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

WALTER LUM
EDWARD WATANABE
EZRA KOIKE
WALLACE WAKAHIRO
3030 WAIALAE AVE., HONOLULU, HAWAII 96816 • TEL. 737-7931

May 25, 1973

M E M O R A N D U M

TO: MR. GEORGE HOUGHTAILING
Community Planning, Inc.

FROM: Walter Lum Associates, Inc.

RE: Waiawa Industrial Park Bridge

For the design of the single-span bridge for the proposed Waiawa Industrial Park, the following additional recommendations may be considered:

From our preliminary discussion, it appears that the abutments will be located about 18 ft away from the side walls of the proposed concrete lined channel.

For design purposes, the bottom of the abutment footings should extend below an imaginary plane drawn at about a 4 horizontal to 1 vertical slope upward from the intersection of the bottom of the channel and the side wall of the channel.

Soft pockets below the bottom of the footing excavation should be removed and the excavation backfilled with select granular material about 1-1/2-in. maximum size and less than 10% passing the No. 200 sieve.

An average bearing value of about 3000 p.s.f. may be assumed. The allowable bearing value may be increased to about 4000 p.s.f. for the toe pressure of the abutments.

A lateral earth pressure of about 40 p.c.f. equivalent fluid plus surcharge load allowances may be used for the abutment design. The above fluid pressure assumes that drainage of the backfill is provided.

Respectfully submitted,

WALTER LUM ASSOCIATES, INC.

By Ezra Koike
Ezra Koike

EK:ms
cc: Harold M. Tanimura

WAIAWA INDUSTRIAL PARK BRIDGE
SOIL EXPLORATION REPORT

WAIAWA, EWA, OAHU, HAWAII
TAX MAP KEY: 9-6-04: POR. 14

To:
COMMUNITY PLANNING, INC.

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

MAY 3, 1973

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

WALTER LUM
EDWARD WATANABE
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3030 WAIALAE AVE., HONOLULU, HAWAII 96816 • TEL. 737-7931

May 2, 1973

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

Dear Mr. Houghtailing:

Subject: Waiawa Industrial Park Bridge
Soil Exploration Report
(for foundation design purposes)
Waiawa, Ewa, Oahu, Hawaii
Tax Map Key: 9-6-04: Por. 14

Transmitted herewith is our soil exploration report for the proposed bridge for Waiawa Industrial Park, Waiawa, Ewa, Oahu, Hawaii.

Continuous beam footing foundations may be considered for the bridge piers and abutments.

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

Respectfully submitted,

WALTER LUM ASSOCIATES, INC.

By Ezra Koike
Ezra Koike

BD/EK:rmf

C O N T E N T S

WAIAWA INDUSTRIAL PARK BRIDGE
SOIL EXPLORATION REPORT

WAIAWA, EWA, OAHU, HAWAII
TAX MAP KEY: 9-6-04: POR. 14

SCOPE OF EXPLORATION

The purpose of this exploration was to determine general soil conditions for foundation design studies for the proposed bridge for Waiawa Industrial Park, Waiawa, Ewa, Oahu, Hawaii.

This report includes field explorations, laboratory tests, general recommendations for the bridge foundation design and limitations.

FIELD EXPLORATION AND LABORATORY TESTS

Four borings were made at the site at the approximate locations shown on the Boring Location Sketch.

Borings were made with 3-in. diameter augers using carbide drag bits, rotary drilling with drag bits and core drilling with diamond bits.

Soil samples were recovered with 2-in. standard split spoon samplers driven with a 140-lb hammer falling 30 inches.

Rock samples were recovered with "BX" core barrels.

Laboratory tests included: natural water content, Atterberg limit and grain-size analysis.

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."

GENERAL SITE CONDITIONS

The site of the proposed bridge across Waiawa Stream is located about 1-1/4 miles north of Kamehameha Highway and the Waiawa cut off road to Wahiawa.

The Waiawa Stream bed at the proposed bridge site is about 80 ft wide with the invert elevation at about 70 ft.

The left (Honolulu) bank of the stream is about 20 ft above the invert and the right (Wahiawa) bank is about 10 ft.

Rainfall in the area is about 40 inches per year.

GENERAL GEOLOGY OF THE SITE

The general geologic map of this area indicates 2 geologic soil types in the stream bed and terraces:

1. Ra: (Recent Alluvium) located in the stream bed and consisting of clayey silt with gravel and cobble layers.

2. Qa: (Older Alluvium) located along the left (Honolulu bank) consisting of pebbles and gravels that are partially decomposed into clayey silt.

Underlying the older alluvial deposits, the rock may be described as follows:

tkb: (Koolau Volcanics) consisting of fairly old basalt rocks underlies the older alluvium.

INTERPRETATION OF SOIL CONDITIONS

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

Brown clayey silts with sand, cobbles and boulders to about 3 to 13 ft underlain by cobbles and boulders with clayey silts to about 14 to 21 ft. Below this may be clayey silt with decomposed gravel to about 31 ft, the maxiumum depth drilled in Boring No. 3.

Water was encountered at about 3-ft depth in Boring Nos. 1, 2 and 4 and at about 18-ft depth in Boring No. 3.

Variations to the above soil conditions may be expected in an alluvial deposit. For more detailed descriptions of soils encountered in the drill holes, refer to the boring logs.

DISCUSSION AND RECOMMENDATIONS

The proposed plan is to line the stream bed with a concrete channel with vertical sidewalls. The channel would be about 40 ft in width.

The proposed bridge would span over the channel; in addition, 2 approach spans would be used at the left and right banks.

Foundations

Because of underlying boulders, pile driving will be very difficult.

The stream channel will be lined with concrete and the possibility of undermining is considerably reduced.

Continuous beam footing foundations may be considered for the bridge piers and abutments. To minimize settlements, the footing loads should be kept as low as practicable by using short-span structures.

The foundations should extend through the upper layer of clayey silt and boulders and rest on the layer of cobbles and boulders with clayey silts.

Soft spots underlying the footing should be removed and the excavation backfilled with fairly granular material compacted in thin level lifts.

If rock is encountered, the rock should be excavated 6 in. below the bottom of the footing and replaced with gravelly material.

Due to the possibility of soft spots below the foundation, some differential settlements may occur. To minimize differential settlements, a low bearing value may be assumed and a continuous beam type foundation is recommended.

For design purposes, footing elevations may be tentatively set at elevation 64 with the understanding that field adjustments up or downward may be required.

A bearing value of about 3000 p.s.f. may be assumed.

Lateral Pressures Against Abutments

To minimize differential settlements between the bridge and the approaches, the backfill at abutments should be constructed with fairly well-graded granular material. The backfill should be placed in thin level lifts and should be well compacted. If practicable, the approaches to the bridge should be surcharged and paving in these sections delayed until the last phase of construction.

A lateral earth pressure of about 60 p.c.f. equivalent fluid plus surcharge load allowance may be used for the abutment design. The above fluid pressure assumes that drainage of the backfill is provided.

Slope

Cut and fill slopes in the vicinity of the abutments should preferably be made at 2 horizontal to 1 vertical or flatter slope ratios. Benches should be provided for slopes higher than 20 ft.

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

To minimize erosion, the runoff from rainstorms should be diverted by berms or ditches away from slopes whenever practicable.

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

Unforeseen Conditions

Unforeseen conditions such as soft spots, seepage water or expansive soil pockets may occur in localized areas and will have to be adjusted and corrected in the field as they are detected.

Contingency

The contract documents should include provisions for field adjustments for foundation of piers and abutments at the site.

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 sieve analysis test results.

WAIAWA BRIDGE

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

Boring Log

PROJECT: WAIAWA INDUSTRIAL PARK BRIDGE
LOCATION: Waiawa, Ewa, Oahu, Hawaii
Tax Map Key: 9-6-04: Por. 14

HAMMER:
Weight: 140#
Drop: 30"
SAMPLER: "BX" - BX DOUBLE TUBE CORE BARREL
2"SS - 2" STANDARD SPLIT SPOON

BORING NO. 1 Sheet No. ____ of ____
Driller W. LUM ASSOC., INC. Date APR. 12 & 13, 1973
Field Party MEYER, OSHIRO
Type of Boring ROTARY (CONCORE 121B) Diam. "BX" & 3"
Elev. 71'± * Datum
Drill Bit T.C. CORING, DIAMOND CORING & T.C. DRAG
Water Level 3.0'
Time –
Date 4-12-73

Unified Soil Classification	DESCRIPTION	Depth (Ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA: Standard Penetration Test, N (Blows per foot) 0 10 20 30 40
	ELEV. = 71'± *	0								
	BROWN, SILTY CLAY W/COBBLES & BOULDERS		WATER 4-12-73							
		5	2"SS	1-A		NO RECOVERY				39/0.1'
			"BX"	RUN #1		CORED: 1.9' RECOV.: 1.5'				
	COBBLES & BOULDERS		"BX"	RUN #2		CORED: 2.0' RECOV.: 1.2'				
		10	"BX"	RUN #3		CORED: 1.0' RECOV.: 0.3'				
	GRAVEL & COBBLES W/BROWN, CLAYEY SILT		"BX"	RUN #4		CORED: 5.0' RECOV.: 3.4'				
		15								
	GRAVEL W/BROWN, CLAYEY SILT & SAND		"BX"	RUN #5		CORED: 2.0' RECOV.: 1.8'				
			"BX"	RUN #6		CORED: 3.0' RECOV.: 3.0'				
	MOTTLED BROWN SILTY CLAY & GRAVEL (DECOMPOSED)	20								
				?						
GM	DENSE, MOTTLED BROWN SILTY GRAVEL W/SAND	25	2"SS	1-B	31	43	69	–	–	35/0.5'
	END OF BORING @ 26'									HAMMER BOUNCES

*ELEVATION ESTIMATED FROM PLAN & PROFILE MAP OF WAIAWA CHANNEL

WAIAWA BRIDGE

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

Boring Log

PROJECT: WAIAWA INDUSTRIAL PARK BRIDGE
LOCATION: Waiawa, Ewa, Oahu, Hawaii
Tax Map Key: 9-6-04: Por. 14

HAMMER:
Weight: 140#
Drop: 30"
SAMPLER: "BX" - BX DOUBLE TUBE CORE BARREL; 2"SS - 2" STANDARD SPLIT SPOON

BORING NO. 2 Sheet No. ____ of ____
Driller: W. LUM ASSOC., INC. Date: APR. 17 & 18, 1973
Field Party: MEYER, OSHIRO
Type of Boring: ROTARY (CONCORE 121B) Diam.: 3" & "BX"
Elev.: 71'± * Datum: —
Drill Bit: T.C. DRAG & DIAMOND CORING
Water Level: 3'
Time: —
Date: 4-18-73

Unified Soil Classification	DESCRIPTION	Depth (Ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA: Standard Penetration Test, N (Blows per foot) 0 10 20 30 40
	ELEV. = 71'± *	0								
	MEDIUM, BROWN CLAYEY SILT & SAND W/ SOME COBBLES & BOULDERS		WATER 4-18-73	(?)						
(GM)	MEDIUM TO STIFF, BROWN CLAYEY SILT, SAND & DECOMPOSED ROCK	5	2"SS	2-A	—	45	—	—	—	
		10	2"SS	2-B		NO RECOVERY				50/0.3'
	BOULDERS, COBBLES & GRAVEL	15	"BX"	RUN #1		CORED: 1.5' RECOV.: 1.0'				10/0.0'
			2"SS	2-C		NO RECOVERY				HAMMER BOUNCES
			"BX"	RUN #2		CORED: 4.0' RECOV.: 2.6'				
		20	"BX"	RUN #3		CORED: 2.0' RECOV.: 1.0'				
				?						
(MH)	STIFF GRAY & MOTTLED BROWN CLAYEY SILT W/ DECOMPOSED ROCK	25	2"SS	2-D	—	54	—	—	—	28/0.5'
				?						
(MH)	STIFF, MOTTLED GRAY CLAYEY SILT (DECOMPOSED ROCK)	30	2"SS	2-E	—	41	—	—	—	53
	END OF BORING @ 31.5'									
	* ELEVATION ESTIMATED FROM PLAN & PROFILE MAP OF WAIAWA CHANNEL									

WAIAWA BRIDGE

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

Boring Log

PROJECT: WAIAWA INDUSTRIAL PARK BRIDGE
LOCATION: Waiawa, Ewa, Oahu, Hawaii
Tax Map Key: 9-6-04: Por. 14

HAMMER:
Weight: 140#
Drop: 30"
SAMPLER: 2"SS - 2" STANDARD SPLIT SPOON
"BX" - BX DOUBLE TUBE CORE BARREL

BORING NO. 3 Sheet No. ____ of ____
Driller W. LUM ASSOC., INC. Date APR. 20 & 23, 1973
Field Party MEYER, OSHIRO
Type of Boring AUGER & CORE (CONCORE-121B) Diam. 3" & "BX"
Elev. 82'± * Datum ____
Drill Bit T.C. DRAG & DIAMOND CORING
Water Level 18.2'± | Time – | Date 4-23-73

Unified Soil Classification	DESCRIPTION	Depth (Ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA: Standard Penetration Test, N (Blows per foot) 0 10 20 30 40
	ELEV.: 82'± *	0								
	BROWN CLAYEY SILT									
(MH)	STIFF, MOTTLED BROWN SILTY CLAY	5	2"SS	3-A	–	28	–	–	–	
(MH)	STIFF, TAN BROWN CLAYEY SILT W/ SAND	10	2"SS	3-B	–	30	–	–	–	12/0.5' 10/0.1' HAMMER BOUNCES
	BOULDER		"BX"	RUN #1		CORED: 2.5' RECOV.: 2.3'				
	COBBLES OR BOULDER & GRAVEL W/ SOME BROWN, CLAY	15	"BX"	RUN #2		CORED: 2.5 RECOV.: 1.5'				
	WATER 4-23-73		2"SS	3-C	–	53	–	–	–	
(GM)	MEDIUM BROWN & LIGHT BROWN CLAYEY SILT W/ GRAVEL	20	2"SS	3-D	ROCK FRAGMENTS					10/0.1' HAMMER BOUNCES
(MH-CH)	STIFF, MOTTLED TAN BROWN SILTY CLAY	25	2"SS	3-E	44	68 71	120	–	–	
CH	STIFF MOTTLED RED & TAN BROWN CLAY									
(MH)	STIFF, TAN BROWN CLAYEY SILT W/ DECOMPOSED ROCK	30	2"SS	3-F	–	72	–	–	–	
	END OF BORING @ 31.5'									

* ELEVATION ESTIMATED FROM PLAN & PROFILE MAP OF WAIAWA CHANNEL

WAIAWA BRIDGE

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

Boring Log

PROJECT: WAIAWA INDUSTRIAL PARK BRIDGE
LOCATION: Waiawa, Ewa, Oahu, Hawaii
Tax Map Key: 9-6-04: Por. 14

HAMMER:
Weight: 140#
Drop: 30"
SAMPLER: "BX" - BX DOUBLE TUBE CORE BARREL; 2"SS - 2" STANDARD SPLIT SPOON

BORING NO. 4 Sheet No. ____ of ____
Driller: W. LUM ASSOC., INC. Date: APR. 16 & 17, 1973
Field Party: MEYER, OSHIRO
Type of Boring: ROTARY (CONCORE 12:8) Diam.: "BX" & 3"
Elev.: 11'± * Datum: —
Drill Bit: T.C. DRAG & DIAMOND CORING
Water Level: 3'
Time: —
Date: 4-16-73

Unified Soil Classification	DESCRIPTION	Depth (Ft.)	Sampler	Sample No.	Plastic Limit	Water Cont. %	Liquid Limit	Unconf. Comp. P.S.F.	Vane Shear P.S.F.	PENETRATION DATA: Standard Penetration Test, N (Blows per foot) 0 10 20 30 40
	ELEV.=11'± & *	0								
	BROWN, CLAYEY SILT & SAND W/ COBBLES & SOME BOULDERS		WATER 4-16-73							
		5	"BX"	RUN #1		CORED: 3.0' RECOV.: 2.2'				
	BOULDER, COBBLES & GRAVEL W/SOME CLAYEY SILT									
			"BX"	RUN #2		CORED: 4.0' RECOV.: 2.2'				
		10								
			"BX"	RUN #3		CORED: 5.0' RECOV.: 0				
MH	STIFF, MOTTLED GRAY BROWN CLAYEY SILT W/DECOMPOSED ROCK	15								
			1"SS	4-A	42	46	76	—	—	
		20								
MH	MEDIUM TO STIFF MOTTLED BROWN CLAYEY SILT (DECOMPOSED ROCK)		2"SS	4-B	44	58	80	—	—	
		25								
(MH)	MEDIUM, GRAY & BROWN CLAYEY SILT W/DECOMPOSED ROCK		2"SS	4-C	—	61	—	—	—	
	END OF BORING @ 26									15/0.5 — CONTINUOUS PENETRATION TEST W/2" DIAM. BLUNT POINT

* ELEVATION ESTIMATED FROM PLAN & PROFILE MAP OF WAIAWA CHANNEL

WAIAWA INDUSTRIAL PARK BRIDGE

TABLE I A - SUMMARY OF LABORATORY TEST RESULTS

BORING NO.	1	2	3	3
SAMPLE NO.	B	E	E (BTM.)	F
DEPTH BELOW SURFACE	25'-26'	30'-31.5'	25'-26.5'	30'-31.5'
DESCRIPTION	MOTTLED BROWN SILTY GRAVEL	MOTTLED GRAY CLAYEY SILT (DECOMP. ROCK)	MOTTLED RED & TAN-BROWN CLAY	TAN-BROWN CLAYEY SILT W/DECOMP. ROCK
GRAIN-SIZE ANALYSIS (% Passing) Sieve				
1"	76.0	100		100
1/2"	73.0	100		100
#4	61.0	98.6		100
#10	47.9	95.8		100
#20	40.0	94.5		99.9
#40	35.7	92.0		99.4
#100	29.6	90.3		99.0
#200	25.6	89.3		98.9
ATTERBERG LIMITS				
Air Dried or Natural	NATURAL		NATURAL	
Liquid Limit	69		120	
Plastic Limit	38		44	
Plasticity Index	31		76	
Dilatancy	NONE-SLOW		NONE	
Toughness	SLIGHT-MED.		MED.-HIGH	
Dry Strength	SLIGHT-MED.		HIGH	
UNIFIED SOIL CLASSIFICATION	GM		CH	
APPARENT SPECIFIC GRAVITY				
EXPANSION AND CBR TESTS (Surcharge-51 P.S.F.)				
Molding Moisture, %				
Molding Dry Density, P.C.F.				
Swell upon saturation, %				
CBR at 0.1" Penetration				
MOISTURE-DENSITY RELATIONS OF SOILS (AASHO T-180-57 Method ___)				
Dry to Wet or Wet to Dry				
Max. Dry Density (P.C.F.)				
Optimum Moisture (%)				

REMARKS:

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

Date 4-27-73 By BT

WAIAWA INDUSTRIAL PARK BRIDGE

TABLE I D - SUMMARY OF LABORATORY TEST RESULTS

BORING NO.	4	4		
SAMPLE NO.	A	B		
DEPTH BELOW SURFACE	15'-16.5'	20'-21.5'		
DESCRIPTION	MOTTLED GRAY & BROWN CLAYEY SILT W/DECOMP. ROCK	MOTTLED BROWN CLAYEY SILT (DECOMP. ROCK)		
GRAIN-SIZE ANALYSIS (% Passing) Sieve				
1"		100		
1/2"		100		
#4		100		
#10		100		
#20		99.5		
#40		96.7		
#100		91.2		
#200		88.8		
ATTERBERG LIMITS				
Air Dried or Natural	NATURAL	NATURAL		
Liquid Limit	76	80		
Plastic Limit	42	44		
Plasticity Index	34	36		
Dilatancy	SLOW-MED.	NONE-SLOW		
Toughness	MEDIUM	MEDIUM		
Dry Strength	SLIGHT-MED.	MEDIUM		
UNIFIED SOIL CLASSIFICATION	MH	MH		
APPARENT SPECIFIC GRAVITY				
EXPANSION AND CBR TESTS (Surcharge-51 P.S.F.)				
Molding Moisture, %				
Molding Dry Density, P.C.F.				
Swell upon saturation, %				
CBR at 0.1" Penetration				
MOISTURE-DENSITY RELATIONS OF SOILS (AASHO T-180-57 Method ___)				
Dry to Wet or Wet to Dry				
Max. Dry Density (P.C.F.)				
Optimum Moisture (%)				

REMARKS:

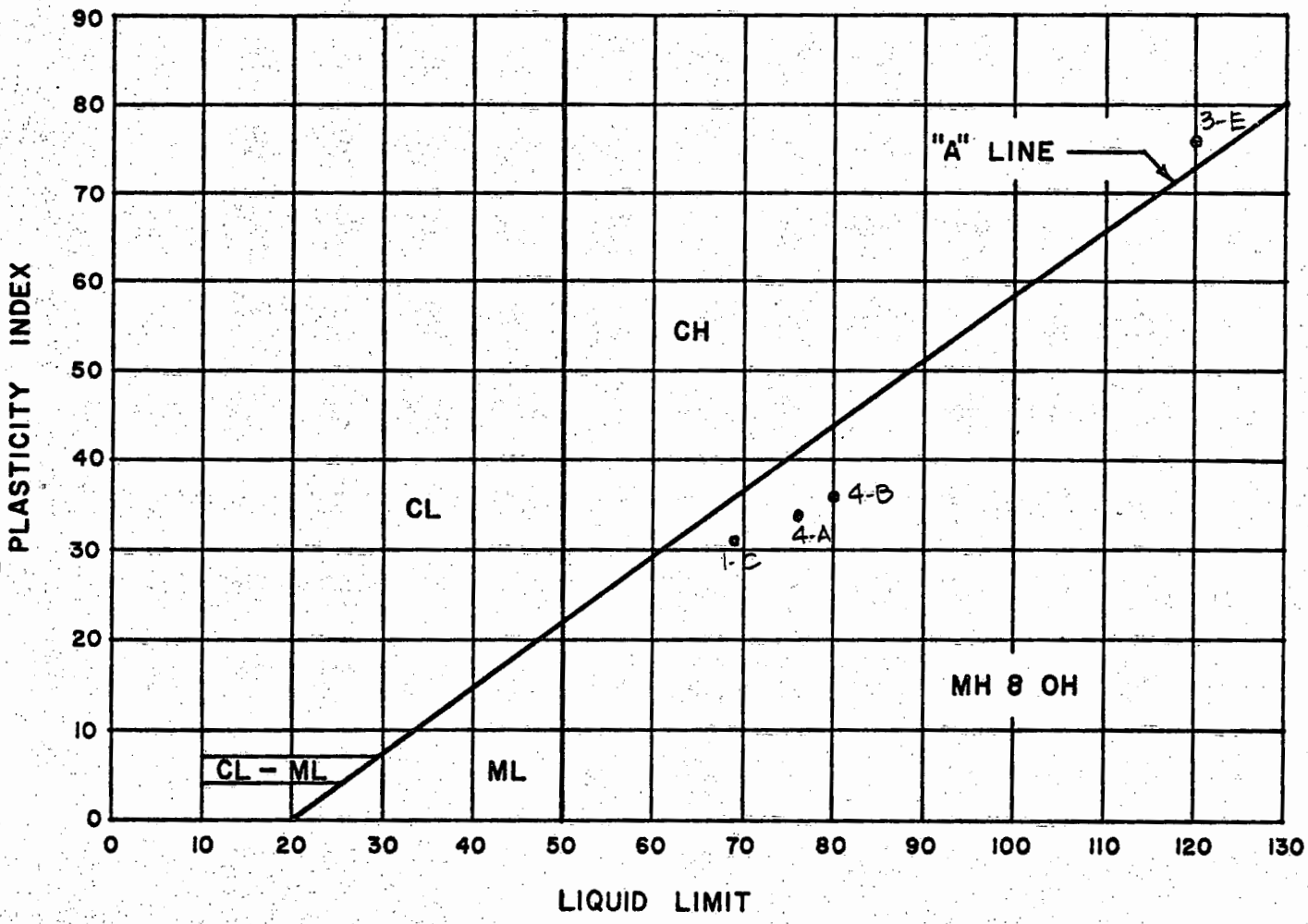
WALTER LUM ASSOCIATES, INC.
CIVIL, STRUCTURAL, SOILS ENGINEERS

Date 4-27-13 By BT

PLASTICITY CHART

PROJECT: WAIAWA INDUSTRIAL PARK BRIDGE.

LOCATION: WAIAWA, EWA, OAHU, HAWAII



DATE 4-27-13 BY BT

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

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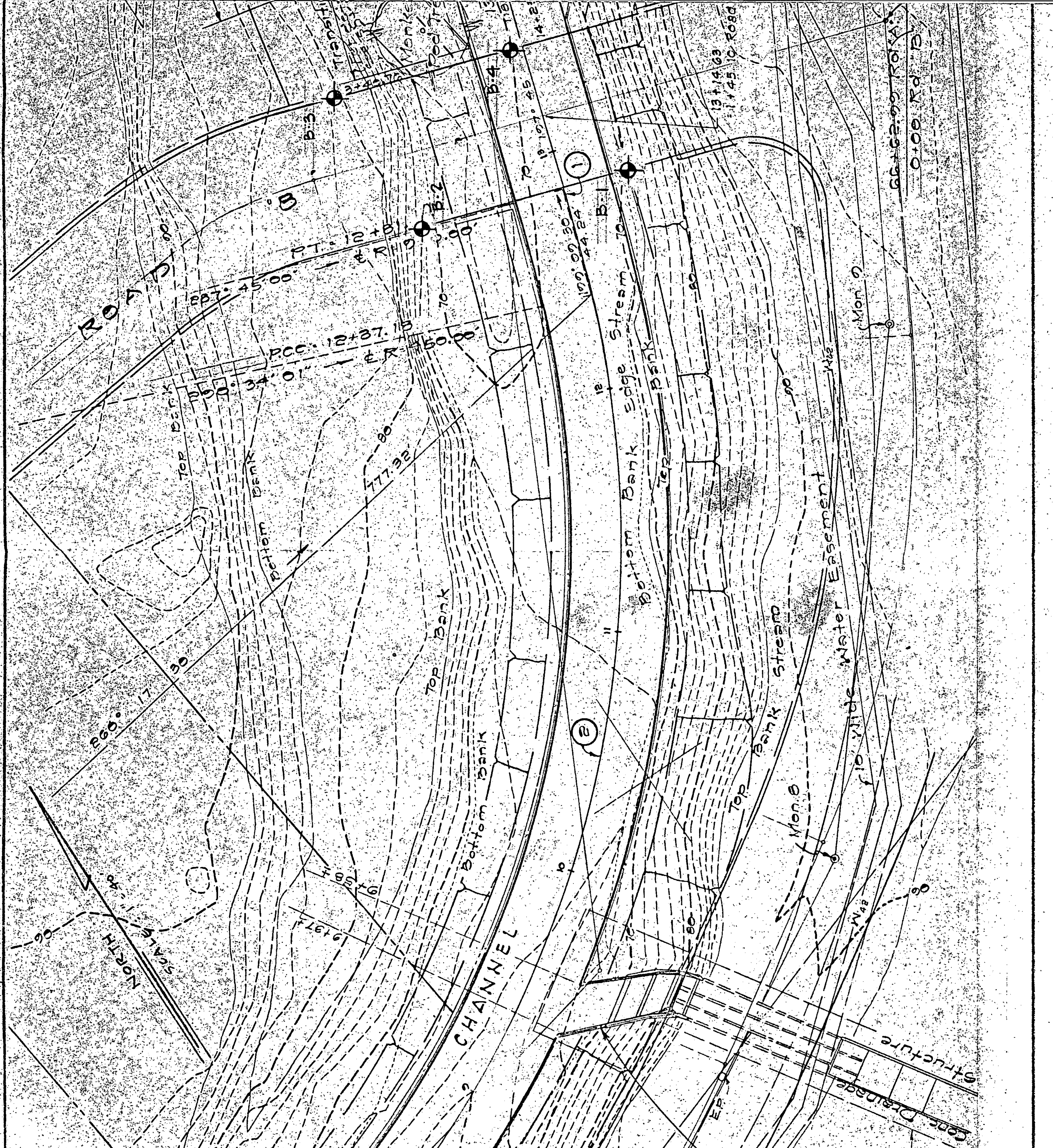
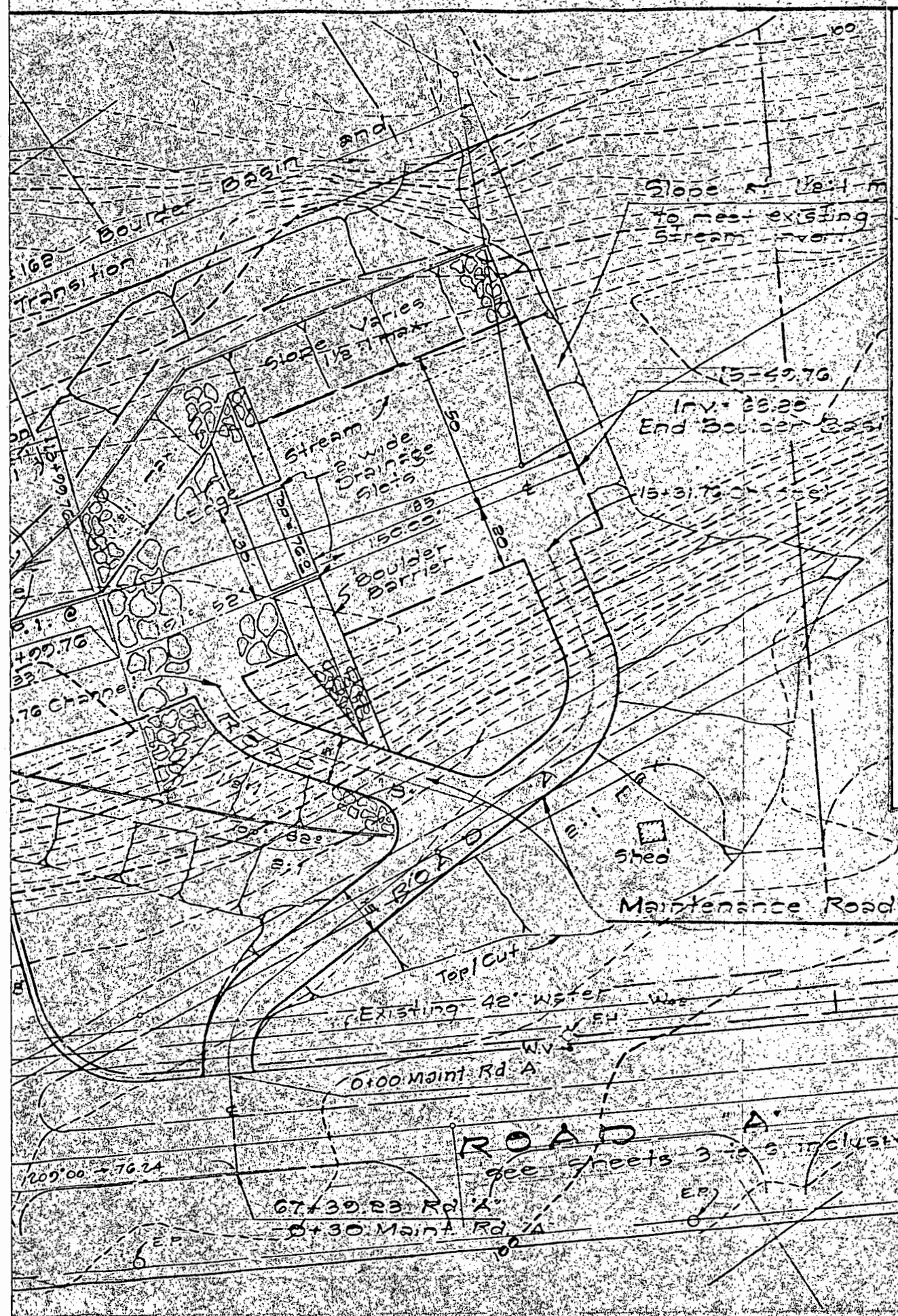
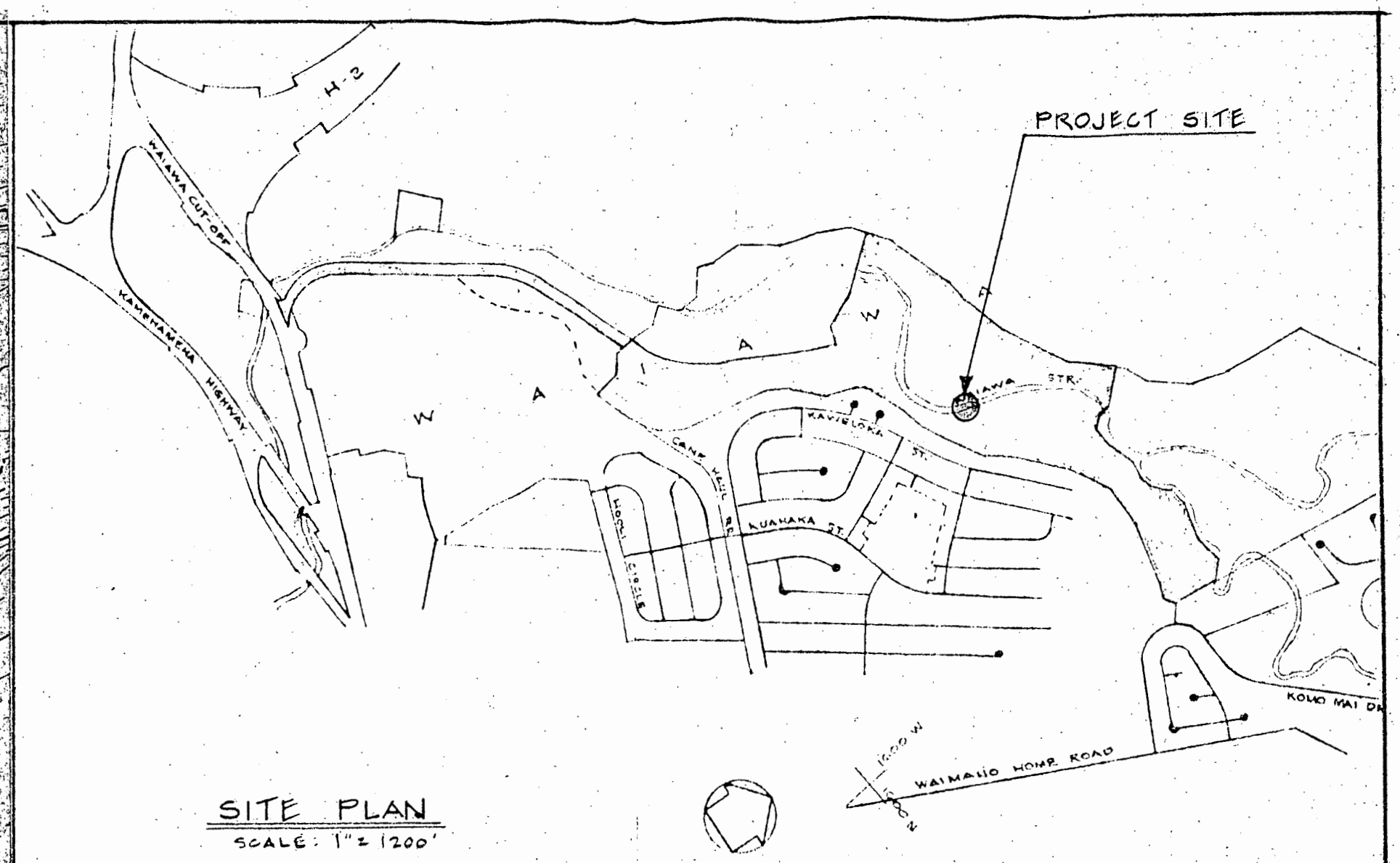

ROAD B
WAIAWA CHANNEL
Top Bank
Bottom Bank
Edge Stream
Bottom Bank
Top Bank Stream
10' Wide Water Easement
Mon. 8
Mon. 9
Conc. Drainage Structure
P.T. 12+81
P.C.C. 12+37.15
777.32
NORTH
SCALE
Chain Link fence





SITE PLAN
SCALE: 1" = 1200'

BORING LOCATION SKETCH
WAIAWA INDUSTRIAL PARK BRIDGE
WAIAWA, EWA, OAHU, HAWAII
TAX MAP KEY: 9-6-04: POR 14

Dr.	WALTER LUM ASSOCIATES, INC.	Sheet
Date 5/13	3030 WAIALAE AVE.	
Rev.	CIVIL ENGINEERS	of
	PHONE 737-7931	

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 and the changed conditions.

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.