CH with a maximum axle capacity of about 229,369 pounds. Other heavy container handlers, such as Taylor TXLC-975 with a maximum axle capacity of about 221,000 pounds (less than the capacity of Hyster H1050-1150HD-CH), may also be considered. Therefore, the design vehicle of the new concrete pavements is assumed to be the Hyster H1050-1150HD-CH Container Handler Forklift.

We understand that a typical 40-foot standard container generally has a maximum gross weight of 68,000 lbs. As suggested by Interpave, reduction of the gross weight up to 40 percent may be used while containers are stacked in a block arrangement up to five high. To be conservative, a reduction of 30 percent for the gross weight is considered in the pavement design. This translates to a maximum front axle load of about 203,409 pounds for the Hyster H1050-1150HD-CH Container Handler Forklift. Detailed information and design parameters for the controlling vehicle are presented in the following table.

DESIGN TRAFFIC PARAMETERS (Hyster H1050-1150HD-CH Container Handler Forklift Truck)	
Pavement Classification	Heavy Industrial
Maximum Front Axle Load (with reduced 49,000 pounds container)	203,409 pounds
Maximum Single Wheel Load	50,852 pounds
Tire Ground Contact Pressure	98 psi
Tire Ground Contact Area	605 square inches
Dual Tire Separation (center to center)	26.7 inches
Dual Wheel Spacing (center to center)	143 inches

3.1.2 Design Subgrade Conditions

Based on our field exploration, the proposed new container yard generally is underlain by granular fills extending to depths of about 4 to 14 feet below the existing ground surface. The granular materials are underlain by lagoonal deposits consisting of soft silty and sandy soil extending to depths of about 6.5 to 22 feet deep.

Based on our field exploration and the anticipated design grades for the project, we believe the pavement subgrade soils will consist of the medium dense to dense granular materials overlying the soft lagoonal deposits. We recommend using a CBR value of about 20 with a modulus of subgrade reaction (k-value) of about 250 pounds per square inch of deflection (pci) for pavement design.

Since soft lagoonal deposits may be present at shallow depths in localized areas, we envision yielding or pumping conditions may be encountered during pavement subgrade proof-rolling. If the yielding or pumping occurs at the subgrade, we recommend a minimum of 12 inches over-excavation to remove the yielding soft soils. The over-excavation should be backfilled with select granular material and a layer of geotextile fabric, such as Mirafi 180N or equivalent, placed at the bottom of the over-excavation.

Additional subgrade preparation requirements are presented in the "Subgrade Preparation Below Pavement Section" subsection.

3.1.3 Design Pavement Sections

Based on the pavement zone map provided, we understand that heavy industrial container forklift is anticipated in Area A (container storage yard fronting Pier 41), Area C (container storage yard fronting Piers 42 and 43), and Area D (storage for empty container and maintenance). Approximate pavement zone locations are shown on Plate 4, Pavement Area Map. Based on the information provided, we understand that the tare weight of a 40-foot container is about 7,000 pounds. In addition, we understand that traffic in Area B (channelized gate lanes) primarily consists of 5-axle trailer trucks, such as HS20-44 or equivalent. Based on information provided, the repetitions of the vehicles at each zone are interpreted and summarized in the following table. Pavement design life of 50-year and 25-year was considered in the design for comparison.

SUMMARY OF VEHICLE REPETITION				
Container Pavement Area	**Design Vehicle**	**Single Wheel Load** (pounds)	**Repetition** (Avg. per year)	
			50-yr	25-yr
A	Hyster H1050-1150HD-CH Container Forklift	50,852	3,267	3,200
C		50,852	3,200	2,400
D		43,896	6,533	6,400
B	HS20-44		270,844	240,472
E	Passenger Cars and Pickup Trucks with Occasional Heavy Trucks			

Rigid concrete pavement for the proposed container yard under heavy container forklift is preferred within the container Pavement Areas A, C and D. At the channelized entry and exit gate access Area B, the pavement structural sections design is assumed to support the trailer truck loads, such as HS20-44. Both rigid and flexible concrete pavements may be considered due to the lower traffic loads. In addition, light-duty flexible pavements are considered for Area E due to vehicular traffic primarily consisting of passenger cars and light pickup trucks with occasional heavy trucks.

Based on the above assumptions and a properly prepared subgrade, we recommend the following pavement structural sections within the proposed container pavement area for the new Kapalama Terminal project.

SUMMARY OF PAVEMENT STRUCTURAL SECTION (750 psi of Flexural Strength)		
Container Pavement Area	**Recommended Pavement Sections**	
	50-Year Design Life	**25-Year Design Life**
A (Toplift)	15.0-inch PCC + 6.0-inch AB	14.5-inch PCC + 6.0-inch AB
C (Toplift)	15.0-inch PCC + 6.0-inch AB	14.0-inch PCC + 6.0-inch AB

SUMMARY OF PAVEMENT STRUCTURAL SECTION
(750 psi of Flexural Strength)

Container Pavement Area	Recommended Pavement Sections	
	50-Year Design Life	25-Year Design Life
D (Empty Container Storage)	14.0-inch PCC + 6.0-inch AB	13.5-inch PCC + 6.0-inch AB
B (Channelized Gate Access)	8.0-inch PCC + 6.0-inch AB or 4.5-inch AC + 10.0-inch ACB	7.5-inch PCC + 6.0-inch AB or 4.0-inch AC + 9.0-inch ACB
E (Parking Lots)	2.0-inch AC + 6.0 AB	

Remarks: PCC – Portland Cement Concrete
AC – Asphaltic Concrete
AB – Aggregate Base Course
ACB – Asphaltic Concrete Base

It should be noted that the above pavement structural sections were calculated based on a minimum concrete flexural strength of 750 psi when tested in accordance with ASTM C78, which is higher than the conventional flexural strength of 650 psi used in the Hawaii concrete industry. If the concrete flexural strength of 650 psi is used, the thickness of the Portland cement concrete will need to be increased from 15 to 16.5 inches.

SUMMARY OF PAVEMENT STRUCTURAL SECTION
(650 psi of Flexural Strength)

Container Pavement Area	Recommended Pavement Sections	
	50-Year Design Life	25-Year Design Life
A (Toplift)	16.5-inch PCC + 6.0-inch AB	16.0-inch PCC + 6.0-inch AB
C (Toplift)	16.5-inch PCC + 6.0-inch AB	16.0-inch PCC + 6.0-inch AB
D (Empty Container Storage)	15.5-inch PCC + 6.0-inch AB	15.0-inch PCC + 6.0-inch AB
B (Channelized Gate Access)	8.0-inch PCC + 6.0-inch AB or 4.5-inch AC + 10.0-inch ACB	7.5-inch PCC + 6.0-inch AB or 4.0-inch AC + 9.0-inch ACB
E (Parking Lots)	2.0-inch AC + 6.0 AB	

The pavement subgrade soils should be scarified to a depth of at least 8 inches, moisture-conditioned to above the optimum moisture content, and compacted to no less than 95 percent relative compaction. Relative compaction refers to the in-place dry density of soil expressed as a percentage of the maximum dry density of the same soil determined in accordance with ASTM D1557 (AASHTO T 180). Optimum moisture is the water content (percentage by dry weight) corresponding to the maximum dry density.

The asphalt concrete base material should consist of asphalt treated basalt aggregates compacted to a density of no less than 91 percent of the maximum theoretical specific gravity determined in accordance with ASTM D2041 or AASHTO T 209. The aggregate base course should consist of basaltic aggregates compacted to a minimum of 95 percent relative compaction.

We recommend performing CBR and field density tests on the actual pavement subgrade materials encountered during construction to confirm the adequacy of the recommended pavement sections.

3.1.4 Subgrade Preparation Below Pavement Section

As previously mentioned, localized soft lagoonal soil may be near the bottom of the aggregate base course layer. Therefore, we recommend proof-rolling the subgrade soils (at the existing grade in fill areas and finished subgrade in cut areas) to obtain a firm and unyielding surface.

If yielding or pumping condition is encountered during the proof-rolling operation, we recommend a minimum of 12-inch over-excavation to remove soft/yielded material. The over-excavation should be backfilled with select granular material and a layer of geotextile fabric, such as Mirafi 180N or equivalent, placed at the bottom of the over-excavation. The select granular backfill should be compacted to a minimum of 95 percent relative compaction. Relative compaction refers to the in-place dry density of soil expressed as a percentage of the maximum dry density of the same soil established in accordance with ASTM D1557. Optimum moisture is the water content (percentage by dry weight) corresponding to the maximum dry density.

A Geolabs representative should further evaluate the need for over-excavation in the field during construction due to the soft and/or loose subgrade soil conditions.

Therefore, contract documents should include unit prices for additional over-excavation and compacted fill placement to account for variations in the over-excavation quantities. For preliminary budgeting purposes, we recommend allocating a contingency fund for an additional over-excavation of 12 inches below the aggregate base course layer and replacement with compacted select granular material underlain by a layer of geotextile fabric, such as Mirafi 180N or equivalent. Based on our field exploration, we estimate the additional over-excavation may entail approximately 15 percent of the pavement area within the project site.

3.1.5 Subgrade Preparation in Old Landfill Area

Landfill materials were encountered in Boring Nos. 105, 107, 111 and 112 at depths of 4 to 13 feet below the existing ground surface. The landfill materials may be part of the former dump site as documented in the project EA report. Approximate landfill limit is presented in the Site Plan, Plate 2.

The landfill materials encountered in our borings consisted primarily of inert glass, metal and plastic debris. Ideally, this landfill debris should be over-excavated and replaced with compacted select granular fill. However, due to the large volume of material, this may be cost prohibitive. Since the landfill debris is at some depth and in a relatively dense condition, we believe that it may remain in place.

To reduce risk of pavement depression overlying the compressible landfill materials, we recommend over-excavating a minimum of 12 inches below existing ground surface (in fill areas) or below the finished subgrade (in cut areas). The bottom of the over-excavation should be proof-rolled with a minimum 20-ton vibratory roller, prior to backfilling with the select granular material. The select granular backfill material should be placed in two lifts and compacted to a minimum of 95 percent relative compaction. In addition, a layer of triaxial geogrid, such as Tensar TX-160 or equivalent, should be placed at the bottom of the pavement section over the entire identified of landfill areas.

3.2 Pavement Drainage

One of the primary distress mechanisms in pavement structures is pumping due to saturation of the subgrade soils. Therefore, the pavement surface should be sloped, and drainage gradients should be maintained to carry surface water off the pavement to appropriate drainage structures. Surface water ponding should not be allowed on-site during or after construction. Where landscaping is planned adjacent to the pavement areas, we recommend constructing a subdrain system to collect the excess water from landscaping irrigation and to reduce the potential for migration of landscape water into the pavement section. The recommended pavement sections assume that good drainage will be provided for the paved areas.

3.3 Pavement Joints

Due to the rigidity of the Portland cement concrete pavements, significant stresses may develop in the concrete from variations in temperature and moisture content. In order to relieve the high level of stress and to reduce the potential for cracking, adequate joints should be provided in the Portland cement concrete pavement. The following describes the various types of joints and general guidelines that should be implemented in the design of concrete pavements.

3.3.1 Crack Control Joints (Contraction Joints)

In general, decrease in temperature or moisture content, such as that during concrete curing, will cause the concrete to contract and possibly crack. Crack control joints are used to provide controlled cracking due to volume changes and relieve the stresses caused by curling or warping. Crack control joints, such as saw cut joints or formed grooves, are provided to a depth of generally one-fourth (¼) the slab thickness. These saw cut joints or formed grooves (crack control joints) provide a weakened plane, which will likely crack through the full depth as the concrete shrinks during the curing process.

In general, the spacing of crack control joints should be limited to a maximum of 20 feet. Smaller joint spacing should be used if the concrete pavement will be subjected to extreme temperature gradients during the placement and/or life span of the pavement. The crack control joints should be provided in both longitudinal and transverse directions. The transverse joint spacing should not vary from the longitudinal joint spacing by more than 25 percent.

3.3.2 Expansion Joints (Isolation Joints)

Expansion joints are typically used to relieve compressive stresses developed at critical locations due to fluctuations in temperature. Expansion joints are cut to the full depth of the concrete slab, and compressible filler materials are placed in the cut. These joints allow for isolated lateral movement of the slabs and reduce the potential for damage to the adjoining concrete (spalling of the edges of the concrete slabs).

Expansion joints should be used at pavement intersections and at intersections of pavements with fixed structures, such as the light pole structures. Because expansion joints generally do not provide for load transfer across the joint, placement of dowels with lubrication on one end of the dowel should be considered for load transfer across the expansion joint, where required.

3.3.3 Construction Joints

Construction joints are generally required when two abutting slabs are placed at different times. Therefore, construction joints usually form the edges of each day's work. For the relatively thick concrete slab (13 to 16 inches) planned for this project, the construction joints should consist of a keyed or butted joint. In general, construction joints should be aligned with the crack control or expansion joints to reduce the number of pavement joints required.

3.4 Below-Grade Structures

Based on the information provided, we understand below-grade structures, such as storm drain inlets, electrical hand holes, and valve vaults, will be installed as part of the terminal development. We anticipate the bottom of these below-grade structures may be embedded within the upper 10 feet below the existing ground surface. Based on our field exploration results, we envision that the bottom of these structures will be underlain by the soft lagoonal deposits encountered at depths of about 4 to 12.5 feet below the existing ground surface. On this basis, we believe that an allowable bearing pressure of up to 1,500 pounds per square foot (psf) may be used for the foundation design of the below-grade structures bearing on a stabilization layer as described below. This allowable bearing pressure is for dead-plus-live loads and may be increased by one-third (1/3) for transient loads, such as temporary wind and/or seismic forces.

Due to the presence of soft subsurface soils near the foundation subgrade level of the below-grade structures, we recommend providing a stabilization layer consisting of at least 2 feet of 3B Fine gravel (ASTM C33, No. 67 gradation) wrapped in a filter fabric, such as Mirafi 180N or equivalent, below the underground structures for uniform bearing support. In addition, the stabilization layer also would serve as a working platform during construction. In order to reduce the potential for significant settlement of the underground structures, we recommend sewing the filter fabric (in lieu of overlapping) and using light compaction equipment during installation of the below-grade structures. In addition, the minimum 2-foot thick stabilization layer should extend at least 2 feet beyond the edges of the structures.

Resistance to uplift loads resulting from buoyancy forces may be mobilized by the dead weight of the underground structure. Contribution of dead weight from the backfill, if applicable, may be estimated using a unit weight of 135 pounds per cubic foot (pcf) above the groundwater table and 70 pcf below the groundwater table. For side shear between the structure and the backfill material, a nominal value of 100 psf may be used in design. For evaluating uplift forces due to hydrostatic pressures, a high groundwater level of Elevation +3 feet MLLW may be used for design to take into consideration tidal fluctuations.

Settlements of the underground structures may result from compression of the soft and/or loose soil layer due to the placement of the backfill material and/or disturbance of the soft and/or loose subsurface soils during construction. We estimate the total settlement of the underground structures to be on the order of about 1 inch. We believe that most of the settlements should occur during the grading period.

Because of the soft and/or loose subsurface soils encountered, some movement of soils around the underground structure excavations should be anticipated due to changes in the earth stresses during and after construction, especially during extraction of the sheet pile shoring system, where provided. In addition, it should be noted that dewatering for construction of adjacent structures in the future may result in settlement of these underground structures. Therefore, we recommend incorporating some flexibility in the connection of the piping network to the underground structures in the design to accommodate possible earth movements.

The lateral earth pressures acting on the proposed underground structures will depend on the type of backfill used, the extent of backfill, and the compactive effort on the backfill material around the structures. For backfill below the groundwater table, we anticipate it may be desirable to backfill behind the retaining structure using a free-draining type of backfill, such as No. 3B Fine gravel (ASTM C33, No. 67 gradation). This is to reduce the compactive effort required and to facilitate backfill below the groundwater table or in a wet environment. If a free-draining type of backfill is used, a filter fabric should be used to wrap around the free-draining backfill.

Underground structures planned at the container yard site should be designed to resist the lateral earth pressures due to the adjacent soil and surcharge effects. Based on the subsurface conditions encountered at the site, we recommend using the following lateral earth pressures, expressed in equivalent fluid pressures of pounds per square foot per foot of depth (pcf), in the design of retaining structures planned at the container yard site.

The values provided below assume that the on-site sandy soils or imported non-expansive, select granular fill materials will be used to backfill behind the structures. It is assumed that the backfill behind retaining structures will be compacted to between 90 and 95 percent relative compaction. Over-compaction of the retaining structure backfill should be avoided. In general, an active condition may be used for gravity retaining walls and structures that are free to deflect by as much as 0.5 percent of the wall height. If the tops of the walls are not free to deflect beyond this degree, or are restrained, the walls should be designed for the at-rest condition.

LATERAL EARTH PRESSURES FOR DESIGN RETAINING STRUCTURES			
Groundwater Conditions	**Active** (pcf)	**At-Rest** (pcf)	**Passive** (pcf)
Above Groundwater	38	60	250
Below Groundwater	84	95	160

Due to the proximity of the project site to the Pacific Ocean, we recommend using a static groundwater level of +3 feet MLLW in the design of retaining structures. Retaining structures that extend below Elevation +3 feet MLLW should be designed based on the lateral earth pressures for the below groundwater condition presented in the table above.

Surcharge stresses due to areal surcharges, traffic loads, line loads, and point loads within a horizontal distance equal to the depth of the structure should be considered in the design. For uniform surcharge stresses imposed on the loaded side of the underground structure (restrained condition), a rectangular distribution with uniform pressure equal to 56 percent of the vertical surcharge pressure acting over the entire depth of the structure may be used in design. Additional analyses during design may be needed to evaluate the surcharge effects of point loads and line loads.

3.5 Building Foundations

Based on the preliminary site plan provided, we understand that a comfort station is planned near the southwestern side of the new terminal. Based on our field exploration, the subsurface conditions in this vicinity consisted of granular fills overlying coralline detritus and coral formation. Therefore, we recommend supporting the new building on a shallow foundation system consisting of spread and/or continuous footings bearing on recompacted on-site granular material. An allowable bearing pressure of up to 3,000 pounds per square foot (psf) may be used for the design of footings bearing on on-site granular materials. This allowable bearing pressure is for dead-plus-live loads and may be increased by one-third (1/3) for transient loads, such as temporary wind and/or seismic forces.

Footings should be embedded a minimum of 18 inches below the lowest adjacent grade. In addition, foundations next to other foundations, utility trenches, or easements should be embedded below a 45-degree imaginary plane extending upward from the bottom edge of the structure or utility trench, or the footings should extend to a depth as deep as the inverts of the utility lines. This requirement is necessary to avoid surcharging adjacent below-grade structures with additional structural loads and to reduce the potential for appreciable foundation settlement.

Soft and/or loose materials encountered at the bottom of footing excavations should be over-excavated until dense materials or to a maximum of 2 feet deep in the footing excavation. The over-excavation should be backfilled with select granular fill materials moisture-conditioned to above the optimum moisture content and compacted to a minimum of 90 percent relative compaction.

If the foundations are designed and constructed in strict accordance with our recommendations, we estimate the total settlements of the foundations to be less than 1 inch. Differential settlements between adjacent footings supported on similar materials may be on the order of about 0.5 inch or less.

Lateral loads acting on the structure may be resisted by friction between the bottom of the foundation and the bearing soil and by passive earth pressure acting against the near-vertical faces of the foundation system. A coefficient of friction of 0.4 may be used for footings bearing on on-site granular fill material. Resistance due to passive earth pressure may be estimated using an equivalent fluid pressure of 450 pounds per square foot per foot of depth (pcf) assuming that the soils around the footings are well compacted. The passive resistance in the upper 12 inches of the soil should be neglected unless covered by pavements or slabs.

A Geolabs representative should observe footing excavations prior to the placement of reinforcing steel and concrete to confirm the foundation bearing conditions and the required embedment depths. Observation of the foundation excavations should be designated a "Special Inspection" item in accordance with Section 1704 of the International Building Code (2006).

3.6 Retaining Walls

We understand that retaining walls may be required at the project site. The following general guidelines may be used for design of the conventional retaining walls planned.

3.6.1 Retaining Wall Foundations

We believe that retaining wall foundations may be designed in accordance with the recommendations and parameters presented in the "Building Foundations" section herein. In addition, retaining wall foundations should be at least 18 inches wide and should be embedded a minimum of 24 inches below the lowest adjacent finished grade.

For sloping ground conditions, the footing should extend deeper to obtain a minimum 6-foot setback distance measured horizontally from the outside edge of the footing to the face of the slope. Wall footings oriented parallel to the direction of the slope should be constructed in stepped footings.

3.6.2 Lateral Earth Pressures

Retaining structures should be designed to resist the lateral earth pressures due to the adjacent soils and surcharge effects. The recommended lateral earth pressures for design of retaining walls, expressed in equivalent fluid pressures of pounds per square foot per foot of depth (pcf), are presented in the following table.

LATERAL EARTH PRESSURES FOR DESIGN OF RETAINING STRUCTURES

Backfill Condition	**Earth Pressure Component**	**Active** (pcf)	**At-Rest** (pcf)
Level Backfill	Horizontal	38	60
	Vertical	None	None
Maximum 2H:1V Sloping Backfill	Horizontal	50	70
	Vertical	25	35

It should be noted that the above lateral earth pressures do not include hydrostatic pressures that might be caused by groundwater trapped behind the structures. The values provided above assume that on-site granular fill materials will be used to backfill behind the wall. It is assumed that the backfill behind retaining structures will be compacted to between 90 and 95 percent relative compaction. Over-compaction of the retaining wall backfill should be avoided.

The at-rest condition should be used for retaining structures where the top of the structure is restrained from movement prior to backfilling of the wall. The active condition should be used only for gravity retaining walls and retaining structures that are free to deflect by as much as 0.5 percent of the wall height.

Surcharge stresses due to areal surcharges, line loads, and point loads within a horizontal distance equal to the depth of the retaining structures should be considered in the design. For uniform surcharge stresses imposed on the loaded side of the retaining structure, a rectangular distribution with uniform pressure equal to 44 percent of the vertical surcharge pressure acting on the entire height of the structure, which is restrained, may be used in design. For retaining structures that are free to deflect (cantilever), a rectangular distribution equal to 28 percent of the vertical surcharge pressure acting over the entire height of the structure may be used for design.

3.6.3 Wall Drainage

Retaining walls should be well drained to reduce the build-up of hydrostatic pressures. A typical drainage system would consist of a 12-inch wide zone of permeable material, such as No. 3B Fine gravel (ASTM C33, No. 67 gradation), placed directly around a perforated pipe (perforations facing down) at the base of the wall discharging to an appropriate outlet or weepholes. As an alternative, a prefabricated drainage product, such as MiraDrain or EnkaDrain, may be used instead of the drainage material. The prefabricated drainage product should also be connected hydraulically to a perforated pipe at the base of the wall.

The backfill from the bottom of the wall to the bottom of the weephole should consist of relatively impervious materials to reduce the potential for significant water infiltration into the subsurface. In addition, the upper 12 inches of the retaining wall backfill should consist of relatively impervious materials to reduce the potential for significant water infiltration behind the retaining structure unless covered by concrete slabs at the surface.

3.7 Light Pole Foundations

Based on the information provided, light poles are planned at the new terminal development. The project structural engineer provided the following structural loads pertaining to the foundation design of the proposed new light poles.

- Vertical Load per pole: 9.5 kips
- Lateral Load at the top of drilled shaft: 7.7 kips
- Overturning Moment at the top of drilled shaft: 377 foot-kips

Based on preliminary information provided by the structural engineer, we envision that the 80-foot light pole may consist of a 24 by 24 inches base plate mounted on concrete foundation system. Based on the above structural loads and the subsoil conditions encountered at the project site, we recommend using a single cast-in-place drilled shaft with a minimum diameter of 48 inches at each light pole planned for the project. The cast-in-place concrete drilled shafts would derive vertical support principally from skin friction between the shafts and the surrounding soils. We recommend supporting the light pole structures on drilled shaft foundations having an embedment length of no less than 25 feet below the design finished grades.

It should be noted that difficult drilling conditions will likely be encountered and should be expected due to the potential for caving-in of the soft subsoil and hard coral formation anticipated during the drilled shaft installation. Temporary casing should be required during the drilled shaft construction for the light pole foundations to reduce the potential for caving-in of the drilled holes. Performance of drilled shaft foundations depends significantly upon the contractor's method of construction, construction procedures, and workmanship. Therefore, special attention should be given to the

"Construction Considerations" in the preparation of the drilled shaft specifications for the project.

It should be noted that the performance of the drilled shafts is generally sensitive to changes in the consistency of the subsurface materials. Therefore, it is critical that the design assumptions and recommendations presented in this report be confirmed in the field during construction. If the actual exposed subsurface conditions encountered during construction are different from those assumed or considered in this report, then appropriate modifications to the design (extending the depths of the drilled shafts) should be made.

3.7.1 Lateral Load Resistance

In general, lateral load resistance of drilled shafts is a function of the stiffness of the surrounding soil, the stiffness of the shaft, allowable deflection at the top of the shaft, and induced moment in the shaft. Based on provided preliminary structural loads at the top of the drilled shaft, we evaluated the required drilled shaft lengths using the computer program, LPILE. The analyses were based on a free-head boundary condition at the top of the drilled shaft. This program is a microcomputer adaptation of a finite difference, laterally loaded pile program originally developed at the University of Texas at Austin. The program solves for deflection and bending moment along a drilled shaft under lateral loads as a function of depth. The analysis was carried out with the use of internally generated non-linear "p-y" curves to represent soil moduli. The lateral deflection was then computed using the appropriate soil moduli at various depths. The analyses were performed for a laterally loaded, cast-in-place concrete drilled shaft. The results of our engineering analyses are summarized in the following table.

FOUNDATION ANALYSES FOR LATERAL LOAD AND MAXIMUM INDUCED MOMENT IN DRILLED SHAFTS				
Drilled Shaft Diameter (inches)	**Drilled Shaft Depth** (feet)	**Lateral Deflection at Ground Line** (inches)	**Maximum Induced Moment** (foot-kips)	**Depth to Maximum Moment** (feet)
48	25	0.22	398	4
NOTE: Drilled Shaft Depth and Depth to Maximum Moment is measured below ground surface.				

3.7.2 Construction Considerations

The performance of drilled shafts depends significantly upon the contractor's method of construction, construction procedures, and workmanship. As a result, a Geolabs representative should be present to observe the installation of drilled shafts during construction. In our opinion, the following may have an impact on the effectiveness and cost of the drilled shaft foundations at the site.

Based on the subsurface conditions encountered, we anticipate that drilling through soft soils over coralline deposits with localized hard coral formation with relatively shallow groundwater conditions will be required during construction of the drilled shaft foundations. Therefore, some difficult drilling conditions likely will be encountered at the project site and should be expected. The drilled shaft contractor will need to have the appropriate equipment and tools to drill through the hard layers. To reduce the potential for caving-in of the drilled holes, temporary casing of the drilled holes should be required during construction. Installation of the casing may be achieved by vibration, driving or twisting to advance the casing. Therefore, the contractor should be made aware that temporary casing of the drilled holes will be required based on the subsurface conditions encountered at the site.

In addition, care should be exercised during removal of the temporary casing to reduce the potential for "necking" of the drilled shaft. Therefore, a minimum 5-foot head of concrete should be maintained above the bottom of the casing and/or groundwater level during removal of the casing.

The load carrying capacity of drilled shafts depends, to a large extent, on the contact between the drilled shafts and the surrounding soils. Therefore, proper construction techniques are important. The contractor should exercise care in drilling the shaft holes and in placing concrete in the holes. The bottom of the drilled shafts should be cleaned of disturbed materials prior to constructing the shaft. The bottom of the drilled shaft hole should also be relatively level. In addition, backfill against the drilled shaft foundations should not be allowed.

Drilling by methods utilizing drilling fluids (mineral and/or polymer slurry) generally is not recommended. Groundwater conditions are anticipated, therefore, placement of concrete by wet construction methods using a tremie pipe will be required. A low-shrink concrete mix with high slump (7 to 9-inch slump range) should be used to provide close contact between the drilled shafts and the surrounding soils. The concrete should be placed in a suitable manner to reduce the potential for segregation of the aggregates from the concrete mix and to displace disturbed material from the bottom of the drilled shaft. Due to the soft consistency of the subsoils and porous coralline formation, we anticipate additional concrete volume, beyond the theoretical size of the drilled shaft, will be required to construct the shaft.

3.8 Site Grading

Based on the information provided, we understand that the proposed site grading may consist of cuts and fills of up to about 4 to 5 feet relative to the existing ground surface. In addition, deeper excavations of up to about 6 to 10 feet in depth may be anticipated for construction of the drainage structures. Items of grading that are addressed in the following subsections include the following:

- Site Preparation
- Fills and Backfills
- Fill Placement and Compaction Requirements
- Excavation

As mentioned previously, two large fish ponds were documented at the project site prior to WWII. The soft/loose lagoonal deposits with thickness varying from 4 to 12.5 feet were encountered in the borings drilled. The approximate fish pond limit is illustrated on the Site Plan, Plate 2. Based on results of the settlement evaluation, we anticipate approximately 3 to 8 inches of settlements may be induced from up to 5 feet of new fills within the approximate fish ponds limit.

To reduce potential pavement depression due to consolidation settlements, we recommend implementing a surcharge and settlement monitoring program to evaluate the magnitude and rates of the ground settlements. A 4-foot high surcharge is recommended in the areas where the new fill thickness is greater than 3 feet. The surcharge should remain for 2 to 3 months of settlement monitoring. Where the new fill thickness is less than 3 feet, the surcharge may be eliminated, but a waiting period should be implemented for 2 to 3 months of settlement monitoring.

The settlement monitoring should be performed between the end of grading and concrete pavement placement. To monitor the fill settlement, we recommend installing settlement gauges. A typical settlement gauge detail is presented on Plate 5. The settlement gauges should be read optically by a qualified surveyor, and the readings should be transmitted to Geolabs for review in a timely manner. We recommend that two readings (minimum 24 hours apart) for each settlement gauge be taken at the start of the settlement monitoring period to establish a baseline. Subsequent readings of the settlement gauges should be taken on a bi-weekly for about 2 to 3 months.

We understand that the grading construction may be conducted in phases. Based on the preliminary grading plan provided, we understand that excessive fill will be generated from site grading. We believe that the excessive fill material may be used for the surcharge and waiting period fills. The following grading sequence summarizes our recommendations.

1. Demolish and remove all existing buildings and utilities on site;
2. In the identified landfill areas, over-excavation a minimum of 12 inches below existing ground surface (in fill areas) or below finished subgrade (in cut areas) and backfill with select granular material;
3. In other grading areas, grade to subgrade with 8 inches of scarification
4. Proof-roll with 20-ton vibratory compactor at existing grade in fill areas and at finished subgrade in cut areas;
5. In yielding areas (except the identified landfill areas), over-excavate a minimum of 12 inches and place a layer of geotextile fabric, and survey location of yielding areas;

6. Backfill over-excavation with select granular material with a minimum of 95% relative compaction;
7. Install settlement gauges for 2 to 3 months of settlement monitoring;
8. Surcharge the fill areas if the new fill is greater than 3 feet thick;
9. Once consolidation of fill areas is complete, fine grade entire site to finished subgrade elevation;
10. Install drainage and utilities (pipes and structures);
11. Place a layer of triaxial geogrid over entire landfill areas;
12. Place aggregate base course;
13. Construct concrete pavements.

A Geolabs representative should monitor site grading operations to observe whether undesirable materials are encountered during the excavation and proof-rolling process and to confirm whether the exposed soil and/or rock conditions are similar to those encountered in our exploration.

3.8.1 Site Preparation

At the on-set of earthwork, areas within the contract grading limits should be cleared and grubbed thoroughly. Old pavements, vegetation, debris, deleterious materials, and other unsuitable materials should be removed and disposed of properly off-site.

Finished subgrades and areas designated to receive fill should be scarified to a depth of about 8 inches, moisture conditioned to above the optimum moisture content, and compacted to at least 95 percent relative compaction. Loose or soft spots encountered at the subgrade level should be removed to expose dense material and replaced with select granular material compacted to a minimum of 95 percent relative compaction. Relative compaction refers to the in-place dry density of soil expressed as a percentage of the maximum dry density as determined by ASTM D1557 (AASHTO T 180). Optimum moisture is the water content (percentage by weight) corresponding to the maximum dry density.

In addition, special attention should be given to the recommendations presented in the "Subgrade Preparation Below Pavement Section" subsection.

3.8.2 Fills and Backfills

The excavated on-site base materials, subbase materials or granular materials may be re-used as fill or backfill materials. Imported materials should consist of aggregate base course material. For backfill behind retaining structures, the maximum particle size of the backfill should be limited to 3 inches in maximum dimension. Imported material should be observed and/or tested by Geolabs for its suitability prior to being transported to the site for the intended use.

3.8.3 Fill Placement and Compaction Requirements

Fills and backfills should be placed in level lifts not exceeding 8 inches in loose thickness, moisture-conditioned to above the optimum moisture content, and compacted to a minimum of 95 percent relative compaction. Relative compaction refers to the in-place dry density of soil expressed as a percentage of the maximum dry density as determined by ASTM D1557 (AASHTO T 180). Optimum moisture is the water content (percentage by weight) corresponding to the maximum dry density.

Compaction should be accomplished by sheepfoot rollers, vibratory rollers, multiple-wheel pneumatic-tired rollers, or other types of acceptable compaction equipment. Field density tests should be performed on the compacted fills and backfills in general accordance with ASTM D6938-10, Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth). In general, field density tests should be performed at the frequencies presented in the following table.

FIELD DENSITY TESTING FREQUENCY

Material	Location of Material	Test Frequency
Aggregate Base	Container Yard / Access Road	One test per 2,500 SF / 100 LF per lift
Aggregate Subbase	Container Yard / Access Road	One test per 2,500 SF / 100 LF per lift
Subgrade	Container Yard / Access Road	One test per 2,500 SF / 100 LF per lift
Backfill	Utility Trenches / Retaining Walls	One test per 200 LF per lift of backfill

3.8.4 Excavation

We understand that drainage structures will be constructed for this project. Excavations of up to about 6 to 10 feet below the existing ground surface are estimated for construction of the drainage structures. Based on our field exploration, the proposed project site is underlain by granular fills and lagoonal deposits. It is anticipated that the near-surface fills and the lagoonal deposits may be excavated with normal heavy excavation equipment, such as large excavators.

3.9 Underground Utility Lines

We understand some new utility lines and connections will be installed. In general, we recommend providing granular bedding consisting of 6 inches of open-graded gravel (ASTM C33, No. 67 gradation) below the pipes for uniform support. Where soft and/or loose soils are encountered at or near the invert of the pipes, a stabilization layer consisting of an additional 24 inches of open-graded gravel wrapped in a non-woven filter fabric (Mirafi 180N or equivalent) should be provided below the bedding layer for uniform support. A typical section of the trench detail is presented on Plate 6.

Free-draining granular materials, such as open-graded gravel (ASTM C33, No. 67 gradation), should also be used for the initial trench backfill up to about 12 inches above the pipes or about 12 inches above the groundwater level to provide adequate support around the pipes. It is critical to use free-draining materials around the pipes to reduce the potential for formation of voids below the haunches of pipes and to provide adequate support around the sides of the pipes. Improper trench backfill around the pipe could result in backfill settlement and pipe damage.

The upper portion of the trench backfill from the level 12 inches above the pipes or groundwater level to the top of the subgrade may consist of the excavated on-site granular soils, provided that they are free of deleterious materials and over-sized materials (greater than 3 inches in maximum particle size). Due to the relatively shallow groundwater table, the excavated on-site soils may require aeration to reduce the moisture content of the soils prior to being re-used as backfill materials. The backfill should be moisture-conditioned to above the optimum moisture, placed in maximum 8-inch level loose lifts, and mechanically compacted to a minimum of 90 percent relative compaction to reduce the potential for appreciable future ground subsidence. Where trenches will be located below areas subjected to vehicular traffic, the upper 3 feet of the trench backfill below the pavement grade should be compacted to a minimum of 95 percent relative compaction.

3.10 Design Review

Preliminary and final drawings and specifications for the proposed construction should be forwarded to Geolabs, Inc. for review and written comments prior to bid advertisement. This review is necessary to evaluate conformance of the plans and specifications with the intent of the geotechnical recommendations provided herein. If this review is not made, Geolabs, Inc. will not be responsible for misinterpretation of our recommendations.

3.11 Post-Design Services/Services During Construction

We recommend retaining Geolabs to provide geotechnical engineering services during construction of the proposed project. The critical items of construction monitoring that require "Special Inspection" include the following:

- Observation of subgrade preparation and proof-rolling
- Review of settlement monitoring data
- Observation of geotextile/geogrid placement
- Observation of fill placement and compaction
- Observation of subgrade preparation for shallow foundation
- Observation of drilled shaft foundation installation

A Geolabs representative should monitor other aspects of the earthwork construction to observe compliance with the intent of the design concepts, specifications, or recommendations and to expedite suggestions for design changes that may be required in the event that subsurface conditions differ from those anticipated at the time this report was prepared. The recommendations provided herein are contingent upon such observations. If the actual exposed subsurface conditions encountered during construction are different from those assumed or considered in this report, then appropriate modifications to the design should be made.

END OF DISCUSSION AND RECOMMENDATIONS

SECTION 4. LIMITATIONS

The analyses and recommendations submitted herein are based, in part, upon information obtained from field borings. Variations of subsoil conditions between and beyond the field borings may occur, and the nature and extent of these variations may not become evident until construction is underway. If variations then appear evident, it will be necessary to re-evaluate the recommendations provided herein.

The field boring locations indicated herein were taped with reference to the features shown on the Site Plan transmitted by R.M. Towill Corporation on April 9, 2013. Boring elevations were obtained by interpolating between the spot elevations shown on the same plan. The physical locations and field boring elevations should be considered accurate only to the degree implied by the method used.

The stratification lines shown on graphic representations of the borings depict the approximate boundaries between soil/rock types and, as such, may denote a gradual transition. Water level data from the borings were measured at the times shown on the graphic representations and/or presented in the text of this report. These data have been reviewed and interpretations made in the formulation of this report. However, it must be noted that fluctuation is expected due to tides, variation in rainfall, temperature, and other factors.

This report has been prepared for the exclusive use of R.M. Towill Corporation and their client, State of Hawaii - Department of Transportation, Harbors Division, for specific application to the proposed *New Kapalama Terminal* project at Kapalama Military Reservation in accordance with generally accepted geotechnical engineering principles and practices. No warranty is expressed or implied.

This report has been prepared solely for the purpose of assisting the engineer in the design of the proposed project. Therefore, this report may not contain sufficient data, or the proper information, to serve as the basis for preparation of construction cost estimates. A contractor wishing to bid on this project is urged to retain a competent geotechnical engineer to assist in the interpretation of this report and/or in the performance of additional site-specific exploration for bid estimating purposes.

The owner/client should be aware that unanticipated soil/rock conditions are commonly encountered. Unforeseen soil conditions, such as perched groundwater, soft deposits, hard layers, or cavities may occur in localized areas and may require additional probing or corrections in the field (which may result in construction delays) to attain a properly constructed project. Therefore, a sufficient contingency fund is recommended to accommodate these possible extra costs.

The geotechnical engineering exploration conducted at the project site was not intended to investigate the potential presence of existing hazardous materials. It should be noted that the equipment, techniques, and personnel used to conduct a geoenvironmental exploration differ substantially from those applied in geotechnical engineering.

END OF LIMITATIONS

CLOSURE

The following plates and appendices are attached and complete this report:

Project Location Map	Plate 1
Site Plan	Plate 2
Generalized Subsurface Profiles	Plates 3.1 thru 3.4
Pavement Area Map	Plate 4
Typical Settlement Gauge	Plate 5
Typical Trench Detail	Plate 6
Field Exploration	Appendix A
Laboratory Tests	Appendix B
In-Situ Permeability Tests	Appendix C

-ΩΩΩΩΩΩΩΩΩ-

Respectfully submitted,

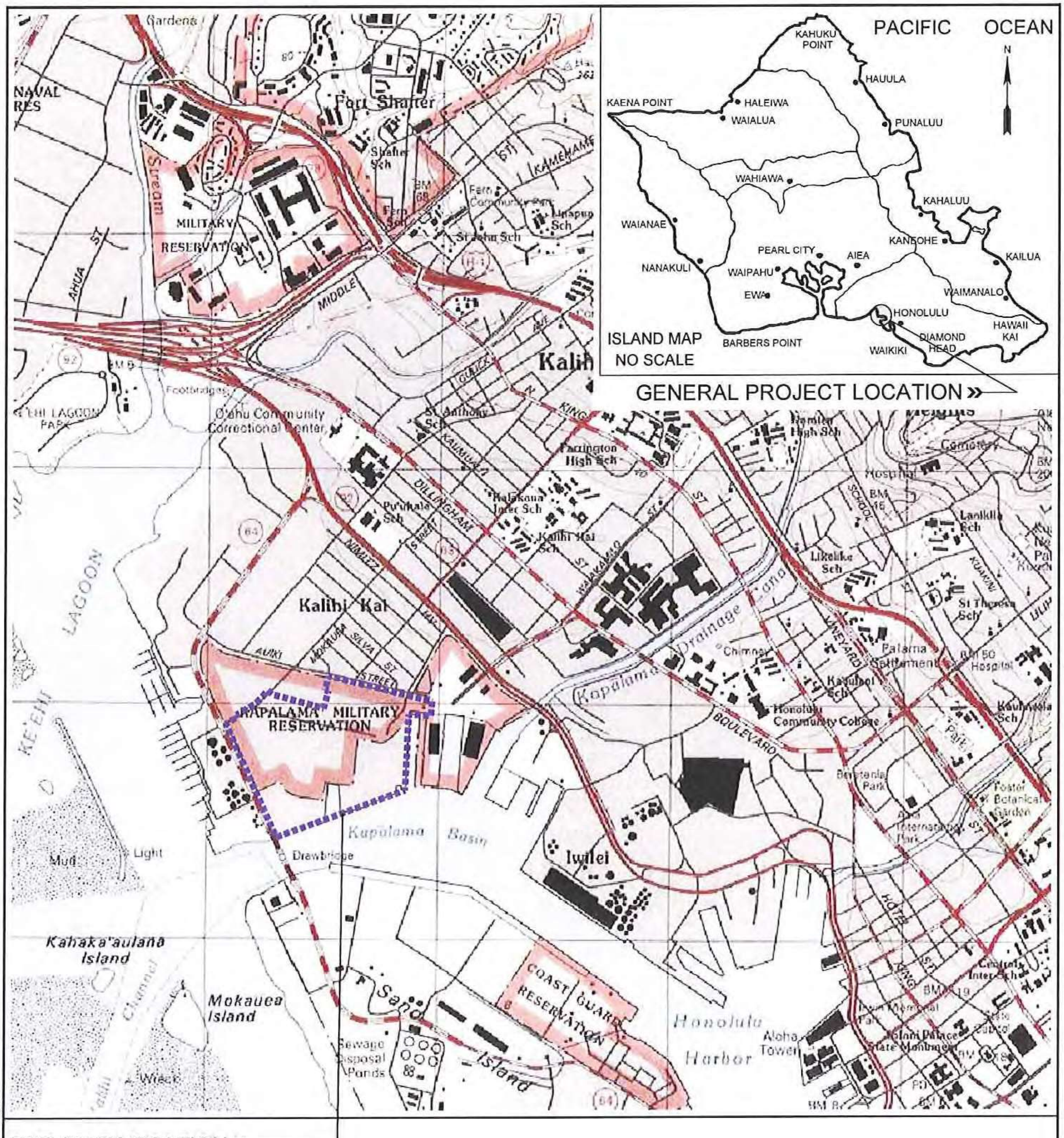
GEOLABS, INC.

By John Chen
John Y.L. Chen, P.E.
Vice President

JC:as

h:\6800Series\6826-00.jc6

PLATES



PROJECT LOCATION »

PROJECT LOCATION MAP

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

2000 1000 0 2000 FT.

GRAPHIC SCALE

N

REFERENCE: MAP CREATED WITH TOPO!® ©2010 NATIONAL GEOGRAPHIC; ©2007 TELE ATLAS, REL. 1/2007.

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DATE	DRAWN BY	PLATE
MAY 2014	JRP	
SCALE	W.O.	1
1" = 2,000'	6826-00	

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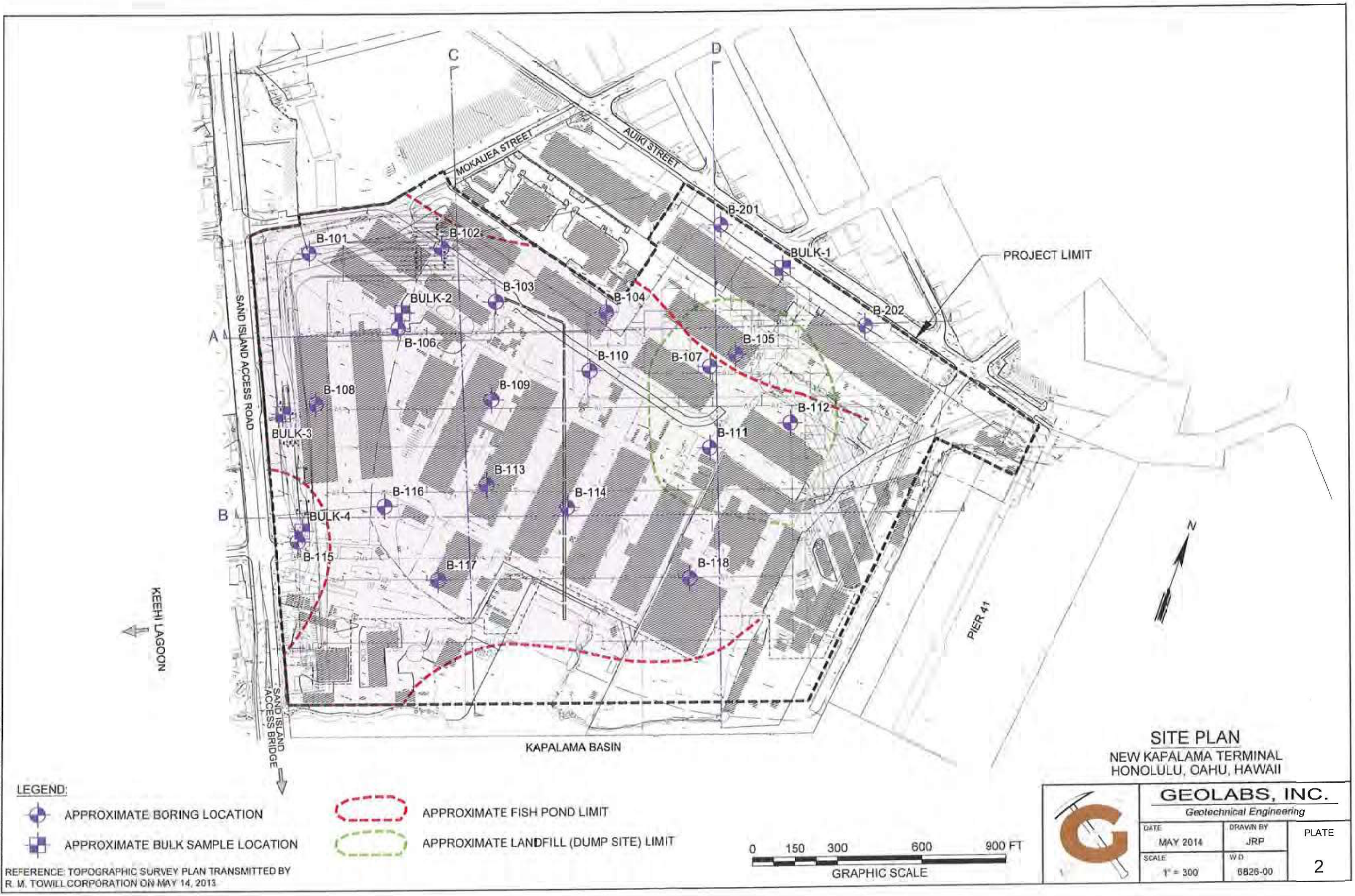

REFERENCE: TOPOGRAPHIC SURVEY PLAN TRANSMITTED BY
R. M. TOWILL CORPORATION ON MAY 14, 2013

SITE PLAN

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

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DATE	DRAWN BY	PLATE
MAY 2014	JRP	
SCALE	W.O.	2
1" = 300'	6826-00	

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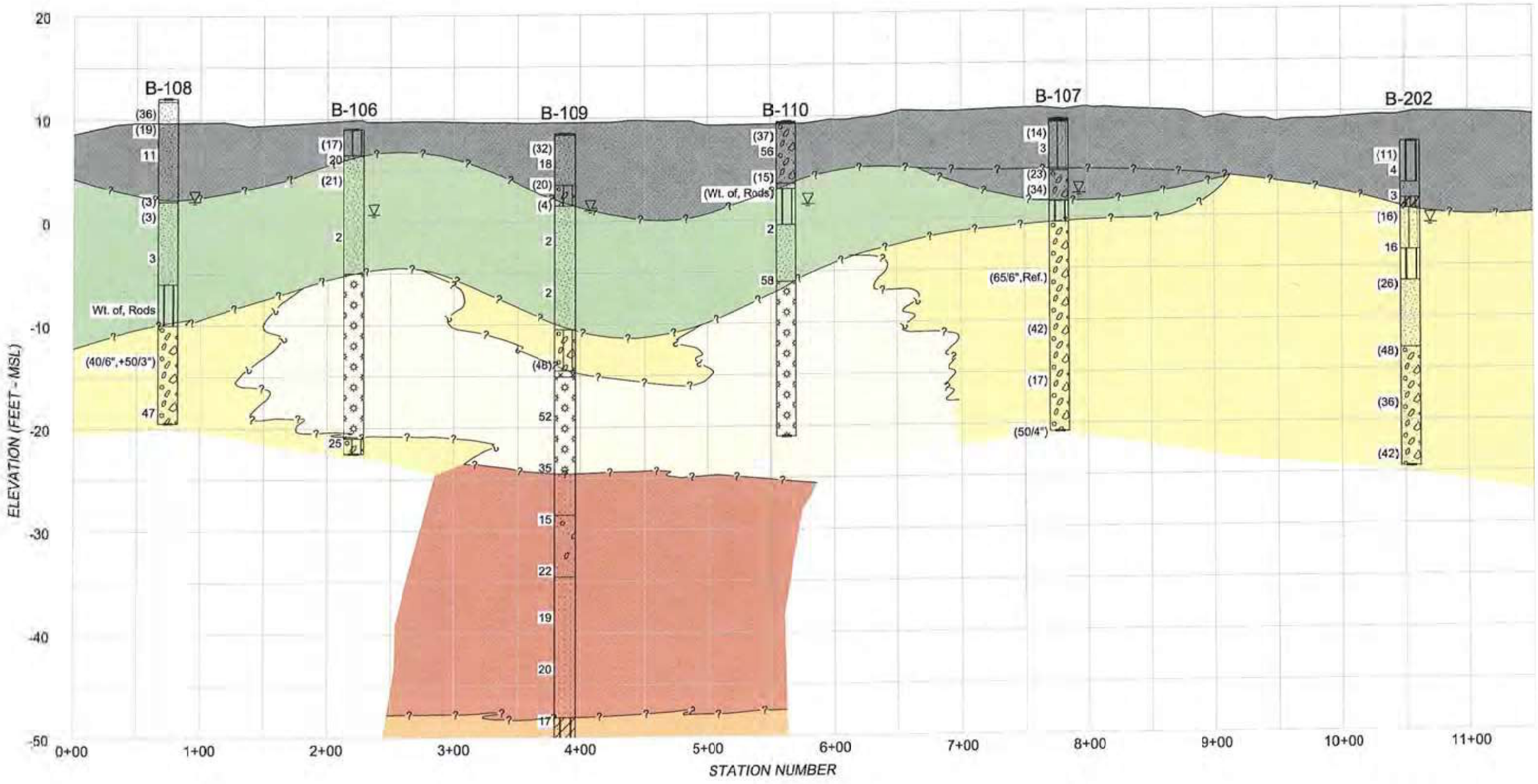

CROSS-SECTION A-A'

LEGEND:

20 BLOW COUNT REQUIRED FOR 12 INCHES OF PENETRATION OF A 2-INCH O.D. STANDARD PENETRATION SAMPLER

(20) BLOW COUNT REQUIRED FOR 12 INCHES OF PENETRATION OF A 3-INCH O.D. MODIFIED CALIFORNIA SAMPLER

▩ FILL
🟩 LAGOONAL DEPOSIT
⬜ CORAL FORMATION
🟨 CORALLINE DETRITUS
🟧 ALLUVIUM
🟥 SANDSTONE

0 40 80 160 240 FT.
HORIZONTAL GRAPHIC SCALE

0 5 10 20 30 FT.
VERTICAL GRAPHIC SCALE

NOTE: THE CONDITIONS ILLUSTRATED ARE BASED ON OUR BORINGS AND GEOLOGICAL INTERPRETATIONS. WHILE THESE ARE BELIEVED TO BE GENERALLY CORRECT, THE CONDITIONS MAY VARY LOCALLY FROM THOSE INDICATED.

GENERALIZED SUBSURFACE PROFILE

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

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DATE	DRAWN BY	PLATE
MAY 2014	JRP	3.1
SCALE	W.O.	
AS SHOWN	6826-00	

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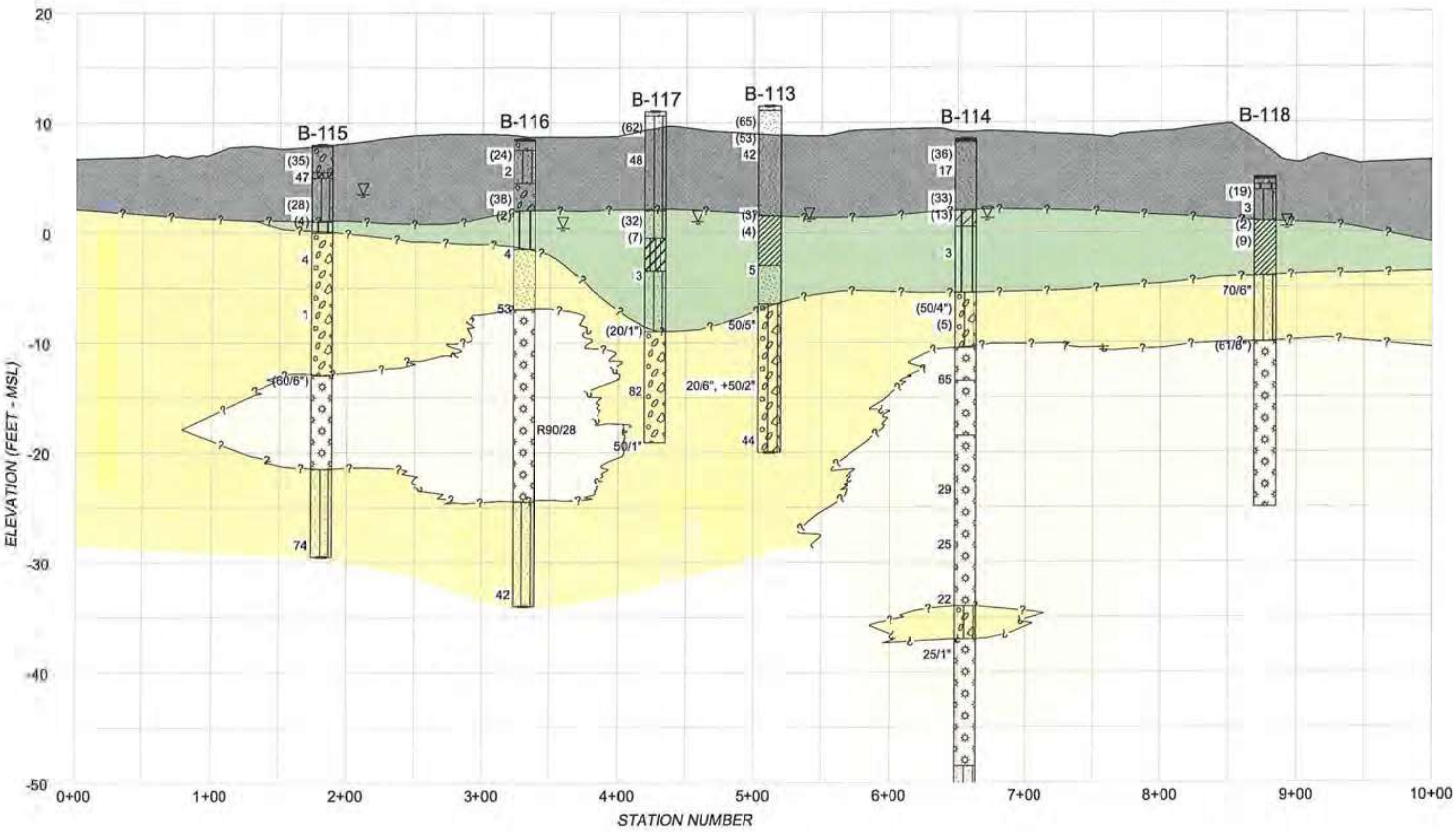

CROSS-SECTION B-B'

LEGEND

20	BLOW COUNT REQUIRED FOR 12 INCHES OF PENETRATION OF A 2-INCH O.D. STANDARD PENETRATION SAMPLER
(20)	BLOW COUNT REQUIRED FOR 12 INCHES OF PENETRATION OF A 3-INCH O.D. MODIFIED CALIFORNIA SAMPLER

▨	FILL
🟩	LAGOONAL DEPOSIT
☐	CORAL FORMATION
🟨	CORALLINE DETRITUS

NOTE: THE CONDITIONS ILLUSTRATED ARE BASED ON OUR BORINGS AND GEOLOGICAL INTERPRETATIONS. WHILE THESE ARE BELIEVED TO BE GENERALLY CORRECT, THE CONDITIONS MAY VARY LOCALLY FROM THOSE INDICATED.

0 40 80 160 240 FT.
HORIZONTAL GRAPHIC SCALE

0 5 10 20 30 FT.
VERTICAL GRAPHIC SCALE

GENERALIZED SUBSURFACE PROFILE

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

GEOLABS, INC.
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DATE	DRAWN BY	PLATE
MAY 2014	JRP	
SCALE	W.O.	
AS SHOWN	6626-00	3.2

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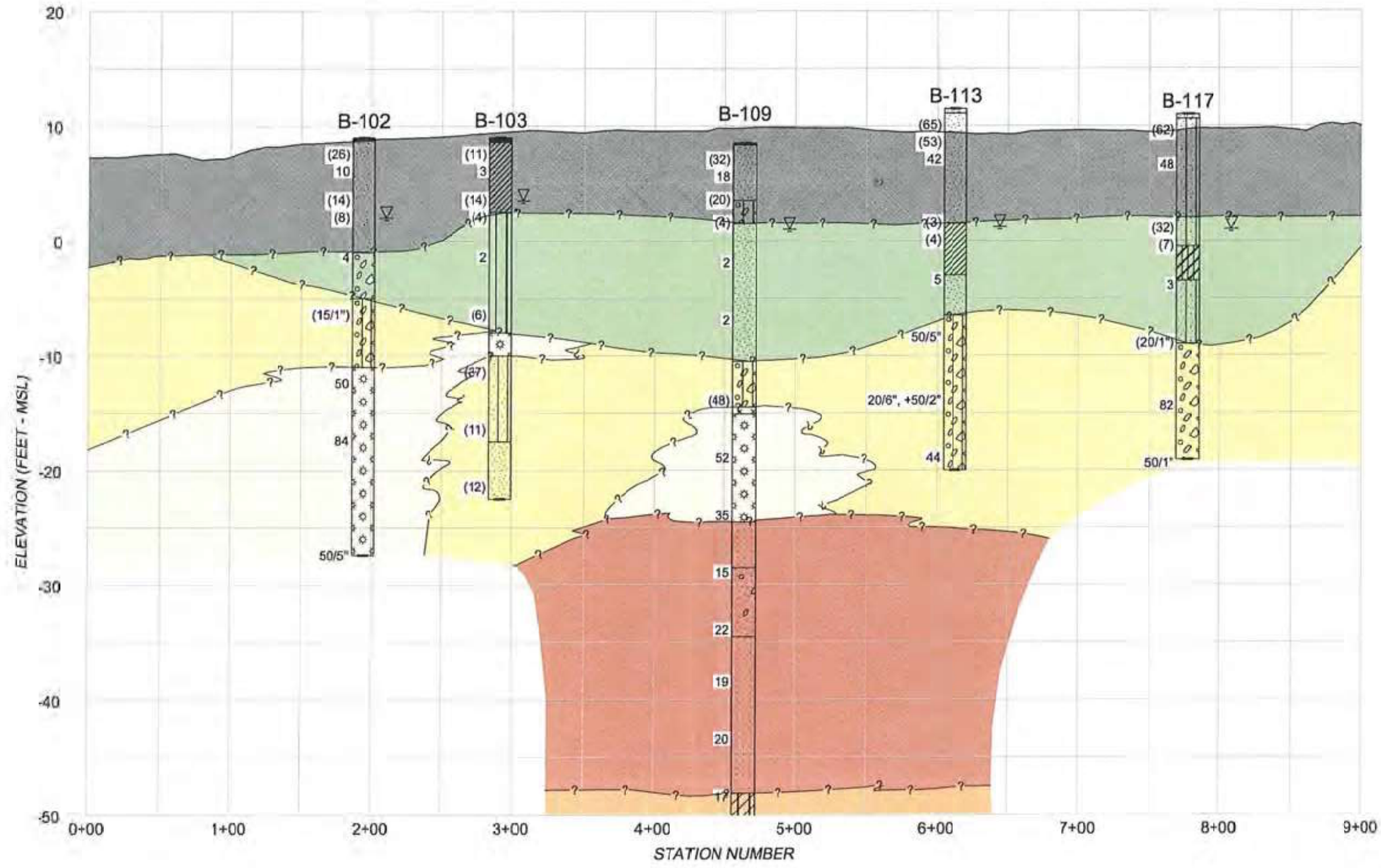

CROSS-SECTION C-C'

LEGEND

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(20) BLOW COUNT REQUIRED FOR 12 INCHES OF PENETRATION OF A 3-INCH O.D. MODIFIED CALIFORNIA SAMPLER

- FILL
- LAGOONAL DEPOSIT
- CORAL FORMATION
- CORALLINE DETRITUS
- ALLUVIUM
- SANDSTONE

0 40 80 160 240 FT.
HORIZONTAL GRAPHIC SCALE

0 5 10 20 30 FT.
VERTICAL GRAPHIC SCALE

NOTE: THE CONDITIONS ILLUSTRATED ARE BASED ON OUR BORINGS AND GEOLOGICAL INTERPRETATIONS. WHILE THESE ARE BELIEVED TO BE GENERALLY CORRECT, THE CONDITIONS MAY VARY LOCALLY FROM THOSE INDICATED.

GENERALIZED SUBSURFACE PROFILE

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
MAY 2014	JRP	3.3
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AS SHOWN	6826-00	

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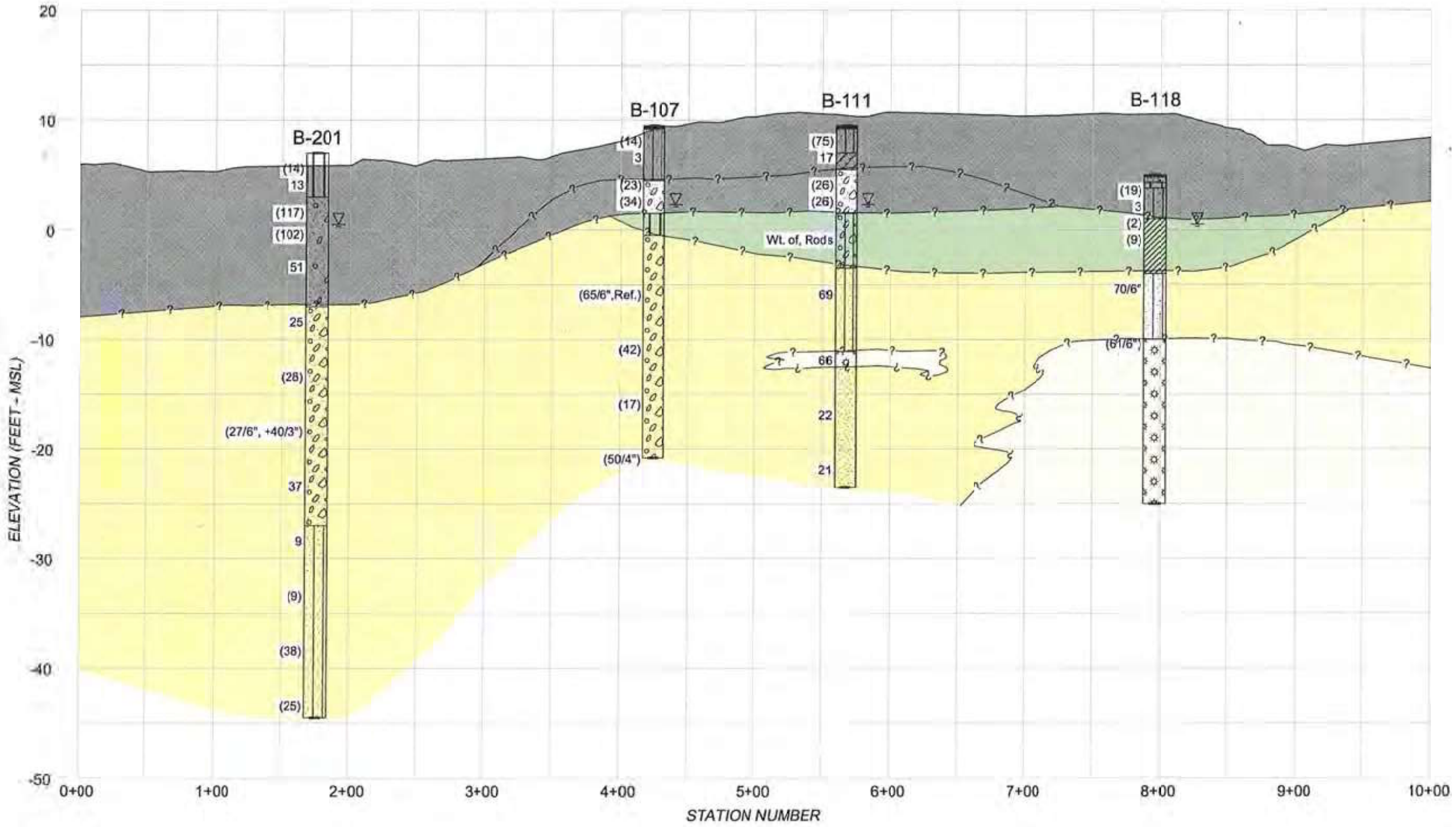

CROSS-SECTION D-D'

LEGEND:

20	BLOW COUNT REQUIRED FOR 12 INCHES OF PENETRATION OF A 2-INCH O.D. STANDARD PENETRATION SAMPLER
(20)	BLOW COUNT REQUIRED FOR 12 INCHES OF PENETRATION OF A 3-INCH O.D. MODIFIED CALIFORNIA SAMPLER

■	FILL
🟩	LAGOONAL DEPOSIT
☐	CORAL FORMATION
🟨	CORALLINE DETRITUS

NOTE: THE CONDITIONS ILLUSTRATED ARE BASED ON OUR BORINGS AND GEOLOGICAL INTERPRETATIONS. WHILE THESE ARE BELIEVED TO BE GENERALLY CORRECT, THE CONDITIONS MAY VARY LOCALLY FROM THOSE INDICATED.

0 40 80 160 240 FT.
HORIZONTAL GRAPHIC SCALE

0 5 10 20 30 FT.
VERTICAL GRAPHIC SCALE

GENERALIZED SUBSURFACE PROFILE

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
MAY 2014	JRP	3.4
SCALE	W.O.	
AS SHOWN	6825-00	

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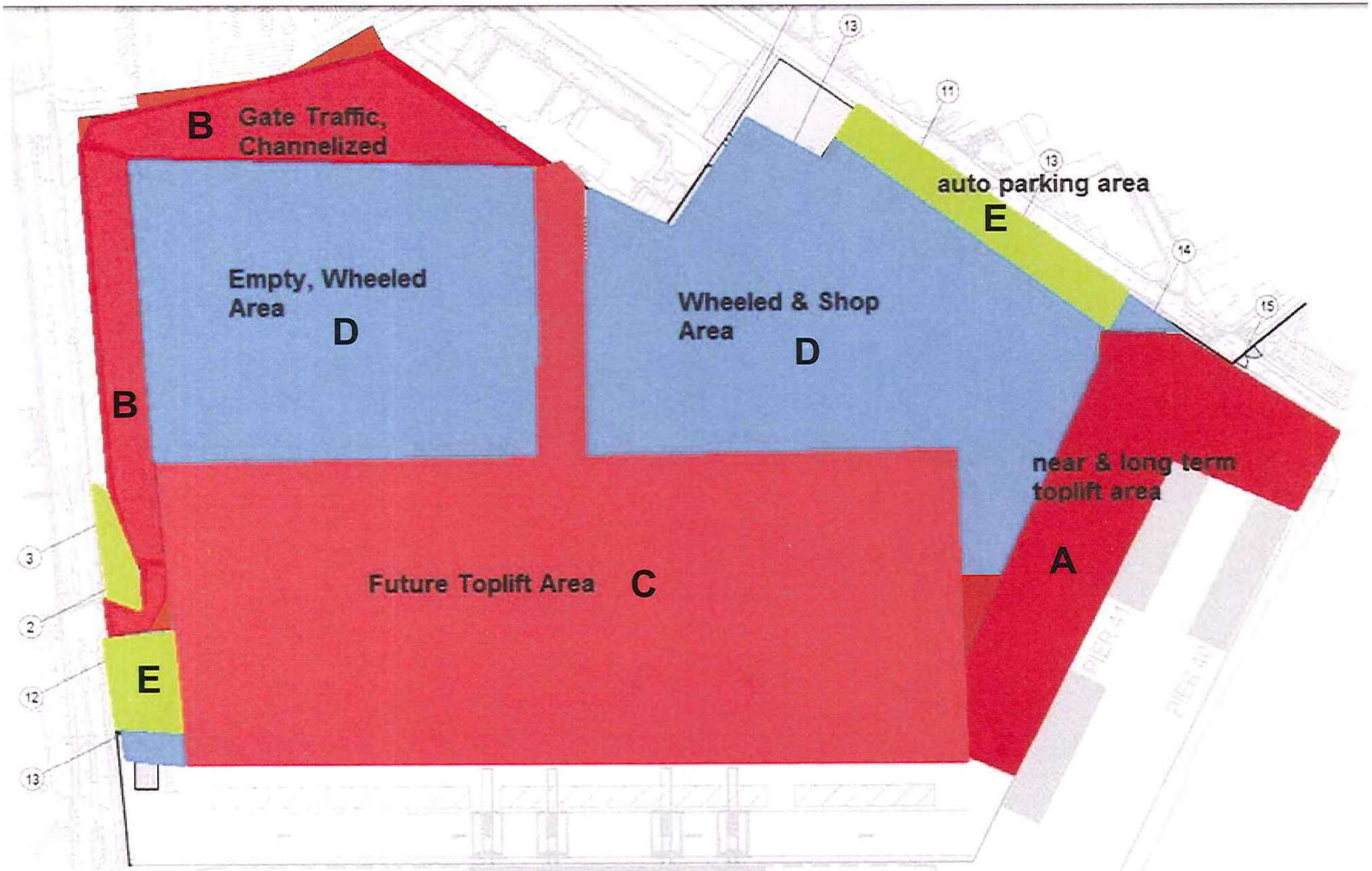
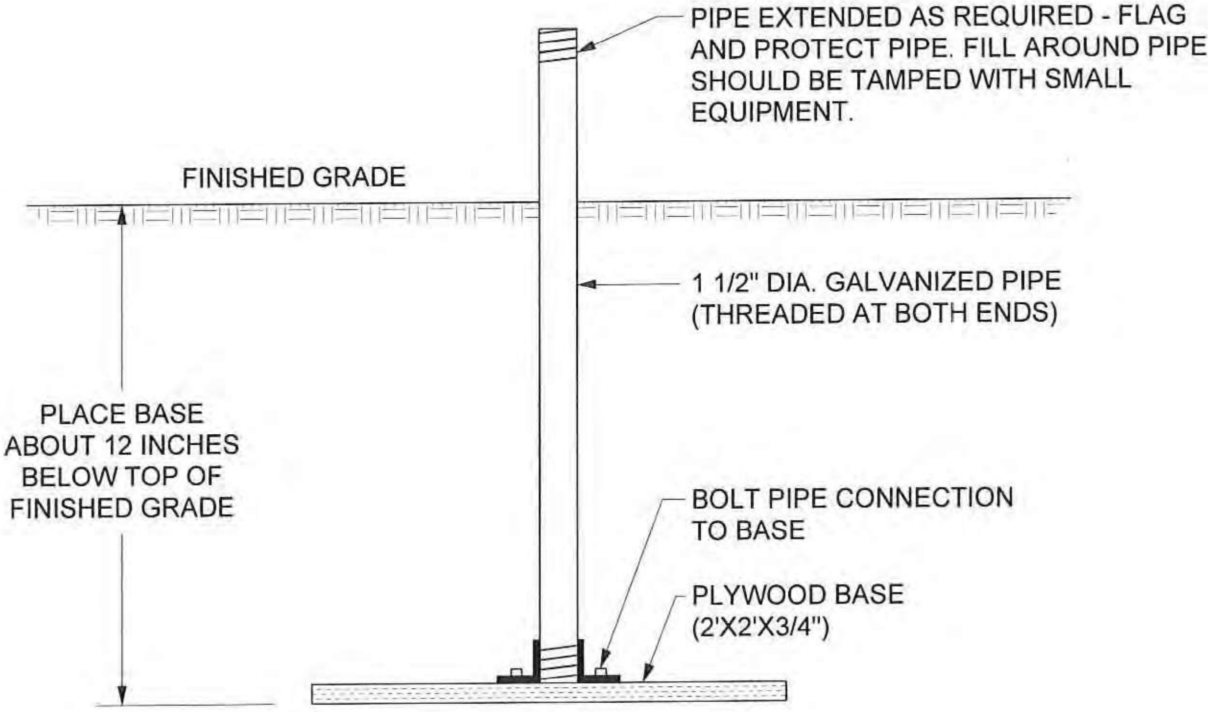


PAVEMENT AREA MAP

W.O. 6826-00

GEOLABS, INC.

PLATE 4



TYPICAL SETTLEMENT GAUGE

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

GEOLABS, INC.

Geotechnical Engineering

DATE	DRAWN BY	PLATE
MAY 2014	JRP	
SCALE	W.O.	
NTS	6826-00	5

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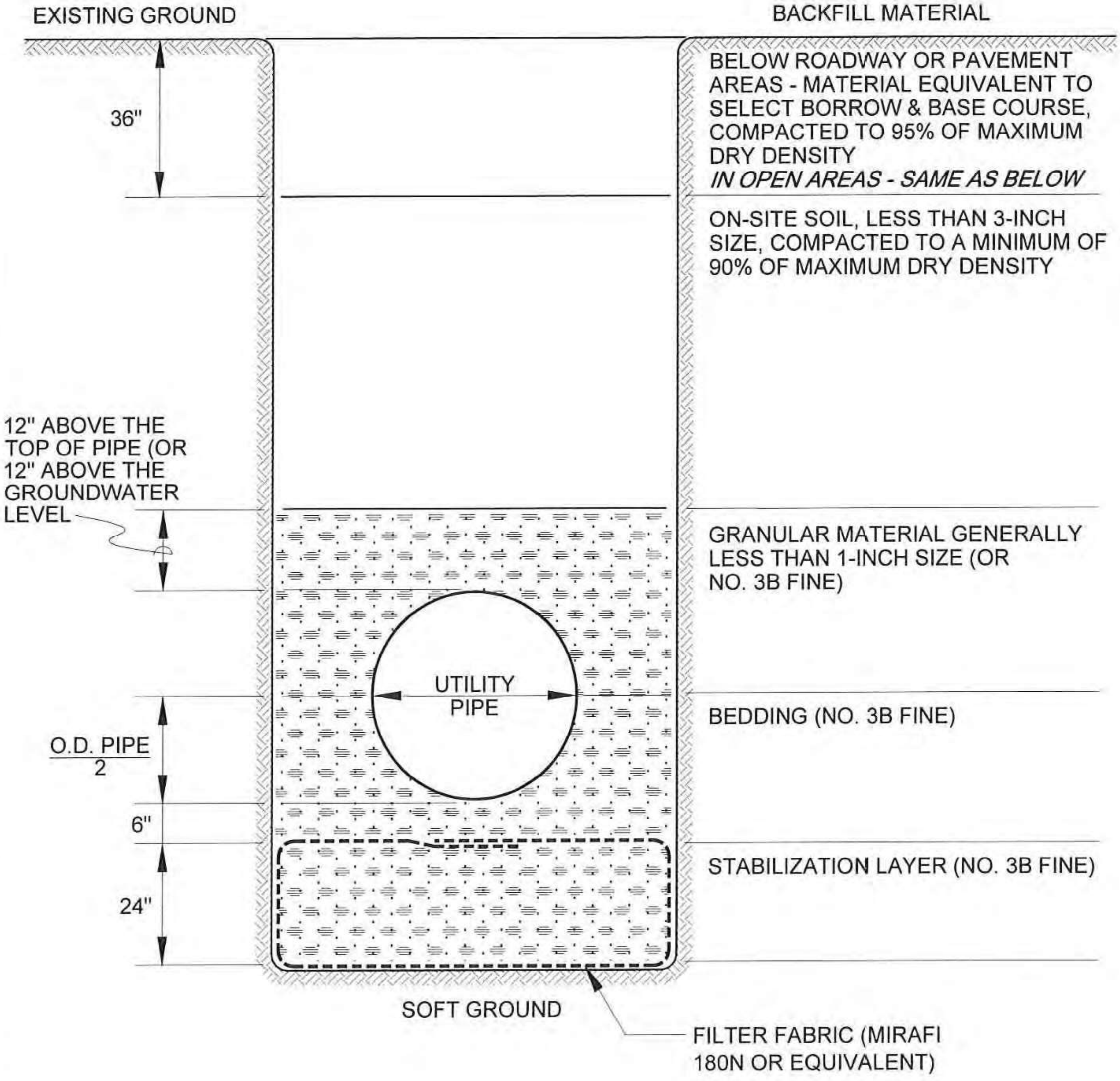

TYPICAL TRENCH DETAIL

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

GEOLABS, INC.
Geotechnical Engineering

DATE	DRAWN BY	PLATE
MAY 2014	JRP	
SCALE	W.O.	6
NOT TO SCALE	6826-00	

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APPENDIX A

APPENDIX A

Field Exploration

We explored the subsurface conditions at the site by drilling and sampling 20 borings, designated as Boring Nos. 101 through 118, and 201 and 202, extending to depths of approximately 30 to 123.5 feet below the existing ground surface. The approximate boring locations are shown on the Site Plan, Plate 2. We drilled the borings using truck-mounted or track-mounted drill equipment equipped with rotary coring tools.

The materials encountered in the borings were classified by visual and textural examination in the field by our geologist, who monitored the drilling operations on a near-continuous basis. Soils were classified in general conformance with the Unified Soil Classification System as shown on the Soil Log Legend, Plate A-01. Graphic representations of the materials encountered are presented on the Logs of Borings, Plates A-1.1 through A-20.

Relatively "undisturbed" soil samples were obtained in general accordance with ASTM D3550, Ring-Lined Barrel Sampling of Soils, by driving a 3-inch OD Modified California sampler with a 140-pound hammer falling 30 inches. In addition, we obtained some samples from the drilled borings in general accordance with ASTM D1586, Penetration Test and Split-Barrel Sampling of Soils, by driving a 2-inch OD standard penetration sampler using the same hammer and drop. The blow counts needed to drive the sampler the second and third 6 inches of an 18-inch drive are shown as the "Penetration Resistance" on the Logs of Borings at the appropriate sample depths.

Core samples of the coral/rock formations encountered at the site were obtained using diamond core drilling techniques in general accordance with ASTM D2113, Diamond Core Drilling for Site Investigation. Core drilling is a rotary drilling method that uses a hollow bit to cut into the coral/rock formation. The material left in the hollow core of the bit is mechanically recovered for examination and description. Rock cores were described in general accordance with the Rock Description System as shown on the Rock Log Legend, Plate A-0.2.

Recovery (REC) is used as a subjective guide to the interpretation of the relative quality of coral/rock masses. Recovery is defined as the actual length of material recovered from a coring attempt versus the length of the core attempt. For example, if 3.7 feet of material is recovered from a 5.0-foot core run, the recovery would be 74 percent and would be shown on the Logs of Borings as REC = 74%.

The Rock Quality Designation (RQD) is also a subjective guide to the relative quality of coral/rock masses. RQD is defined as the percentage of the core run that is sound material in excess of 4 inches in length without discontinuities, discounting drilling induced fractures or breaks. If 2.5 feet of sound material is recovered from a 5.0-foot core run, the RQD would be 50 percent and would be shown on the Logs of Borings as RQD = 50%. Generally, the following is used to describe the relative quality of the rock, based on the "Practical Handbook of Physical Properties of Rocks and Minerals."

Rock Quality	**RQD** (%)
Very Poor	0 – 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	90 – 100

Soil Log Legend

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISIONS			USCS		TYPICAL DESCRIPTIONS
COARSE-GRAINED SOILS	GRAVELS	CLEAN GRAVELS	▨	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		LESS THAN 5% FINES	▨	GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES	▨	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
		MORE THAN 12% FINES	▨	GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
MORE THAN 50% OF MATERIAL RETAINED ON NO. 200 SIEVE	SANDS	CLEAN SANDS	▨	SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		LESS THAN 5% FINES	▨	SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
	50% OR MORE OF COARSE FRACTION PASSING THROUGH NO. 4 SIEVE	SANDS WITH FINES	▨	SM	SILTY SANDS, SAND-SILT MIXTURES
		MORE THAN 12% FINES	▨	SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE-GRAINED SOILS	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
50% OR MORE OF MATERIAL PASSING THROUGH NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT 50 OR MORE	▨	MH	INORGANIC SILT, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
			▨	CH	INORGANIC CLAYS OF HIGH PLASTICITY
			▨	OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			▨	PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

LEGEND

◪	(2-INCH) O.D. STANDARD PENETRATION TEST
⧗	(3-INCH) O.D. MODIFIED CALIFORNIA SAMPLE
S	SHELBY TUBE SAMPLE
G	GRAB SAMPLE
▮	CORE SAMPLE
▽	WATER LEVEL OBSERVED IN BORING AT TIME OF DRILLING
▼	WATER LEVEL OBSERVED IN BORING AFTER DRILLING

LL	LIQUID LIMIT (NP=NON-PLASTIC)
PI	PLASTICITY INDEX (NP=NON-PLASTIC)
TV	TORVANE SHEAR (tsf)
PEN	POCKET PENETROMETER (tsf)
UC	UNCONFINED COMPRESSION (psi)
UU	UNCONSOLIDATED UNDRAINED TRIAXIAL COMPRESSION (ksf)

Plate
A-0.1

Rock Log Legend

ROCK DESCRIPTIONS

⁄	**BASALT**	△	**FINGER CORAL**
○	**BOULDERS**	▦	**LIMESTONE**
△	**BRECCIA**	⋯	**SANDSTONE**
× ○	**CLINKER**	×	**SILTSTONE**
○	**COBBLES**	▩	**TUFF**
☼	**CORAL**	☐	**VOID/CAVITY**

ROCK DESCRIPTION SYSTEM

ROCK FRACTURE CHARACTERISTICS

The following terms describe general fracture spacing of a rock:

Massive:	Greater than 24 inches apart
Slightly Fractured:	12 to 24 inches apart
Moderately Fractured:	6 to 12 inches apart
Closely Fractured:	3 to 6 inches apart
Severely Fractured:	Less than 3 inches apart

DEGREE OF WEATHERING

The following terms describe the chemical weathering of a rock:

Unweathered:	Rock shows no sign of discoloration or loss of strength.
Slightly Weathered:	Slight discoloration inwards from open fractures.
Moderately Weathered:	Discoloration throughout and noticeably weakened though not able to break by hand.
Highly Weathered:	Most minerals decomposed with some corestones present in residual soil mass. Can be broken by hand.
Extremely Weathered:	Saprolite. Mineral residue completely decomposed to soil but fabric and structure preserved.

HARDNESS

The following terms describe the resistance of a rock to indentation or scratching:

Very Hard:	Specimen breaks with difficulty after several "pinging" hammer blows. Example: Dense, fine grain volcanic rock
Hard:	Specimen breaks with some difficulty after several hammer blows. Example: Vesicular, vugular, coarse-grained rock
Medium Hard:	Specimen can be broked by one hammer blow. Cannot be scraped by knife. SPT may penetrate by ~25 blows per inch with bounce. Example: Porous rock such as clinker, cinder, and coral reef
Soft:	Can be indented by one hammer blow. Can be scraped or peeled by knife. SPT can penetrate by ~100 blows per foot. Example: Weathered rock, chalk-like coral reef
Very Soft:	Crumbles under hammer blow. Can be peeled and carved by knife. Can be indented by finger pressure. Example: Saprolite

GEOLABS, INC.

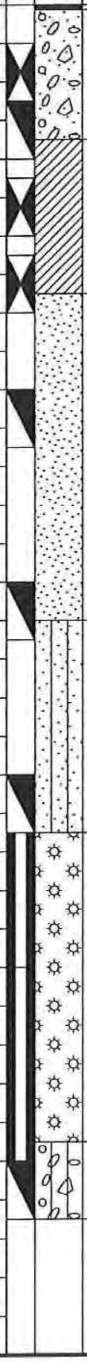
Geotechnical Engineering

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Log of Boring

101

Approximate Ground Surface Elevation (feet): 9 *



Laboratory: Other Tests	Laboratory: Moisture Content (%)	Laboratory: Dry Density (pcf)	Field: Core Recovery (%)	Field: RQD (%)	Field: Penetration Resistance (blows/foot)	Field: Pocket Pen. (tsf)	Depth (feet)	USCS	Description
								GW	1.5-inch **ASPHALTIC CONCRETE** Light brown **SANDY GRAVEL**, dense, moist (fill)
	10	91			28				
LL=58 PI=41	13				16				grades with clay
								CH	Brown **CLAY** with gravel (coralline), medium stiff, moist (fill)
	33	86			5		5		
					3				
								SP-SM	Gray **SILTY SAND** with gravel (coralline), loose (lagoonal deposit)
						▽			
Sieve - #200 = 7.7%	33				2		10		
	38				13		15		
								SM	Light tan angular **SILTY SAND** with gravel (coralline), very dense (coralline detritus)
	17				118		20		
			100	10					Tannish white vugular **CORAL**, closely to severely fractured, moderately weathered, medium hard
			20	0			25		
	13				26		30	GM	Light tan subangular **SANDY GRAVEL (CORALLINE)** with a little silt, medium dense (coralline detritus)
							35		

Date Started:	February 16, 2013	Water Level: ▽	8.5 ft. 02/16/2013 1000 HRS
Date Completed:	February 23, 2013		
Logged By:	M. Gruver	Drill Rig:	CME-75GY
Total Depth:	31.5 feet	Drilling Method:	4" Auger, 6" HS Auger & PQ Coring
Work Order:	6826-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 1.1

GEOLABS, INC.

Geotechnical Engineering

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Log of Boring

101

(Continued from previous plate)

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
											Boring terminated at 31.5 feet * Elevations estimated from Topographic Survey Plan transmitted by R. M. Towill Corporation on April 9, 2013.
							40				
							45				
							50				
							55				
							60				
							65				
							70				

Date Started: February 16, 2013
Date Completed: February 23, 2013
Logged By: M. Gruver
Total Depth: 31.5 feet
Work Order: 6826-00

Water Level: ⊻ 8.5 ft. 02/16/2013 1000 HRS
Drill Rig: CME-75GY
Drilling Method: 4" Auger, 6" HS Auger & PQ Coring
Driving Energy: 140 lb. wt., 30 in. drop

Plate

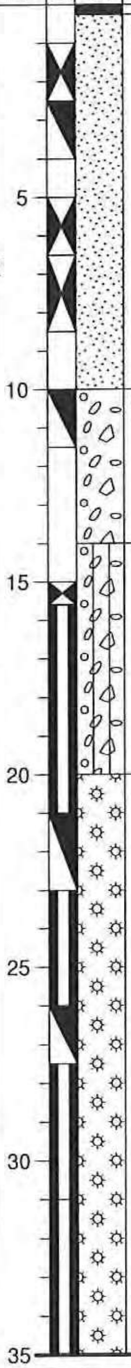
A - 1.2

BORING_LOG 6826-00.GPJ GEOLABS.GDT 5/17/13

GEOLABS, INC. Geotechnical Engineering		NEW KAPALAMA TERMINAL HONOLULU, OAHU, HAWAII	Log of Boring 102

Approximate Ground Surface Elevation (feet): 9 *

Laboratory			Field				
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)
	16	93			26		
Sieve - #200 = 10.3%	14				10		
	25	72			14		5
					8	▽	
Sieve - #200 = 6.4%	45				4		10
	50	68	20	0	15/1"		15
	17				50		20
			31	0			
	16				84		25
			33	0			
			3	0			30



USCS	Description
	3-inch **ASPHALTIC CONCRETE**
SP-SM	Tan **SILTY SAND (CORALLINE)** with some gravel (coralline), medium dense, moist to wet (fill)
GP-GM	Gray **SILTY GRAVEL (CORALLINE)** with some sand (coralline), loose (lagoonal deposit)
GM	Tannish white with some gray **SILTY GRAVEL (CORALLINE)** with some sand, dense (coralline detritus)
	Tannish white **CORAL**, severely fractured, moderately to highly weathered, soft to medium hard

Date Started:	February 14, 2013	Water Level: ▽	7.0 ft. 02/15/2013 1424 HRS	Plate
Date Completed:	February 27, 2013			
Logged By:	S. Latronic	Drill Rig:	CME-75GY	
Total Depth:	36.4 feet	Drilling Method:	4" Auger, 6" HS Auger & PQ Coring	A - 2.1
Work Order:	6826-00	Driving Energy:	140 lb. wt., 30 in. drop	

GEOLABS, INC. Geotechnical Engineering	NEW KAPALAMA TERMINAL HONOLULU, OAHU, HAWAII	Log of Boring 102

Laboratory			Field								(Continued from previous plate)
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
	17				50/5"						grades to hard
											Boring terminated at 36.4 feet
							40				
							45				
							50				
							55				
							60				
							65				
							70				

Date Started:	February 14, 2013	Water Level: ∇	7.0 ft. 02/15/2013 1424 HRS	Plate
Date Completed:	February 27, 2013			
Logged By:	S. Latronic	Drill Rig:	CME-75GY	
Total Depth:	36.4 feet	Drilling Method:	4" Auger, 6" HS Auger & PQ Coring	A - 2.2
Work Order:	6826-00	Driving Energy:	140 lb. wt., 30 in. drop	

BORING_LOG 6826-00.GPJ GEOLABS.GDT 5/17/13

GEOLABS, INC.

Geotechnical Engineering

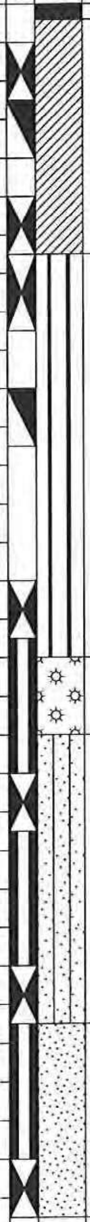
NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Log of Boring

103

Approximate Ground Surface Elevation (feet): 9 *

Laboratory			Field						
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
									5-inch **ASPHALTIC CONCRETE**
					11	2.5		CH	Tannish brown **CLAY** with a little gravel (coralline), stiff, moist (fill)
LL=64 PI=50	19				3	0.5			grades to soft
TXUU	27	89			14	2.9 ▽	5		grades to stiff
					4			ML	Gray **CLAYEY SILT** with some sand (coralline), very soft (lagoonal deposit)
Sieve - #200 = 93.5%	36				2	<0.5	10		
Consol.	33	91			6	0.5	15		
			40	0					White **CORAL**, severely fractured, moderately to highly weathered, hard
								SM	White **SILTY SAND (CORALLINE)** with gravel, dense (coralline detritus)
	24	97			37		20		
			10						
									grades to medium dense
	34	85			11		25		
			71					SP	White fine **SAND**, medium dense
	41	81			12		30		
									Boring terminated at 31.5 feet
							35		



Date Started: February 15, 2013
Date Completed: February 22, 2013
Logged By: M. Gruver
Total Depth: 31.5 feet
Work Order: 6826-00

Water Level: ▽ 5.5 ft. 02/22/2013 1615 HRS

Drill Rig: CME-75GY
Drilling Method: 4" Auger, 6" HS Auger & PQ Coring
Driving Energy: 140 lb. wt., 30 in. drop

GEOLABS, INC.

Geotechnical Engineering

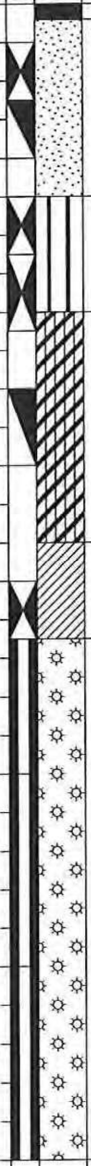
NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Log of Boring

104

Approximate Ground Surface Elevation (feet): 8.5 *

Laboratory			Field						
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
									5-inch **ASPHALTIC CONCRETE**
	12	95			44			SP-SM	Tan **SILTY SAND (CORALLINE)** with some gravel (coralline), dense, moist (fill)
	16				32				
	35	87			16		5	ML	Gray **SANDY SILT** with a little gravel (coralline), stiff, wet (lagoonal deposit)
					4	▽			grades to soft
								CL	Gray **SILTY CLAY** with some sand and gravel (coralline) and coralline gravel, soft (lagoonal deposit)
LL=32 PI=16	39				4	<0.5	10		
								CH	Dark brownish gray **CLAY**, stiff (lagoonal deposit)
TXUU	52	70			13	2.5	15		
			86	55					Tannish white vugular **CORAL**, closely to severely fractured, moderately weathered, medium hard
UC			77	33			20		
UC			100	67			25		
							30		Boring terminated at 30 feet
							35		



Date Started:	February 15, 2013
Date Completed:	February 22, 2013
Logged By:	M. Gruver
Total Depth:	30 feet
Work Order:	6826-00

Water Level: ▽ 7.0 ft. 02/15/2013 1300 HRS

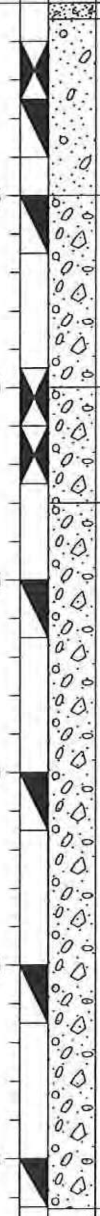
Drill Rig:	CME-75GY
Drilling Method:	4" Auger, 6" HS Auger & PQ Coring
Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 4

GEOLABS, INC. Geotechnical Engineering	NEW KAPALAMA TERMINAL HONOLULU, OAHU, HAWAII	Log of Boring 105

Approximate Ground Surface Elevation (feet): 12.5 *



Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
											5-inch **CONCRETE SLAB**
					46					SW	Light brown **GRAVELLY SAND (CORALLINE)**, medium dense to dense, damp (fill)
Sieve - #200 = 8.3%	10				23						
	17				11		5			GW	Brown **SANDY GRAVEL (CORALLINE)**, medium dense, damp (fill)
					24		⊻				
							10			GW	Dark brown **SANDY GRAVEL** with glass and metal debris, medium dense (landfill)
	28	79			17						
										GW	Tannish brown **SANDY GRAVEL (CORALLINE)**, medium dense
	32				17		15				
	23				45		20				grades to dense
	27				43		25				grades with shell fragments
	17				24/6" +25/3"		30				grades with finger coral
											Boring terminated at 31.3 feet
							35				

Date Started:	February 17, 2013	Water Level: ⊻	9.5 ft. 02/17/2013 1215 HRS	Plate
Date Completed:	February 17, 2013			
Logged By:	J. Chen	Drill Rig:	CME-45B	
Total Depth:	31.3 feet	Drilling Method:	4" Auger, 6" HS Auger & PQ Coring	A - 5
Work Order:	6826-00	Driving Energy:	140 lb. wt., 30 in. drop	

GEOLABS, INC.

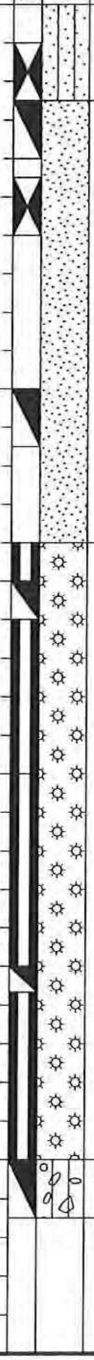
Geotechnical Engineering

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Log of Boring

106

Approximate Ground Surface Elevation (feet): 9 *



Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
	8	84			17					SM	Light brown **SILTY SAND (CORALLINE)** with gravel, medium dense, dry (fill)
Sieve - #200 = 9.2%	9				20					SP-SM	Light brown **SILTY SAND** with gravel, medium dense, dry (lagoonal deposit)
					21		5				
						∇					
											grades to loose
Sieve - #200 = 7.7%	40				2		10				
			100	83							Tannish white vugular **CORAL**, closely to severely fractured, moderately weathered, medium hard
UC	22				105/6" Ref.		15				
			88	27							
			60	0			20				
	20				24/6" +15/0"		25				
			58	0							
	11				25		30			GM	Light tan subangular **SANDY GRAVEL** with a little silt, medium dense (coralline detritus)
											Boring terminated at 31.5 feet
							35				

Date Started:	February 22, 2013	Water Level: ∇	8.3 ft. 02/15/2013 1314 HRS
Date Completed:	February 22, 2013		
Logged By:	M. Gruver	Drill Rig:	CME-75GY
Total Depth:	31.5 feet	Drilling Method:	4" Auger, 6" HS Auger & PQ Coring
Work Order:	6826-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 6

GEOLABS, INC.

Geotechnical Engineering

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Log of Boring

107

Approximate Ground Surface Elevation (feet): 9.5 *

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
											4-inch **ASPHALTIC CONCRETE**
	11	78			14					SM	Tan **SILTY SAND (CORALLINE)** with gravel, medium dense, damp (fill)
Sieve - #200 = 28.9%	27				3						grades to loose
	25	104			23		5			GW	Black **SANDY GRAVEL** with asphalt and glass debris, medium dense, moist (landfill)
					34	∇					
										ML	Gray **SANDY SILT** with some gravel (coralline), very soft (lagoonal deposit)
	24				30/2"		10			GP	Whitish tan **SANDY GRAVEL (CORALLINE)**, very dense
	24	98			65/6" Ref.		15				grades to tan
	19	81			42		20				
	13				17		25				grades to medium dense
	11	96			50/4"		30				Boring terminated at 30.3 feet
							35				

Date Started:	February 14, 2013
Date Completed:	February 20, 2013
Logged By:	D. Gremminger
Total Depth:	30.3 feet
Work Order:	6826-00

Water Level: ∇ 7.2 ft. 02/14/2013 1418 HRS

Drill Rig:	CME-75GY
Drilling Method:	6" Hollow-Stem Auger & 4" Casing
Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 7

GEOLABS, INC.

Geotechnical Engineering

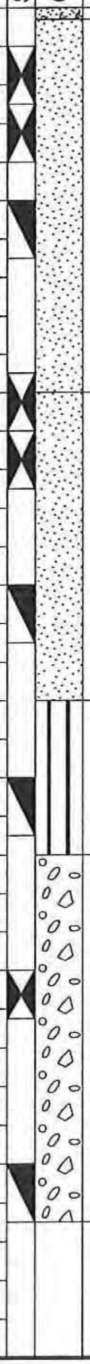
NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Log of Boring

108

Approximate Ground Surface Elevation (feet): 12 *

Laboratory			Field						
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
									4-inch **CONCRETE SLAB**
	12	80			36			SP-SM	Brown **SILTY SAND (CORALLINE)** with gravel, medium dense, damp (fill)
					19				
Sieve - #200 = 7.9%	11				11		5		
					3		▽ 10	SP-SM	Gray **SILTY SAND** with gravel, loose (lagoonal deposit)
Consol.	57	64			3				
Sieve - #200 = 11.2%	39				3		15		
								ML	Gray **SANDY SILT**, soft (lagoonal deposit)
	94				Wt. of Rods		20		
								GP	Tannish brown **SANDY GRAVEL (CORALLINE)**, hard (coralline detritus)
	17	101			40/6" +50/3"		25		
	22				47		30		
									Boring terminated at 31.5 feet
							35		



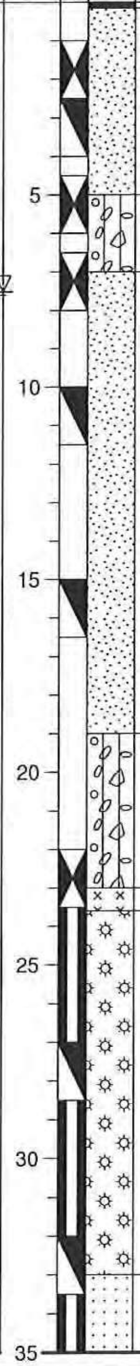
Date Started:	February 17, 2013	Water Level: ▽	10.0 ft. 02/17/2013 0915 HRS
Date Completed:	February 17, 2013		
Logged By:	M. Gruver	Drill Rig:	CME-75GY
Total Depth:	31.5 feet	Drilling Method:	6" Hollow-Stem Auger
Work Order:	6826-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 8

GEOLABS, INC. Geotechnical Engineering	NEW KAPALAMA TERMINAL HONOLULU, OAHU, HAWAII	Log of Boring 109

Approximate Ground Surface Elevation (feet): 8.5 *



Laboratory			Field						
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
								SP	1.5-inch **ASPHALTIC CONCRETE** Light brown **SILTY SAND** with some gravel (coralline), medium dense, moist (fill)
					32				
Sieve - #200 = 4.9%	9				18				
	13	80			20		5	GM	Tannish white **SILTY GRAVEL (CORALLINE)** with some sand, medium dense, moist (fill)
					4		∇	SP-SM	Gray **SILTY SAND** with a little gravel (coralline), soft, loose, moist (lagoonal deposit)
Sieve - #200 = 9.5%	45				2		10		
					2		15		
							20	GM	Light gray **SILTY GRAVEL (CORALLINE)** with a little sand, medium dense (coralline detritus)
	52	77			48				
									Greenish gray with some white bedded **SILTSTONE**, closely fractured, moderately weathered, medium hard
UC			100	74			25		Grayish white to tannish white **CORAL**, moderately fractured, slightly weathered, medium hard to hard
	18				52				
			100	40					
UC							30		
	22				35				
UC			100	48			35		

Date Started:	February 15, 2013	Water Level: ∇	7.5 ft. 02/22/2013 1530 HRS	Plate
Date Completed:	February 22, 2013			
Logged By:	S. Latronic	Drill Rig:	CME-75DG1	
Total Depth:	121.5 feet	Drilling Method:	4" Auger, 6" HS Auger & PQ Coring	A - 9.1
Work Order:	6826-00	Driving Energy:	140 lb. wt., 30 in. drop	

GEOLABS, INC.

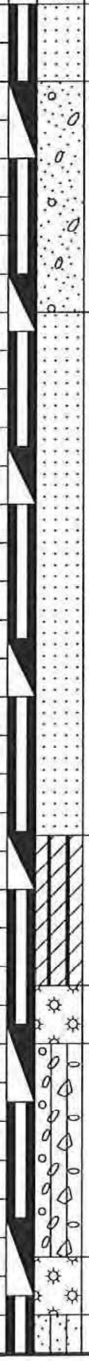
Geotechnical Engineering

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Log of Boring

109

(Continued from previous plate)



Laboratory			Field						
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
									Tannish white calcareous **SANDSTONE**, moderately fractured, moderately weathered, medium hard to hard (coralline sandstone)
Sieve - #200 = 7.5%	34				15			SW-SM	Light tannish white **SILTY SAND** with gravel, medium dense (weathered sandstone)
			56						
							40		
	27				22				
			100	36					Light tan calcareous **SANDSTONE**, moderately fractured, slightly to moderately weathered, soft to medium hard (coralline sandstone)
							45		
	31				19				
			100	40					
							50		
	34				20				
			33	12					
							55		
	36				17			MH	Brown **CLAYEY SILT**, very stiff (alluvium)
			43	21					
							60		
									Grayish white **CORAL**, moderately fractured, moderately weathered, medium hard
	14				9			GM	Light grayish white **SILTY GRAVEL (CORALLINE)** with a little sand, medium dense (coralline detritus)
			0						
							65		
	21				37				
									Light tannish white **CORAL**, severely fractured, moderately to highly weathered, soft to medium hard
			0	0				SM	
							70		

Date Started: February 15, 2013
Date Completed: February 22, 2013
Logged By: S. Latronic
Total Depth: 121.5 feet
Work Order: 6826-00

Water Level: ⊻ 7.5 ft. 02/22/2013 1530 HRS
Drill Rig: CME-75DG1
Drilling Method: 4" Auger, 6" HS Auger & PQ Coring
Driving Energy: 140 lb. wt., 30 in. drop

Plate

A - 9.2

GEOLABS, INC.

Geotechnical Engineering

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Log of Boring

109

(Continued from previous plate)

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
										SM	Light grayish white **SILTY SAND** with some gravel, medium dense (coralline detritus)
	15				12						
			87	28							Light tannish white calcareous **SANDSTONE**, moderately fractured, slightly weathered, hard (coralline sandstone)
							75				
			17	0							
										GM	Light tan with some brown **SILTY GRAVEL (CORALLINE)**, medium dense
							80				
	19				12					GM-GP	Light tannish white **SILTY GRAVEL (CORALLINE)**, medium dense (coralline detritus)
			36								
							85				
	20				24						
			100	28							White **CORAL**, moderately fractured, slightly weathered, hard
							90				
			63	23							
							95				
			7	0						GM	Light tannish white **SILTY GRAVEL (CORALLINE)**, medium dense to dense (coralline detritus)
							100				
	15				35						
			0								
							105				

Date Started:	February 15, 2013
Date Completed:	February 22, 2013
Logged By:	S. Latronic
Total Depth:	121.5 feet
Work Order:	6826-00

Water Level: ⊻	7.5 ft. 02/22/2013 1530 HRS
Drill Rig:	CME-75DG1
Drilling Method:	4" Auger, 6" HS Auger & PQ Coring
Driving Energy:	140 lb. wt., 30 in. drop

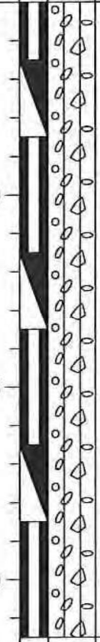
Plate

A - 9.3

BORING_LOG 6826-00.GPJ GEOLABS.GDT 5/17/13

GEOLABS, INC. Geotechnical Engineering	NEW KAPALAMA TERMINAL HONOLULU, OAHU, HAWAII	Log of Boring 109

(Continued from previous plate)



Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
										GM	grades with sandstone seams
	14				16						
			0								
							110				
	18				8						
			0								
							115				
	14				14						
			58								
							120				
											Boring terminated at 121.5 feet
							125				
							130				
							135				
							140				

Date Started:	February 15, 2013	Water Level: ∇	7.5 ft. 02/22/2013 1530 HRS	Plate
Date Completed:	February 22, 2013			
Logged By:	S. Latronic	Drill Rig:	CME-75DG1	A - 9.4
Total Depth:	121.5 feet	Drilling Method:	4" Auger, 6" HS Auger & PQ Coring	
Work Order:	6826-00	Driving Energy:	140 lb. wt., 30 in. drop	

GEOLABS, INC.

Geotechnical Engineering

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Log of Boring

110

Approximate Ground Surface Elevation (feet): 9.5 *

Laboratory			Field						
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
								GW	1.5-inch **ASPHALTIC CONCRETE**
	9	99			37				Light brownish tan **SANDY GRAVEL (CORALLINE)** with a little silt and traces of shells, dense, moist (fill)
	10				56				
	33	89			15		5		
								SP	Gray poorly graded fine **SAND**, loose, moist (lagoonal deposit)
					Wt. of Rods		⊽	ML	Gray **CLAYEY SILT**, soft, wet (lagoonal deposit)
Sieve - #200 = 7.4%	47				2		10	SP-SM	Brownish gray **SILTY SAND (CORALLINE)** with gravel, loose (coralline detritus)
	28				58		15		Tannish white **CORAL**, moderately fractured, slightly weathered, hard
UC			94	52					
			57	7			20		
									grades to severely fractured, moderately to highly weathered, soft to medium hard
UC							25		
			87	33					grades to moderately fractured, slightly weathered, hard
							30		Boring terminated at 30.5 feet
							35		

Date Started:	February 16, 2013	Water Level: ⊽	8.0 ft. 02/16/2013 1630 HRS
Date Completed:	February 27, 2013		
Logged By:	S. Latronic	Drill Rig:	CME-75GY
Total Depth:	30.5 feet	Drilling Method:	6" Hollow-Stem Auger & PQ Coring
Work Order:	6826-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 10

BORING LOG 6826-00.GPJ GEOLABS.GDT 5/17/13

GEOLABS, INC.

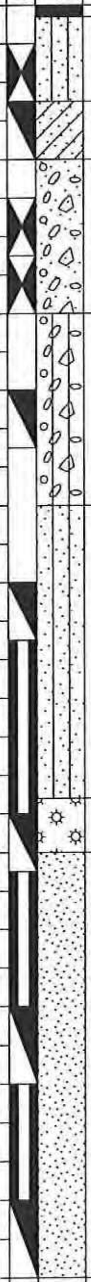
Geotechnical Engineering

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Log of Boring

111

Approximate Ground Surface Elevation (feet): 9.5 *



Laboratory			Field						
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
									4-inch **ASPHALTIC CONCRETE**
	12	108			75			SM	Tan **GRAVELLY SAND (CORALLINE)** with a little silt, very dense, moist (fill)
	22				17			SC	Gray **CLAYEY SAND (CORALLINE)** with gravel (coralline), medium dense, moist (fill)
								GW	Black **SANDY GRAVEL** with asphalt and glass debris, medium dense, moist (landfill)
	20	100			26		5		
					26		∇		
								GM	Gray **SANDY GRAVEL (CORALLINE)** with some silt, loose (lagoonal deposit)
					Wt. of Rods		10		
								SM	Whitish tan **GRAVELLY SAND (CORALLINE)** with a little silt, dense (weathered coral)
	20				69		15		
			9	9					
							20		Light tannish white **CORAL**, severely fractured, moderately weathered, medium hard to hard
	30				66				
								SP	Tan poorly graded medium to coarse **SAND** with traces of gravel and silt, medium dense (weathered sandstone)
			0				25		
Sieve - #200 = 9.8%	26				22				
			0				30		
	28				21				
									Boring terminated at 33 feet
							35		

Date Started: February 15, 2013
Date Completed: February 28, 2013
Logged By: Gremminger & Latronic
Total Depth: 33 feet
Work Order: 6826-00

Water Level: ∇ 7.2 ft. 02/25/2013 0835 HRS

Drill Rig: CME-75GY
Drilling Method: 6" HS Auger, 4" Casing & PQ Coring
Driving Energy: 140 lb. wt., 30 in. drop

Plate

A - 11

GEOLABS, INC. Geotechnical Engineering	NEW KAPALAMA TERMINAL HONOLULU, OAHU, HAWAII	**Log of Boring** 112

Approximate Ground Surface Elevation (feet): 9.5 *

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
										GM	3-inch **ASPHALTIC CONCRETE**
	23	103			13						Tan **SILTY GRAVEL (CORALLINE)** with sand, medium dense, moist (fill)
Sieve - #200 = 24.7%	21				4						grades to loose
					38		5 ∇			GW	Black **SANDY GRAVEL** with asphalt and glass debris, medium dense, moist (landfill)
	15	60			6						
										GM	Gray **SILTY GRAVEL (CORALLINE)** with some sand, loose (lagoonal deposit)
	43				4		10				
										GP	Whitish tan **SANDY GRAVEL (CORALLINE)**, dense
	24				34		15				
										GM	Tannish white **SILTY GRAVEL (CORALLINE)**, very dense (coralline detritus)
	12				83		20				
	21	93			60/6" Ref.		25				
										GP	Tannish white **SILTY GRAVEL (CORALLINE)**, medium dense
	36	84			16		30				
											Boring terminated at 31.5 feet
							35				

Date Started:	February 15, 2013	Water Level: ∇	5.8 ft. 02/15/2013 0857 HRS	Plate
Date Completed:	February 20, 2013			
Logged By:	D. Gremminger	Drill Rig:	CME-75GY	A - 12
Total Depth:	31.5 feet	Drilling Method:	6" Hollow Stem Auger, 4" Casing	
Work Order:	6826-00	Driving Energy:	140 lb. wt., 30 in. drop	

GEOLABS, INC.

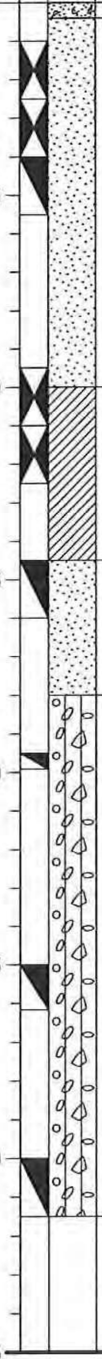
Geotechnical Engineering

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Log of Boring

113

Approximate Ground Surface Elevation (feet): 11.5 *



Laboratory			Field						
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
									5-inch **CONCRETE**
					65			SP-SM	Tan **SILTY SAND (CORALLINE)** with gravel, dense, moist (fill)
	11	107			53				
Sieve - #200 = 9.0%	12				42		5		
					3		▽ 10	CH	Gray **CLAY** with some fine sand, very soft, wet (lagoonal deposit)
LL=83 PI=57 Consol.	65	69			4	<0.5			
Sieve - #200 = 9.2%	40				5		15	SP-SM	Gray **SILTY SAND (CORALLINE)** with gravel (coralline), loose (lagoonal deposit)
								GM	Tan **SILTY GRAVEL (CORALLINE)** with some sand, very dense
	17				50/5"		20		
	23				20/6" +50/2"		25		
	18				44		30		
									Boring terminated at 31.5 feet
							35		

Date Started:	February 16, 2013
Date Completed:	February 25, 2013
Logged By:	D. Gremminger
Total Depth:	31.5 feet
Work Order:	6826-00

Water Level: ▽ 10.3 ft. 02/16/2013 1328 HRS

Drill Rig:	CME-75GY
Drilling Method:	6" Hollow Stem Auger, 4" Casing
Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 13

GEOLABS, INC.

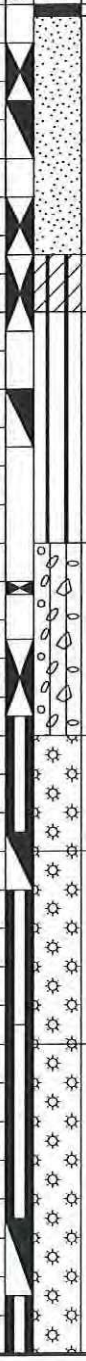
Geotechnical Engineering

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Log of Boring

114

Approximate Ground Surface Elevation (feet): 8.5 *



Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
											4-inch **ASPHALTIC CONCRETE**
	14	99			36					SP-SM	Tan **SILTY SAND (CORALLINE)** with some gravel (coralline), medium dense, damp (fill)
	11				17						
							5				
	21	93			33						
					13		▽			MH	Brown **CLAYEY SILT** with some sand (coralline), stiff to medium stiff, moist (lagoonal deposit)
										ML	Gray **CLAYEY SILT** with some sand and gravel (coralline), very soft (lagoonal deposit)
							10				
					3						
										GM	Light gray **SILTY GRAVEL** with a little wood and broken glass, loose (lagoonal deposit)
							15				
	29	74			50/4"						
	41				5						
			3	0							
											Light tannish white **CORAL**, severely fractured, moderately weathered, medium hard
							20				
	14				65						
											Light grayish white **CORAL**, moderately fractured, slightly weathered, hard
UC			100	60							
							25				
			20	8							
											Grayish white to tannish white **CORAL**, severely fractured, moderately to highly weathered, soft to medium hard
							30				
	14				29						
			53	0							
							35				

Date Started:	February 15, 2013	Water Level: ▽	7.2 ft. 02/25/2013 0835 HRS
Date Completed:	February 25, 2013		
Logged By:	Gremminger & Latronic	Drill Rig:	CME-75GY
Total Depth:	123.5 feet	Drilling Method:	6" HS Auger, 4" Casing & PQ Coring
Work Order:	6826-00	Driving Energy:	140 lb. wt., 30 in. drop

GEOLABS, INC.

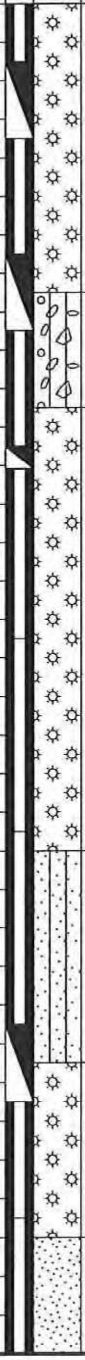
Geotechnical Engineering

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Log of Boring

114

(Continued from previous plate)



Laboratory			Field						
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
	12				25				
			28	0					
							40		
	11				22				
								GM	Tan **SILTY GRAVEL (CORALLINE)** with a little sand, medium dense (coralline detritus)
			31	17					
							45		
									Light grayish white **CORAL**, closely fractured, slightly weathered, medium hard to hard
	27				25/1"				
			70	13					
							50		
UC									
			72	38					
							55		
			13	0					
								SM	Tannish white **SILTY SAND** with a little gravel, loose to medium dense (coralline detritus)
							60		
	28				14				
									Light tannish white **CORAL**, moderately fractured, slightly to moderately weathered, medium hard
	20								
			86	28					
							65		
			15	0					
								SP	Tan poorly graded **SAND**, medium dense (weathered sandstone)
							70		

Date Started:	February 15, 2013	Water Level: ∇	7.2 ft. 02/25/2013 0835 HRS
Date Completed:	February 25, 2013		
Logged By:	Gremminger & Latronic	Drill Rig:	CME-75GY
Total Depth:	123.5 feet	Drilling Method:	6" HS Auger, 4" Casing & PQ Coring
Work Order:	6826-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 14.2

BORING LOG 6826-00.GPJ GEOLABS.GDT 5/17/13

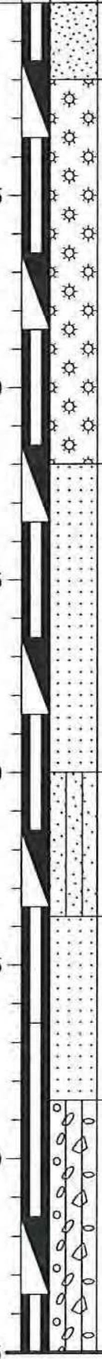
GEOLABS, INC.

Geotechnical Engineering

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Log of Boring

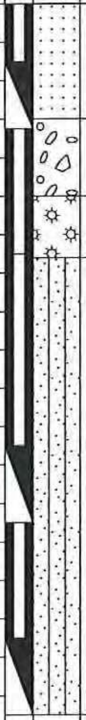
114



Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	(Continued from previous plate) Description
										SP	
	13				39						White **CORAL**, severely fractured, moderately to highly weathered, soft to medium hard
			31	0							
							75				
	17				21						
			28	0							
							80				
	16				22						Light tannish white calcareous **SANDSTONE**, severely fractured, moderately to highly weathered, soft (coralline sandstone)
			33	0							
							85				
	18				24						
			53	0							
							90			SM	Light tan **SILTY SAND** with traces of gravel, loose to medium dense (weathered sandstone)
	32				9						
			92	39							Light tannish white calcareous **SANDSTONE**, moderately fractured, slightly weathered, medium hard (coralline sandstone)
							95				
			42	17							
										GM	Tan with some light brown **SILTY GRAVEL (CORALLINE)** with some sand, medium dense (alluvium with coral debris)
							100				
	23				17						
			19	0							grades with rounded gravel
							105				

Date Started:	February 15, 2013	Water Level: ⊻	7.2 ft. 02/25/2013 0835 HRS
Date Completed:	February 25, 2013		
Logged By:	Gremminger & Latronic	Drill Rig:	CME-75GY
Total Depth:	123.5 feet	Drilling Method:	6" HS Auger, 4" Casing & PQ Coring
Work Order:	6826-00	Driving Energy:	140 lb. wt., 30 in. drop

(Continued from previous plate)



Laboratory			Field						
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
	17				36				Tan calcareous **SANDSTONE**, severely fractured, moderately to highly weathered, soft (coralline sandstone)
	18								
			62	15				GP	Tan with some gray **SANDY GRAVEL (BASALTIC)**, very dense (river deposit)
							110		Tannish white **CORAL**, moderately fractured, slightly weathered, hard
			2	0				SM	Light tannish white **SILTY SAND** with traces of gravel, medium dense (weathered sandstone)
							115		
	22				14				
			0						
							120		
	16				26				
									Boring terminated at 123.5 feet
							125		
							130		
							135		
							140		

Date Started:	February 15, 2013
Date Completed:	February 25, 2013
Logged By:	Gremminger & Latronic
Total Depth:	123.5 feet
Work Order:	6826-00
Water Level: ∇	7.2 ft. 02/25/2013 0835 HRS
Drill Rig:	CME-75GY
Drilling Method:	6" HS Auger, 4" Casing & PQ Coring
Driving Energy:	140 lb. wt., 30 in. drop

Plate
A - 14.4

GEOLABS, INC.

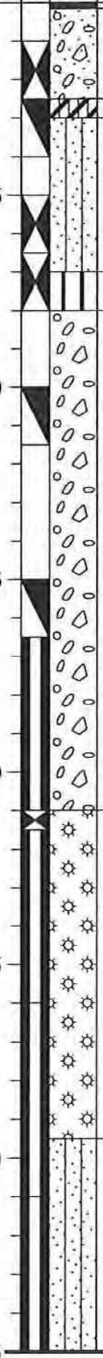
Geotechnical Engineering

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Log of Boring

115

Approximate Ground Surface Elevation (feet): 8 *



Laboratory			Field						
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
								GW	1.5-inch **ASPHALTIC CONCRETE** Brown **SANDY GRAVEL (CORALLINE)**, dense, moist (fill)
	12	100			35				
	10				47			CL	Brown **SILTY CLAY** with some sand and a little gravel (coralline), soft, moist (fill)
								SM	Tannish white **SILTY SAND** with some gravel (coralline), dense, moist (fill)
							∇		
							5		
	31	83			28				
					4				
								ML	Dark gray **SANDY SILT**, soft (lagoonal deposit)
								GP-GM	Tannish gray **SILTY GRAVEL (CORALLINE)** with a little sand, loose (coralline detritus)
							10		
Sieve - #200 = 5.3%	38				4				
							15		
					1				
			0						
							20		
					60/6"				Light grayish white **CORAL**, moderately fractured, slightly to moderately weathered, medium hard to hard
			100	43					
UC							25		
			72	20					
							30	SM	Brownish tan **SILTY SAND** with some gravel and a little cobbles (coralline), dense (coralline detritus)
			23						
							35		

Date Started:	February 16, 2013	Water Level: ∇	4.5 ft. 02/26/2013 0945 HRS
Date Completed:	February 26, 2013		
Logged By:	S. Latronic	Drill Rig:	CME-75GY
Total Depth:	37.5 feet	Drilling Method:	6" HS Auger, 4" Casing & PQ Coring
Work Order:	6826-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 15.1

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	(Continued from previous plate) Description
	13				74					SM	
											Boring terminated at 37.5 feet
							40				
							45				
							50				
							55				
							60				
							65				
							70				

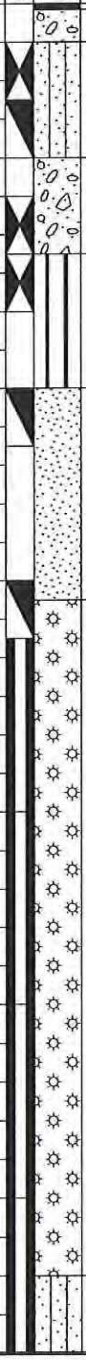
Date Started: February 16, 2013
Date Completed: February 26, 2013
Logged By: S. Latronic
Total Depth: 37.5 feet
Work Order: 6826-00

Water Level: ∇ 4.5 ft. 02/26/2013 0945 HRS
Drill Rig: CME-75GY
Drilling Method: 6" HS Auger, 4" Casing & PQ Coring
Driving Energy: 140 lb. wt., 30 in. drop

Plate A - 15.2

GEOLABS, INC. Geotechnical Engineering	NEW KAPALAMA TERMINAL HONOLULU, OAHU, HAWAII		Log of Boring 116

Approximate Ground Surface Elevation (feet): 8.5 *



Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
										GW	1.5-inch **ASPHALTIC CONCRETE**
	22	84			24					SM	Brown **SANDY GRAVEL**, medium dense, damp (fill)
	53				2						Brown **SILTY SAND**, medium dense, damp (fill) grades to gray, very loose, moist at 2.5 feet
										GW	Light tannish brown **SANDY GRAVEL (CORALLINE)**, dense, moist (fill)
	32	77			38		5				
					2					ML	Dark gray to black **SANDY SILT**, very soft, wet (lagoonal deposit)
							▽				
Sieve - #200 = 8.7%	38				4		10			SP-SM	Grayish tan **SILTY SAND (CORALLINE)** with gravel, loose (coralline detritus)
	31				53		15				Tannish white **CORAL**, moderately fractured, slightly weathered, hard
			74	22							
UC							20				
			100	68							
UC							25				
			90	28							
							30				
			42	12							
UC											
										SM	
							35				

Date Started:	February 16, 2013	Water Level: ▽	8.1 ft. 02/25/2013 1450 HRS	Plate
Date Completed:	February 25, 2013			
Logged By:	S. Latronic	Drill Rig:	CME-75GY	
Total Depth:	42.5 feet	Drilling Method:	6" HS Auger, 4" Casing & PQ Coring	A - 16.1
Work Order:	6826-00	Driving Energy:	140 lb. wt., 30 in. drop	

(Continued from previous plate)

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
			52							SM	Tannish white **SILTY SAND** with a little gravel (coralline), medium dense (weathered sandstone)
							40				
	23				42						
											Boring terminated at 42.5 feet
							45				
							50				
							55				
							60				
							65				
							70				

Date Started: February 16, 2013
Date Completed: February 25, 2013
Logged By: S. Latronic
Total Depth: 42.5 feet
Work Order: 6826-00

Water Level: ⊻ 8.1 ft. 02/25/2013 1450 HRS
Drill Rig: CME-75GY
Drilling Method: 6" HS Auger, 4" Casing & PQ Coring
Driving Energy: 140 lb. wt., 30 in. drop

GEOLABS, INC.

Geotechnical Engineering

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Log of Boring

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Approximate Ground Surface Elevation (feet): 11 *

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
							0				5-inch **CONCRETE SLAB**
	8	91			62					SM	Tan **SILTY SAND (CORALLINE)** with gravel, dense, moist (fill)
Sieve - #200 = 12.0%	11				48		5				
					32		▽ 10			SM	Gray **SILTY SAND (CORALLINE)** with a little gravel (coralline), medium dense, wet (lagoonal deposit)
	57	69			7	<0.5				CL	Gray **SILTY CLAY** with some fine sand, very soft (lagoonal deposit)
Sieve - #200 = 29.0%	39				3		15			SM	Gray **SILTY SAND** with gravel (coralline), very soft (lagoonal deposit)
	63	62			20/1"		20			GP	Tan **SANDY GRAVEL (CORALLINE)**, very dense (coralline detritus)
	20				82		25				
					50/1"		30				Boring terminated at 30.1 feet
							35				

Date Started:	February 16, 2013	Water Level: ▽	10.0 ft. 02/16/2013 2227 HRS
Date Completed:	February 23, 2013		
Logged By:	Gremminger & Latronic	Drill Rig:	CME-45B
Total Depth:	30.1 feet	Drilling Method:	6" HS Auger, 4" Casing
Work Order:	6826-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 17

GEOLABS, INC.

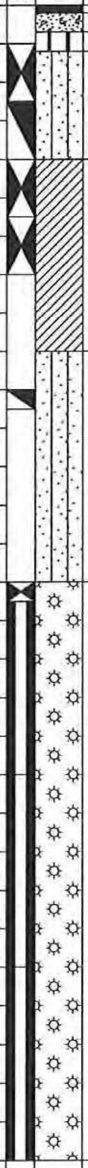
Geotechnical Engineering

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Log of Boring

118

Approximate Ground Surface Elevation (feet): 5 *



Laboratory			Field						
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
									2-inch **ASPHALTIC CONCRETE**
									6-inch **CONCRETE**
	26	89			19			ML	Tannish brown **CLAYEY SILT** with some sand and gravel, stiff, moist (fill)
Sieve - #200 = 10.0%	35				3			SM	Tan **SILTY SAND (CORALLINE)** with a little gravel (coralline), very loose, wet (fill)
					2		▽		
LL=54 PI=33 Consol.	62	67			9	<0.5	5	CH	Gray **CLAY** with some fine sand and gravel (coralline), very soft, wet (lagoonal deposit) grades with some cobbles (coralline) at 5.5 feet
	21				70/6"		10	GM	Tan **SILTY GRAVEL (CORALLINE)** with sand, very dense (coralline detritus)
	31		89	26	61/6"		15		Light tannish white **CORAL**, severely to closely fractured, moderately weathered, medium hard
UC			92	37			20		
UC									
			63	7			25		
							30		Boring terminated at 30 feet
							35		

Date Started:	February 16, 2013	Water Level: ▽	4.5 ft. 02/16/2013 1549 HRS
Date Completed:	March 2, 2013		
Logged By:	D. Gremminger	Drill Rig:	CME-75GY
Total Depth:	30 feet	Drilling Method:	6" Hollow Stem Auger & PQ Coring
Work Order:	6826-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 18

GEOLABS, INC.

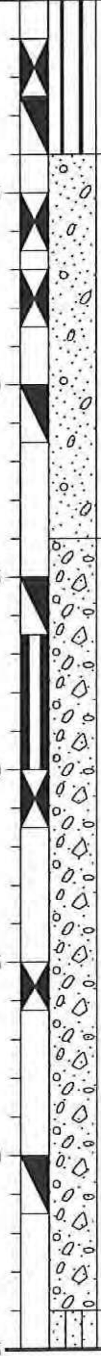
Geotechnical Engineering

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Log of Boring

201

Approximate Ground Surface Elevation (feet): 7 *



Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
										ML	Tannish gray **SANDY SILT** with a little gravel (coralline), stiff, dry (fill)
Sieve - #200 = 53.7%	20	95			14						
	18				13						grades to medium stiff
										SW	Tan **GRAVELLY SAND (CORALLINE)**, very dense, dry
	20	102			117		5				
							▽				
					102						
	24				51		10				
										GW-GM	Tan **SANDY GRAVEL (CORALLINE)** with a little silt, cemented, medium dense to very dense (coralline detritus)
	20				25		15				
			71								
Sieve - #200 = 8.1%	11	107			28		20				
	9				27/6" +40/3"		25				
	15				37		30				
										SM	
							35				

Date Started:	February 14, 2013	Water Level: ▽	6.5 ft. 02/21/2013 1000 HRS	Plate
Date Completed:	February 21, 2013			
Logged By:	D. Gremminger	Drill Rig:	CME-75GY	
Total Depth:	51.5 feet	Drilling Method:	6" HS Auger, 4" Casing & PQ Coring	A - 19.1
Work Order:	6826-00	Driving Energy:	140 lb. wt., 30 in. drop	

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NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Log of Boring

201

(Continued from previous plate)

Laboratory			Field								
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	Sample	Graphic	USCS	Description
	8				9					SM	Tan **SILTY SAND (CORALLINE)** with some gravel, loose (coralline detritus)
	18	95			9		40				
											grades to cemented, medium dense
	21	94			38		45				
	23	98			25		50				
											Boring terminated at 51.5 feet
							55				
							60				
							65				
							70				

Date Started:	February 14, 2013	Water Level: ⊻	6.5 ft. 02/21/2013 1000 HRS
Date Completed:	February 21, 2013		
Logged By:	D. Gremminger	Drill Rig:	CME-75GY
Total Depth:	51.5 feet	Drilling Method:	6" HS Auger, 4" Casing & PQ Coring
Work Order:	6826-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 19.2

BORING_LOG 6826-00.GPJ GEOLABS.GDT 5/17/13

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NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Log of Boring

202

Approximate Ground Surface Elevation (feet): 7 *

Laboratory			Field						
Other Tests	Moisture Content (%)	Dry Density (pcf)	Core Recovery (%)	RQD (%)	Penetration Resistance (blows/foot)	Pocket Pen. (tsf)	Depth (feet)	USCS	Description
								ML	Tannish gray **SANDY SILT** with a little gravel (coralline), stiff, damp (fill)
	10	99			11				
	10				4				grades to soft
								SP	Tan **SAND (CORALLINE)** with a little gravel (coralline), loose, moist (fill)
	37				3	<0.5	5		
								CL	Grayish brown **SILTY CLAY** with some fine sand, soft, moist (fill)
								SM	Tan **SILTY SAND (CORALLINE)** with gravel, medium dense, moist (coralline detritus)
					16	⊻			
	84				16		10		
								ML	Tan **SANDY SILT**, very stiff
Sieve - #200 = 12.9%	23	99			26			SP-SM	Tan **SILTY SAND (CORALLINE)** with gravel, medium dense
							15		
	23	88			48		20	GW	Tannish brown **SANDY GRAVEL (CORALLINE)**, dense
	27	81			36		25		
	8	90			42		30		
									Boring terminated at 31.5 feet
							35		

Date Started:	February 14, 2013	Water Level: ⊻	7.9 ft. 02/15/2013 0841 HRS
Date Completed:	February 20, 2013		
Logged By:	D. Gremminger	Drill Rig:	CME-75GY
Total Depth:	31.5 feet	Drilling Method:	6" HS Auger, 4" Casing
Work Order:	6826-00	Driving Energy:	140 lb. wt., 30 in. drop

Plate

A - 20

APPENDIX B

APPENDIX B

Laboratory Tests

Moisture Content and Dry Density tests were performed on selected soil samples to aid in defining the interface between the various soil layers encountered and correlating the layers between test borings. The moisture content tests were performed in general accordance with ASTM D2216. The test results are presented on the Logs of Borings at the appropriate sample depths.

Five (5) Atterberg Limits tests (ASTM D4318) were performed on selected soil samples to evaluate the liquid limit (LL), plastic limit (PL), and plasticity index (PI), as an aid in classifying the soils. The Atterberg Limits tests were performed in general accordance with ASTM D4318. The test results are summarized on the Logs of Borings at the appropriate sample depths. Graphic presentation of the test results are provided on Plate B-1.

Twenty-six (26) Sieve Analysis tests (ASTM C117 & C136) were performed to evaluate the gradation characteristics and to aid in soil classification. The tests were performed in accordance with ASTM C117 and C136. Graphic presentation of the test results are provided on Plates B-2 through B-7.

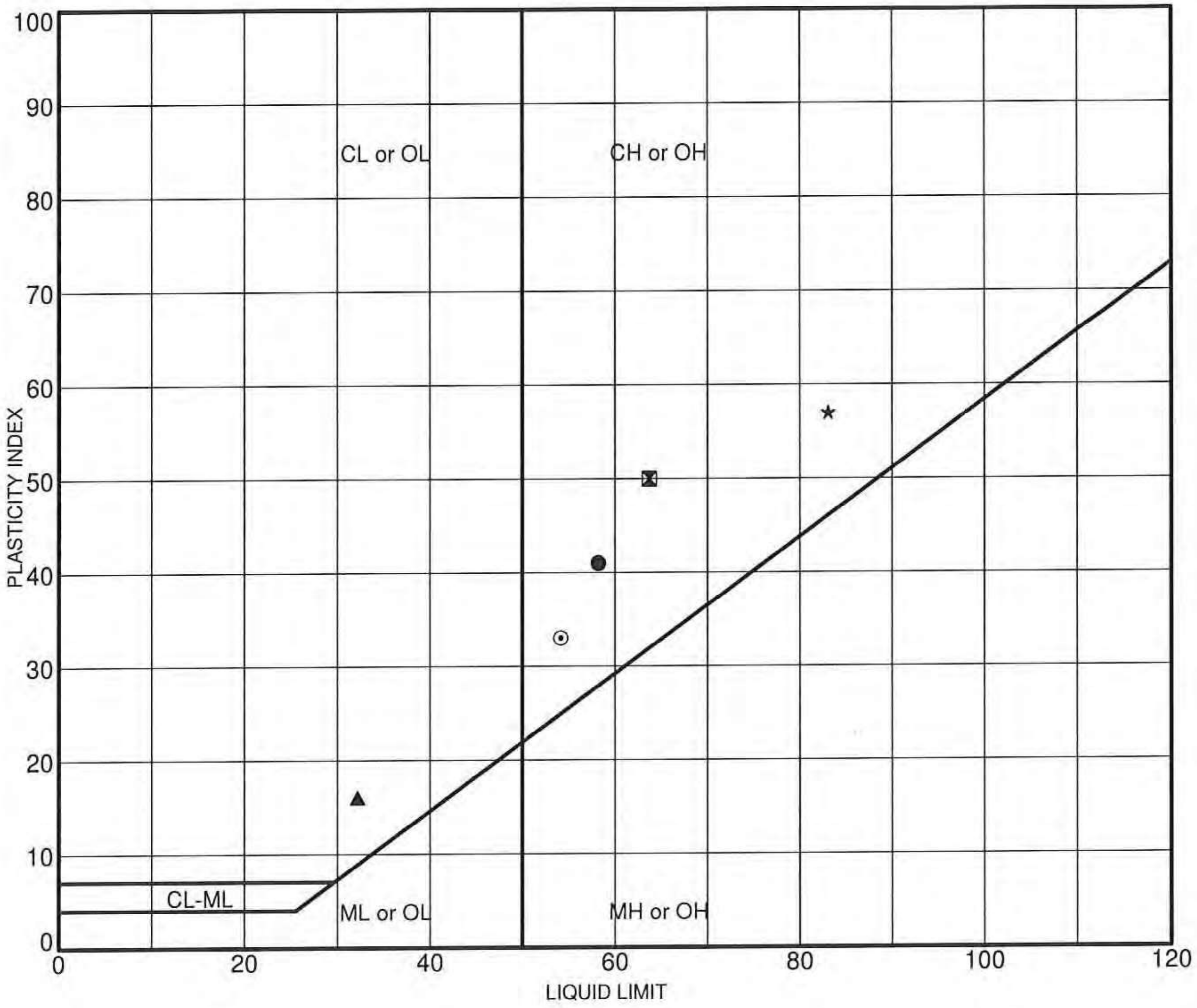
Four (4) Consolidation tests (ASTM D2435) were performed on samples of the soft compressible soils to evaluate the compressibility characteristics of the materials encountered. The test results are presented on Plates B-8 through B-11.

Two (2) Unconsolidated Undrained Triaxial Compression (TXUU) tests (ASTM D2850) were performed on selected soil samples to evaluate the undrained shear strength of the silty and clayey soils encountered. The approximate in-situ effective overburden pressure was used as the applied confining pressure for the relatively "undisturbed" soil sample. The test results and the stress-strain curves are presented on Plates B-12 and B-13.

Four sets of California Bearing Ratio (CBR) tests (ASTM D1883) were performed on bulk samples of the near-surface soils to evaluate the strength characteristics for pavement subgrade support. Each set of CBR test was conducted with two compaction densities, to simulate various compaction efforts ranging from 90 to 100 percent relative compaction. CBR test results are presented on Plates B-14 through B-21.

Four Modified Proctor compaction tests (ASTM D1557) were performed on bulk samples of the near-surface soils to evaluate the relationship between the moisture content and the dry density of the near-surface soils as fill materials. The test results are presented on Plates B-22 through B-25.

Sixteen Unconfined Compression tests (ASTM D7012 Method C) were performed on selected rock cores to evaluate their unconfined compressive strength of the rock formation encountered. Unconfined compression test results are presented on Plate B-26.



	Sample	Depth (ft)	LL	PL	PI	Description
●	B-101	2.5-4.0	58	17	41	Tannish brown clay (CH) with some gravel (coralline)
☒	B-103	2.5-4.0	64	14	50	Brown clay (CH) with some sand and traces of gravel (coralline)
▲	B-104	10.0-11.5	32	16	16	Gray silty clay (CL) with little gravel (coralline)
★	B-113	11.0-12.5	83	26	57	Gray clay (CH) with some fine sand
⊙	B-118	5.5-7.0	54	21	33	Gray clay (CH) with sand and traces of gravel (coralline)

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ATTERBERG LIMITS TEST RESULTS - ASTM D 4318

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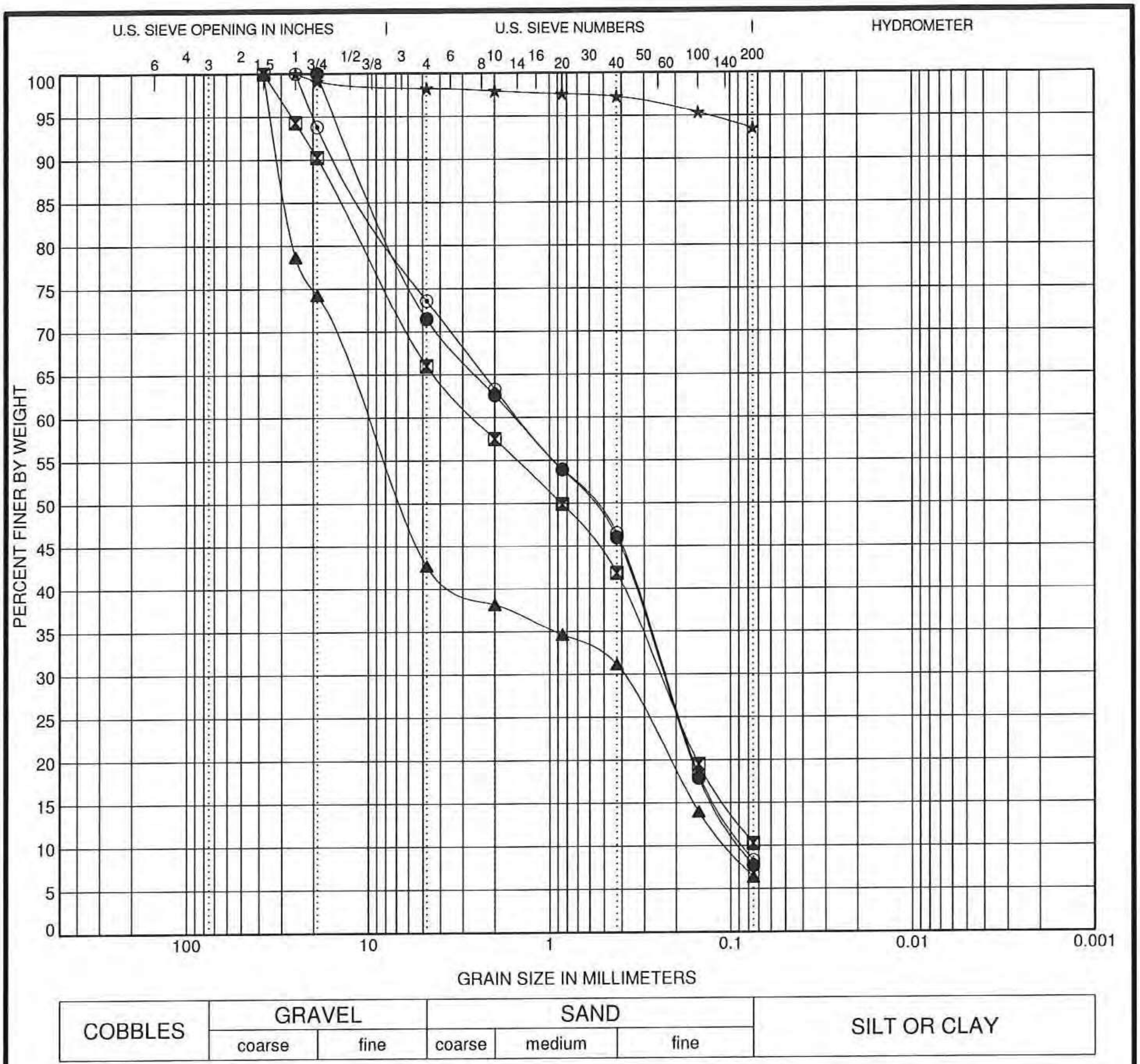
HONOLULU, OAHU, HAWAII

Plate
B - 1



	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	B-101	10.0-11.5	Gray silty sand (SP-SM) with gravel (coralline)				0.4	17.7
⊠	B-102	2.5-4.0	Brown silty sand (SP-SM) with gravel (coralline)				0.3	35.1
▲	B-102	10.0-11.5	Gray sandy gravel (GP-GM) with a little silt				0.1	97.2
★	B-103	10.0-11.5	Gray silt (ML) with traces of sand and gravel					
⊙	B-105	2.5-4.0	Tan silty sand (SP-SM) with some gravel				0.4	17.6

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
●	B-101	10.0-11.5	19	1.553	0.235	0.088	28.5	63.8	7.7
⊠	B-102	2.5-4.0	37.5	2.582	0.245		34.0	55.7	10.3
▲	B-102	10.0-11.5	37.5	10.154	0.396	0.104	57.3	36.4	6.4
★	B-103	10.0-11.5	25				1.8	4.7	93.5
⊙	B-105	2.5-4.0	25	1.48	0.231	0.084	26.4	65.3	8.3

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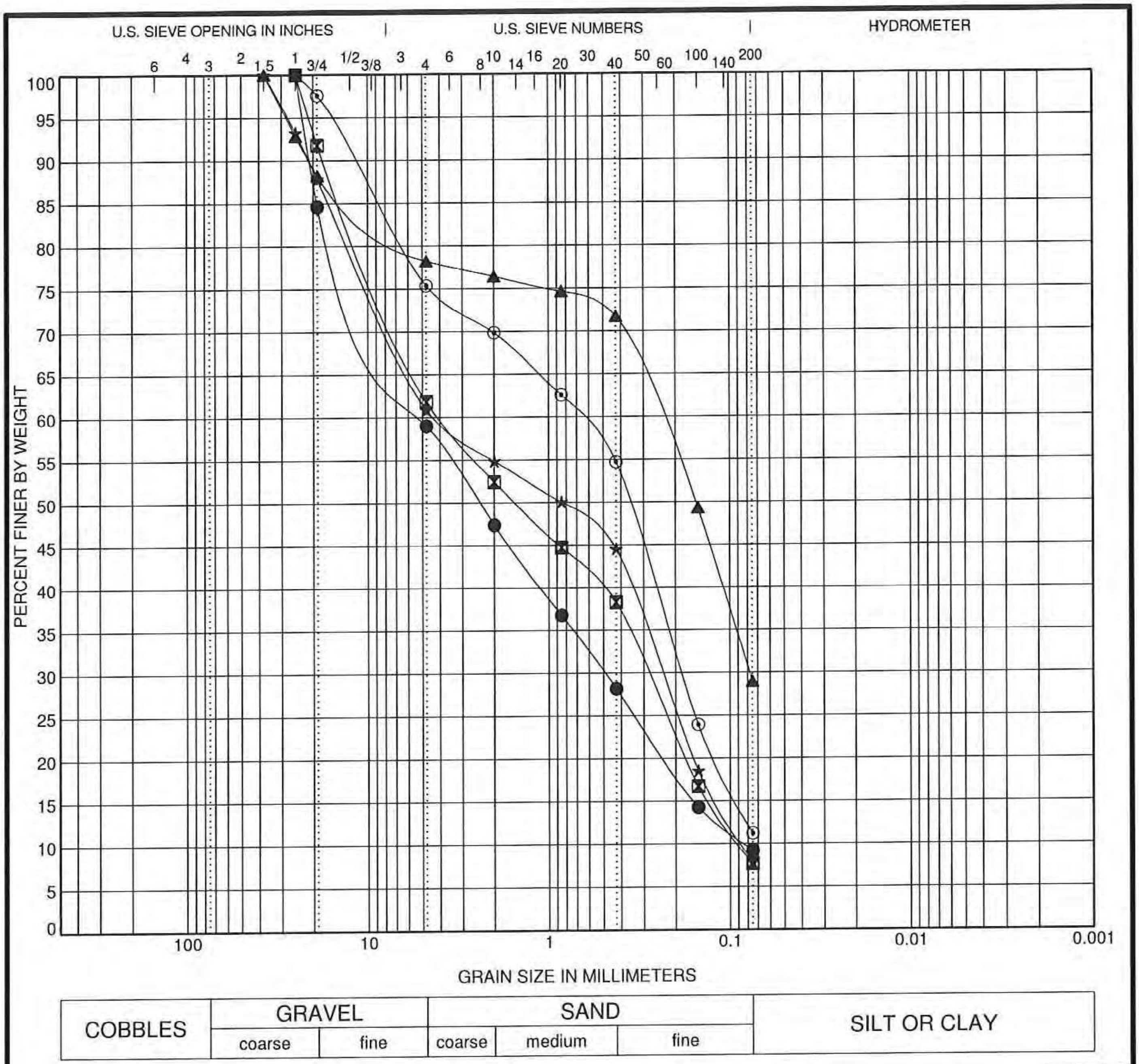
NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Plate
B - 2



	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	B-106	2.5-4.0	Brownish tan silty sand (SP-SM) with gravel				0.6	60.1
☒	B-106	10.0-11.5	Grayish brown silty sand (SP-SM) with gravel				0.2	45.0
▲	B-107	2.5-4.0	Tannish brown silty sand (SM) with some gravel					
★	B-108	5.0-6.5	Brown silty sand (SP-SM) with gravel				0.2	48.8
⊙	B-108	15.0-16.5	Gray silty sand (SP-SM) with gravel				0.7	9.7

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
●	B-106	2.5-4.0	25	5.019	0.493	0.084	41.0	49.8	9.2
☒	B-106	10.0-11.5	25	4.033	0.285	0.09	38.2	54.1	7.7
▲	B-107	2.5-4.0	37.5	0.247	0.078		21.8	49.3	28.9
★	B-108	5.0-6.5	37.5	4.196	0.237	0.086	39.1	53.0	7.9
⊙	B-108	15.0-16.5	25	0.679	0.184		24.6	64.2	11.2

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Plate
B - 3

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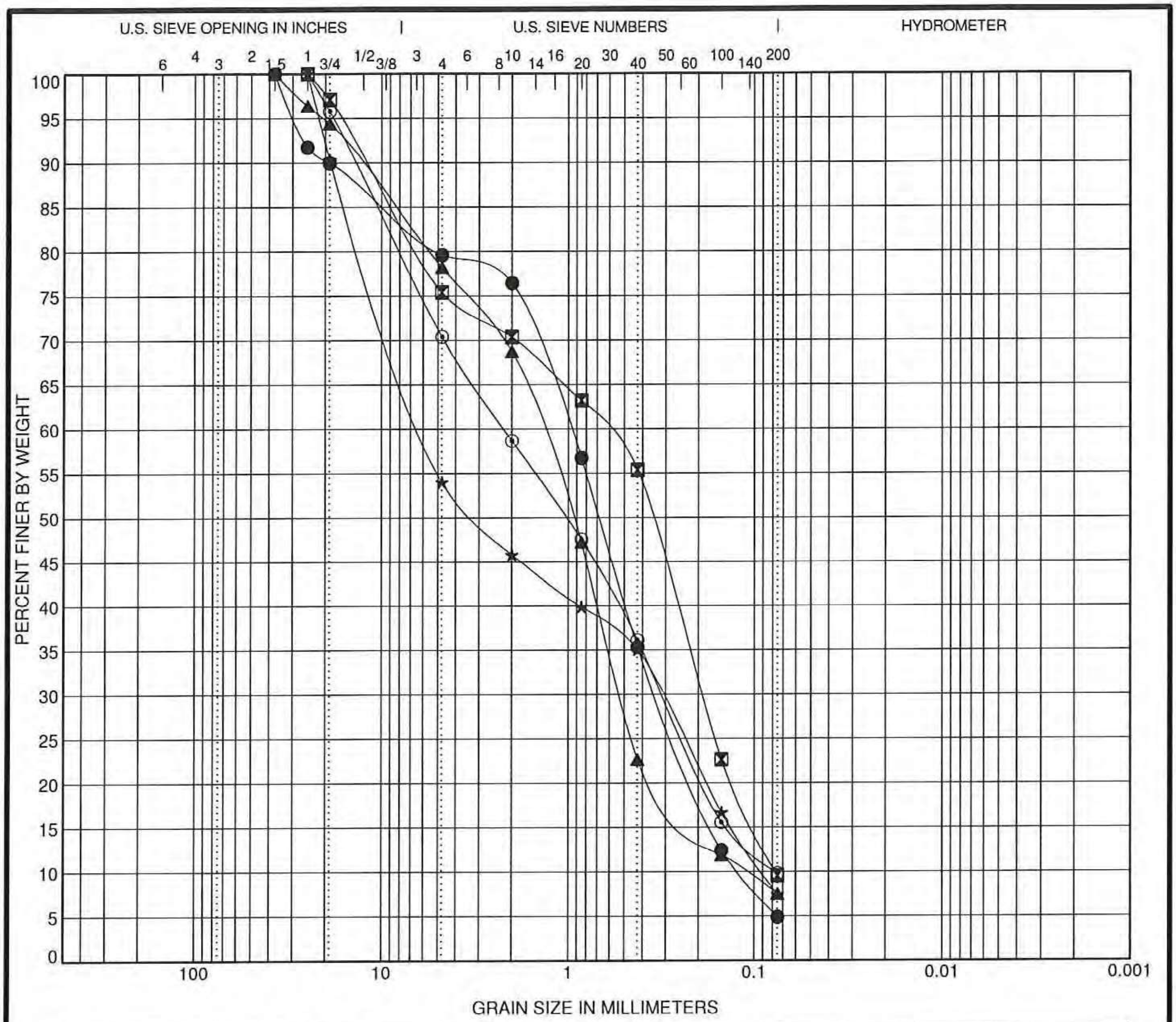

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	B-109	2.5-4.0	Tan silty sand (SP) with gravel				0.9	8.1
⊠	B-109	10.0-11.5	Gray silty sand (SP-SM) with gravel				0.7	8.3
▲	B-109	37.0-39.0	Tan gravelly sand (SW-SM) with a little silt				1.7	12.7
★	B-110	10.0-11.5	Gray silty sand (SP-SM) with gravel				0.2	65.6
⊙	B-111	26.0-28.0	Tan gravelly sand (SP-SM) with a little silt				0.6	28.8

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
●	B-109	2.5-4.0	37.5	0.98	0.334	0.12	20.4	74.7	4.9
⊠	B-109	10.0-11.5	25	0.641	0.19	0.077	24.6	65.9	9.5
▲	B-109	37.0-39.0	37.5	1.415	0.523	0.112	21.8	70.7	7.5
★	B-110	10.0-11.5	25	5.973	0.319	0.091	46.0	46.6	7.4
⊙	B-111	26.0-28.0	25	2.21	0.312	0.077	29.6	60.6	9.8

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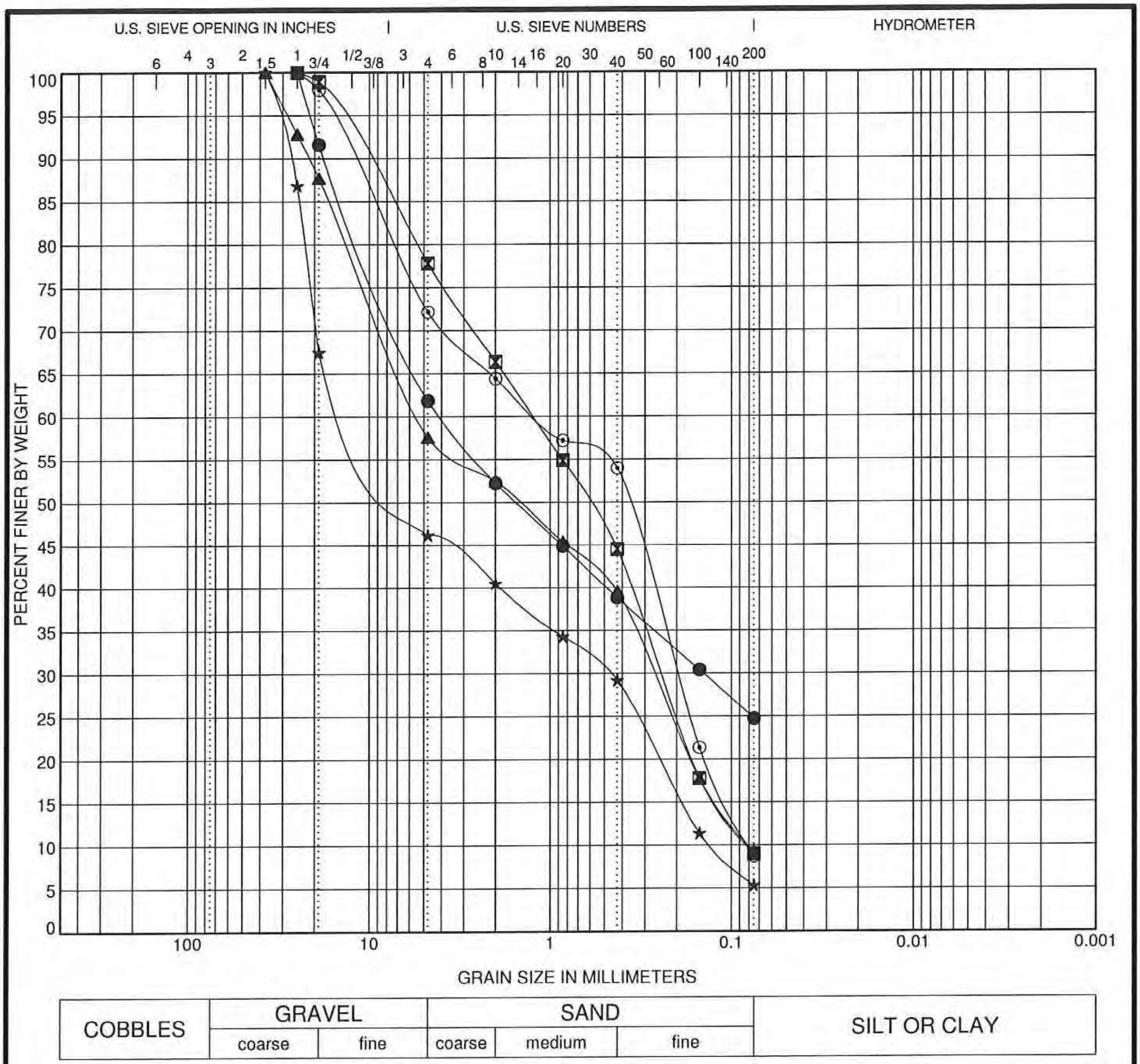
Plate
B - 4



	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	B-112	2.5-4.0	Grayish brown silty gravel (GM) with some sand					
⊠	B-113	4.0-5.5	Tan silty sand (SP-SM) with gravel				0.6	15.3
▲	B-113	14.5-16.0	Gray silty sand (SP-SM) with gravel				0.2	66.4
★	B-115	10.0-11.5	Gray silty gravel (GP-GM) with a little sand				0.1	91.1
⊙	B-116	10.0-11.5	Gray silty sand (SP-SM) with gravel				0.4	14.8

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
●	B-112	2.5-4.0	25	4.033	0.143		38.2	37.1	24.7
⊠	B-113	4.0-5.5	25	1.246	0.241	0.081	22.2	68.8	9.0
▲	B-113	14.5-16.0	37.5	5.314	0.269	0.08	42.4	48.4	9.2
★	B-115	10.0-11.5	37.5	11.685	0.473	0.128	53.8	40.9	5.3
⊙	B-116	10.0-11.5	25	1.189	0.198	0.08	27.8	63.4	8.7

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NEW KAPALAMA TERMINAL
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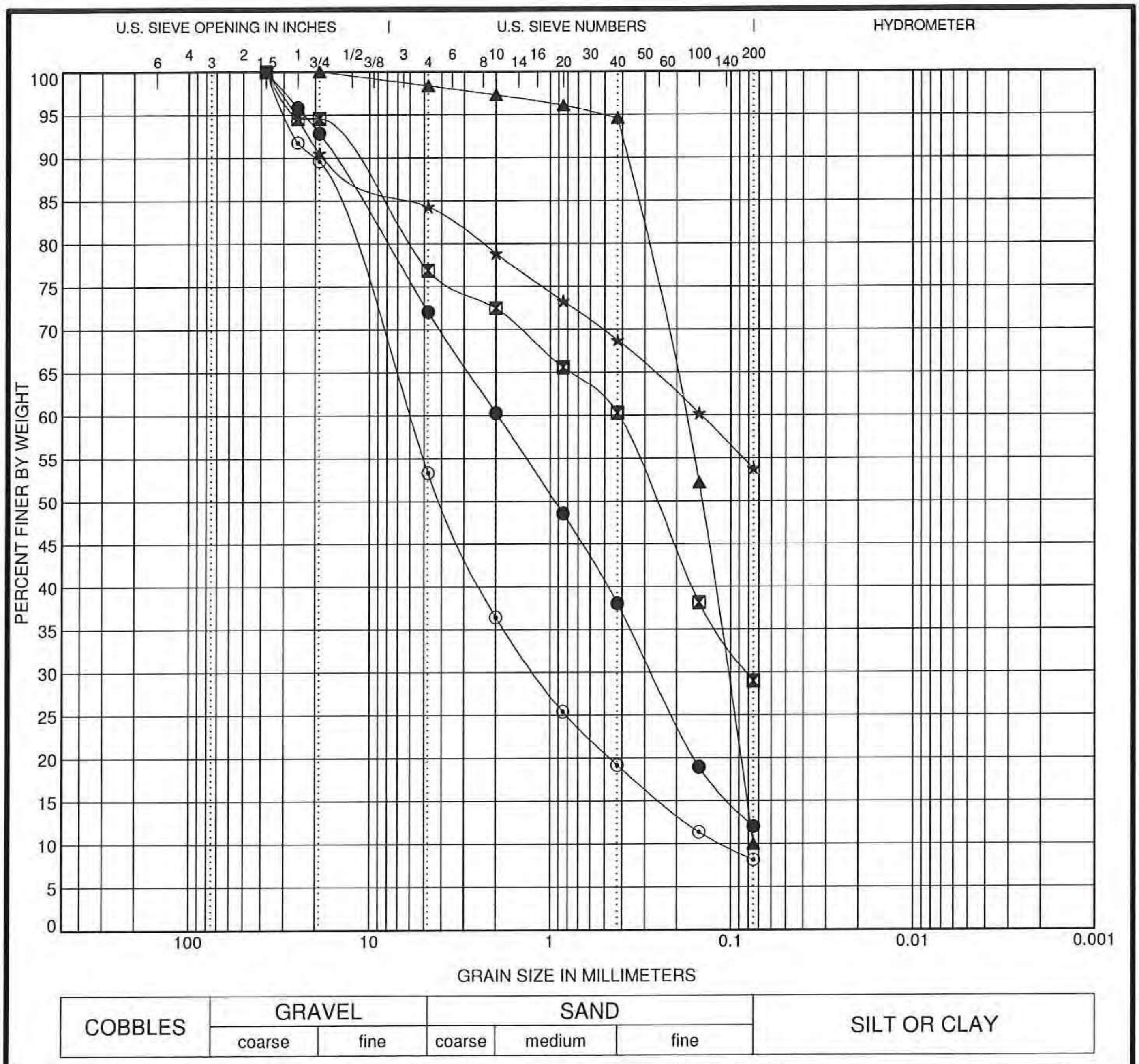
Plate
B - 5



	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	B-117	4.0-5.5	Brown gravelly sand (SM) with a little silt				0.6	31.9
☒	B-117	14.5-16.0	Gray silty sand (SM) with some gravel					
▲	B-118	2.5-4.0	Brown silty sand (SP-SM) with traces of gravel				0.8	2.4
★	B-201	1.0-2.5	Brown sandy silt (ML) with some gravel					
⊙	B-201	20.0-21.5	Tan sandy gravel (GW-GM) with a little silt				2.1	54.7

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
●	B-117	4.0-5.5	37.5	1.96	0.274		27.9	60.0	12.0
☒	B-117	14.5-16.0	37.5	0.42	0.081		23.1	47.9	29.0
▲	B-118	2.5-4.0	19	0.182	0.104	0.075	1.6	88.4	10.0
★	B-201	1.0-2.5	37.5	0.147			15.7	30.6	53.7
⊙	B-201	20.0-21.5	37.5	6.136	1.213	0.112	46.7	45.2	8.1

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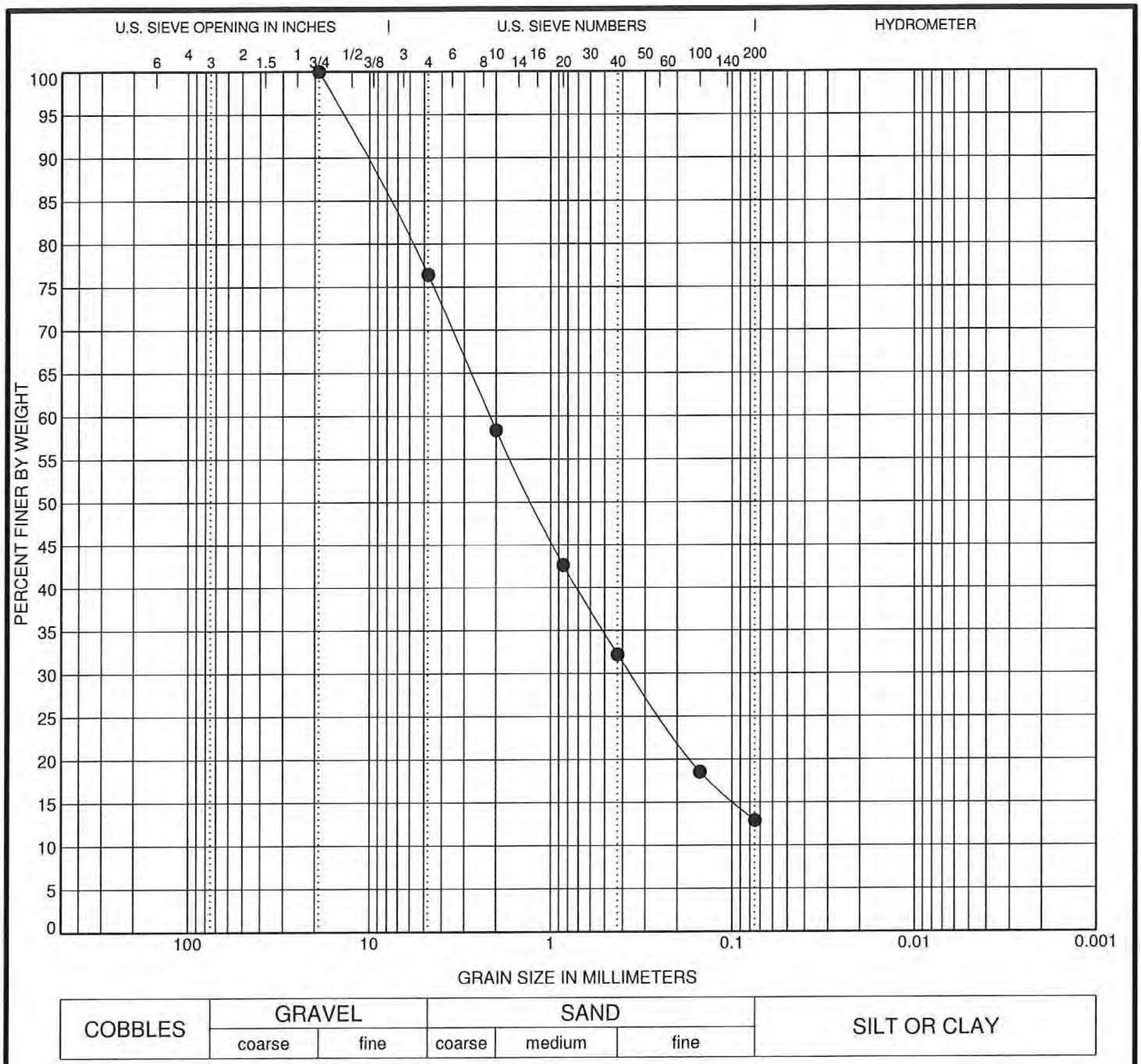
Plate
B - 6



	Sample	Depth (ft)	Description	LL	PL	PI	Cc	Cu
●	B-202	13.5-15.0	Tan silty sand (coralline) (SP-SM) with some gravel					

	Sample	Depth (ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Fine
●	B-202	13.5-15.0	19	2.164	0.359		23.6	63.6	12.9

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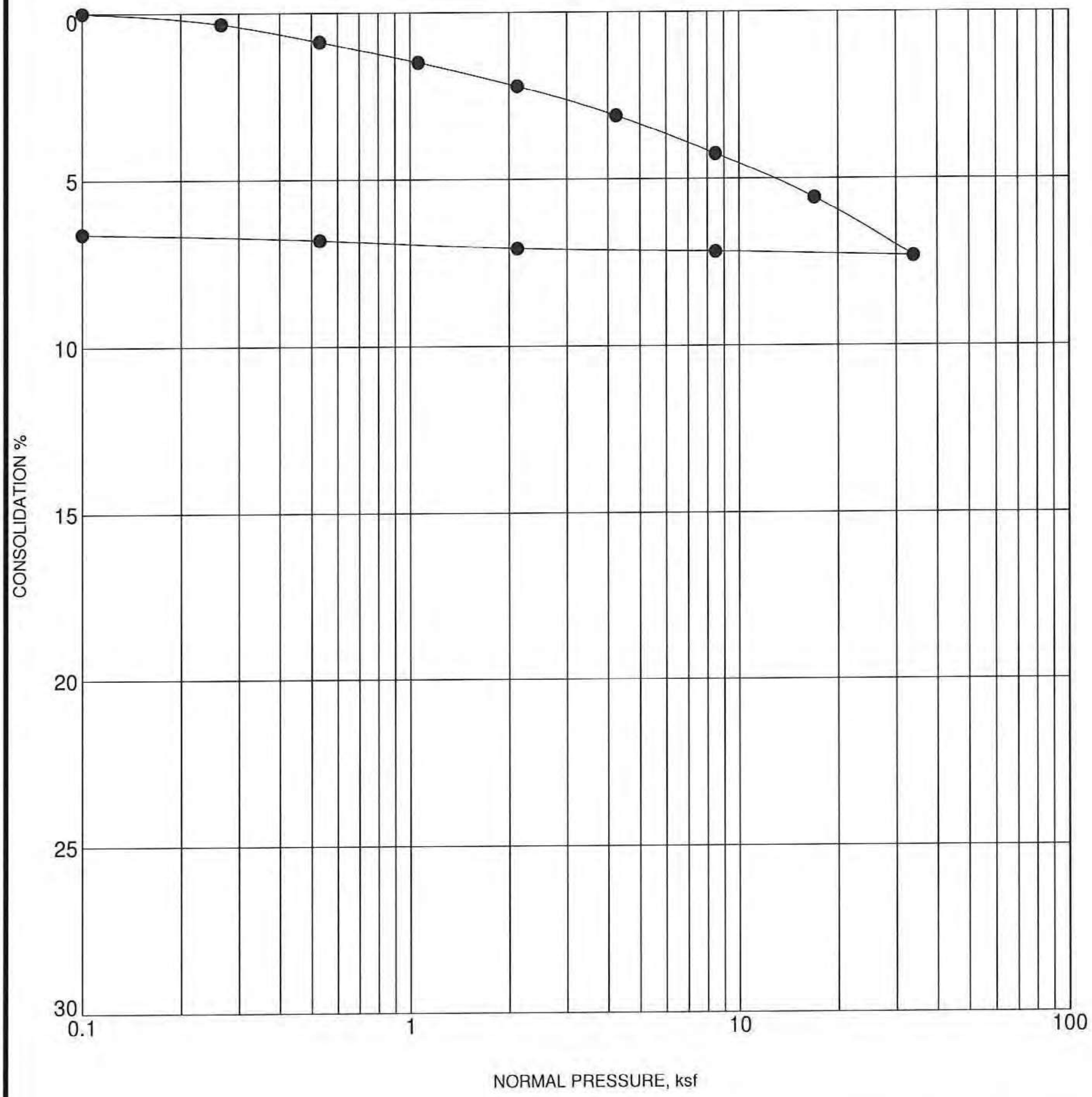
Plate
B - 7



Sample: B-103
Depth: 15.0 feet
Description: Gray clayey silt with some sand (coralline)

Liquid Limit = N/A Plasticity Index = N/A

	Initial	Final
Water Content, %	32.7	28.3
Dry Density, pcf:	90.5	96.9
Void Ratio	0.909	0.783
Degree of Saturation, %	99.5	100.0
Sample Height, inches	1.0000	0.9079

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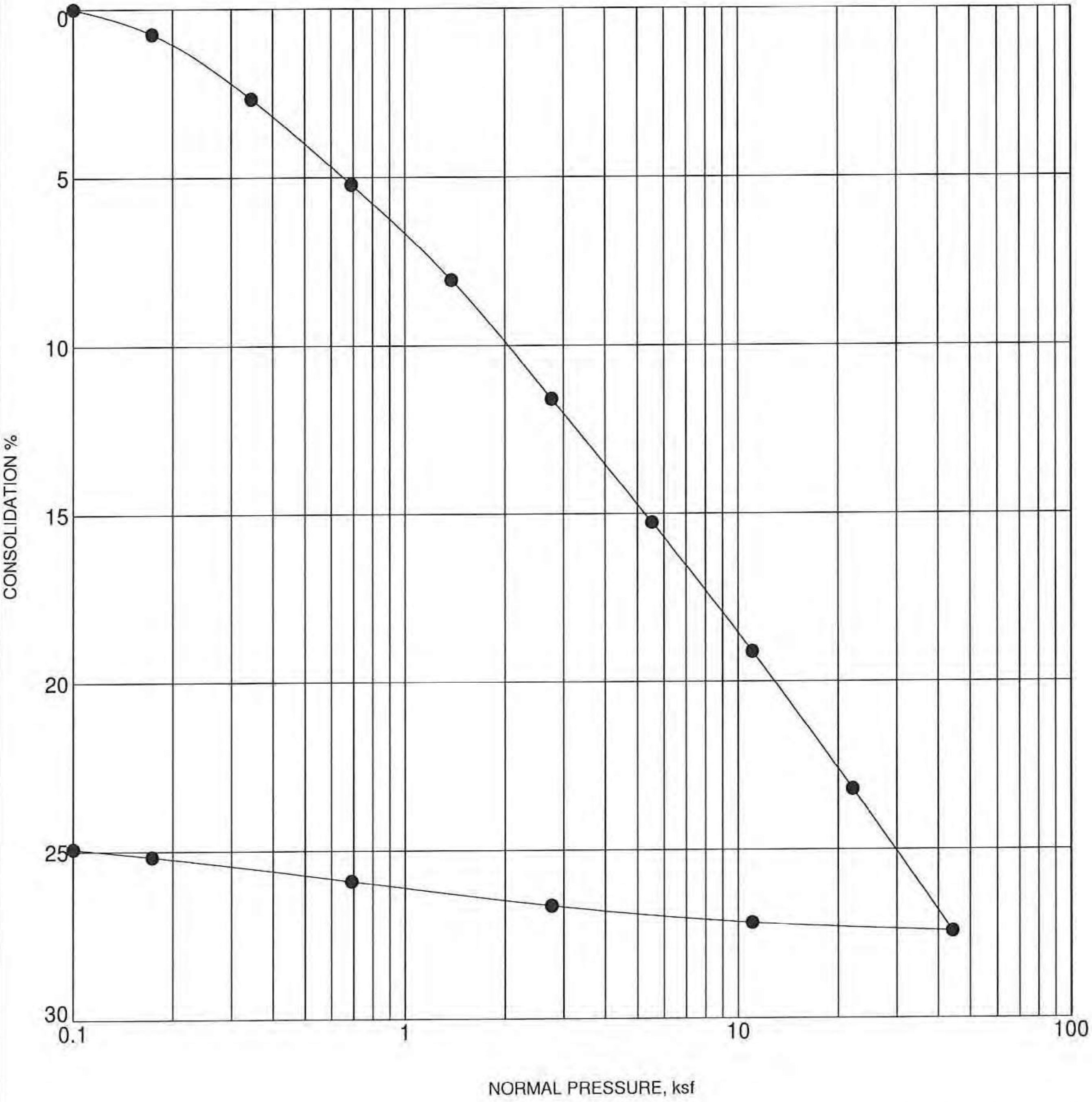
CONSOLIDATION TEST - ASTM D 2435

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Plate
B - 8



Sample: B-108
Depth: 11.0 - 12.5 feet
Description: Gray silty sand

	Initial	Final
Water Content, %	53.0	31.0
Dry Density, pcf:	71.2	94.9
Void Ratio	1.523	0.894
Degree of Saturation, %	100.3	100.0
Sample Height, inches	1.0000	0.7186

Liquid Limit = N/A Plasticity Index = N/A

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CONSOLIDATION TEST - ASTM D 2435

NEW KAPALAMA TERMINAL
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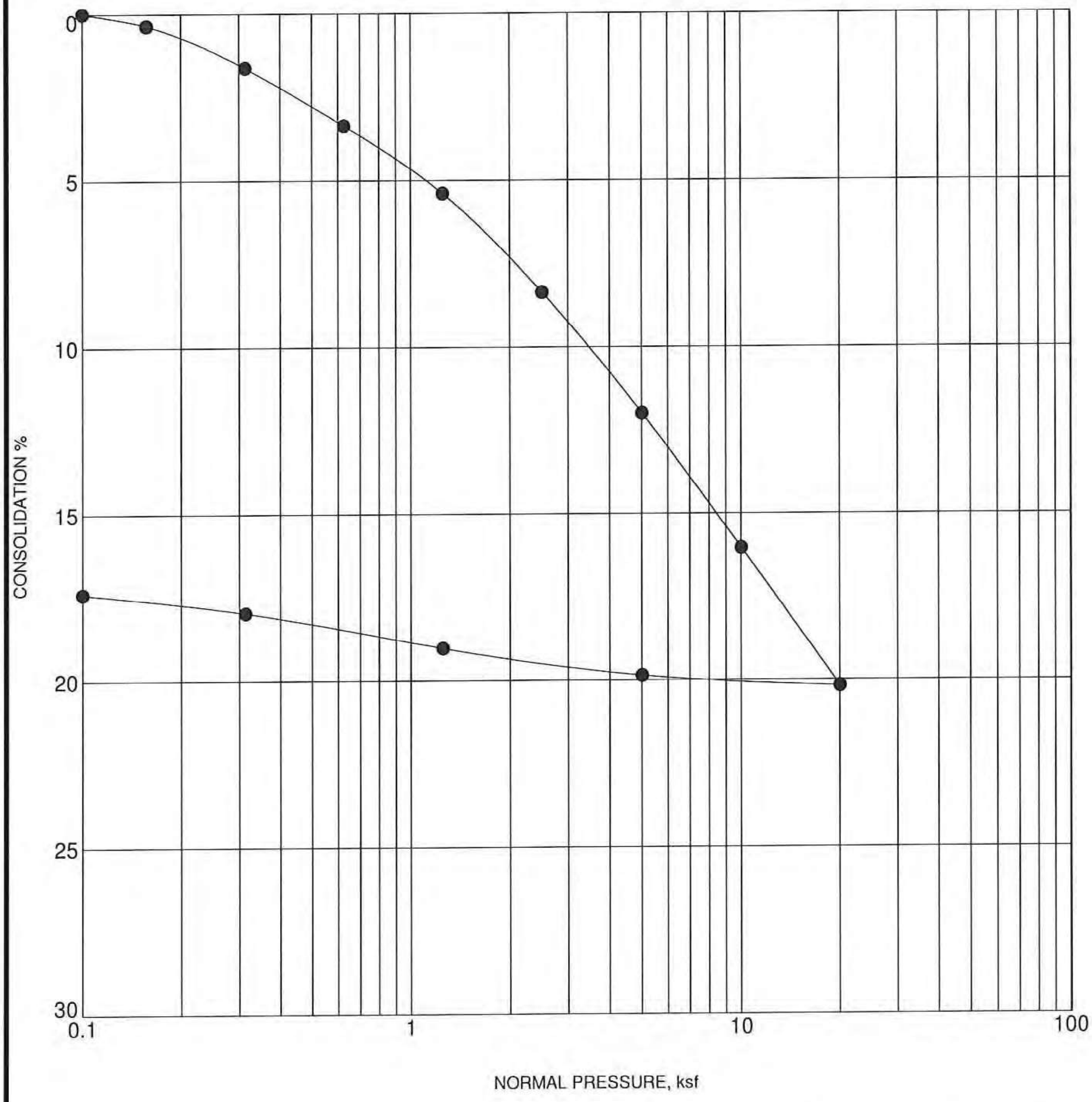
Plate
B - 9



Sample: B-113

Depth: 11.0 - 12.5 feet

Description: Gray clay (CH) with some fine sand

Liquid Limit = 83

Plasticity Index = 57

	Initial	Final
Water Content, %	52.6	37.8
Dry Density, pcf:	69.5	84.1
Void Ratio	1.467	1.038
Degree of Saturation, %	98.4	100.0
Sample Height, inches	1.0000	0.7972

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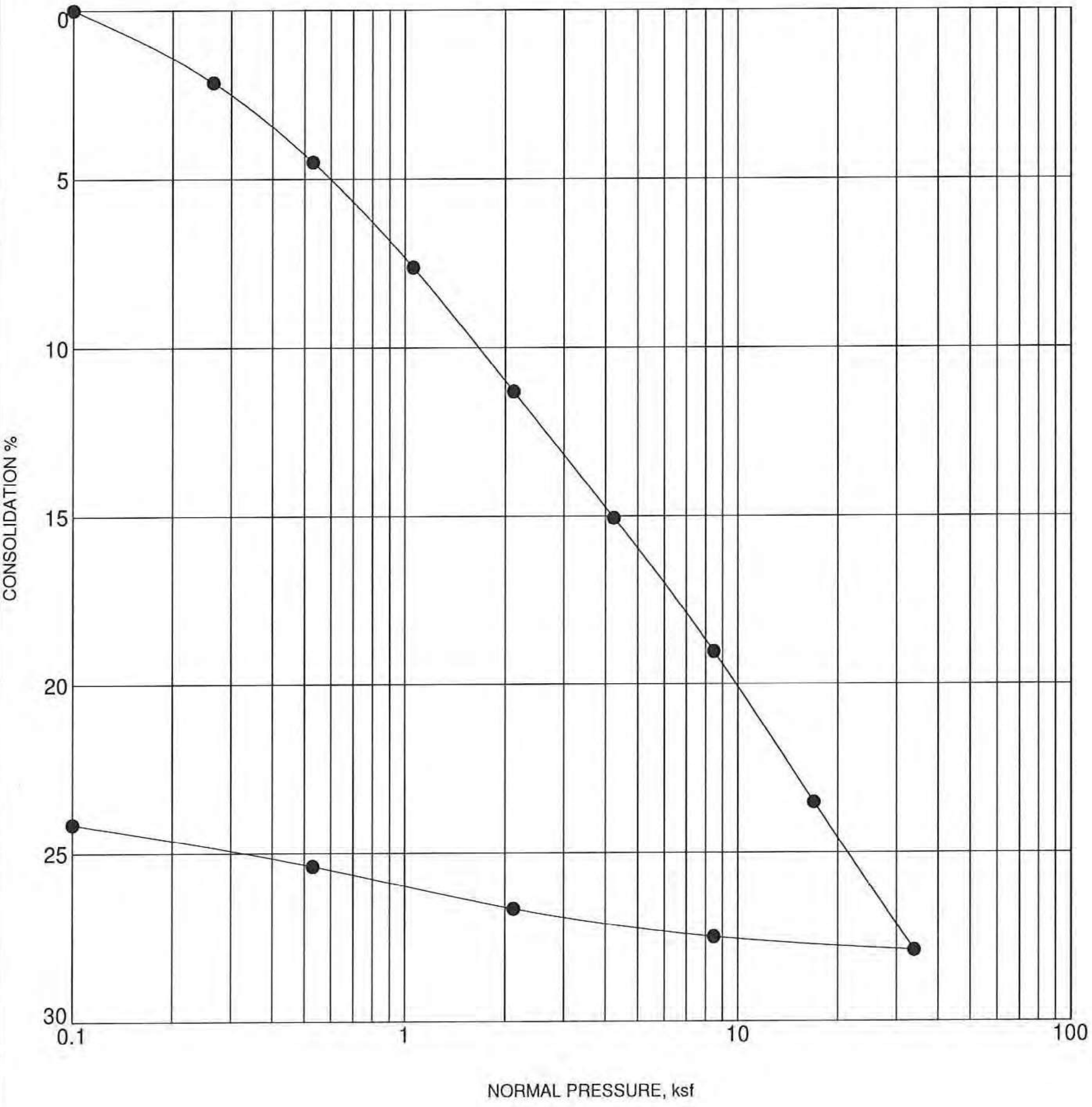
CONSOLIDATION TEST - ASTM D 2435

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Plate
B - 10



Sample: B-118

Depth: 5.5 - 7.0 feet

Description: Gray clay (CH) with sand and traces of gravel (coralline)

Liquid Limit = 54 Plasticity Index = 33

	Initial	Final
Water Content, %	59.4	35.8
Dry Density, pcf:	66.3	87.3
Void Ratio	1.639	1.002
Degree of Saturation, %	101.5	100.0
Sample Height, inches	1.0000	0.7165

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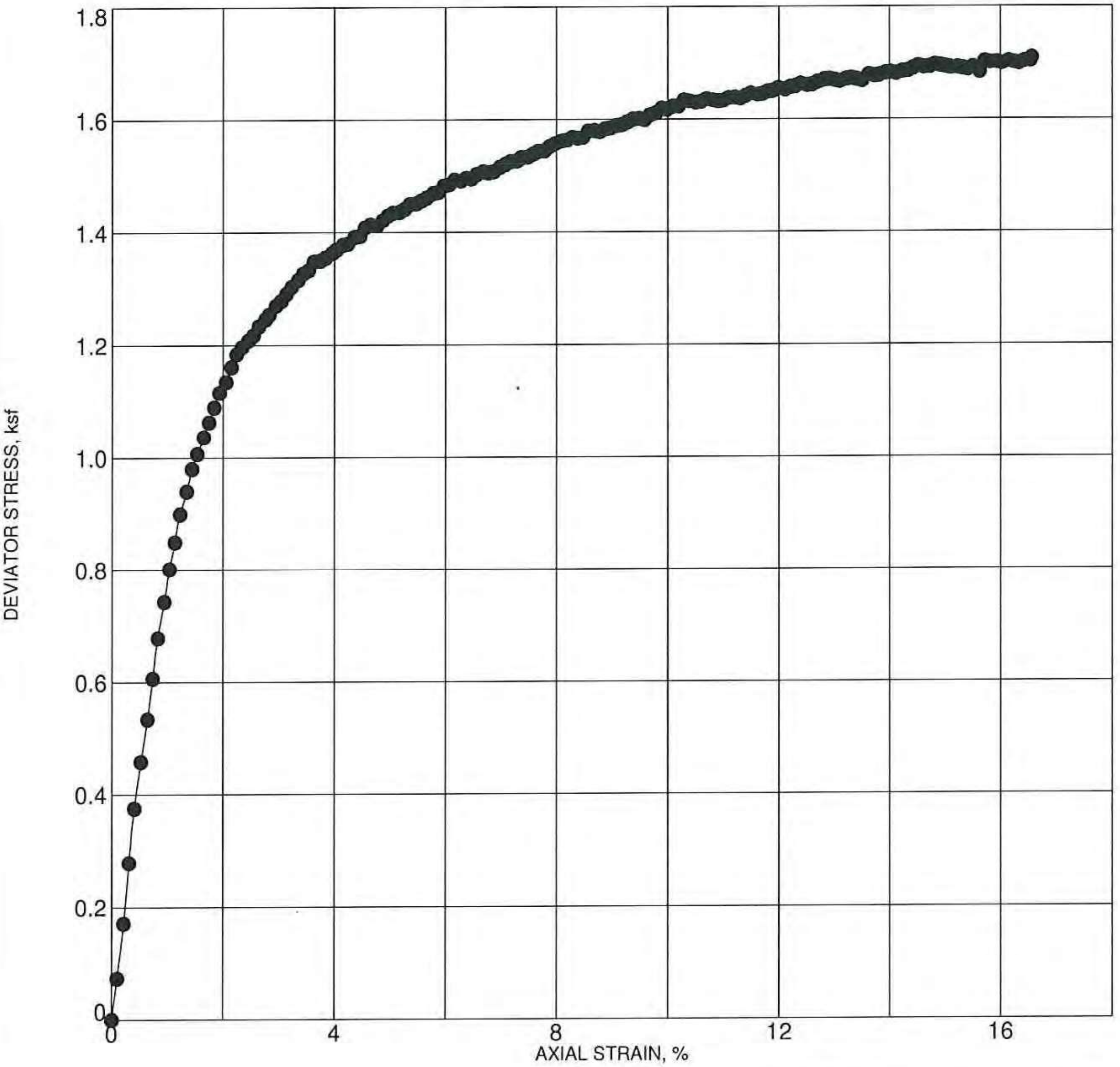
CONSOLIDATION TEST - ASTM D 2435

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Plate
B - 11



Max. Deviator Stress (ksf):	1.7
Confining Stress (ksf):	0.5

Location: B-103
Depth: 5.0 - 6.5 feet
Description: Brown clay with some gravel (coralline)
Test Date: 3/15/2013

Dry Density (pcf)	88.6	Sample Diameter (inches)	2.347
Moisture (%)	27.1	Sample Height (inches)	4.887
Axial Strain at Failure (%)	15.0	Strain Rate (% / minute)	1.01

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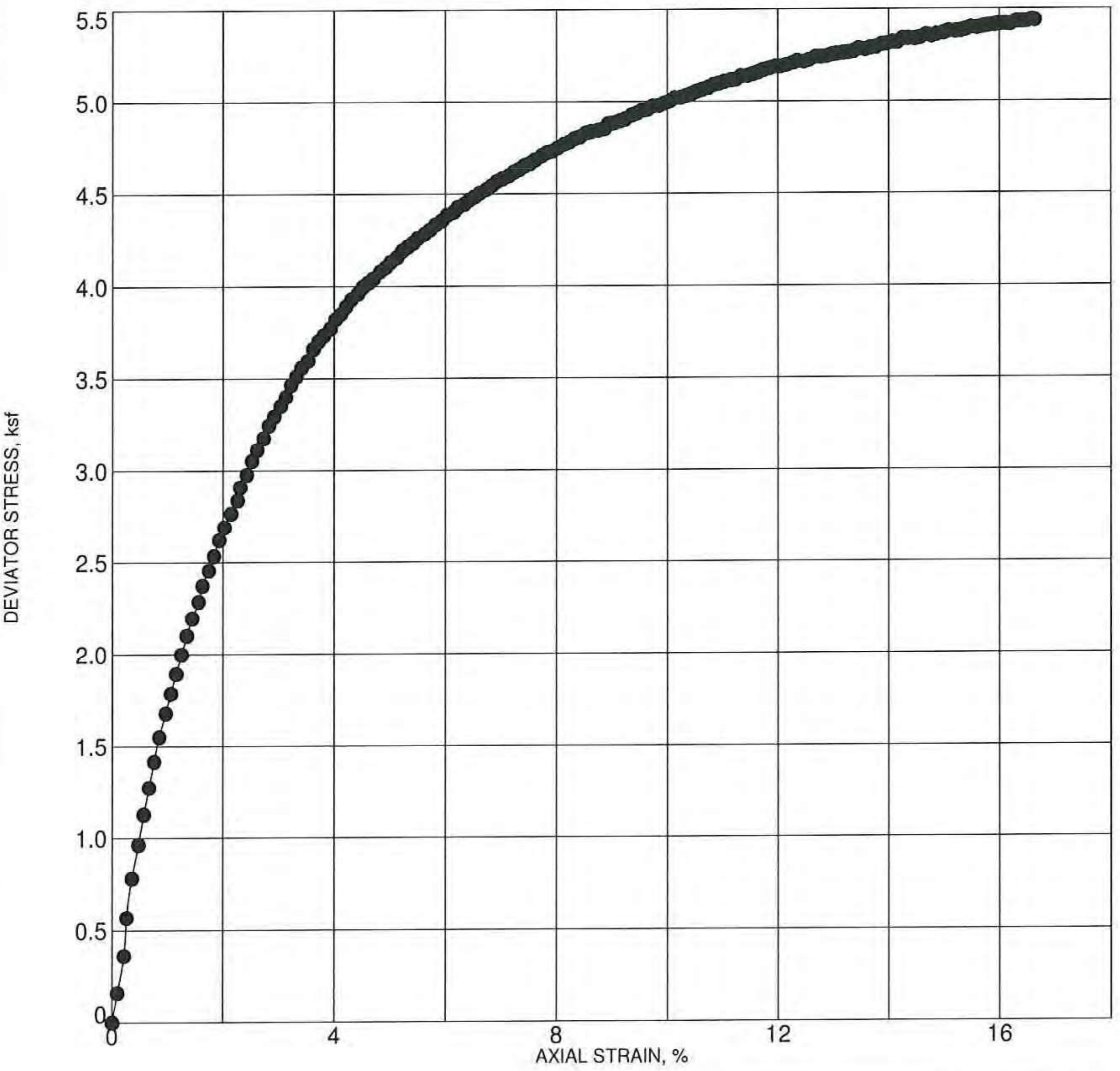
TRIAXIAL UU COMPRESSION TEST - ASTM D 2850

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Plate
B - 12



Max. Deviator Stress (ksf):	5.4
Confining Stress (ksf):	1.2

Location:	B-104
Depth:	15.0 - 16.5 feet
Description:	Dark brown clay
Test Date:	3/15/2013

Dry Density (pcf)	70.1	Sample Diameter (inches)	2.397
Moisture (%)	52.2	Sample Height (inches)	4.897
Axial Strain at Failure (%)	15.0	Strain Rate (% / minute)	1.01

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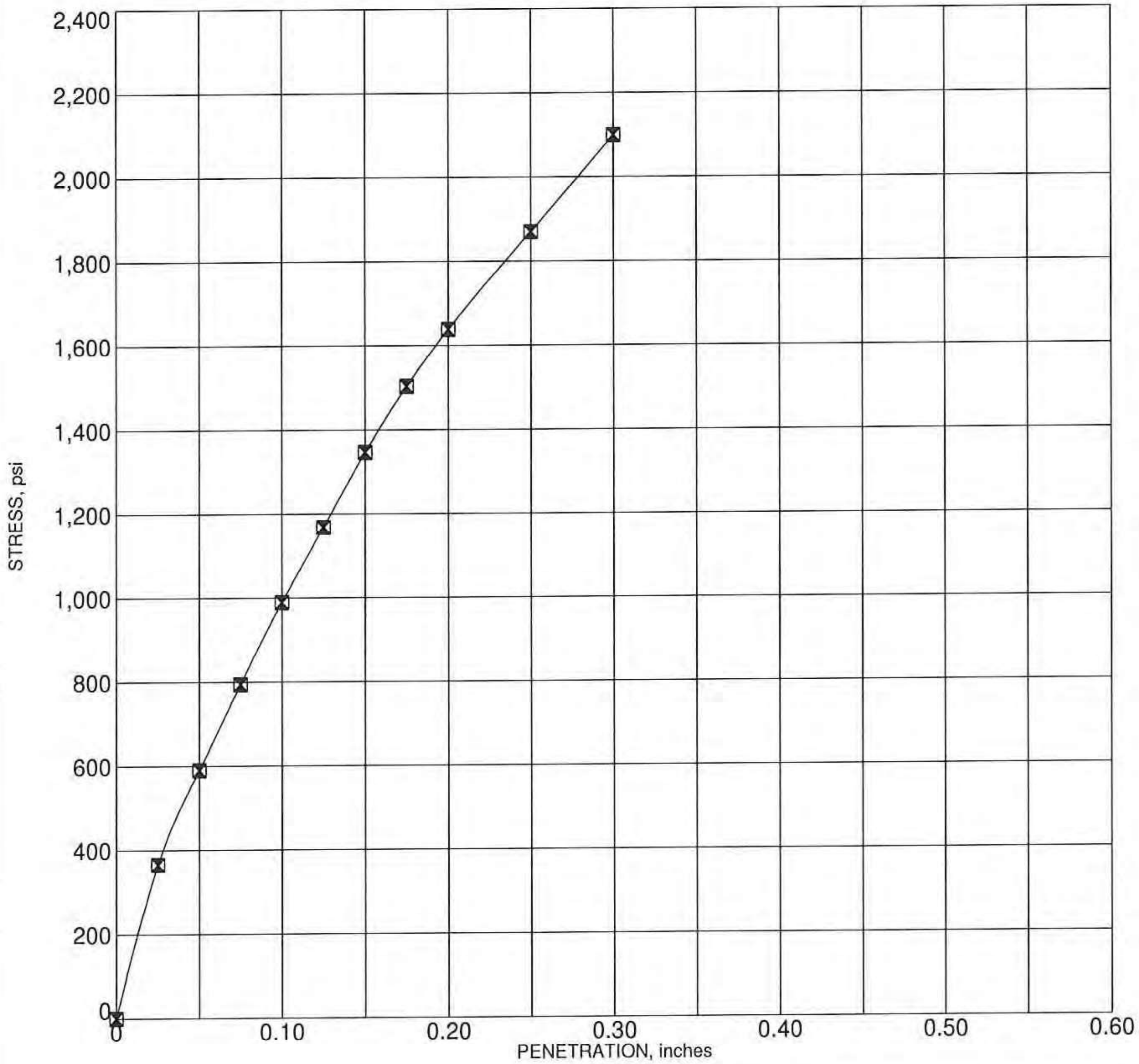
TRIAXIAL UU COMPRESSION TEST - ASTM D 2850

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Plate
B - 13



Corr. CBR @ 0.1"	98.9
Corr. CBR @ 0.2"	109.2
Swell (%)	0.13

Sample: BULK-1 @ 56 blows
Depth: Surface
Description: Tannish brown silty gravel (coralline) with sand

Molding Dry Density (pcf)	122.6	Hammer Wt. (lbs)	10
Molding Moisture (%)	9.7	Hammer Drop (inches)	18
Days Soaked	3	No. of Blows	56
Aggregate	3/4 inch minus	No. of Layers	5

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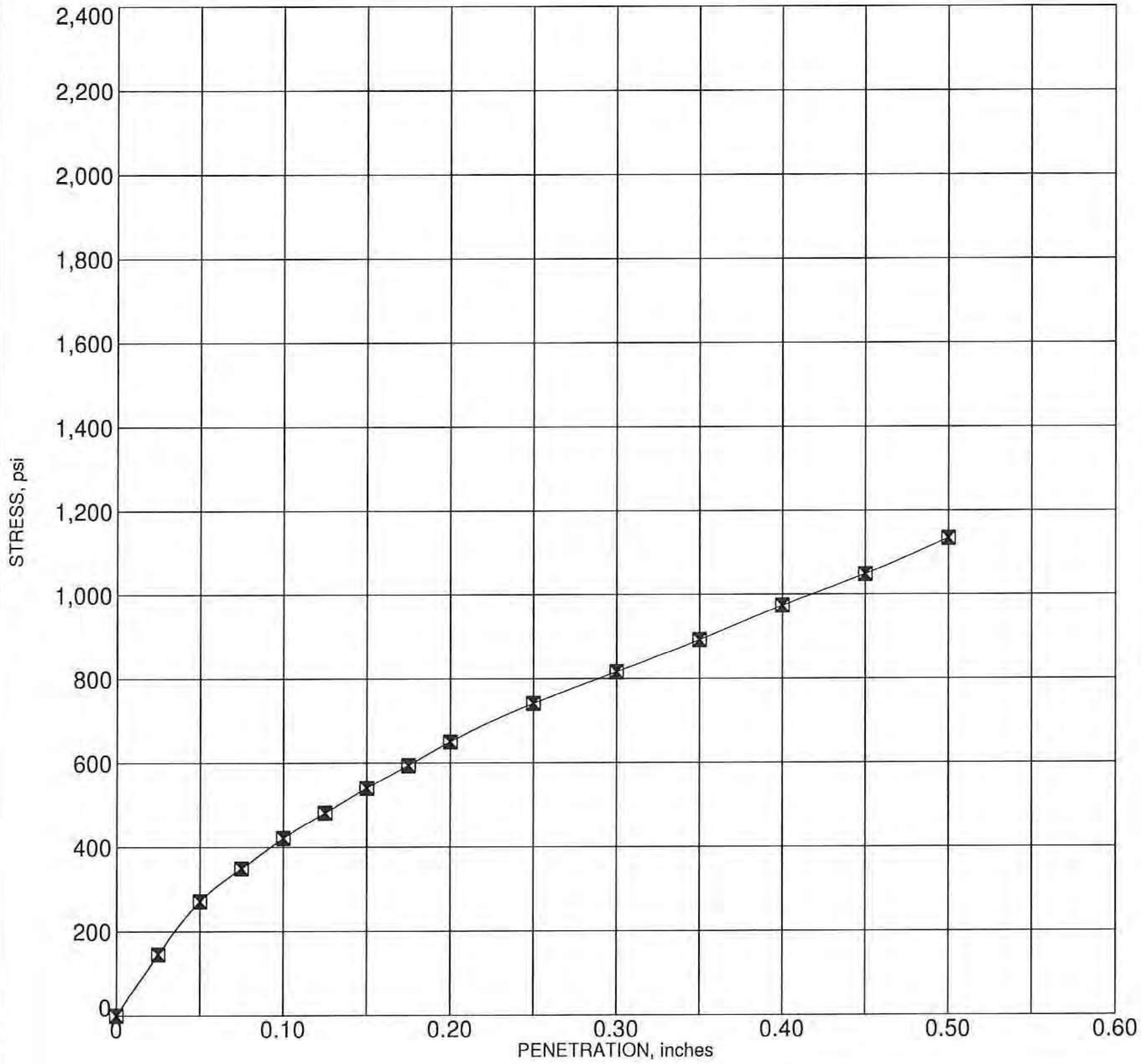
CALIFORNIA BEARING RATIO - ASTM D 1883

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Plate
B - 14



Corr. CBR @ 0.1"	42.1
Corr. CBR @ 0.2"	43.3
Swell (%)	0.04

Sample: BULK-1 @ 25 blows
Depth: Surface
Description: Tannish brown silty gravel (coralline) with sand

Molding Dry Density (pcf)	115.2	Hammer Wt. (lbs)	10
Molding Moisture (%)	9.2	Hammer Drop (inches)	18
Days Soaked	3	No. of Blows	25
Aggregate	3/4 inch minus	No. of Layers	5

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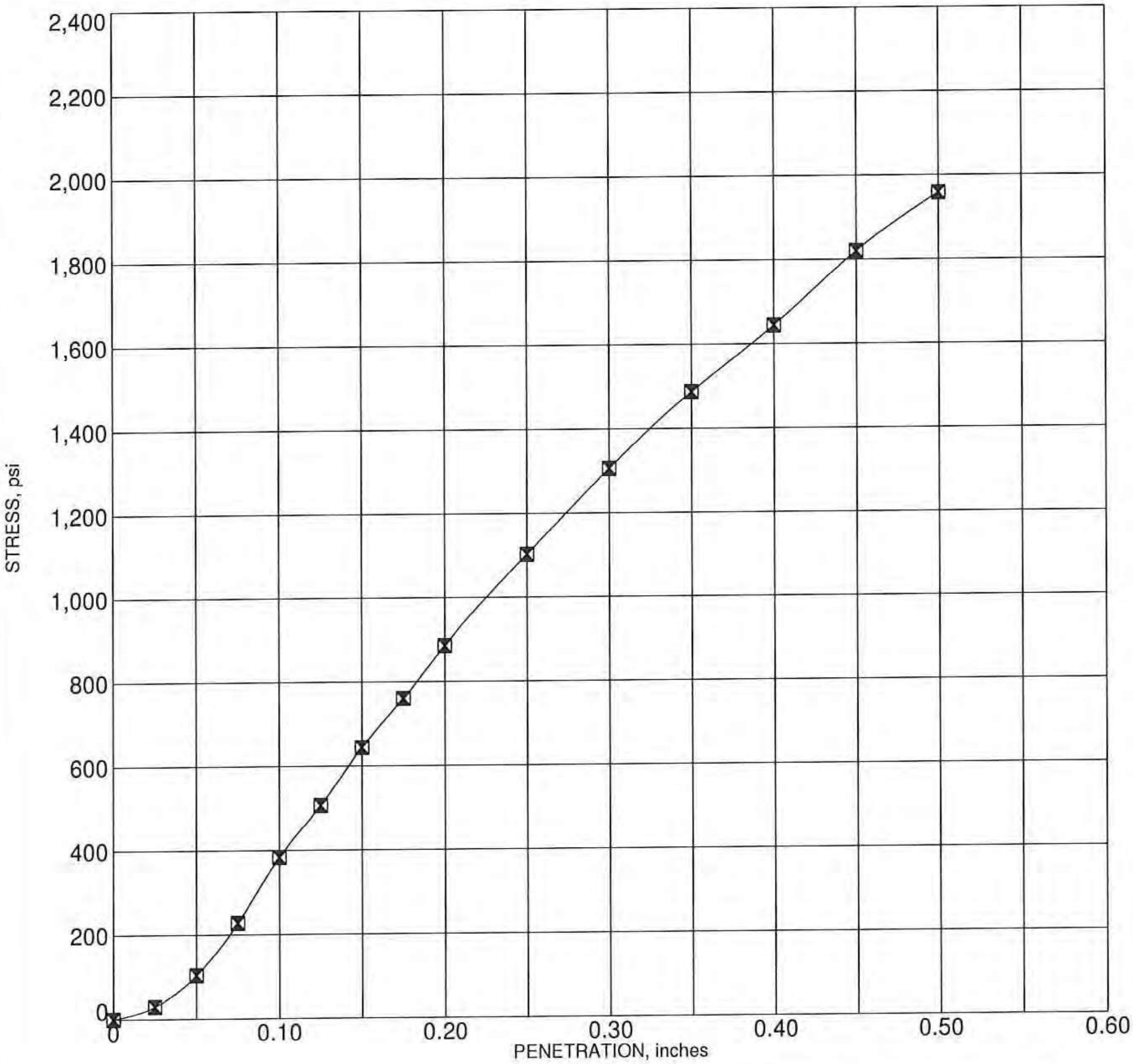
CALIFORNIA BEARING RATIO - ASTM D 1883

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Plate
B - 15

G CBR 6826-00.GPJ GEOLABS.GDT 5/17/13



Corr. CBR @ 0.1"	57.5
Corr. CBR @ 0.2"	70.7
Swell (%)	0.00

Sample: BULK-2 @ 56 blows
Depth: Surface
Description: Dark tannish brown silty sand with gravel (coralline)

Molding Dry Density (pcf)	113.6	Hammer Wt. (lbs)	10
Molding Moisture (%)	15.1	Hammer Drop (inches)	18
Days Soaked	3	No. of Blows	56
Aggregate	3/4 inch minus	No. of Layers	5

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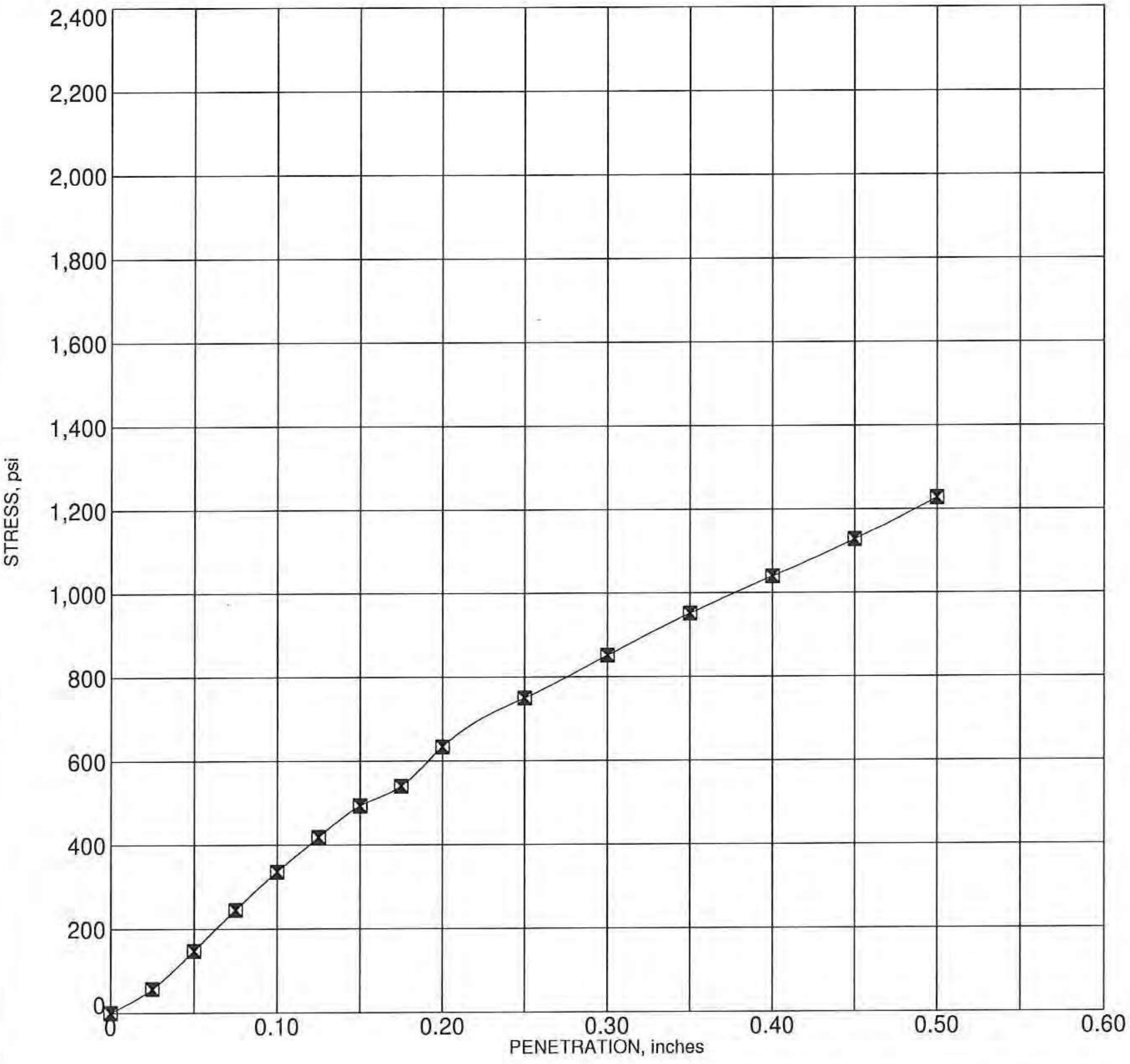
CALIFORNIA BEARING RATIO - ASTM D 1883

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Plate
B - 16

G CBR 6826-00.GPJ GEOLABS.GDT 5/17/13



Corr. CBR @ 0.1"	36.6
Corr. CBR @ 0.2"	44.0
Swell (%)	0.04

Sample: BULK-2 @ 25 blows
Depth: Surface
Description: Dark tannish brown silty sand with gravel (coralline)

Molding Dry Density (pcf)	107.6	Hammer Wt. (lbs)	10
Molding Moisture (%)	14.5	Hammer Drop (inches)	18
Days Soaked	3	No. of Blows	25
Aggregate	3/4 inch minus	No. of Layers	5

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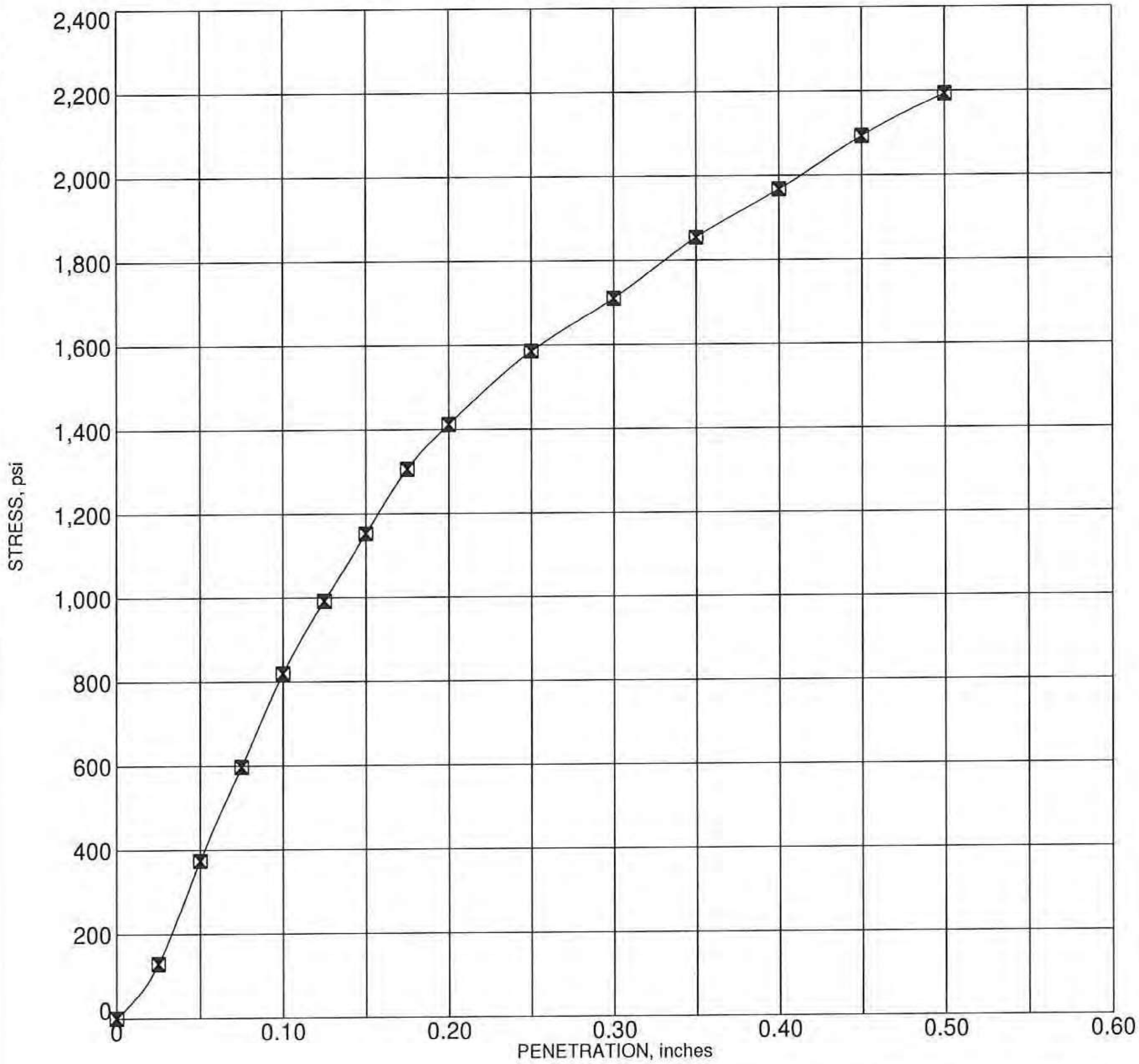
CALIFORNIA BEARING RATIO - ASTM D 1883

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Plate
B - 17



Corr. CBR @ 0.1"	92.5
Corr. CBR @ 0.2"	97.3
Swell (%)	0.00

Sample: BULK-3 @ 56 blows
Depth: Surface
Description: Tan sand (coralline) with some gravel

Molding Dry Density (pcf)	109.2	Hammer Wt. (lbs)	10
Molding Moisture (%)	11.4	Hammer Drop (inches)	18
Days Soaked	2	No. of Blows	56
Aggregate	3/4 inch minus	No. of Layers	5

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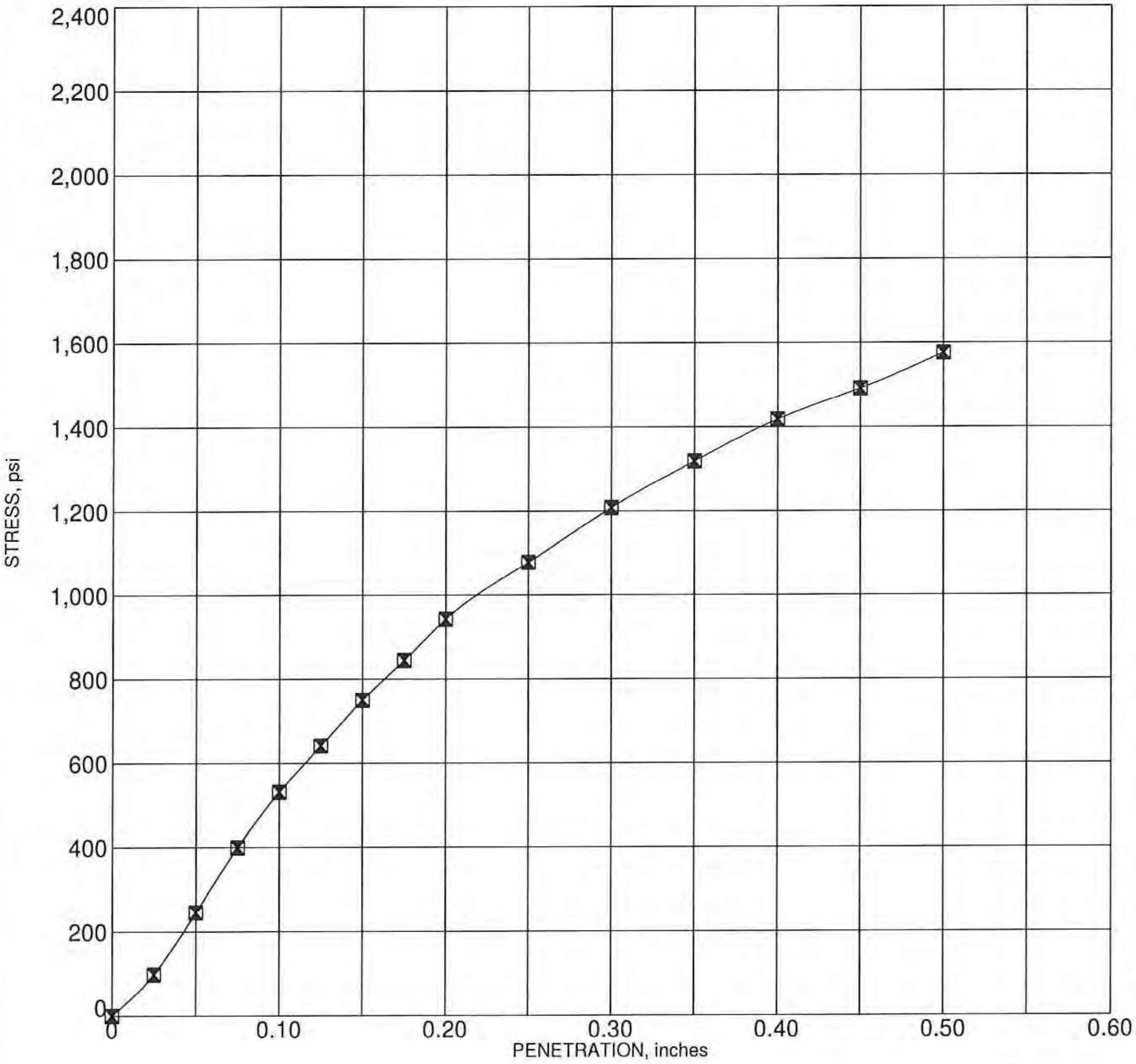
CALIFORNIA BEARING RATIO - ASTM D 1883

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Plate
B - 18



Corr. CBR @ 0.1"	56.3
Corr. CBR @ 0.2"	64.2
Swell (%)	0.00

Sample: BULK-3 @ 25 blows
Depth: Surface
Description: Tan sand (coralline) with some gravel

Molding Dry Density (pcf)	106.3	Hammer Wt. (lbs)	10
Molding Moisture (%)	11.2	Hammer Drop (inches)	18
Days Soaked	2	No. of Blows	25
Aggregate	3/4 inch minus	No. of Layers	5

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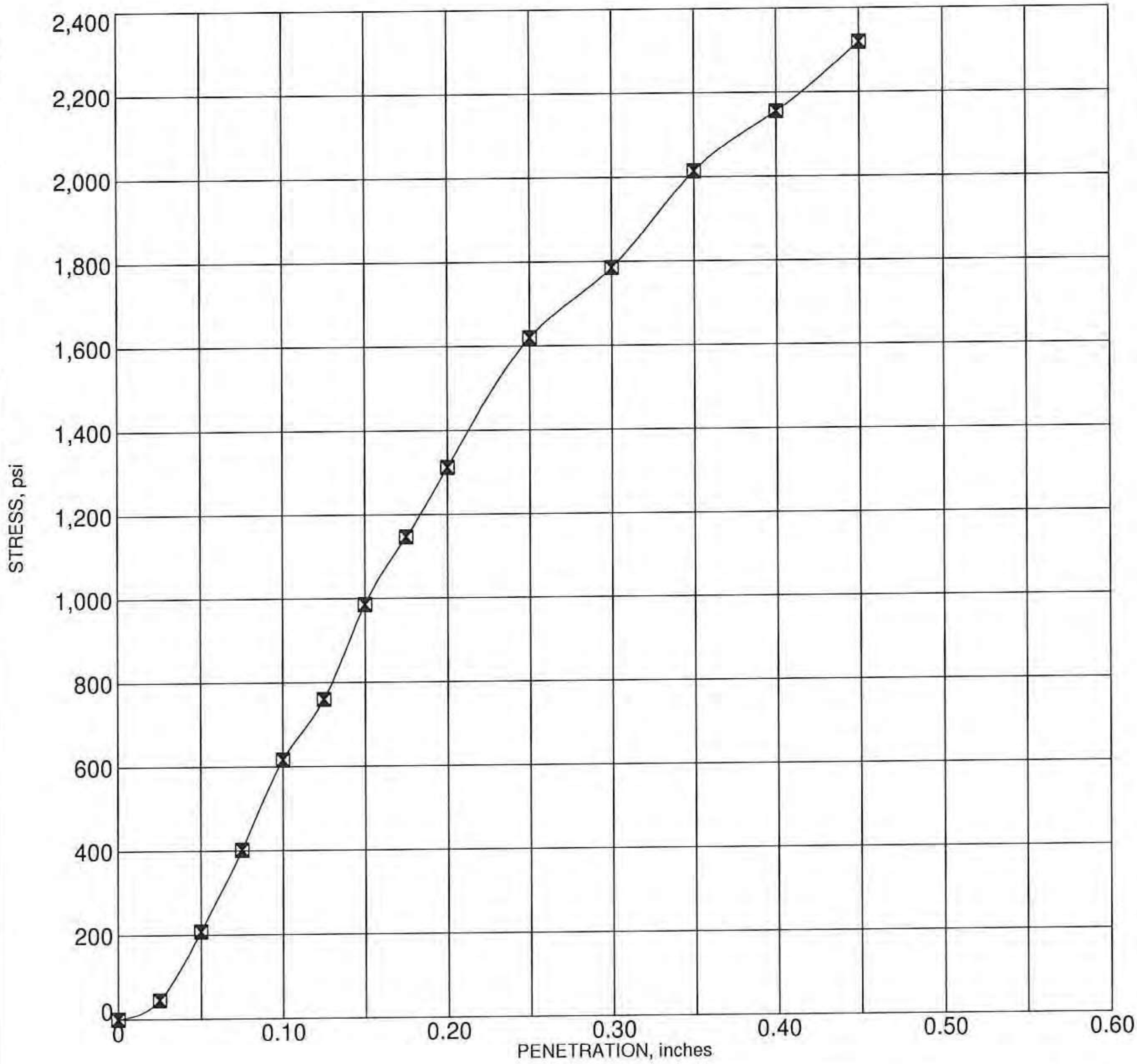
CALIFORNIA BEARING RATIO - ASTM D 1883

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Plate
B - 19

G CBR 6826-00.GPJ GEOLABS.GDT 5/17/13



Corr. CBR @ 0.1"	77.7
Corr. CBR @ 0.2"	98.9
Swell (%)	0.00

Sample: BULK-4 @ 56 blows
Depth: Surface
Description: Tan silty sand with gravel (coralline)

Molding Dry Density (pcf)	117.7	Hammer Wt. (lbs)	10
Molding Moisture (%)	13.2	Hammer Drop (inches)	18
Days Soaked	2	No. of Blows	56
Aggregate	3/4 inch minus	No. of Layers	5

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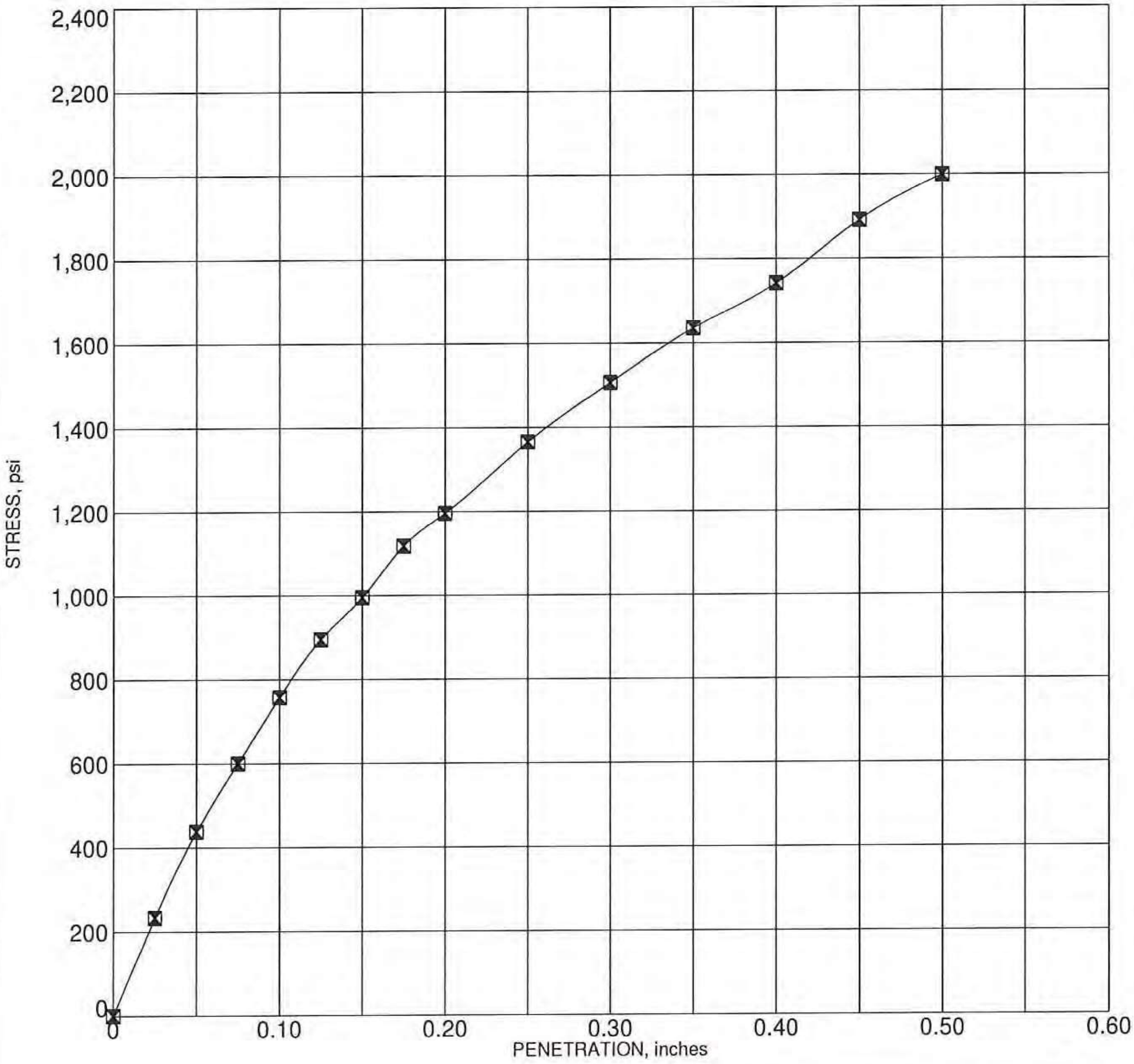
CALIFORNIA BEARING RATIO - ASTM D 1883

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Plate
B - 20

G CBR 6826-00.GPJ GEOLABS.GDT 5/17/13



Corr. CBR @ 0.1"	75.7
Corr. CBR @ 0.2"	79.7
Swell (%)	0.04

Sample: BULK-4 @ 25 blows
Depth: Surface
Description: Tan silty sand with gravel (coralline)

Molding Dry Density (pcf)	113.3	Hammer Wt. (lbs)	10
Molding Moisture (%)	13.1	Hammer Drop (inches)	18
Days Soaked	2	No. of Blows	56
Aggregate	3/4 inch minus	No. of Layers	5

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CALIFORNIA BEARING RATIO - ASTM D 1883

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

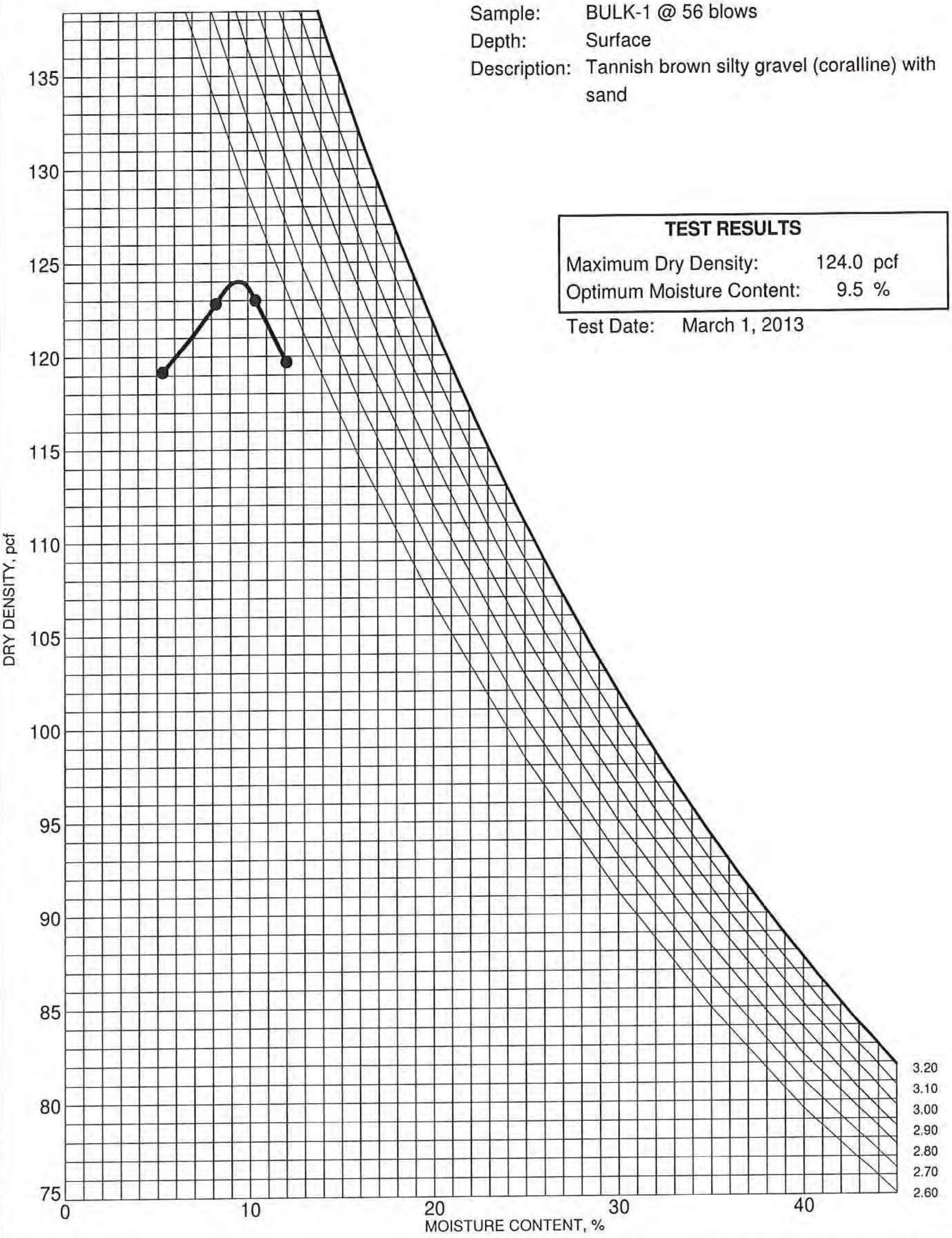
Plate
B - 21

Sample: BULK-1 @ 56 blows
Depth: Surface
Description: Tannish brown silty gravel (coralline) with sand

TEST RESULTS

Maximum Dry Density:	124.0 pcf
Optimum Moisture Content:	9.5 %

Test Date: March 1, 2013



G_COMPACTION 6826-00.GPJ GEOLABS.GDT 5/17/13

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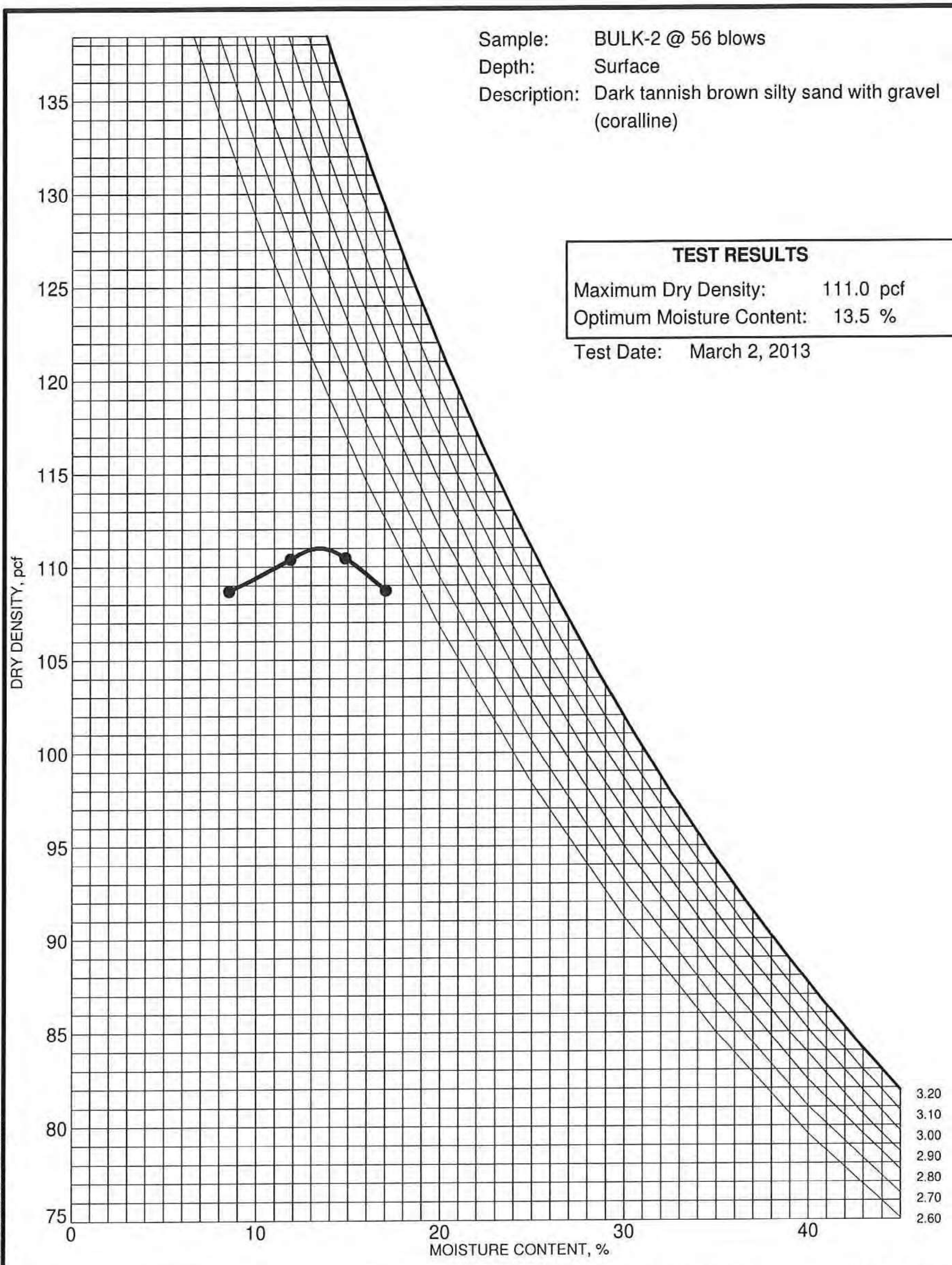
MOISTURE-DENSITY RELATIONSHIP - ASTM D 1557 C

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Plate
B - 22

Sample: BULK-2 @ 56 blows
Depth: Surface
Description: Dark tannish brown silty sand with gravel (coralline)



TEST RESULTS	
Maximum Dry Density:	111.0 pcf
Optimum Moisture Content:	13.5 %

Test Date: March 2, 2013

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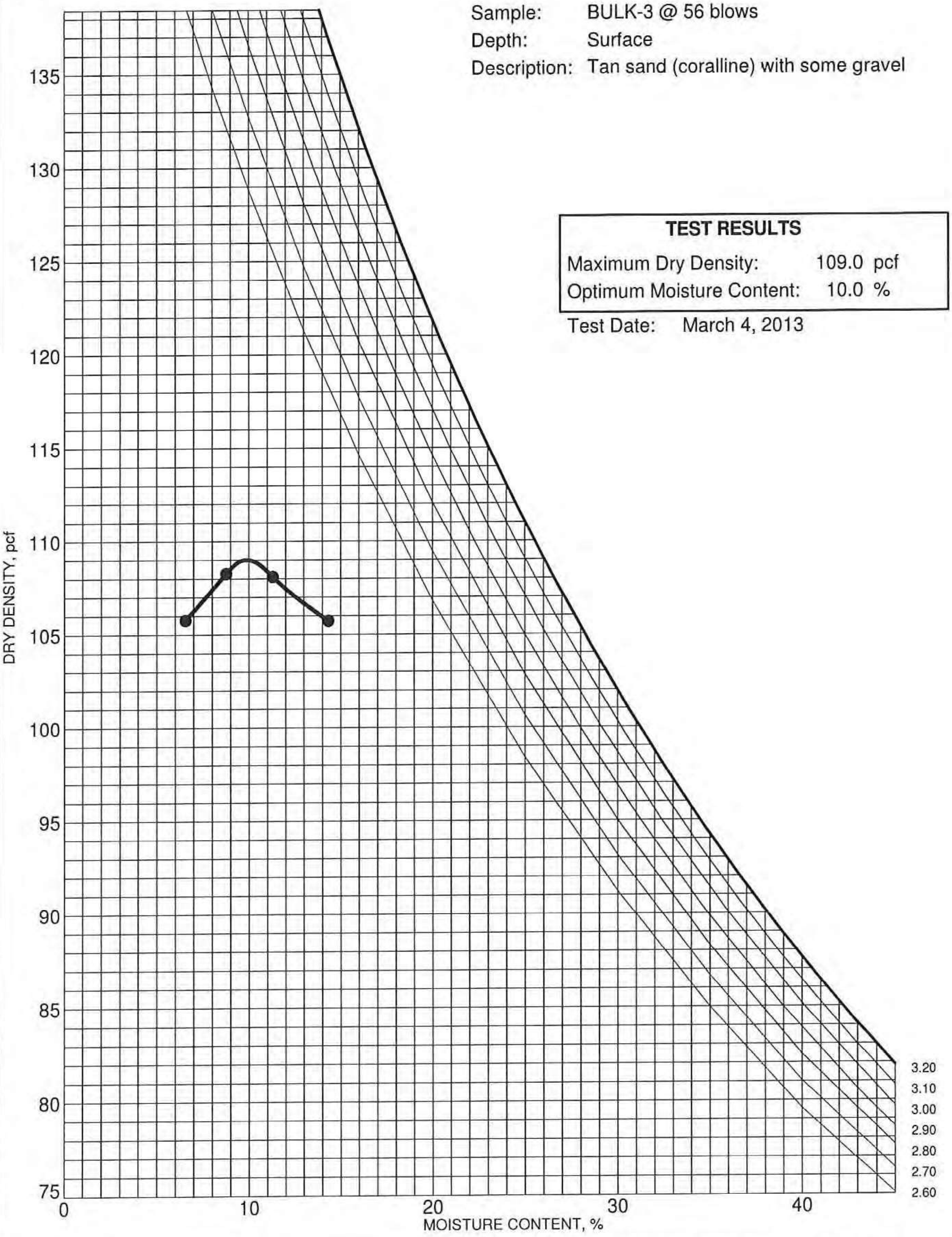
MOISTURE-DENSITY RELATIONSHIP - ASTM D 1557 A

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Sample: BULK-3 @ 56 blows
Depth: Surface
Description: Tan sand (coralline) with some gravel

TEST RESULTS	
Maximum Dry Density:	109.0 pcf
Optimum Moisture Content:	10.0 %

Test Date: March 4, 2013



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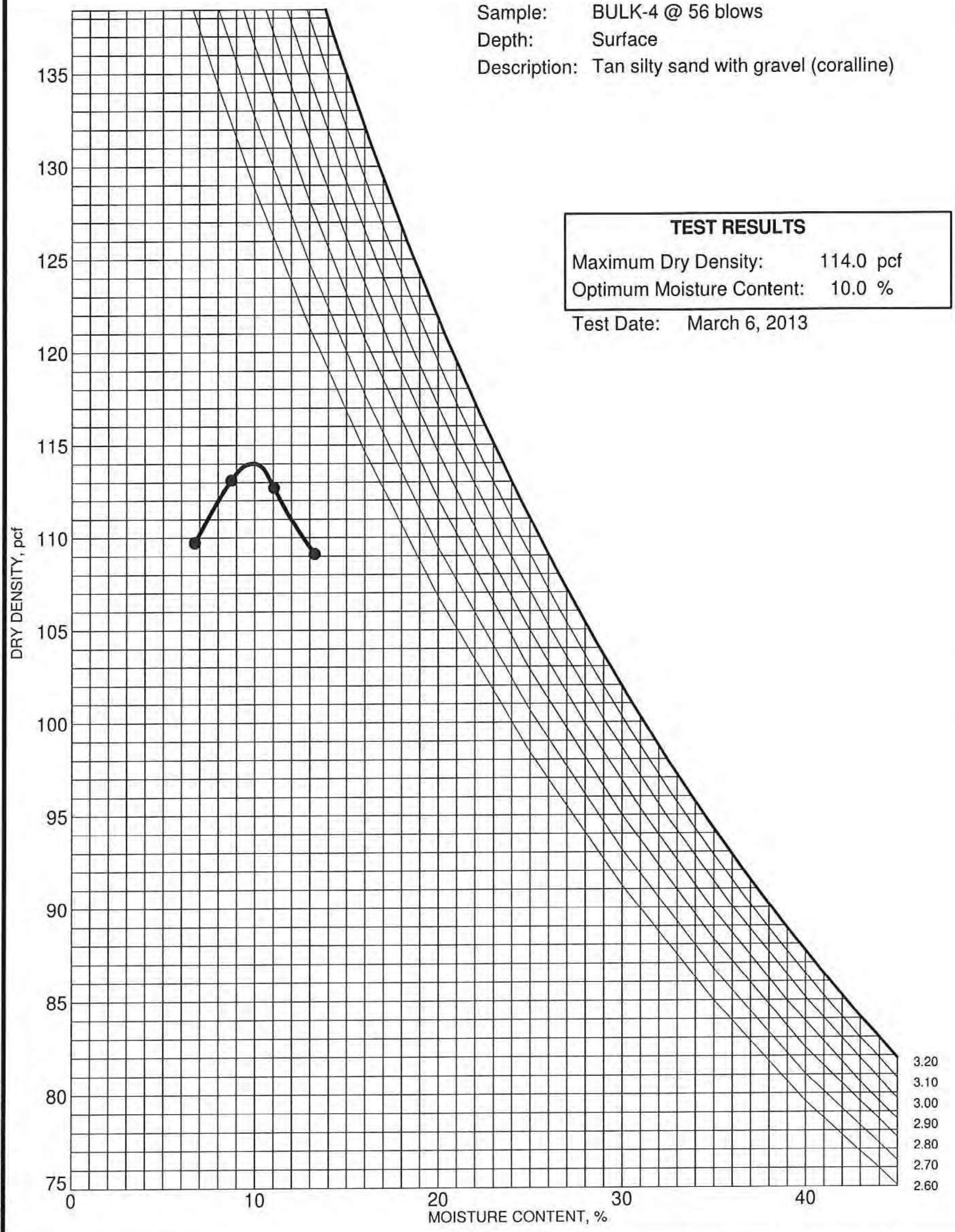
MOISTURE-DENSITY RELATIONSHIP - ASTM D 1557 B

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Plate
B - 24



Sample: BULK-4 @ 56 blows
Depth: Surface
Description: Tan silty sand with gravel (coralline)

TEST RESULTS	
Maximum Dry Density:	114.0 pcf
Optimum Moisture Content:	10.0 %

Test Date: March 6, 2013

G COMPACTION 6826-00.GPJ GEOLABS.GDT 5/17/13

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MOISTURE-DENSITY RELATIONSHIP - ASTM D 1557/698

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Plate
B - 25

Location	Depth	Length	Diameter	Length/ Diameter Ratio	Density	Load	Compressive Strength
	(feet)	(inches)	(inches)	(pcf)	(pcf)	(lbs.)	(psi)
B-104	20 - 23	6.900	3.180	2.17	109.5	2,040	260
B-104	25 - 28	6.100	3.140	1.94	121.4	2,410	310
B-106	15 - 18	4.910	3.200	1.53	108.8	3,030	380
B-109	24 - 27	6.900	3.260	2.12	119.7	4,520	540
B-109	30 - 33	6.700	3.240	2.07	122.4	2,920	350
B-109	34 - 37	6.800	3.260	2.09	113.6	1,220	150
B-110	16 - 19	5.780	3.250	1.78	117.7	5,590	670
B-110	25 - 28	5.200	3.250	1.60	105.2	3,630	440
B-114	23 - 26	6.700	3.260	2.06	102.9	8,110	970
B-114	50 - 53	6.800	3.250	2.09	134.9	4,520	540
B-115	25 - 28	6.900	3.260	2.12	122.2	2,290	270
B-116	20 - 23	6.700	3.250	2.06	127.0	3,350	400
B-116	24 - 27	6.800	3.250	2.09	131.8	1,820	220
B-116	32 - 35	4.670	3.250	1.44	117.8	6,870	830
B-118	20 - 23	6.500	3.250	2.00	107.1	2,700	330
B-118	23 - 25	6.800	3.240	2.10	118.1	2,410	290

ASTM D 7012 (METHOD C)

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UNCONFINED COMPRESSIVE STRENGTH TEST

NEW KAPALAMA TERMINAL
HONOLULU, OAHU, HAWAII

Plate
B - 26

G ROCK UC TEST PORTRAIT 6826-00.GPJ GEOLABS.GDT 5/17/13

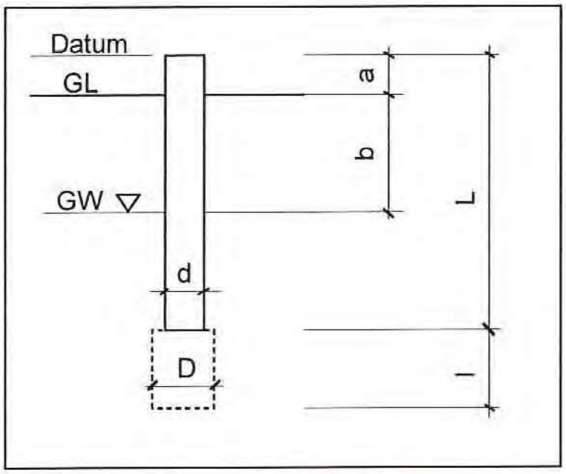
APPENDIX C

APPENDIX C

In-Situ Permeability Tests

Three In-Situ Percolation tests using constant head or falling head methods were performed in selected locations (B-106, B-115 and B-201). The in-situ percolation tests provide the coefficient of permeability within the testing interval. For the constant head testing, the flow rate was recorded by timing and calculating the volume as a relatively constant flow rate was achieved. For the falling head testing, the water level was measured versus time until reached equilibrium steady state. The results of the percolation tests are presented on Plates C-1 through C-3.

Percolation Test Calculation Sheet (Constant Head Method: Well point-filter in uniform soil)



Boring:	**B-106**	
GW table, b (from ground):	**7.5**	feet
Datum, a (above ground):	**0**	feet
Depth of casing:	**0**	feet
Length, L (from datum):	**0**	feet
Open hole Length, l:	**14**	feet
Diameter of open hole (D):	**4.5**	inches
Diameter of casing (d):	**4.5**	inches
Constant flow rate, Q:	**26.09**	gpm
Constant water level (FD):	**0.00**	feet

Constant flow rate, Q =	26.09	gpm
=	3.49	feet³/min
Piezometer head, H_c=	7.50	feet

Factor of m ($\sqrt{\frac{k_h}{k_v}}$) = 1.00

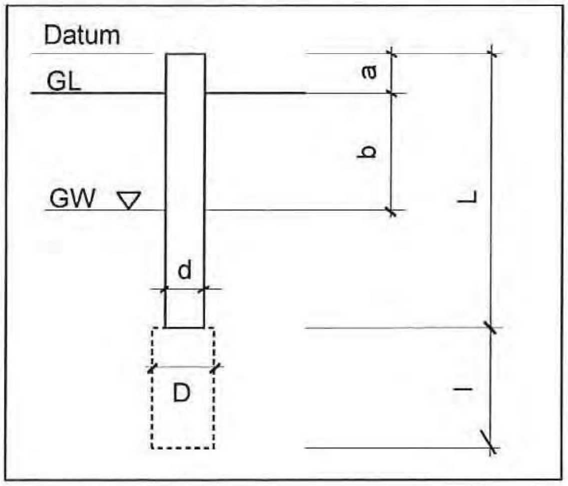
Permeability, k

$$k = \frac{q \times \ln[\frac{mI}{D} + \sqrt{1 + (\frac{mI}{D})^2}\,]}{2 \times \pi \times I \times H_c}$$

=

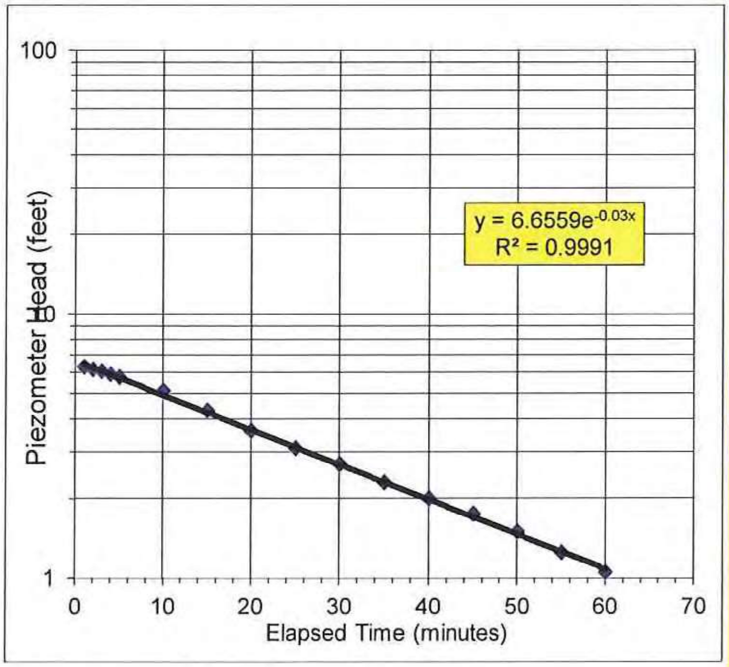
0.023	feet/min
0.012	cm/s

Percolation Test Calculation Sheet (Falling Head Method: Well point-filter in uniform soil)



Boring:	**B-115**	
GW table, b (from ground):	**4**	feet
Datum, a (above ground):	**2.5**	feet
Depth of casing:	**16**	feet
Length, L (from datum):	**18.5**	feet
Open hole Length, l:	**5**	feet
Diameter of open hole (D):	**4.5**	inches
Diameter of casing (d):	**4**	inches

Factor of m ($\sqrt{\frac{k_h}{k_v}}$) = 1.00



Time (min)	Depth of water (from datum) (feet)	Piezometer Head, H_c (feet)
0.0	**0.0**	6.5
1.0	**0.2**	6.3
2.0	**0.4**	6.2
3.0	**0.5**	6.1
4.0	**0.6**	5.9
5.0	**0.8**	5.8
10.0	**1.4**	5.1
15.0	**2.2**	4.3
20.0	**2.9**	3.6
25.0	**3.4**	3.1
30.0	**3.8**	2.7
35.0	**4.2**	2.3
40.0	**4.5**	2.0
45.0	**4.8**	1.8
50.0	**5.0**	1.5
55.0	**5.3**	1.3
60.0	**5.5**	1.1

Constant factor of the trendline $y = \lambda e^{cx}$

$\lambda=$ 6.6559

c= -0.0300

$$\frac{\ln(H_{1c}/H_{2c})}{(t_2-t_1)} = 0.03$$

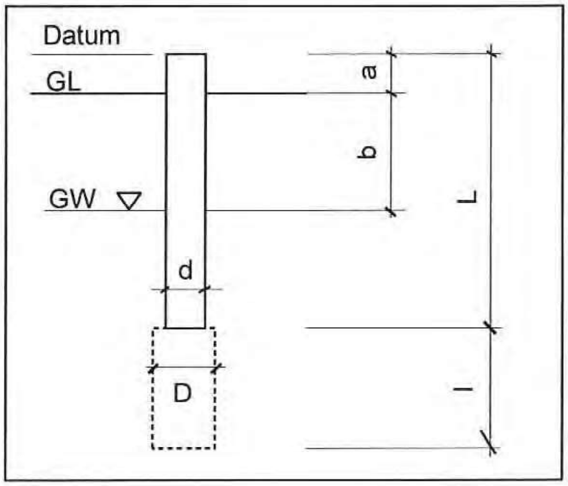
Permeability, k, When 2ml/D <= 4,

$$k = \frac{d^2 \times \ln[\frac{ml}{D} + \sqrt{1+(\frac{ml}{D})^2}\,]}{8 \times l \times (t_2 - t_1)} \times \ln(\frac{H_{1c}}{H_{2c}}) = \begin{array}{c} 2.7\text{E-}04 \\ \boxed{1.4\text{E-}04} \end{array}$$

Permeability, k, When 2ml/D > 4,

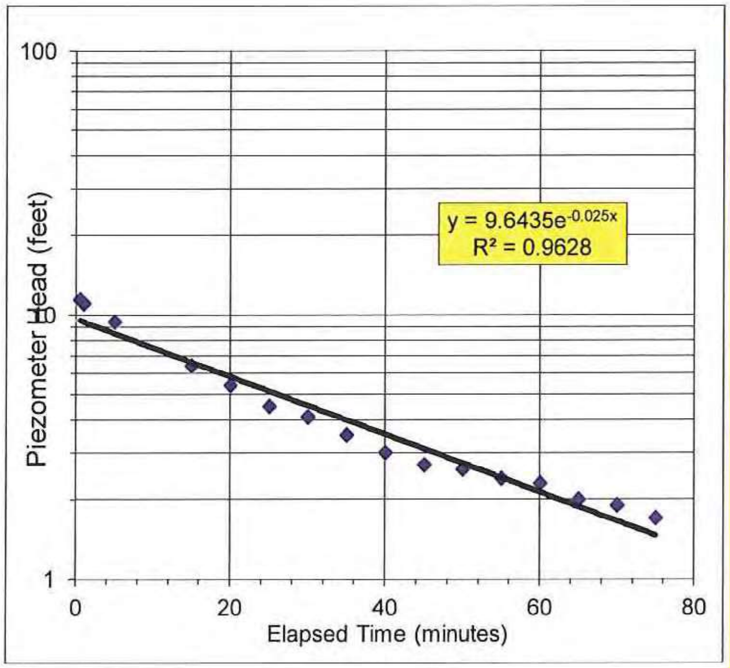
$$k = \frac{d^2 \times \ln(\frac{2ml}{D})}{8 \times l \times (t_2 - t_1)} \times \ln(\frac{H_{1c}}{H_{2c}}) = \begin{array}{c} 2.7\text{E-}04 \\ \boxed{1.4\text{E-}04} \end{array} \text{cm/s}$$

Percolation Test Calculation Sheet (Falling Head Method: Well point-filter in uniform soil)



Boring:	B-201	
GW table, b (from ground):	8.6	feet
Datum, a (above ground):	3.3	feet
Depth of casing:	16	feet
Length, L (from datum):	19.3	feet
Open hole Length, l:	1	feet
Diameter of open hole (D):	4.5	inches
Diameter of casing (d):	4	inches

Factor of m ($\sqrt{\frac{k_h}{k_v}}$) = 1.00



Time (min)	Depth of water (from datum) (feet)	Piezometer Head, H_c (feet)
0.0	0.0	11.9
0.5	0.5	11.4
1.0	0.9	11.0
5.0	2.5	9.4
15.0	5.5	6.4
20.0	6.5	5.4
25.0	7.4	4.5
30.0	7.8	4.1
35.0	8.4	3.5
40.0	8.9	3.0
45.0	9.2	2.7
50.0	9.3	2.6
55.0	9.5	2.4
60.0	9.6	2.3
65.0	9.9	2.0
70.0	10.0	1.9
75.0	10.2	1.7
80.0	10.3	1.6
85.0	10.3	1.6
90.0	10.4	1.5
95.0	10.4	1.5
100.0	10.5	1.4
105.0	10.5	1.4

Constant factor of the trendline $y = \lambda e^{cx}$

λ= 9.6435

c= -0.0250

$$\frac{\ln (H_{1c} / H_{2c})}{(t_2 - t_1)} = 0.03$$

Permeability, k, When 2ml/D <= 4,

$$k = \frac{d^2 \times \ln[\frac{ml}{D} + \sqrt{1 + (\frac{ml}{D})^2}\,]}{8 \times l \times (t_2 - t_1)} \times \ln(\frac{H_{1c}}{H_{2c}}) =$$

5.9E-04

3.0E-04

Permeability, k, When 2ml/D > 4,

$$k = \frac{d^2 \times \ln(\frac{2ml}{D})}{8 \times l \times (t_2 - t_1)} \times \ln(\frac{H_{1c}}{H_{2c}}) =$$

5.8E-04

3.0E-04 cm/s