RESORT NO. 2 - PRELIMINARY SOIL REPORT

MAUNALUA, OAHU, HAWAII
TAX MAP KEY: 3-9-11

To:
KAI SER-AETNA

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

September 29, 1970
KAI SER-AETNA
P.O. Box 2997
Honolulu, Hawaii 96802

Gentlemen:

Subject: Resort No. 2
Preliminary Soil Report
(for site grading design purposes)
Maunalua, Oahu, Hawaii
Tax Map Key: 3-9-11
Chapter 23, Revised Ordinances of Honolulu, 1961 As Amended

The Resort Division area consists of resort, apartment and residential subdivisions.

In accordance with your request, preliminary soil explorations were made to cover the general area. This report concerns only the preliminary soil explorations at the site for the proposed Resort No. 2, Maunalua, Oahu, Hawaii.

The borings generally indicated surface layers of silty or clayey sand and coral underlain by lava rock. However, localized areas of clay (adobe) and muck were encountered. Rock outcrops were noted adjacent to the highway and Wawamalu Stream, and generally along the shoreline.

Some grading and filling of the site are contemplated. The earthwork should be done in accordance with the requirements of Chapter 23, Revised Ordinances of Honolulu, 1961 As Amended and the recommendations contained herein.

Light apartment structures may be constructed with ordinary footings or foundations.
Because lava rock may be encountered relatively close to the surface, high-rise buildings may be constructed with relatively simple foundations. The depth of the rock formation was not determined for this report. More explorations should be made for the design of a specific structure and location.

The report includes a Boring Location Plan, boring logs, laboratory test results, recommendations and limitations.

Respectfully submitted,

WALTER LUM ASSOCIATES, INC.

Ezra Koike
Professional Engineer
Hawaii No. 1450
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RESORT NO. 2 - PRELIMINARY SOIL REPORT

MAUNALUA, OAHU, HAWAII
TAX MAY KEY: 3-9-11

SCOPE OF EXPLORATION

The Resort Division area consists of resort, apartment and residential subdivisions. This report concerns only the preliminary soil explorations at the site for the proposed Resort No. 2 at Maunalua, Oahu, Hawaii. The limits of this area are shown on Figure 1. The purpose of this exploration was to determine general soil conditions for site grading design purposes.

This report includes field exploration, laboratory tests and general recommendations for site grading and light building foundation design.

FIELD EXPLORATION

Fourteen borings were made at the site. The locations of these borings are shown on Figure 1, Boring Location Plan.

The borings were made with 3 and 4-in. diameter augers using tungsten carbide bits. Soil samples were recovered with a standard split spoon driven with a 140-lb hammer falling 30 inches.

Soft spots were probed by pushing a re-bar into the muck. Soil samples were recovered with a hand auger.
Soil samples were visually observed and subjected to appropriate tests in the laboratory. Based on visual observations and laboratory tests, the soil descriptions in the boring logs are generally made in accordance with the "Unified Soil Classification System."

LABORATORY TESTS

Laboratory tests for on-site soils included: natural water content, Atterberg limits, specific gravity, sieve analysis, AASHO T-180-57 density, expansion and CBR.

A list of the standard field and laboratory test methods used for this project is given in the Appendix.

A summary of the laboratory test results is given in Tables IA and IB.

GENERAL SITE CONDITIONS

The proposed resort site is east of Kalanianaole Highway and north of Wawamalu Stream.

The area abuts two tidal inlets, Wawamalu Stream channel outlet known as Kaloko and the drainage outlet for Kealakipapa Valley. Access roads cross portions of the site. Existing fills or stockpiled soils were noted along the northern and southern portions of the site.

Grass, saltwater plants and low brush cover most of the area. The site generally slopes towards the shoreline at 2 to 5% gradient with steeper slopes in localized areas. Lava outcrops were noted along the shoreline.
with localized accumulations of sand and coral fragments. Lava outcrops were also noted adjacent to the highway along Wawamalu Stream. Muck was encountered at the tidal inlet into which the drainage from Kealakipapa Valley discharges.

INTERPRETATION OF SOIL CONDITIONS

From the field exploration, the soils at the site may be generally described as follows:

Fills or stockpiles of about 1 to 12 ft of medium to dense silty and clayey sand with gravel and coral fragments were noted along the northern boundary and on the north bank of Wawamalu Stream. Underlying the fills was lava rock to about 7 to 16 ft, the depths drilled.

Boring No. 89 in the northeast section of the site indicated surface layers about 10 ft of clay (adobe) with decomposed rocks and boulders underlain by lava rock to about 15 ft, the depths drilled.

In the east section, near the outlet of the natural drainage way, shallow muck deposits of about 1 to 3 ft or more were underlain by rocky material.

Water was noted in several borings from about 1 to 11-ft depths. Because the resort area is exposed to open water, ground water level will probably vary closely with the tidal variations.
For more detailed descriptions of soils encountered in the drill holes, refer to the boring logs.

DISCUSSION AND RECOMMENDATIONS

The proposed plan is to grade the site for resort development with fills generally less than 15 to 20 ft in height.

Some fills are contemplated along the shoreline of the tidal inlet in the eastern section of the site. Portions of the fill may extend below the water line.

Site Grading

All surface vegetation and miscellaneous debris should be cleared and removed prior to site filling. Localized soft pockets encountered during site preparations should be excavated and backfilled with compacted select material. Provisions to drain the site should be included during and after the completion of filling operations.

Grading work should be done in general conformance with the requirements of Chapter 23, Revised Ordinances of Honolulu, 1961 As Amended.

Fills Below Water

Fills below water should generally be constructed with fairly well-graded granular material such as coral or crushed rock. The material should generally be less than 6-in. maximum size
with less than 30% passing the No. 200 sieve for coral and less than 15% for materials with plastic fines.

Surface deposits of soft clayey soils and pockets of muck should be displaced or flushed out during placement of fills in wet areas. The fills may be placed by end dumping up to about elevation 3 to form a working platform. The working platform should be brought to a fairly level surface and compacted with vibratory equipment.

Controlled fills may be constructed above the working platform.

**Controlled Fills**

For the construction of fills generally above elevation +3 ft, the following is recommended:

1. Rubble, loose boulders and unsuitable materials should be removed.

2. Stockpiles and loose surface soils should generally be removed or scarified and recompacked before the placement of fills.

3. Hard surfaces along existing access roads should be scarified down to stiff soils and recompacked to match the density of the surrounding soils.
4. Loose soils along the sides of the natural drainageways and stream beds should be removed and the slopes reconstructed. Subdrains should be placed along the bottom and sides and the embankment constructed with compacted select fill material.

5. Fill material may be approved on-site or borrow soils. If practicable, fill material imported to the site should be select soils with a plasticity index generally less than 20.

6. Fills should be constructed in approximately level layers starting at the lower end and working upward. Where fills are made on sloping areas steeper than about 5 horizontal to 1 vertical, the ground at the toe of the fill should be benched to a generally level condition. As the fill is brought up, it should be continually keyed into the stiff natural ground by cutting steps into the slopes and compacting the fill into these steps.
7. Fills should be laid in 6-in. compacted layers with a relative density of at least 90% of AASHO T-180-57 density.

8. If clay (adobe) soils are used for fills, they should be placed preferably below 2 ft of finish grades, well above the ground water level and several feet from the face of fill slopes. Adobe fill should be kept less than 10 ft in height and preferably less than 8 ft. See attached sketch, Figure 2.

9. If boulders are proposed to be used in the construction of fills, they should generally be placed along the toe sections of fill slopes and outside of probable building sites. Before placing any boulders, the subgrade should be stripped to stiff natural ground and shaped to drain. A layer of granular filter material should be placed on the subgrade and the boulders placed on the filter layer. The void spaces between boulders should be filled with granular material. A blanket of filter material should be placed against the boulders before any earth fills are placed against the boulders. See attached sketch, Figure 3.
Slopes

In general, for slopes above the water table, the following may be used as a guide:

1. Cut and fill slopes of 2 horizontal to 1 vertical or flatter should be used.

2. For low cuts thru mixtures of rock and clinkers, slope ratios of 1-1/2 horizontal to 1 vertical or flatter may be used.

3. For low cuts (less than 5+ ft in height) in rock that is fairly homogeneous, slope ratios of 3/4 horizontal to 1 vertical or flatter may be used.

If slope heights (top to toe) of greater than 15 ft are considered, 8-ft wide benches should be placed at height intervals of about 15 ft in both cuts and fills.

For protection against erosion, the runoff from rainstorms should be diverted by berms or ditches away from slopes whenever practicable.

The surface of fill slopes should be compacted by cat-tracking or with a sheepsfoot roller.

In general, slope planting is recommended on cut and fill slopes to minimize erosion.
Slopes exposed to open water and possible wave action should include some type of slope protection, such as rip-rap. Otherwise, flat slopes should be used depending on the type of soils used to construct the slopes.

Foundations

Light, short-span structures may be constructed at the site with ordinary footings or foundations.

Because lava rock may be encountered relatively close to the surface, high-rise buildings may be constructed with relatively simple foundations. The depth of the rock formation was not determined for this report. More explorations should be made for the design of a specific structure and location.

For heavy or long-span or multiple story structures, foundation explorations should be made at each building site to evaluate the ground conditions before foundations are designed.

The following may be used as a guide for foundation design for light, short-span structures:

1. Bearing values for a given soil vary with the size and depth of footings. For light, one and 2-story, short-span structures, bearing values of about 2000 p.s.f. may be used.
2. If soft spots or pockets of loose material are encountered in footing excavations or below a building area, they should be excavated and replaced with compacted select on-site or borrow soils.

3. Foundation design adjustments must be made if adobe soils are encountered or imported. Care should be taken that there is at least 2 ft of compacted select material below building footings in adobe areas.

4. Concrete slab on ground should be placed over a base course of 4 in. of well-graded gravel less than 3/4 in. and greater than 1/4 in. in size. The subgrade should be compacted and shaped to a level surface or to drain, if practicable, and generally should be kept slightly higher than the finish grade outside of the building.

5. In general, buildings and structures should be placed about 15 ft from the tops of slopes.

6. Construction of retaining walls on slopes should generally be avoided.
7. Good surface drainage away from the foundation of structures should be maintained and the site should be graded at all times to prevent ponding of water.

Roadway

In general, a rough estimate of the roadway pavement thickness for the light residential traffic anticipated is as follows:


2. Base course - 6-in. base course over a prepared subgrade.

Provisions should be made in the contract documents to allow for local adjustments regarding subbase requirements in the field as ground conditions are exposed at subgrade levels. The subbase thickness will depend upon the type of material within the top 2 ft of subgrade.

The subgrade should be compacted and shaped to drain. To avoid the ponding of water and softening of the subgrade at low points, weep holes should be placed at subgrade levels through the walls of catch basins which are placed in these low areas.
Utilities

Although the probability of differential settlements in localized areas is slight in this area, utilities should be placed after the fills are constructed. Utility lines should be designed with flexible joints, particularly where lines are connected to structures. Gravity flow lines should be made as steep as practicable.

Unforeseen or undetected conditions may occur in localized areas and will have to be adjusted and corrected in the field as they are detected.
PROPOSED SPECIFICATION FOR EARTHWORK

RESORT NO. 2

General Description

This item shall consist of clearing and grubbing, removing of existing structures, preparing of land to be filled, excavating and filling of the land, spreading, compacting and testing of the fill, and subsidiary work necessary to complete the grading.

Clearing, Grubbing and Preparing Areas to be Filled

Vegetation, concrete slabs and rubbish shall be removed and disposed of, leaving the disturbed area with a neat, debris-free appearance.

Vegetable matter shall be removed from the surface upon which fill is to be placed. Topsoil and stockpiled soils shall be (1) stripped to stiff natural ground or (2) scarified and recompressed before the placement of fills. Topsoil encountered at finish grade shall be scarified and recompressed.

Hard surfaces along the existing access roads shall be scarified down to stiff soils and recompressed to match the density of the surrounding soil before the placement of fills.

Where fills are proposed in sidehill areas and gullies, loose material along the bottom and the sides shall be stripped down to stiff natural ground before the placement of fills. New fills shall be keyed into the stiff natural ground.
Subdrains shall be placed along the bottom and sides of the natural drainageways before the construction of fills. The locations of subdrains should be determined in the field after clearing and grubbing.

Where fills are made on sloping areas steeper than 5 horizontal to 1 vertical, the ground at the toe of the slope shall be benched to a generally level condition. As the fill is brought up, it shall be continually keyed into the stiff natural ground by the cutting of steps into the hillside and compacting the fill into these steps. Ground slopes which are flatter than 5 horizontal to 1 vertical shall be benched when considered necessary by the Soil Engineer.

Materials

Fill materials shall consist of approved on-site or borrow soils. The soils shall contain no more than a trace of organic matter. Fill material imported to the site shall be select soils with a plasticity index less than 20.

Placing, Spreading and Compacting Fill Material

The selected fill material shall be placed in level layers which, when compacted, shall not exceed 6 inches. Each layer shall be spread evenly and thoroughly blade-mixed during the spreading to insure uniformity of material and water content within each layer.

No rocks or cobbles shall be allowed to nest and voids between rocks must be carefully filled and compacted with small stones or earth.
When the water content of the fill material is well below the optimum for compacting purposes, water shall be added until the water content assures a thorough bonding during the compacting process.

When the water content of the material is well above the optimum for compacting purposes, the fill material shall be aerated by blading or by other satisfactory methods until the water content is near the optimum.

After each layer has been placed, mixed and spread evenly, it shall be thoroughly compacted to no less than 90% of maximum density in accordance with AASHO Test No. T-180-57 or other comparable density tests. Compaction shall be with sheepsfoot rollers, multiple-wheel pneumatic-tired rollers or other acceptable rollers which shall be able to compact the fill to the specified density. Rolling shall be accomplished while the fill material is near the optimum water content. The rolling of each layer shall be continuous over its entire area and the roller shall make sufficient passes to insure the obtainment of the desired density.

Field density tests shall be made to get an indication of the compaction of the fill. Where sheepsfoot rollers are used, the soil may be disturbed to a depth of several inches. Density readings shall be taken as often as necessary in the compacted material below the disturbed surface. When these readings indicate that the density of any layer of fill or portion thereof is below the required 90% density, that layer or portion shall be reworked until the required density has been obtained.

The fill operation shall be continued in 6-in. compacted layers as specified above, until the fill has been brought to the finished slopes and grades as shown on the accepted plans.
Excavation

Suitable material from excavation shall be used in the fill and unsuitable material from excavation shall be disposed of.

Fills Below Water

Fills below water shall be constructed with fairly well-graded granular material such as coral or crushed rock. The material shall be less than 6-in. maximum size with less than 30% passing the No. 200 sieve for coral and less than 15% for materials with plastic fines.

Surface deposits of soft clayey soils and pockets of muck shall be displaced or flushed out during placement of fills in wet areas. The fills may be placed by end dumping up to about elevation 3 to form a working platform. The working platform shall be brought to a fairly level surface and compacted with vibratory equipment.

Controlled fills may be constructed above the working platform.

Boulder Fills

If boulders are proposed to be used in the construction of fills, they shall be placed along the toe section of slopes and at locations indicated on the plan. The subgrade shall be stripped to stiff natural ground and shaped to drain. A layer of granular filter material shall be placed on it. All voids between boulders shall be filled with smaller granular soils. A blanket of filter material shall be placed against the boulder fill before construction of earth fills behind or above the boulders.
Unforeseen Conditions

If unforeseen or undetected critical soil conditions such as soft spots are encountered during the field operation, corrective measures shall be made in the field as they are detected.

Rainy Weather

No fill material shall be placed, spread or rolled during unfavorable weather conditions. When the work is interrupted by heavy rain, fill operations shall not be resumed until field tests indicate that the water content and density are as previously specified.
BORING LOGS

Symbols

Symbols used generally are in accordance with the Unified Soil Classification System.

Where a parenthesis "(MH)" is used, the soil sample was classified by visual observation of the sample recovered.

Where no parenthesis "MH" is used, the soil sample was classified from either the Atterberg limits or sieve analysis test results.

Note

Boring No. 83 was not made. Rock outcrops may be visually observed at this location.
Boring Log

PROJECT: RESORT NO. 2
LOCATION: Maunalua, Oahu, Hawaii
TAX MAP KEY: 3-9-11

HAMMER:
- Weight: 140 lbs
- Drop: 30 ft

SAMPLER: 2" STANDARD SPLIT SPOON

---

BORING NO. 80  Sheet No. ______ of ______
Driller: Walter Lum Assoc.  Date: 4-6-70
Field Party: SETO, GLORY
Type of Boring: AUGER
Diam.: 3"
Elev.: 14' + 2"
Drill Bit: T.C. DRAG BIT
Water Level NOT NOTICED
Time: ______
Date: 4-7-70

---

UNITED
CLASSIFICATION

DESCRIPTION

ELEV. = 14' + 2"

- Brown Silty Sand with Gravel
- Lava Rock
- END OF BORING @ 6.5' 6"

---

Sample No.: 80A
Sample Type: ROCK FRAGMENT
Depth: 4-6.70
Water Content: 0.0
Silt: 0.0
Clay: 0.0
SAND: 100.0
Vane Shear: 0.0 V.S.F.
PENETRATION DATA

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SAMPLE: 80B
No Recovery

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NOTE:

- Two borings attempted 20' apart were similar. First attempt 3' 3" depth. Second attempt 6.5' 6" depth.

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* ELEVATION ESTIMATED FROM CONTOUR MAP.
Boring Log

**PROJECT:** RESORT NO. 2  
**LOCATION:** Maunalua, Oahu, Hawaii  
**Tax Map Key:** 3-9-11

**HAMMER:**  
Weight: 10 # SLEDGE HAMMER  
Drop:  
**SAMPLE:** 2" STANDARD SPLIT SPOON

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<th>Description</th>
<th>Depth (ft)</th>
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<th>Water Cont. %</th>
<th>Dry Density, P.C.F.</th>
<th>Unconfined Comp.</th>
<th>Vane Shear, P.C.F.</th>
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**BORING NO. 81**  
**Date:** 4-2-70  
**Driller:** Walter Lum Assoc.  
**Field Party:** KAKU MEYER  
**Type of Boring:** AUGER  
**Diam:** 4"  
**Elev.:** 5'  
**Datum:**  
**Water Level:** NOT NOTICED  
**Time:** 3:40 PM  
**Date:** 4-2-70

**PENETRATION DATA**  
W/10 lb. SLEDGE HAMMER

---

* ELEVATION ESTIMATED FROM CONTOUR MAP
# Boring Log

**PROJECT**  RESORT NO. 2  
**LOCATION**  Maunalua, Oahu, Hawaii  

**Tax Map Key:** 3-9-11  

**DRILLER**  Walter Lum Assoc.  
**DATE**  4-6-70  

**FIELD PARTY**  SETO, GLORY  
**TYPE OF BORING**  AUGER (ACKERACE)  
**DIAM.**  3"  
**ELEV.**  0'± *  
**DRILL BIT**  T.C.DRAb  

**WATER LEVEL**  0.5'  
**TIME**  11:00 AM  
**DATE**  4-6-70  

**SAMPLER:**  2" STANDARD SPLIT SPOON

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**END OF BORING @ 15' ±**

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* ELEVATION ESTIMATED FROM CONTOUR MAP
Boring Log

PROJECT  RESORT NO. 2
LOCATION Maunalua, Oahu, Hawaii
Tax Map Key: 3-9-11

HAMMER:
Weight  140 lb
Drop  30"

SAMPLER:  2" STANDARD SPLIT SPOON

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END OF BORING @ 10'.

NOTE:
TWO BORINGS ATTEMPTED ABOUT 10' APART.
FIRST ATTEMPT 2' DEPTH
(SECOND ATTEMPT 10' DEPTH)
(LOG SHOWS 2' HOLE)

*ELEVATION ESTIMATED FROM CONTOUR MAP.
## Boring Log

**PROJECT** RESORT NO. 2  
**LOCATION** Maunalua, Oahu, Hawaii  
**Tax Map Key:** 3-9-11

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<table>
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<th>SAMPLER:</th>
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<td>2&quot;-S 2&quot; O.D.TIN WALL TUBE</td>
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**BOARING NO.** 85  
**Sheet No.** of  
**Driller** Walter Lum Assoc.  
**Date** 4-7-70  
**Field Party** LINING, MAESHIRO  
**Type of Boring** AUGER (CONCREE)  
**Diam.** 4"

**Elev.** 5' ± 7  
**Datum** __________

**Drill Bit** T.C. DRAG

**Water Level** NOT NOTICED  
**Time** __________  
**Date** 4-7-70

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### PENETRATION DATA

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<th>Penetration Test</th>
<th>2&quot; O.D. THIN WALL TUBE</th>
</tr>
</thead>
<tbody>
<tr>
<td>N (Blows per foot)</td>
<td>0 10 20 30 40</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>2-S</td>
<td>85A</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>2-SS</td>
<td>85B</td>
<td>ROCK FRAGMENT</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2-SS</td>
<td>85C</td>
<td>-</td>
<td>NO RECOVERY</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>-</td>
</tr>
</tbody>
</table>

**ELEVATION ESTIMATED FROM CONTOUR MAP**

---

**DESCRIPTION**

- ELEV. 5' ± 7
- MEDIUM, REDDISH BROWN CLAYEY SILT W SAND
- LAVA ROCK
- VOID (4' to 4.5')
- LAVA ROCK
- END OF BORING @ 7' ±
Boring Log

PROJECT: RESORT NO. 2
LOCATION: Maunalua, Oahu, Hawaii
Tax Map Key: 3-9-11

HAMMER:
- Weight: 140 lbs
- Drop: 30"

SAMPLER: 2" STANDARD SPLIT SPOON

ELEV. = 24' + 2"

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>(SM)</td>
<td>BROWN-WHITE SILTY SAND W/ COBBLES</td>
<td>0</td>
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<td>86A</td>
<td>10</td>
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<td>-</td>
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<tr>
<td>CH</td>
<td>MEDIUM BROWN CLAY W/ COBBLES</td>
<td>5</td>
<td></td>
<td>86B</td>
<td>29</td>
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<tr>
<td>(ML)</td>
<td>MEDIUM BROWN CLAYEY SILT W/ DECOMPOSED ROCK</td>
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<td></td>
<td>86C</td>
<td>15</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>BOULDER OR ROCK</td>
<td>15</td>
<td></td>
<td>86D</td>
<td>NO RECOVERY</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
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*ELEVATION ESTIMATED FROM CONTOUR MAP
### Boring Log

**Project:** Resort No. 2  
**Location:** Maunalua, Oahu, Hawaii  
**Tax Map Key:** 3-9-11  
**Hammer:**  
- **Weight:** 140 lb  
- **Drop:** 30"  
**Sampler:** 2 1/4" - 2" STANDARD SPLIT SPOON  

---

**Penetration Data**

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<thead>
<tr>
<th>ELEV. = 23 ± 2</th>
<th>0</th>
<th>10</th>
<th>100</th>
<th>200</th>
<th>400</th>
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</thead>
<tbody>
<tr>
<td>Depth (ft)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Penetrator No.</td>
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<tr>
<td>Sample No.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Wet Dens. P.C.F.</td>
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<td></td>
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</tr>
<tr>
<td>Water Cont. %</td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Dry Dens. P.C.F.</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Unconf. Comp. P.S.F.</td>
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<td></td>
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<td></td>
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</tr>
<tr>
<td>Penetration Test</td>
<td></td>
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<table>
<thead>
<tr>
<th>(M)</th>
<th>Unified Soil Classification</th>
<th>Description</th>
<th>Depth (ft)</th>
<th>Sampler</th>
<th>Sample No.</th>
<th>Penetration Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>(SM)</td>
<td>MEDIUM, BROWN, SILTY SAND W/ GRAVEL &amp; CORAL FRAGMENTS</td>
<td>2 1/4&quot;</td>
<td>5</td>
<td>87-A</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>(ML)</td>
<td>STIFF, DARK BROWN, SILTY CLAY</td>
<td>2 1/4&quot;</td>
<td>10</td>
<td>87-B</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DECOMP. ROCK W/ REDDISH BROWN CLAYEY SILT</td>
<td>2 1/4&quot;</td>
<td>15</td>
<td>87-C</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PUKA PUKA ROCK</td>
<td>2 1/4&quot;</td>
<td>15</td>
<td>87-D</td>
<td>ROCK FRAGMENTS</td>
<td>41</td>
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---

**Notes:**
- Elevation estimated from contour map.
# Boring Log

**PROJECT** RESORT NO. 2  
**LOCATION** Maunalua, Oahu, Hawaii  
**Tax Map Key:** 3-9-11

**HAMMER:**  
- **Weight:** 140 lb  
- **Drop:** 30"  
**SAMPLER:** 2"-4" Standard Split Spoon

**BORING NO.** 88  
**Sheet No.**  
**Date:** MAY 16, 1970  
**Driller:** Walter Lum Associates  
**Field Party:** MEYER, MAESHIRO  
**Type of Boring:** AUGER (Acker)  
**Diam.:** 4"

### Penetration Data

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sampler</th>
<th>Sample No.</th>
<th>Water Cont. %</th>
<th>Dry Density P.C.F.</th>
<th>Uncont. Comp. P.S.F.</th>
<th>Shear Viscosity</th>
<th>N (Blows per foot)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>88-A</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0 10 20 30 40</td>
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<tr>
<td>5</td>
<td>88-B</td>
<td>23</td>
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<td></td>
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<td></td>
<td>0 10 20 30 40</td>
</tr>
<tr>
<td>10</td>
<td>88-C</td>
<td></td>
<td>ROCK FRAGMENTS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>88-D</td>
<td>NO RECOVERY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**ELEVATION ESTIMATED FROM CONTOUR MAP**

- MEDIUM DENSITY, BROWN, SILTY SAND W/CORAL  
- STIFF, BROWN, CLAYEY SAND W/GRAVEL & CORAL  
- PUCA PUCA ROCK  
- END OF BORING @ 15'
**Boring Log**

**PROJECT**
Resort No. 2

**LOCATION**
Maunalua, Oahu, Hawaii

**Tax Map Key:** 3-9-11

**BORING NO.:** 89
**Sheet No.:** of

**Driller:** Walter Lum Assoc. Date: May 16, 1970

**Field Party:** MEYER, MAESHIRO

**Type of Boring:** AUGER (ACE)

**Diam.:** 4"  

**Elev.:** 11'  

**Datum:**

**Weight:** 140 #  

**Drop:** 30"  

**HAMMER:**

**Weight:** 140 #  

**Drop:** 30"  

**SAMPLER:** 2 ½" 4" STANDARD SPLIT SPOON

**LOCATION**
Maunalua, Oahu, Hawaii

**Tax Map Key:** 3-9-11

**PROJECT RESORT NO.:** 2

**Drill Party:**

**Type of Boring:** AUGER (ACE)

**Diam.:** 4"  

**Elev.:** 11'  

**Datum:**

**Weight:** 140 #  

**Drop:** 30"  

**HAMMER:**

**Weight:** 140 #  

**Drop:** 30"  

**SAMPLER:** 2 ½" 4" STANDARD SPLIT SPOON

**PENETRATION DATA**

<table>
<thead>
<tr>
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<td>10</td>
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<tr>
<td>10</td>
<td>89-B</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20/5</td>
</tr>
<tr>
<td>15</td>
<td>89-C</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>30/2</td>
</tr>
</tbody>
</table>

**DESCRIPTION**

- STIFF, DARK BROWN, CLAY (ADobe)
- BOULDER
- STIFF, BROWN, CLAY W/GRAVEL & PUCA PUCA ROCK.
- STIFF, GRAY, CLAY
- PUCA PUCA ROCK.
- END OF BORING @ 15.2'

*Elevation estimated from contour map*
# Boring Log

**PROJECT**: RESORT NO. 2  
**LOCATION**: MaunaLua, Oahu, Hawaii  
**Tax Map Key**: 3-9-11

**HAMMER**:  
- **Weight**:  
- **Drop**:  

**SAMPLER**:  

**LOCATION**: MaunaLua, Oahu, Hawaii  
**Date**: 10-20-70  
**Time**: 10:20 AM  
**Elev.**: 0'  
**Datum**:  

<table>
<thead>
<tr>
<th>Penetration Test</th>
<th>Standard Penetration Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>N (Blows per foot)</td>
<td>0 10 20 30 40</td>
</tr>
</tbody>
</table>

## PENETRATION DATA

### BORING NO. 20 A  
**ELEV.**: 0'  
**DESCRIPTION**:  
- GRAYISH BROWN, CLAY W/SAND  
- ROCK OR SAND  
- END OF BORING @ 3'  

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample No.</th>
<th>Penetration Test</th>
<th>Standard Penetration Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>67</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### BORING NO. 20 B  
**ELEV.**: 0'  
**DESCRIPTION**:  
- GRAYISH BROWN, WATER  
- CLAY W/SOME SAND  
- ROCK  
- END OF BORING @ 0.5'  

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample No.</th>
<th>Penetration Test</th>
<th>Standard Penetration Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>71</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### BORING NO. 20 C  
**ELEV.**: 0'  
**DESCRIPTION**:  
- BLACK ORGANIC CLAY  
- (MOSS)  
- WATER  
- ROCK  
- END OF BORING @ 1.5'  

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample No.</th>
<th>Penetration Test</th>
<th>Standard Penetration Test</th>
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<tbody>
<tr>
<td>5</td>
<td>108</td>
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<td>129</td>
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</tbody>
</table>

**ELEVATION ESTIMATED FROM CONTOUR PLAN**
**Boring Log**

**PROJECT** RESORT NO. 2

**LOCATION** Maunalua, Oahu, Hawaii

Tax Map Key: 3-9-11

**HAMMER:**
- **Weight:** 140 lbs
- **Drop:** 30"

**SAMPLER:** 2' STANDARD SPLIT SPOON

**LOCATION** Maunalua, Oahu, Hawaii

**LOCATION** Maunalua, Oahu, Hawaii

**Tax Map Key:** 3-9-11

---

### Penetration Data

<table>
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<th>10</th>
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<tr>
<td><strong>Sample No.</strong></td>
<td><strong>Water Cont.</strong></td>
<td><strong>Drill Bit</strong></td>
<td><strong>Penetration</strong></td>
</tr>
<tr>
<td>91A</td>
<td>12</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>91B</td>
<td>19</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>91C</td>
<td>ROCK FRAGMENT</td>
<td>-</td>
<td>HAMMER BOUNCES</td>
</tr>
</tbody>
</table>

**Type of Boring:** AUGER (ACSR)

**Diam.:** 4"

**Datum:**

**Time:**

**Date:** 5-21-70

---

*ELEVATION ESTIMATED FROM CONTOUR MAP*
**Boring Log**

**PROJECT** RESORT NO. 2  
**LOCATION** Maunalua, Oahu, Hawaii  
**Tax Map Key:** 3-9-11

**HAMMER:**  
- **Weight:** 140 lb  
- **Drop:** 30"

**SAMPLER:** 2" 44-2" STANDARD SPLIT SPOON

<table>
<thead>
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<td>ELEV. 7' 2&quot;</td>
<td>MEDIUM, BROWN, SILTY SAND &amp; CORAL FRAGMENTS</td>
<td>9.5</td>
<td>2.55</td>
<td>92-A</td>
<td>-</td>
<td>12</td>
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<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(CH) STIFF, BROWN, CLAY</td>
<td>2.55</td>
<td>92-B</td>
<td>40</td>
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<td>45/2</td>
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<tr>
<td>PUKA PUKA ROCK</td>
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<td>ROCK FRAGMENTS</td>
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<td>25/2</td>
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</tr>
<tr>
<td>END OF BORING @ 10.2'</td>
<td>10.5</td>
<td>92-C</td>
<td>-</td>
<td>ROCK FRAGMENTS</td>
<td>-</td>
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<td>-</td>
<td>45/2</td>
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*ELEVATION ESTIMATED FROM CONTOUR MAP*
## Boring Log

**PROJECT** RESORT NO. 2  
**LOCATION** Maunalua, Oahu, Hawaii  
**Tax Map Key:** 3-9-11  
**BoRiNg NO.** 93  
**Borer Lum Assoc.** MAY 18, 1970

**HammEr:**  
**Weight:** 140 lb  
**Drop:** 30"  
**SAMPLER:** 2"-SPLIT SPOON

**Location:** Maunalua, Oahu, Hawaii  
**Field Party:** MAKALU, MAESHIRO  
**Type of Boring:** AUGER (A)  
**Diam.:** 4"  
**Datum:** HAMMER  
**Drill Bit:** T.C. DRAG  
**Water Level:** NOT NOTICED  
**Date:** 5-19-70

### PENETRATION DATA

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<td>93-A</td>
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<tr>
<td>93-B</td>
<td>2&quot;-SPLIT SPOON</td>
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<td>93-C</td>
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<td>93-D</td>
<td>-</td>
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</tbody>
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*ELEVATION ESTIMATED FROM CONTOUR PLAN*
**Boring Log**

**PROJECT**
RESORT NO. 2

**LOCATION**
Maunalua, Oahu, Hawaii
Tax Map Key: 3-9-11

**HAMMER:**
- Weight: 140#
- Drop: 30"

**SAMPLER:**
- 2" SPLIT SPOON

**LOCATION:** Maunalua, Oahu, Hawaii
Tax Map Key: 3-9-11

**HAMMER:**
- Weight: 140#
- Drop: 30"

**SAMPLER:**
- 2" SPLIT SPOON

### Penetration Data

<table>
<thead>
<tr>
<th>Depth (Ft.)</th>
<th>Sampler</th>
<th>Water Cont.</th>
<th>Dry Cont.</th>
<th>Unc. Comp.</th>
<th>Penetration Test</th>
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</tr>
<tr>
<td>5</td>
<td>2&quot;44</td>
<td>28</td>
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</tr>
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<td>10</td>
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<tr>
<td>15</td>
<td>2&quot;44</td>
<td>21</td>
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</tbody>
</table>

**MEDIUM, RED-BROWN, CLAY W/PUKA PUKA ROCK**

**LAVA ROCK (CLINKERS) W/ TRACES OF BROWN, CLAYEY SILT**

**ELEVATION ESTIMATED FROM CONTOUR PLAN**

---

**CH**

**LAVA ROCK W/ BLACK SAND**

**END OF BORING @ 16'**

---

**Dates:**
- May 15, 1970
- May 10, 1970
- May 12, 1970
- May 13, 1970
- May 15, 1970

**Water Level:**
- 11.5'

**Time:**
- 3:00 PM

**Date:**
- 5-15-70

---

**Type of Boring:** AUGER (PICKER)

**Diam.:** 4"
TABLE I-A - SUMMARY OF LABORATORY TEST RESULTS

<table>
<thead>
<tr>
<th>BORING NO.</th>
<th>PA</th>
<th>PS (TOP)</th>
<th>PS</th>
<th>B</th>
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<tbody>
<tr>
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<tr>
<td>DEPTH BELOW SURFACE</td>
<td>SURFACE</td>
<td>5'-6.6</td>
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<td>BROWN</td>
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<td>SILT SAND</td>
<td>SILT CLAY</td>
<td>CLAYEY SAND</td>
<td>BROWN</td>
</tr>
<tr>
<td>W/GRAVEL</td>
<td>W/SAND</td>
<td>W/MUDROCK</td>
<td>CLAY</td>
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</table>

<table>
<thead>
<tr>
<th>GRAIN-SIZE ANALYSIS (% Passing)</th>
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</thead>
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<td>1/2&quot;</td>
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<thead>
<tr>
<th>ATTERBERG LIMITS</th>
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<tr>
<td>Air Dried or Natural</td>
</tr>
<tr>
<td>Liquid Limit</td>
</tr>
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<td>Plastic Limit</td>
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<td>Plasticity Index</td>
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<table>
<thead>
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<th>Dilatancy</th>
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<th>Toughness</th>
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<td>Slight-Medium</td>
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<th>Dry Strength</th>
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<th>APPARENT SPECIFIC GRAVITY</th>
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<tr>
<th>EXPANSION AND CBR TESTS</th>
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<tr>
<td>(Surcharge-51 P.S.F.)</td>
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<tr>
<td>Molding Moisture, %</td>
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<tr>
<td>Molding Dry Density, P.C.F.</td>
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<tr>
<td>Swell upon saturation, %</td>
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<td>CBR at 0.1&quot; Penetration</td>
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<tr>
<th>MOISTURE-DENSITY RELATIONS OF SOILS</th>
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<tr>
<td>(AASHO T-180-57 Method)</td>
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<tr>
<td>Dry to Wet or Wet to Dry</td>
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<tr>
<td>Max. Dry Density (P.C.F.)</td>
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<tr>
<td>Optimum Moisture (%)</td>
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REMARKS:

Date 9-1-70  By BT.
**TABLE I B - SUMMARY OF LABORATORY TEST RESULTS**

| BORING NO. | 94 |
| SAMPLE NO. | 5.5 |
| DEPTH BELOW SURFACE | RED-BROWN CLAY |
| DESCRIPTION | WIDE COMPACT |

### GRAIN-SIZE ANALYSIS (% Passing)

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<tr>
<th>Sieve</th>
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<th>#10</th>
<th>#20</th>
<th>#40</th>
<th>#100</th>
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### ATTERBERG LIMITS

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<td>Plasticity Index</td>
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<td>Dilatancy</td>
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<td>Toughness</td>
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<tr>
<td>Dry Strength</td>
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### UNIFIED SOIL CLASSIFICATION

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<th>UNIFIED SOIL CLASSIFICATION</th>
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### APPARENT SPECIFIC GRAVITY

| APPARENT SPECIFIC GRAVITY | |
|----------------------------| |

### EXPANSION AND CBR TESTS

(Surcharge-51 P.S.F.)

| Molding Moisture, % | |
|---------------------| |
| Molding Dry Density, P.C.F. | |
| Swell upon saturation, % | |
| CBR at 0.1" Penetration | |

### MOISTURE-DENSITY RELATIONS OF SOILS

(AASHTO T-180-57 Method)

| Dry to Wet or Wet to Dry | |
| Max. Dry Density (P.C.F.) | |
| Optimum Moisture (%) | |

**REMARKS:**

Date: 9-1-70  By: BT
PLASTICITY CHART

PROJECT: Resort No. 2
LOCATION: Maunalua, Oahu, Hawaii

PLASTICITY INDEX

LIQUID LIMIT

"A" LINE

CL

MH & OH

CL-ML

ML

85 SURFACE

80 SURFACE

84-B

82-B

DATE 9-1-70 BY C.M.

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS
MOISTURE–DENSITY CURVE (AASHO T-180-57, METHOD A.)

PROJECT: RESORT NO. 2

LOCATION: MAUNALUA, OAHU, HAWAII

SAMPLE NO.: BO–SURFACE

SAMPLE DESCRIPTION: BROWN SILTY SAND

AGGREGATE: 1/4" MINUS

MOLD SIZE: 4" X 4.5"

HAMMER: 100 LBS. 18" DROP

LAYERS: 5

BLOWS: 25 PER LAYER

MAX. DRY DENSITY: 109.9 P.C.F.

OPTIMUM MOISTURE CONTENT: 16.9%

ZERO AIR voidS CURVE

SPECIFIC GRAVITY: 2.85

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

DATE 8-30-70  BY ST.
MOISTURE-DENSITY CURVE (AASHO T-180-57, METHOD A)

PROJECT: RESORT NO. 2

LOCATION: MAUNALUA, OAHU, HAWAII

SAMPLE NO.: 05-SURFACE

SAMPLE DESCRIPTION: BROWN CLAYEY SAND

AGGREGATE: 1/4" MINUS
MOLD SIZE: 4" x 4.59"
HAMMER: 10 LBS 15" DROP
LAYERS: 6
BLOWS: 25 PER LAYER

MAX. DRY DENSITY - 109.2 P.C.F.
OPTIMUM MOISTURE CONTENT - 24.0 %
ZERO AIR Voids CURVE
SPECIFIC GRAVITY 2.89

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

DATE 7-31-70 BY E.T.
CBR TEST

PROJECT: RESORT NO. 2

LOCATION: MAUNALUA, OAHU, HAWAII

SAMPLE NO: 80-SURFACE
SAMPLE DESCRIPTION: BROWN SILTY SAND

---

<table>
<thead>
<tr>
<th>PENETRATION (INCHES)</th>
<th>LOAD (LBS)</th>
<th>LOAD (PSI)</th>
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<td>0.050</td>
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<td>0.075</td>
<td>410</td>
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<td>600</td>
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<tr>
<td>0.125</td>
<td>715</td>
<td>238</td>
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<td>0.150</td>
<td>430</td>
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<td>0.175</td>
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<td>0.250</td>
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<td>549</td>
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<td>1320</td>
<td>464</td>
</tr>
<tr>
<td>0.500</td>
<td>1410</td>
<td>490</td>
</tr>
</tbody>
</table>

---

AGGREGATE 1/4" MINUS
HAMMER WEIGHT 10 LBS.
HAMMER DROP 18"
No. OF BLOWS 50
No. OF LAYERS 6

---

TEST RESULTS:
MOLDING MOISTURE, % 15.0
MOLDING DRY DENSITY, P.C.F. 107.7
CBR @ 0.1" PENETRATION 72.2

DATE 1/28/70 BY A.F.
DATE 6/2/70 BY S.T.
CBR TEST

PROJECT: RESORT NO. 2

LOCATION: MAUNALUA, OAHU, HAWAII

SAMPLE NO.: 85-SURFACE
SAMPLE DESCRIPTION: BROWN CLAYEY SAND

TEST RESULTS:

MOLDING MOISTURE, %: 16.7
MOLDING DRY DENSITY, P.C.F.: 106.5
CBR @ 0.1" PENETRATION: 6.1

DATE: 1-30-70 BY C.H.
DATE: 6-4-70 BY S.T.
GENERAL TESTING METHODS

EXPLORATORY BORINGS AND SAMPLING

Method for soil investigation and sampling by auger borings (Tentative)
Method for thin wall tube sampling of soils (Tentative)
Method for penetration test and split barrel sampling of soils (Tentative)

LABORATORY TESTING

Grading Analysis

Sieve analysis of fine and coarse aggregates
Amount of material finer than No. 200 sieve in aggregate

Atterberg Limits

Determining the liquid limit of soils Modified as follows: Substitute Casagrande grooving tool. Tests conducted from natural moisture content unless noted otherwise.
Determining the plastic limit of soils
Calculating the plasticity index of soils

Specific Gravity

Specific gravity of soils Modified as follows: 500 ML Pycnometer

Expansion and CBR Tests

Expansion test and California Bearing Ratio (CBR)

Compaction Test

Moisture-Density relations of soils using a 10# rammer and an 18" drop

Unified Soil Classification

AASHO Designation: T 1452-63T
AASHO Designation: T 1587-63T
AASHO Designation: T 1586-64T
AASHO Designation: T 10-60
AASHO Designation: T 11-60
AASHO Designation: T 27-60
AASHO Designation: T 89-60
AASHO Designation: T 90-56
AASHO Designation: T 91-54
AASHO Designation: T 100-60

Section VIII - TM 5-530 "Materials Testing" by Headquarters, Dept. of the Army
AASHO Designation: T 180-57
Designation E-3 from "Earth Manual" by the United States Department of the Interior Bureau of Reclamation
GENERAL TESTING METHODS

Consolidation Test

Laboratory Shear Test

Laboratory shear test using the Torvane

Chapter IX
"Soil Testing for Engineers"
by T. William Lambe
The Massachusetts Institute of Technology

Brochure by Soiltest, Inc.
LIMITATIONS

In general, soil formations are commonly erratic and rarely uniform or regular. The boring logs indicate the approximate subsurface soil conditions encountered only at the drill holes where the borings were made at the times designated on the logs and may not represent conditions at other locations or at other dates. Soil conditions and water levels may change with the passage of time and construction methods or improvements at the site.

During construction, should subsurface conditions much different from those in the borings be observed, encountered, or otherwise indicated, we should be advised immediately to review or reconsider our recommendations in light of the new developments.

Our professional services were performed, findings obtained and recommendations prepared in accordance with generally accepted engineering practices. This warranty is in lieu of all other warranties expressed or implied.
FIGURE 3

PROPOSED BOULDER FILL

RESORT NO. 2

MAUNALUA, OAHU, HAWAII

TAX MAP KEY: 3-2-11

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS