Reference RFI Addendum #1 Question #18

GEOTECHNICAL ENGINEERING EXPLORATION

SMMH PHASE 1A
BEHAVIORAL HEALTH NEW PATIENT FACILITY
TMK: (4) 4-6-014: 113
KAPAA, KAUAI, HAWAII

DECEMBER 10, 2021

Prepared for:
G70

PROJECT NO. 100521-00

Kokua Geotech LLC
Soil and Foundation Engineering

December 10, 2021
Project No. 100521-00

G70
111 S. King Street, Suite 170
Honolulu, HI 96813

Attention: Ms. Katherine M. MacNeil

Subject: **Geotechnical Engineering Exploration**
SMMH Phase 1A
Behavioral Health New Patient Facility
TMK: (4) 4-6-014: 113
Kapaa, Kauai, Hawaii

Dear **Ms. MacNeil**:

We are pleased to submit this report entitled "Geotechnical Engineering Exploration, SMMH Phase 1A, Behavioral Health New Patient Facility, TMK: (4) 4-6-014: 113, Kapaa, Kauai, Hawaii" prepared for the design of the project.

The purpose of our field exploration and this report was to observe and evaluate the general subsurface conditions at accessible locations at the project site to formulate geotechnical recommendations to assist in the design of the project. Our work was performed in general accordance with the scope of services outlined in our fee proposal dated October 8, 2021.

Our findings and recommendations are summarized as follows:

1. Our field exploration generally encountered residual soils overlying saprolite extending down to the maximum depth explored of about 21.5 feet below the existing ground surface. The residual soils encountered were encountered to depths ranging from about 8 to 13 feet below the existing ground surface and generally consisted of very stiff to hard clayey silt/silty clay with some sand and gravel.

   Saprolitic soils generally consisting of medium stiff to very stiff clayey silt with varying amounts of sand and decomposed gravel were encountered underlying the residual materials and extended down to the maximum depth explored of about 21.5 feet below the existing ground surface.

2. We did not encounter groundwater in the test pits at the time of our field exploration. However, it should be noted that groundwater levels are subject to change due to rainfall, time of year, seasonal precipitation, surface water runoff, and other factors. In addition, subterranean seepage may be encountered during construction due to high rainfall in the area, sloping terrain and relict structure in the residual and saprolitic soils encountered.

3. Based on the results of our laboratory testing, the on-site clayey soils have low to moderate expansion potential when subjected to moisture fluctuations. Highly expansive clayey soils tend to swell when exposed to moisture and shrink when dried. Such soils are potentially capable of uplifting foundations and slabs, with resulting distress to the structures they support. In addition, these soils can settle significantly if saturated and/or poorly compacted.

4. In general, we believe that the primary geotechnical considerations for the project include the following:

   - Adequate foundation support of the proposed building structures
   - Expansive clayey soils beneath concrete slabs-on-grade and pavements
   - Site preparation and grading

5. Based on the subsurface conditions anticipated at the project site, a shallow foundation system consisting of spread and/or continuous footings may be used to support the planned building structure(s). To reduce the potential for changes in the moisture content of the clayey soils beneath the building foundations and to provide a firm and unyielding bearing layer, we recommend placing a minimum 12-inch thick layer of non-expansive structural fill material below the foundations.

6. An allowable bearing pressure of up to 2,500 pounds per square foot (psf) may be utilized for the design of shallow foundations bearing on the minimum 12-inch thick layer of structural fill materials. This bearing value is for supporting dead-plus-live loads and may be increased by one-third (⅓) for transient loads, such as those caused by wind or seismic forces.

7. We anticipate that concrete slabs-on-grade will be utilized for portions of the building structure and walkways at the project site. To reduce the potential for changes in the moisture content of the slab subgrade clayey soils, we recommend capping the slab subgrade with a minimum 12-inch thick layer of non-expansive structural fill material. The structural fill should be compacted to a minimum of 90 percent relative compaction.

8. The structural fill material should consist of imported, non-expansive granular material such as crushed coral or basalt. In addition, the structural fill material should be well-graded from coarse to fine with particles no larger than 3 inches in largest dimension. The material should have a CBR value of 20 or higher and a swell potential of 1 percent or less when tested in accordance with ASTM D1883. The material should also contain between 10 and 30 percent particles passing the No. 200 sieve.

9. In general, the on-site soils may be re-used as a source of general fill material, provided they are free of vegetation, deleterious materials, and rock fragments greater than 3 inches in maximum dimension.

10. The construction plans and specifications for the project should be forwarded to us for review to determine whether the recommendations contained in this report are adequately reflected in those documents. If this review is not made, Kokua Geotech LLC cannot assume responsibility for misinterpretation of our recommendations.

11. Kokua Geotech LLC should also be retained to monitor the site and subgrade preparation, fill placement, foundation construction, and other aspects of earthwork construction to determine whether the recommendations of this report are followed. The recommendations presented herein are contingent upon such observations. If the actual exposed subsurface soil conditions encountered during construction differ from those assumed or considered in this report, Kokua Geotech LLC should be contacted to review and/or revise the geotechnical recommendations presented herein.

Detailed discussion of our findings and geotechnical engineering recommendations are contained in the body of this report. We appreciate the opportunity to be of service for this project. Should you have any questions concerning this report, please contact our office.

Very truly yours,

Kokua Geotech LLC

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Xiaobin (Tim) Lin, P.E.
President

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SECTION 1.0 INTRODUCTION

We have performed a geotechnical engineering exploration for the *SMMH Phase 1A – Behavioral Health New Patient Facility* project in Kapaa on the Island of Kauai, Hawaii. The location of the project and general vicinity are shown on the Project Location Map, Plate 1.

The purpose of our exploration was to observe and evaluate the general subsurface conditions at accessible locations at the project site to formulate geotechnical recommendations to assist in the design of the project. This report summarizes the findings and presents our geotechnical recommendations resulting from our site reconnaissance, field exploration, laboratory testing, and engineering analyses for the project. The findings and recommendations presented herein are subject to the limitations noted at the end of this report.

1.1 PROJECT CONSIDERATIONS

The project generally involves a new facility at the Samuel Mahelona Memorial Hospital (SMMH) in Kapaa on the Island of Kauai, Hawaii. Based on the information provided, we understand the new facility will be located in an open area near the existing inpatient behavioral health unit and will generally provide acute psychiatric care for inpatients and provide outpatient behavioral health services. A layout of the project site is shown on the Site Plan, Plate 2.

Structural plans and details for the planned facility were not available at the time this report was prepared. However, we understand the new facility will be single level with a physical connection back to the existing hospital with possible grade changes between the new facility site and the current facility. We understand additional site improvements are planned to include a new driveway and paved parking area at the drop off zone, other paved parking areas, and a grassed area for overflow parking.

We also anticipate the installation of underground utilities such as water, drain, sewer, electrical lines, and other related site improvements will be required for the project. A grading plan was not available at the time this fee report was prepared; however, we anticipate cuts and fills on the order of about 6 feet deep/thick may be required to achieve the design grades for the project. In addition, we understand Low Impact Development (LID) improvements are being considered for the on-site management of storm water runoff at the project site.

1.2 PURPOSE AND SCOPE OF WORK

The purpose of our services was to generally explore and evaluate the subsurface soil conditions at accessible locations at the project site to provide geotechnical recommendations to assist in the design of the project. The work was performed in general accordance with our fee proposal dated October 8, 2021. The scope of work for this exploration included the following items:

1. Coordination of boring stake-out and utility clearances by our engineer.
2. Mobilization and demobilization of a truck-mounted drill rig and two operators from the Island of Oahu to the project site and back.
3. Drilling and sampling of seven boreholes extending to depths ranging from about 1.3 to 21.5 feet below the existing ground surface (five borings at 21.5 feet deep, one boring at 6 feet deep, and 1 boring at 1 foot deep). In addition, collection of bulk samples of the near-surface soils for California Bearing Ratio (CBR) analysis.
4. Performance of five field infiltration tests at selected locations to evaluate the infiltration characteristics of the subsurface materials to assist in the design of the on-site LID systems.
5. Provided a field engineer to observe and log the borings and infiltration tests, obtain samples, and performed a general reconnaissance of the project site.
6. Performed laboratory tests on selected soil samples obtained during the field exploration as an aid in classifying the materials and evaluating their engineering properties.
7. Analyses of the field and laboratory data to formulate our geotechnical recommendations for the design of the project.

8. Preparation of this report summarizing our findings and presenting geotechnical recommendations for the project.

Detailed descriptions of our field exploration methodology are presented in the following section and the Logs of Borings are presented in Appendix A. Results of the laboratory tests performed are presented in Appendix B. Results of the field infiltration tests performed are presented in Appendix C.

END OF INTRODUCTION

SECTION 2.0 SITE CHARACTERIZATION AND FINDINGS

2.1 GENERAL SITE GEOLOGY

Based on the geologic maps of the Island of Kauai (Macdonald, 1960 and Sherrod and others, 2007), the general area of the project site is underlain by Koloa Volcanics Lava Flows (QTkl). In general, rock formations of the Koloa Volcanic Series are generally characterized as thick lava flows composed of dense basalt extruded from groups of vents aligned in north-south trends at various locales. In-situ weathering of these lava flows has occurred for the last 1 to 2 million years, forming a mantle of residual and saprolitic soils overlying the top of the basalt rock formation.

In general, saprolite is composed mainly of silty material that may exhibit a relict structure (vesicles, joints, etc.) from its parent rock, while residual soil tends to be more clayey and is usually "structureless." Both residual and saprolitic soils are typical of the tropical weathering of volcanic rocks. The residual and saprolitic soils grade to basaltic rock formation with increased depth.

The surface soils underlying the project site are classified as Lihue Silty Clay (LhB) by the U.S. Soil Conservation Service in their publication "Soil Survey of Islands of Kauai, Oahu, Maui, Molokai and Lanai, State of Hawaii" (1972). This soil type is described as dark reddish brown silty clay that developed in material weathered from basic igneous rock. This soil type is described as sticky and plastic and having moderate shrink-swell potential. Agricultural development within the last 100 years and mass grading work at the SMMH have brought the area to its present form.

2.2 SITE DESCRIPTION

The project site is within an open area near the existing inpatient behavioral health unit in the Samuel Mahelona Memorial Hospital in Kapaa on the Island of Kauai, Hawaii. The existing building borders the project site on the western side, the paved access road borders the site on both northern and eastern sides, and the remaining side are open lawn area. At the time of our field exploration, the project site was generally covered by mown lawn grass.

Based on our field observations, the topography of the site appears relatively flat and gradually slope down from west to east along the main axis of the site. A topographic survey plan was not provided at the time this report was prepared; however, we anticipate existing ground surface elevations to range from about +122 to +112 feet Mean Sea Level (MSL) at the western and eastern portions of the project site, respectively.

2.3 FIELD EXPLORATION

We explored the subsurface conditions at the project site by drilling and sampling seven borings, designated as Borings Nos. 1 through 7, extending to depths ranging from about 1.3 to 21.5 feet below the existing ground surface. Boring No. 7 was terminated at about 1.3 feet below the existing ground surface by encountering concrete at that depth. Five alternative locations, each at about 5 feet apart each from Boring No. 7, were re-drilled but all terminated at about 1-foot deep by encountering concrete. At this time, the nature of the concrete in this area is not clear.

In addition, two bulk samples of near-surface soils at Boring Nos. 5 and 6 were obtained to evaluate the pavement support characteristics of the near-surface soils. The borings were drilled using a Mobile B-53 truck-mounted drill rig equipped with continuous flight augers.

Five infiltration tests, designated as I-1 through I-5, were also performed at selected locations to a depth of about 4 feet below the existing ground surface to evaluate the infiltration characteristics of the subsurface soils for the planning of the LID systems. The approximate boring and infiltration test locations are shown on the Site Plan, Plate 2.

Our engineer classified the materials encountered in the borings by visual and textural examination in the field in general accordance with ASTM D2488, Standard Practice for Description and Identification of Soils, and monitored the excavating operations on a near continuous (full-time) basis. These classifications were further reviewed visually and by testing in the laboratory. Soils were classified in general accordance with ASTM D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System). Graphic representations of the materials encountered are presented on the Logs of Borings, Plates A-1 through A-7.

Soil samples were obtained in general accordance with ASTM D1586 by driving a 2-inch OD standard penetration sampler with a 140-pound hammer falling 30 inches. In addition, relatively undisturbed soil samples were obtained in general accordance with ASTM D3550 by driving a 3-inch OD Modified California 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 "Sampling Resistance" on the Logs of Borings at the appropriate sample depths. The blow counts may need to be factored to obtain the Standard Penetration Test (SPT) blow counts.

2.4 LABORATORY TESTING

Moisture Content (ASTM D2216) and Unit Weight (ASTM D2937) determinations were performed on selected samples as an aid in the classification and evaluation of soil properties. The test results are presented on the Logs of Borings at the appropriate sample depths.

Two Atterberg Limits tests (ASTM D4318) were performed on selected soil samples to evaluate the liquid and plastic limits. The samples tested generally had moderate Plasticity Indices (PIs) of about 19 and 23 and plotted as high plasticity silts (MH) on a Standard Plasticity Chart. The test results are summarized on the Logs of Borings at the appropriate sample depths. Graphic presentation of the Atterberg Limits test results are provided on Plate B-1.

Five one-inch Ring Swell tests were performed on relatively undisturbed (natural) samples to evaluate the swelling potential of the on-site soils. Swell test results ranging from about 1.1 to 3.2 percent were observed for the natural samples, indicating the on-site soils have a low to moderate swelling potential when subjected to moisture fluctuations. The Ring Swell test results are summarized on Plate B-2.

Three laboratory unconfined compressive strength (UCS) tests (ASTM D2166) were performed on selected samples to evaluate the unconfined compressive strength of the subsurface soils. Results of our UCS tests indicate the surface soils exhibit moderate to high unconfined compressive strengths of between 1,200 pounds per square feet (psf) to 4,550 psf.

The test results are summarized Plate B-3 and on the Logs of Borings at the appropriate sample depths.

One laboratory CBR test (ASTM D1883) was performed on a bulk sample of the near-surface soils to evaluate the pavement support characteristics of the on-site soils. Results of our laboratory CBR test indicates the sample of on-site soils tested had a moderate CBR value of 16.5 with a low to moderate swell of 0.2 percent. The CBR test results are presented on Plate B-4.

2.5 SUBSURFACE CONDITIONS

Our borings generally encountered residual soils overlying saprolite extending down to the maximum depth explored of about 21.5 feet below the existing ground surface. The residual soils encountered were encountered to depths ranging from about 8 to 13 feet below the existing ground surface and generally consisted of very stiff to hard clayey silt/silty clay with some sand and gravel.

Saprolitic soils generally consisting of medium stiff to very stiff clayey silt with varying amounts of sand and decomposed gravel were encountered underlying the residual materials and extended down to the maximum depth explored of about 21.5 feet below the existing ground surface.

We did not encounter groundwater in the six borings at the time of our field exploration. However, it should be noted that groundwater levels are subject to change due to rainfall, time of year, seasonal precipitation, surface water runoff, and other factors.

2.6 SEISMIC DESIGN CONSIDERATIONS

Based on the International Building Code, 2012 Edition (IBC 2012) and American Society of Civil Engineers Standard ASCE/SEI 7-10 (ASCE 7-10), the project site may be subject to seismic activity, and seismic design considerations will need to be addressed. Based on the subsurface materials encountered at the project site and the geologic setting of the area, we anticipate the project site may be classified from a seismic analysis standpoint as being a “Stiff Soil Profile” site corresponding to a Site Class D soil profile type based on Chapter 20 of ASCE 7-10.

Based on Site Class D, the following seismic design parameters were estimated and may be used for seismic analysis of the project.

SUMMARY OF SEISMIC DESIGN PARAMETERS	
Mapped MCE Spectral Response Acceleration, S_S	0.223g
Mapped MCE Spectral Response Acceleration, S_1	0.063g
Site Class	D
Site Coefficient, F_a	1.600
Site Coefficient, F_v	2.400
Design Spectral Response Acceleration, S_{DS}	0.238g
Design Spectral Response Acceleration, S_{D1}	0.101g
Peak Ground Acceleration, PGA	0.102g
Site Modified Peak Ground Acceleration, PGA_M	0.163g

Based on the subsurface conditions encountered, the phenomenon of soil liquefaction is not a design consideration for this project site.

END OF SITE CHARACTERIZATION AND FINDINGS

SECTION 3.0 DISCUSSION AND RECOMMENDATIONS

Based on the results from our field exploration, the project site is generally underlain by residual soils overlying saprolite extending down to the maximum depth explored of about 21.5 feet below the existing ground surface. The residual soils encountered were encountered to depths ranging from about 8 to 13 feet below the existing ground surface and generally consisted of very stiff to hard clayey silt/silty clay with some sand and gravel.

Saprolitic soils generally consisting of medium stiff to very stiff clayey silt with varying amounts of sand and decomposed gravel were encountered underlying the residual materials and extended down to the maximum depth explored of about 21.5 feet below the existing ground surface.

We did not encounter groundwater in the six borings at the time of our field exploration. However, it should be noted that groundwater levels are subject to change due to rainfall, time of year, seasonal precipitation, surface water runoff, and other factors. In addition, subterranean seepage may be encountered during construction due to high rainfall in the area, sloping terrain and relict structure in the residual soils and basalt rock formation encountered.

Based on the results of our laboratory testing, the on-site clayey soils have low to moderate expansion potential when subjected to moisture fluctuations. Highly expansive clayey soils tend to swell when exposed to moisture and shrink when dried. Such soils are potentially capable of uplifting foundations and slabs, with resulting distress to the structures they support. In addition, these soils can settle significantly if saturated and/or poorly compacted. The actual extent or timing of expansive soil uplift and shrinkage is not entirely predictable, but usually occurs after extreme dry or wet weather periods.

In general, we believe that the primary geotechnical considerations for the project include the following:

- Adequate foundation support of the proposed building structures
- Expansive clayey soils beneath concrete slabs-on-grade and pavements
- Site preparation and grading

Based on the subsurface conditions anticipated at the project site, a shallow foundation system consisting of spread and/or continuous footings may be used to support the planned building structure(s). To reduce the potential for changes in the moisture content of the clayey soils beneath the building foundations and to provide a firm and unyielding bearing layer, we recommend placing a minimum 12-inch thick layer of non-expansive structural fill material below the foundations. The layer of structural fill would also provide uniform bearing conditions for the foundations and serve as a protective layer and/or working platform since the site is in a relatively high rainfall environment.

We anticipate that concrete slabs-on-grade will be utilized for portions of the building structure and walkways at the project site. As discussed above, our laboratory test results indicate the on-site clayey soils have low to moderate expansion potential when subjected to moisture fluctuations. To reduce the potential for changes in the moisture content of the slab subgrade clayey soils, we recommend capping the slab subgrade with a minimum 12-inch thick layer of non-expansive structural fill material. The structural fill should be compacted to a minimum of 90 percent relative compaction.

Structural fill should be imported, non-expansive granular material, such as crushed coral or basalt. The structural fill should be well-graded from coarse to fine with particles no larger than 3 inches in largest dimension. The material should have a CBR value of 20 or higher and a swell potential of 1 percent or less when tested in accordance with ASTM D1883. The material should also contain between 10 and 30 percent particles passing the No. 200 sieve.

In general, the on-site soils may be re-used as a source of general fill material, provided they are free of vegetation, deleterious materials, and rock fragments greater than 3 inches in maximum dimension. However, our laboratory test results indicate the on-site clayey soils have a low to moderate expansion potential when subjected to moisture fluctuations. Therefore, we do not recommend using the on-site clayey soils beneath concrete slabs-on-grade, unless capped with a minimum 12-inch thick layer of non-expansive structural fill material, or for backfill behind retaining structures.

Detailed discussion of these items and our geotechnical recommendations for design of building foundations, slabs-on-grade, retaining structures, site grading, and other geotechnical aspects of the project are further discussed in the following sections.

3.1 BUILDING FOUNDATIONS

Based on the subsurface conditions anticipated at the project site, a shallow foundation system consisting of spread and/or continuous footings may be used to support the proposed building structure(s). To reduce the potential for changes in the moisture content of the clayey soils beneath the building foundations and to provide a firm and unyielding bearing layer, we recommend placing a minimum 12-inch thick layer of non-expansive structural fill material below the foundations. The layer of structural fill would also provide uniform bearing conditions for the foundations and serve as a protective layer and/or working platform since the site is located in a high rainfall environment.

An allowable bearing pressure of up to 2,500 pounds per square foot (psf) may be utilized for the design of shallow foundations bearing on the minimum 12-inch thick layer of structural fill materials. This bearing value is for supporting dead-plus-live loads and may be increased by one-third (⅓) for transient loads, such as those caused by wind or seismic forces.

The over-excavated footing subgrades (beneath the minimum 12-inch thick layer of structural fill material) should be recompacted to a firm surface prior to the placement of the structural fill material. Soft and/or loose materials encountered at the bottom of footing excavations should be over-excavated to expose the underlying firm materials. The over-excavation should be backfilled with structural fill material compacted to a minimum of 90 percent relative compaction.

In general, the bottom of footings should be embedded a minimum of 24 inches below the lowest adjacent finished grades. Footings constructed near tops of slopes or on sloping ground should be embedded deep enough to provide a minimum horizontal set-back distance of 6 feet measured from the outside edge of the footings to the slope face. Loose fill material or topsoil on the slope face should not be included when determining the extent of lateral cover.

Footings located adjacent to planned (or existing) retaining walls or structures should be embedded deep enough to avoid surcharging the retaining wall or existing structure foundations. Foundations next to utility trenches should be embedded below a one horizontal to one vertical (1H:1V) imaginary plane extending upward from the bottom edge of the utility trench, or the foundation should be extended 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.

If foundations are designed and constructed in strict accordance with the recommendations presented herein, we estimate 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 structures may be resisted by friction between the base of the foundation and the bearing materials and by passive earth pressure developed against the near-vertical faces of the embedded portion of foundations. A coefficient of friction of 0.4 may be used for footings bearing directly on the 12-inch thick layer of structural fill material. Resistance due to passive earth pressure may be estimated using an equivalent fluid pressure of 300 pounds per square foot per foot of depth (pcf) assuming that the soils around the footings are well compacted. Unless covered by pavements or slabs, the passive pressure resistance in the upper 12 inches below the finished grade should be neglected.

A Kokua Geotech LLC representative should observe footing excavations prior to placement of the reinforcing steel and concrete to confirm the foundation bearing conditions and the required embedment depths.

3.2 SLABS-ON-GRADE

We anticipate concrete slabs-on-grade may be utilized for portions of the building structure and walkways at the project site. Our laboratory test results indicate the on-site clayey soils have low to moderate expansion potential when subjected to moisture fluctuations.

To reduce the potential for changes in the moisture content of the slab subgrade clayey soils, we recommend capping the slab subgrades with a minimum 12-inch thick layer of structural fill. The structural fill should consist of imported non-expansive granular material such as crushed coral or basalt. In addition, the structural fill material should be well-graded from coarse to fine with particles no larger than 3 inches in largest dimension. The material should have a CBR value of 20 or higher and a swell potential of 1 percent or less when tested in accordance with ASTM D1883. The material should also contain between 10 and 30 percent particles passing the No. 200 sieve.

Prior to placing the non-expansive structural fill material, we recommend scarifying the subgrade soils to a depth of about 10 inches, moisture-conditioning the soils to at least 2 percent above the optimum moisture content, and compacting to a minimum of 90 percent relative compaction. The underlying subgrade soils and structural fill should be wetted and kept moist until the final placement of slab concrete. Saturation and subsequent yielding of the exposed subgrade due to inclement weather and poor drainage may require over-excavation of the soft areas and replacement with well-compacted structural fill material.

For interior building slabs (not subjected to vehicular traffic or machinery vibration), we recommend placing a minimum 4-inch thick layer of cushion fill consisting of open-graded gravel (ASTM C33, No. 67 gradation) below the slabs and above the non-expansive structural fill layer. The open-graded gravel cushion fill would provide uniform support of the slabs and would serve as a capillary moisture break. To reduce the potential for future moisture infiltration through the slab and subsequent damage to floor coverings, an impervious moisture barrier is recommended on top of the gravel cushion fill layer.

Where the slabs will be subjected to equipment vibration and/or vehicular traffic, we recommend placing the floor slab over 6 inches of aggregate subbase material in lieu of the minimum 4-inch thick layer of open-graded gravel cushion fill. The aggregate subbase should be compacted to a minimum of 95 percent relative compaction and meet the material requirements as specified in the Standard Specifications for Public Works Construction, County of Kauai, September 1986.

Where slabs are intended to function as rigid pavements, a minimum slab thickness of 6 inches may be used for preliminary design purposes. Provisions should be made for proper load transfer across the slab joints that will be subject to vehicular traffic.

Control joints should be provided along planned walkways at intervals equal to the width of the walkway with expansion joints at right-angle intersections. The bottom of thickened edges of slabs adjacent to unpaved areas should be embedded at least 12 inches below the lowest adjacent grade. It should be emphasized that the areas adjacent to the slab edges should be backfilled tightly against the edges of the slabs with relatively impervious soils. These areas should also be graded to divert water away from the slabs and to reduce the potential for water ponding around the slabs.

3.3 RETAINING STRUCTURES

We anticipate retaining walls up to about 6 feet high may be used for grade separation at the project site. In general, we believe 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 grades.

For sloping ground conditions, the footings 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. Loose fill material or topsoil on the slope face should not be included when determining the extent of lateral cover. Wall footings oriented parallel to the direction of the slope should be constructed in stepped footings.

Retaining structures should be designed to resist lateral earth pressures due to the adjacent soils and surcharge effects caused by loads adjacent to the walls. The recommended lateral earth pressures for the design of the retaining structures, 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	40	60
	Vertical	None	None
Maximum 3H:1V Sloping Backfill	Horizontal	45	64
	Vertical	15	22

The values provided in the table above assume that structural fill materials will be used to backfill behind the retaining structures. It is assumed that the backfill behind the retaining structures will be compacted to between 90 and 95 percent relative compaction per ASTM D1557. Over-compaction of the retaining structure backfill materials should be avoided.

In general, an active condition may be used only for gravity walls or walls that are free to deflect by as much as 0.5 percent of the structure height. If the tops of structures are not free to deflect beyond this degree, the structures should be designed for the at-rest condition. These lateral earth pressures do not include hydrostatic pressures that might be caused by groundwater trapped behind the structures.

Surcharge stresses due to areal surcharges, 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 structure, a rectangular distribution with a uniform pressure equal to 33 percent of the vertical surcharge pressure acting over the entire height of the wall, which is free to deflect (cantilever), may be used in the design.

For walls that are restrained, a rectangular distribution equal to 50 percent of the vertical surcharge pressure acting over the entire height of the structure may be used for design. Additional analyses during design may be needed to evaluate the surcharge effects of point loads and line loads.

The retaining walls should be well-drained to reduce the potential for build-up of hydrostatic pressures. A typical drainage system would consist of a 12-inch wide zone of permeable material, such as No. 3 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 weep holes. As an alternative, a prefabricated drainage product, such as MiraDrain, may be used instead of the drainage material. The prefabricated drainage product also should be hydraulically connected to a perforated pipe at the base of the wall.

The backfill from the bottom of the wall to the bottom of the perforated pipe or weep hole 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 structure 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.

3.4 SITE GRADING

A grading plan was not available at the time this report was prepared. We envision site grading for the project to generally consist of cuts and fills on the order of about 6 feet deep/thick and grading related to the foundation construction, infrastructure installation, and retaining structures. Site grading items that are addressed in the subsequent subsections include the following:

1. Site and Subgrade Preparation
2. Excavations
3. Fill Materials
4. Fill Compaction Requirements

A Kokua Geotech LLC representative should monitor site grading operations to observe whether undesirable materials are encountered during the excavation and scarification process, and to confirm whether the exposed soil conditions are similar to those assumed in this report.

3.4.1 SITE AND SUBGRADE PREPARATION

At the on-set of earthwork, the area within the contract grading limits should be cleared and grubbed thoroughly. Surface vegetation, debris, deleterious materials, existing stockpiled soils, and other unsuitable materials should be removed and disposed of properly off-site. After clearing and grubbing, areas to receive fills and finished subgrades in cut areas should be scarified to a depth of 10 inches, moisture-conditioned to above the optimum moisture content, and compacted to a minimum of 90 percent relative compaction.

Soft and yielding areas encountered during clearing should be over-excavated to expose firm material, and the resulting excavation should be backfilled with well-compacted general fill. The excavated soft soils should be properly disposed of off-site and/or used in landscape areas, where appropriate. A Kokua Geotech LLC field representative should evaluate the need for over-excavation due to soft subgrade soil conditions.

Saturation and subsequent yielding of the exposed subgrade due to inclement weather and poor drainage may require over-excavating the soft areas and replacing these areas with well-compacted general fill. A Kokua Geotech LLC field representative should evaluate the need for over-excavation due to soft subgrade soil conditions.

3.4.2 EXCAVATIONS

All excavations should be made in accordance with applicable Occupational Safety and Health Administration (OSHA) and state regulations. The contractor should determine the method and equipment to be used for the excavations, subject to practical limits and safety considerations. In addition, the excavations should comply with the applicable federal, state, and local safety requirements. The contractor should be responsible for trench shoring design and installation.

Based on the information provided, we envision excavations for the project will generally consist of excavations for foundation construction and infrastructure installation. Based on our borings and field observations, these excavations will likely encounter clayey residual soils overlying saprolite. In addition, boulders and/or cobble clusters may be encountered in the planned excavations.

It is anticipated that most of the material may be excavated with normal heavy excavation equipment. However, excavations encountering cobbles and boulders may require the use of hoe rams. Contractors should be encouraged to examine the site conditions and the subsurface data to make their own reasonable and prudent interpretation.

3.4.3 FILL MATERIALS

In general, the on-site soils may be re-used as a source of general fill material, provided they are free of vegetation, deleterious materials, and rock fragments greater than 3 inches in maximum dimension.

Imported materials to be used as structural fill should be non-expansive granular material, such as crushed coral or basalt. The structural fill should be well-graded from coarse to fine with particles no larger than 3 inches in largest dimension. The material should have a CBR value of 20 or higher and a swell potential of 1 percent or less when tested in accordance with ASTM D1883. The material should also contain between 10 and 30 percent particles passing the No. 200 sieve.

Aggregate base and subbase course materials should meet the material requirements as specified in the Standard Specifications for Public Works Construction, County of Kauai, September 1986.

3.4.4 FILL COMPACTION REQUIREMENTS

General fill materials should be moisture-conditioned to at least 2 percent above the optimum moisture content, placed in level lifts not exceeding 8 inches in loose thickness, and compacted to a minimum of 90 percent relative compaction. The non-expansive structural fill materials should be placed in level lifts of about 8 inches in loose thickness, moisture-conditioned to above the optimum moisture, and compacted to at least 90 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 test procedures. Optimum moisture is the water content (percentage by dry weight) corresponding to the maximum dry density.

Site grading operations should be observed by a representative from Kokua Geotech LLC. It is important that a representative from our office observe the site grading operations to evaluate whether undesirable materials are encountered during the scarification process and whether the exposed soil conditions are similar to those encountered in our field exploration.

3.5 PAVEMENT DESIGN

We anticipate both asphaltic concrete (flexible) and Portland cement concrete (rigid) pavements will be considered to serve the new development. In general, we anticipate vehicle loading for the project will consist primarily of passenger vehicles and light trucks with some heavy trucks. We have made our preliminary pavement design assuming the pavement subgrade soil will consist of the clayey surface fill materials encountered during our field exploration.

Based on the above assumptions, we recommend using the following pavement design sections for preliminary design purposes:

Flexible Pavements for Parking Areas
2.0-Inch Asphaltic Concrete
6.0-Inch Aggregate Base Course (95 Percent Relative Compaction)
6.0-Inch Aggregate Subbase Course (95 Percent Relative Compaction)
14.0-Inch Total Pavement Thickness on Moist Compacted Subgrade

Flexible Pavements for Access Driveways and Loading Zones
3.0-Inch Asphaltic Concrete
6.0-Inch Aggregate Base Course (95 Percent Relative Compaction)
6.0-Inch Aggregate Subbase Course (95 Percent Relative Compaction)
15.0-Inch Total Pavement Thickness on Moist Compacted Subgrade

Rigid Pavements
6.0-Inch Portland Cement Concrete
12.0-Inch Aggregate Subbase Course (95 Percent Relative Compaction)
18.0-Inch Total Pavement Thickness on Moist Compacted Subgrade

The pavement subgrade soils should be scarified to a minimum depth of about 10 inches, moisture-conditioned to above the optimum moisture content, and compacted to not less than 95 percent relative compaction. The subgrade soils should be thoroughly moistened and kept moist until covered by the pavement structural section.

Aggregate base and subbase course materials should be compacted to at least 95 percent relative compaction and meet the material requirements as specified in the Standard Specifications for Public Works Construction, City & County of Kauai, September 1986. CBR and field density tests should be performed on the actual materials used during construction to confirm the adequacy of the above section. The recommended section also assumes that adequate drainage will be provided for the paved areas.

Paved areas should be sloped, and drainage gradients should be maintained to carry the surface water off the site. Surface water ponding should not be allowed on the site during or after construction. Where concrete curbs are used to isolate landscaping in or adjacent to the pavement areas, we recommend that the curbs be extended a minimum of 2 inches into the soils below the subgrade to reduce the potential for appreciable landscape water migration into the pavement section.

3.6 UTILITY TRENCHES

We anticipate that underground utilities such as sewer, drain, water, and electrical lines may be required for the project. As discussed above, all excavations should be made in accordance with applicable Occupational Safety and Health Administration (OSHA) and state regulations. The contractor should determine the method and equipment to be used for utility trench excavation, subject to practical limits and safety considerations. In addition, the trench excavations should comply with the applicable federal, state, and local safety requirements. The contractor should be responsible for trench shoring design and installation.

In general, we recommend providing granular bedding consisting of 6 inches of open-graded gravel, such as No. 3 Fine gravel (ASTM C33, No. 67 gradation), under the pipes for uniform support. In addition, 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 to provide adequate support around the pipes. It is critical to use a free-draining material, such as open-graded gravel, to reduce the potential for formation of voids below the haunches of pipes and to provide adequate support for the sides of the pipes. Improper trench backfill could result in backfill settlement and pipe damage.

Trench backfill material above the open-graded gravel may consist of general fill materials (on-site soils with rock fragments less than 3 inches in largest dimension). The backfill should be placed in maximum 8-inch level loose lifts and mechanically compacted to no less than 90 percent relative compaction to reduce the potential for appreciable future ground subsidence. The upper 2 feet below the finished grade in areas subjected to vehicular traffic should be compacted to a minimum of 95 percent relative compaction.

3.7 FIELD INFILTRATION TESTING

We understand that the project will include a system, or systems, for Low Impact Development (LID) improvements for the on-site management of stormwater runoff. In order to obtain subsurface infiltration information in support of the planning of the LID systems, we conducted falling head infiltration tests, designated as Infiltration Test Nos. I-1 through I-5, at selected locations at the project site. The approximate field infiltration test locations are shown on the Site Plan, Plate 2.

The field infiltration tests were performed generally in accordance with the procedures in Appendix D of the State of Maryland Department of the Environment "Stormwater Design Manual, Volumes I and II" (rev. 2009). These procedures are consistent with other state's procedures and may generally be considered an industry standard.

The field infiltration tests were performed by augering a borehole to the selected testing depth of about 4 feet below the existing ground surface. Upon reaching the testing depth, a 4-inch diameter PVC solid casing was set to the bottom of the drilled hole to allow infiltration only through the soil exposed at the bottom of the borehole. Falling head infiltration tests were performed to determine the average infiltration rates of the underlying subsurface materials. Each test consisted of four trials of filling the casing with 24 inches of water and taking periodic readings over a 1-hour trial period. The infiltration rates are then calculated based on the results of the fourth and last trial for each test location.

The calculated infiltration rate at the test location is summarized in the following table and in Appendix C.

FIELD INFILTRATION TEST RESULTS		
Test Location	Test Depth (feet)	Average Measured Infiltration Rate (inches/hour)
I-1	4.0	7.1
I-2	4.0	12.5
I-3	4.0	4.4

FIELD INFILTRATION TEST RESULTS		
Test Location	**Test Depth** (feet)	**Average Measured Infiltration Rate** (inches/hour)
I-4	4.0	3.1
I-5	4.0	2.5

In general, the results of the field infiltration tests performed are considered favorable to the use of infiltration systems for the management of stormwater runoff. It should be noted that the infiltration tests were conducted through a 4-inch diameter borehole, which may not represent the actual percolation condition within the entire infiltration system footprint. Therefore, it is necessary to require the contractor to verify the actual infiltration rate during construction. A Kokua Geotech LLC representative should observe the excavation for the infiltration systems to confirm the anticipated infiltration substrata conditions.

3.8 SITE DRAINAGE CONSIDERATIONS

The drainage condition around the building structure(s) is critical to maintaining proper foundation performance because ponded water could cause subsurface soil saturation and subsequent heaving or loss of strength. Finished grades outside the new structure(s) should be sloped to shed water away from the slab and foundations and to reduce the potential for ponding around the structures. In addition, it is advised to install roof gutter systems around the building and to divert the discharge away from the slab and foundation areas.

Drainage systems and finished grades for the project site should be designed by a Licensed Civil Engineer so that surface runoff is directed away from the building and other related structures. Drainage swales should be provided as soon as possible and should be maintained to drain surface water runoff away from the slab and foundations. The foundation excavations should be properly backfilled against the walls or slab edges immediately after setting of the concrete to reduce the potential for excessive water infiltration into the subsurface.

3.9 DESIGN REVIEW AND CONSTRUCTION OBSERVATION SERVICES

The construction plans and specifications for the project should be forwarded to us for review to determine whether the recommendations contained in this report are adequately reflected in those documents. If this review is not made, Kokua Geotech LLC cannot assume responsibility for misinterpretation of our recommendations.

Kokua Geotech LLC should also be retained to monitor the site and subgrade preparation, fill placement, foundation and roadway construction, and other aspects of earthwork construction to determine whether the recommendations of this report are followed. The recommendations presented herein are contingent upon such observations. If the actual exposed subsurface soil conditions encountered during construction differ from those assumed or considered in this report, Kokua Geotech LLC should be contacted to review and/or revise the geotechnical recommendations presented herein.

END OF DISCUSSION AND RECOMMENDATIONS

SECTION 4.0 LIMITATIONS

This report has been prepared for the exclusive use of G70 and their project consultants for specific application to the design of the *SMMH Phase 1A – Behavioral Health New Patient Facility* project in accordance with generally accepted geotechnical engineering principles and practices. No warranty is expressed or implied. If any part of the project concept is altered or if subsurface conditions differ from those described in this report, then the information presented herein shall be considered invalid, unless the changes are reviewed, and any supplemental or revised recommendations issued in writing by Kokua Geotech LLC.

The analyses and report recommendations are based in part upon information obtained from the field borings and the assumption that subsurface conditions do not vary significantly from those observed in the borings. Variations of the subsurface 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, Kokua Geotech LLC should be notified so that we can re-evaluate the recommendations presented herein.

The owner/client should be aware that unanticipated soil conditions are commonly encountered. Unforeseen subsurface 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 field boring locations indicated herein are approximate, having been estimated by using a handheld Global Positioning System (GPS) to field locate selected locations shown on the Site Plan. A Topographic Survey Plan was not available at the time of this report. The elevations of the field borings were estimated using Google Earth imagery. The field boring locations and elevations should be considered accurate only to the degree implied by the methods used.

The stratification breaks shown on the graphic representations of the borings depict the approximate boundaries between soil types and, as such, may denote a gradual transition. We did not encounter groundwater in the borings at the time of our field exploration. However, it should be noted that groundwater levels are subject to change due to rainfall, time of year, seasonal precipitation, surface water runoff, and other factors. In addition, subterranean seepage may be encountered during construction due to high rainfall in the area, sloping terrain and relict structure in the residual soils and basalt rock formation encountered.

This report has been prepared solely for the purpose of assisting the architect and design engineers in the design of the project. Therefore, this report may not contain sufficient data, or the proper information, to serve as a basis for detailed construction cost estimates.

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

END OF LIMITATIONS

CLOSURE

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

This report concludes our scope of work outlined in our fee proposal dated October 8, 2021. If you have any questions regarding this report or if any part of the report is not clear, please contact our office.

Respectfully submitted,

Kokua Geotech LLC

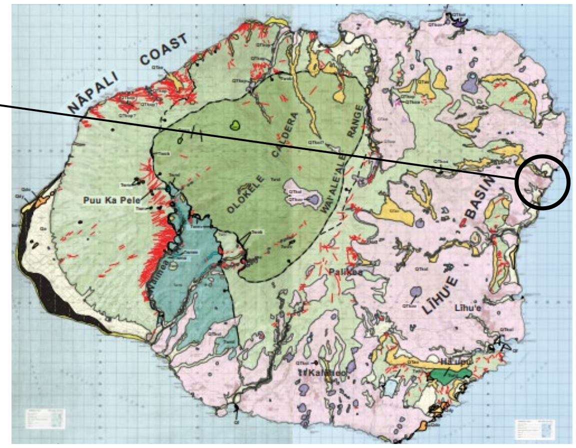
Xiaobin (Tim) Lin, P.E.
President

XIAOBIN (TIM) LIN
LICENSED PROFESSIONAL ENGINEER
No. 13982-C
HAWAII, U.S.A.

THIS WORK WAS PREPARED BY
ME OR UNDER MY SUPERVISION.
(MY LICENSE EXPIRES 4/30/2022)

PLATES

GENERAL PROJECT LOCATION



Mercator Projection
WGS84
UTM Zone 4Q
CALTOPO

0.5 1.0 1.5 2.0 km
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 mi
Scale **1:11580** 1 inch = 965 feet

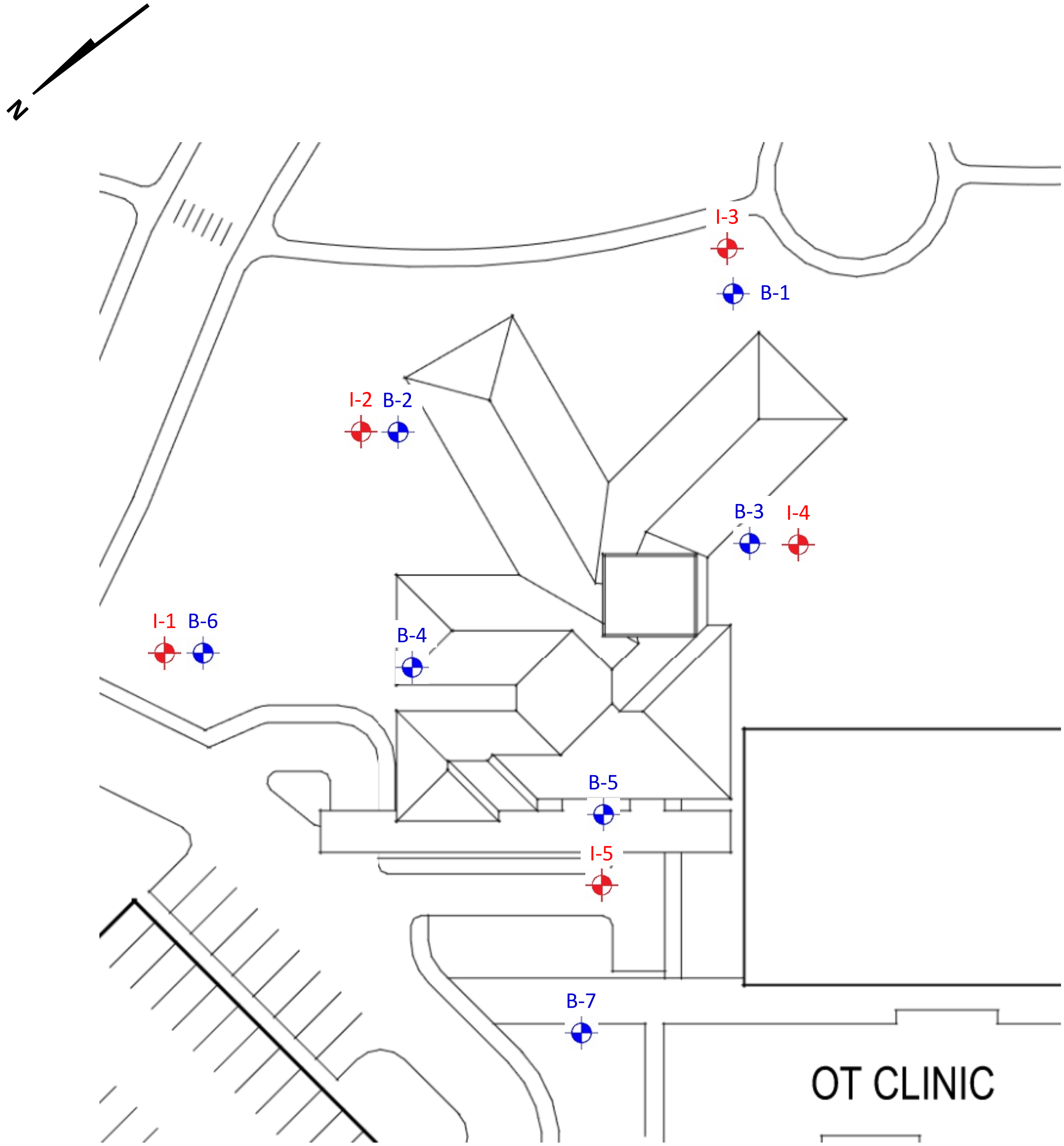
N MN 9°

PROJECT LOCATION MAP

SMMH PHASE 1A
BEHAVIORAL HEALTH NEW PATIENT FACILITY
TMK: (4) 4-6-014: 113
KAPAA, KAUAI, HAWAII

PROJECT NO.: 100521-00	**PLATE**
DATE: DECEMBER 2021	**1**

Kokua Geotech LLC
Soil and Foundation Engineering



REFERENCE: CONCEPTUAL SITE PLAN TRANSMITTED BY G70 ON OCTOBER 21, 2021

APPROXIMATE BORING LOCATION

APPROXIMATE INFILTRATION TEST LOCATION

Kokua Geotech LLC
Soil and Foundation Engineering

SITE PLAN

SMMH PHASE 1A
BEHAVIORAL HEALTH NEW PATIENT FACILITY
TMK: (4) 4-6-014: 113
KAPAA, KAUAI, HAWAII

PROJECT NO.: 100521-00	**PLATE**
DATE: DECEMBER 2021	**2**

APPENDIX A

Project: **SMMH Phase 1A, Behavioral Health New Patient Facility** Project Location: **Samuel Mahelona Memorial Hospital, Kapaa, Kauai, HI** Project Number: **100521-00**	**Kokua Geotech LLC** 94-974 Pakela Street, Suite 109 Waipahu, HI 96797 (808) 397-6974	Key to Logs of Borings Sheet 1 of 1

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	U.S.C.S	Graphic Log	MATERIAL DESCRIPTION	Pocket Pen./Torvane, tsf	Water Content, %	Dry Unit Weight, pcf	Remarks and Other Tests
1	2	3	4	5	6	7	8	9	10	11	12

COLUMN DESCRIPTIONS

1. Elevation (feet): Elevation (MSL, feet).
2. Depth (feet): Depth in feet below the ground surface.
3. Sample Type: Type of soil sample collected at the depth interval shown.
4. Sample Number: Sample identification number.
5. Sampling Resistance, blows/ft: Number of blows to advance driven sampler one foot (or distance shown) beyond seating interval using the hammer identified on the boring log.
6. U.S.C.S: Type of material encountered.
7. Graphic Log: Graphic depiction of the subsurface material encountered.
8. MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
9. Pocket Pen./Torvane, tsf: the reading from Poecket Penetrometer or Torvane.
10. Water Content, %: Water content of the soil sample, expressed as percentage of dry weight of sample.
11. Dry Unit Weight, pcf: Dry weight per unit volume of soil sample measured in laboratory, in pounds per cubic foot.
12. Remarks and Other Tests: Other Tests

FIELD AND LABORATORY TEST ABBREVIATIONS

CHEM: Chemical tests to assess corrosivity
COMP: Compaction test
CONS: One-dimensional consolidation test
LL: Liquid Limit, percent
PI: Plasticity Index, percent
SA: Sieve analysis (percent passing No. 200 Sieve)
UC: Unconfined compressive strength test, Qu, in ksf
WA: Wash sieve (percent passing No. 200 Sieve)

MATERIAL GRAPHIC SYMBOLS

Fat CLAY, CLAY w/SAND, SANDY CLAY (CH)

Portland Cement Concrete

SILT, SILT w/SAND, CLAYEY SILT (MH)

TYPICAL SAMPLER GRAPHIC SYMBOLS

Auger sampler
Bulk Sample
Grab Sample
HQ Coring
3-inch OD Modified California w/ brass liners
PQ Coring
Probing w/Pointed Tip
2-inch OD unlined split spoon (SPT)
Shelby Tube (Thin-walled, fixed head)

OTHER GRAPHIC SYMBOLS

Water level (at time of drilling, ATD)
Water level (after waiting)
Minor change in material properties within a stratum
Inferred/gradational contact between strata
Queried contact between strata

GENERAL NOTES

1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

Project: SMMH Phase 1A, Behavioral Health New Patient Facility Project Location: Samuel Mahelona Memorial Hospital, Kapaa, Kauai, HI Project Number: 100521-00	**Kokua Geotech LLC** 94-974 Pakela Street, Suite 109 Waipahu, HI 96797 (808) 397-6974	# Log of Boring No. 1 Sheet 1 of 1

Date(s) Drilled **11/6/2021**	Logged By **JL**	Checked By **AJF**
Drilling Method **CF Auger**	Drill Bit Size/Type **4-inch Solid Stem Auger**	Total Depth of Borehole **21.5 feet**
Drill Rig Type **Moblie B-53**	Drilling Contractor **Kokua Geotech LLC**	Approximate Surface Elevation **+115 feet MSL***
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **MCS & SPT**	Hammer Data **140 lbs. with 30-inch drop**
Borehole Backfill **Soil Cuttings**	Location **See Site Plan (Plate 2)**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	U.S.C.S	Graphic Log	MATERIAL DESCRIPTION	Pocket Pen./Torvane, tsf	Water Content, %	Dry Unit Weight, pcf	Remarks and Other Tests
115	0				CH		Reddish brown SILTY CLAY with a little sand and gravel, stiff, dry to moist (residual soil)				
			1	23					20	64	Sw.= 3.2%
							grades to very stiff				
			2	26					26		
110	5						grades to hard				
			3	63					25	80	UC=1.8 ksf
105	10						grades to very stiff to hard				
			4	30					35		
					MH		Brown with multi-color mottling CLAYEY SILT with a little sand and decomposed gravel, stiff to very stiff, moist (saprolite)				
100	15										
			5	14					36		
95	20										
			6	15					40		
							Boring terminated at approximately 21.5 feet below the existing ground surface				
90	25										

Project: **SMMH Phase 1A, Behavioral Health New Patient Facility** Project Location: **Samuel Mahelona Memorial Hospital, Kapaa, Kauai, HI** Project Number: **100521-00**	**Kokua Geotech LLC** 94-974 Pakela Street, Suite 109 Waipahu, HI 96797 (808) 397-6974	# Log of Boring No. 2 Sheet 1 of 1

Date(s) Drilled **11/6/2021**	Logged By **JL**	Checked By **AJF**
Drilling Method **CF Auger**	Drill Bit Size/Type **4-inch Solid Stem Auger**	Total Depth of Borehole **21.5 feet**
Drill Rig Type **Moblie B-53**	Drilling Contractor **Kokua Geotech LLC**	Approximate Surface Elevation **+114 feet MSL***
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **MCS & SPT**	Hammer Data **140 lbs. with 30-inch drop**
Borehole Backfill **Soil Cuttings**	Location **See Site Plan (Plate 2)**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	U.S.C.S	Graphic Log	MATERIAL DESCRIPTION	Pocket Pen./Torvane, tsf	Water Content, %	Dry Unit Weight, pcf	Remarks and Other Tests
114	0				MH		Reddish brown CLAYEY SILT with a little sand and gravel, very stiff, dry to moist (fill/residual soil)				
			1	39					25	70	UC=1.2 ksf
			2	35			grades to hard		29		
109	5		3	50/6"					28	75	Sw.= 1.1%
					MH		Brown with multi-color mottling CLAYEY SILT with a little sand and decomposed gravel, stiff to very stiff, moist (saprolite)				
104	10		4	15					40		
99	15		5	19			grades to very stiff		39		
94	20		6	12			grades to stiff		46		
							Boring terminated at approximately 21.5 feet below the existing ground surface				
89	25										

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Project: SMMH Phase 1A, Behavioral Health New Patient Facility Project Location: Samuel Mahelona Memorial Hospital, Kapaa, Kauai, HI Project Number: 100521-00	**Kokua Geotech LLC** 94-974 Pakela Street, Suite 109 Waipahu, HI 96797 (808) 397-6974	# Log of Boring No. 3 Sheet 1 of 1

Date(s) Drilled **11/6/2021**	Logged By **JL**	Checked By **AJF**
Drilling Method **CF Auger**	Drill Bit Size/Type **4-inch Solid Stem Auger**	Total Depth of Borehole **21.5 feet**
Drill Rig Type **Moblie B-53**	Drilling Contractor **Kokua Geotech LLC**	Approximate Surface Elevation **+119 feet MSL***
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **MCS & SPT**	Hammer Data **140 lbs. with 30-inch drop**
Borehole Backfill **Soil Cuttings**	Location **See Site Plan (Plate 2)**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	U.S.C.S	Graphic Log	MATERIAL DESCRIPTION	Pocket Pen./Torvane, tsf	Water Content, %	Dry Unit Weight, pcf	Remarks and Other Tests
119	0				MH		Reddish brown CLAYEY SILT with some sand and a little gravel, very stiff, moist (residual soil)				
		MCS	1	44					26	86	
		SPT	2	40			grades to hard		24		
114	5	MCS	3	62					35	82	Sw.= 2.6%
109	10	SPT	4	32					32		
					MH		Brown with multi-color mottling CLAYEY SILT with some sand and decomposed gravel, stiff, moist (saprolite)				
104	15	SPT	5	13					39		
99	20	SPT	6	18			grades to very stiff		44		
							Boring terminated at approximately 21.5 feet below the existing ground surface				
94	25										

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Project: SMMH Phase 1A, Behavioral Health New Patient Facility Project Location: Samuel Mahelona Memorial Hospital, Kapaa, Kauai, HI Project Number: 100521-00	**Kokua Geotech LLC** 94-974 Pakela Street, Suite 109 Waipahu, HI 96797 (808) 397-6974	# Log of Boring No. 4 Sheet 1 of 1

Date(s) Drilled **11/5/2021**	Logged By **JL**	Checked By **AJF**
Drilling Method **CF Auger**	Drill Bit Size/Type **4-inch Solid Stem Auger**	Total Depth of Borehole **21.5 feet**
Drill Rig Type **Moblie B-53**	Drilling Contractor **Kokua Geotech LLC**	Approximate Surface Elevation **+117 feet MSL***
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **MCS & SPT**	Hammer Data **140 lbs. with 30-inch drop**
Borehole Backfill **Soil Cuttings**	Location **See Site Plan (Plate 2)**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	U.S.C.S	Graphic Log	MATERIAL DESCRIPTION	Pocket Pen./Torvane, tsf	Water Content, %	Dry Unit Weight, pcf	Remarks and Other Tests
117	0				MH		Reddish brown CLAYEY SILT with a little sand and gravel, very stiff, dry to moist (residual soil)				
			1	44					31	63	Sw.= 1.5%
							grades to hard				
			2	35					28		LL=55, PI=19
112	5		3	50/3"					31	82	UC= 4.6 ksf
107	10						grades to very stiff to hard				
			4	30					35		
					MH		Brown with multi-color mottling CLAYEY SILT with a little sand and decomposed gravel, stiff to very stiff, moist (saprolite)				
102	15		5	27					36	77	
97	20						grades to very stiff				
			6	22					50		
							Boring terminated at approximately 21.5 feet below the existing ground surface				
92	25										

Project: SMMH Phase 1A, Behavioral Health New Patient Facility Project Location: Samuel Mahelona Memorial Hospital, Kapaa, Kauai, HI Project Number: 100521-00	**Kokua Geotech LLC** 94-974 Pakela Street, Suite 109 Waipahu, HI 96797 (808) 397-6974	# Log of Boring No. 5 Sheet 1 of 1

Date(s) Drilled **11/5/2021**	Logged By **JL**	Checked By **AJF**
Drilling Method **CF Auger**	Drill Bit Size/Type **4-inch Solid Stem Auger**	Total Depth of Borehole **21.5 feet**
Drill Rig Type **Moblie B-53**	Drilling Contractor **Kokua Geotech LLC**	Approximate Surface Elevation **+120 feet MSL***
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **MCS & SPT**	Hammer Data **140 lbs. with 30-inch drop**
Borehole Backfill **Soil Cuttings**	Location **See Site Plan (Plate 2)**	

Elevation (feet)	Depth (feet)	Sample Number	Sampling Resistance, blows/ft	U.S.C.S	MATERIAL DESCRIPTION	Pocket Pen./Torvane, tsf	Water Content, %	Dry Unit Weight, pcf	Remarks and Other Tests
120	0			CH	Reddish brown SILTY CLAY with a little sand and gravel, hard, moist (residual soil)				
		1	62				29	69	Sw.= 3.4%
		2	46				29		
115	5	3	35/3" +10/0" Ref.				30	84	
				MH	Brown with multi-color mottling CLAYEY SILT with a little sand and decomposed gravel, very stiff, moist (saprolite)				
110	10	4	16				36		
105	15	5	9		grades to stiff		39		LL=66, PI=23
100	20	6	7		grades to medium stiff		49		
					Boring terminated at approximately 21.5 feet below the existing ground surface				
95	25								

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PLATE A-5

Project: SMMH Phase 1A, Behavioral Health New Patient Facility Project Location: Samuel Mahelona Memorial Hospital, Kapaa, Kauai, HI Project Number: 100521-00	**Kokua Geotech LLC** 94-974 Pakela Street, Suite 109 Waipahu, HI 96797 (808) 397-6974	# Log of Boring No. 6 Sheet 1 of 1

Date(s) Drilled **11/5/2021**	Logged By **JL**	Checked By **AJF**
Drilling Method **CF Auger**	Drill Bit Size/Type **4-inch Solid Stem Auger**	Total Depth of Borehole **6.0 feet**
Drill Rig Type **Moblie B-53**	Drilling Contractor **Kokua Geotech LLC**	Approximate Surface Elevation **+113 feet MSL***
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **MCS & SPT**	Hammer Data **140 lbs. with 30-inch drop**
Borehole Backfill **Soil Cuttings**	Location **See Site Plan (Plate 2)**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	U.S.C.S	Graphic Log	MATERIAL DESCRIPTION	Pocket Pen./Torvane, tsf	Water Content, %	Dry Unit Weight, pcf	Remarks and Other Tests
113	0				MH		Reddish brown CLAYEY SILT with a little sand and gravel, hard, dry to moist (residual soil)				
		MCS	1	58					27	79	
		SPT	2	38					27		
108	5	MCS	3	50/6"					28	82	
	6						Boring terminated at approximately 6.0 feet below the existing ground surface				
103	10										
98	15										
93	20										
88	25										

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Project: SMMH Phase 1A, Behavioral Health New Patient Facility Project Location: Samuel Mahelona Memorial Hospital, Kapaa, Kauai, HI Project Number: 100521-00	**Kokua Geotech LLC** 94-974 Pakela Street, Suite 109 Waipahu, HI 96797 (808) 397-6974	Log of Boring No. 7 Sheet 1 of 1

Date(s) Drilled **11/5/2021**	Logged By **JL**	Checked By **AJF**
Drilling Method **CF Auger**	Drill Bit Size/Type **4-inch Solid Stem Auger**	Total Depth of Borehole **1.3 feet**
Drill Rig Type **Moblie B-53**	Drilling Contractor **Kokua Geotech LLC**	Approximate Surface Elevation **+122 feet MSL***
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **MCS & SPT**	Hammer Data **140 lbs. with 30-inch drop**
Borehole Backfill **Soil Cuttings**	Location **See Site Plan (Plate 2)**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	U.S.C.S	Graphic Log	MATERIAL DESCRIPTION	Pocket Pen./Torvane, tsf	Water Content, %	Dry Unit Weight, pcf	Remarks and Other Tests
122	0		1		MH		Reddish brown CLAYEY SILT with a little sand and gravel, hard, dry to moist (fill)		29		
							Gray CONCRETE				
							Boring terminated at approximately 1.3 feet below the existing ground surface on apparent concrete; drilled 5 additional borehholes in the area and all encountered concrete at the same depth				
117	5										
112	10										
107	15										
102	20										
97	25										

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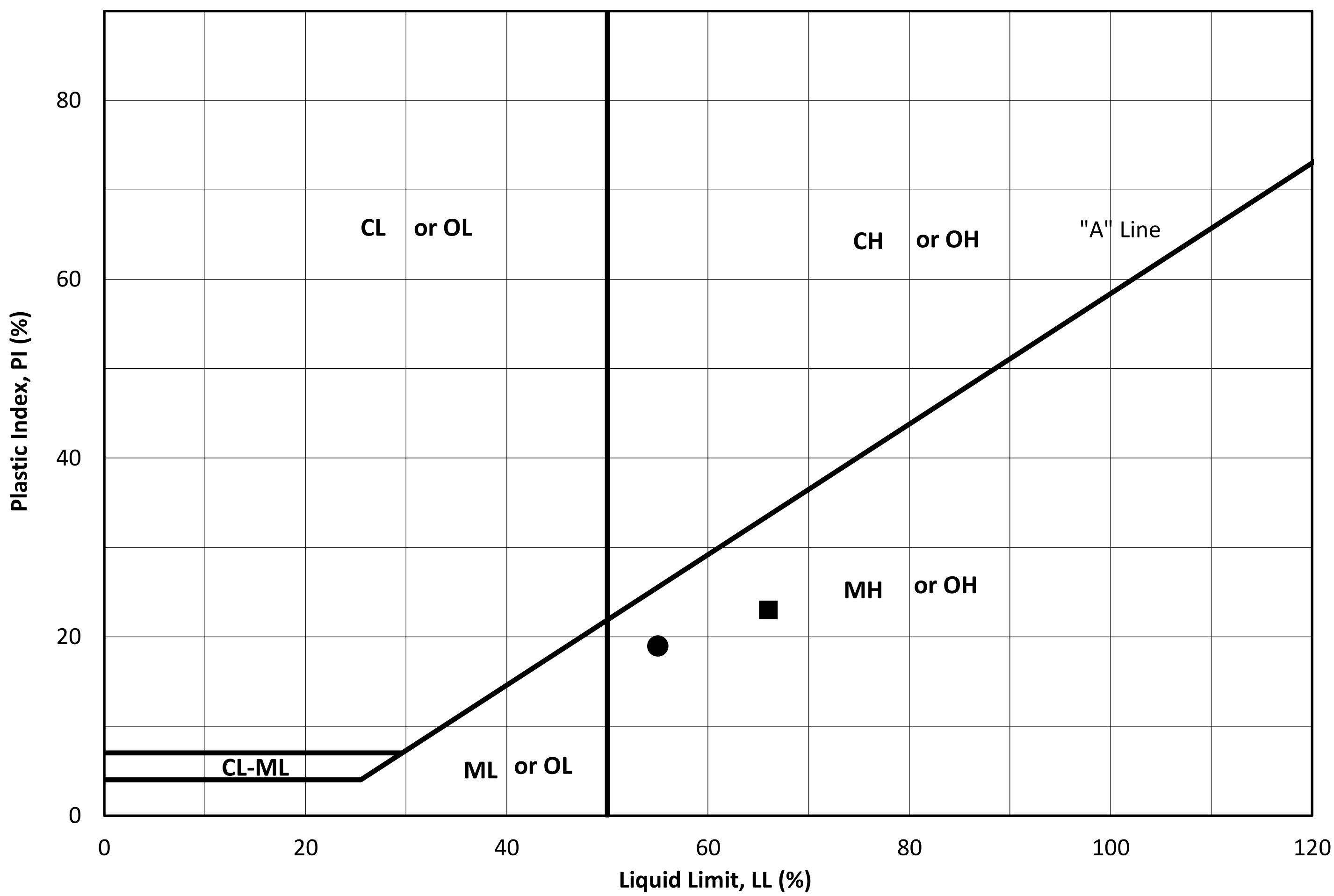
APPENDIX B

PLASTICITY CHART



Symbol	Sample	Depth (feet)	Material Description	USCS	LL %	PL %	PI %
●	B-4	2.5 to 4.0	Reddish brown CLAYEY SILT	MH	55	36	19
■	B-5	13.5 to 15.0	Brown with multi-color mottling CLAYEY SILT	MH	66	43	23
▲							
◆							
○							
□							
△							
◇							

SUMMARY OF ATTERBERG LIMITS (ASTM D4318) TEST RESULTS

Kokua Geotech LLC
Soil and Foundation Engineering

SMMH PHASE 1A
BEHAVIORAL HEALTH NEW PATIENT FACILITY
KAPAA, KAUAI, HAWAII

PROJECT NO.: 100521-00
DATE: DECEMBER 2021

PLATE
B-1

Sample	Depth	Test Type	Material Description	Dry Density	Moisture Contents			Ring Swell
					Initial	Air-dried	Final	
	(feet)			(pcf)	(%)	(%)	(%)	(%)
B-1	1.0 to 2.5	Natural	Reddish brown SILTY CLAY with a little sand and gravel	64.2	19.5	11.4	50.2	3.2
B-2	5.0 to 6.5	Natural	Reddish brown CLAYEY SILT with a little sand and gravel	74.6	28.3	25.0	48.9	1.1
B-3	5.0 to 6.5	Natural	Reddish brown CLAYEY SILT with some sand and a little gravel	81.7	34.8	32.5	43.3	2.6
B-4	1.0 to 2.5	Natural	Reddish brown CLAYEY SILT with a little sand and gravel	62.5	30.6	24.3	50.1	1.5
B-5	1.0 to 2.5	Natural	Reddish brown SILTY CLAY with a little sand and gravel	68.9	29.3	25.8	49.2	3.4

Note: Samples tested were relatively undisturbed (natural) in 2.4-inch diameter by 1-inch high rings. Samples were then air-dried overnight followed by saturating for a minimum of 24 hours under a surcharge pressure of 60 psf.

SUMMARY OF RING SWELL TEST RESULTS

Kokua Geotech LLC
Soil and Foundation Engineering

SMMH PHASE 1A
BEHAVIORAL HEALTH NEW PATIENT FACILITY
KAPAA, KAUAI, HAWAII

PROJECT NO.: 100521-00

DATE: DECEMBER 2021

PLATE
B-2

Sample	Depth (feet)	Material Description	Dry Density (pcf)	Moisture Content (%)	Axial Strain at Failure (%)	Unconfined Compressive Strength (psf)
B-1	5.0 to 6.5	Reddish brown SILTY CLAY w/ sand & gravel	79.9	25.1	1.1	1,757
B-2	1.0 to 2.5	Reddish brown CLAYEY SILT w/ sand & gravel	70.2	25.0	0.6	1,218
B-4	5.0 to 6.5	Reddish brown CLAYEY SILT w/ sand & gravel	82.2	31.4	2.8	4,565

SUMMARY OF UNIAXIAL COMPRESSIVE STRENGTH TEST RESULTS

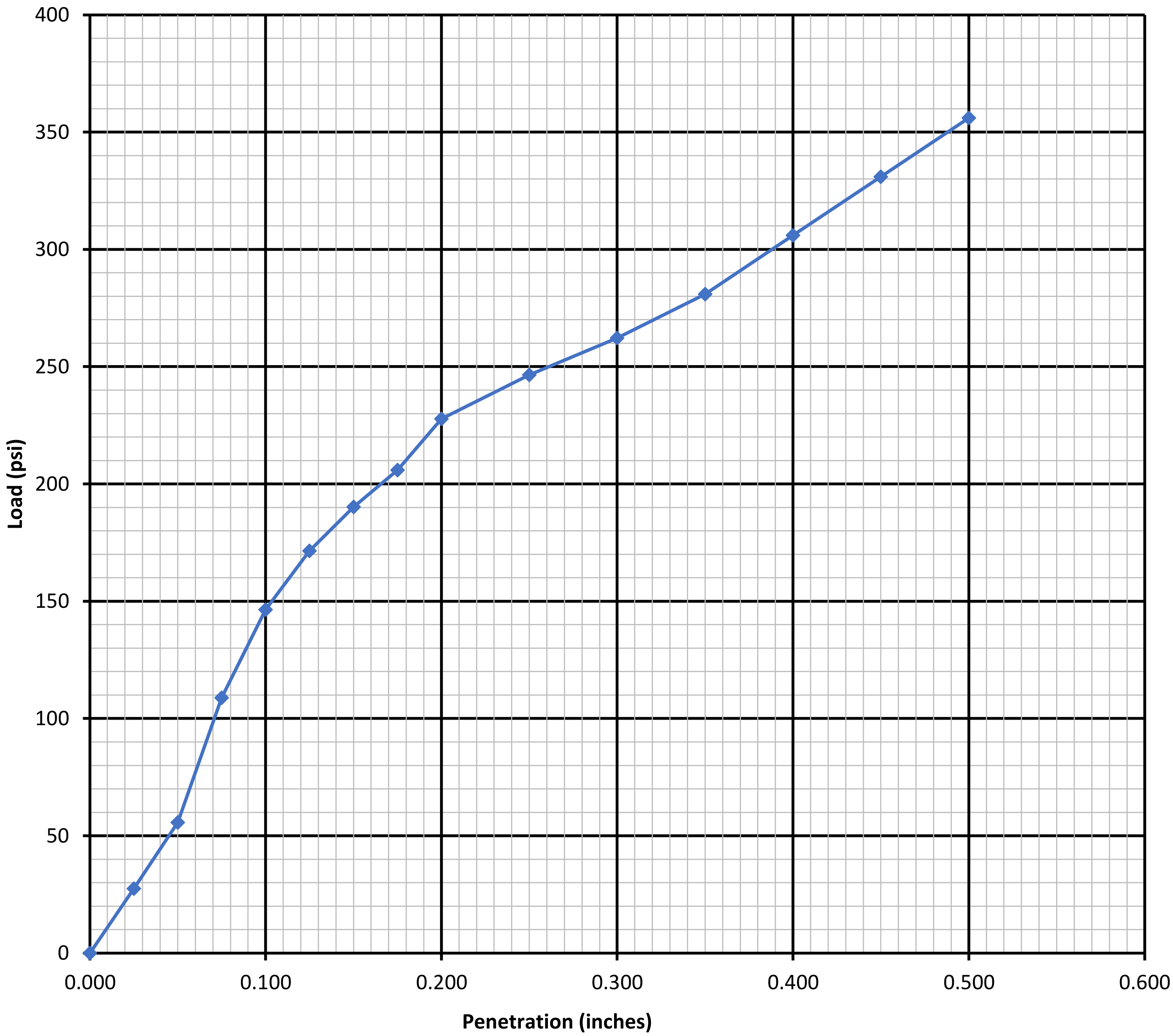
Kokua Geotech LLC
Soil and Foundation Engineering

SMMH PHASE 1A
BEHAVIORAL HEALTH NEW PATIENT FACILITY
KAPAA, KAUAI, HAWAII

PROJECT NO.: 100521-00

DATE: DECEMBER 2021

PLATE
B-3



Sample	Depth (feet)	Material Description	Dry Density (pcf)	Moisture Content (%)	CBR @ 0.1"	CBR @ 0.2"	Swell (%)
BULK @ B-6	1.0 to 5.0	Reddish brown CLAYEY SILT with a little sand and gravel	94.5	37.2	16.5	15.6	0.2

SUMMARY OF CALIFORNIA BEARING RATIO (ASTM D1883) TEST RESULTS

Kokua Geotech LLC
Soil and Foundation Engineering

SMMH PHASE 1A
BEHAVIORAL HEALTH NEW PATIENT FACILITY
KAPAA, KAUAI, HAWAII

PROJECT NO.: 100521-00
DATE: DECEMBER 2021

PLATE
B-4

APPENDIX C

FIELD INFILTRATION TEST RECORD

Project Name:	SMMH Phase 1A		Date of Testing:	11/6/2021	
Project No.:	100521-00		Infiltration Test No.:	I-1	
Method of Testing:	LID Falling Head				
Diameter of Borehole:	5.0	inches	Depth of Borehole:	4.0	feet
Diameter of Casing (ID):	4.0	inches	Length of Casing:	4.0	feet
Datum (above ground):	0.0	feet	Depth of Casing:	4.0	feet
GW level (from ground):	Not Encountered	feet			

Depth (from ground, feet)	Anticipated Subsurface Soil Profile
0.0 to 4.0	Reddish brown SILTY CLAY with a little sand and gravel

Testing Trial	Elapsed Time (minutes)	Time (hh:mm)	Depth to Water Level (measured from datum) (inches)	Infiltration Rate (inches per hour)
Trial 1	0	10:25	24.0	
	2	10:27	25.3	
	5	10:30	26.3	
	10	10:35	26.3	
	20	10:45	27.5	
	40	11:05	29.5	
	60	11:25	31.5	7.5
Trial 2	0	11:25	24.0	
	2	11:27	25.5	
	5	11:30	25.5	
	10	11:35	25.5	
	20	11:45	26.0	
	40	12:05	29.0	
	60	12:25	31.0	7.0
Trial 3	0	12:26	24.0	
	2	12:28	25.0	
	5	12:31	25.0	
	10	12:36	26.0	
	20	12:46	27.0	
	40	13:06	29.0	
	60	13:26	31.0	7.0
Trial 4	0	13:26	24.0	
	2	13:28	25.0	
	5	13:31	25.0	
	10	13:36	26.5	
	20	13:46	27.0	
	40	14:06	29.00	
	60	14:26	31.00	7.0

FIELD INFILTRATION TEST RECORD

Project Name:	SMMH Phase 1A			Date of Testing:	11/6/2021
Project No.:	100521-00			Infiltration Test No.:	I-2
Method of Testing:	LID Falling Head				
Diameter of Borehole:	5.0	inches	Depth of Borehole:	4.0	feet
Diameter of Casing (ID):	4.0	inches	Length of Casing:	4.0	feet
Datum (above ground):	0.0	feet	Depth of Casing:	4.0	feet
GW level (from ground):	Not Encountered	feet			

Depth (from ground, feet)	Anticipated Subsurface Soil Profile
0.0 to 4.0	Reddish brown SILTY CLAY with a little sand and gravel

Testing Trial	Elapsed Time (minutes)	Time (hh:mm)	Depth to Water Level (measured from datum) (inches)	Infiltration Rate (inches per hour)
Trial 1	0	10:14	24.0	
	2	10:16	25.3	
	5	10:19	26.0	
	10	10:24	27.0	
	20	10:34	29.0	
	40	10:54	33.5	
	60	11:14	37.5	13.5
Trial 2	0	11:15	24.0	
	2	11:17	25.0	
	5	11:20	26.0	
	10	11:25	27.0	
	20	11:35	28.5	
	40	11:55	32.0	
	60	12:15	35.3	11.3
Trial 3	0	12:17	24.0	
	2	12:19	26.0	
	5	12:22	27.0	
	10	12:27	28.0	
	20	12:37	30.0	
	40	12:57	34.0	
	60	13:17	37.5	13.5
Trial 4	0	13:17	24.0	
	2	13:19	26.0	
	5	13:22	27.0	
	10	13:27	28.0	
	20	13:37	29.5	
	40	13:57	32.0	
	60	14:17	35.5	11.5

FIELD INFILTRATION TEST RECORD

Project Name:	SMMH Phase 1A	Date of Testing:	11/6/2021
Project No.:	100521-00	Infiltration Test No.:	I-3

Method of Testing:	LID Falling Head				
Diameter of Borehole:	5.0	inches	Depth of Borehole:	4.0	feet
Diameter of Casing (ID):	4.0	inches	Length of Casing:	4.0	feet
Datum (above ground):	0.0	feet	Depth of Casing:	4.0	feet
GW level (from ground):	Not Encountered	feet			

Depth (from ground, feet)	Anticipated Subsurface Soil Profile
0.0 to 4.0	Reddish brown SILTY CLAY with a little sand and gravel

Testing Trial	Elapsed Time (minutes)	Time (hh:mm)	Depth to Water Level (measured from datum) (inches)	Infiltration Rate (inches per hour)
Trial 1	0	10:10	24.0	
	2	10:12	25.0	
	5	10:15	25.5	
	10	10:20	26.0	
	20	10:30	27.5	
	40	10:50	29.0	
	60	11:10	30.5	6.5
Trial 2	0	11:11	24.0	
	2	11:13	24.0	
	5	11:16	24.5	
	10	11:21	25.0	
	20	11:31	26.0	
	40	11:51	27.0	
	60	12:11	28.5	4.5
Trial 3	0	12:12	24.0	
	2	12:14	24.5	
	5	12:17	24.5	
	10	12:22	25.0	
	20	12:32	26.0	
	40	12:52	26.8	
	60	13:12	27.0	3.0
Trial 4	0	13:13	24.0	
	2	13:15	24.0	
	5	13:18	24.5	
	10	13:23	25.0	
	20	13:33	26.0	
	40	13:53	27.0	
	60	14:13	27.5	3.5

FIELD INFILTRATION TEST RECORD

Project Name: SMMH Phase 1A
Date of Testing: 11/6/2021
Project No.: 100521-00
Infiltration Test No.: I-4

Method of Testing: LID Falling Head
Diameter of Borehole: 5.0 inches
Depth of Borehole: 4.0 feet
Diameter of Casing (ID): 4.0 inches
Length of Casing: 4.0 feet
Datum (above ground): 0.0 feet
Depth of Casing: 4.0 feet
GW level (from ground): Not Encountered feet

Depth (from ground, feet)	Anticipated Subsurface Soil Profile
0.0 to 4.0	Reddish brown SILTY CLAY with a little sand and gravel

Testing Trial	Elapsed Time (minutes)	Time (hh:mm)	Depth to Water Level (measured from datum) (inches)	Infiltration Rate (inches per hour)
Trial 1	0	10:23	23.0	
	2	10:25	23.5	
	5	10:28	24.0	
	10	10:33	24.5	
	20	10:43	25.0	
	40	11:03	26.0	
	60	11:23	27.0	4.0
Trial 2	0	11:23	24.0	
	2	11:25	24.0	
	5	11:28	24.0	
	10	11:33	24.5	
	20	11:43	25.0	
	40	12:03	26.0	
	60	12:23	27.0	3.0
Trial 3	0	12:24	24.0	
	2	12:26	24.0	
	5	12:29	24.5	
	10	12:34	25.0	
	20	12:44	25.0	
	40	13:04	26.0	
	60	13:24	27.0	3.0
Trial 4	0	13:25	24.0	
	2	13:27	24.0	
	5	13:30	24.5	
	10	13:35	25.0	
	20	13:45	25.0	
	40	14:05	25.5	
	60	14:25	26.5	2.5

FIELD INFILTRATION TEST RECORD

Project Name:	SMMH Phase 1A	Date of Testing:	11/6/2021
Project No.:	100521-00	Infiltration Test No.:	I-5

Method of Testing:	LID Falling Head				
Diameter of Borehole:	5.0	inches	Depth of Borehole:	4.0	feet
Diameter of Casing (ID):	4.0	inches	Length of Casing:	4.0	feet
Datum (above ground):	0.0	feet	Depth of Casing:	4.0	feet
GW level (from ground):	Not Encountered	feet			

Depth (from ground, feet)	Anticipated Subsurface Soil Profile
0.0 to 4.0	Reddish brown SILTY CLAY with a little sand and gravel

Testing Trial	Elapsed Time (minutes)	Time (hh:mm)	Depth to Water Level (measured from datum) (inches)	Infiltration Rate (inches per hour)
Trial 1	0	10:32	23.00	
	2	10:34	23.50	
	5	10:37	24.00	
	10	10:42	24.00	
	20	10:52	24.30	
	40	11:12	25.00	
	60	11:32	26.50	3.5
Trial 2	0	11:33	24.00	
	2	11:35	24.50	
	5	11:38	24.50	
	10	11:43	25.00	
	20	11:53	25.00	
	40	12:13	26.00	
	60	12:33	26.50	2.5
Trial 3	0	12:34	23.00	
	2	12:36	23.00	
	5	12:39	23.50	
	10	12:44	24.00	
	20	12:54	24.00	
	40	13:14	24.50	
	60	13:34	25.00	2.0
Trial 4	0	13:36	24.00	
	2	13:38	24.00	
	5	13:41	24.50	
	10	13:46	25.00	
	20	13:56	25.00	
	40	14:16	25.50	
	60	14:36	26.00	2.0