GEOTECHNICAL INVESTIGATION REPORT
PUUNANI HOMESTEAD
WAILUKU, MAUI, HAWAII

A report by:
HAWAII GEOTECHNICAL CONSULTING, INC.

July 17, 2019

ROBERT M. GIBBENS
LICENSED PROFESSIONAL ENGINEER
No. 10094-C
HAWAII, U.S.A.

THIS WORK WAS PREPARED BY
ME OR UNDER MY SUPERVISION

SIGNATURE

04/30/2020
EXPIRATION DATE
OF LICENSE

Hawaii Geotechnical Consulting

- I n c o r p o r a t e d -

P.O. Box 331223 • Kahului, Hawaii 96733 • Phone (808) 205-1727

July 17, 2019
File No. 19011.01

Mr. Everett R. Dowling
DDC, LLC
2005 Main Street
Wailuku, Maui, Hawaii 96793

Subject: **GEOTECHNICAL INVESTIGATION REPORT FOR PUUNANI HOMESTEAD WAILUKU, MAUI, HAWAII**

Dear Mr. Dowling:

We are pleased to submit our Geotechnical Investigation Report for the Puunani Homestead project in Wailuku, Maui, Hawaii. The enclosed report describes our subsurface investigation and presents our geotechnical recommendations for earthwork, foundations, retaining walls, pavements and utilities.

We appreciate the opportunity to work with you on this project. If you should have any questions or require additional information, please contact us.

Sincerely,

HAWAII GEOTECHNICAL CONSULTING, INC.

Robert M. Gibbens, P.E.
Senior Geotechnical Engineer

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1. INTRODUCTION

1.1 Authorization

Hawaii Geotechnical Consulting, Inc. (HGC) was retained by DDC, LLC to conduct a geotechnical investigation for the proposed Puunani Homestead project in Wailuku, Maui, Hawaii. The scope of our services was outlined in our Aril 29, 2019 proposal No. P-442.

Authorization to proceed was received via a May 20, 2019 signed Professional Services Agreement. The undated Puunani Homestead Conceptual Urban Development Plan was used as a preliminary guide to the site.

1.2 Purpose and Scope

The purpose of this geotechnical investigation was to explore and evaluate the proposed site's subsurface conditions in order to provide geotechnical recommendations for the project's mass grading, foundations, retaining walls, pavements and utilities. In addition to evaluating the subsurface soil conditions, the site's groundwater conditions and construction considerations were addressed. A description of the scope of work is presented below:

Phase 1 – Test Pit Field Investigation. A total of 18 test pits were excavated across the site with a CAT 420D rubber-tired backhoe equipped with a 5 tooth 24 inch wide bucket. Each test pit was excavated to an initial depth of 4 to 5 feet below the existing ground surface. The cut face of each test pit was then hand logged and relatively undisturbed drive and disturbed grab and bulk samples were obtained where appropriate. After initial logging and sample collection, each test pit was extended further. During the additional excavation, the disturbed soil cuttings were sampled when visual changes were observed.

The test pits were each excavated to a depth of 10 feet below the existing ground surface. An engineer with HGC observed and directed the test pit investigation, maintained a log of the subsurface soils encountered and collected relatively undisturbed drive and disturbed grab and bulk samples for laboratory testing. A description of the field investigation, the Logs of Test Pits, and a Unified Soil Classification System (USCS) chart are presented in Appendix A. The test pit locations are presented on the Test Pit Location Plan, Figure 1.

Phase 2 – Percolation Tests. A single percolation test was performed within the storm water detention basin area at the sites northeast corner. The percolation test was performed at a depth of 66 inches below the existing ground surface following the State of Hawaii Department of Health – Wastewater Branch testing method.

Phase 3 – Laboratory Testing. Laboratory tests were performed on relatively undisturbed drive and disturbed grab and bulk samples obtained during the field investigation. Laboratory tests were selected to verify field classifications and provide geotechnical parameters for use in design. Testing consisted of in-place dry density and moisture content, gradation, Atterberg limit and California Bearing Ratio (CBR) tests. The laboratory test methods and results are described and presented graphically in Appendix B and tabulated on the Logs of Test Pits in Appendix A, where applicable.

Phase 4 – Geotechnical Analysis. Our field observations and laboratory test results were analyzed in combination with the plans. We evaluated a shallow foundation system for support of the proposed residential structures. Our analysis focused on the suitability of the sites in-place soils. We also analyzed the existing subsurface conditions as they relate to general site earthwork and pavement design. Design recommendations for use with standard IBC seismic criteria are also provided.

Phase 5 – Geotechnical Report. This report was prepared to present our findings, conclusions, and recommendations regarding the geotechnical feasibility for site earthwork, foundations, retaining walls and pavement design. Discussions and recommendations regarding foundation types, bearing capacity, settlement and pavement design are presented.

1.3 Site Location

The proposed 48 acre site is located west of the Honoapiilani Highway, just north of the Waiolani Mauka Homestead. The site is bounded by the Waiolani Mauka Homestead to the south, the Old Waikapu Road to the west, vacant land to the north and by the Honoapiilani Highway to the east.

1.4 Site Description and Conditions

The site is currently vacant and overgrown with knee high brush and weeds. Some smaller diameter trees are spread throughout the site. Barbed wire fences generally cross the site intermittently from west to east. The site generally sloped down from west to east, although no topographic maps were made available.

The vacant parcel is currently being used to graze cattle and horses. Several wooden structures and corals relating to the cattle and horse operations were observed along the sites west central region.

END OF INTRODUCTION

2. PROJECT DESIGN CONSIDERATIONS

2.1 Proposed Project/Development Plans

We understand that the project will include the construction of a 137 unit single family residential Homestead. We understand that the residential structures will consist of 1 and 2 storied wood framed structures supported on shallow concrete foundation systems and concrete slab-on-grade lower floors. In addition to the residential structures, interior roadways, entranceways off Honoapiilani Highway and buried utilities including water, sewer, drain and electrical are also planned. We have assumed that retaining walls will be used to support grade changes across the site. We have assumed that either CMU or segmental reinforced retaining walls will be utilized.

2.2 Grading

No grading plan was available at the time of this report. The Conceptual Urban Development Plan indicates that the site will be graded into a series of north/south running terraces which step down toward the east. We estimate that cuts and fills on the order of 5 to 15 feet will be required in order to achieve finished grades.

2.3 Pavements

Paving will be provided for entranceways and interior roadways. We have assumed that asphaltic concrete pavement (ACP) will be utilized for all site paving. No traffic information was made available at this time. We have assumed traffic within the proposed project will include primarily passenger and light truck traffic.

END OF PROJECT DESIGN CONSIDERATIONS

3. SUBSURFACE INVESTIGATION

3.1 Test Pits

A total of 18 test pits were excavated within the proposed site. The test pits were excavated with a CAT 420D rubber tired backhoe equipped with a 5 tooth 24 inch wide bucket. Each test pit was excavated to an initial depth of 4 to 5 feet below the existing ground surface. The cut face of each test pit was hand logged and relatively undisturbed drive and disturbed grab and bulk samples were obtained where appropriate. After initial logging and sample collection, each test pit was extended further. During the additional excavation, the disturbed soil cuttings were sampled when visual changes were observed.

The test pits were each excavated to a depth of 10 feet below the existing ground surface. An engineer with HGC observed and directed the test pit investigation, maintained a log of the subsurface soils encountered and collected relatively undisturbed drive and disturbed grab and bulk samples for laboratory testing. A description of the field exploration, the Logs of Test Pits, and a USCS chart are presented in Appendix A. The test pit locations are presented on the Test Pit Location Plan, Figure 1.

3.2 Laboratory Testing

Laboratory tests were performed on relatively undisturbed drive and disturbed grab and bulk samples obtained during the field investigation. Laboratory tests were selected to verify field classifications and provide geotechnical parameters for use in design. Testing consisted of in-place dry density and moisture content, gradation, Atterberg limit and CBR tests. The laboratory test methods and results are described and presented in graphically Appendix B, and tabulated on the Logs of Test Pits in Appendix A, where applicable.

3.3 Percolation Test

A single percolation test was performed within the storm water detention basin area at the sites northeast corner. The percolation test was performed at a depth of 66 inches below the existing ground surface following the State of Hawaii Department of Health – Wastewater Branch testing method.

Approximately 1 inch of clean ¾-inch gravel was placed at the bottom of a 6 inch diameter, 12 inch deep hand excavated hole. Step C of the procedure for Sandy (granular) Soils was used to perform the percolation test, as a 12 inch head of water seeped away in under 10 minutes twice. Water was added to 6 inches above the gravel and allowed to percolate. The water drop was recorded every 5 minute time interval for 1 hour. The final drop was used to calculate the percolation rate.

A senior engineer with HGC performed the percolation test and maintained a log of the time and water drop intervals. The percolation test results are presented in Appendix C.

END OF SUBSURFACE INVESTIGATION

4. SUBSURFACE CONDITIONS

4.1 General

The site is generally blanketed by a thin layer of agriculturally disturbed soil underlain by alluvial (water deposited) soil to the maximum depth of our explorations. The alluvial soils include clay, silt, sand and gravel deposits in various layers throughout the site. A detailed description of the underlying soils is presented below.

4.2 Agriculturally Disturbed Soil

The site was previously used for the cultivation of cane sugar. The cultivation process left the entire site with approximately 12 inches of agriculturally disturbed soil. The agriculturally disturbed soil consisted of soft and loose silts and sands. The agriculturally disturbed soils contain both irrigation plastic and heavy roots within the upper 6 inch depths.

4.3 Alluvial Clays

Alluvial brown silty clays with sand and trace gravel were encountered along the sites southern boundary and along a small portion of the sites northeast corner. The alluvial clays were encountered from the ground surface to depths of more than 10 feet. The clays were typically classified as CL under the Unified Soil Classification System (USCS). The clays were generally hard and moist, with measured in-place dry densities ranging from 68 to 71 pounds per cubic foot (pcf) and measured in-place moisture contents ranging from 19 to 33 percent. Atterberg limit tests on the alluvial clays indicated that they possess a moderate plasticity, with Plasticity Index (PI) values ranging from 19 to 20.

4.4 Alluvial Silts

Alluvial brown clayey silts with sand and some gravel were encountered along all but the sites most southerly boundary. The alluvial silts were encountered from the ground surface to depths of more than 10 feet. The alluvial silts were occasionally encountered under an upper layer of sand or gravel near the sites central region. Most of the silts were typically classified as ML under the USCS with an area of MH silt encountered near the sites southern region. The silts were generally hard and moist, with measured in-place dry densities ranging from 68 to 75 pcf and measured in-place moisture contents ranging from 18 to 32 percent. Atterberg limit tests on the alluvial silts indicated that they possess a low to moderate plasticity, with Plasticity Index (PI) values ranging from 16 to 21.

4.5 Alluvial Sands

Alluvial brown silty sands with gravel and occasionally cobbles were encountered along all but the sites most southerly boundary. The alluvial sands were encountered at various depths from the ground surface to as deep as 9 feet. The sands were typically classified as SM under the USCS. The sands were generally dense and moist, with measured in-place dry densities ranging from 83 to 96 pcf and measured in-place moisture contents ranging from 21 to 36 percent.

A percolation rate of 1.25 minutes per inch was determined for the alluvial silty sand in the area of Test Pit No. 3. The results of the percolation test are presented in Appendix C.

4.6 Alluvial Gravels

Alluvial brown gravels and silty gravels and occasionally cobbles were encountered along all but the sites most southerly boundary. The alluvial gravels were encountered at various depths from the ground surface to as deep as 8 feet. The gravels were typically classified as GM under the USCS. The gravels were generally dense and moist, with measured in-place dry densities ranging from 86 to 103 pcf and measured in-place moisture contents ranging from 14 to 30 percent.

4.5 Groundwater Conditions

No free water or groundwater was encountered during our field investigation and is not expected to impact construction. Groundwater levels within the project areas may vary depending on seasonal rainfall and runoff conditions not apparent at the time of our field investigation. Therefore, groundwater levels may vary from those presented above at the time of construction.

5. DISCUSSION AND ANALYSIS

5.1 General

Based on the results of our field exploration, laboratory testing, and geotechnical analysis, we believe that it is geotechnically feasible to construct the proposed residential project, provided the recommendations of this report are closely followed. The primary geotechnical concern regarding the proposed construction is the presence of soft agriculturally disturbed soils blanketing the site and the presence of moderately plastic soil along the sites southern boundary. A more detailed discussion regarding these as well as other concerns is presented below.

5.2 Agriculturally Disturbed Soils

About 12 inches of the sites upper soils has been agriculturally disturbed by the past cane cultivation. The disturbed soils are soft and dry and posses the potential for future settlement if not remediated. The agriculturally disturbed soils will need to be compacted in place prior to the placement of fill. The compaction should proceed in accordance with the subgrade preparation recommendations of Section 6.7.2. The upper 6 inches of agriculturally disturbed soils contain a significant quantity of irrigation plastic and roots. This upper 6 inches of soil is not suitable as fill and should be removed and wasted offsite during site grubbing.

5.3 Potentially Expansive Soil

Although plasticity index testing on several of the site alluvial clay and silt soils indicated a moderate to low plasticity, our experience in the project area indicates that higher plasticity soils can exist outside our investigation area. In order to minimize the potential for damaging expansive soils, we recommend that all onsite soils to be used as engineered fill be brought to a moisture content no less than 2 percent above their optimum prior to compaction. All cut or at grade areas not requiring fill should be scarified and moisture conditioned at least 12 inches deep and to at least 2 percent above their optimum moisture contents prior to the excavation of footings.

This moisture conditioning will pre-swell the soils and should reduce the swell potential to less than 1 percent, provided the moisture contents are maintained until permanent cover is provided. Maintaining moisture is critical in reducing the swell potential and should be achieved through the use of sprinklers and a vegetative cover when concrete cover is not planned immediately after mass grading. The moisture contents of the upper 12 inches of each pad and to at least 12 inches below each footing bottom, should be checked just prior to footing excavation. Once footing excavation has begun, it is difficult to increase the moisture content of the footing bottom without disturbing the footing sidewalls.

END OF DISCUSSION AND ANALYSIS

6. ENGINEERING RECOMMENDATIONS

6.1 General

Site grading design can be developed in accordance with the following recommendations. Unless stated otherwise, the maximum dry density (MDD) and optimum moisture content (OMC) of all engineered fill referenced within this report is based on Laboratory Test Method ASTM D1557.

6.2 Seismic Design Considerations

The following sections address what we believe to be the project's major seismic design considerations.

6.2.1 Ground Shaking

The proposed development is located in an area with some seismic activity and the proposed structures will likely be subjected to seismic shaking during their design life. The primary potential seismic hazard is ground shaking. We recommend that the proposed development be designed in accordance with the requirements of the latest (2006) edition of the International Building Code (IBC). According to Table 1613.52 of the 2006 IBC, the project site can be characterized by a Site Class of D.

6.2.2 Liquefaction

Liquefaction occurs in loose, saturated sands that are subjected to earthquake type motions. In sands where constant volume conditions are maintained during shaking (i.e., where no immediate drainage path exists), excess pore water pressures build quickly and as a result, soil strength is rapidly reduced and settlement occurs. Neither loose sands nor a shallow groundwater table underlie the site. Therefore no liquefaction-induced settlements are likely.

6.2.3 Other Seismic Considerations

The site is not located within an Earthquake Fault Zone. Therefore the likelihood of the ground surface rupturing due to faulting is considered to be low. Based on the materials encountered and the existing and planned topographic conditions, we do not expect seismic slope instability to be a concern. Due to the site's elevation, we do not believe that tsunamis are a potential threat.

6.3 Foundations

The residential structures may be founded on shallow continuous strip or spread footings provided the recommendations for site preparation are followed. We recommend that all foundations founded in native alluvial soil or engineered fill be placed a minimum depth of 6 inches below the lowest adjacent grade for both interior and exterior footings. These embedment depths should provide bearing surfaces consisting of either fine grained alluvial soils or engineered fil.

For a shallow foundation system designed with the recommendations presented above, an allowable bearing pressure of 3,050 pounds per square foot (psf) may be used. This bearing value is for total dead plus sustained live loads and may be increased by one-third for transient loads such as wind or seismic. We estimate that total and differential settlements should be less than ½-inch for foundations designed as described above.

The bottom of all foundations should be cleaned of loose material and all agriculturally disturbed soils should be compacted in place to no less than 90 percent of the soils MDD at a moisture content no less than 2 percent wet of its OMC. The subgrade soil should also be compacted to at least 90 percent of the materials MDD at a moisture content no less than 2 percent wet of optimum. Footings located near adjacent slopes should be embedded such that a minimum horizontal distance of 5 feet is maintained between the footing's bottom edge and the exposed slope face.

Lateral resistance may be derived from passive resistance along the footing sides and friction along the footing bottoms. An allowable passive earth pressure of 275 psf per foot of depth may be used for footings founded in either alluvial or residual soil or engineered fill. Allowable lateral earth pressures should not exceed 3,000 psf. We recommend that the lateral earth pressure of any footing be neglected for the upper 12-inches unless the surface around the footing is protected from erosion or disturbance by a slab, pavement, or some other form of confinement.

A coefficient of friction value of 0.40 may be used between the bottom of concrete footings and the underlying alluvial soil or engineered fill. Sliding resistance should be calculated based on the dead load only.

6.4 Slab-on Grade Floors

Concrete slab-on-grade floors bearing on alluvial soil or engineered fill can be used for the residential structures. If reducing the passage of water vapor through the slab is desired, we recommend that a vapor barrier be placed beneath the slab.

For exterior slabs and slabs designed as rigid pavements, the water vapor barrier should be replaced by 6 inches of Aggregate for Untreated Base (UTB). The UTB should conform to Section 703.06 of the 2005 Hawaii Standard Specifications for Road, Bridge, and Public Works Construction (Standard Specifications). The UTB should be compacted to at least 95 percent of its MDD.

Lateral resistance may be derived from passive resistance along the footing sides and friction along the footing bottoms. An allowable passive earth pressure of 275 psf per foot of depth may be used for footings founded in either alluvial or residual soil or engineered fill. We recommend that the lateral earth pressure of any footing be neglected for the upper 12-inches unless the surface around the footing is protected from erosion or disturbance by a slab, pavement, or some other form of confinement.

A coefficient of friction value of 0.40 may be used between the bottom of concrete footings and the underlying alluvial soil or engineered fill. Sliding resistance should be calculated based on the dead load only.

6.5 Retaining Walls

We understand that the yielding free-standing retaining walls will be used to support site grade changes. We assume that the retaining walls will be CMU or reinforced segmental with level onsite soils used as backfill.

Unrestrained walls that are free to rotation at the top should be designed with active lateral earth pressures. For yielding CMU walls with level backfill, we recommend that an active lateral earth pressure equivalent to a fluid weighing 45 pcf be used in design. For reinforced segmental walls we recommend that a phi angle of 28 degrees and a total unit weight of 105 pcf be used as design values for the level onsite alluvial silt backfill.

Lateral resistance may be derived from passive resistance along the wall footing sides and friction along the footing bottoms. An allowable passive earth pressure of 275 psf per foot of depth may be used for design. We recommend that the lateral earth pressure of any footing be neglected for the upper 12-inches unless the surface around the footing is protected from erosion or disturbance by a slab, pavement, or some other form of confinement.

A coefficient of friction value of 0.40 may be used between the bottom of the concrete footings and the underlying native alluvial soils or engineered fill. Sliding resistance should be calculated based on the dead load only.

These pressures are given in terms of equivalent fluid pressure for unrestrained walls and do not include compaction-induced, surcharge, foundation, or hydrostatic loads, which must be added where appropriate.

Wall backfill should be placed and compacted in accordance with the engineered fill recommendations. Wall backfill compaction should not exceed 95 percent relative compaction to minimize lateral wall pressures. Heavy construction equipment should be maintained a distance of at least three feet away from the walls while the backfill soils are being placed. Hand operated compaction equipment should be used to compact the wall backfill within a three foot zone adjacent to the walls.

Adequate wall drainage should be provided.

6.6 Pavement Design

Detailed vehicular load and frequency information was not made available to us. We have assumed traffic within the proposed residential Homestead will include passenger and light truck traffic.

6.6.1 Flexible Pavement

Because of the high volume of cut and fill across the site, it was difficult to determine the type of soil which will be the final subgrade for the projects entranceways and driveways. We have therefore assumed a minimum CBR value of 20 for all proposed road subgrades. Based on this, and the assumed traffic, we believe that a pavement section consisting of 2.0 inches of Asphaltic Concrete over 6.0 inches of Aggregate for Untreated Base (UTB) should be sufficient for the passenger and truck traffic.

The UTB should conform to Sections 703.06 of the 2005 Standard Specifications and should be compacted to at least 95 percent of the materials MDD at a moisture content between optimum and 3 percent wet of the soils OMC. All pavement subgrades should be sloped to drain. All pavement subgrades should be compacted to at least 90 percent of their MDD at a moisture content at least 2 percent wet of their OMC for a depth of at least 12 inches.

6.6.2 Rigid Pavement

Portland cement concrete pavements (PCCP) may be desirable at entry points and other locations where tight-turning heavy vehicles are expected. For commercial usage, we recommend a 6-inch thick rigid concrete pavement over 6 inches of UTB. The UTB should conform to Section 703.06 of the Standard Specifications and should be compacted to at least 95 percent of the materials MDD. The subgrade should be compacted to at least 90 percent of its MDD at a moisture content at least 2 percent wet of its OMC for a depth of at least 12 inches.

6.6.3 Construction Considerations

After completion of site grading, we recommend that the final subgrade soils be tested for their CBR value to confirm the values assumed in design. Modified pavement sections may be required if subgrade conditions vary from those assumed in design.

In the event unstable (pumping) subgrades are encountered within the planned pavement areas, we recommend that a heavy rubber tired vehicle (typically a loaded water truck) be used to test the load/deflection characteristics of the finished subgrade. If the tested surface shows a visible deflection, corrective measures should be implemented.

6.7 Construction Considerations

The following recommendations are provided for geotechnical earthwork design. All site preparation and earthwork operations should be performed in accordance with the Standard Specifications.

6.7.1 Stripping and Grubbing

Prior to commencement of site grading, the site should be cleared and grubbed to remove all organics, vegetation, and other deleterious materials in accordance with the Standard Specifications. We anticipate stripping and grubbing will include surface vegetation and the removal of all irrigation plastic. We believe the stripping and grubbing to depths of 6 inches will be required. Organic material should not be mixed with the underlying native soils that may be later used as fill or backfill. Material with organic matter in excess of about 4 percent should not be used as fill or backfill.

The stripping and grubbing work should include the removal or recompaction of all agriculturally disturbed soils that, in the judgment of the geotechnical engineer, is uncertified, compressible, collapsible, or contains significant voids. The voids caused by the removal of subsurface features, if encountered, must also be processed and backfilled in accordance with the recommendations presented in this report.

6.7.2 Site Preparation

Based on our interpretation of the geotechnical subsurface profile, we anticipate that the soils exposed during construction will consist primarily of fine-grained low to moderate plasticity alluvial clays, silts and sands with gravel and cobble. All areas to receive fill should be stripped and grubbed to expose a firm, non-yielding subgrade, free of large voids, organics, and deleterious materials. The exposed subgrade soils should be moisture conditioned to at least 2 percent wet of the soils OMC for a depth of at least 12 inches prior to being compacted to at least 90 percent of the soils MDD for a minimum depth of 12-inches.

Although our laboratory testing revealed that the site's subgrade soils generally possess low to moderate plasticity, areas of higher plasticity soil may be encountered outside those areas tested. Subgrade soils which, in the opinion of HGC personnel, are potentially expansive, should be tested via an Atterberg limit and/or a swell test.

6.7.3 Excavation Characteristics

Cobbles and boulders were generally encountered within both the alluvial and residual onsite soils. We anticipate that cuts in excess of 10 to 15 feet may be required for mass grading and the installation of onsite utilities. We believe that conventional to heavy-duty earth moving construction equipment should be capable of performing the anticipated excavations. Areas with limited excavation widths, such as utility trenches, may encountered boulders that may be difficult to remove without the assistance of some form of hard rock removal technique.

6.7.4 Engineered Fill

The onsite soils are generally suitable for use as engineered fill provided all organics and rocks or clods larger than 6 inches in diameter are removed and the fill is placed and maintained at a moisture content at least 2 percent wet of the soils OMC. If imported fill is required it should consist of fine- or coarse-grained material with a maximum particle size of 3 inches. Additionally, all imported fill should possess a PI less than 20 and should qualify as SW, SP, GP, GM, SM, or ML in accordance with the USCS.

All fill should be placed in successive horizontal lifts of not more than 12 inches in loose thickness for the full width of the area being filled. The fill should be moisture conditioned to at least 2 percent above the materials OMC prior to being compacted to at least 90 percent of its MDD.

Ground surfaces to receive fill with slopes in excess of 5H:1V should be benched with a series of horizontal terraces prior to fill placement. The benches should extend through any disturbed slope materials into the native alluvial or residual soils.

6.8 Utilities

All utility installations should be performed in accordance with the Standard Specifications. The following recommendations are meant to supplement the Standard Specifications.

We recommend that the minimum excavated width for any utility trench be such that at least 14 inches of clearance exists between the edge of the utility pipe and the excavated trench sidewall prior to utility pipe placement. Insufficient space between the utility pipe and trench sidewall could lead to inadequate backfill compaction and potential pipe failure.

All utility backfills should be placed in horizontal lifts for the full width of the utility trench prior to compaction. In overwidened trenches, such as trenches excavated in hard rock, arching or shaping of the initial bedding lifts should not be allowed.

Shallow temporary utility trench excavations are anticipated for installation of the required utility lines. All vertical or steeply sided trench excavations deeper than 5 feet should be braced and shored in accordance with good construction practices and all applicable safety ordinances and codes.

6.9 Site Drainage

The ground surface should slope away from pavement areas, toward appropriate drop inlets or other surface drainage devices. These grades should be maintained for the life of the project.

END OF ENGINEERING RECOMMENDATIONS

7. ADDITIONAL SERVICES

We recommend that a thorough review of the project plans and specifications be conducted before they are finalized to verify that our geotechnical recommendations have been properly interpreted and implemented during the design. If we are not accorded this review, we can assume no responsibility for misinterpretation of our recommendations. The review can be completed on a time-and-expense basis in accordance with our current Fee Schedule.

The construction process is an integral design component with respect to the geotechnical aspects of a project. Because geotechnical engineering is an inexact science due to the variability of natural processes and because we sample only a small portion of the soils affecting the performance of the proposed structures, unanticipated or changed conditions can be disclosed during grading. Proper geotechnical observation and testing during construction is imperative to allow the geotechnical engineer the opportunity to verify assumptions made during the design. Therefore, we recommend that Hawaii Geotechnical Consulting, Inc. be kept apprised of design modifications and construction schedules for the proposed development so that design changes can be made if subsurface field conditions warrant.

END OF ADDITIONAL SERVICES

8. LIMITATIONS

This report has been prepared for the exclusive use of DDC, LLC and their agents for specific application to the proposed Puunani Homestead project in Wailuku, Maui, Hawaii.

The findings, conclusions, and recommendations presented in this report were prepared in accordance with generally accepted geotechnical engineering practice as it exists in the site area at the time of our study. No warranty is expressed or implied. The recommendations provided in this report are based on the assumption that our firm will conduct an adequate program of tests and observations during the construction phase in order to evaluate compliance with our recommendations. If the scope of the proposed construction, including the proposed loads, grades, or structural locations change from that described in this report, our recommendations should also be reviewed. We have not reviewed a final grading or building plan for the project.

Hazardous materials may have been discovered during the course of Hawaii Geotechnical Consulting, Inc.'s services. Hawaii Geotechnical Consulting, Inc. will assume no responsibility or liability whatsoever for any claim, loss of property value, damage, or injury that results from pre-existing hazardous materials being encountered or present on the project site, or from the discovery of such hazardous materials.

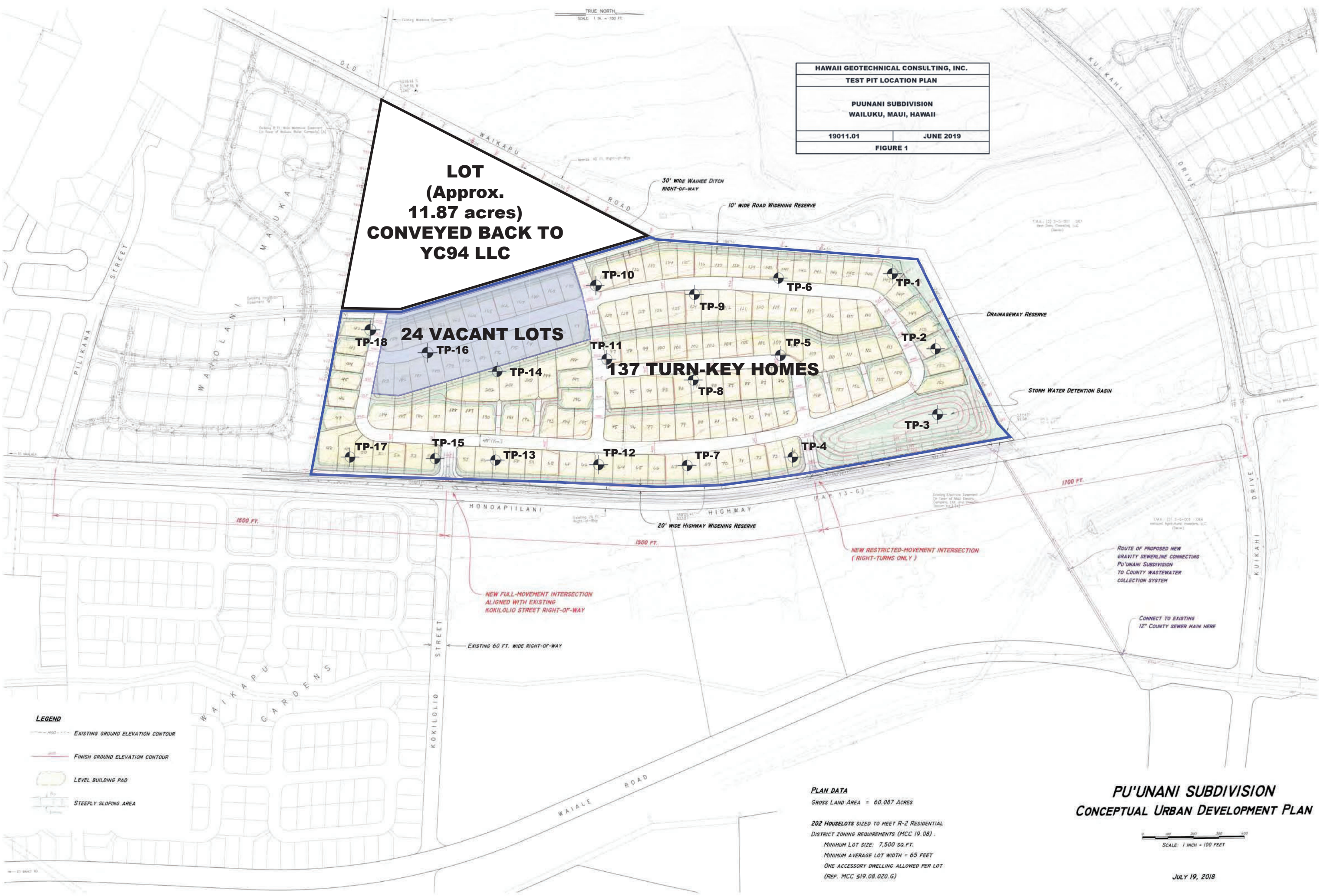
Nothing contained in this scope of work should be construed or interpreted as requiring Hawaii Geotechnical Consulting, Inc. to assume the status of an owner, operator, generator, or person who arranges for disposal, transport, storage, or treatment of hazardous materials within the meaning of any governmental statute, regulation, or order.

The client has the responsibility to see that all parties to the project, including the designer, contractor, subcontractor, etc., are made aware of this report in its entirety. This report contains information that may be useful in the preparation of contract specifications. However, the report is not designed as a specification document and may not contain sufficient information for this use without proper modification.

The recommendations contained in this report are based on our field observations and our present knowledge of the proposed construction. It is possible that soil conditions could vary between or beyond the areas observed. If soil conditions are encountered during construction which differ from those described herein, we should be notified immediately in order that a review may be made and any supplemental recommendations provided.

This report may be used only by the client and only for the purpose stated, within a reasonable time from its issuance. Land use, site conditions (both onsite and offsite) or other factors may change over time, and additional work may be required with the passage of time. Any party other than the client who wishes to use this report shall notify Hawaii Geotechnical Consulting, Inc. of such intended use. Based on the intended use of this report, Hawaii Geotechnical Consulting, Inc. may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the client or anyone else will release Hawaii Geotechnical Consulting, Inc. from any liability resulting from the use of this report by any unauthorized party.

FIGURES


HAWAII GEOTECHNICAL CONSULTING, INC.
TEST PIT LOCATION PLAN
PUUNANI SUBDIVISION
WAILUKU, MAUI, HAWAII
19011.01
JUNE 2019
FIGURE 1
LOT
(Approx.
11.87 acres)
CONVEYED BACK TO
YC94 LLC
24 VACANT LOTS
137 TURN-KEY HOMES
TP-1
TP-2
TP-3
TP-4
TP-5
TP-6
TP-7
TP-8
TP-9
TP-10
TP-11
TP-12
TP-13
TP-14
TP-15
TP-16
TP-17
TP-18
30' wide Waihee Ditch right-of-way
10' wide Road Widening Reserve
Drainageway Reserve
Storm Water Detention Basin
20' wide Highway Widening Reserve
New restricted-movement intersection (right-turns only)
New full-movement intersection aligned with existing Kokilolio Street right-of-way
Existing 60 ft. wide right-of-way
Route of proposed new gravity sewerline connecting Pu'unani Subdivision to County wastewater collection system
Connect to existing 12" County sewer main here
1500 ft.
1700 ft.
Old Waikapu Road
Honoapiilani Highway
Waiale Road
Kokilolio Street
Pilikana Street
Kuikahi Drive
Waikapu Gardens
Legend
Existing ground elevation contour
Finish ground elevation contour
Level building pad
Steeply sloping area
Plan data
Gross Land Area = 60.087 Acres
202 Houselots sized to meet R-2 Residential District zoning requirements (MCC 19.08):
Minimum Lot size: 7,500 sq.ft.
Minimum average lot width = 65 feet
One accessory dwelling allowed per lot
(Ref. MCC §19.08.020.G)
PU'UNANI SUBDIVISION
Conceptual Urban Development Plan
Scale: 1 inch = 100 feet
July 19, 2018

APPENDIX A
Field Exploration

APPENDIX A
FIELD EXPLORATION

The subsurface exploration program for the Puunani Homestead project included excavating and logging a total of 18 test pits. The test pits were excavated to depths of 10 feet below the existing ground surface.

The Logs of Test Pits are presented as Figures A2 through A19. A USCS soil classification chart is presented as Figure A1. The Logs of Test Pits describe the materials encountered, samples obtained, and show field and laboratory tests performed. The logs also show the test pit number, excavation date, name of the logger and excavation subcontractor, and the groundwater level. A senior geotechnical engineer logged the materials encountered in accordance with the USCS. The boundaries between soil types shown on the logs are approximate because the transition between different soil layers may be gradual.

The test pits were excavated with a CAT 430D rubber tired backhoe equipped with a 2 foot wide, 5-tooth bucket. Each test pit was excavated to an initial depth of 4 to 5 feet below the existing ground surface. The cut face of each test pit was then hand logged and disturbed grab and bulk samples and relatively undisturbed drive samples were obtained where appropriate. After initial logging and sample collection, each excavatable test pit was extended further. During the additional excavation, the disturbed soil cuttings were observed and sampled when visual changes were observed.

USCS SOIL CLASSIFICATION CHART

Major Divisions			Symbol	Typical Descriptions
COARSE GRAINED SOILS MORE THAN HALF OF THE MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVELS MORE THAN HALF OF COURSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE	CLEAN GRAVELS (LITTLE OR NO FINES)	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
			GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNTS OF FINES)	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS MORE THAN HALF OF COURSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE	CLEAN SANDS (LITTLE OR NO FINES)	SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
			SP	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNTS OF FINES)	SM	SILTY SANDS, SAND-SILT MIXTURES
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAINED SOILS MORE THAN HALF OF THE MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTSAND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SOILS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS

FIGURE
A1

Date Completed:	05/22/2019	Water Depth:	Not Encountered
Drilled By:	Bermejo Excavation	Elevation:	--
Drilling Method:	Backhoe	Location:	Lot 147
Logged By:	R.M. Gibbens, P.E.	Symbols:	Bulk Sample; Drive/Grab Sample

Depth (feet)	Sample Type	Sample No.	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Additional Tests
0			Clayey SILT (ML) with Sand and trace Gravel (irrigation plastic and roots to 6") brown, soft, dry AGRICULTURALLY DISTURBED				
1	Drive/Grab	1	Clayey SILT (ML) with some Sand and trace Gravel and trace Cobble brown, hard, moist	3.75	70	20	Gravel = 10% Sand = 28% Silt/Clay = 62%
3	Drive/Grab	2	no Gravel from 3.0 ft.	4.00	73	30	Gravel = 0% Sand = 16% Silt/Clay = 84%
5	Drive/Grab	3		--	--	29	Gravel = 0% Sand = 10% Silt/Clay = 90%
9	Drive/Grab	4	ALLUVIUM	--	--	29	Gravel = 0% Sand = 13% Silt/Clay = 87%
10			Bottom at 10.0 feet No free water observed Test pit backfilled with excavated materials				

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LOG OF TEST PIT 1

FIGURE

A2

Date Completed:	05/22/2019	Water Depth:	Not Encountered
Drilled By:	Bermejo Excavation	Elevation:	--
Drilling Method:	Backhoe	Location:	Lot 151
Logged By:	R.M. Gibbens, P.E.	Symbols:	Bulk Sample; Drive/Grab Sample

Depth (feet)	Sample Type	Sample No.	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Additional Tests
0–1			SILTY SAND (SM) with trace Gravel (irrigation plastic and roots to 10") brown, loose, dry — AGRICULTURALLY DISTURBED				
1–5			SILTY SAND (SM) with Gravel and trace Cobble brown, dense, moist — ALLUVIUM				
3	Drive/Grab	1		--	93	26	Gravel = 20% Sand = 39% Silt/Clay = 41%
5–9	Drive/Grab	2	GRAVEL (GM) and Sand with some Silt and Boulders brown, dense, moist — ALLUVIUM	--	101	20	Gravel = 48% Sand = 35% Silt/Clay = 17%
9–10	Drive/Grab	3	Clayey SILT (ML) with trace Gravel and some Sand brown, hard, moist — ALLUVIUM	--	--	28	Gravel = 3% Sand = 17% Silt/Clay = 80%

Bottom at 10.0 feet
No free water observed
Test pit backfilled with excavated materials

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LOG OF TEST PIT 2

FIGURE **A3**

Date Completed:	05/22/2019	Water Depth:	Not Encountered
Drilled By:	Bermejo Excavation	Elevation:	--
Drilling Method:	Backhoe	Location:	Detention Basin
Logged By:	R.M. Gibbens, P.E.	Symbols:	Bulk Sample; Drive/Grab Sample

Depth (feet)	Sample Type	Sample No.	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Additional Tests
0–1			Clayey SILT (ML) and Sand with trace Gravel (irrigation plastic and roots to 6") brown, soft, dry — AGRICULTURALLY DISTURBED				
1–3	Drive/Grab; Bulk	1	Clayey SILT (ML) and Sand with trace Gravel brown, very stiff, moist; with trace Cobbles and Boulders from 2.0 ft. — ALLUVIUM	4.00	68	19	Gravel = 6% Sand = 38% Silt/Clay = 55% LL = 45 PI = 16
3–5	Drive/Grab	2	SILTY GRAVEL (GM) and Sand brown, dense, moist — ALLUVIUM	--	103	19	Gravel = 47% Sand = 23% Silt/Clay = 30%
5–9	Drive/Grab	3	SILTY SAND (SM) and Gravel brown, dense, moist — ALLUVIUM	--	--	23	Gravel = 29% Sand = 38% Silt/Clay = 33%
9–10	Drive/Grab	4	Clayey SILT (ML) and Sand with trace Gravel brown, hard, moist — ALLUVIUM	--	--	28	Gravel = 2% Sand = 40% Silt/Clay = 58%

Bottom at 10.0 feet
No free water observed
Test pit backfilled with excavated materials

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LOG OF TEST PIT 3

FIGURE **A4**

Date Completed:	05/22/2019	Water Depth:	Not Encountered
Drilled By:	Bermejo Excavation	Elevation:	--
Drilling Method:	Backhoe	Location:	Lot 74
Logged By:	R.M. Gibbens, P.E.	Symbols:	Bulk Sample; Drive/Grab Sample

Depth (feet)	Sample Type	Sample No.	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Additional Tests
0–1			Clayey SILT (ML) and Sand with trace Gravel (irrigation plastic and roots to 6") brown, soft, dry — AGRICULTURALLY DISTURBED				
1–3	Drive/Grab	1	Clayey SILT (ML) and Sand with some Gravel brown, hard, dry to moist — ALLUVIUM	4.00	75	18	Gravel = 13% Sand = 30% Silt/Clay = 57%
3–5	Drive/Grab	2	SILTY GRAVEL (GM) and Sand brown, dense, moist — ALLUVIUM	--	100	18	Gravel = 45% Sand = 27% Silt/Clay = 28%
5–7	Drive/Grab	3	SILTY SAND (SM) with some Gravel brown, dense, moist — ALLUVIUM	--	--	26	Gravel = 11% Sand = 47% Silt/Clay = 42%
7–10	Drive/Grab	4	SILTY GRAVEL (GM) with Sand and some Cobble brown, dense, moist — ALLUVIUM	--	--	20	Gravel = 51% Sand = 23% Silt/Clay = 26%

Bottom at 10.0 feet
No free water observed
Test pit backfilled with excavated materials

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LOG OF TEST PIT 4

FIGURE **A5**

Date Completed:	05/22/2019	Water Depth:	Not Encountered
Drilled By:	Bermejo Excavation	Elevation:	--
Drilling Method:	Backhoe	Location:	Lot 107
Logged By:	R.M. Gibbens, P.E.	Symbols:	Bulk Sample; Drive/Grab Sample

Depth (feet)	Sample Type	Sample No.	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Additional Tests
0–1			Clayey SILT (ML) and Sand with some Gravel (irrigation plastic and roots to 6") brown, soft, dry — AGRICULTURALLY DISTURBED				
1–8			Clayey SILT (ML) and Sand with some Gravel brown, hard, moist — ALLUVIUM				
3	Drive/Grab	1		4.00	71	29	Gravel = 1% Sand = 16% Silt/Clay = 83% LL = 47 PI = 19
5	Drive/Grab	2		4.00	--	27	Gravel = 5% Sand = 14% Silt/Clay = 81%
8–10			SILTY SAND (SM) with trace Gravel brown, dense, moist — ALLUVIUM				
9	Drive/Grab	3		--	--	34	Gravel = 9% Sand = 48% Silt/Clay = 43%
10			Bottom at 10.0 feet No free water observed Test pit backfilled with excavated materials				

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LOG OF TEST PIT 5

FIGURE **A6**

Date Completed:	05/22/2019	Water Depth:	Not Encountered
Drilled By:	Bermejo Excavation	Elevation:	--
Drilling Method:	Backhoe	Location:	Lot 141
Logged By:	R.M. Gibbens, P.E.	Symbols:	Bulk Sample; Drive/Grab Sample

Depth (feet)	Sample Type	Sample No.	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Additional Tests
0–1			Silty CLAY (CL) with Sand and some Gravel (irrigation plastic and roots to 6") brown, soft, dry AGRICULTURALLY DISTURBED				
1	Drive/Grab	1	Silty CLAY (CL) with Sand and some Gravel brown, hard, moist	4.00	--	19	Gravel = 17% Sand = 24% Silt/Clay = 59%
3	Drive/Grab	2		4.00	70	26	Gravel = 4% Sand = 20% Silt/Clay = 76% LL = 45 PI = 19
5	Drive/Grab	3		--	--	27	Gravel = 12% Sand = 17% Silt/Clay = 71%
10			ALLUVIUM				
			Bottom at 10.0 feet No free water observed Test pit backfilled with excavated materials				

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LOG OF TEST PIT 6

FIGURE **A7**

Date Completed:	05/22/2019	Water Depth:	Not Encountered
Drilled By:	Bermejo Excavation	Elevation:	--
Drilling Method:	Backhoe	Location:	Lot 68
Logged By:	R.M. Gibbens, P.E.	Symbols:	Bulk Sample; Drive/Grab Sample

Depth (feet)	Sample Type	Sample No.	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Additional Tests
0–1			Clayey SILT (ML) with Sand and some Gravel (irrigation plastic and roots to 6") brown, soft, dry — AGRICULTURALLY DISTURBED				
1–9			SILTY GRAVEL (GM) with Sand and trace Cobble brown, dense, moist — ALLUVIUM				
3	Drive/Grab	1		--	100	18	Gravel = 41% Sand = 33% Silt/Clay = 26%
5	Drive/Grab	2		--	--	18	Gravel = 55% Sand = 22% Silt/Clay = 23%
9–10	Drive/Grab	3	SAND (SM) and Silt with Gravel brown, dense, moist — ALLUVIUM	--	--	26	Gravel = 25% Sand = 26% Silt/Clay = 49%
10			Bottom at 10.0 feet No free water observed Test pit backfilled with excavated materials				

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LOG OF TEST PIT 7

FIGURE **A8**

Date Completed:	05/22/2019	Water Depth:	Not Encountered
Drilled By:	Bermejo Excavation	Elevation:	--
Drilling Method:	Backhoe	Location:	Lot 91
Logged By:	R.M. Gibbens, P.E.	Symbols:	Bulk Sample; Drive/Grab Sample

Depth (feet)	Sample Type	Sample No.	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Additional Tests
0–1			Clayey SILT (ML) with Sand and some Gravel (irrigation plastic and roots to 6") brown, soft, dry AGRICULTURALLY DISTURBED				
1–4	Drive/Grab	1	Clayey SILT (ML) with Sand, trace Gravel and trace Cobble brown, hard, moist	4.00	68	20	Gravel = 2% Sand = 30% Silt/Clay = 68%
	Bulk						
	Drive/Grab	2	ALLUVIUM	4.00	72	25	Gravel = 1% Sand = 27% Silt/Clay = 72%
4–8	Drive/Grab	3	SILTY SAND (SM) and Gravel with some Cobble brown, dense, moist ALLUVIUM	--	86	28	Gravel = 34% Sand = 42% Silt/Clay = 24%
8–10	Drive/Grab	4	GRAVEL (GM) with Sand, some Silt and Cobble brown, dense, moist ALLUVIUM	--	--	22	Gravel = 50% Sand = 31% Silt/Clay = 19%

Bottom at 10.0 feet
No free water observed
Test pit backfilled with excavated materials

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LOG OF TEST PIT 8

FIGURE A9

Date Completed:	05/22/2019	Water Depth:	Not Encountered
Drilled By:	Bermejo Excavation	Elevation:	--
Drilling Method:	Backhoe	Location:	Lot 124
Logged By:	R.M. Gibbens, P.E.	Symbols:	Bulk Sample; Drive/Grab Sample

Depth (feet)	Sample Type	Sample No.	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Additional Tests
0–1			SILT (ML) with Sand and trace Gravel (irrigation plastic and roots to 6") brown, soft, dry AGRICULTURALLY DISTURBED				
1–2	Drive/Grab	1	SILT (ML) with Sand and trace Gravel, Cobble and Boulders brown, very stiff, moist ALLUVIUM	4.00	68	19	Gravel = 10% Sand = 29% Silt/Clay = 61%
2–4	Drive/Grab	2	GRAVEL(GM) and Silt with Sand and trace Cobble and Boulders brown, loose to medium dense, moist ALLUVIUM	--	102	20	Gravel = 35% Sand = 25% Silt/Clay = 41%
4–10	Drive/Grab	3	SILTY SAND (SM) with Gravel brown, medium dense, moist becomes dense at 6 ft. ALLUVIUM	--	96	21	Gravel = 30% Sand = 37% Silt/Clay = 33%

Bottom at 10.0 feet
No free water observed
Test pit backfilled with excavated materials

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LOG OF TEST PIT 9

FIGURE **A10**

Date Completed:	05/22/2019	Water Depth:	Not Encountered
Drilled By:	Bermejo Excavation	Elevation:	--
Drilling Method:	Backhoe	Location:	Lot 130
Logged By:	R.M. Gibbens, P.E.	Symbols:	Bulk Sample; Drive/Grab Sample

Depth (feet)	Sample Type	Sample No.	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Additional Tests
0–1			SILT (ML) with Sand and trace Gravel (irrigation plastic and roots to 6") brown, soft, dry — AGRICULTURALLY DISTURBED				
1–2			SILT (ML) with Sand and trace Gravel, Cobble and Boulders brown, very stiff, moist — ALLUVIUM				
2–10			GRAVEL(GM) with Sand and some Silt and trace Cobble and Boulders brown, loose to medium dense, moist				
3	Drive/Grab	1		--	103	14	Gravel = 53% Sand = 28% Silt/Clay = 19%
4			no Boulders from 4 ft, becomes dense				
5	Drive/Grab	2		--	--	15	Gravel = 63% Sand = 25% Silt/Clay = 12%
10			ALLUVIUM				
			Bottom at 10.0 feet No free water observed Test pit backfilled with excavated materials				

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LOG OF TEST PIT 10

FIGURE **A11**

Date Completed:	05/22/2019	Water Depth:	Not Encountered
Drilled By:	Bermejo Excavation	Elevation:	--
Drilling Method:	Backhoe	Location:	Lot 97
Logged By:	R.M. Gibbens, P.E.	Symbols:	Bulk Sample; Drive/Grab Sample

Depth (feet)	Sample Type	Sample No.	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Additional Tests
0–1			SAND (SM) and Silt with Gravel (irrigation plastic and roots to 6") brown, loose, dry AGRICULTURALLY DISTURBED				
1–3	Drive/Grab	1	SAND (SM) and Silt with Gravel brown, dense, moist ALLUVIUM	--	83	18	Gravel = 23% Sand = 34% Silt/Clay = 44%
3–5.5	Drive/Grab	2	Clayey SILT (ML) with Sand and trace Gravel brown, hard, moist	4.00	74	22	Gravel = 27% Sand = 36% Silt/Clay = 37%
	Drive/Grab	3	ALLUVIUM	--	--	28	Gravel = 3% Sand = 21% Silt/Clay = 76%
5.5–10			Silty GRAVEL (GM) with Sand brown, dense, moist				
	Drive/Grab	4	ALLUVIUM	--	--	26	Gravel = 46% Sand = 30% Silt/Clay = 24%
10			Bottom at 10.0 feet No free water observed Test pit backfilled with excavated materials				

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LOG OF TEST PIT 11

FIGURE **A12**

Date Completed:	05/22/2019	Water Depth:	Not Encountered
Drilled By:	Bermejo Excavation	Elevation:	--
Drilling Method:	Backhoe	Location:	Lot 63
Logged By:	R.M. Gibbens, P.E.	Symbols:	Bulk Sample; Drive/Grab Sample

Depth (feet)	Sample Type	Sample No.	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Additional Tests
0–1			Clayey SILT (ML) and Sand with some Gravel (irrigation plastic and roots to 6") brown, soft, dry — AGRICULTURALLY DISTURBED				
1–9			Clayey SILT (ML) and Sand with some Gravel brown, hard, moist				
3	Drive/Grab	1		4.00	72	26	Gravel = 10% Sand = 38% Silt/Clay = 53%
5	Drive/Grab	2	no Gravel from 5 ft. — ALLUVIUM	4.00	--	29	Gravel = 0% Sand = 39% Silt/Clay = 61%
9–10	Drive/Grab	3	SAND (SM) and Silt with some Gravel brown, dense, moist — ALLUVIUM	--	--	25	Gravel = 14% Sand = 43% Silt/Clay = 43%

Bottom at 10.0 feet
No free water observed
Test pit backfilled with excavated materials

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LOG OF TEST PIT 12

FIGURE A13

Date Completed:	05/22/2019	Water Depth:	Not Encountered
Drilled By:	Bermejo Excavation	Elevation:	--
Drilling Method:	Backhoe	Location:	Lot 57
Logged By:	R.M. Gibbens, P.E.	Symbols:	Bulk Sample; Drive/Grab Sample

Depth (feet)	Sample Type	Sample No.	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Additional Tests
0–1			Clayey SILT (MH) with some Sand (irrigation plastic and roots to 6") brown, soft, dry AGRICULTURALLY DISTURBED				
1			Clayey SILT (MH) with some Sand brown, hard, moist				
3	Drive/Grab	1		4.00	70	32	Gravel = 0% Sand = 17% Silt/Clay = 83% LL = 53 PI = 21
5	Drive/Grab	2	more Sand and Gravel from 5 ft.	--	--	26	Gravel = 8% Sand = 25% Silt/Clay = 66%
9	Drive/Grab	3		--	--	32	Gravel = 1% Sand = 20% Silt/Clay = 79%
10			ALLUVIUM				
			Bottom at 10.0 feet No free water observed Test pit backfilled with excavated materials				

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LOG OF TEST PIT 13

FIGURE **A14**

Date Completed:	05/22/2019	Water Depth:	Not Encountered
Drilled By:	Bermejo Excavation	Elevation:	--
Drilling Method:	Backhoe	Location:	Lot 202
Logged By:	R.M. Gibbens, P.E.	Symbols:	☒ Bulk Sample ■ Drive/Grab Sample

Depth (feet)	Sample Type	Sample No.	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Additional Tests
0–1			Clayey SILT (MH) with Sand and some Gravel (irrigation plastic and roots to 6") brown, soft, dry — AGRICULTURALLY DISTURBED				
1			Clayey SILT (MH) with Sand and some Gravel brown, hard, moist				
3	Drive/Grab	1		4.00	72	32	Gravel = 10% Sand = 35% Silt/Clay = 55%
5	Drive/Grab	2	more Gravel from 5.5 ft.	4.00	--	29	Gravel = 27% Sand = 25% Silt/Clay = 48%
10			ALLUVIUM				
			Bottom at 10.0 feet No free water observed Test pit backfilled with excavated materials				

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LOG OF TEST PIT 14

FIGURE **A15**

Date Completed:	05/22/2019	Water Depth:	Not Encountered
Drilled By:	Bermejo Excavation	Elevation:	--
Drilling Method:	Backhoe	Location:	Lot 54
Logged By:	R.M. Gibbens, P.E.	Symbols:	☒ Bulk Sample ■ Drive/Grab Sample

Depth (feet)	Sample Type	Sample No.	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Additional Tests
0–1			SAND (SM) and Clayey Silt with trace Gravel (irrigation plastic and roots to 6") brown, loose, dry AGRICULTURALLY DISTURBED				
1	Bulk (1–3)		SAND (SM) and Clayey Silt with trace Gravel brown, dense, moist				
3	Drive/Grab	1		--	86	36	Gravel = 5% Sand = 46% Silt/Clay = 49%
4			more Gravel and less Clayey Silt from 4 ft.				
5	Drive/Grab	2		--	84	28	Gravel = 24% Sand = 46% Silt/Clay = 29%
10			ALLUVIUM				

Bottom at 10.0 feet
No free water observed
Test pit backfilled with excavated materials

Hawaii Geotechnical Consulting, Inc.

PROJECT NO. 19011.01
DATE 05/26/2019

PUUNANI SUBDIVISION
WAILUKU, MAUI, HAWAII

LOG OF TEST PIT 15

FIGURE **A16**

Date Completed:	05/22/2019	Water Depth:	Not Encountered
Drilled By:	Bermejo Excavation	Elevation:	--
Drilling Method:	Backhoe	Location:	Lot 180
Logged By:	R.M. Gibbens, P.E.	Symbols:	Bulk Sample; Drive/Grab Sample

Depth (feet)	Sample Type	Sample No.	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Additional Tests
0–1			GRAVEL (GM) with Sand and some Silt (irrigation plastic and roots to 6") brown, loose, dry — AGRICULTURALLY DISTURBED				
1			GRAVEL (GM) with Sand and some Silt and trace Cobble brown, dense, moist				
3	Drive/Grab	1		--	86	24	Gravel = 56% Sand = 24% Silt/Clay = 20%
5	Drive/Grab	2	more Silt from 5 ft.	--	--	30	Gravel = 33% Sand = 22% Silt/Clay = 45%
10			ALLUVIUM				
			Bottom at 10.0 feet No free water observed Test pit backfilled with excavated materials				

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LOG OF TEST PIT 16

FIGURE **A17**

Date Completed:	05/22/2019	Water Depth:	Not Encountered
Drilled By:	Bermejo Excavation	Elevation:	--
Drilling Method:	Backhoe	Location:	Lot 49
Logged By:	R.M. Gibbens, P.E.	Symbols:	Bulk Sample; Drive/Grab Sample

Depth (feet)	Sample Type	Sample No.	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Additional Tests
0–1			Silty CLAY (CL) with Sand and trace Gravel (irrigation plastic and roots to 6") brown, soft, dry — AGRICULTURALLY DISTURBED				
1–10			Silty CLAY (CL) with Sand and trace Gravel brown, hard, moist — ALLUVIUM				
3	Drive/Grab	1		4.00	68	28	Gravel = 3% Sand = 28% Silt/Clay = 68% LL = 48 PI = 20
5	Drive/Grab	2		--	--	33	Gravel = 10% Sand = 31% Silt/Clay = 59%
10			Bottom at 10.0 feet No free water observed Test pit backfilled with excavated materials				

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PUUNANI SUBDIVISION
WAILUKU, MAUI, HAWAII

LOG OF TEST PIT 17

FIGURE

A18

Date Completed:	05/22/2019	Water Depth:	Not Encountered
Drilled By:	Bermejo Excavation	Elevation:	--
Drilling Method:	Backhoe	Location:	Lot 42
Logged By:	R.M. Gibbens, P.E.	Symbols:	Bulk Sample; Drive/Grab Sample

Depth (feet)	Sample Type	Sample No.	GEOTECHNICAL DESCRIPTION AND CLASSIFICATION	Penetrometer (tsf)	Dry Density (pcf)	Moisture Content (%)	Additional Tests
0–1			Silty CLAY (CL) with Sand and trace Gravel (irrigation plastic and roots to 6") brown, soft, dry AGRICULTURALLY DISTURBED				
1–10			Silty CLAY (CL) with Sand and trace Gravel brown, hard, moist				
3	Drive/Grab	1		4.00	71	28	Gravel = 6% Sand = 28% Silt/Clay = 66%
5	Drive/Grab	2		4.00	71	32	Gravel = 9% Sand = 25% Silt/Clay = 66%
10			ALLUVIUM				
			Bottom at 10.0 feet No free water observed Test pit backfilled with excavated materials				

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PUUNANI SUBDIVISION
WAILUKU, MAUI, HAWAII

LOG OF TEST PIT 18

FIGURE A19

APPENDIX B

Laboratory Testing

APPENDIX B
LABORATORY TESTING

Laboratory tests were performed on selected grab, bulk, and drive samples to estimate their pertinent engineering characteristics. Testing was performed in accordance with ASTM Standards for Soil Testing, latest revision.

MOISTURE CONTENT AND DRY DENSITY

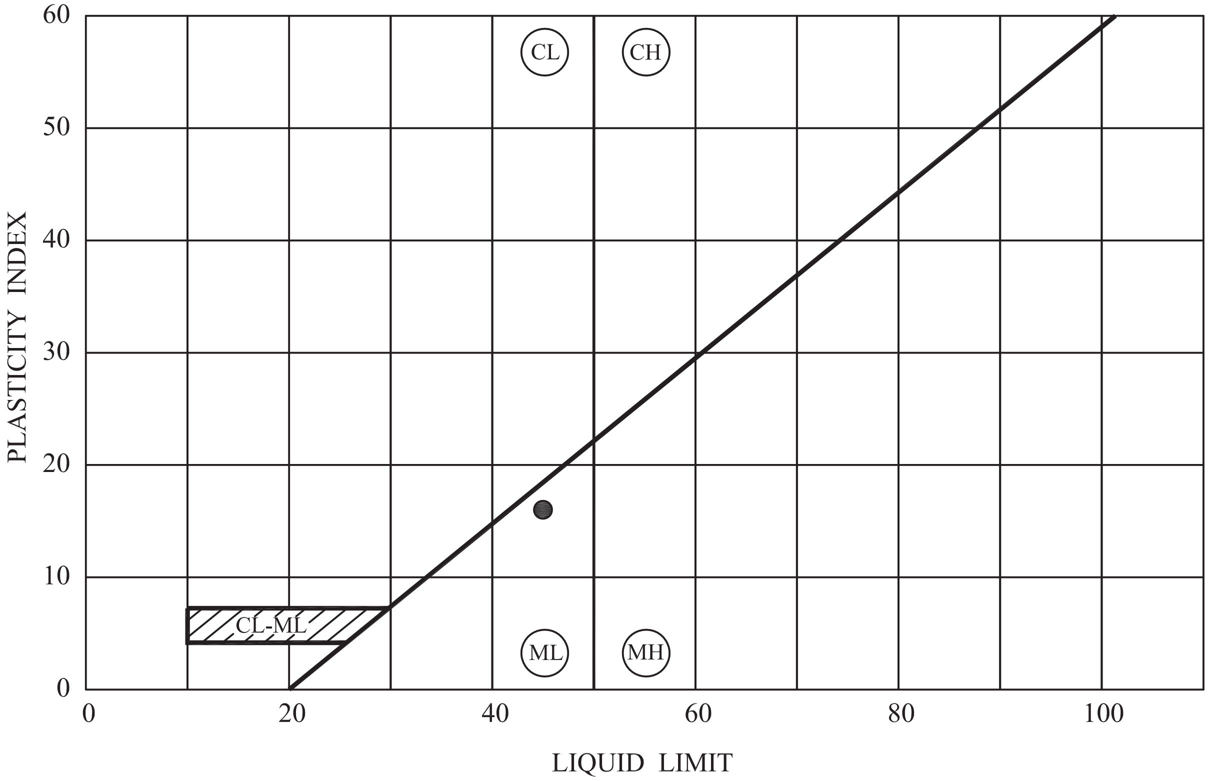
Natural moisture content and dry density tests were performed on multiple samples in accordance with ASTM D2216 and D2937, respectively. The results of these tests are presented on the Logs of Test Pits in Appendix A.

PLASTICITY

Atterberg limits tests were performed in accordance with ASTM D4318. The results of the tests are presented on the Logs of Test Pits in Appendix A and graphically in Appendix B.

GRAIN SIZE

Grain size analyses were performed on select samples in accordance with ASTM D2487. The results are presented on the Logs of Test Pits in Appendix A.



	Sample ID	Depth (ft)	LL	PL	PI	Classification
●	3-1	1.0	45	29	16	Brown Clayey SILT (ML) and Sand and trace Gravel

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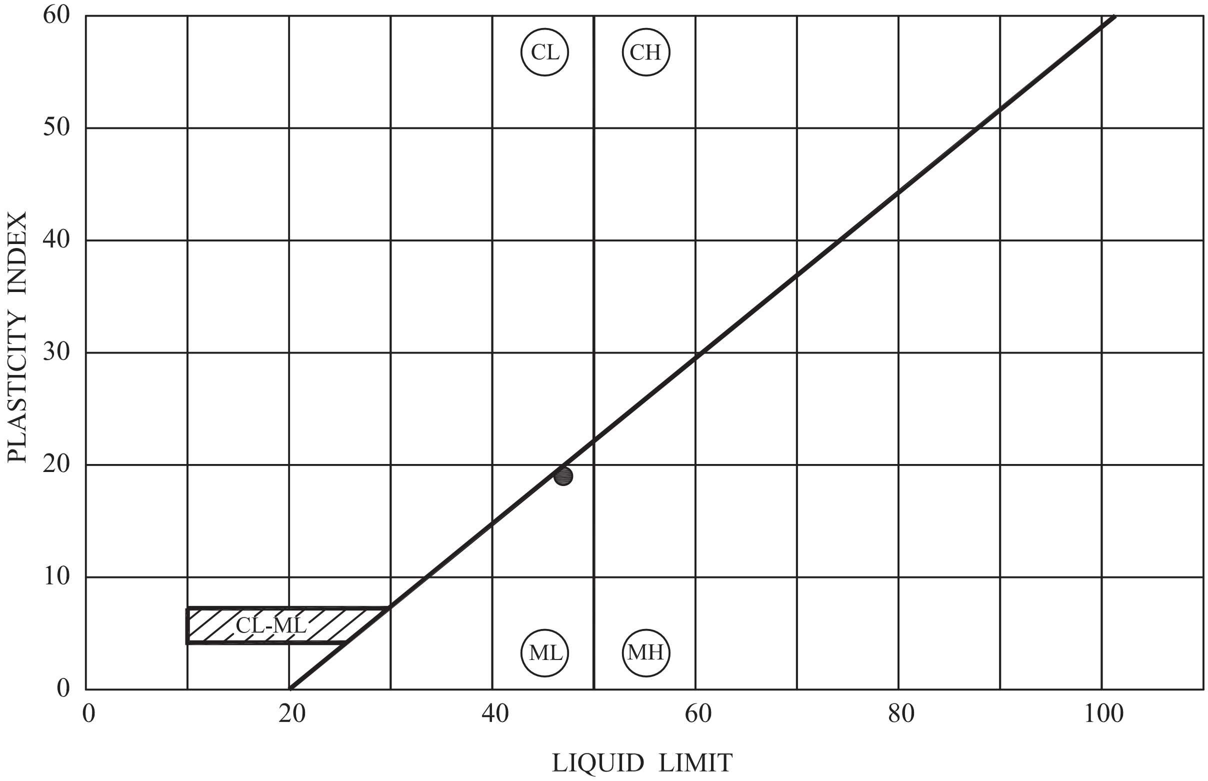
PLASTICITY INDEX

FIGURE
B1



	Sample ID	Depth (ft)	LL	PL	PI	Classification
●	5-3	3.0	47	28	19	Brown Clayey SILT (ML) and Sand with some Gravel

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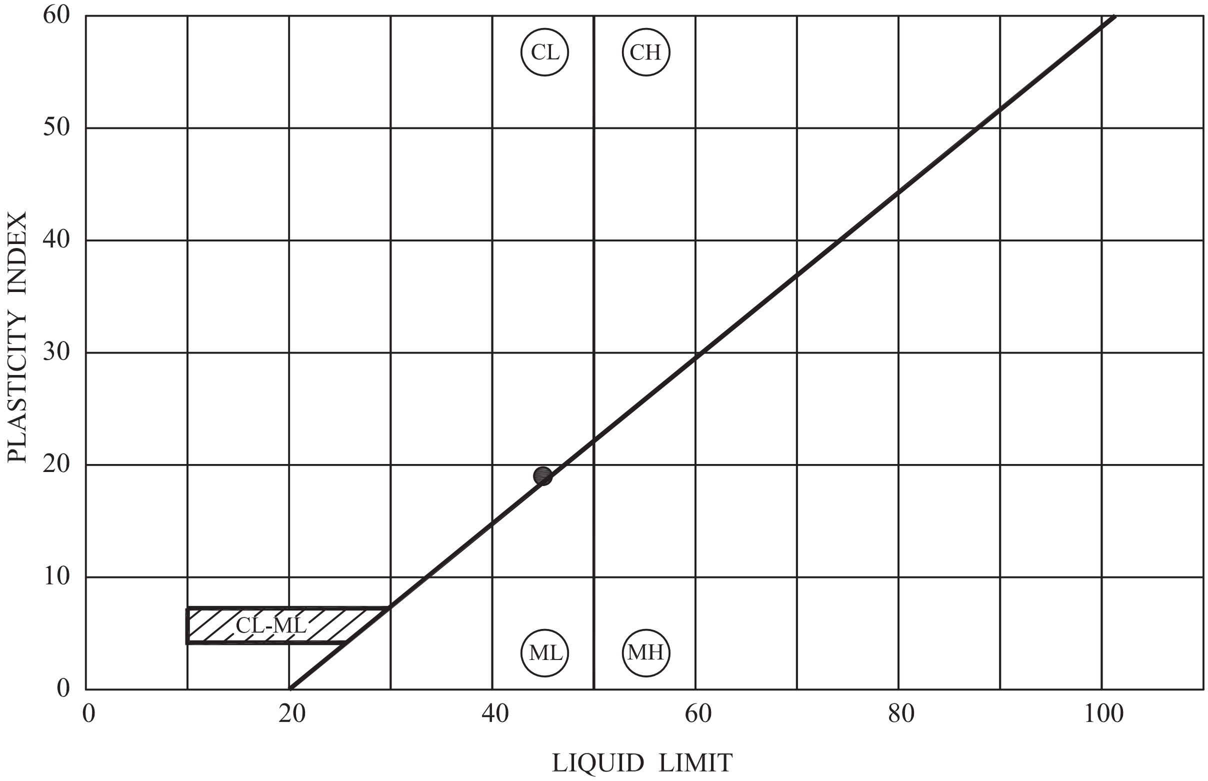
PUUNANI SUBDIVISION
WAILUKU, MAUI, HAWAII

PLASTICITY INDEX

FIGURE

B2



	Sample ID	Depth (ft)	LL	PL	PI	Classification
●	6-3	3.0	45	26	19	Brown Silty CLAY (CL) with Sand and some Gravel

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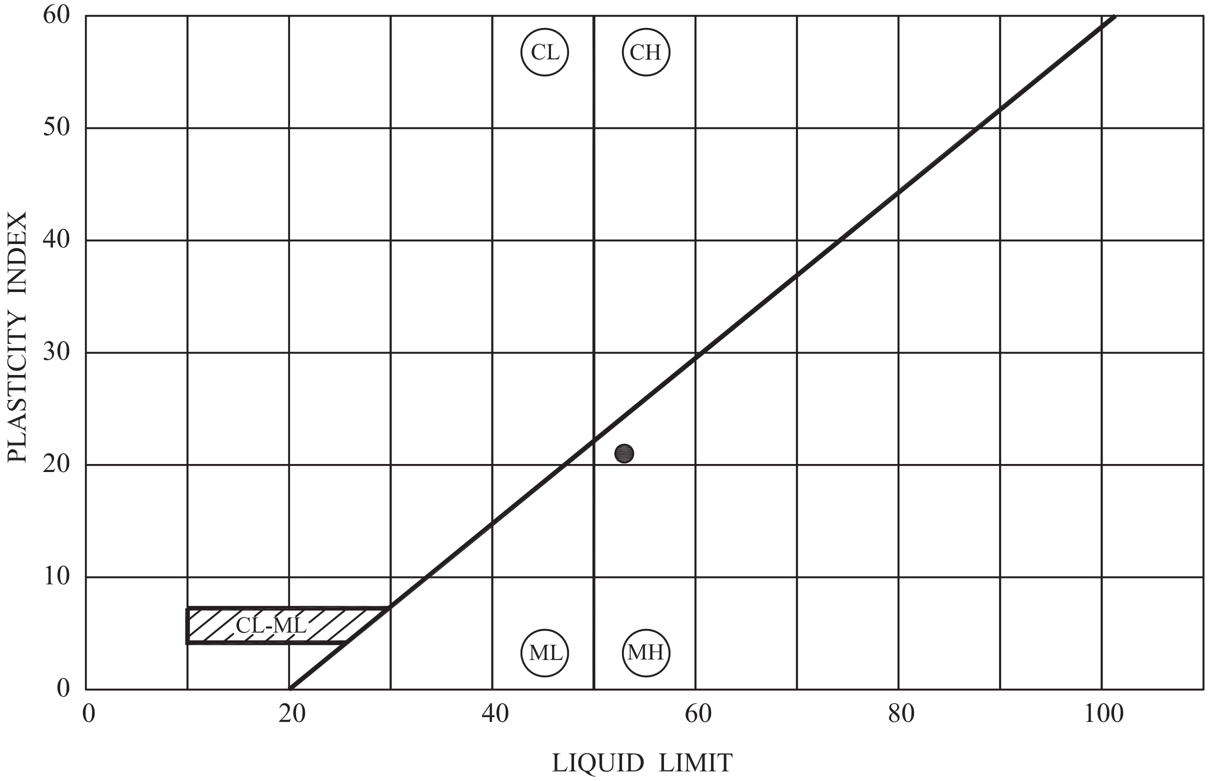
WAILUKU, MAUI, HAWAII

PLASTICITY INDEX

FIGURE

B3



	Sample ID	Depth (ft)	LL	PL	PI	Classification
●	13-3	3.0	53	32	21	Brown Clayey SILT (MH) with some Sand

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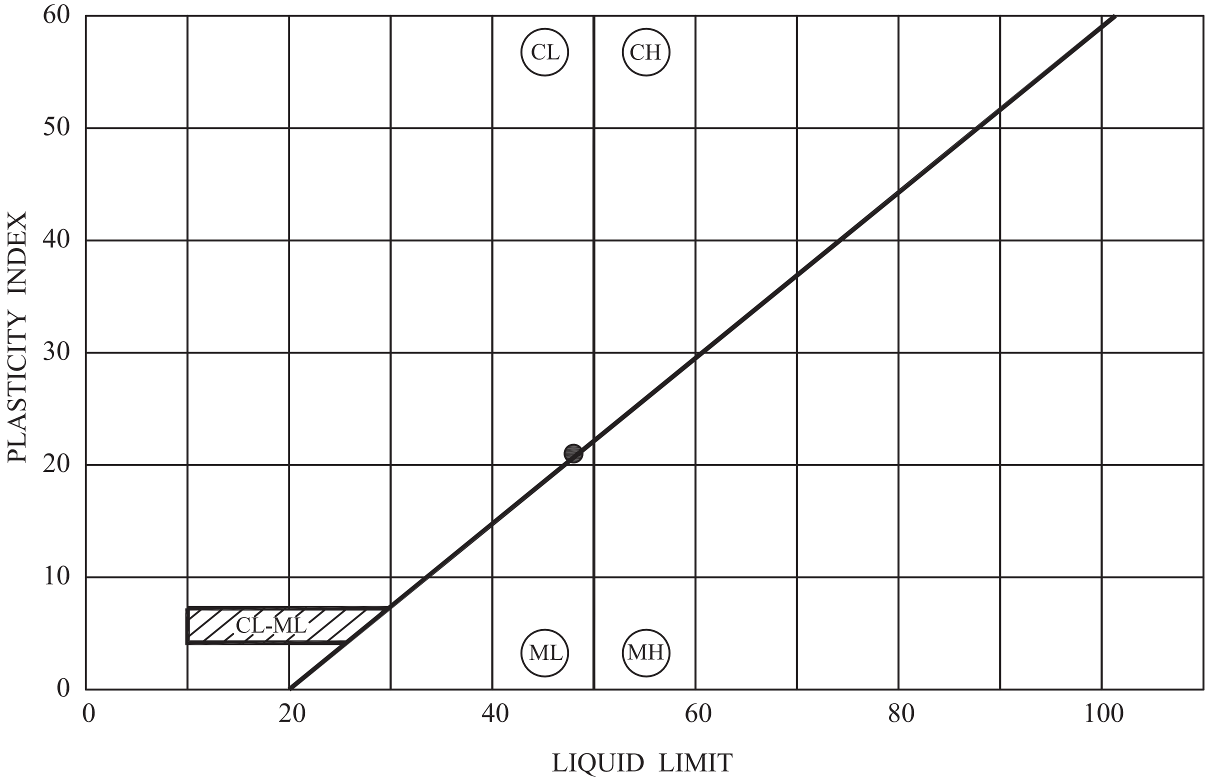
PUUNANI SUBDIVISION
WAILUKU, MAUI, HAWAII

PLASTICITY INDEX

FIGURE

B4



	Sample ID	Depth (ft)	LL	PL	PI	Classification
●	17-3	3.0	48	28	20	Brown Silty CLAY (CL) with Sand and trace Gravel

Hawaii Geotechnical Consulting, Inc.

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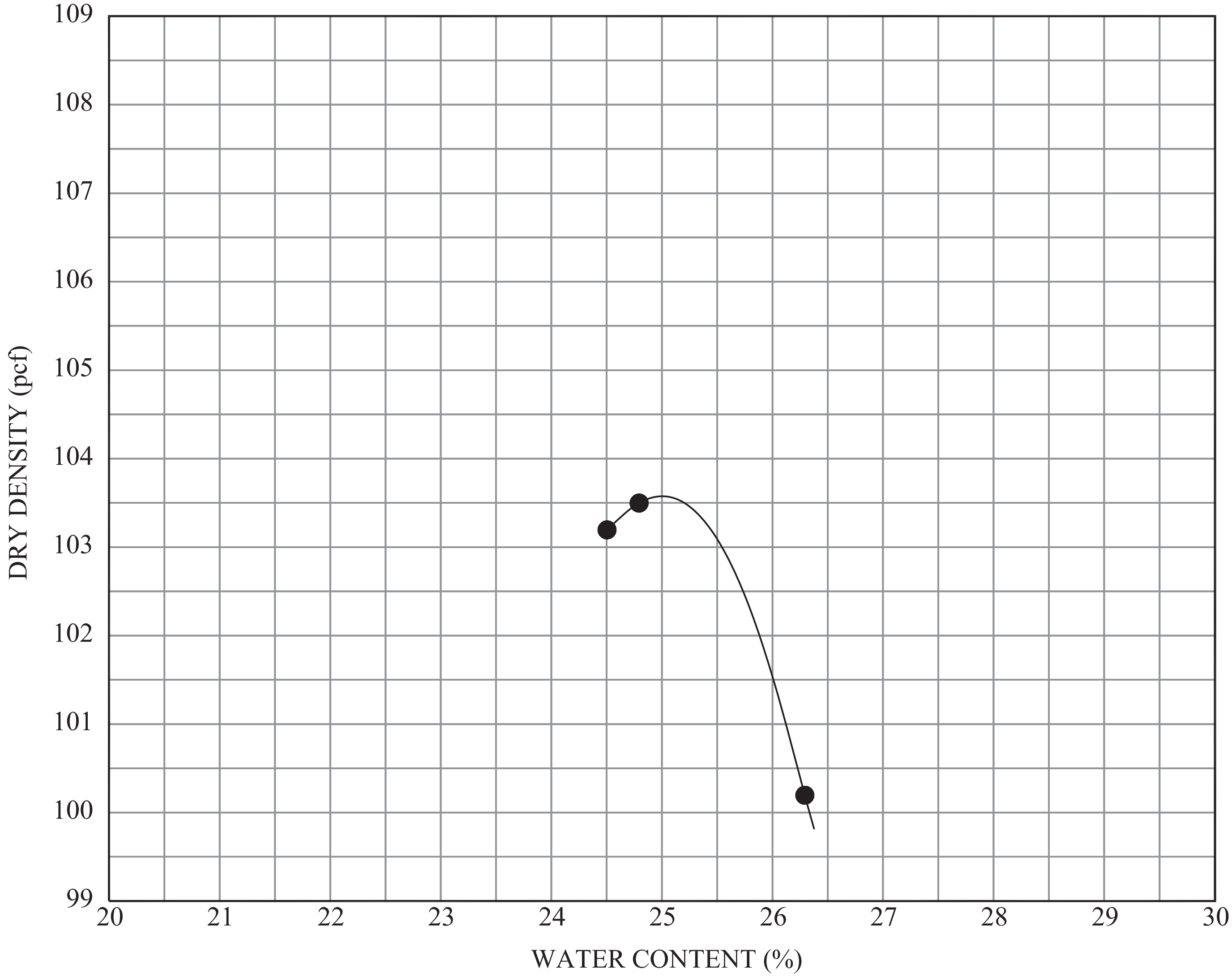
PUUNANI SUBDIVISION
WAILUKU, MAUI, HAWAII

PLASTICITY INDEX

FIGURE
B5



Sample Identification		Classification	Method	Maximum Dry Density	Optimum Moisture Content
●	A	Brown Clayey SILT (ML) and Sand ONSITE	ASTM D1557 Method A	104 pcf	25 %

ID	Percent			Atterberg Limits			In-Situ Moisture Content (%)
	Gravel	Sand	Silt/Clay	LL	PL	PI	
A	--	--	--	--	--	--	--

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PROJECT NO. 19011.01
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PUUNANI SUBDIVISION
WAILUKU, MAUI, HAWAII

COMPACTION CURVE

FIGURE

B6

APPENDIX C
Percolation Testing

APPENDIX C
PERCOLATION TESTING

A single percolation test was performed at the location of the proposed detention basin (Test Pit No. 3). The percolation test was performed at a depth of 66 inches below the existing ground surface following the State of Hawaii Department of Health – Wastewater Branch testing method.

Approximately 1 inch of clean ¾-inch gravel was placed at the bottom of a 6 inch diameter, 12 inch deep hand excavated hole. Step C of the procedure for Sandy (granular) Soils was used to perform the percolation test, as a 12 inch head of water seeped away in under 10 minutes twice. Water was added to 6 inches above the gravel and allowed to percolate. The water drop was recorded every 5 minute time interval for 1 hour. The final drop was used to calculate the percolation rate.

A senior engineer with HGC performed the percolation tests and maintained a log of the time and water drop intervals.

DEPARTMENT OF HEALTH – WASTEWATER BRANCH
INDIVIDUAL WASTEWATER SYSTEM (IWS) – SITE EVALUATION/PERCOLATION TEST
(PERCOLATION TEST NO. 1)

Date/Time: June 8, 2019 | Test Performed by: Hawaii Geotechnical Consulting, Inc.

Owner: DDC, LLC | TMK: --

Elevation:	Unknown	feet
Depth to Groundwater Table:	>25 ft.	feet below grade
Depth to Bedrock (if observed):	Unknown	feet below grade
Diameter of Hole:	6.0	Inches
Depth to Hole Bottom:	66	inches below grade

Depth, inches below grade	Soil Profile (color, texture, other)
0-36	Brown Clayey SILT (ML) and Sand with trace Gravel
36-60	Brown Silty GRAVEL (GM) and Sand
60-108	Brown Silty SAND (SM) and Gravel

PERCOLATION READINGS:

Time 12 inches of water to seep away:	5:10	minutes
Time 12 inches of water to seep away:	7:45	minutes

Check one:

X Percolation tests in sandy soils, recorded time intervals and water drops at least every 10 minutes for at least 1 hour.

____ Percolation tests in non-sandy soils, presoaked the test hole for at least 4 hours. Recorded time intervals and water drops at least every 10 minutes for 1 hour of time for the first 6 inches to seep away in greater than 30 minutes recorded time intervals and water drops at least every 30 minutes for 4 hours or until 2 successive drops do not vary by more than 1/16 inch.

Time Interval (min)	Drop in Inches	Time Interval (min)	Drop in Inches	Time Interval (min)	Drop in Inches
5	4	5	3-15/16	5	4-1/16
5	3-7/8	5	4	5	4
5	3-7/8	5	4-1/16	5	4
5	3-15/16	5	4	5	4

Percolation Rate (time/final water level drop): 1.25 minute/inch

As the engineer responsible for gathering and providing site information and percolation test results, I attest to the fact that above site information is accurate and that the site evaluation was conducted in accordance with the provisions of Chapter 11-62, “Wastewater Systems” and the results were acceptable. I also attest that three feet of suitable soil exists between the bottom of the soil absorption system and the groundwater table or any other limiting layer.

Engineer’s Signature/Stamp

ROBERT M. GIBBENS
LICENSED PROFESSIONAL ENGINEER
No. 10094-C
HAWAII, U.S.A.

June 8, 2019

License Expires 04/30/2020

Hawaii Geotechnical Consulting
- I n c o r p o r a t e d -
P.O. Box 331223 • Kahului, Hawaii 96733 • Phone (808) 205-1727

August 8, 2019
File No. 19011.01

Mr. Everett R. Dowling
DDC, LLC
2005 Main Street
Wailuku, Maui, Hawaii 96793

Subject: **ADDITIONAL SEEPAGE RECOMMENDATIONS FOR PU'UNANI SUBDIVISION WAILUKU, MAUI, HAWAII**

We understand that an embankment as tall as 10 feet will be constructed along the sites northeast corner for the storm water detention basin. Concern has been raised regarding piping and scour within the granular soils likely to be used during construction of the detention basin embankment. All the onsite granular soils are classified as silty sand or silty gravel which possess silt contents ranging from 25 to 45 percent. With the high percentage of fine-grained silt within the silty sands and silty gravels, we believe that the percolation velocity through the detention basin embankment, regardless of the onsite soils used for its construction, will be quite slow in the horizontal direction and that piping or scour will not be a problem.

We also understand that concern has been raised as to the need for seepage protection along the cut slope below the ditch along the sites eastern boundary. A review of the test pits in the area of the ditch indicate that the existing moisture contents to depths of 10 feet are not higher than those across the entire site. It does not appear that leakage from the ditch is currently affecting the current site soils and we do not anticipate that they will in the future. We do not believe that seepage protection is necessary.

If you have any questions pertaining to any aspect of the services that we provide or any item contained herein, please do not hesitate to contact us.

Respectfully,
HAWAII GEOTECHNICAL CONSULTING, INC.

Robert M. Gibbens, P.E.
Senior Geotechnical Engineer

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