March 25, 1963

Blackfield Enterprises
915 South Street
Honolulu, Hawaii

Re: Keapuka, Unit 2-E

Gentlemen:

Transmitted herewith is our soil investigation report on Unit 2-E of Keapuka Subdivision.

On the whole, we find the soil conditions on the site to be favorable. Therefore, except for unfavorable weather, there should not be any particular construction difficulties as a result of soil conditions.

Very truly yours,

K. B. HIRASHIMA

HIRASHIMA REGISTERED PROFESSIONAL ENGINEER No. 209 HAWAII U.S.A.

K. B. Hirashima
Reg. Prof. Engineer No. 209

KBH:nyk

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REPORT

TO

BLACKFIELD ENTERPRISES

915 SOUTH STREET

HONOLULU, HAWAII

ON

SOIL INVESTIGATION FOR HOUSING DEVELOPMENT

KEAPUKA, UNIT 2-E

KANEOHE, OAHU, HAWAII

by

K. B. Hirashima
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Honolulu 13, Hawaii

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REGISTERED PROFESSIONAL ENGINEER
No. 209
HAWAII, U.S.A.

R E P O R T

TO

BLACKFIELD ENTERPRISES

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HONOLULU, HAWAII

ON

SOIL INVESTIGATION FOR HOUSING DEVELOPMENT

KEAPUKA, UNIT 2-E

KANEOHE, OAHU, HAWAII

LOCATION AND SCOPE OF INVESTIGATION

The proposed subdivision, Keapuka, Unit 2-E is a continuation of the Keapuka Subdivision, located near the junction of Kamehameha Highway and Likelike Highway.

The present investigation was conducted to determine the soil conditions on the site of this latest unit, their engineering properties, and the possible effects of such conditions and engineering properties on construction procedures, as well as, subsequent stability of earthworks constructed with the native soils.

Accordingly borings were made and samples of the subsurface soils obtained for laboratory inspection and analysis. From the field and laboratory investigations, it was possible to draw certain conclusions concerning the soil conditions on the site and their engineering properties. These conclusions and recommendations have been embodied in this report.

FIELD INVESTIGATIONS

A series of four (4) borings were made, located as shown on Figure 1. The holes were advanced by means of a hand auger. Samples of the subsurface materials were obtained by driving thin-wall Shelby type samplers with an internal diameter of approximately 2 inches. Samples were visually identified and classified in the field, then sealed, and sent to the laboratory for appropriate tests.

The samples were numbered according to the boring from which they were taken, their sequence in that particular hole, as well as their depth from the surface of the ground. Thus the designation "Sample No. 2-B-3" signifies that the sample was taken from Boring No. 2, that it was the second sample, in chronological order, taken from that particular hole, and that its depth from the surface of the ground was 3 feet.

SOIL CONDITIONS

The soil conditions here are in general similar to soil conditions on Units 1-A, 1-B, 2-A, and 2-B of the same subdivision. Specifically, the soils have been derived by lateritic weathering from volcanic rocks. Pedologically, these soils have been classified as "humic latosols" because of their generally high natural moisture contents, the result of moderately heavy annual rainfall. The silica and the bases are depleted, resulting in a high concentration of iron and aluminum throughout the solum. The clays are predominantly oxide clays, which accounts for their non-expansive nature.

In the Unified System of Soil Classification, the soils here will fall in the classifications "CH" or "CL" for soils with liquid limit greater than, or less than 50, respectively.

At the time of this investigation the land was planted in alfalfa, which was being used as cattle feed.

LABORATORY TESTS

The laboratory tests included among others, in-place density, moisture content, unconfined compression, expansion, Atterburg limits, specific gravity, gradation, compaction test according to AASHO Method T180-57 and CBR test for bearing value.

From the results of the unconfined compression tests, it was possible to draw certain conclusions concerning the bearing value of the soils in their natural, undisturbed state. From the expansion test and the CBR test, the expansive properties of the soil, if any, and the stability and probable bearing value of compacted fills made of the native soils, were determined.

The conclusions arrived at were as follows: (1) The soils on the site are on the whole non-expansive; (2) the soils can be satisfactorily compacted so as to have relatively satisfactory bearing values as indicated by the CBR test; (3) cut and fill slopes of the native soils are stable against slides.

The results of the laboratory tests have been summarized in the appendix.

BEARING VALUES

It is estimated that the bearing values of the natural, undisturbed soils in-place is equal to at least 2,000 pounds per square foot. The bearing value of compacted fills have been estimated at 1,500 pounds per square foot. It is believed that the above bearing values are more than sufficient for the proposed light type of residential development.

For heavier construction such as footings for masonry walls, commercial buildings, etc., a design load not to exceed 1,500 pounds per square foot and 1,000 pounds per square foot for cut and fill areas respectively should be used.

FILLS

It is imperative that all fills be constructed and compacted in accordance with the "Guide Specifications for Engineered Fill" attached hereto.

SLOPES

The following slope ratios are recommended. For cuts, slopes of 1-1/2 horizontal to 1 vertical; for fills, slopes of 2 horizontal to 1 vertical.

FOUNDATION FOR HOUSING UNITS

It is believed that satisfactory results for house foundation can be obtained for both the slab-on-ground type of structures as well as for the conventional 4" x 4" underpinning on individual building blocks by using bearing values as recommended.

The soil conditions on the site are relatively favorable. Hence no special foundations requiring piling, drilled caissons, heavy reinforcements, etc., are necessary. The slabs, however, should be laid on 4" drainage layer of select material.

A "Guide Specifications for Select Material" is included in this report for your information.

PLANTING

As soon as practical, grasses such as those suggested by the "Guide Specifications for Planting" should be planted on all slopes of more than 3 feet height. These plantings will act as a permanent protection against erosion.

COMPACTION OF FILLS

The soils on the site have naturally high moisture contents. However, experience shows that lateritic soils, such as the present, dry readily under favorable weather conditions so that the densities contemplated in the AASHO Test Method can generally be matched. However, if the natural moisture content is extremely high, drying is of doubtful benefit. Should such soils be encountered during construction, it is suggested that they be wasted or else placed in the lower lifts of roadway areas.

ROADWAYS

The City and County standards require a subbase course in addition to a regular base course if the expansion and/or the moisture content of subgrade soils exceed 1% or 30% respectively. It is, therefore, suggested that, the soils with low expansion and low moisture contents be reserved for use in the upper 2 to 3 feet of roadway fills. The moisture content of the subgrade soils can be controlled to some extent by allowing the wetter soils to dry.

CONCLUSIONS

From the results of the field and laboratory investigations, it is concluded that: (1) the soil conditions are favorable for residential subdivision purposes, having desirable properties, as high unconfined compressive strength and negligible expansive tendencies; (2) the soils will satisfactorily support the proposed fill and structural loads; (3) the earthwork resulting from the cut and fill grading operations will be stable against slides provided the recommended slope ratios are met; and (4) slab-on-ground type structures are feasible without any special foundation requirements.

It is concluded that the soil conditions on the site are suitable for the intended development.

GUIDE SPECIFICATIONS FOR PLANTING

Planting materials shall be hunnan grass, buffalo grass, or manienie. In damp areas where manienie will not thrive hunnan grass shall be planted. In shaded areas buffalo grass shall be planted.

Planting of slopes shall commence as soon as practical, following just behind the grading work. Planting materials shall be obtained by digging up luxuriant growths thereof from areas that are free of seeds, roots, plants, and grasses that are objectionable. Plant and water within 24 hours after digging from original growing position.

Grasses for planting shall be in short lengths of approximately 4-inch runners. Planting shall be done in staggered rows 12 inches apart over areas previously topsoiled. After planting, cover with one-half inch of additional topsoil. Flat areas shall be rolled with lawn roller. Water soon after planting and continue daily, or twice daily as necessary, until the planting material begins to take hold.

Initial Maintenance Period. After the planting material has successfully taken hold, continue watering occasionally as necessary to maintain growth for a period of 3 months or until growth sufficient to cover 50% of the slope has been achieved. Any area that does not catch during this period shall be replanted. Also apply 10-10-2 fertilizer 3 to 4 weeks after planting to those areas that show slow growth, at the rate of 800 pounds per acre.

GUIDE SPECIFICATIONS FOR ENGINEERED FILL

General. The designation "engineered fill" is applied to a fill placed under the direct supervision of a Soils Engineer for the purpose of supporting building foundations or other loads. The Soils Engineer shall approve the material, the method of placing and compacting, and shall give written approval of the completed fill. No deviation from these specifications shall be made except upon the written approval of the Soils Engineer and written concurrence from F.H.A.

AASHO Specifications hereinafter referred to are the Standard Specifications of the American Association of State Highway Officials, 1949 printing, or later revisions.

Clearing and Grubbing. All timber logs, trees, brush, buried rubbish, or decayed matter, and other undesirable material within the areas affected by the grading operations, or if called for on the plans, shall be removed, piled up and burned, or otherwise disposed of in a satisfactory manner.

All vegetable matter such as roots, tree stumps, grass, etc., shall be removed from the surface upon which fill is to be placed. Such surfaces shall be uniformly scarified to a depth of at least six (6) inches and the operation shall be continued until all objectionable matter is disposed of and the soil is free of same as well as large clods. It shall then be brought to the proper moisture content, additional fill soil being added if necessary, and recompacted until the density meets the requirements as hereafter specified.

When fills or embankments are to be made and compacted on hillsides, or when new fill is to be compacted against existing fill, or where fill is to be built part width at a time, the slopes of the original hillside, old or new fill, shall

be cut into or benched as the work is brought up in layers. Material thus cut out shall be recompacted along with the material brought up. No soil containing objectionable vegetable matter of the kind mentioned shall be used in fills supporting housing units, but shall be disposed of as directed by the Soils Engineer, in special waste areas.

Compaction Requirements. All fill areas and embankments shall be built up in uniform layers. The loose thickness of each layer shall be adjusted so that the required degree of compaction, as hereafter specified, can be readily attained, but shall not in any event exceed approximately six (6) inches compacted thickness. Each layer shall be thoroughly compacted before the next layer is laid thereon.

In general, the layers of fill shall be compacted with the use of conventional equipment designed for the purpose. The incidental compaction achieved by the passage of hauling units such as trucks, carryalls, etc. over the fill shall not be considered acceptable.

In general, all fill compaction operations shall be carried out and the layers of soil compacted at a moisture content which is optimum for the soil, the optimum moisture content being determined by AASHO Method T180-57 or the equivalent ASTM Designation D1557 Method A. If the moisture content of the soil is below optimum enough water shall be added to the soil to bring its moisture content up to optimum. If above, the soil shall be allowed to dry, aerating by blading, harrowing, etc., to speed up the drying, until the moisture content drops down to approximately optimum.

Compaction of each and every layer of fill shall be continued until the density, as determined by field tests reaches a value of at least 90% of the maximum indicated by AASHO Method T180-57 modified as hereafter specified.

Drainage. Care shall be exercised during the rough grading work so that areas involved will drain properly. Thus, as far as practicable, all ruts and depressions resulting from construction traffic shall be carefully smoothed out at the end of the day's work. All fill slopes shall be protected by temporary berms.

Field Tests. The Soils Engineer shall be notified in advance as to the date grading operations are scheduled to start, so that he may make the necessary preparations for carrying out field density tests to determine the actual relative compactions being obtained, and thus determine appropriate corrective measures, if needed.

Field density tests shall be made by the Soils Engineer of the compaction of each layer of fill. Density tests may be made at intervals not exceeding 2 feet of fill height provided all layers are tested. Where sheepsfoot rollers are used the soil may be disturbed to a depth of several inches. Density reading shall be taken in the compacted material below the disturbed surface, and as often as necessary, as determined by the Soils Engineer, and found acceptable to the F.H.A. When these readings indicate that the density of any layer of fill or portion thereof is below the required (90%) density, the particular layer or portion shall be reworked until the required density has been obtained.

Rainy Weather. No fill material shall be placed, spread or rolled during unfavourable weather conditions. When the work is interrupted by heavy rain, fill operations shall not be resumed until field tests by the Soils Engineer indicate that the moisture content and density of the fill are as previously specified.

Supervision. Supervision by the Soils Engineer shall be made during the fill and compacting operation so that he can certify that the fill was made in accordance with accepted specifications.

GUIDE SPECIFICATIONS FOR SELECT MATERIAL

Materials. The select material for use under ground floor slabs shall consist of crushed rock, quarry waste, dredged coral, black sand, or other material as approved by the Soils Engineer. It shall be free from adobe, organic matter, and other such deleterious matter.

Grading. The material shall conform to the following gradation:

Sieve No.	% Passing
2"	Not less than 95%
#40	10 to 20%
#200	5 to 10%

The Plasticity Index as determined by ASTM Method D424-54T shall not exceed 10.

Compacting. The select material shall be put down in layers not to exceed 6 inches compacted thickness. Each layer shall be properly moistened, if necessary, and thoroughly compacted to a density of not less than 90% of the maximum indicated by the Modified AASHO Method T99-49. (ASTM Designation D 1557-58T.)

APPENDIX

SUMMARY OF LABORATORY TEST RESULTS

Boring No.	1	1	1	1	2	2	2
Sample No.	A	B	C	D	A	B	C
Depth (ft.)	1	3	6	10	1	3	6
IN-PLACE DENSITIES							
Wet Density (lb/c.f.)	116.1	108.1	88.0	91.9	111.3	116.1	88.7
Moist. Content, %	39.9	46.7	61.4	59.6	45.6	44.9	57.1
Dry Density (lb/c.f.)	83.0	73.7	54.5	57.6	76.4	80.1	56.5
UNCONFINED COMP. TEST							
Yield Point (lb/s.f.)	2394	1702	1383	2394	1543	2287	1968
EXPANSION TEST							
Swell upon Saturation, %	2.2	----	----	----	1.9	----	----
ATTERBURG LIMITS							
Liquid Limit	51	----	----	----	51	----	----
Plasticity Index	19	----	----	----	20	----	----
SPECIFIC GRAVITY	2.72	----	----	----	2.65	----	----
GRADING ANALYSIS (% Passing) Sieve							
#4	98.5	----	----	----	99.0	----	----
#10	92.0	----	----	----	88.9	----	----
#20	83.3	----	----	----	75.6	----	----
#40	76.5	----	----	----	67.2	----	----
#80	66.4	----	----	----	56.2	----	----
#100	63.8	----	----	----	53.6	----	----
#200	55.8	----	----	----	45.4	----	----
COMPACTION TEST (AASHO Method T180-57)							
Max. Dry Density (Lb/c.f.)	89.6	----	----	----	90.6	----	----
Optimum Moist., %	37.1	----	----	----	32.4	----	----
CBR TEST							
CBR at 0.1" penetration	7.2	----	----	----	10.0	----	----
CLASSIFICATION							
Casagrande Airfield	CH	----	----	----	CH	----	----

SUMMARY OF LABORATORY TEST RESULTS

Boring No.	2	3	3	3	4	4	4
Sample No.	D	A	B	C	A	B	C
Depth (ft.)	10	1	5	7	1	5	8
IN-PLACE DENSITIES							
Wet Density (lb/c.f.)	91.9	117.7	114.5	88.7	106.4	111.3	90.3
Moist. Content, %	54.0	43.8	39.7	58.7	40.9	55.1	80.9
Dry Density (lb/c.f.)	59.7	81.8	82.0	55.9	75.5	71.8	49.9
UNCONFINED COMP. TEST							
Yield Point (lb/s.f.)	1330	2500	5319	1330	1702	3791	2447
EXPANSION TEST							
Swell Upon Saturation, %	----	2.0	----	----	----	----	----
ATTERBURG LIMITS							
Liquid Limit	----	54	----	----	----	----	----
Plasticity Index	----	18	----	----	----	----	----
SPECIFIC GRAVITY	----	2.82	----	----	----	----	----
GRADING ANALYSIS (% Passing) Sieve							
#4	----	99.6	----	----	----	----	----
#10	----	89.2	----	----	----	----	----
#20	----	76.0	----	----	----	----	----
#40	----	68.3	----	----	----	----	----
#80	----	58.3	----	----	----	----	----
#100	----	56.0	----	----	----	----	----
#200	----	47.7	----	----	----	----	----
COMPACTION TEST (AASHO Method T180-57)							
Max. Dry Density (lb/c.f.)	----	87.3	----	----	----	----	----
Optimum Moist., %	----	35.1	----	----	----	----	----
CBR TEST							
CBR at 0.1" penetration	----	10.0	----	----	----	----	----
CLASSIFICATION							
Casagrande Airfield	----	CH	----	----	----	----	----

BORING NO. 1

Depth	Sample No.	Driller's Description
0.0'		
		Moist brown clay
1.5'	1-A-1	
		Light brown clay
3.0'		
	1-B-3	
	1-C-6	Mottle clay with decomposed rocks
10.0'		
	1-D-10	

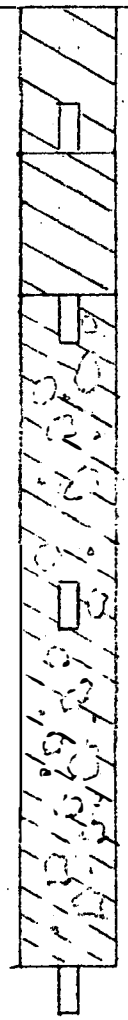

FIGURE 2A

Keapuka, Unit 2E
Kaneohe, Oahu, Hawaii

K. B. Hirashima
Consulting Foundation
and Soils Engineers

BORING NO. 2

Depth	Sample No.	Driller's Description
0.0'		
	2-A-1	Reddish brown clay
2.0'		
	2-B-3	
		Brown Clay
6.0'		
	2-C-6	
		Brown clay with decomposed rocks
10.0'		
	2-D-10	

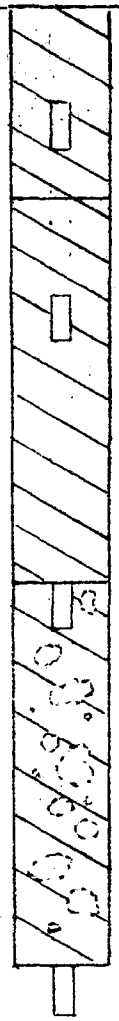

FIGURE 2B

Keapuka, Unit 2E
Kaneohe, Oahu, Hawaii

K. B. Hirashima
Consulting Foundation
and Soils Engineers

BORING NO. 3

Depth	Sample No.	Driller's Description
0.0'		
	3-A-1	Brown clay
2.0'		
		Light brown clay
5.0'		
	3-B-5	Light brown clay with decomposed rocks
7.0'		
	3-C-7	

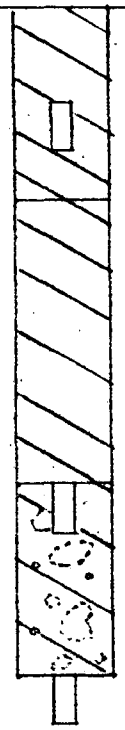

FIGURE 2C

Keapuka, Unit 2E
Kaneohe, Oahu, Hawaii

K. B. Hirashima
Consulting Foundation
and Soils Engineer

BORING NO. 4

Depth	Sample No.	Driller's Description
0.0'		
	4-A-1	Brown Clay
2.0'		
		Light brown clay
5.0'		
	4-B-5	
		Light brown clay with decomposed rocks
8.0'		
	4-C-8	

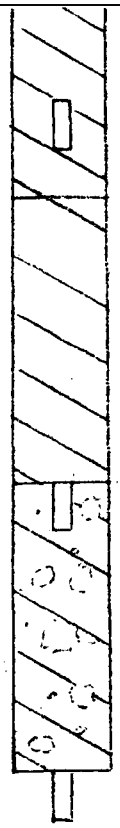

FIGURE 2D

Keapuka, Unit 2E
Kaneohe, Oahu, Hawaii

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and Soils Engineer