GEOTECHNICAL ENGINEERING EXPLORATION
ANAHOLA RESIDENCE LOTS - UNIT 6
ANAHOLA, KAUAI, HAWAII

W.O. 3348-00   JANUARY 25, 1995

FOR

AKINAKA & ASSOCIATES, LTD.

GEOLABS-HAWAII

Geotechnical Engineering, Geology and Environmental Services

C.W. ASSOCIATES, INC. dba
GEOLABS-HAWAII
Geotechnical Engineering, Geology and Environmental Services

January 25, 1995
W.O. 3348-00

Mr. Henry Morita
Akinaka & Associates, Ltd.
250 N. Beretania Street, Suite 300
Honolulu, HI 96817-4716

Dear **Mr. Morita:**

Submitted herewith is our report entitled "Geotechnical Engineering Exploration, Anahola Residence Lots - Unit 6, Anahola, Kauai, Hawaii."

Our work was performed in general accordance with the scope of services outlined in our fee proposal of December 18, 1991.

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

Very truly yours,

C.W. ASSOCIATES, INC.
dba **GEOLABS-HAWAII**

Robin M. Lim, P.E.
Vice President

RML:TK:crc
TK
(h:\user\crc\cover\3348-00.tk - pg. 2)

2006 Kalihi St. • Honolulu, Hawaii 96819
Facsimile: (808) 847-1749 • Phone: (808) 841-5064

TABLE OF CONTENTS

Table of Contents (Continued)

(h:\user\crc\cover\3348-00.tk - pg. 3)

GEOTECHNICAL ENGINEERING EXPLORATION

ANAHOLA RESIDENCE LOTS - UNIT 6

ANAHOLA, KAUAI, HAWAII

W.O. 3348-00 JANUARY 25, 1995

SUMMARY OF FINDINGS AND RECOMMENDATIONS

Our field exploration generally encountered a relatively thick deposit of residual soils, consisting of stiff to hard clayey silt soils, extending to the maximum depths explored. The surficial residual soils were underlain by highly weathered basalt (saprolite), consisting of dense silty sands and sandy gravels, in the majority of the borings drilled at the eastern side of the project site. Groundwater was not encountered in the drilled borings at the time of our field exploration.

Based on our field exploration and analyses, it is our opinion that the proposed subdivision development project is feasible from a geotechnical engineering point-of-view provided that the recommendations presented in this report are properly followed.

The on-site clayey silts and silty sands generated from cut areas may be reused as a source of fill material provided that they are properly placed on prepared subgrades as recommended in the "Site Grading" section of this report.

Because of the relatively competent subsoil conditions encountered at the project site, shallow foundations consisting of posts-and-beams and slabs-on-grade may be utilized for the future house construction. An allowable bearing pressure of up to 2,500 pounds per square foot (p.s.f.) may be used for the design of foundations bearing on the recompacted in-situ soils or engineered fill.

Our laboratory testing indicated that the on-site clayey silt soils generally have moderately low potential of swelling/ shrinkage when subjected to moisture fluctuations. However, the on-site soils have moderate to high in-situ moisture contents. Therefore, special attention should be given to the subgrade preparation and slab-on-grade design for this project. To reduce the potential for structural distress to the future slabs-on-grade resulting from the swelling of the clayey silt soils, we recommend that the subgrade soils be scarified, moisture-conditioned, and recompacted in accordance with the recommendations presented in the "Site Grading" section of this report.

The text of this report should be referred to for detailed discussion and special design recommendations.

INTRODUCTION

This report presents the results of our geotechnical engineering exploration performed for the proposed Anahola Residence Lots - Unit 6 project in the Anahola area of the eastern coast of the island of Kauai, Hawaii. The general location and vicinity of the project site are shown on the Project Location Map, Plate 1.

This report summarizes the findings from our field exploration and laboratory testing and presents our geotechnical engineering recommendations derived from our analyses of the proposed project. These recommendations are intended for design input only and may not be appropriate to form the basis for construction cost estimates nor for construction bidding purposes.

PROJECT CONSIDERATIONS

The project site is located in the Anahola area of the eastern coast of the island of Kauai, Hawaii. The terrain in the area of the site slopes gently down toward the east and the ocean. The site was previously used for the cultivation of sugar cane by Lihue Plantation Company.

It is proposed by the Department of Hawaiian Home Lands (DHHL) to develop the site for residential use. Plans of the development were not available at the time this report was prepared. However, we anticipate that the development will generally consist of subdividing the site into approximately 250 single-family residential lots with associated infrastructure. Homes would be constructed either by the individual lot user or by the DHHL.

Generally, we anticipate that the site grading will consist of cuts and fills of less than 20 feet deep, and that the infrastructure will consist of dry sewer, water, drainage and roads designed for medium traffic. We understand that on-site sewage treatment and disposal by double cesspools or septic tank with seepage pit methods will be utilized on an interim basis until a regional sewage system can be developed. Therefore, field percolation tests were conducted to obtain data pertaining to the design of the sewage disposal system.

PURPOSE AND SCOPE

The purpose of our field exploration was to obtain an overview of the subsurface conditions at the project site to develop an idealized soil data set for the formulation of geotechnical engineering recommendations pertinent to the design of the site grading, house foundations, pavement sections, and sewage disposal system for the subject project. The work was performed in general accordance with our fee proposal dated December 16, 1991. Our scope of work included the following tasks and work efforts:

1. Review of available soils and geologic information pertinent to the project site and its vicinity.

2. Mobilization and demobilization of a truck-mounted drill rig and operators to and from the project site.

3. Drilling and sampling of 12 borings to depths ranging from 20 to 21½ feet below the existing ground surface for a total footage of approximately 255 lineal feet of exploration.

4. Coordination of the field exploration and logging of the borings by a field engineer of our firm.

5. Performance of 11 field percolation tests to evaluate the subsoil infiltration characteristics for the formulation of recommendations pertinent to the design of the disposal components of the on-site individual wastewater systems. Five of the percolation tests were conducted in additional borings (Boring Nos. P-2, P-4, P-8, P-10, and P-11) drilled for the percolation testing.

6. Laboratory testing of selected samples obtained during the field exploration to evaluate the classification and engineering properties of the materials encountered.

7. Analyses of the field and laboratory data for the purpose of developing geotechnical engineering recommendations pertinent to the design of the site grading, house foundations, pavement sections, and sewage disposal system for the proposed project.

8. Preparation of this report summarizing our work on the project and presenting our findings and geotechnical engineering recommendations.

9. Coordination of our overall work on the project by a Project Manager from our firm.

10. Quality assurance of our work and client/design team consultation by a Principal Engineer of our firm.

11. Miscellaneous work efforts such as drafting, word processing, and clerical support.

Detailed descriptions of our field exploration and Logs of Borings are presented in Appendix A of this report. Results of the laboratory tests are presented in Appendix B, and results of the field percolation tests are presented in Appendix C.

SITE DESCRIPTION

The project site is located adjacent to the existing DHHL Residence Lots at Anahola in the District of Kawaihau on the island of Kauai, Hawaii. The project site is bounded to the northwest by Kukuihale Road and lies between Kuhio Highway and the northeast coastline of Kauai. An existing residential subdivision is located to the southwest of the subject site. The parcel is approximately rectangular in shape encompassing approximately 70 acres of land area.

At the time of our field exploration, the site was observed to be an undeveloped parcel of land vegetated with grass and abandoned sugar canes ranging in height from about 2 to 7 feet. Some basalt boulders were observed at the surface throughout the site. Cane haul trails were observed traversing the site which provide access for four-wheel drive vehicles or trucks. Additional trails were cleared at the site during our field exploration to provide access to our truck-mounted drilling equipment.

An area containing abandoned automobiles and refuse exists along the southern property boundary adjacent to an existing dirt trail and Boring No. 2. A drainage channel and associated gullied surface topography exists at the southeast portion of the site. This channel appeared to be naturally developed and was observed to be dry at the time of our field work. A recently constructed, earthen drainage channel was observed at the northern half of the project site near the location of Boring No. 10.

The terrain at the site slopes gently down toward the ocean in the northeast with existing ground elevations ranging from approximately +130 feet Mean Sea Level (MSL) in the west to approximately +30 feet MSL in the eastern side of the site.

REGIONAL GEOLOGY

The island of Kauai is composed of a single basalt shield volcano built by the extrusion of the lavas of the Waimea Canyon Volcanic Series during the late Pliocene (more than 2¼ million years before present). Following the cessation of this main shield building phase, there was renewed volcanic activity with the extrusion of basaltic lavas of the post-erosional Koloa Volcanic Series and the concurrent deposition of the alluvial sediments of the Palikea Formation.

Rocks of the Koloa Volcanic Series cover most of the eastern half of the island of Kauai. Rocks of the Koloa Volcanic Series are generally characterized as thick flows of dense basalt extruded from groups of vents aligned in north-south trends in various locales. Associated with the vents are pyroclastic materials, which usually form low cinder cones at the vent.

During the Pleistocene, there were many sea level changes as a result of widespread glaciation in the continental areas of the world. As the great continental glaciers accumulated, the level of the ocean fell since there was less water available to fill the oceanic basins. Conversely, as the glaciers receded, or melted, global sea levels rose because more water was available. The land mass of Kauai remained essentially stable during these changes and the fluctuations were eustatic in nature. These glacio-eustatic fluctuations resulted in stands of the sea which were both higher and lower relative to present sea level on Kauai.

The higher sea level stands caused the accumulation of deltas and fans of terrigenous sediments in the heads of old bays, accumulation of reef deposits at correspondingly higher elevations, and lagoonal/marine sediments in the quiet waters protected by fringing reefs.

The project site is located on the eastern coast of the island of Kauai. It is underlain by residual soils developed from the in-situ weathering of Koloa lavas.

SUBSURFACE CONDITIONS

Our field exploration program consisted of drilling and sampling 12 borings to depths ranging between 20 and 21½ feet below the existing ground surface. The majority of our borings encountered a relatively thick deposit of residual soils, consisting of very stiff to hard clayey silt soils, extending to a depth of approximately 20 feet below the existing ground surface. The surficial residual soils were underlain by highly weathered basalt (saprolite), consisting of dense silty sands and sandy gravels, in the majority of the borings drilled at the eastern side of the project site. Groundwater was not encountered in the borings at the time of our field exploration. Groundwater levels are expected to vary with seasonal rainfall and time of year.

For more detailed descriptions of the materials encountered, please refer to the Logs of Borings presented on Plates A-1 through A-12 of Appendix A.

DISCUSSION AND RECOMMENDATIONS

Our field exploration generally encountered stiff residual soils and dense saprolites throughout the depths of the borings drilled at the subject site. We believe that the proposed subdivision development project is feasible from a geotechnical engineering point-of-view provided the recommendations presented herein are properly followed.

The on-site clayey silts and silty sands generated from cut areas may be reused as a source of fill material provided that they are properly placed on prepared subgrades as recommended in the "Site Grading" section of this report. Because of the relatively competent subsoil conditions encountered at the project site, shallow foundations consisting of posts-and-beams and slabs-on-grade may be utilized for the future house construction. Our laboratory testing indicated that the on-site clayey silt soils generally have moderately low potential of swelling/shrinkage when subjected to moisture fluctuations. However, the on-site soils have moderate to high in-situ moisture contents. Therefore, special attention should be given to subgrade preparation and slab-on-grade design for this project. To reduce the potential for structural distress to future slabs-on-grade resulting from the swelling/shrinkage of the clayey silt soils, we recommend that the subgrade soils be scarified, moisture-conditioned, and recompacted in accordance with the recommendations presented in the "Site Grading" section of this report.

Detailed discussion of these items and our geotechnical engineering design recommendations are presented in the following sections of this report.

Site Grading

Based on our discussions with the project civil engineer, design grades for the proposed subdivision development project have not been finalized at the time this report was prepared. In general, we anticipate that the site grading work will consist of cuts and fills less than 20 feet in height. Site preparation and grading should be performed in accordance with the following general guidelines and the current version of the Standard Specification of Public Works Construction, County of Kauai. General guide specifications for earthwork are presented in Appendix D of this report and may be used as a reference. Items of grading that are addressed in the following subsections include: (1) Site Preparation; (2) Fills and Backfills; (3) Boulder Disposal; (4) Fill Placement and Compaction Requirements; (5) Slopes; and (6) Subdrainage.

Site grading operations should be observed by a representative of Geolabs-Hawaii. It is important that a representative from our office observe the site grading to evaluate whether any undesirable materials are encountered during the excavation process and whether the exposed soil/rock conditions are similar to those encountered in our field exploration.

Site Preparation

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

Soft and yielding areas encountered during clearing and grubbing below any areas designated to receive fill should be over-excavated to expose firm natural material and the resulting excavation should be backfilled with well-compacted engineered fill. The excavated soft and/or organic soils should be properly disposed of off-site.

After clearing and grubbing, areas designated to receive fills should be scarified to a depth of about 8 inches, moisture-conditioned to at least 2 percent above the optimum moisture, and compacted to a minimum of 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 D 1557-91 test procedures. Optimum moisture is the water content (percentage by dry weight) corresponding to the maximum dry density. If the subgrade soils are pumping during subgrade preparation, the subgrade should be proof-rolled and a filter fabric, such as Mirafi 500X or equivalent, should be placed on the subgrade prior to placement of fill material.

Where shrinkage cracks are noted after compaction of the subgrade, we recommend that the soil be thoroughly moistened to close all cracks. 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 engineered fill.

Soft and wet soils may be encountered at the ground surface in the vicinity of the existing maintenance easement and drainage channel areas. We recommend that these soft and wet soils, if encountered, be removed to expose the underlying firm natural soils prior to the placement of fill materials.

Contract documents should include additive and deductive unit prices for over-excavation and engineered fill placement to account for variations in the over-excavation quantities.

Fills and Backfills

Generally, the on-site silty and sandy soils should be suitable for use as engineered fill materials provided that they are properly moisture-conditioned and compacted. It should be noted that the on-site soils have moderate to high in-situ moisture contents. Therefore, it may be difficult to achieve the required compaction without some aeration of the on-site soils. If imported material is required, the material should be non-expansive granular material, such as crushed coral, mudrock, basalt or cinder sand. The material should be well-graded from coarse to fine with no particles larger than 3 inches in largest dimension and should contain a maximum of 20 percent particles passing the No. 200 sieve. The material should have a laboratory CBR value of 20 or more and should have a maximum swell of less than 1 percent. Imported fill material should be tested by Geolabs-Hawaii for conformance with these recommendations prior to delivery to the project site for its intended use.

Boulder Disposal

Boulders were observed at the ground surface throughout the project site. This would indicate that occasional boulders may be encountered during site grading. Boulders, i.e., rock fragments larger than 12 inches in maximum size, encountered during site grading may be used in the lower portion of relatively thick fills (greater than 6 feet thick) provided that the following recommendations are followed:

1. Boulders should be spread out and must not be nested together. They should be placed such that compaction equipment will be able to compact between and around them.

2. Boulders or portions of boulders should not encroach within 4 feet of the finish subgrade elevation.

3. Boulders larger than 2 feet in its largest dimension may be utilized as rock fills or boulder fills where proposed fills are greater than 5 feet thick. For boulders larger than 4 feet in maximum dimension, it may be necessary to reduce the size of these large boulders or dispose of them off-site.

4. Care must be exercised to avoid placement of boulders in the proposed utility alignment and within the depths of the proposed utility lines to reduce the potential for encountering the boulders during excavation for the utility trenches. This condition also applies to the location of the proposed seepage pits.

Fill Placement and Compaction Requirements

Fill materials consisting of the on-site soils should be moisture-conditioned to between 2 and 5 percent above the optimum moisture, placed in level lifts not exceeding 8 inches in loose thickness, and compacted to a minimum of 90 percent relative compaction. Imported granular materials should be moisture-conditioned to above the optimum moisture, placed in level lifts not exceeding 12 inches in loose thickness, and compacted to not less than 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 D 1557-91 test procedures. Optimum moisture is the water content (percentage by dry weight) corresponding to the maximum dry density. Mechanical compaction equipment should be used to compact the materials encountered at the project site. Water tamping, jetting or ponding should not be allowed to compact the on-site soils.

Backfills behind conventional retaining walls may consist of the on-site soils or non-expansive materials compacted to between 90 and 95 percent relative compaction. Over-compaction of the retaining wall backfill would exert additional lateral earth pressures on the walls and should be avoided.

Slopes

All permanent cut and fill slopes constructed with the on-site silty soils or imported fill material should be designed with an inclination of two horizontal to one vertical (2H:1V) or flatter. For fill slopes with a vertical height greater than 20 feet, we recommend that a key be provided at the toe of the fill slope to provide additional stability of the new embankment fill against sliding. The key should be embedded at least 2 feet below the lowest adjacent grade and should have a minimum base width of 15 feet. A typical sketch of the key is shown on Plate 3.

For slopes steeper than 4H:1V with vertical heights greater than 20 feet, we recommend that a minimum 8-foot wide bench be provided at the mid-point of the slope to reduce the potential for erosion due to surface run-off water. We also recommend that V-ditches (or earth berms) be provided at the top of slopes and placement of geotextile fabrics on the slope to reduce the potential for erosion.

All fills to be placed on slopes with inclinations steeper than 5H:1V should be keyed and benched into the existing slope to provide stability of the new fill against sliding. The filling operations should start at the lowest point and continue up in level horizontal compacted layers in accordance with the above fill placement recommendations. Fill slopes should be constructed by overfilling and cutting back to the design slope ratio to obtain a well-compacted slope face. In the event that over-cutting occurs, consideration should be given to leaving the slope rather than attempting to backfill the slope to the design grade with silver fills. If backfilling of an over-cut slope is necessary, keying and benching requirements should be implemented. Alternatively, cut slopes may be buttressed with fill slopes constructed of non-expansive fills. Water should be diverted away from the top of slopes and slope planting should be provided as soon as possible to reduce potential erosion of the finished slopes. A typical sketch of keying and benching is shown on Plate 3.

Subdrainage

Seepage conditions were not observed at the site during our field exploration; however, a drainage channel and associated gullied surface topography exists at the southeast portion of the site. This channel appeared to be naturally developed and was observed to be dry at the time of our field work. A recently constructed, earthen drainage channel was also observed at the northern half of the project site near the location of Boring No. 10.

Although seepage conditions were not noted during our exploration, we recommend that provisions be incorporated into the construction documents to provide for subdrains in the following areas.

1. At all springs and seepage areas;
2. Where fill abuts natural uphill slopes;
3. On the uphill side of all keyways; and
4. In other areas of the site where seepage is observed during and after grading or as recommended by Geolabs-Hawaii during construction.

In general, subdrains should consist of perforated pipes with perforations placed down and should be at least 4 inches in diameter. All subdrains should be surrounded and underlain by at least 6 inches of drainage material, such as No. 3B Fine gravel (ASTM C 33, No. 67 gradation) or equivalent. A filter fabric, such as Mirafi 140N or equivalent, should wrap around the drainage material. In general, subdrain trenches should be at least 12 inches wide, at least 2 feet deep, and should be capped with engineered fill. A sketch of the Typical Trench Subdrain Detail is presented on Plate 4. Subdrains should be positioned along the upside of all keyway excavations and should discharge into storm drain structures, where possible, or other outlet structures.

House Foundations

We understand that both post-and-beam and slab-on-grade foundations may be utilized during the future house construction. Based on our field exploration, an allowable bearing pressures of up to 2,500 pounds per square foot (p.s.f.) may be used for the design of footing foundations bearing on the in-situ stiff silty soils or engineered fill. The bearing value is for dead plus live loads and may be increased by one-third (⅓) for transient loads, such as those caused by wind or seismic forces.

Post-and-Beam Construction

If it is desired to utilize post-and-beam construction for the proposed house structures, we recommend that short cast-in-place drilled piers end-bearing on the in-situ very stiff to hard clayey silt soils or engineered fill be used for foundation support. The drilled piers should be embedded a minimum of 3 feet below the lowest adjacent finish grades. The bottom of the drilled holes should be cleaned of loose soils prior to the placement of reinforcing steel and concrete. If soft soils are encountered at the bottom of the drilled piers during construction or resulting from inclement weather, the pier footings should be extended deeper to bear on the underlying firm in-situ soils. Special attention should be given to the recommendations presented in the "Drainage" section of this report for posts-and-beams type foundations.

It is anticipated that some on-grade slabs may be required for the houses, garages, driveways and other areas. These slabs should be designed and constructed in accordance with the recommendations presented below. Alternately, flexible pavements, such as asphaltic concrete, should be considered for driveway and sidewalk areas.

Slabs-on-Grade Construction

Because of the generally competent subsoil conditions encountered in our field exploration, we believe that slab-on-grade foundations with thickened edges bearing on the near-surface very stiff to hard clayey silt soils or engineered fill may also be used for support of the proposed house structures.

Perimeter thickened edge footings should be embedded a minimum of 18 inches below the lowest adjacent finish grade. Footing embedment may be reduced to 12 inches for interior footings. The base of the thickened edge should have a minimum width of 12 inches. The bottom of the footing excavations should be recompacted to a minimum of 90 percent relative compaction prior to the placement of reinforcing steel or concrete. If soft and/or loose materials are encountered at the bottom of footing excavations, they should be over-excavated to expose the underlying firm materials. The over-excavation should be backfilled with select granular material compacted to a minimum of 90 percent relative compaction, or the footing bottom may be extended down to the underlying competent material.

To reduce the potential for structural distress of the slabs-on-grade resulting from the swelling on the site clayey silt subgrade soils, we recommend that the subgrade soils underneath the slab areas be scarified to a depth of about 8 inches, moisture-conditioned to approximately 2 to 5 percent above the optimum moisture, and recompacted to a minimum of 90 percent relative compaction.

The slab subgrades should be kept moist prior to placement of concrete. To reduce the potential for drying of the subgrade soils and to reduce the costs of form construction, we recommend that the slab edges be cast "neat" against the soils. The slab edges should incorporate a sufficient amount of top and bottom longitudinal steel reinforcement. The top and bottom steel reinforcement bars should be connected by stir-ups. The ends of the stir-ups should extend into the floor slab area and should be tied to the welded wire mesh. A structural engineer should be consulted for design details of this thickened edge which is intended to function both as a moisture barrier and as a perimeter wall footing.

The welded wire mesh in the slab-on-grade should be embedded at the proper height in the concrete to provide adequate reinforcement. Blocks or saddles may be used to raise the wire mesh. A stiff grade or wire mesh is thus recommended.

We recommend that a minimum 4-inch thick layer of No. 3B Fine gravel (ASTM C 33, No. 67 gradation) cushion be placed below the slab to provide more uniform support of the slab. To reduce future moisture infiltration and subsequent damage to the floor coverings, an impervious moisture vapor barrier, such as a plastic membrane, is recommended on top of the gravel cushion layer. Two inches of moist fine sand should be placed above the plastic membrane to provide protection for the membrane and to aid in curing of the slab concrete.

Flexible floor coverings, such as carpet or sheet vinyl, should be considered since they can better mask any minor slab cracking. It is also recommended that interior walls be designed to incorporate some flexibility to accommodate small amount of possible ground movements.

Where the slab is subjected to vehicular traffic, such as the garage slab and driveway area, a 6-inch layer of base course compacted to a minimum of 95 percent relative compaction is recommended in-lieu of the No. 3B Fine gravel cushion layer. The 2-inch moist fine sand and vapor barrier may be omitted for the garage and driveway slabs.

Exterior concrete walkways may be required for the proposed project. We recommend that a minimum 4-inch thick cushion layer of No. 3B Fine gravel be provided below the concrete walkway slab. The subgrade soils underneath the sidewalk slabs should be prepared in accordance with the recommendations presented above. Construction joints should be provided at intervals equal to the width of the walkways with expansion joints at right-angle intersections.

The area adjacent to the slabs should be backfilled tightly against the slab with non-expansive impervious soil and graded to divert water away from the slab to reduce the potential of water ponding around the foundations.

If foundations are located next to utility trenches or easements, they should be embedded below a 1H:1V imaginary plane extending upward from the bottom edge of the utility trench or as deep as the inverts of the utility lines.

We estimate that footing settlements under the anticipated design loads for footings bearing on the in-situ stiff soils or engineered fill as recommended herein to be less than 1 inch total with differential settlements on the order of ½ inch.

Lateral loads acting on the structure may be resisted by passive earth pressure acting against the near-vertical faces of the foundation system and by frictional resistance developed between the bottom of the foundation and the bearing soil. Resistance due to passive earth pressure may be estimated using an equivalent fluid pressure of 300 pounds per square foot per foot of depth (p.c.f.). This assumes that the soil around footings is well-compacted. The passive pressure should be reduced for foundations located on slopes. Unless covered by pavements or slabs, the passive resistance in the upper 12 inches of soil should be neglected. A coefficient of friction of 0.3 and 0.35 may be used for footings bearing on the in-situ stiff soils and compacted engineered fill, respectively.

Uplift loads acting on the foundations may be resisted by the dead weight of the footings and the side shear along the vertical faces of the footings. A side shear value of 150 p.s.f. may be used for estimating resistance to uplift forces. This value is intended for transient loads and should not be increased by one-third (⅓). Additional uplift resistance may be obtained from the gravity loads of grade beams and/or floor slabs provided that they are structurally connected to the foundations.

We also recommend that footing excavations be observed by a representative of Geolabs-Hawaii prior to the placement of reinforcing steel or concrete to confirm the foundation bearing conditions and the required embedment depths.

Building Set-Back

Some of the house lots may be located adjacent to relatively steep slopes. We recommend that the lot owners be informed that the residential structures constructed on these lots should be set-back a minimum of 15 feet away from the tops of these steep slopes to reduce the effects of possible slope creep movements.

The use of post-and-beam construction with pier footing foundations is highly desirable and, is recommended for residential structures on these lots. However, it is important that the bottoms of the individual post footings be embedded deep enough to achieve a minimum 10-foot set-back distance between the outside edge of the footing bottom and the slope face. A qualified geotechnical engineer should be retained to provide consultation and monitoring services for the foundation design of these house lots.

Retaining Walls

We anticipate that retaining walls may be required to provide grade separation at the project site. The following guidelines may be used for the preliminary design of retaining walls:

1. An allowable bearing pressure of up to 2,500 p.s.f. may be used for the design of wall footing foundations bearing on the in-situ stiff soils or engineered fill. This bearing value is for dead plus live loads and may be increased by one-third for transient loadings, such as wind or seismic forces.

2. For lateral earth pressures, the following values may be used:

Walls unrestrained at the top (active condition, level backfill)	-	40 p.s.f. equivalent fluid pressure per foot of depth
Walls unrestrained at the top (active condition, 2H:1V sloping backfill)	-	55 p.s.f. equivalent fluid pressure per foot of depth
Walls restrained at the top (at-rest condition, level backfill)	-	55 p.s.f. equivalent fluid pressure per foot of depth

   Level backfill condition may be used for 5H:1V slopes or flatter. The surcharge stresses due to areal surcharges, line loads, and point loads within a horizontal distance equal to the height of the wall should be considered in the design. For uniform surcharge stresses imposed on the loaded side of the wall, a rectangular distribution over the height of the wall with a pressure equal to 40 and 55 percent of the surcharge load is normally used for active and at-rest conditions, respectively.

3. For resistance to lateral loads, a passive earth pressure of 300 p.s.f. per foot of depth may be used for wall footing on level areas. The passive pressure should be reduced for walls located on slopes. A base friction

factor of 0.3 may also be used to evaluate the resistance against sliding of the walls.

4. Wall footings should have a minimum width of 18 inches. Wall foundations on relatively flat areas should be embedded a minimum depth of 24 inches below the lowest adjacent finish grade. For sloping ground, the footing should extend deeper to obtain a minimum 8-foot set-back distance measured horizontally from the outside edge of the footing to the face of the slope. Wall footings oriented parallel to the direction of the slope should be constructed in stepped footings.

5. Wall foundations located next to sewer/drainage easements should be embedded below a 1H:1V imaginary plane extending upward from the bottom edge of the utility trench or as deep as the inverts of the utility lines.

6. Unless covered by concrete slabs, a subsurface drainage system (subdrains or weepholes) should be utilized behind the walls to reduce potential build-up of hydrostatic pressures. A typical drainage system consists of 1 to 2-foot wide zone of No. 3B Fine gravel material wrapped in a filter fabric (Mirafi 140N or equivalent) immediately adjacent to the wall with a perforated pipe, with perforations down, at the base of the structure discharging to a storm drain or other discharge facility. As an alternative, a prefabricated drainage product, such as MiraDrain or EnkaDrain, may be used instead of the drainage material with filter fabric. The prefabricated drainage product should also be hydraulically connected to a perforated pipe at the base of the wall.

7. Backfill behind the No. 3B Fine gravel drainage zone may consist of on-site soils or select granular fill material. Unless covered by concrete slabs, the upper 12 inches of backfill should consist of non-expansive impervious material to reduce water infiltration behind the walls.

Pavement Design

Asphaltic concrete pavements are anticipated for the subdivision roadways. The anticipated subgrade soils for the proposed roadways as encountered in our borings consist of the brown clayey silts. Based on our field exploration and laboratory testing, the above anticipated subgrade soils appear to have a CBR value of 15 with expansion value of about 1.3 percent. Considering the medium traffic anticipated for the proposed roadways, we recommend the following preliminary pavement designs for budgeting purposes:

Asphaltic Concrete Pavement

2.0-Inch Asphaltic Concrete
6.0-Inch Base Course (95 percent relative compaction)
6.0-Inch Select Borrow (95 percent relative compaction)
14.0-Inch Total Pavement Thickness on Compacted
Moist Subgrade Soil

Portland Cement Concrete Apron

6.0-Inch Portland Cement Concrete
6.0-Inch Base Course (95 percent compaction)
12.0-Inch Total Pavement Thickness on Compacted
Moist Subgrade Soil

The base course should consist of crushed basalt aggregate compacted to not less than 95 percent relative compaction. CBR and density tests should be performed on the actual subgrade soils encountered during construction to confirm the adequacy of the above section. Joints for rigid pavements are recommended at about 8 to 10-foot intervals and at discontinuities to allow for some relative movements of the concrete.

Paved areas should be sloped and drainage gradients maintained to carry all surface water off the site. Surface water ponding should not be allowed anywhere on the site during or after construction. Where concrete curbs are used to isolate landscaping in or adjacent to the pavement areas, we recommend the curbs be extended a minimum of 2 inches into the subgrade soil below the base course aggregate to reduce migration of landscape water into the pavement section. Alternatively, a subdrain system could be constructed to collect excessive water from landscaping irrigation. For long-term performance, we recommend a subdrain system be constructed adjacent to paved/landscape areas.

Sewage Disposal System

We understand that on-site sewage treatment and disposal by double cesspools or septic tank with seepage pit methods will be utilized on an interim basis until a regional sewage system can be developed. Therefore, we have conducted field percolation tests to obtain data pertaining to the design of the sewage disposal system.

A total of 11 field percolation tests were performed at selected locations across the project site. Five of these tests were performed at shallow depths ranging from 3.3 to 5 feet below the existing ground surface with the remaining six percolation tests conducted at greater depths of approximately 20 feet below the existing ground surface. Results of our percolation tests are presented on Plates C-1 through C-11 of Appendix C. Due to the variability of the subsoil conditions, the absorption capacity of the disposal system should be confirmed by additional percolation tests during construction.

Utility Trench

We envision that new utility lines may be required for the project. A granular bedding consisting of 6 inches of No. 3B Fine gravel (ASTM C 33, No. 67 gradation) is recommended under the pipes. Free-draining granular materials, such as No. 3B Fine gravel (ASTM C 33, No. 67 gradation), should also be used for the trench backfill up to about 12 inches above the pipes to provide adequate support around the pipes and to reduce the compaction effort of the backfill, thus reducing the possibility of damaging the pipes. It is critical to use this free-draining material to reduce the potential of formation of voids below the haunches of pipes and to provide adequate support for the sides of the pipes which could result in settlement of the backfill and damage to the pipes.

The upper portion of the trench backfill from the level 12 inches above the pipes to the top of the subgrade or finished grade should consist of on-site soils or select fill material. The backfill should be placed in maximum 8-inch level loose lifts and mechanically compacted to not less than 90 percent relative compaction to reduce the potential for future ground subsidence. Where trenches are below pavement areas, the upper 2 feet of the trench backfill below the pavement subgrade should be compacted to 95 percent relative compaction.

Drainage

The finished grades outside the residential structures should be sloped to shed water away from foundations and to reduce the potential for ponding. Also, it is advised that gutter systems be installed around the residential structures and that the discharge be diverted away from the foundation and pavement areas. Excessive landscape watering near the foundations and slabs should also be avoided. Planters next to foundations should be avoided or have concrete bottoms and drains to reduce water infiltration into the subsoils.

These drainage requirements are essential for the proper performance of the above foundation recommendations since ponded water could cause subsurface soil saturation and subsequent heaving or loss of strength. The foundation excavations should be properly backfilled against the walls or slab footings immediately after setting of the concrete to reduce water infiltration.

Drainage swales should be provided as soon as possible and should be maintained to drain all surface run-off away from the slab and footing foundations.

Design Review

Preliminary and final drawings and specifications for the proposed subdivision development project should be forwarded to Geolabs-Hawaii for review and written comments prior to advertisement for bidding. This review is necessary to evaluate conformance with the intent of the earthwork and foundation recommendations provided herein. If this review is not made, Geolabs-Hawaii cannot be responsible for mis-interpretation of our recommendations.

Construction Monitoring

It is recommended that Geolabs-Hawaii be retained to provide geotechnical engineering services during the site grading and construction of the foundations. This is to observe compliance with the intent of the design concepts, specifications, or recommendations and to expedite suggestions for design changes that may be required in the event that subsurface conditions differ from those anticipated at the time this report was prepared. The recommendations provided in this report are contingent upon such observations.

Any imported material required should be tested by Geolabs-Hawaii for conformance with the project specifications prior to hauling to the project site.

If actual exposed subsurface conditions encountered during construction are different from those assumed or considered in this report, then appropriate modifications to the design should be made.

LIMITATIONS

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

The location of the field borings indicated in this report are approximate, having been estimated by taping from the property lines shown on the Conceptual Layout by Akinaka & Associates, Ltd. dated July 21, 1994. Elevations of the field borings were estimated by interpolation from the contours shown on the same plan. The physical locations and elevations of the borings should be considered accurate only to the degree implied by the methods used.

The stratification lines shown on graphic representations of the borings depict the approximate boundaries between soil types and, as such, may denote a gradual transition.

Water level data from the borings were measured at the times shown on the graphic representations and/or in the text of this report. These data have been reviewed and interpretations made in the formulation of this report. However, it must be noted that fluctuation may occur due to variation in rainfall, tides, temperature and other factors.

This report has been prepared for the exclusive use of Akinaka & Associates, Ltd., their client, DHHL, and their consultants for specific application to the proposed Anahola Residence Lots - Unit 6 project in accordance with generally accepted geotechnical engineering principles and practices. No warranty is expressed or implied.

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

The Owner/Client should be aware that unanticipated soil conditions are commonly encountered. Unforeseen soil conditions, such as perched groundwater, soft deposits, hard layers or loose fills 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.

APPENDICES AND PLATES

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

Appendix A	-	Field Exploration
Plate A	-	Boring Log Legend
Plates A-1 thru A-12	-	Logs of Borings

-o0o0o0o0o0o0o0o0o0o0o-

Respectfully submitted,

C.W. ASSOCIATES INC.
dba **GEOLABS-HAWAII**

By Teddy S.T. Kwok
Teddy S.T. Kwok, P.E.
Project Engineer

By [signature]
Robin M. Lim, P.E.
Vice President

RML:TK:crc

(h:\user\crc\reports\3348-00.tk)

APPENDIX A

Field Exploration

The subsurface conditions at the site were explored by drilling and sampling 12 borings to depths ranging from 20 to 21½ feet below the existing ground surface at the approximate locations shown on the Site Plan, Plate 2. The borings were drilled using truck-mounted drilling equipment.

The material encountered in the borings were classified by visual and textural examination in the field by our field engineer, who monitored the drilling operations on a near-continuous basis. These classifications were further reviewed visually and by testing in the laboratory. Soils were classified in general conformance with the Unified Soil Classification System, as shown on Plate A. Graphic representation of the materials encountered are presented on the Logs of Borings, Plates A-1 through A-12.

Soil samples were obtained from the drilled borings in general accordance with ASTM Test Designation D 1586-84, Penetration Test and Split-Barrel Sampling of Soils, by driving a 2-inch O.D. standard penetration sampler or a 3-inch O.D. Modified California sampler with a 140-pound hammer falling 30 inches. The blow counts needed to drive the sampler the last 12 inches of an 18-inch drive are shown on the Logs of Borings at the appropriate sample depths.

W.O. 3348-00 DECEMBER 1994

(h:\user\crc\reports\3348-00.tk - pg 30)

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

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

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

LEGEND:

	2-INCH O.D. STANDARD PENETRATION TEST	LL	LIQUID LIMIT
	3-INCH O.D. MODIFIED CALIFORNIA SAMPLE	PI	PLASTICITY INDEX
	SHELBY TUBE SAMPLE	TV	TORVANE SHEAR (tsf)
	CORE SAMPLE	PEN	POCKET PENETROMETER (tsf)
REC	CORE RECOVERY		WATER LEVEL OBSERVED IN BORING
RQD	ROCK QUALITY DESIGNATION		

CW ASSOCIATES, INC. dba **GEOLABS-HAWAII** Geology Soils and Foundation Engineering	**BORING LOG LEGEND** ANAHOLA RESIDENCE LOTS - UNIT 6 ANAHOLA, KAUAI, HAWAII	PLATE A
WORK ORDER NO. 3348-00 Nov 94		

Date Started:	11/2/94	**Drill Rig:**	Mobile B-53
Date Completed:	11/2/94	**Drilling Method:**	4" Auger
Logged By:	B. Chang		
Total Depth:	21.5 feet	**Driving Energy:**	140 lb. wt., 30 in. drop

Depth, ft	FIELD: Sample	FIELD: Penetra. Resist. Blows/ft	LABORATORY: Dry Density pcf	LABORATORY: Moisture Content %	LABORATORY: Compress. Strength ksf	Other Data	Pen, tsf	DESCRIPTION (Approximate Surface Elevation (ft): 128*)
		24		29			>4.5	Reddish brown **CLAYEY SILT (MH)**, very stiff to hard, damp (residual soil)
		54		31		LL=64 PI=27		
5		53/.3'	86	29				
10		25		36				
15		7		42				Grayish brown mottled **CLAYEY SILT (MH)**, medium stiff, moist (residual/saprolite)
								Reddish brown **CLAYEY SILT (MH)**, hard, moist (residual soil)
20		63		32				
								Boring terminated at 21.5 feet Groundwater not encountered *Elevations estimated from Conceptual Layout by Akinaka & Associates, Ltd. dated July 21, 1994.
25								
30								
35								

tk [A]BC.D/KHN.F

CW ASSOCIATES, INC. dba
GEOLABS-HAWAII
Geology Soils and Foundation Engineering

WORK ORDER NO. 3348-00 BC Nov 94

LOG OF BORING 1

ANAHOLA RESIDENCE LOTS-UNIT 6
ANAHOLA, KAUAI, HAWAII

PLATE
A-1

Date Started: 11/1/94

Date Completed: 11/1/94

Logged By: B. Chang

Total Depth: 21.5 feet

Drill Rig: Mobile B-53

Drilling Method: 4" Auger

Driving Energy: 140 lb. wt., 30 in. drop

Depth, ft	FIELD Sample	FIELD Penetra. Resist. Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Compress. Strength ksf	Other Data	Pen, tsf	DESCRIPTION (Approximate Surface Elevation (ft): 107*)
		29		31				Reddish brown **CLAYEY SILT (MH)**, very stiff to hard, damp (residual soil)
		34		29				
5		55	75	28			>4.5	grades with some decomposed basalt gravel
10		20		32				Brown **CLAYEY SILT (MH)**, very stiff, damp (residual soil)
15		14		45				Brownish gray **CLAYEY SILT (MH)** with some fine sand, stiff to very stiff, moist (residual soil)
20		23		43				Reddish brown **CLAYEY SILT (MH)**, very stiff, moist (residual soil)
								Boring terminated at 21.5 feet
								Groundwater not encountered
25								
30								
35								

tk [R]BC.D/KHW.F

CW ASSOCIATES, INC. dba

GEOLABS-HAWAII

Geology Soils and Foundation Engineering

WORK ORDER NO. 3348-00 BC Nov 94

LOG OF BORING 2

ANAHOLA RESIDENCE LOTS-UNIT 6

ANAHOLA, KAUAI, HAWAII

PLATE A-2

Date Started: 11/2/94
Date Completed: 11/2/94
Logged By: B. Chang
Total Depth: 21.5 feet

Drill Rig: Mobile B-53
Drilling Method: 4" Auger
Driving Energy: 140 lb. wt., 30 in. drop

Depth, ft	FIELD: Sample	FIELD: Penetra. Resist. Blows/ft	LABORATORY: Dry Density pcf	LABORATORY: Moisture Content %	LABORATORY: Compress. Strength ksf	Other Data	Pen, tsf	DESCRIPTION (Approximate Surface Elevation (ft): 107*)
		60	85	33			>4.5	Brown **CLAYEY SILT (MH)**, very stiff to hard, damp (residual soil)
		24		32				grades with decomposed basalt gravel
5		27		31				
10		13		38				Light brown mottled **SILTY GRAVEL (GM)** with sand, medium dense, damp (saprolite)
15		22		38				Brownish gray mottled **SANDY SILT (ML)**, very stiff, moist (saprolite)
20		8		38				Brown **CLAYEY SILT (MH)**, medium stiff, moist (residual)
								Boring terminated at 21.5 feet
								Groundwater not encountered
25								
30								
35								

tk [R]BC.D/KHN.F

CW ASSOCIATES, INC. dba
GEOLABS-HAWAII
Geology Soils and Foundation Engineering
WORK ORDER NO. 3348-00 BC Nov 94

LOG OF BORING 3
ANAHOLA RESIDENCE LOTS-UNIT 6
ANAHOLA, KAUAI, HAWAII

PLATE
A-3

Date Started: 11/1/94
Date Completed: 11/1/94
Logged By: B. Chang
Total Depth: 21.3 feet

Drill Rig: Mobile B-53
Drilling Method: 4" Auger
Driving Energy: 140 lb. wt., 30 in. drop

Depth, ft	Sample	FIELD Penetra. Resist. Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Compress. Strength ksf	Other Data	Pen, tsf	DESCRIPTION (Approximate Surface Elevation (ft): 123*)
		39		31				Reddish brown **CLAYEY SILT (MH)**, very stiff to hard, moist (residual soil)
		63		32			>4.5	
5		40		31				
10		54	92	32			>4.5	
								Brown **CLAYEY SILT (MH)**, very stiff, moist (residual soil)
15		23		38				
								Brownish gray **SILTY SAND (SM)** with decomposed basalt gravel, very dense, moist
20		26/.5' +23/.3' Ref.		36				
								Boring terminated at 21.3 feet Groundwater not encountered
25								
30								
35								

tk [R]BC.D/KHH.F

CW ASSOCIATES, INC. dba
GEOLABS-HAWAII
Geology Soils and Foundation Engineering

WORK ORDER NO. 3348-00 BC Nov 94

LOG OF BORING 4

ANAHOLA RESIDENCE LOTS-UNIT 6
ANAHOLA, KAUAI, HAWAII

PLATE A-4

Date Started: 11/2/94
Date Completed: 11/2/94
Logged By: B. Chang
Total Depth: 21.5 feet

Drill Rig: Mobile B-53
Drilling Method: 4" Auger
Driving Energy: 140 lb. wt., 30 in. drop

Depth, ft	FIELD Sample	FIELD Penetra. Resist. Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Compress. Strength ksf	Other Data	Pen, tsf	DESCRIPTION (Approximate Surface Elevation (ft): 98*)
		18		27				Reddish brown **CLAYEY SILT (MH)**, very stiff to hard, damp (residual soil)
		76	93	30			>4.5	
5		39		29		LL=58 PI=22		
10		32		33				
15		27		32				
								Brown **CLAYEY SILT (MH)**, stiff, moist
20		12		39				
								Boring terminated at 21.5 feet Groundwater not encountered
25								
30								
35								

tk (R)BC.D/KHN.F

CW ASSOCIATES, INC. dba
GEOLABS-HAWAII
Geology Soils and Foundation Engineering

WORK ORDER NO. 3348-00 BC Nov 94

LOG OF BORING 5
ANAHOLA RESIDENCE LOTS-UNIT 6
ANAHOLA, KAUAI, HAWAII

PLATE A-5

Date Started: 11/2/94
Date Completed: 11/2/94
Logged By: B. Chang
Total Depth: 21.5 feet

Drill Rig: Mobile B-53
Drilling Method: 4" Auger
Driving Energy: 140 lb. wt., 30 in. drop

Depth, ft	Sample (FIELD)	Penetra. Resist. Blows/ft (FIELD)	Dry Density pcf (LABORATORY)	Moisture Content % (LABORATORY)	Compress. Strength ksf (LABORATORY)	Other Data	Pen, tsf	DESCRIPTION — Approximate Surface Elevation (ft): 75*
		22		26				Light reddish brown **CLAYEY SILT (MH)**, very stiff to hard, damp (residual soil)
		71		32				
5		28		31				
10		23	82	34			3.8	
								Brown **CLAYEY SILT (MH)**, medium stiff, moist (residual soil)
15		8		45				
20		9		41				
								Boring terminated at 21.5 feet Groundwater not encountered
25								
30								
35								

tk (R)BC.D/KHN.F

CW ASSOCIATES, INC. dba
GEOLABS-HAWAII
Geology Soils and Foundation Engineering

WORK ORDER NO. 3348-00 BC Nov 94

LOG OF BORING 6

ANAHOLA RESIDENCE LOTS-UNIT 6
ANAHOLA, KAUAI, HAWAII

PLATE
A-6

Date Started: 10/31/94
Date Completed: 10/31/94
Logged By: B. Chang
Total Depth: 21.5 feet

Drill Rig: Mobile B-53
Drilling Method: 4" Auger
Driving Energy: 140 lb. wt., 30 in. drop

Depth, ft	FIELD Sample	FIELD Penetra. Resist. Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Compress. Strength ksf	Other Data	Pen, tsf	DESCRIPTION (Approximate Surface Elevation (ft): 65*)
		30		28				Reddish brown **CLAYEY SILT (MH)**, very stiff to hard, damp (residual soil)
		44		31		LL=72 PI=32		
5		71	77	32			>4.5	Brown **CLAYEY SILT (MH)**, hard, damp (residual soil)
10		50		33				
15		27		43				grades to very stiff, moist
20		17		44				
								Boring terminated at 21.5 feet Groundwater not encountered
25								
30								
35								

tk [R]BC.D/KHN.F

CW ASSOCIATES, INC. dba
GEOLABS-HAWAII
Geology Soils and Foundation Engineering

WORK ORDER NO. 3348-00 BC Nov 94

LOG OF BORING 7

ANAHOLA RESIDENCE LOTS-UNIT 6
ANAHOLA, KAUAI, HAWAII

PLATE A-7

Date Started:	11/1/94	Drill Rig:	Mobile B-53
Date Completed:	11/1/94	Drilling Method:	4" Auger
Logged By:	B. Chang	Driving Energy:	140 lb. wt., 30 in. drop
Total Depth:	20.1 feet		

Depth, ft	FIELD Sample	FIELD Penetra. Resist. Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Compress. Strength ksf	Other Data	Pen, tsf	DESCRIPTION (Approximate Surface Elevation (ft): 86*)
		44	78	30			>4.5	Light reddish brown **CLAYEY SILT (MH)**, very stiff to hard, damp (residual soil)
		43		28				
5		36		31			3.8	
10		30		32			>4.5	
								Grayish brown **SILTY SAND (SM)** with decomposed gravel, medium dense, moist (saprolite)
15		16		44				
20		20/.1' Ref.		15				Gray **SANDY GRAVEL (GW)**, very dense, damp (decomposed basalt)
								Boring terminated at 20.1 feet
								Groundwater not encountered
25								
30								
35								

tk [R]BC.D/KHN.F

CW ASSOCIATES, INC. dba
GEOLABS-HAWAII
Geology Soils and Foundation Engineering

WORK ORDER NO. 3348-00 BC Nov 94

LOG OF BORING 8

ANAHOLA RESIDENCE LOTS-UNIT 6
ANAHOLA, KAUAI, HAWAII

PLATE A-8

Date Started:	11/1/94	Drill Rig:	Mobile B-53
Date Completed:	11/1/94	Drilling Method:	4" Auger
Logged By:	B. Chang	Driving Energy:	140 lb. wt., 30 in. drop
Total Depth:	21.5 feet		

Depth, ft	Sample	FIELD Penetra. Resist. Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Compress. Strength ksf	Other Data	Pen, tsf	DESCRIPTION (Approximate Surface Elevation (ft): 75*)
		10		29				Reddish brown **CLAYEY SILT (MH)**, stiff, damp (residual soil)
		42		29				grades to hard
5		32/.5' +40/.4'		28				
10		29	82	33			4.0	grades with fine sand, very stiff
15		45		38				Grayish brown **SILTY SAND (SM)** with decomposed gravel, dense, damp (saprolite)
								grades to medium dense, moist
20		14		47				
								Boring terminated at 21.5 feet
								Groundwater not encountered
25								
30								
35								

tk (P)BC.D/KHN.F

CW ASSOCIATES, INC. dba **GEOLABS-HAWAII** Geology Soils and Foundation Engineering	**LOG OF BORING 9** ANAHOLA RESIDENCE LOTS-UNIT 6 ANAHOLA, KAUAI, HAWAII	PLATE **A-9**
WORK ORDER NO. 3348-00 BC Nov 94		

Date Started: 11/1/94
Date Completed: 11/1/94
Logged By: B. Chang
Total Depth: 21.5 feet

Drill Rig: Mobile B-53
Drilling Method: 4" Auger
Driving Energy: 140 lb. wt., 30 in. drop

Depth, ft	FIELD Sample	FIELD Penetra. Resist. Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Compress. Strength ksf	Other Data	Pen, tsf	DESCRIPTION — Approximate Surface Elevation (ft): 62*
		37		29			>4.5	Brown **CLAYEY SILT (MH)**, hard, damp (residual soil)
		93	82	31			>4.5	Reddish brown **CLAYEY SILT (MH)**, hard, damp (residual soil)
5		20		29				grades to very stiff
10		53		15				Gray **SANDY BASALT GRAVEL (GW)**, very dense, damp (highly weathered basalt)
15		49		31				
20		26		15				grades medium dense to dense
								Boring terminated at 21.5 feet
								Groundwater not encountered
25								
30								
35								

tk [R]BC.D/KHN.F

CW ASSOCIATES, INC. dba
GEOLABS-HAWAII
Geology Soils and Foundation Engineering

WORK ORDER NO. 3348-00 BC Nov 94

LOG OF BORING 10
ANAHOLA RESIDENCE LOTS-UNIT 6
ANAHOLA, KAUAI, HAWAII

PLATE A-10

Date Started: 10/31/94

Date Completed: 10/31/94

Logged By: B. Chang

Total Depth: 21.5 feet

Drill Rig: Mobile B-53

Drilling Method: 4" Auger

Driving Energy: 140 lb. wt., 30 in. drop

Depth, ft	FIELD Sample	FIELD Penetra. Resist. Blows/ft	LABORATORY Dry Density pcf	LABORATORY Moisture Content %	LABORATORY Compress. Strength ksf	Other Data	Pen, tsf	DESCRIPTION (Approximate Surface Elevation (ft): 62*)
		50	76	31			>4.5	Reddish brown **CLAYEY SILT (MH)**, hard, damp (residual soil)
		62		31				
5		65		28		LL=71 PI=37		Light brown **CLAYEY SILT (MH)**, hard, damp (residual soil)
10		8		36				Grayish brown **SILTY SAND (SM)**, loose, moist (saprolite) grades to medium dense
15		31/.5' +40/.3'		34				Brownish gray **SILTY SAND (SM)** with a little decomposed gravel, medium dense, moist (saprolite)
20		20		39				Boring terminated at 21.5 feet Groundwater not encountered
25								
30								
35								

tk [R]BC.D/KHN.F

CW ASSOCIATES, INC. dba
GEOLABS-HAWAII
Geology Soils and Foundation Engineering

WORK ORDER NO. 3348-00 BC Nov 94

LOG OF BORING 11

ANAHOLA RESIDENCE LOTS-UNIT 6

ANAHOLA, KAUAI, HAWAII

PLATE A-11

Date Started:	10/31/94	Drill Rig:	Mobile B-53
Date Completed:	10/31/94	Drilling Method:	4" Auger
Logged By:	B. Chang	Driving Energy:	140 lb. wt., 30 in. drop
Total Depth:	20.0 feet		

Depth, ft	FIELD: Sample	FIELD: Penetra. Resist. Blows/ft	LABORATORY: Dry Density pcf	LABORATORY: Moisture Content %	LABORATORY: Compress. Strength ksf	Other Data	Pen, tsf	DESCRIPTION — Approximate Surface Elevation (ft): 57*
		37		27				Reddish brown **CLAYEY SILT (MH)**, hard, damp (residual soil)
		55/.4'	80	27			2.3	Brown **SILTY SAND (SM)**, dense, damp (saprolite)
5								basalt rock from 4 to 5.5 feet, very dense
		28		27				grades to medium stiff, moist
10								basalt rock from 9.5 to 10.5 feet, very dense
		8		41				grades to loose
15		36		34				grades with decomposed gravel, medium dense (highly weathered basalt)
								grades to very dense
20		Ref.		9				Boring terminated at 20 feet
								Groundwater not encountered
25								
30								
35								

tk (R)BC.D/KHN.I

CW ASSOCIATES, INC. dba
GEOLABS-HAWAII
Geology Soils and Foundation Engineering

WORK ORDER NO. 3348-00 BC Nov 94

LOG OF BORING 12
ANAHOLA RESIDENCE LOTS-UNIT 6
ANAHOLA, KAUAI, HAWAII

PLATE
A-12

APPENDIX B

Laboratory Testing

Moisture content and unit weight determinations were performed on selected soil samples as an aid in the classification and evaluation of soil properties. The results of these tests are presented on the Logs of Borings at the appropriate sample depths.

Eight 1-inch ring swell tests were performed on selected samples to evaluate the swelling potential of the subsoils. The test results are summarized on Plate B-1.

Four Atterberg Limits tests were performed on selected samples of the soils to evaluate their liquid and plastic limits and to aid in soil classification. The test results are presented on the Logs of Borings at the appropriate sample depths. Graphic presentation of the test results is provided on Plate B-2.

Three sieve analyses were performed on selected samples to determine the gradation characteristics of the soils and to aid in soil classification. Graphic presentation of the grain size distribution is presented on Plate B-3.

One laboratory California Bearing Ratio Test (ASTM Test Method D 1883-87) was performed on the typical clayey silt soils to evaluate the pavement support characteristics of the soils. The test results are presented on Plate B-4.

W.O. 3348-00 DECEMBER 1994

(h:\user\crc\reports\3348-00.tk - pg 31)

SUMMARY OF ONE-INCH RING SWELL TESTS

Anahola Residence Lots - Unit 6
Anahola, Kauai, Hawaii

Location	Depth (feet)	Soil Description	Dry Density (p.c.f.)	Moisture Contents Initial (%)	Moisture Contents Air-Dried (%)	Moisture Contents Final (%)	Ring Swell (%)
B-1	5.0 - 6.5	REDDISH BROWN CLAYEY SILT	88	28	--	40	3.9
B-2	5.0 - 6.5	REDDISH BROWN CLAYEY SILT	80	28	--	47	0.5
B-3	1.0 - 2.5	BROWN CLAYEY SILT	87	35	18	40	3.7
B-4	10.0 - 11.5	REDDISH BROWN CLAYEY SILT	93	32	16	36	5.0
B-7	10.0 - 11.5	BROWN CLAYEY SILT	84	33	17	43	4.2
B-8	1.0 - 2.5	LIGHT REDDISH BROWN CLAYEY SILT	80	31	--	44	1.9
B-9	10.0 - 11.5	REDDISH BROWN CLAYEY SILT W/SAND	86	36	19	39	1.9
B-10	3.0 - 4.5	REDDISH BROWN CLAYEY SILT	86	31	--	39	1.9

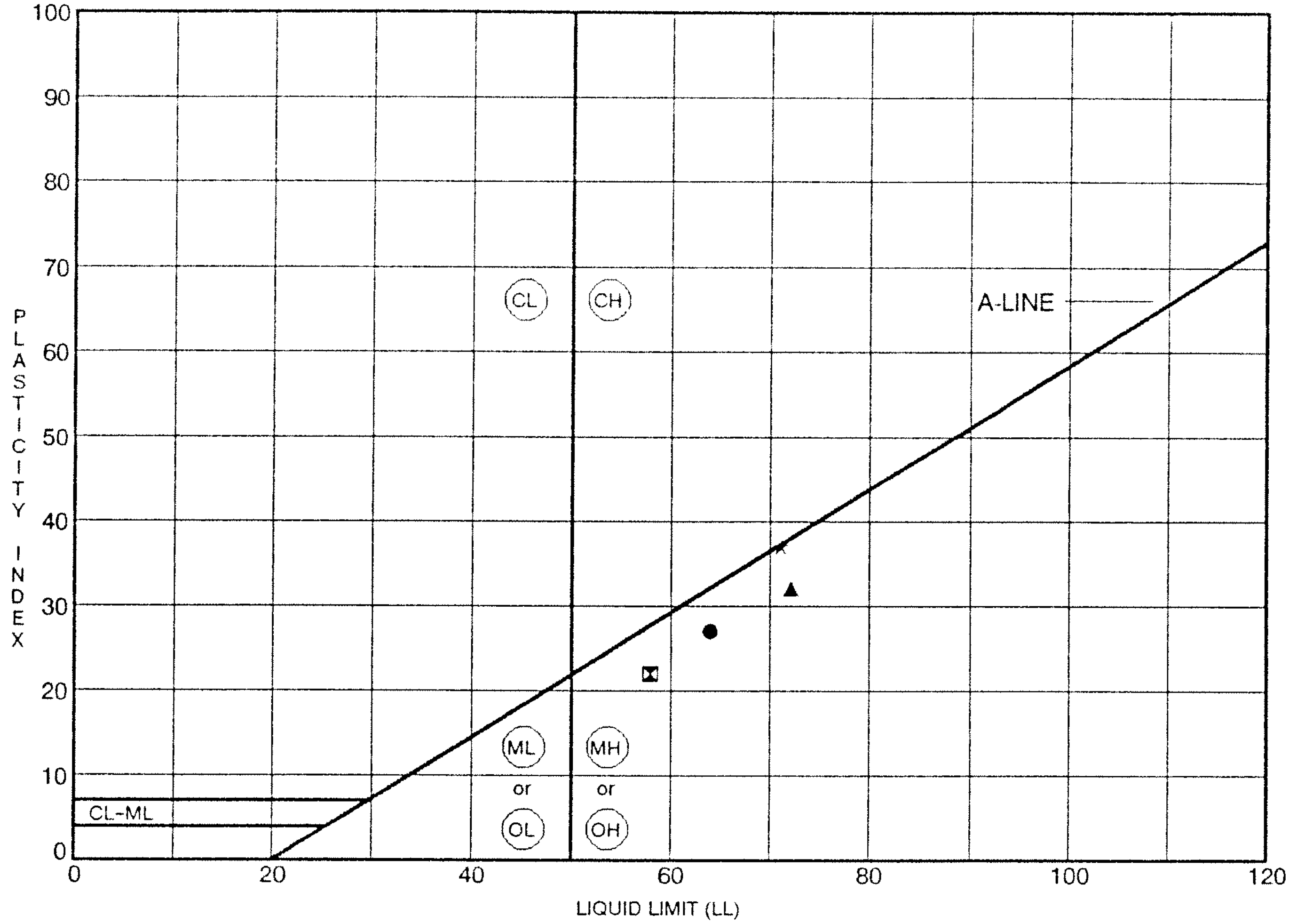
NOTE: Samples tested were undisturbed in 2.4-inch diameter by 1 inch high rings. They were air-dried overnight then saturated for 24 hours under a surcharge load of 55 p.s.f.

W.O. 3348-00 DECEMBER 1994

PLATE B-1

TK:crc

(h:\user\crc\ringswel\3348-00.tk)



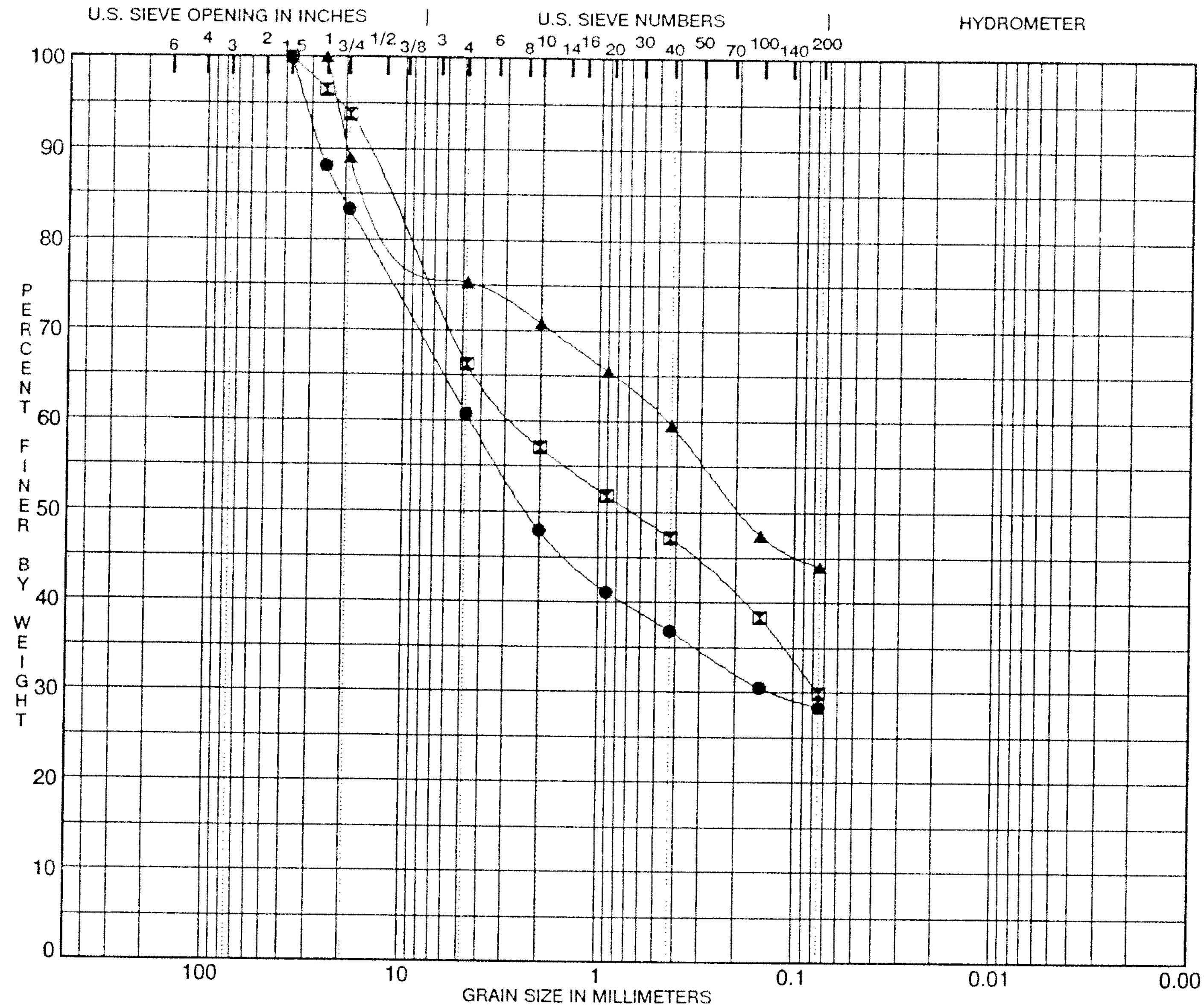
	Location	Depth (feet)	Description	LL	PL	PI
●	B - 1	3.0 - 4.5	Reddish brown CLAYEY SILT	64	37	27
⧗	B - 5	5.0 - 6.5	Reddish brown CLAYEY SILT	58	36	22
▲	B - 7	3.0 - 4.5	Reddish brown CLAYEY SILT	72	40	32
★	B - 11	5.0 - 6.5	Light brown CLAYEY SILT	71	34	37

PROJECT:
ANAHOLA RESIDENCE LOTS-UNIT 6
ANAHOLA, KAUAI, HAWAII

ATTERBERG LIMITS SUMMARY	
C.W. ASSOCIATES, Inc. dba **Geolabs-Hawaii**	
DATE Nov 94	W.O. 3348-00

ATTERBRG

PLATE B - 2



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Location	Depth (feet)	Description	LL	PL	PI
●	B - 3	10.0 - 11.5	Light brown mottled SILTY GRAVEL (GM) with sand			
⧗	B - 8	15.0 - 16.5	Grayish brown SILTY SAND (SM) with gravel			
▲	B - 9	15.0 - 16.5	Grayish brown SILTY SAND (SM) with gravel			

PROJECT:
ANAHOLA RESIDENCE LOTS-UNIT 6
ANAHOLA, KAUAI, HAWAII

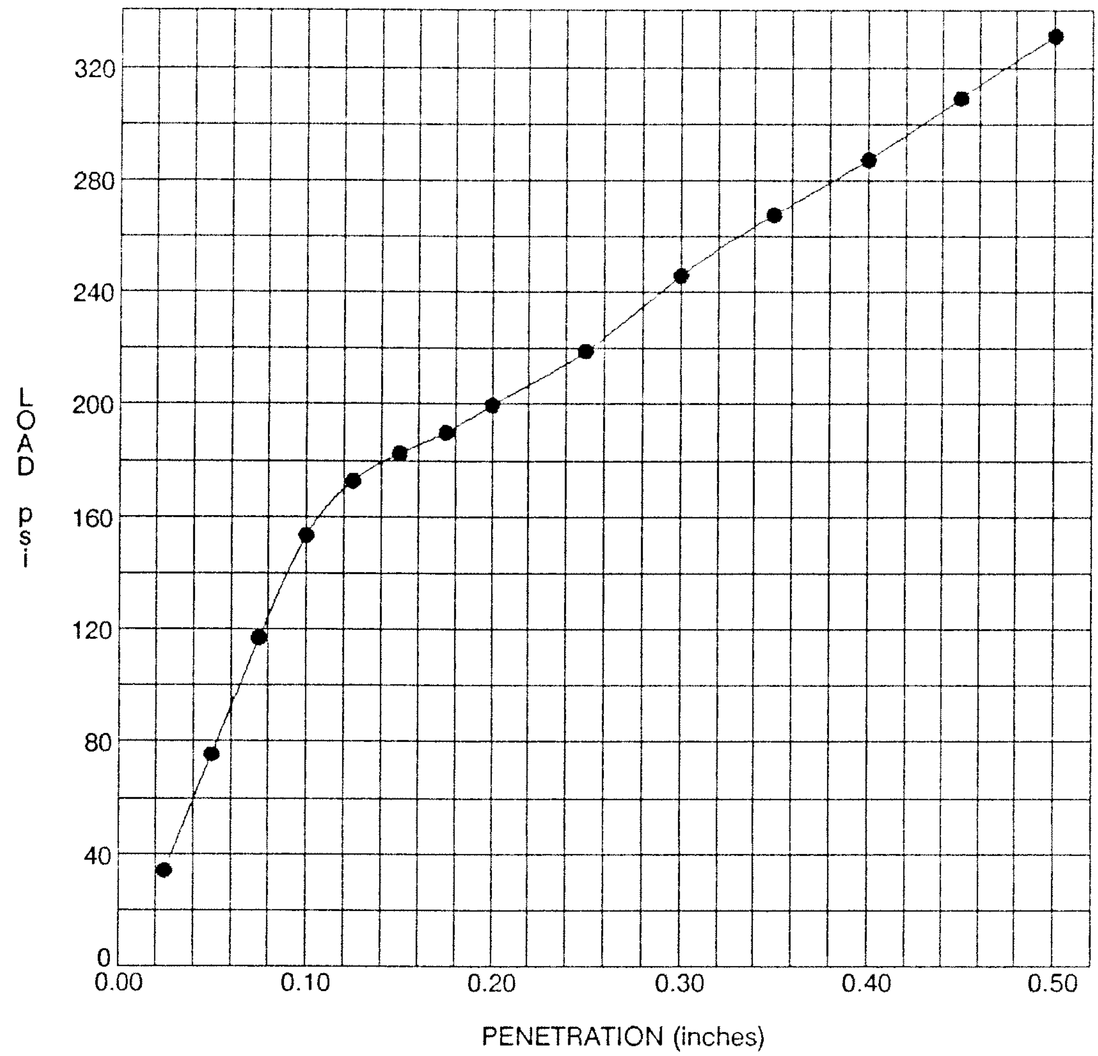
SIEVE ANALYSIS

C.W. ASSOCIATES, Inc. dba
Geolabs-Hawaii

DATE	W.O.
Nov 94	3348-00

SIEVE#1

PLATE B - 3



LOCATION: B - 4
DEPTH (FEET): 0.0 - 1.0
DESCRIPTION: Reddish brown CLAYEY SILT

AGGREGATE 3/4 inch minus
HAMMER WT. 10 lbs.
HAMMER DROP 18 inches
NO. OF BLOWS 56
NO. OF LAYERS 5

MOLDING MOISTURE (%): 29.0
MOLDING DRY DENSITY (p.c.f.): 93.0
CBR @ 0.1 PENETRATION: 15.4
DAYS SOAKED: 3
SWELL (%): 1.30

CORRECTED CBR @ 0.1 "
PENETRATION: 154 X 100/1000 = 15.4

PROJECT:
ANAHOLA RESIDENCE LOTS-UNIT 6
ANAHOLA, KAUAI, HAWAII

CBR TEST

C.W. ASSOCIATES, Inc. dba
Geolabs-Hawaii

DATE	W.O.
Nov 94	3348-00

PLATE B - 4

APPENDIX C

Field Percolation Testing

The field percolation rate of the on-site soils were estimated by performing 11 falling head percolation tests in Boring Nos. P-2, P-4, P-8, P-10, P-11, B-2, B-4, B-8, B-9, B-10, and B-11. The test results are presented on Plates C-1 through C-11.

The percolation tests were performed by drilling 4-inch diameter boreholes to depths ranging from approximately 3 to 21½ feet below the existing ground surface. Six inches to 1 foot of gravel was then placed at the bottom of the boreholes to protect the bottom of the holes from scouring and sediments. The boreholes were then presoak for at least 4 hours prior to testing.

During testing, the holes were carefully filled with water to a minimum depth of 12 inches over the gravel pack. The time intervals and water drops were then recorded to provide data upon which to base calculation of the percolation rates.

W.O. 3348-00 DECEMBER 1994

(h:\user\crc\reports\3348-00.tk - pg 32)

SITE EVALUATION/PERCOLATION TEST

Date/Time: November 4, 1994 / 0733 / Boring P-2

Test performed by: Brian Chang

Owner: Department of Hawaiian Home Lands

Tax Map Key: N/A

Elevation: 107 ft
Depth to Groundwater Table: N/A ft below grade
Depth to Bedrock (if observed): N/A ft below grade
Diameter of Hole: 4 in
Depth to Hole Bottom: 4.5 ft below grade

Depth below grade (ft)	Soil Profile (color, texture, other)
0 - 4.5	Brown clayey silt, very stiff, damp

PERCOLATION READINGS

Time 12 in of water to seep away: - min (first trial reading)
Time 6 in of water to seep away: - min (second trial reading)

For percolation tests in sandy soils, record time intervals and water drops at least every 10 minutes for at least 1 hour.

For percolation tests in non-sandy soils, presoak the test hole for at least 4 hours. Record time intervals and water drops at least every 10 minutes for 1 hour; or if the time for the first 6 inches to seep away is greater than 30 minutes, record 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
55	9.76		
31	3.56		
30	5.75		
40	4.75		
50	4.13		

Percolation Rate (time/final water level drop): 12 min/in

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.

SHUI TAT KWOK
LICENSED PROFESSIONAL ENGINEER
No. 7951-C
HAWAII, U.S.A.

Shui Tat Kwok

Engineer's Signature/Stamp
Shui Tat Kwok, P.E.

revised 5/92

W.O. 3348-00 NOVEMBER 1994

(h:\user\crc\siteeval\3024-00)

PLATE C-1

GEOLABS-HAWAII

SITE EVALUATION/PERCOLATION TEST

Date/Time: November 4, 1994 / 0817 / Boring P-4

Test performed by: Brian Chang

Owner: Department of Hawaiian Home Lands

Tax Map Key: N/A

Elevation: 123 ft
Depth to Groundwater Table: N/A ft below grade
Depth to Bedrock (if observed): N/A ft below grade
Diameter of Hole: 4 in
Depth to Hole Bottom: 3.3 ft below grade

Depth below grade (ft)	**Soil Profile** (color, texture, other)
0 - 3.3	Brown clayey silt, very hard, moist

PERCOLATION READINGS

Time 12 in of water to seep away: - min (first trial reading)
Time 6 in of water to seep away: - min (second trial reading)

For percolation tests in sandy soils, record time intervals and water drops at least every 10 minutes for at least 1 hour.

For percolation tests in non-sandy soils, presoak the test hole for at least 4 hours. Record time intervals and water drops at least every 10 minutes for 1 hour; or if the time for the first 6 inches to seep away is greater than 30 minutes, record 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
49	0.87		
42	0.37		
37	3.00		
39	2.75		
25	1.50		
18	1.13		

Percolation Rate (time/final water level drop): 16 min/in

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.

SHUI TAT KWOK
LICENSED PROFESSIONAL ENGINEER
No. 7961-C
HAWAII, U.S.A.

Kwok Shui Tat

Engineer's Signature/Stamp
Shui Tat Kwok, P.E.

revised 5/92

W.O. 3348-00 NOVEMBER 1994

(h:\user\crc\siteeval\3024-00)

GEOLABS-HAWAII

PLATE C-2

SITE EVALUATION/PERCOLATION TEST

Date/Time: November 3, 1994 / 0853 / Boring P-8

Test performed by: Brian Chang

Owner: Department of Hawaiian Home Lands

Tax Map Key: N/A

Elevation: 86 ft
Depth to Groundwater Table: N/A ft below grade
Depth to Bedrock (if observed): N/A ft below grade
Diameter of Hole: 4 in
Depth to Hole Bottom: 5 ft below grade

Depth below grade (ft)	**Soil Profile** (color, texture, other)
0 - 5	Brown clayey silt, hard, damp

PERCOLATION READINGS

Time 12 in of water to seep away: - min (first trial reading)
Time 6 in of water to seep away: - min (second trial reading)

For percolation tests in sandy soils, record time intervals and water drops at least every 10 minutes for at least 1 hour.

For percolation tests in non-sandy soils, presoak the test hole for at least 4 hours. Record time intervals and water drops at least every 10 minutes for 1 hour; or if the time for the first 6 inches to seep away is greater than 30 minutes, record 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
38	0.43	32	0.44
35	0.50	28	0.49
32	0.49		
30	0.50		
31	0.31		
29	0.62		
30	0.25		

Percolation Rate (time/final water level drop): 57 min/in

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.

SHUI TAT KWOK
LICENSED PROFESSIONAL ENGINEER
No. 7951-C
HAWAII, U.S.A.

Engineer's Signature/Stamp
Shui Tat Kwok, P.E.

revised 5/92

W.O. 3348-00 NOVEMBER 1994

SITE EVALUATION/PERCOLATION TEST

Date/Time: November 3, 1994 / 0821 / Boring P-10

Test performed by: Brian Chang

Owner: Department of Hawaiian Home Lands

Tax Map Key: N/A

Elevation: 62 ft
Depth to Groundwater Table: N/A ft below grade
Depth to Bedrock (if observed): 10 ft below grade
Diameter of Hole: 4 in
Depth to Hole Bottom: 4.75 ft below grade

Depth below grade (ft)	**Soil Profile** (color, texture, other)
0 - 4.75	Brown clayey silt, very hard, damp

PERCOLATION READINGS

Time 12 in of water to seep away: - min (first trial reading)
Time 6 in of water to seep away: - min (second trial reading)

For percolation tests in sandy soils, record time intervals and water drops at least every 10 minutes for at least 1 hour.

For percolation tests in non-sandy soils, presoak the test hole for at least 4 hours. Record time intervals and water drops at least every 10 minutes for 1 hour; or if the time for the first 6 inches to seep away is greater than 30 minutes, record 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
50	0.82	30	0.18
42	0.68	10	0.04
31	0.50	22	0.37
30	0.31		
30	0.56		
30	0.37		
30	0.37		

Percolation Rate (time/final water level drop): 59 min/in

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.

SHUI TAT KWOK
LICENSED PROFESSIONAL ENGINEER
No. 7951-C
HAWAII, U.S.A.

Shui Tat Kwok

Engineer's Signature/Stamp
Shui Tat Kwok, P.E.

revised 5/92

W.O. 3348-00 NOVEMBER 1994

(h:\user\crc\siteeval\3024.00)

PLATE C-4

GEOLABS-HAWAII

SITE EVALUATION/PERCOLATION TEST

Date/Time: November 4, 1994 / 0700 / Boring P-11

Test performed by: Brian Chang

Owner: Department of Hawaiian Home Lands

Tax Map Key: N/A

Elevation: 62 ft
Depth to Groundwater Table: N/A ft below grade
Depth to Bedrock (if observed): N/A ft below grade
Diameter of Hole: 4 in
Depth to Hole Bottom: 3.1 ft below grade

Soil Profile

Depth below grade (ft)	(color, texture, other)
0 - 3.1	Brown silty clay, hard, damp

PERCOLATION READINGS

Time 12 in of water to seep away: - min (first trial reading)
Time 6 in of water to seep away: - min (second trial reading)

For percolation tests in sandy soils, record time intervals and water drops at least every 10 minutes for at least 1 hour.

For percolation tests in non-sandy soils, presoak the test hole for at least 4 hours. Record time intervals and water drops at least every 10 minutes for 1 hour; or if the time for the first 6 inches to seep away is greater than 30 minutes, record 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
48	2.87		
50	5.00		
35	1.25		
57	2.75		
30	1.09		
37	2.44		

Percolation Rate (time/final water level drop): 15 min/in

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.

SHUI TAT KWOK
LICENSED PROFESSIONAL ENGINEER
No. 7951-C
HAWAII, U.S.A.

Kwok Shui Tat

Engineer's Signature/Stamp
Shui Tat Kwok, P.E.

revised 5/92

W.O. 3348-00 NOVEMBER 1994

(h:\user\crc\siteeval\3024-00)

PLATE C-5

GEOLABS-HAWAII

SITE EVALUATION/PERCOLATION TEST

Date/Time: November 4, 1994 / 0729 / Boring B-2

Test performed by: Brian Chang

Owner: Department of Hawaiian Home Lands

Tax Map Key: N/A

Elevation: 107 ft
Depth to Groundwater Table: N/A ft below grade
Depth to Bedrock (if observed): N/A ft below grade
Diameter of Hole: 4 in
Depth to Hole Bottom: 21 ft below grade

Depth below grade (ft)	**Soil Profile** (color, texture, other)
0 - 15	Brown clayey silt, very stiff to hard, damp
15 - 21	Brown silt w/clay, very stiff, moist

PERCOLATION READINGS

Time 12 in of water to seep away: - min (first trial reading)
Time 6 in of water to seep away: - min (second trial reading)

For percolation tests in sandy soils, record time intervals and water drops at least every 10 minutes for at least 1 hour.

For percolation tests in non-sandy soils, presoak the test hole for at least 4 hours. Record time intervals and water drops at least every 10 minutes for 1 hour; or if the time for the first 6 inches to seep away is greater than 30 minutes, record 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
62	6.88		
32	2.07		
61	3.44		
30	1.12		
37	2.00		
46	1.75		
20	0.94		

Percolation Rate (time/final water level drop): 21 min/in

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.

SHUI TAT KWOK
LICENSED PROFESSIONAL ENGINEER
No. 7951-C
HAWAII, U.S.A.

Engineer's Signature/Stamp
Shui Tat Kwok, P.E.

revised 5/92

W.O. 3348-00 NOVEMBER 1994

PLATE C-6

(h \user\crc\siteeval\3024-00)

GEOLABS-HAWAII

SITE EVALUATION/PERCOLATION TEST

Date/Time: November 4, 1994 / 0819 / Boring B-4

Test performed by: Brian Chang

Owner: Department of Hawaiian Home Lands

Tax Map Key: N/A

Elevation: 123 ft
Depth to Groundwater Table: N/A ft below grade
Depth to Bedrock (if observed): N/A ft below grade
Diameter of Hole: 4 in
Depth to Hole Bottom: 21 ft below grade

Depth below grade (ft)	**Soil Profile** (color, texture, other)
0 - 17	Brown clayey silt, very stiff to hard, moist
17 - 21	Brownish gray silty sand w/decomposed basalt gravel, very dense, moist

PERCOLATION READINGS

Time 12 in of water to seep away: - min (first trial reading)
Time 6 in of water to seep away: - min (second trial reading)

For percolation tests in sandy soils, record time intervals and water drops at least every 10 minutes for at least 1 hour.

For percolation tests in non-sandy soils, presoak the test hole for at least 4 hours. Record time intervals and water drops at least every 10 minutes for 1 hour; or if the time for the first 6 inches to seep away is greater than 30 minutes, record 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
35	5.12		
51	4.07		
39	2.94		
40	2.50		
36	2.00		
26	1.50		
19	0.56		

Percolation Rate (time/final water level drop): 34 min/in

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.

SHUI TAT KWOK
LICENSED PROFESSIONAL ENGINEER
No. 7951-C
HAWAII, U.S.A.

Kwok Shui Tat

Engineer's Signature/Stamp
Shui Tat Kwok, P.E.

revised 5/92

W.O. 3348-00 NOVEMBER 1994

PLATE C-7

(h:\user\crc\siteeval\3024-00)

SITE EVALUATION/PERCOLATION TEST

Date/Time: November 3, 1994 / 0867 / Boring B-8

Test performed by: Brian Chang

Owner: Department of Hawaiian Home Lands

Tax Map Key: N/A

Elevation: 86 ft
Depth to Groundwater Table: N/A ft below grade
Depth to Bedrock (if observed): N/A ft below grade
Diameter of Hole: 4 in
Depth to Hole Bottom: 19.6 ft below grade

Depth below grade (ft)	**Soil Profile** (color, texture, other)
0 - 13	Brown clayey silt, hard, damp
13 - 18	Grayish brown silty sand, medium dense, moist
18 - 20	Gray sandy gravel, very hard, damp (decomposed rock)

PERCOLATION READINGS

Time 12 in of water to seep away: - min (first trial reading)
Time 6 in of water to seep away: - min (second trial reading)

For percolation tests in sandy soils, record time intervals and water drops at least every 10 minutes for at least 1 hour.

For percolation tests in non-sandy soils, presoak the test hole for at least 4 hours. Record time intervals and water drops at least every 10 minutes for 1 hour; or if the time for the first 6 inches to seep away is greater than 30 minutes, record 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
39	7.50	30	6.25
31	4.18	30	4.87
30	3.81		
30	3.94		
30	4.01		
30	7.93		
30	7.25		

Percolation Rate (time/final water level drop): 6 min/in

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.

SHUI TAT KWOK
LICENSED PROFESSIONAL ENGINEER
No. 7951-C
HAWAII, U.S.A.

Engineer's Signature/Stamp
Shui Tat Kwok, P.E.

revised 5/92

W.O. 3348-00 NOVEMBER 1994

(h:\user\crc\siteeval\3024-00)

SITE EVALUATION/PERCOLATION TEST

Date/Time: November 3, 1994 / 0819 / Boring B-9

Test performed by: Brian Chang

Owner: Department of Hawaiian Home Lands

Tax Map Key: N/A

Elevation: 75 ft
Depth to Groundwater Table: N/A ft below grade
Depth to Bedrock (if observed): N/A ft below grade
Diameter of Hole: 4 in
Depth to Hole Bottom: 19.75 ft below grade

Depth below grade (ft)	Soil Profile (color, texture, other)
0 - 13	Brown clayey silt, hard, moist
13 - 20	Brownish gray silty sand, dense, damp

PERCOLATION READINGS

Time 12 in of water to seep away: - min (first trial reading)
Time 6 in of water to seep away: - min (second trial reading)

For percolation tests in sandy soils, record time intervals and water drops at least every 10 minutes for at least 1 hour.

For percolation tests in non-sandy soils, presoak the test hole for at least 4 hours. Record time intervals and water drops at least every 10 minutes for 1 hour; or if the time for the first 6 inches to seep away is greater than 30 minutes, record 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
51	6.00	37	2.50
39	3.50		
31	2.63		
30	3.25		
30	2.93		
30	2.44		
30	2.26		

Percolation Rate (time/final water level drop): 15 min/in

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.

SHUI TAT KWOK
LICENSED PROFESSIONAL ENGINEER
No. 7951-C
HAWAII, U.S.A.

Engineer's Signature/Stamp
Shui Tat Kwok, P.E.

revised 5/92

W.O. 3348-00 NOVEMBER 1994

(h:\user\crc\siteeval\3024-00)

PLATE C-9

GEOLABS-HAWAII

SITE EVALUATION/PERCOLATION TEST

Date/Time: November 3, 1994 / 0810 / Boring B-10

Test performed by: Brian Chang

Owner: Department of Hawaiian Home Lands

Tax Map Key: N/A

Elevation: 62 ft
Depth to Groundwater Table: N/A ft below grade
Depth to Bedrock (if observed): 10 ft below grade
Diameter of Hole: 4 in
Depth to Hole Bottom: 21.5 ft below grade

Depth below grade (ft)	**Soil Profile** (color, texture, other)
0 - 10	Brown clayey silt, very hard, damp
10 - 21.5	Gray sandy basalt gravel, dense, damp (decomposed rock)

PERCOLATION READINGS

Time 12 in of water to seep away: - min (first trial reading)
Time 6 in of water to seep away: - min (second trial reading)

For percolation tests in sandy soils, record time intervals and water drops at least every 10 minutes for at least 1 hour.

For percolation tests in non-sandy soils, presoak the test hole for at least 4 hours. Record time intervals and water drops at least every 10 minutes for 1 hour; or if the time for the first 6 inches to seep away is greater than 30 minutes, record 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
No water was retained in the borehole with an injection rate of 60 gal/min for 5 minutes			

Percolation Rate (time/final water level drop): <1 min/in

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.

SHUI TAT KWOK
LICENSED PROFESSIONAL ENGINEER
No. 7951-C
HAWAII, U.S.A.

Kwok Shui Tat

Engineer's Signature/Stamp
Shui Tat Kwok, P.E.

revised 5/92

W.O. 3348-00 NOVEMBER 1994

PLATE C-10

(h:\user\crc\siteeval\3024-00)

GEOLABS-HAWAII

SITE EVALUATION/PERCOLATION TEST

Date/Time: November 4, 1994 / 0709 / Boring B-11

Test performed by: Brian Chang

Owner: Department of Hawaiian Home Lands

Tax Map Key: N/A

Elevation: 62 ft
Depth to Groundwater Table: N/A ft below grade
Depth to Bedrock (if observed): N/A ft below grade
Diameter of Hole: 4 in
Depth to Hole Bottom: 20.4 ft below grade

Depth below grade (ft)	**Soil Profile** (color, texture, other)
0 - 8	Brown silty clay, hard, damp
8 - 13	Brown clayey silt, medium stiff, moist
13 - 15	Brown silty clay, medium stiff, moist
15 - 21.5	Brown clayey silt w/decomposed rock, very stiff to hard, moist

PERCOLATION READINGS

Time 12 in of water to seep away: - min (first trial reading)
Time 6 in of water to seep away: - min (second trial reading)

For percolation tests in sandy soils, record time intervals and water drops at least every 10 minutes for at least 1 hour.

For percolation tests in non-sandy soils, presoak the test hole for at least 4 hours. Record time intervals and water drops at least every 10 minutes for 1 hour; or if the time for the first 6 inches to seep away is greater than 30 minutes, record 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
45	13.87		
48	8.75		
35	4.19		
60	4.88		
30	1.81		
37	1.74		

Percolation Rate (time/final water level drop): 21 min/in

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.

SHUI TAT KWOK
LICENSED PROFESSIONAL ENGINEER
No. 7951-C
HAWAII, U.S.A.

Engineer's Signature/Stamp
Shui Tat Kwok, P.E.

revised 5/92

W.O. 3348-00 NOVEMBER 1994

(h:\user\crc\siteeval\3024-00)

PLATE C-11

GEOLABS-HAWAII

APPENDIX D

Standard Earthwork and Grading Specifications

STANDARD EARTHWORK AND GRADING SPECIFICATIONS

ANAHOLA RESIDENCE LOTS - UNIT 6

ANAHOLA, KAUAI, HAWAII

W.O. 3348-00 JANUARY 25, 1995

The work under this section includes clearing and grubbing, preparation of fill areas, placement and compaction of fill, and removal and backfilling of underground structures. These specifications are of a general nature and may be superseded by specific requirements or recommendations contained within the Geotechnical Engineering Exploration Report.

I. General

A. Applicable References

The following standard references shall be applicable to this project to the extent referenced and, except as specifically modified, in this section:

1. Standard Specification for Public Works Construction, September 1986, Departments of Public Works, Counties of Kauai, Maui, Hawaii, City and County of Honolulu, hereinafter called Standard Public Works Specifications.

2. American Society for Testing and Materials Standards, hereinafter called ASTM.

B. Conformance to Applicable Standards

All site and roadway grading shall conform to the local County Grading Ordinances, the Geolabs-Hawaii Geotechnical Engineering Exploration, Anahola Residence Lots - Unit 6, Anahola, Kauai, Hawaii dated January

25, 1995 and the applicable Standard Public Works Specifications unless otherwise specified or modified in writing by the Project Engineers.

C. Contractor's and Geotechnical Engineer's Responsibilities

1. The Geotechnical Engineer's services shall be provided by the Owner. For the purpose of these specifications, observation by Geotechnical Engineer includes monitoring and testing performed by any person or persons employed by and responsible to, the licensed Civil Engineer retained as the Geotechnical Engineer.

2. The words "monitoring" or "observing" shall mean periodic observation of the work (and the taking of soil tests as deemed necessary) by the Geotechnical Engineer for substantial compliance with plans, specifications, and design concepts.

3. The presence of the Geotechnical Engineer will be for the purpose of providing observation and field testing to provide the Owner a greater degree of confidence that the earthwork conforms to the contract documents. The service does not include supervision or direction of the actual work of the Contractor, his employees or agents.

   The Contractor should also be informed that neither the presence of the Geotechnical Engineer nor the observation and testing shall excuse him in any way for defects discovered in his work. The Geotechnical Engineer will not be responsible for job or site safety on this project. Job and site safety will be the sole responsibility of the Contractor.

4. The Geotechnical Engineer has power of inspection limited to the rejection of non-conforming work.

5. All clearing and site preparation of earthwork performed on the project up to the approximate finish grade or roadway subgrades shall be conducted by the Contractor under the monitoring of the Geotechnical Engineer.

6. It is the Contractor's responsibility to prepare the ground surface to receive the fills and to place, spread, mix, moisture condition and compact the fill in accordance with the specifications herein. The Contractor shall also remove all unsuitable material and deleterious materials.

7. It is also the Contractor's responsibility to have suitable and sufficient compaction equipment on the job site to handle the amount of fill being placed. If necessary, excavation equipment shall be shut down to allow completion of compaction. Sufficient watering apparatus will also be provided by the Contractor with due consideration for the fill material, rate of placement, and the time of year.

8. If the Contractor encounters subsurface conditions at the site that (a) are materially different from those indicated in the contract

plans or in the specifications, or (b) could not have been reasonably anticipated as inherent in the work of the character provided in the contract, the Contractor shall immediately notify the Owner verbally and in writing within 24 hours. This notification shall be a condition before any negotiations for "changed or differing site conditions" may proceed. If the Owner determines that conditions do materially so differ and cause an increase or decrease in the Contractor's cost of, or the time required for, performance of any part of the work under this contract, then negotiations shall commence between Owner and Contractor to provide an equitable adjustment to Owner or Contractor resulting therefrom.

II. <u>Special Considerations</u>

A. Cut slopes shall be excavated to the lines and grades indicated on the contract drawings and where necessary, adjusted in accordance with the recommendations of the Geotechnical Engineer during construction.

B. All trench backfill placed above 12 inches of the top of the pipes shall be compacted in maximum lift thickness of 8 inches unless specifically authorized by the Geotechnical Engineer. The Geotechnical Engineer may require thinner lifts should compaction operations consistently fail to produce the specified compaction requirements. In any event, the required levels of compaction shall be obtained throughout the full depth and width of each layer of backfill.

C. "Jetting" and "ponding" of the backfill or fill materials shall not be permitted on this project unless specifically authorized by the Geotechnical Engineer in writing.

D. Upon completion of grading or temporary interruption of grading and the consequent termination of observation by the Geotechnical Engineer, no further filling or excavating shall be performed without notifying the Geotechnical Engineer in advance and ascertaining his requirements.

III. Site Preparation

A. Clearing and grubbing shall be performed and debris shall be disposed of in accordance with Section 10 - CLEARING AND GRUBBING of the Standard Public Works Specifications.

All vegetation and deleterious materials encountered within the Grading Limits shall be cleared and disposed of off-site. This removal shall be completed prior to excavating and filling.

B. Organically contaminated topsoil shall be stripped prior to actual grading. Materials determined as being unsuitable for placement in compacted fill shall be removed and wasted off-site. Any material incorporated as a part of the compacted fill must be approved by the Geotechnical Engineer.

C. Any abandoned underground structures such as cesspools, cisterns, tunnels, septic tanks, wells, pipelines or others not located prior to grading are to be removed and the resulting depression backfilled and compacted in accordance with these specifications.

D. Loose surface soils encountered in areas to receive fill shall be removed to expose competent natural soils. Localized soft pockets shall be undercut and backfilled with compacted select materials.

E. All surfaces shall be observed and approved by the Geotechnical Engineer prior to the placement of any fill.

F. After approval, the surface shall be scarified to a depth of 8 inches, moisture-conditioned to above the optimum moisture content, and compacted as herein specified.

G. Where the existing surface exceeds a slope of five horizontal to one vertical (5H:1V) the ground surface shall be keyed and benched into competent soil to bond the fill to the existing ground surface.

H. Subsurface drains may be required as directed by the Geotechnical Engineer where springs or zones of seepage are encountered.

I. Where soft or unstable conditions are encountered during these operations, the Geotechnical Engineer shall be notified immediately so that supple-mental recommendations can be made prior to the commencing of fill placement.

J. Over-excavation to remove unsuitable material shall be carried out to the depths required by field conditions and as specified. The Geotechnical Engineer may require an increase or decrease in the amount of over-excavation depending on the site conditions.

IV. Fill Materials

Material for fill shall consist of on-site soils or approved imported material. Fill material shall contain less than 5 percent organic matter and other deleterious representative samples of the materials to be used as compacted fill shall be tested by the Geotechnical Engineer. Samples of the proposed materials shall be submitted to the Geotechnical Engineer at least seven working days prior to its intended delivery to the jobsite.

V. Placement and Compaction of Fill

A. The fill shall be placed in horizontal layers, which, when compacted, will not exceed 8 inches in thickness. Each layer shall be spread uniformly and blade-mixed to attain uniformity of material and water content within each layer.

Additional fill material shall not be placed on any fill layer which has not been properly compacted. Removal of any material so placed shall be done at the Contractor's expense.

B. Rock fragments or boulders less than 12 inches in diameter may be utilized provided they are not concentrated in any one area and that there is sufficient fine-grained material to fill the voids between the rocks.

C. Rocks greater than 12 inches in diameter shall be removed from the fill unless specifically approved for placement in the fill by the Geotechnical Engineer.

D. All fill shall be compacted to a minimum of 90 percent of the maximum dry density as determined by ASTM Test Method D 1557-91 unless otherwise specified in the Geotechnical Engineer's Report.

E. Boulders encountered in excavations may be used in the deeper fills provided that the following are followed:

1. Boulders shall be spread out and must not be nested. They should be placed so that compaction equipment will be able to compact around them.

2. No part of any boulder shall be allowed to encroach any closer to finished subgrade than the boulder's largest dimension and, in no case, be closer than 4 feet to finished subgrade.

3. No boulder larger than 4 feet in its largest dimension shall be allowed to be placed in the fill. It may be necessary to reduce the size of larger boulders or dispose of them off-site.

4. Care must be exercised to avoid placement of boulders in the proposed utility alignments to reduce potential difficulties in the later excavation of the utility trenches.

F. The compaction equipment may be sheepsfoot, vibratory, or pneumatic-tired rollers suited to the soil type and capable of producing the specified results in an expedient and efficient manner. The equipment shall be in good working condition, fully ballasted, and self cleaning.

G. The compaction shall be accomplished in a systematic and uniform manner over the entire fill area to produce a uniformly compacted fill.

H. The Contractor shall be required to obtain the above specified levels of compaction out to the finish slope of fill slopes. This may be achieved by either over-building the slopes and cutting back to the compacted core or by direct compaction of the slope faces with suitable equipment.

I. Fill placed against previously graded cut or fill slopes shall be properly keyed through topsoil or loose slope material into firm material, and the transition stripped of loose material prior to fill placement. Fill shall be placed and compacted from the low side up.

J. Fill slopes should be planted or protected from erosion by methods indicated on the plans.

K. Fill material placed in an unsatisfactory condition and not in accordance with these specifications shall not be approved and shall be removed or reworked until the required density and moisture are obtained.

L. The Geotechnical Engineer shall be provided unrestricted access to the fill to perform the compaction tests.

M. No fill shall be placed during unfavorable weather conditions. When interruption of work is due to heavy rain, the previous fill surface shall be approved before resumption of earthmoving operations.

N. The Contractor shall maintain the surface of the fill so that it will be free draining and will not pond surface water.

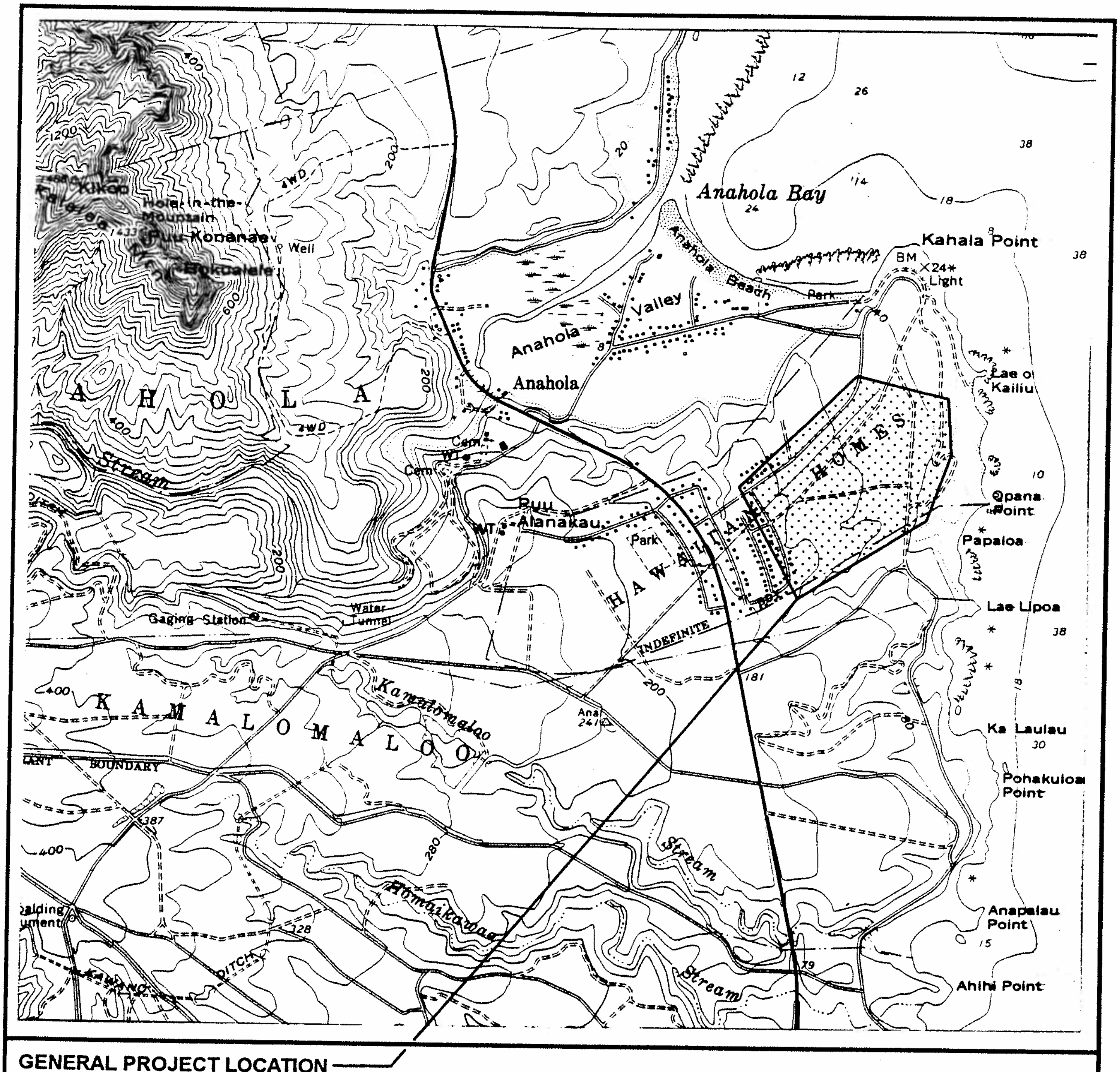
VI. Unforeseen Subsurface Conditions

A. If any conditions not described in the contract documents such as perched water, seepage, lenticular, or confined strata of a potentially adverse nature are encountered during grading, these conditions shall be immediately brought to the attention of the Project Engineer so that supplemental recommendations may be made to treat these problems.

B. Should excavations encounter loose or unstable conditions, the Contractor shall notify the Geotechnical Engineer and Project Civil Engineer immediately so that supplemental recommendations can be given.

-o0o0o0o0o0o0o0o-

(h:\crc\reports\3348-00.tk)



N

GRAPHIC SCALE IN FEET (1000, 0, 1000, 2000)

REFERENCE: U.S.G.S. QUADRANGLE MAP; ANAHOLA, KAUAI, HAWAII (1983)

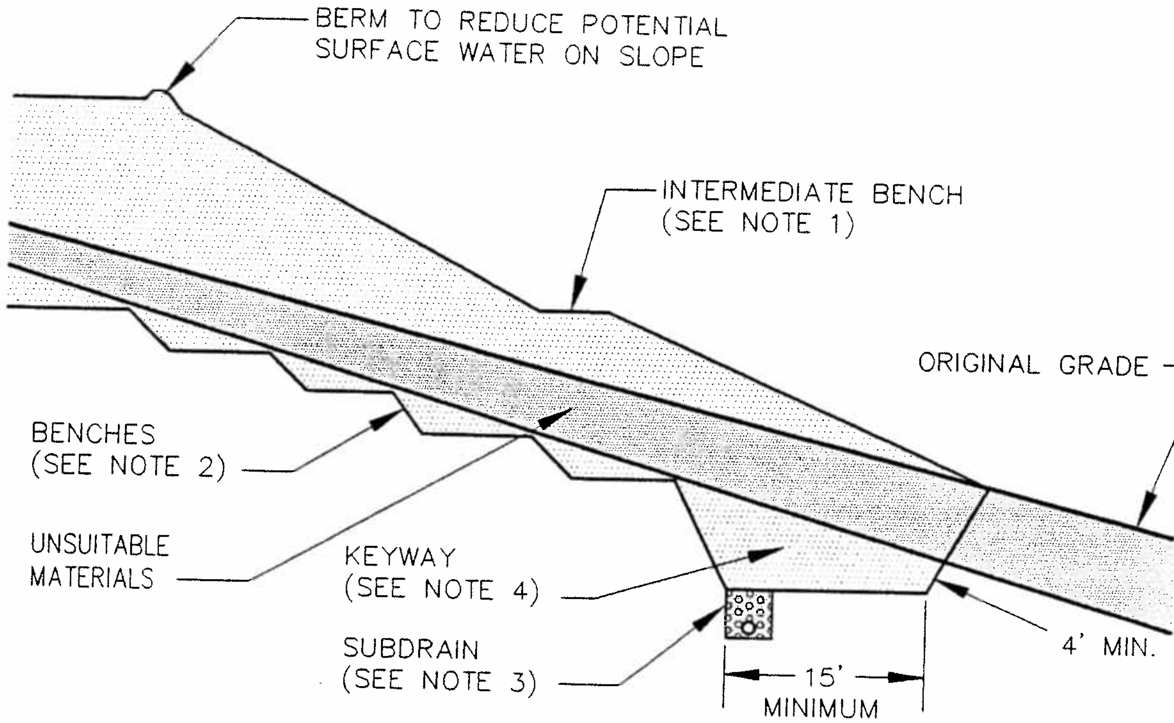
PROJECT LOCATION MAP

ANAHOLA RESIDENCE LOTS - UNIT 6
ANAHOLA, KAUAI, HAWAII

PLATE 1

GEOLABS-HAWAII
Foundation & Soil Engineering·Geology

DATE	DRAWN BY
NOVEMBER 1994	KHN
SCALE 1" = 2,000'	W.O. 3348-00



NOTES:

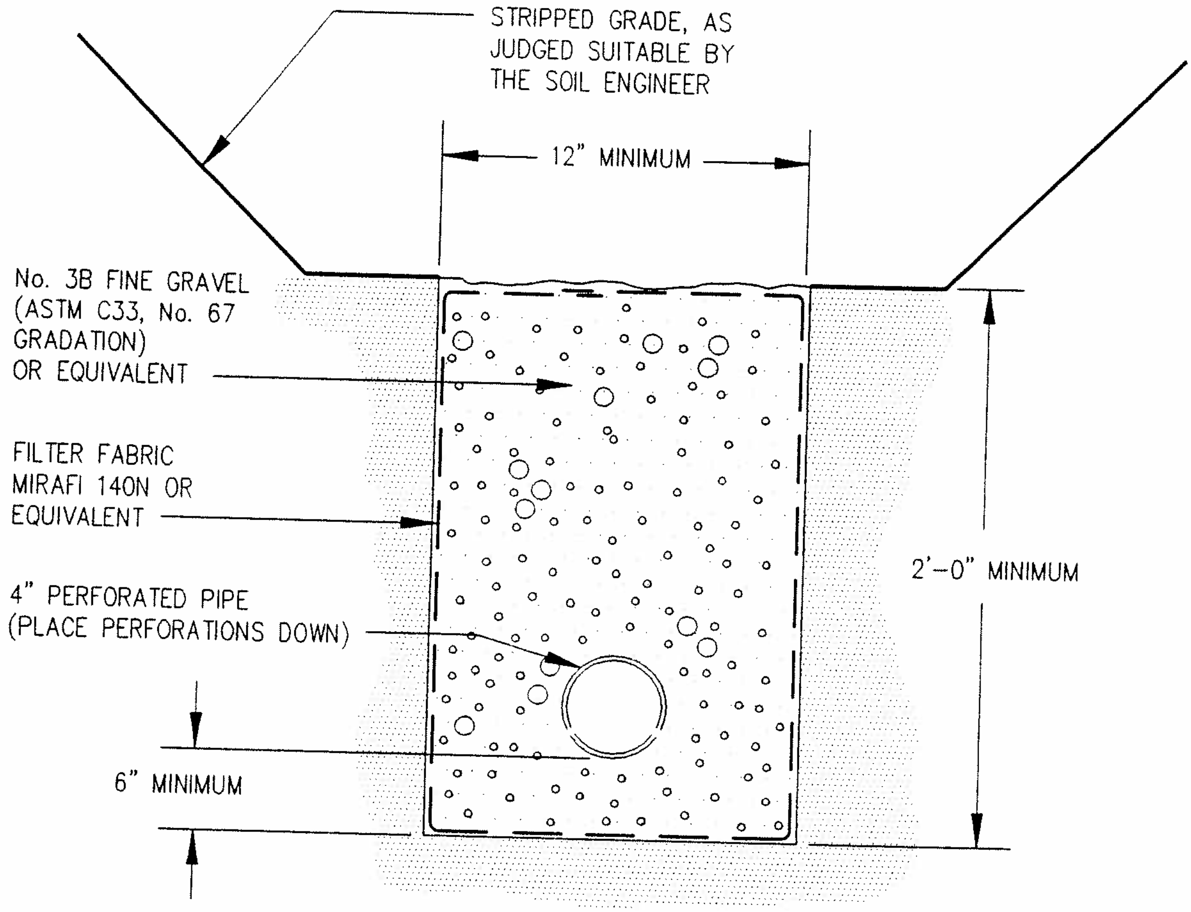
1. INTERMEDIATE BENCHES SHOULD BE SPACED EVERY 20 VERTICAL FEET.
2. WHERE NATURAL GRADE IS STEEPER THAN 5H:1V, BENCH INTO STIFF SOIL AS RECOMMENDED BY SOIL ENGINEER.
3. SUBDRAIN SHOULD DISCHARGE VIA A CLOSED PIPE TO STORM DRAIN OR SUITABLE NATURAL DRAINAGE.
4. KEYWAY SHOULD EXTEND AT LEAST 2 FEET INTO STIFF SOIL AS RECOMMENDED BY THE SOIL ENGINEER. KEYWAY WIDTH SHOULD BE A MINIMUM OF 15 FEET OR 1/3 OF THE FILL SLOPE HEIGHT, WHICHEVER IS GREATER.

TYPICAL KEYING AND BENCHING DETAIL

PLATE 3

GEOLABS-HAWAII Foundation & Soil Engineering·Geology		
DATE	DECEMBER 1994	
DRAWN BY	KHN	
SCALE	NOT TO SCALE	
W.O.	3348-00	

KBENCHG



TYPICAL SUBDRAIN DETAIL

PLATE 4

GEOLABS-HAWAII
Foundation & Soil Engineering-Geology

DATE DECEMBER 1994	DRAWN BY KHN
SCALE NOT TO SCALE	W.O. 3348-00

SUBDRAN6

GEOTECHNICAL ENGINEERING EXPLORATION
ANAHOLA RESIDENCE LOTS - UNIT 6
ANAHOLA, KAUAI, HAWAII

W.O. 3348-00 JANUARY 25, 1995

FOR

AKINAKA & ASSOCIATES, LTD.