TO:
COMMUNITY PLANNING, INC.

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS
APRIL 11, 1975
July 29, 1975

MR. GEORGE HOUGHTAILING
Community Planning, Inc.
700 Bishop Street, Suite 608
Honolulu, Hawaii 96813

Dear Mr. Houghtailing:

Subject: Addendum No. 1 to Bougainville Industrial Park Off-site Sewers Soil Exploration Report

Dated April 11, 1975
Halawa, Ewa, Oahu, Hawaii
Tax Map Key: 9-9-02: 2, 3, 18 & 25

It has been brought to our attention that the proposed sewer line will cross over an existing Navy utility tunnel near Boring No. 8. The proposed sewer invert will be about 8-1/2 ft above the crown of the tunnel.

Boring No. 8, which may be about 10 to 20 ft from the tunnel, indicated mudrock down to about the crown of the tunnel, then underlain with stiff clays.

It is our understanding that the tunnel at the crossing is lined. The tunnel lining in the vicinity of the sewer line crossing should be observed and evaluated for the proposed construction. Based on the evaluation, the tunnel lining may have to be reinforced.

The sewer line should be jacketed or reinforced to span across the tunnel.

The contractor should be advised to exercise care when working near the tunnel. Blasting or excavation procedures that may disturb the in-place mudrock should be avoided to reduce possible damages to the tunnel.

Respectfully submitted,

WALTER LUM ASSOCIATES, INC.

By Ezra Koike

EK:vl
April 11, 1975

MR. GEORGE HOUGHTAILING
Community Planning, Inc.
700 Bishop Street, Suite 608
Honolulu, Hawaii  96813

Dear Mr. Houghtailing:

Subject: Bougainville Industrial Park
Off-Site Sewers
Soil Exploration Report
(for sewer pipe bedding design purposes)
Halawa, Ewa, Oahu, Hawaii
Tax Map Key: 9-9-02: 2, 3, 18 & 25

Transmitted herewith is our soil exploration report for the design of the proposed Bougainville Industrial Park Off-Site Sewers at Halawa, Ewa, Oahu, Hawaii.

This report includes a Boring Location Sketch, boring logs, laboratory test results, recommendations and limitations.

Respectfully submitted,

WALTER LUM ASSOCIATES, INC.

By Ezra Koike

FM/EK:vl
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BOUGAINVILLE INDUSTRIAL PARK OFF-SITE SEWERS
SOIL EXPLORATION REPORT

HALAWA, EWA, OAHU, HAWAII
TAX MAP KEY: 9-9-02: 2, 3, 18 & 25

SCOPE OF EXPLORATION

The purpose of this soil exploration was to evaluate general soil conditions for design considerations for the proposed Bougainville Industrial Park Off-Site Sewers at Halawa, Ewa, Oahu, Hawaii.

This report includes field explorations, laboratory tests, general pipe bedding design recommendations and limitations.

FIELD EXPLORATION

Nine exploratory borings were made along the proposed alignment. The approximate locations of the borings are shown on the Boring Location Sketch.

Borings were made with 4-in. diameter augers using tungsten carbide drag bits and finger type bits. Soil samples were recovered with 3-in. thin-wall tubes and 2-in. standard split spoon samplers driven with a 140-lb hammer falling 30 inches.

LABORATORY TESTS

Laboratory tests included: natural water content and density, unconfined compression, laboratory vane shear, Atterberg limit, grain-size analysis, triaxial and consolidation.
SOIL CLASSIFICATION SYSTEM

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."

GEOLOGIC AND SOIL CLASSIFICATIONS BY OTHERS

From a review of geologic literature and the U. S. Soil Conservation Service maps of the area, the soils are generally described by others as follows:


Qht - (Honolulu Volcanic Series)
Consolidated gray, lavender and brown bedded only slightly permeable deposits of basic vitric - crystal - lithic tuff


MdB - Makalapa clay, 2 to 6% slopes
Unified Soil Classification - CH

KTKE - Kokokahi very stony clay, 0 to 35% slopes
Unified Soil Classification - CH

rRK - Rockland
GENERAL SITE CONDITIONS

A sewer line about 3,600 ft in length is proposed from Bougainville Road (under construction) to Salt Lake Boulevard. The route crosses the back (westerly) portions of Hale Keiki School, Radford High School and Makalapa Elementary School grounds.

A 30-ft wide energy corridor and the proposed H-1 Freeway are located on the west side of the proposed route. A shallow unlined ditch generally follows alongside the freeway and energy corridor.

A 30-in. Navy water line, some sewer lines and drainage culverts cross portions of the site near Hale Keiki School. Some highway construction work was in progress south of the Hale Keiki school grounds during the field explorations.

The route crosses a depression behind (west) Hale Keiki School and Radford High School. Some water was ponded in localized pockets during the field exploration. Several mounds of miscellaneous soils, boulders, etc. were stockpiled along this section. An earth surcharge about 10 to 12 ft in height was noted in the H-1 Freeway right-of-way about 75 to 100 ft west of the proposed sewer.

A track field, bleachers, floodlights, classroom building, parking lot, basketball court, Navy water lines and some concrete structures occur along the proposed route in back of (west) Radford High School and Makalapa Elementary School grounds.
INTERPRETATION OF SOIL CONDITIONS

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

B-1 & B-2 (Fills over mudrock)
Surface fills of clays, sands and gravels to about 8 to 9 ft, then dense silty sands and mudrock to about 25 to 30-ft, the depths drilled.

B-3, B-4, B-5, B-6 (Fills over soft clay deposits)
Surface fills of clayey silty materials mixed with sand, gravel, coral and occasional boulders about 5 to 10 ft thick, then soft clay deposits to about 25 to 30 ft or more. Below this, stiffer materials of clay and/or decomposed mudrock (?) were noted.

B-7, B-8, B-9 (Fills over mudrock)
Surface fills of clayey silts, sands and gravel to about 3 to 7 ft, then dense silty sands and mudrock to about 38 to 42-ft depths.

In Boring Nos. 7 and 8, stiff brown clay and silty sand were noted below the mudrock to about 46 to 50 ft, the depths drilled.

Water was noted in Boring Nos. 3 thru 6 at about 5 to 25-ft depths during the field explorations.
Variations to the above soil conditions are to be expected between borings and in localized areas. For more detailed descriptions of soils encountered in the borings, refer to the boring logs.

DISCUSSION AND RECOMMENDATIONS

A 12-in. diameter gravity flow sewer line about 3,600 ft in length is proposed.

The profile of the ground starts about elevation 52, slopes generally to about elevation 33 about the middle of the line, then rises to elevation 64 for most of the latter half of the line. The ground slopes down to about elevation 25 ft at the end of the project.

The invert of the sewer line generally varies from about elevation 34 ft at the beginning (Bougainville Road) to about elevation 24 ft at the end (Salt Lake Boulevard).

The depth to the pipeline will be about 13 ft at the beginning of the Bougainville Road to a few feet along the depressed area of the middle section and deepens to about 35 ft at the ending half of the project.

At the beginning (from about B-1 to B-2), the invert of the pipeline will probably be in dense silty sands and mudrock. In the middle (B-3 thru B-6), the pileline will probably be in soft to medium clay soils. In the ending one-third of the project, the invert of the pipeline will probably be in mudrock or dense silty sands.
For about one-half of the project, about the middle of the route, the invert of the sewer line will be in soft clays. Settlements of several inches to over a foot may occur in this area depending what loads are placed over the line at the ground surface. Also, the line may be disturbed from construction activities next door along the energy corridor.

**General Design Guidelines**

The sewer line will be in mudrock at the beginning, then soft mud and end in mudrock or dense sands.

Because of the hard and soft materials, the sewer lines should be constructed with flexible joints, particularly where the lines are connected to sewer manholes.

Where the sewer is underlain with soft clay deposits, some waving of the line from differential settlements are anticipated, particularly where the underlying material transitions from the soft deposits to dense silty sand and mudrock formations. In general, the sewer line profile should be steep so that the overall line would function even with some localized sags or dips.

If grading work, particularly the construction of fills are planned along the sewer line route, it should be done as soon as practicable over the soft area to allow time for
the ground to consolidate and settle prior to the start of pipeline construction. Preferably, a surcharge should be placed over the sewer easement prior to the installation of the line.

Because of potential slope creep, manholes should generally be avoided on or near tops of slopes.

Subbase for Sewer Line

In general, because the soil conditions would vary along the proposed route, the subbase thickness should be adjusted according to the material below the sewer invert.

Guidelines for the thickness of the subbase may be as follows:

<table>
<thead>
<tr>
<th>Material below invert</th>
<th>Subbase thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft clayey silty soils</td>
<td>36+ in.</td>
</tr>
<tr>
<td>Gravel, boulders, mudrock or decomposed rock</td>
<td>6+ in.</td>
</tr>
</tbody>
</table>

The granular materials for the subbase should generally be equivalent to base course rock, 1-1/2 in. to dust sizes. The fines passing the No. 200 sieve should be less than about 15% of the fraction passing the 1-in. sieve.

If the contractor's excavation and dewatering methods weaken or disturb the subgrade, the above thicknesses should be increased.
Provisions should be made in the contract documents to allow for local adjustments for subbase in the field where soft or weak spots are encountered during construction.

**Pipe bedding**

In general, crushed rock cradle or concrete cradle may be considered over the subbase. A crushed rock cradle would be preferable.

In general, the sewer pipe should be set in a bed of granular materials beginning from about 6 in. below the pipe invert to about 1 ft over the top of the pipe.

The granular materials should preferably be equivalent to base course rock, well graded from about 1-1/2 to 0 in. with less than about 15% passing the No. 200 sieve.

**Backfill**

Backfill above the pipe may be made with soils compacted to about 90% of AASHO T-180-73 if fine-grained soils are used.

Where water is encountered, the backfill material should be constructed with fairly well-graded granular materials. The granular materials may be placed by sluicing with water, provided there is good drainage for the water to flow.
Construction Considerations

Care should be exercised when working near existing utilities, particularly along the energy corridor where oil and gas lines are located and near Navy water mains by Boring Nos. 1 and 8.

Caution should be taken and support provided to minimize damage to existing buildings, walls, fences and utility lines that are located mostly along the developed sections of the school grounds. Some underpinning may be required.

Work should also be coordinated with the respective utilities to minimize damages and interference with their operations.

Support at excavations in soft area

The excavation depths will vary from shallow to fairly deep. The sidewalls of the excavations in the soft clayey deposits should be well supported.

To minimize settlements if sheeting or soldier piles are used, the portion of sheets or soldier piles that extend below the top of the sewer line should be left in place. (See Figure 1.)

Dewatering

Water was generally noted over the soft deposits at the middle portion at various elevations. Some dewatering will probably be done to install the sewer line.
Unforeseen Conditions

Because of the variability of soil deposits, site improvements, design and construction techniques, conditions may be encountered that cannot be foreseen with even the most exhaustive studies of site and project conditions. These unforeseen conditions should be recognized when encountered and then evaluated so that the designs or the construction methods may be modified accordingly, if necessary.

Unforeseen or undetected conditions such as soft spots, existing utility trenches, underground structures, boulders, expansive soil pockets or seepage water, etc., may occur in localized areas and will have to be adjusted and corrected in the field as they are detected.
BORING LOGS

The stratification lines shown on each of the boring logs represent the approximate boundary between soil types and the transition may be gradual.

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 limit or grain-size analysis test results.
Boring Log

**BOUGAINVILLE INDUSTRIAL PARK**

**PROJECT**
OFFSITE SEWERS

**LOCATION**
Halawa, Ewa, Oahu, Hawaii

**Tax Map Key:** 9-9-02: 2, 3, 18

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

**SAMPLER:**
2" STANDARD SPLIT SPOON

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### PENETRATION DATA

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</table>

**END OF BORING & 30’ 8-3-75**

* Elevation estimated from topographic survey dated 6-5-74.
Boring Log

BOUGAINVILLE INDUSTRIAL PARK
PROJECT: OFFSITE SEWERS
LOCATION: Halawa, Ewa, Oahu, Hawaii
Tax Map Key: 9-9-02: 2, 3, 18 & 25

HAMMER:
Weight: 140#
Drop: 20"

SAMPLER: 2" STANDARD SPLIT SPOON

---

PENETRATION DATA

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<th>Depth (Ft)</th>
<th>Sampler</th>
<th>Sample No.</th>
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<th>Water Cont.</th>
<th>Liquid Limit</th>
<th>Unconf. Comp.</th>
<th>P.S.I.</th>
<th>Vane Shear</th>
<th>P.S.E.</th>
<th>Standard Penetration Test</th>
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<td>MEDIUM, GRAY BROWN CLAY W/ SOME CORAL, GRAVEL &amp; SAND (FILL)</td>
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<td>2.2</td>
<td>2-A</td>
<td>17</td>
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<td>2-C</td>
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<td>END OF BORING @ 25.3' 9-4-74</td>
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* Elevation estimated from topographic survey dated 6-5-74.
# Boring Log

**BOUGAINVILLE INDUSTRIAL PARK**

**PROJECT**

OFFSITE SEWERS

**LOCATION**

Halawa, Ewa, Oahu, Hawaii

**Tax Map Key:** 5-9-02: 2, 3, 18

---

**HARMER:**

- **Weight:** 140#
- **Drop:** 2'-3" - 2" STANDARD SPLIT SPOON
- **3" - 6" O.D. THIN WALL TUBE

**SAMPLER:**

- **Weight:** 140#
- **Drop:** 3'-3"
- **Type of Boring:** AUGER (MOBILE)
- **Diam.:** 4"

---

**BORE No.:** 3

**Sheet No.:** of 3

**Driller:** W. LUM ASSOC., INC.

**Date:** SEPT. 4, 1974

**Field Party:** MEETER, CHOW, SEARELL

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

**Diam.:** 4"

**Elev:** 42' ±

**Datum:**

**Hammer:**

- **Weight:** 140#
- **Drop:** 3'-3"

**Water Level:** 24.0'

**Time:**

- **Date:** 9-4-74

---

**PROJECT:** OFFSITE SEWERS

**LOCATION:** Halawa, Ewa, Oahu, Hawaii

**Field Party:** MEETER, CHOW, SEARELL

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

**Diam.:** 4"

**Elev:** 42' ±

**Datum:**

**Hammer:**

- **Weight:** 140#
- **Drop:** 3'-3"

**Water Level:** 24.0'

**Time:**

- **Date:** 9-4-74

---

**UNIFIED CLASSIFICATION**

**DESCRIPTION**

**SAMPLER:**

- **Depth:** 42' ±
- **Sample No.:**
- **Sample Limit:**
- **Water Cont.:**
- **Liquid Limit:**
- **Plastic Limit:**
- **Using Comp.:**
- **Standard Penetration Test:**
- **Blows per foot:**

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<td>2.55</td>
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<td>22</td>
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<td>3.55</td>
<td>3-B</td>
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<td>16</td>
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<td>4.55</td>
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</table>

**NOTE:**

- **Yd:** WET DENSITY, P.E.
- **Yo:** DRY DENSITY, I.G.

---

**END OF BORING @ 96.5 ft 9-4-74.**
### Boring Log

**PROJECT**
BOUGAINVILLE INDUSTRIAL PARK
OFFSITE SEWERS

**LOCATION**
Halawa, Ewa, Oahu, Hawaii

**Tax Map Key:** 9-9-02: 2, 3, 18 & 25

### Hammer:
- **Weight**: 140#
- **Drop**: 2.65 - 2.9" standard split spoon
- **3" - 3.5" O.D. Thin Wall Tube

### Sampler:

#### Unified Soil Classification

<table>
<thead>
<tr>
<th>Unified Soil Classification</th>
<th>Description</th>
<th>Depth (ft.)</th>
<th>Sampler</th>
<th>Sample No.</th>
<th>Plastic Limit</th>
<th>Water Cont.</th>
<th>Liquid Limit</th>
<th>Unconf. Comp.</th>
<th>P.S.F.</th>
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<tbody>
<tr>
<td>(CH)</td>
<td>Stiff, dark brown clay with mudrock fragments</td>
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<td>4-A</td>
<td>90</td>
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<td>(CH)</td>
<td>Medium, mottled gray brown clay</td>
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<td>CH</td>
<td>Soft, gray clay (partly organic)</td>
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<td>CH</td>
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<td>2.55</td>
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### Penetration Data

- **Standard Penetration Test (SPT)**
- **3" O.D. Thin Wall Tube Sampler**

#### Penetration Test

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<tr>
<th>Depth (ft.)</th>
<th>Penetration Test (SPT)</th>
<th>Penetration Test (SPT)</th>
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<td>2.55</td>
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### Note:

- **Elevation estimated from topographic survey dated 6-5-74.**

---

*Elevation estimated from topographic survey dated 6-5-74.*
**BORING LOG**

**BOUGAINVILLE INDUSTRIAL PARK**  
**OFFSITE SEWERS**  
**PROJECT**

**LOCATION:** Halawa, Ewa, Oahu, Hawaii

**Tax Map Key:** 9-9-02: 2, 3, 18

**WALTER LUM ASSOCIATES, INC.**  
3030 WAIALAE AVENUE • HONOLULU, HAWAII 96816 • PHONE 737-7931

---

**Boring No. 5**  
**Sheet No.**

**Driller:** K. LUM ASSOC., INC  
**Date:** FEBRUARY 21 TO MARCH 4, 1975

**Field Party:** CHOW, KAJ, SHIGENAGA ASATO  
**Type of Boring:** auger  
**Dia.:** 4"  
**Datum:** 10'

---

**Water Level:** 3'  
**Time:** 8:45 PM  
**Date:** 3-3-75  
**Time:** 1:45 PM

---

**Hammer:** J.G. DRAG

---

**PENETRATION DATA**  
**Standard Penetration Test:** 3/8" O.D. THIN WALL TUBE SAMPLER

---

**SAMPLER:**

---

**PERIOD DATA**

---

**ELEV = 47' 7"**  
**Sample No.**

---

**DESCRIPTION**  
**ELEV. = 47' 7"**

**Note:** Moved hole 4 times, cobble or boulder encountered

---

**STIFF, MOTTLED BROWN  
SILTY CLAY WITHROCK, DECOMPOSED ROCK, GRAVEL, SAND SOME CORAL (FILL)  
COBBLE OR BOULDER**

---

---

**SAMPLER:**

---

**HAMMER BOUNCES**

---

**Elevation estimated from topographic survey dated 6-5-74.**
**Location:** Halawa, Ewa, Oahu, Hawaii  
**Date:** 2-26-75

**Driller:** W. LUM ASSOCIATES, INC.  
**No. of Boring:** 6

**Boring Log**

**BOUGAINVILLE INDUSTRIAL PARK**

- **PROJECT:** OFFSITE SEWERS

**LOCATION:**

- **Tax Map Key:** 9-9-02: 2, 3, 18

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

**SAMPLE:**
- **Standard Penetration Test:** 3' O.D. TIN WALL TUBE SAMPLER

<table>
<thead>
<tr>
<th>ELEV. = 52'40&quot;</th>
<th>DESCRIPTION</th>
<th>SAMPLE No.</th>
<th>SAMPLE No.</th>
<th>PLASTIC LIMIT</th>
<th>LIQUEFIED LIMIT</th>
<th>Voids</th>
<th>Penetration</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.65</td>
<td>STIFF, MOTTLED BROWN SILTY CLAY (M) GRANUL. CORAL &amp; SAND (FILL). COBBLE</td>
<td>G-A</td>
<td>21</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1/m.0</td>
<td>29/0.1</td>
</tr>
<tr>
<td>2.55</td>
<td>LOOSE, GRAY BROWN SILTY CLAY &amp; SAND &amp; GRAVEL (FILL). WOOD PIECE, CAULIF. OR VOID 5'-7'</td>
<td>G-B</td>
<td>14</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1/m.0</td>
<td>-</td>
</tr>
<tr>
<td>2.45</td>
<td>BROWN CLAYEY GRAVEL (FILL)</td>
<td>G-C</td>
<td>24</td>
<td>-</td>
<td>-</td>
<td>1/m.0</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** MOVED HUC 9 TIMES TO AUGER PASS 10.5' DEPTH, HIT SCRAP METAL (?) & BOULDER.

<table>
<thead>
<tr>
<th>ELEV. = 57'0&quot;</th>
<th>DESCRIPTION</th>
<th>SAMPLE No.</th>
<th>SAMPLE No.</th>
<th>PLASTIC LIMIT</th>
<th>LIQUEFIED LIMIT</th>
<th>Voids</th>
<th>Penetration</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.65</td>
<td>SOFT, LIGHT GRAY CLAY</td>
<td>G-E</td>
<td>-</td>
<td>NO RECOVERY</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**NOTE:** NO RECOVERY ON SECOND ATTEMPT WITH SPLIT SPOON

<table>
<thead>
<tr>
<th>ELEV. = 62'40&quot;</th>
<th>DESCRIPTION</th>
<th>SAMPLE No.</th>
<th>SAMPLE No.</th>
<th>PLASTIC LIMIT</th>
<th>LIQUEFIED LIMIT</th>
<th>Voids</th>
<th>Penetration</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.55</td>
<td>MEDIUM, GRAY CLAY</td>
<td>G-G</td>
<td>11</td>
<td>-</td>
<td>-</td>
<td>540</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**NOTE:**
- **WEE: 195**
- **Yo: 55**

<table>
<thead>
<tr>
<th>ELEV. = 67'40&quot;</th>
<th>DESCRIPTION</th>
<th>SAMPLE No.</th>
<th>SAMPLE No.</th>
<th>PLASTIC LIMIT</th>
<th>LIQUEFIED LIMIT</th>
<th>Voids</th>
<th>Penetration</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.55</td>
<td>STIFF, GRAY CLAY</td>
<td>G-H</td>
<td>52</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**NOTE:**
- **WEE: 120**
- **Yo: 19**

**END OF BORING @ 36' 2-26-75**

**REMARKS:**
- **WEE:** 170
- **Pray:** 45

* Elevation estimated from topographic survey dated 6-5-74.
<table>
<thead>
<tr>
<th>Boring Log</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PROJECT</strong></td>
</tr>
<tr>
<td><strong>LOCATION</strong></td>
</tr>
<tr>
<td><strong>HtMER</strong></td>
</tr>
<tr>
<td><strong>DroLP</strong></td>
</tr>
<tr>
<td><strong>SAMPLER</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>DESCRIPTION</strong></th>
<th><strong>ELEV.</strong></th>
<th><strong>PAHT</strong></th>
<th><strong>Sample</strong></th>
<th><strong>Penetration Test</strong></th>
<th><strong>Penetration Data</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>STIFF GROWISH BROWN CLAY</td>
<td>41&quot;</td>
<td>0.0</td>
<td>50</td>
<td>40</td>
<td>42</td>
</tr>
<tr>
<td>MEDIUM DENSE BROWN SILT SAND</td>
<td>41&quot;</td>
<td>0.0</td>
<td>50</td>
<td>40</td>
<td>42</td>
</tr>
<tr>
<td>GRAY BROWN MUDROCK</td>
<td>41&quot;</td>
<td>0.0</td>
<td>50</td>
<td>40</td>
<td>42</td>
</tr>
<tr>
<td>GRAY MUDROCK, SILT SAND</td>
<td>41&quot;</td>
<td>0.0</td>
<td>50</td>
<td>40</td>
<td>42</td>
</tr>
<tr>
<td>GRAY MUDROCK, WGRavel</td>
<td>41&quot;</td>
<td>0.0</td>
<td>50</td>
<td>40</td>
<td>42</td>
</tr>
<tr>
<td>BROWN, SILT SAND</td>
<td>41&quot;</td>
<td>0.0</td>
<td>50</td>
<td>40</td>
<td>42</td>
</tr>
<tr>
<td>DENSE BROWN SILT SAND</td>
<td>41&quot;</td>
<td>0.0</td>
<td>50</td>
<td>40</td>
<td>42</td>
</tr>
<tr>
<td>MEDIUM DENSE BROWN BROWN, SILT SAND</td>
<td>41&quot;</td>
<td>0.0</td>
<td>50</td>
<td>40</td>
<td>42</td>
</tr>
</tbody>
</table>

* Elevation estimated from topographic survey dated 6-5-74.
**BOURGAINVILLE INDUSTRIAL PARK**

**PROJECT**
OFFSITE SEWERS

**LOCATION**
Halawa, Ewa, Oahu, Hawaii

**Tax Map Key:** 9-9-02: 2, 3, 18

---

**HAMMER:**
140 #

**Weight**
50 #

**Drop**
25 #

**SAMPLER:**
2" STANDARD SPLIT SPOON

---

**BORING NO.**
B-1

**Sheet No.**
2 & 25

**Drill**
IGA

**Date**
M, 7-11-75

**Elev.**
58' +

**Datum**
-

---

**PROJECT**
OFFSITE SEWERS

**LOCATION**
Halawa, Ewa, Oahu, Hawaii

**Tax Map Key:** 9-9-02: 2, 3, 18

---

**ELEVATION DATA**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Description</th>
<th>Sample</th>
<th>Plastic Limit</th>
<th>Water Cont.</th>
<th>Liquid Limit</th>
<th>V.S.</th>
<th>Penetration Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>STIFF, BROWN GLAY &amp; MUDROCK</td>
<td>B-A</td>
<td>29</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>DENSE, BROWN Silty SAND &amp; GRAVEL</td>
<td>B-B</td>
<td>27</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>15</td>
<td>STIFF, BROWN Silty SAND &amp; GRAVEL</td>
<td>B-E</td>
<td>24</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>20</td>
<td>BROWN Silty SAND &amp; GRAVEL</td>
<td>B-D</td>
<td>24</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>25</td>
<td>BROWN Silty SAND &amp; MUDROCK</td>
<td>B-C</td>
<td>43</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>30</td>
<td>BROWN Silty SAND &amp; MUDROCK</td>
<td>B-G</td>
<td>33</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>35</td>
<td>STIFF, BROWN GLAY</td>
<td>B-F</td>
<td>33</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>40</td>
<td>STIFF, BROWN GLAY</td>
<td>B-I</td>
<td>34</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>45</td>
<td>STIFF, BROWN GLAY</td>
<td>B-J</td>
<td>44</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

---

**END OF BORING @ 44.5'**

---

*Elevation estimated from topographic survey dated 6-5-74.*
Boring Log

BOUGAINVILLE INDUSTRIAL PARK

PROJECT OFFSITE SEWERS

LOCATION Halawa, Ewa, Oahu, Hawaii

Tax Map Key: 9-9-02: 2, 3, 18

HAMMER:
Weight 140#
Drop 30"

SAMPLER: 2" STANDARD SPLIT SPOON

Penetration Data

<table>
<thead>
<tr>
<th>Und. Soil Classification</th>
<th>Depth (ft)</th>
<th>Plastic Limit</th>
<th>Water Cont.</th>
<th>Liquid Limit</th>
<th>Uncorr. Comp.</th>
<th>Penetration Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>(CH) MEDIUM, MOTTLED BROWN CLAY W/ WOOD &amp; DECOMPOSED ROCK (FILL)</td>
<td>9.6</td>
<td>31</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4 BOUNCES</td>
</tr>
<tr>
<td>(MA) DENSE, BROWN SILTY SAND &amp; MUDDY ROCK</td>
<td>10.5</td>
<td>27</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4 BOUNCES</td>
</tr>
<tr>
<td>(SM) DENSE, MOTTLED BROWN SILTY SAND &amp; DECOMPOSED MUDDY ROCK</td>
<td>15.0</td>
<td>31</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5 BOUNCES</td>
</tr>
<tr>
<td></td>
<td>20.5</td>
<td>60</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>6 BOUNCES</td>
</tr>
<tr>
<td></td>
<td>25.0</td>
<td>31</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4 BOUNCES</td>
</tr>
</tbody>
</table>

Elevation estimated from topographic survey dated 6-5-74.
TABLE IA - SUMMARY OF LABORATORY TEST RESULTS

<table>
<thead>
<tr>
<th>BORING NO.</th>
<th>3</th>
<th>3</th>
<th>4</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAMPLE NO.</td>
<td>C</td>
<td>E</td>
<td>C</td>
<td>E</td>
</tr>
<tr>
<td>DEPTH BELOW SURFACE</td>
<td>10'-11.5</td>
<td>19'-16.5</td>
<td>10'-11.5</td>
<td>20'-21.5</td>
</tr>
<tr>
<td>DESCRIPTION</td>
<td>GRAY CLAY (PARTLY ORGANIC)</td>
<td>GRAY CLAY (PARTLY ORGANIC)</td>
<td>GRAY CLAY (PARTLY ORGANIC)</td>
<td>GRAY CLAY</td>
</tr>
</tbody>
</table>

**GRAIN-SIZE ANALYSIS**

<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>
</tr>
</thead>
<tbody>
<tr>
<td>Pass (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**ATTERBERG LIMITS**

<table>
<thead>
<tr>
<th>Air Dried or Natural</th>
<th>Liquid Limit</th>
<th>Plastic Limit</th>
<th>Plasticity Index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Natural</td>
<td>Natural</td>
<td>Natural</td>
</tr>
<tr>
<td></td>
<td>95</td>
<td>78</td>
<td>117</td>
</tr>
<tr>
<td></td>
<td>35</td>
<td>26</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>55</td>
<td>60</td>
<td>79</td>
</tr>
</tbody>
</table>

**Dilatancy**

- Slow

**Toughness**

- Medium

**Dry Strength**

- High

**UNIFIED SOIL CLASSIFICATION**

| CH | CH | CH | CH |

**MOISTURE-DENSITY RELATIONS OF SOILS**

(AASHTO T-180-73I, Method )

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

**REMARKS:**

Date: 3-21-75

By: [Signature]

WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS
### TABLE I - SUMMARY OF LABORATORY TEST RESULTS

<table>
<thead>
<tr>
<th>BORING NO.</th>
<th>SAMPLE NO.</th>
<th>DEPTH BELOW SURFACE</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>70'-71.5'</td>
<td>GRAY BROWN CLAY (PARTLY DECOMPOSED)</td>
</tr>
</tbody>
</table>

#### DESCRIPTION

**GRAIN-SIZE ANALYSIS**

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

#### ATTERBERG LIMITS

- Air Dried or Natural
- Liquid Limit
- Plastic Limit
- Plasticity Index

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural</td>
<td></td>
</tr>
<tr>
<td>Liquid Limit</td>
<td>104</td>
</tr>
<tr>
<td>Plastic Limit</td>
<td>41</td>
</tr>
<tr>
<td>Plasticity Index</td>
<td>69</td>
</tr>
<tr>
<td>Dilatancy</td>
<td>NONE</td>
</tr>
<tr>
<td>Toughness</td>
<td>HIGH</td>
</tr>
<tr>
<td>Dry Strength</td>
<td>HIGH</td>
</tr>
</tbody>
</table>

#### UNIFIED SOIL CLASSIFICATION

- C.W.

#### APPARENT SPECIFIC GRAVITY

- C.G.

#### CBR TEST

- (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

- (AASHO T-180-73I, Method ___)
- Dry to Wet or Wet to Dry
- Max. Dry Density (P.C.F.)
- Optimum Moisture (%)
### Sample Description:

**Gray-Brown Clay (Partly Organic)**

<table>
<thead>
<tr>
<th>Sample Description</th>
<th>Sample Size</th>
<th>Atterberg Limits</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gray-Brown Clay (Partly Organic)</strong></td>
<td>2 3/8&quot;</td>
<td>LL = 104</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1&quot;</td>
<td>PL = 4.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6&quot;</td>
<td>PI = 62</td>
<td></td>
</tr>
</tbody>
</table>

#### EXPLANATION

- **KEY:**
  - Boring Sample No.
  - Sample No.
  - Depth
  - Test Type
  - Lateral Pressure P.S.F.
  - Deviator Stress P.S.F.
  - Water Content, %
  - Degree of Saturation, %
  - Axial Strain %

<table>
<thead>
<tr>
<th>Key</th>
<th>Boring Sample No.</th>
<th>Sample No.</th>
<th>Depth</th>
<th>Test Type</th>
<th>Lateral Pressure P.S.F.</th>
<th>Deviator Stress P.S.F.</th>
<th>Water Content, %</th>
<th>Degree of Saturation, %</th>
<th>Axial Strain</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>E</td>
<td>20' - 21.5'</td>
<td>Q</td>
<td>1440</td>
<td>615</td>
<td>84</td>
<td>-</td>
<td>-</td>
<td>6.0</td>
</tr>
</tbody>
</table>

- **BOUGAINVILLE INDUSTRIAL PARK - OFFSITE SEWERS**
- Halawa, Ewa, Oahu, Hawaii
- **Q"-UNCONSOLIDATED, UNDRAINED**
- **WALTER LUM ASSOCIATES, INC.**
### CONSOLIDATION TEST
**LOAD-DEFLECTION CURVE**

**PROJECT:** BOUGAINVILLE INDUSTRIAL PARK-OFFSITE SEWERS

**LOCATION:** WAIKUNA, EWA, OAHU, HAWAII

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>4C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth</td>
<td>10'-11-1/2</td>
</tr>
<tr>
<td>Water Content (Before Test)</td>
<td>21 %</td>
</tr>
<tr>
<td>Water Content (After Test)</td>
<td>16 %</td>
</tr>
<tr>
<td>Sample Dry Weight</td>
<td>59 g</td>
</tr>
<tr>
<td>Height of Sample</td>
<td>100&quot;</td>
</tr>
<tr>
<td>Diameter of Sample</td>
<td>2.25&quot;</td>
</tr>
<tr>
<td>Area of Sample</td>
<td>4.48 sq.</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>2.64</td>
</tr>
</tbody>
</table>

**ATTERBERG LIMITS:**
- Liquid Limit: 117
- Plastic Limit: 35
- Plasticity Index: 79

---

Load in P.S.F.  

---

WALTER LUM ASSOCIATES, INC.  
STRUCUTRAL & SOIL ENGINEERS
FIGURE 1
SCHEMATIC SECTION - SUGGESTED SEWER PIPE BEDDING OVER SOFT GROUND
BOUGAINVILLE INDUSTRIAL PARK OFFSITE SEWERS
HALAWA, EWA, OAHU, HAWAII

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

APRIL, 1975
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.

If there is a substantial lapse of time between the submission of this report and the start of work at the site, or if conditions have changed due to natural causes, plan changes, or construction operations at or adjacent to the site, it is recommended that this report be reviewed to determine the applicability of the recommendations considering the time lapse, changed conditions, and changes in the state of the art of soil engineering.

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.