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not to be taken from this room

SOILS REPORT
for
PUOHALA SUBSTATION
HAWAIIAN ELECTRIC COMPANY INC.
KANEHOE HAWAII

TRANS-ASIA ENGINEERING ASSOCIATES, INC.
1160 AUANI STREET, HONOLULU, HAWAII

MUNICIPAL REFERENCE & RECORDS CENTER
City & County of Honolulu
City Hall Annex, 558 S. King Street
Honolulu, Hawaii 96813
SOILS INVESTIGATION
PUOHALA SUBSTATION
KANEHOE, HAWAII

FOR
HAWAIIAN ELECTRIC CO., INC.

BY
TRANS-ASIA ENGINEERING ASSOCIATES, INC.
1160 AUahi STREET
HONOLULU, HAWAII 96814

MAY 1973
SOILS INVESTIGATION

PUOHALA SUBSTATION

GENERAL

Three borings were made at this site, two (P1 and P2) for grading and slope stability considerations and one (P3) for bearing capacity indications for the transformer pad. Borings P1 and P2 were made to a depth of approximately 30 feet which would place the bottom of the boring 10 feet below transformer pad elevation of 46.5'.

Soil Surveys of Hawaii identifies this soil as the Lolekaa Series which is derived from old alluvium. The parent material, from approximately four below the surface, is red, yellow and grey weathered gravel retaining its original structure and which is weakly cemented with limonite and hematite.

The Soil Conservation Service lists the following physical and chemical properties: Silty clay to loam (ML-MH) with a permeability of 2.0 to 6.0 inches per hour, low shrink-swell potential but having high corrosivity to uncoated steel and concrete. The Engineering Properties are given as: Good roadway fill, with favorable features for highway location but with care required to reduce the natural moisture content to that required for favorable compaction, terraces and slopes up to 70%.

CUT SLOPES

The soils in the ridge to be excavated are classified as a cohesive material of low pasticity or a soil with granular-cohesive characteristics.
Even at the comparatively high moisture content of 40%, the material is friable and exhibits some evidence of iron cementation. For the maximum cut of 22 feet, see Figure 4, at a slope of 1 to 1 with a bench at mid-height the shearing resistance required to reduce the lateral pressure to zero is 670 psf at elevation 55 feet and 1230 psf at elevation 45 feet. Without mobilizing shearing resistance along the horizontal plane, this allows a factor of safety of two. No stability problems will arise from the proposed excavations.

TRANSFORMER AND SWITCHGEAR PADS.

A portion of the area occupied by these pads is in fill and the remaining area is in cut. After obtaining approximate grade, all cut areas shall be scarified to a depth of twelve inches and recompacted at about 30% moisture content to a dry unit weight of 86 pounds per cubic foot.

Field observations and boring logs indicate approximately eleven feet of fill in the new transformer area. There is no indication that compaction control procedures were followed when this fill was placed. It is recommended that this soil be removed to a depth of 6 feet below existing grade and recompacted, at 30% moisture content, to a dry unit weight of 85 pounds per cubic foot. If soft spots are exposed during this operation the material should be removed and replaced with excavated soil from the adjacent ridge. Allowable bearing capacity will be 4000 psf.

Compacted material from the on-site excavation will safely stand on slopes of 1-1/2 to 1 for the height of 7 feet indicated on the drawings by
Hawaiian Electric Co., Ltd. The maximum fill occurs adjacent to the stream and outside of the chain link fence. Planting on the slope face is recommended although the roadway northwest of the fill slope should effectively cut off overland flow from the transformer and switchgear areas.

The curvature in the alignment of Kawa Stream in this area may possibly produce erosion of the fill slope during flood flows, since the toe of the slope is approximately four feet outside of the curve in the channel. It is suggested that stream flow characteristics be carefully studied to evaluate the possibility of damage to the roadway and substation installations.

Respectfully submitted,

John R. Evans
SPECIFICATION FOR

COMPACTION OF FILL MATERIAL

Areas on which fill is to be placed will be excavated to natural ground or a depth of six (6) feet, whichever is the least, and the excavated material inspected for its suitability, by Hawaiian Electric Company representatives. Satisfactory fill material shall be placed in layers not exceeding 12 inches, loose, at a moisture content within plus or minus 2% of 30% (by dry weight) and compacted to a dry density of not less than 85 pounds per cubic foot.

A completed lift shall be tested to determine its acceptability before any additional material is placed.

Material to be excavated from the adjacent bank is acceptable soil for this fill.
**SOIL PROFILE**

**SOIL SAMPLE**

<table>
<thead>
<tr>
<th>Sample</th>
<th>No.</th>
<th>Elev.</th>
<th>Consistency</th>
<th>Penetration</th>
<th>By Unit</th>
<th>Dry Wt.</th>
<th>Lab Consistency</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>BORING P1</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>62.5</td>
<td>62.0 Firm</td>
<td>20</td>
<td>12</td>
<td>42.0</td>
<td>78.9</td>
<td>Friable mottled, grey brown yellow CLAY</td>
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<td></td>
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<tr>
<td>62.5</td>
<td>57.0 Hard</td>
<td>32</td>
<td>12</td>
<td>34.8</td>
<td>61.7</td>
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<tr>
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<td>48.0 Hard</td>
<td>12</td>
<td>12</td>
<td>47.2</td>
<td>72.8</td>
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<tr>
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<td>41.5 Hard</td>
<td>14</td>
<td>12</td>
<td>45.0</td>
<td>76.8</td>
<td>Friable tan sandy SILT, some black &amp; white mottling</td>
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<td>BORING P2</td>
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<tr>
<td>62.5</td>
<td>61.0 Firm</td>
<td>28</td>
<td>12</td>
<td>21.7</td>
<td>64.3</td>
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<td>12</td>
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<td>72.8</td>
<td>Friable, tan sandy SILT, w/some clay pockets &amp; gravel</td>
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<tr>
<td>62.5</td>
<td>46.0 Hard</td>
<td>36</td>
<td>12</td>
<td>44.0</td>
<td>78.9</td>
<td>Tan very silty CLAY</td>
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<tr>
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<td>28.5 Hard</td>
<td>21</td>
<td>12</td>
<td>46.5</td>
<td>76.1</td>
<td>Friable, tan clayey SILT, w/ little sand and thin black seams</td>
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<td>BORING P3</td>
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<tr>
<td>62.5</td>
<td>36.0 Firm</td>
<td>7</td>
<td>12</td>
<td>39.4</td>
<td>74.9</td>
<td>Friable, brown silty CLAY, w/some organic</td>
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<tr>
<td>62.5</td>
<td>31.5 Soft</td>
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<td>12</td>
<td>20.07</td>
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<td>Non-uniform; brown silty CLAY to mottled tan-black sandy SILT</td>
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<tr>
<td>62.5</td>
<td>28.5 Firm</td>
<td>56</td>
<td>12</td>
<td>19.7</td>
<td>71.1</td>
<td>Grey-tan silty SAND, w/little clay</td>
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**SHEARING RESISTANCE & VOLUME OF SOLIDS CURVES**

**PENETRATION NOTE:** Number of blows required to drive sampler distance given using a 1/2 lb hammer and a 30 inch drop.

**NOTE:** 6000 pounds of thrust were applied to obtain data. Data is recorded as percent of reduction in shear strength from a peak value of 30 feet. Shear strength was obtained from confined compression test. Shear strength is defined as the ratio of the load, after failure, to the cross-sectional area of the specimen at failure. The specimen is 7 inches in diameter and 7 inches long of a solid or a sand-cemented normal soil. The test is performed on a compression testing machine with a constant rate of cross-head travel of 0.5 inches per minute. The load at failure is recorded and the shear strength is calculated.

**SUBSOIL ANALYSIS OF BORINGS P1, P2 & P3 FOR SUBSTATION, HAWAII**

**APPENDED NOTES:**

- Hard brown silty CLAY, w/some sand pockets & gravel
- Firm brown silty CLAY, w/ traces of highly weathered rock (sand & gravel) and streaks of tan, grey, red & black
- Loose light brown silty CLAY, w/some boulders
- Slightly weathered Boulders
- Weathered Rock, w/some clay pockets
- Firm brown silty CLAY, w/ traces of weathered rock (sand & gravel) and streaks of tan, grey, red & black
- Friable, tan sandy SILT, some black & white mottling
- Very friable, firm tan silty SAND
- Friable, tan sandy SILT, w/some clay pockets & gravel
- Tan very silty CLAY
- Friable, tan clayey SILT, w/ little sand and thin black seams
- Friable, brown silty CLAY, w/some organic
- Non-uniform; brown silty CLAY to mottled tan-black sandy SILT
- Grey-tan silty SAND, w/little clay

**APPROVED:** John R. Evans

**DATE:** May 22, 1973

**TRANSACTION ENGINEERING ASSOCIATES, INC.**

1140 ALAMO STREET
HONOLULU, HAWAI 96814

**HAWAIIAN ELECTRIC CO., LTD.**

HONOLULU, HAWAI

**SUBSTATION, HAWAII**

**FIGURE 2**
The above Composite Soil Profile is intended to present average conditions throughout the group of borings represented. See Individual Boring Charts for details.
STABILITY CONSIDERATIONS
PUOHALA SUBSTATION
HAWAIIAN ELECTRIC CO., LTD.

Scale 1" = 8'
Elevation 70'

65'
Existing Ground Surface

60'

55'

50'

Trans. Pad Elev. @ 46.5'

45'

Drainage Swale

1340 psf

22'

2020

S_{uc} = 6240 psf

2460

S_{uc} = 2820 psf

31'

TRANS-ASIA ENGINEERING ASSOCIATES, INC.
1160 AUAHI STREET
HONOLULU, HAWAII 96814
CROSS-SECTION AT LOCATION OF MAXIMUM CUT
PUOHALA SUBSTATION
HAWAIIAN ELECTRIC CO., LTD HONOLULU, HAWAII
Approved: John R. Evans Date: May 22, 1973

FIGURE 4