WAIPAHU ESTATES SUBDIVISION UNIT 1A
PRELIMINARY SOIL REPORT

WAIPIO, EWA, OAHU, HAWAII
TAX MAP KEY: 9-4-07: 9

To:
COMMUNITY PLANNING, INCORPORATED

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

OCTOBER 26, 1970

Grading Permit No. 4744

FOR REFERENCE
not to be taken from this room
COMMUNITY PLANNING, INC.
700 Bishop Street, Suite 608
Honolulu, Hawaii 96813

Gentlemen:

Subject: Waipahu Estates Subdivision Unit 1A
Preliminary Soil Report
(for residential development)
Waipio, Ewa, Oahu, Hawaii
Tax Map Key: 9-4-07: 9
Chapter 23, Revised Ordinances of
Honolulu, 1961 As Amended

In accordance with your request, soil explorations were made to determine
general soil conditions at the proposed residential development site for
the Waipahu Estates Subdivision Unit 1A at Waipio, Ewa, Oahu, Hawaii.

The borings generally indicated stiff reddish-brown to brown clayey silts
to about 15 to 20 ft, the depths drilled.

From the field explorations and laboratory test results, it is our opinion
that the site may be developed for the proposed residential housing. Houses
can be supported either directly on stiff existing ground or on compacted
fills constructed from on-site soils.

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.

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

Respectfully submitted,

Ezra Koike
Professional Engineer
Hawaii No. 1450
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WAIPAHU ESTATES SUBDIVISION UNIT 1A
PRELIMINARY SOIL REPORT

WAIPIO, EWA, OAHU, HAWAII
TAX MAP KEY: 9-4-07: 9

SCOPE OF EXPLORATION

The purpose of this exploration was to determine general soil conditions for residential development for the proposed Waipahu Estates Subdivision Unit 1A at Waipio, Ewa, Oahu, Hawaii.

This report includes field explorations, laboratory tests and general recommendations for site grading and residential foundation design.

FIELD EXPLORATION

Twelve exploratory borings were made at the site. The locations of these borings are shown on Figure 1, Boring Location Plan. Descriptions of the underlying soils encountered are shown on Boring Logs Nos. 1 thru 11. Also attached are 6 borings made for Waipahu Estates Subdivision Units I and II.

Borings were made with 3-in. diameter augers using tungsten carbide drag bits. Soil samples were recovered with 2-in. thin-wall tube and standard split spoon samplers driven with a 140-lb hammer falling 30 inches.

Soil samples were visually observed and subjected to appropriate tests in the laboratory. Based on visual observations and laboratory tests, the soil descriptions given on the boring logs are generally made in accordance with the "Unified Soil Classification System."
LABORATORY TESTS

Laboratory tests included: natural density, water content and unconfined compression, 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 is given in the Appendix.

A summary of the laboratory test results is given in Tables IA thru IC.

GENERAL SITE CONDITIONS

The project site is located north of Waipahu Estates Subdivision Units I and II.

The site was previously a sugar cane field. An existing cane haul road was noted along a portion of the northern boundary. Unlined drainage ditches cut thru the south and west portions of the site.

Two stockpiles of soils and a trench about 5 ft wide by 15 ft long and 15 ft in depth were noted in the southern section of the site at the time of exploration. The approximate locations of stockpiles and trench are shown on Figure 1.

The existing ground generally slopes down toward the south at about 5% grade with steeper sections in localized areas along the drainageways and shoulders of the cane haul roads.
INTERPRETATION OF SOIL CONDITIONS

From the field exploration and laboratory test results, the soils encountered in the borings may be generally described as follows:

Stiff reddish-brown and brown clayey silts to about 15 to 20 ft, the depths drilled.

Rock or boulders were encountered at about 15 to 20-ft depths in Boring Nos. 1, 4, 8 and 11.

Water was noted in Boring No. 4 at about 7-ft depth during the field explorations.

For more detailed descriptions of soils encountered in the borings, refer to the boring logs.

DISCUSSION AND RECOMMENDATIONS

In general, the present plan is to clear and grade the site for residential development. The proposed grading at this time is to use cut and fill slopes of generally less than about 15 ft in height. The proposed grading generally indicates fills of less than about 10 ft in thickness.

In the opinion of the Soil Engineer, the on-site soils, in general, have sufficient strength to support the fills and proposed light residential structures, provided the site is cleared and grubbed, drained and localized soft spots are removed.
Site Grading

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.

In general, the on-site soils may be used for the construction of the proposed fills. Grading work should be done as required by the F.H.A. Data Sheet 79-G; Revised Ordinances of Honolulu, 1961 As Amended; and as recommended below:

1. Topsoil and stockpiled soils should be either
   (a) stripped to stiff natural ground or (b)
   scarified and recompacted before the placement of fills.

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

3. Hard surfaces along existing access roads should be scarified down to stiff soils and recompacted to match the density of the surrounding soil.
4. Where fills are proposed, loose material along the bottom and the sides of the low spots and natural drainageways should be stripped down to stiff natural ground or scarified and recompacted before the placement of fills. New fills should be keyed into the stiff natural ground. The open pit in the southern section should be backfilled in thin compacted layers.

5. Subdrains should be placed in a herringbone pattern along the bottom and sides of natural drainageways or dips before the placement of fills. The locations of subdrains should be determined in the field after clearing and grubbing.

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.

Slopes
In general, cut and fill slopes of 2 horizontal to 1 vertical or flatter should be used.

If slope heights (toe to top) of greater than 15 ft are considered, 8-ft-wide benches should be placed at height intervals of about 15 to 25 ft.

To minimize 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 with a sheepsfoot roller or by cat-tracking.

Slope planting is recommended on cut and fill slopes to minimize erosion.

Slope adjustments or other precautions may be necessary if seepage zones or soft spots are encountered in localized areas.

Foundations
If earthwork is carried out as specified, the stiff natural ground and compacted fills should develop adequate bearing values to support the proposed light residential structures.
For light one and two-story houses, differential settlements will probably be negligible and within the settlement tolerances of residential structures.

General recommendations for foundation construction are as follows:

1. For light residential structures, conventional house foundations such as slab-on-ground construction or post-and-beam construction may be used.

2. Bearing values for a given soil usually vary with the size and depth of the footings. For light residential structures, bearing values of 1500 p.s.f. on compacted fills and 2000 p.s.f. on stiff natural ground may be used.

3. Soft spots or pockets of loose material encountered in footing excavations or below the building area should be excavated and backfilled with well-graded granular material such as S4C or other approved material.

4. Concrete slabs 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 the building.

5. Because of the downhill creep effect of soils on a slope, some settlement may occur near the tops of slopes. Buildings should generally be placed about 15 ft from the tops of slopes. This distance may be reduced for lower slope heights, e.g., 10 ft for 10-ft-high slopes, but generally not closer than 5 ft from the top of any slope.

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 the 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.
3. Subbase course - 6-in. subbase course over a prepared subgrade.

Provisions should be made in the contract documents to allow for local adjustments regarding subbase requirements in the field in accordance with the design standards of the City and County of Honolulu. In fill areas, the use of select soils within the top 2 to 3 ft of the subgrade may reduce the thickness or eliminate the need for the subbase course.

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 thru the walls of the catch basins which are placed in these low areas.

Utilities

Utilities should be placed after the fills are constructed. Utility lines should be designed with flexible joints, particularly where lines are connected to structures.
**Unforeseen Conditions**

Unforeseen or undetected conditions such as soft spots and abandoned utilities may occur in localized areas and will have to be adjusted and corrected in the field as they are detected.
PROPOSED SPECIFICATION FOR EARTHWORK
WAIPAHU ESTATES SUBDIVISION UNIT 1A

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, rubble, scrap metals 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 recompacted before the placement of fills. Topsoil encountered at finish grade shall be scarified and recompacted.

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

Where fills are proposed in sidehill areas, gullies, and along drainage and irrigation ditches, 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 or dips before the construction of fills. The locations of subdrains should be determined in the field after clearing and grubbing.

If abandoned irrigation conduits are detected during construction, they shall be located on the construction plans. Conduits within 4 ft of finish grades shall be removed and the excavations backfilled with compacted fill.

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 and no particles larger than 6 in. in diameter. Also, it shall contain no more than 40% gravel (#4 sieve to 3 in. sieve sizes) and no more than 10% cobbles larger than gravel and smaller than 6 in. in diameter. Fill material placed in the top 2 ft of fills shall contain no more than 30% gravel and any material larger than gravel.
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 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 sheepfoot 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 sheepfoot 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.

Unforeseen Conditions

If unforeseen or undetected critical soil conditions such as soft
spots or seepage water 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.
**BORING NO. 1**  
**UNIT 1A**  
**LOCATION** Waipio, Ewa, Oahu, Hawaii  
**Tax Map Key:** 9-4-07: 9  
**Type of Boring** AUGER (MOBILE)  
**Diam.** 4"  
**Drill Bit** T.C. DRAG  
**DATE** 9-30-70  

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

**WAIPAHU ESTATES SUBDIVISION**

**PROJECT**
UNIT 1-A

**LOCATION**
Waipio, Ewa, Oahu, Hawaii

**Tax Map Key:** 9-4-07: 9

**Date:** Sept 30, 1970

**WALTER LUM ASSOCIATES**
303 PWAIALAE AVENUE • HONOLULU, HAWAII 96816 • PHONE 737-7931

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**BORING NO.** 2

**Driller** WALTER LUM ASSOC.

**Field Party** MAESHIRO KAKU

**Type of Boring** AUGER (B-48-L) Diam. 4"  
**Elev.** 2'-4" *  
**Date** 9-30-70

**Doll Bit** T.E. DRAG

**Water Level** Not Necessary

**Time** —

---

**HAMMER:**

**Weight** 140 lbs

**Drop** 30"  
**2" 4'-2" O.D. THIN WALL TUBE**

**SAMPLER:**  
**2" 64'-2" STANDARD SPLIT SPOON**

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#### PENETRATION DATA

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**ELEVATION ESTIMATED FROM CONTOUR PLAN**
| ELEVATION ESTIMATED FROM CONTOUR PLAN |
**WALTER LUM ASSOCIATES**

**Boring Log**

**PROJECT:** WAIPAHU ESTATES SUBDIVISION  
**UNIT 1A**

**LOCATION:** Waipio, Ewa, Oahu, Hawaii

**Tax Map Key:** 9-4-07: 9

**HAMMER:**
- **Weight:** 14.0 lbs
- **Drop:** 30" 2.5" - 2" O.D. THIN WALL TUBE  
2.55 - 2" STANDARD SPLIT SPOON

**Driller:** WALTER LUM ASSOCIATES  
**Date:** OCT. 11, 1970

**Field Party:** MAESHIRO KAKU, HASHIDA  
**Type of Boring:** AUGER (D.40-L)

**Diam.:** 4"  
**Elev.:** 77" *  
**Datum:** __________

**Dil Bit:** T.C. DRAG

**Water Level:** 7.0'  
**Time:** 3:30PM  
**Irrigation Ditch Above 10' from Date:** 10-1-70  
**Boring During Drilling Operation.**

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**Elevation Estimated From Contour Plan.**
Boring Log

**LOCATION**
Waipio, Ewa, Oahu, Hawaii

**Tax Map Key:**  9-4-07: 9

**HAMMER:**
- **Weight:** 14.0 #
- **Drop:** 30"

**SAMPLER:** 2" STANDARD SPLIT SPOON

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**ELEVATION ESTIMATED FROM CONTOUR PLAN**

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**PENETRATION DATA**

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**BORING NO.: 4 A**

- **PROJECT:** WAIPAHU ESTATES SUBDIVISION
- **UNIT 1A**
- **LOCATION:** Waipio, Ewa, Oahu, Hawaii
- **Tax Map Key:** 9-4-07: 9
- **Driller:** WALTER LUM ASSOC.
- **Date:** OCT. 2, 1970
- **Field Party:** MAESHIRO, KAKU
- **Hashida**
- **Type of Boring:** AUGER (MOBILE)
- **Diam.:** 4"
- **Elev.:** 27'2"*
- **Datum:** -
- **Drill Bit:** T.C. DRAG
- **Water Level:** NOT NOTICED
- **Time:** -
- **Date:** 10-2-70
**Boring Log**

**Project:** WAIPAHU ESTATES SUBDIVISION  
**Location:** Waipio, Ewa, Oahu, Hawaii  
**Tax Map Key:** 9-4-07:9  
**Hammer:**  
- Weight: 140 lbs  
- Drop: 30"  
**Sampler:**  
- 2" 4 - 2" O.D. THIN WALL TUBE  
- 2" 5 - 2" STANDARD SPLIT SPOON  

### Penetration Data

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**End of Boring:** 21'  
**Elevation Estimated from Contour Plan:**
**Boring No. G**  
**Driller** WALTER LUM ASSOC.  
**Date** OCT. 1, 1970  
**Field Party** MAESHIRO, KAKU, HASHIDA  
**Type of Boring** AUGER (MOBILE)  
**Diam.** 1"  
**Elev.** 03'  
**Datum**  
**Drill Bit** T.C. DRAG  
**Water Level** NOT NOTICED  
**Time**  
**Date** 10-1-70

### PENETRATION DATA

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<td>2'</td>
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**END. OF BORING @ 21"**

*ELEVATION ESTIMATED FROM CONTOUR PLAN*
## Boring Log

**Waipahu Estates Subdivision**

**Project:** Unit 1A

**Location:** Waipio, Ewa, Oahu, Hawaii

**Tax Map Key:** 9-4-07: 9

**Hammer:**
- **Weight:** 140 lb
- **Drop:** 30" to 2" O.D. Thin Wall Tube
- **Sampler:** 2" 5/8 - 2" Standard Split Spoon

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<tr>
<th>Unified Soil Classification</th>
<th>Description</th>
<th>ELEV. = 05' 17&quot;</th>
<th>Depth (ft)</th>
<th>Sampler</th>
<th>Sample No.</th>
<th>Wet Density (p.c.f.)</th>
<th>Water Cont. (p.c.f.)</th>
<th>Dry Density (p.c.f.)</th>
<th>Unconfined Comp. (p.s.f.)</th>
<th>Penetrometer</th>
<th>Penetration Test</th>
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<td>0</td>
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<td>7-A</td>
<td>22</td>
<td>LL = 46</td>
<td>FL = 27</td>
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<td>-</td>
<td>9/5, 3/5</td>
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<td>5</td>
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<td>9/5, 8/5</td>
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<td>Stiff, Mottled Gray Brown, Clay w/ traces of decomposed rock</td>
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<td>2.5</td>
<td>7-C</td>
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<td>26</td>
<td>9620</td>
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<td>Stiff, Gray Brown Clay w/ streaks of black ash</td>
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<td>7-D</td>
<td>36</td>
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**End of Boring @ 16'.**

*Elevation estimated from contour plan.*
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<td>2 3/4</td>
<td>8-D</td>
<td>114</td>
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<td>2 3/4</td>
<td>8-D</td>
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<tr>
<td>20</td>
<td>2 3/4</td>
<td>8-E</td>
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**Penetration Data**

- Standard Penetration Test: 2" O.D. Thin Wall Tube
- N (Blows per foot): 0 10 20 30 40, BLOWs/0.5

**Location:** Ewa, Oahu, Hawaii

**Tax Map Key:** 9-4-07; 9

**Elevation:** 105'2"

**Description:**

- Stiff, reddish brown, silty clay
- Medium to stiff, mottled brown, clayey silt (decomposed rock)
- Cobble or boulder

**Elevation Estimated from Contour Plan**
Boring Log

WAIPAHU ESTATES SUBDIVISION

PROJECT: UNIT 1A

LOCATION: Waipio, Ewa, Oahu, Hawaii

Tax Map Key: 9-4-07: 9

HAMMER:

Weight: 140#
Drop: 30"

SAMPLER: 2" O.D. THIN WALL TUBE

Boring Log Data

BORING NO. D  Sheet No. of Driller WALTER LUM ASSOC. Date OCT. 2, 1970
Field Party MAESHIRO, KAKU, HASHIDA
Type of Boring AUGER (MINUTEMAN) Diam. 3"
Elev. 84'2" Datum
Drill Bit FINGER TYPE

WATER LEVEL NOT NOTICED

Water Level

Time

Date 10-2-70

Penetration Data

Penetration Test

2" O.D. THIN WALL TUBE

ELEV. = 84'2" * 0

Depth (ft.)

Sample No.

Wet Density

Dry Density

Unit Weight

Sample No.

Wet Density

Dry Density

Unit Weight

1. STIFF, BROWN, Silty Clay w/Gravels

2. STIFF, REDDISH BROWN, Clayey, Silt

3. STIFF, BROWN, Clay

4. STIFF, REDDISH BROWN, Silty Clay

END OF BORING 2-10'

ELEVATION ESTIMATED FROM CONTOUR PLAN

7.5' 10/5'

4.5' 5/5'

7.5' 12/5'

5/5' 0/5'

N (Bows per foot)

0 10 20 30 40

PENETRATION DATA

Standard Penetration Test

ELEVATION ESTIMATED FROM CONTOUR PLAN

WALTER LUM ASSOCIATES
3000 WAI ALAE AVENUE • HONOLULU, HAWAII 96816 • PHONE 737-7931
Boring Log

**Project:** Waipahu Estates Subdivision  
**Location:** Wai`ula, E. Oahu, Hawaii  
**Tax Map Key:** 9-4-07: 9  
**Hammer:**  
- Weight: 140 lb  
- Drop: 30"  
- Type of Boring: Auger (Mobile)  
- Diameter: 4"  
**Sampler:**  
- 2" x 4" thin wall tube  
- 2" x 4" standard split spoon  

**Penetration Data**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample</th>
<th>Wet-Dry</th>
<th>P. C. F.</th>
<th>Water Cont.</th>
<th>Unconf. Comp.</th>
<th>Vane Shear</th>
<th>P. S. F.</th>
<th>Standard Penetration Test</th>
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<td>0</td>
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<td>3/5’ - 3/5’</td>
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<td>11/5’ - 23/5’</td>
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<td>30/5’</td>
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**Description:**
- CL-ML: Medium, Brown, Silty Clay  
- CL: Stiff, Brown, Silty Clay  
- CL-ML: Stiff, Brown, Silty Clay  

**Notes:**
- End of Boring 216"  
- Elevation estimated from contour plan  

**Additional Information:**
- Boring No.: 10  
- Sheet No.: of  
- Driller: Walter Lum Assoc  
- Date: Oct 1, 1974  
- Field Party: Masahiro Kaku, Hashida  
- Type of Boring: Auger (Mobile)  
- Datum:  
- Water Level: Not Noted  
- Time:  
- Date: 10-1-70  

---

*Elevation estimated from contour plan*
**Boring Log**

**Project:** Waipahu Estates Subdivision  
**Unit:** 1A  
**Location:** Waipio, Ewa, Oahu, Hawaii  
**Tax Map Key:** 9-4-07: 9

**Hammer:**  
- **Weight:** 140#  
- **Drop:** 30”

**Sampler:**  
- 2” - 2” O.D. Thin Wall Tube  
- 2" - 2" Standard Split Spoon

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*Elevation estimated from contour plan.*

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<th>Elevation</th>
<th>Water Level Notice</th>
<th>Time</th>
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<td>Maeshiro, Kaku</td>
<td>AUGER (MOBILE)</td>
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**Penetration Data**

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- 4/5’ - 8.5’
- 4.5’ - 5.5’
- 5/5’ - 8/5’
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<td>MOISTURE-DENSITY RELATIONS OF SOILS (AASHO T-180-57 Method)</td>
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REMARKS: * EXPANSION TEST:
SAMPLE: 2 3/4" DIA. X 1" HEIGHT
SURCHARGE: 1 1/2 FT
SOAKING: 4 DAYS

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

Date 10-20-70  By BT
# TABLE I & - SUMMARY OF LABORATORY TEST RESULTS

<table>
<thead>
<tr>
<th>BORING NO.</th>
<th>SAMPLE NO.</th>
<th>DEPTH BELOW SURFACE</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
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<td>SURFACE</td>
<td>REDDISH BROWN CLAYEY SILT</td>
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<td>1'-2'</td>
<td>REDDISH BROWN SILT CLAYEY SILT</td>
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## GRAIN-SIZE ANALYSIS

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<tr>
<td>#100</td>
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<tr>
<td>#200</td>
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</tbody>
</table>

## ATTERBERG LIMITS

<table>
<thead>
<tr>
<th>Air Dried or Natural</th>
<th>Liquid Limit</th>
<th>Plastic Limit</th>
<th>Dilatancy</th>
<th>Toughness</th>
<th>Dry Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>NATURAL</td>
<td>49</td>
<td>28</td>
<td>QUICK</td>
<td>SLIGHT-MED</td>
<td>SLIGHT-MED</td>
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<tr>
<td>NATURAL</td>
<td>46</td>
<td>27</td>
<td>QUICK</td>
<td>SLIGHT-MED</td>
<td>SLIGHT-MED</td>
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<tr>
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<td>30</td>
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<tr>
<td>NATURAL</td>
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<td>27</td>
<td>QUICK</td>
<td>SLIGHT-MED</td>
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## UNIFIED SOIL CLASSIFICATION

<table>
<thead>
<tr>
<th>ML</th>
<th>CL-ML</th>
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## APPARENT SPECIFIC GRAVITY

<table>
<thead>
<tr>
<th>EXPANSION AND CBR TESTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Surcharge-51 P.S.F.)</td>
</tr>
<tr>
<td>Molding Moisture, %</td>
</tr>
<tr>
<td>Molding Dry Density, P.C.F.</td>
</tr>
<tr>
<td>Swell upon saturation, %</td>
</tr>
<tr>
<td>CBR at 0.1&quot; Penetration</td>
</tr>
</tbody>
</table>

## MOISTURE-DENSITY RELATIONS OF SOILS

(AASHO T-180-57 Method)

<table>
<thead>
<tr>
<th>Dry to Wet or Wet to Dry</th>
<th>Max. Dry Density (P.C.F.)</th>
</tr>
</thead>
</table>

## REMARKS:

Date: 10-20-70

By: BT
TABLE 1.C - SUMMARY OF LABORATORY TEST RESULTS

| BORING NO. | 11 |
| SAMPLE NO. |   |
| DEPTH BELOW SURFACE | SURFACE |
| DESCRIPTION | REDDISH BROWN SILTY CLAY |

GRAIN-SIZE ANALYSIS (% Passing)

<table>
<thead>
<tr>
<th>Sieve</th>
<th>1&quot;</th>
<th>1/2&quot;</th>
<th>#4</th>
<th>#10</th>
<th>#20</th>
<th>#40</th>
<th>#100</th>
<th>#200</th>
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<tbody>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ATTERBERG LIMITS

| Air Dried or Natural | NATURAL |
| Liquid Limit | 42 |
| Plastic Limit | 26 |
| Plasticity Index | 16 |
| Dilatancy | QUICK |
| Toughness | SLIGHT |
| Dry Strength | SLIGHT-MED |

UNIFIED SOIL CLASSIFICATION

| CL-MCL |

APPARENT SPECIFIC GRAVITY

| 2.90 |

EXPANSION AND CBR TESTS (Surcharge-51 P.S.F.)

| Molding Moisture, % | 24.1 |
| Molding Dry Density, P.C.F. | 103.5 |
| Swell upon saturation, % | 11.0 |
| CBR at 0.1" Penetration | 70.8 |

MOISTURE-DENSITY RELATIONS OF SOILS (AASHO T-180-57 Method)

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

REMARKS:

Date 10-20-70 By T.J.
PLASTICITY CHART

PROJECT: WAIKIU ESTATES SUBDIVISION-UNIT 1-A
LOCATION: WAIPIO, EWA, OAHU, HAWAII

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

DATE 10-20-70  BY  G.T.
MOISTURE-DENSITY CURVE (AASHO T-180-57, METHOD A.)

PROJECT: WAIWAIU ESTATES SUBDIVISION - UNIT IA

LOCATION: WAIPAHU, EWA, OAHU, HAWAII

SAMPLE NO.: 5 SURFACE

SAMPLE DESCRIPTION: REDDISH BROWN SILTY CLAY (CLAY BLOWS: 25 PER LAYER)

AGGREGATE: 1/4" MINUS
MOLD SIZE: 4" X 4.59"
HAMMER: 10.82, 10" DROP
LAYERS: 5

MAXIMUM DRY DENSITY: 101.0 P.O. F.

OPTIMUM MOISTURE CONTENT: 24.0 %

ZERO AIR VOIDS CURVE

SPECIFIC GRAVITY: 2.93
MOISTURE–DENSITY CURVE (AASHO T-180-57, METHOD A)

PROJECT: WAIPAHU ESTATES SUBDIVISION – UNIT 1-A

LOCATION: WAIPAHU, EWA, OAHU, HAWAII
SAMPLE NO: II SURFACE
SAMPLE DESCRIPTION: REDDISH-BROWN SILTY CLAY (CL-MU)

AGGREGATE: 3/4" MINUS
MOLD SIZE: 4' X 4.59'
HAMMER: 150 LBS, 18" DROP
LAYERS: 6
BLOWS: 25 PER LAYER

MAX. DRY DENSITY = 102.7 P.C.F.
OPTIMUM MOISTURE CONTENT = 10.4 %
ZERO AIR VOIDS CURVE
SPECIFIC GRAVITY = 2.90

WALTER LUM ASSOCIATES, INC.
civil, structural, soils engineers

DATE 10.27.70 BY S.T.
CBR TEST
PROJECT: WAIPAHU ESTATES SUBDIVISION - UNIT 1-A
LOCATION: WAIPAHU, EWA, OAHU, HAWAII
SAMPLE NO: 5 SURFACE
SAMPLE DESCRIPTION: REDDISH BROWN SILTY CLAY (CL-ML)

TEST RESULTS:
MOLDING MOISTURE, % 24.0
MOLDING DRY DENSITY, P.C.F 104.0
CBR @ 0.1" PENETRATION 31.0

DATE 9-16-70 BY R.M.
DATE 10-1-70 BY S.T.

CBR PENETRATION DATA

<table>
<thead>
<tr>
<th>PENETRATION (INCHES)</th>
<th>LOAD (LBS)</th>
<th>LOAD (PSI)</th>
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<tr>
<td>0.025</td>
<td>75</td>
<td>25</td>
</tr>
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<td>0.050</td>
<td>500</td>
<td>200</td>
</tr>
<tr>
<td>0.075</td>
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<td>180</td>
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<tr>
<td>0.100</td>
<td>165</td>
<td>65</td>
</tr>
<tr>
<td>0.125</td>
<td>930</td>
<td>310</td>
</tr>
<tr>
<td>0.150</td>
<td>1090</td>
<td>369</td>
</tr>
<tr>
<td>0.175</td>
<td>1210</td>
<td>403</td>
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<tr>
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<td>497</td>
</tr>
<tr>
<td>0.300</td>
<td>1600</td>
<td>533</td>
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<tr>
<td>0.350</td>
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<td>580</td>
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<tr>
<td>0.400</td>
<td>1850</td>
<td>617</td>
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<tr>
<td>0.450</td>
<td>1950</td>
<td>650</td>
</tr>
<tr>
<td>0.500</td>
<td>2050</td>
<td>689</td>
</tr>
</tbody>
</table>

AGGREGATE 1/4" MINUS
HAMMER WEIGHT 10 LBS.
HAMMER DROP 15"
No. OF BLOWS 56
No. OF LAYERS 5

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS
**CBR TEST**

**PROJECT:** WAIPAHU SUBDIVISION ESTATES - UNIT 1-A

**LOCATION:** WAIPAHU, EWA, OAHU, HAWAII

**SAMPLE NO.:** 6 SURFACE

**SAMPLE DESCRIPTION:** REDDISH-BROWN CLAYEY SILT (ML)

---

![CBR Penetration Data Graph]

**CBR Penetration Data**

<table>
<thead>
<tr>
<th>Penetration (Inches)</th>
<th>Load (LBS)</th>
<th>Load (PSI)</th>
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<tbody>
<tr>
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<td>23</td>
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<tr>
<td>0.050</td>
<td>85</td>
<td>28</td>
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<tr>
<td>0.075</td>
<td>100</td>
<td>33</td>
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<td>0.100</td>
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<td>36</td>
</tr>
<tr>
<td>0.125</td>
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<td>42</td>
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<td>0.175</td>
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<td>52</td>
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<tr>
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<td>55</td>
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<tr>
<td>0.250</td>
<td>190</td>
<td>63</td>
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<td>0.300</td>
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<td>90</td>
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<tr>
<td>0.500</td>
<td>290</td>
<td>97</td>
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</tbody>
</table>

**AGGREGATE** 1/4" MINUS

**HAMMER WEIGHT** 10LBS

**HAMMER DROP** 15"

**No. OF BLOWS** 50

**No. OF LAYERS** 5

---

**TEST RESULTS:**

- Molding Moisture, %: 29.3
- Molding Dry Density, P.C.F: 94.8
- CBR @ 0.1" Penetration: 3.8
- Expansion Days: 4

---

**DATE** 10-13-70 **BY** CU

**DATE** 10-19-70 **BY** ST

---

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

PROJECT: WAIPOU ESTATES SUBDIVISION - UNIT 1-A

LOCATION: WAIPOU, EWA, OAHU, HAWAII

SAMPLE NO: 10 SURFACE

SAMPLE DESCRIPTION: REDDISH BROWN CLAYEY SILT (ML)

CBR PENETRATION DATA

<table>
<thead>
<tr>
<th>PENETRATION (INCHES)</th>
<th>LOAD (LBS)</th>
<th>LOAD (PSI)</th>
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<tr>
<td>0.025</td>
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<td>43</td>
</tr>
<tr>
<td>0.050</td>
<td>250</td>
<td>83</td>
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<tr>
<td>0.075</td>
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<td>113</td>
</tr>
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<td>0.100</td>
<td>420</td>
<td>143</td>
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<tr>
<td>0.125</td>
<td>520</td>
<td>173</td>
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<td>0.150</td>
<td>590</td>
<td>191</td>
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<td>0.175</td>
<td>660</td>
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<td>0.200</td>
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<td>0.300</td>
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<td>301</td>
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<td>0.350</td>
<td>970</td>
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<td>361</td>
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</tr>
<tr>
<td>0.550</td>
<td>1,290</td>
<td>420</td>
</tr>
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</table>

AGGREGATE 1/4" MINUS

HAMMER WEIGHT 10 LBS

HAMMER DROP 18"

NO. OF BLOWS 50

NO. OF LAYERS 5

TEST RESULTS:

MOLDING MOISTURE, %: 26.0

MOLDING DRY DENSITY, P.C.F.: 102.7

CBR @ 0.1" PENETRATION: 160

DATE 10-5-70 BY AF

DATE 10-12-70 BY ST

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

PROJECT: WAI'IPAHU ESTATES SUBDIVISION - UNIT I-A

LOCATION: WAI'IPAHU, EWA, OAHU, HAWAII

SAMPLE NO: II SURFACE

SAMPLE DESCRIPTION: REDDISH-BROWN SILTY CLAY (CL-ML)

TEST RESULTS:

MOLDING MOISTURE, % 24.1
MOLDING DRY DENSITY, P.C.F. 103.5
CBR @ 0.1" PENETRATION 20.0

DATE 10-1-70 BY RM
DATE 10-6-70 BY ST

CBR PENETRATION DATA

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<th>PENETRATION (INCHES)</th>
<th>LOAD (LBS)</th>
<th>LOAD (PSI)</th>
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<tr>
<td>0.025</td>
<td>90</td>
<td>30</td>
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<tr>
<td>0.050</td>
<td>200</td>
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<tr>
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<td>497</td>
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<tr>
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<td>1500</td>
<td>521</td>
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</table>

AGGREGATE 1/4" MINUS
HAMMER WEIGHT 10 LBS
HAMMER DROP 18"
No. OF BLOWS 55
No. OF LAYERS 5

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS
LOGS OF BORINGS
FROM
"WAIPAHU ESTATES SUBDIVISION UNIT I"
DATED FEBRUARY 3, 1969
AND
"WAIPAHU ESTATES SUBDIVISION UNIT II"
DATED DECEMBER 26, 1969
## Boring Log

**PROJECT**: WAIPAHU ESTATES SUBDIVISION UNIT 1  
**LOCATION**: WAIPAO, EWA, OAHU, HAWAII  
**T.M.K.:** 9-4-07 : 9

### HAMMER:
- **Weight**: 10-LB. SLEDGE HAMMER  
- **Drop**: 2" STANDARD SPLIT SPOON

### Sampler:
- **Type of Boring**: AUGER (MOBILE)  
- **Diam.**: 3"  
- **Elev.**: 71' ± *

### Sampler:
- **Date**: JUN 16, 1969

### Sampler:
- **Field Party**: PA, MOENOA  
- **Driller**: WALTER LUM

### Penetration Data

<table>
<thead>
<tr>
<th>Soil Classification</th>
<th>Description</th>
<th>ELEV. = 71' ± *</th>
<th>Depth (ft)</th>
<th>Blows Per Foot</th>
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</thead>
<tbody>
<tr>
<td>(ML)</td>
<td>VERY STIFF, BROWN CLAYEY SILT</td>
<td></td>
<td>0</td>
<td></td>
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<tr>
<td>(ML)</td>
<td>STIFF, REDDISH BROWN CLAYEY SILT</td>
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<td>5</td>
<td></td>
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<tr>
<td>(MH)</td>
<td>VERY STIFF, REDDISH BROWN-GRAY CLAYEY SILT</td>
<td></td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

**END OF BORING @ 15.5**

*ELEVATION ESTIMATED FROM TOPO MAP.*
Boring Log

**Project:** Waipahu Estates Subdivision Unit 1

**Location:** Waipio, Ewa, Oahu, Hawaii

**T.M.K.:** 9-4-07 : 9

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

**Sampler:** 2" Standard Split Spoon

**Type of Boring:** Auger (Mobile)

**Elevation:** 93' ±

**Driller:** WALTER LUM ASSOC.

**Date:** Jan. 15, 1969

**Field Party:** PA. MOENOA

---

### Penetration Data

<table>
<thead>
<tr>
<th>Blows Per Foot</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
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<tbody>
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<td>Sample No.</td>
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<tr>
<td>Wet Density P.C.</td>
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<tr>
<td>Dry Density P.C.</td>
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<tr>
<td>Unconf. Comps.</td>
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<tr>
<td>Vane Shear P.S.</td>
<td></td>
<td></td>
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</tr>
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</table>

---

**Unified Soil Classification**

- **ML:** Stiff Brown Clayey Silt
- **ML:** Very Stiff Reddish Brown, Clayey Silt

**End of Boring @ 165"**

*Elevation Estimated from Topo Map.*
Boring Log

**PROJECT**  WAIPAHU ESTATES SUBDIVISION UNIT 1

**LOCATION**  WAIPIO, EWA, OAHU, HAWAII

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

**SAMPLER:**  2" STANDARD SPLIT SPOON

**Type of Boring**  AUGER/JOHNSTON

**Drill Bit**  FINGER TYPE BIT

**Water Level**  NOT NOTICED

**Date**  1-21-69

<table>
<thead>
<tr>
<th>Unconfined</th>
<th>Classification</th>
<th>ELEV. = 96(^1) ± 2</th>
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<tr>
<td>(MH)</td>
<td>STIFF BROWN SILTY CLAY</td>
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</tr>
<tr>
<td>(MH)</td>
<td>VERY STIFF BROWN SILTY CLAY</td>
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</tr>
<tr>
<td><strong>END OF BORING @ 14'</strong></td>
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**PENETRATION DATA**

<table>
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<tr>
<th>Depth (ft)</th>
<th>ELEV.</th>
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<td>96(^1) ± 2</td>
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</tr>
<tr>
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<tbody>
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<td>25</td>
<td>20</td>
<td></td>
<td>15 / 15</td>
<td>20 / 20</td>
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<td></td>
<td></td>
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</tr>
<tr>
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<td></td>
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</tr>
</tbody>
</table>

* ELEVATION ESTIMATED FROM TOPO MAP.
Boring Log

**PROJECT:** WAIPAHU ESTATES SUBDIVISION UNIT 1

**LOCATION:** WAIPIO, EWA, OAHU, HAWAII

**T.M.K.:** 9-4-07:9

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

**SAMPLER:** 2" STANDARD SPLIT SPOON

---

**DESCRIPTION**

<table>
<thead>
<tr>
<th></th>
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<tr>
<td>4-B</td>
<td>27</td>
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</tr>
<tr>
<td>4-C</td>
<td>26</td>
<td></td>
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</tr>
</tbody>
</table>

**END OF BORING @ 135'**

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**STIFF REDDISH BROWN CLAYEY SILT**

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**VERY STIFF REDDISH BROWN, CLAYEY SILT**

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**ELEVATION ESTIMATED FROM TOPO MAP**
Boring Log

PROJECT: WAIPAHU ESTATES SUBDIVISION UNIT 1
LOCATION: WAIPIO, EWA, OAHU, HAWAII
T.M.K.: 9-4-07:9

HAMMER:
Weight: 140 #
Drop: 30"

SAVLER: 2" STANDARD SPLIT SPOON

**ELEVATION ESTIMATED FROM TOPO MAP**

* bore log details and descriptions*
Boring Log

PROJECT: WAIPI'O ESTATES SUBDIVISION-II
LOCATION: WAIPI'O, EWA, OAHU, HAWAII

Hammer:
Weight: 140 #
Drop: 30".

Sampler:
2" S - 2" O.D. THIN WALL TUBES
2" 66 - 3" STANDARD SPLIT SPOON

Penetration Data

Depth (ft)
0 2.5 5 10 15 20 25 30 35 40

ELEV. = 76' + *

Sample No. 3-A 3-B 3-C 3-D 3-E

Penetration
8/5" 8/5" 13/5" 57/5" 55 47/5"

Sample Method:
STIFF, REDDISH BROWN CLAYEY Silt
STIFF LIGHT BROWN w/ GRAY, CLAYEY Silt
VERY STIFF REDDISH BROWN, CLAYEY Silt w/ SOME SAND
VERY STIFF, REDDISH BROWN, CLAYEY Silt

*ELEVATION ESTIMATED FROM TOPO MAP.

Date: 11-15-69
Datum: 2" O.D. THIN WALL TUBE TEST SAMPLER.
GENERAL TESTING METHODS

EXPLORATORY BORINGS AND SAMPLING

Method for soil investigation and sampling by auger borings (Tentative)  
ASTM Designation: D 1452-63T

Method for thin wall tube sampling of soils (Tentative)  
ASTM Designation: D 1587-63T

Method for penetration test and split barrel sampling of soils (Tentative)  
ASTM Designation: D 1586-64T

LABORATORY TESTING

Grading Analysis

Sieve analysis of fine and coarse aggregates  
AASHTO Designation: T 27-60

Amount of material finer than No. 200 sieve in aggregate  
AASHTO Designation: T 11-60

Atterberg Limits

Determining the liquid limit of soils  
Modified as follows: Substitute Casagrande grooving tool. Tests conducted from natural moisture content unless noted otherwise.  
AASHTO Designation: T 89-60

Determining the plastic limit of soils  
AASHTO Designation: T 90-56

Calculating the plasticity index of soils  
AASHTO Designation: T 91-54

Specific Gravity

Specific gravity of soils  
Modified as follows: 500 ML Pycnometer  
AASHTO Designation: T 100-60

Expansion and CBR Tests

Expansion test and California Bearing Ratio (CBR)  
Section VIII - TM 5-530  
"Materials Testing" by Headquarters, Dept. of the Army

Compaction Test

Moisture-Density relations of soils using a 10# rammer and an 18" drop  
AASHTO Designation: T 180-57

Unified Soil Classification

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.