

GEOTECHNICAL REPORT
LONG BEACH ALIGNMENT

PREPARED BY

LeROY CRANDALL AND ASSOCIATES

ADE-85005-10

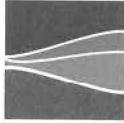
FOR

SOUTHERN CALIFORNIA RAIL CONSULTANTS

CONTRACT TW 1005

JANUARY 10, 1986

28554081



January 10, 1986

Southern California Rail Consultants
403 West Eighth Street, Suite 800
Los Angeles, California 90014

Contract No. TW1005
(Our Job No. ADE-85005-10)

Attention: Mr. Simon Zweighaft
Project Director

Gentlemen:

Our "Geotechnical Report, Long Beach Alignment, Proposed Long Beach-Los Angeles Rail Transit Project" is herewith submitted.

The scope of the investigation was planned in collaboration with Mr. B. I. Maduke of your staff. The cooperation and guidance provided by Mr. Maduke and others with SCRC are sincerely appreciated.

Respectfully submitted,

LeROY CRANDALL AND ASSOCIATES

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cc: Mr. B. I. Maduke

TABLE OF CONTENTS

	<u>Text</u>	<u>Page No.</u>
SECTION 1.0	EXECUTIVE SUMMARY -----	1.1
1.1	INTRODUCTION -----	1.1
1.2	DESCRIPTION OF EXPLORATION AND TESTING PROGRAMS -----	1.1
1.3	PROJECT GEOLOGY -----	1.2
1.4	SUBSURFACE CONDITIONS -----	1.2
1.5	DESIGN CONSIDERATIONS -----	1.3
SECTION 2.0	INTRODUCTION -----	2.1
2.1	PROJECT LOCATION -----	2.1
2.2	PROJECT DESCRIPTION -----	2.1
2.3	PURPOSE OF INVESTIGATION -----	2.2
2.4	SCOPE OF WORK -----	2.2
2.5	LIMITATIONS OF INVESTIGATION -----	2.3
2.6	INSPECTION OF BORING SAMPLES -----	2.3
2.7	PREVIOUS INVESTIGATIONS -----	2.3
SECTION 3.0	FIELD EXPLORATION AND LABORATORY TESTING	3.1
3.1	FIELD EXPLORATION PROGRAM -----	3.1
3.1.1	Borings -----	3.1
3.1.2	Drilling Contractors and Equipment	3.1
3.1.3	Soil Classifications -----	3.4
3.2	PIEZOMETER INSTALLATION -----	3.4
3.3	DOWNHOLE SEISMIC SURVEYS -----	3.4
3.4	LABORATORY TESTING PROGRAM -----	3.5

TABLE OF CONTENTS

(continued)

	<u>Text</u>	<u>Page No.</u>
SECTION 4.0	GEOLOGY -----	4.1
4.1	GENERAL -----	4.1
4.2	GEOLOGIC MATERIALS -----	4.1
4.2.1	Recent Alluvium -----	4.1
4.2.2	Pleistocene Deposits -----	4.2
4.2.3	Pliocene Series -----	4.2
4.2.3.1	Pliocene Fernando Formation	4.2
4.2.3.2	Picc Formation -----	4.2
4.2.3.3	Repetto Formation -----	4.3
4.2.4	Miocene Series -----	4.3
4.2.5	Jurassic System -----	4.3
4.3	GEOLOGIC STRUCTURE -----	4.3
4.4	GROUND WATER -----	4.4
4.5	GEOLOGIC HAZARDS -----	4.5
4.5.1	General -----	4.5
4.5.2	Faults -----	4.5
4.5.2.1	San Andreas Fault -----	4.9
4.5.2.2	Newport-Inglewood System	4.9
4.5.2.3	Cherry Hill Fault -----	4.9
4.5.2.4	Los Alamitos Fault -----	4.9
4.5.3	Seismicity -----	4.10
4.5.4	Subsidence -----	4.10
4.5.5	Liquefaction -----	4.11
4.5.6	Slope Stability -----	4.11
4.5.7	Tsunamis, Seiches, and Flooding -	4.12
4.5.8	Oil and Gas Fields -----	4.12
4.6	REFERENCES -----	4.13

TABLE OF CONTENTS

(continued)

	<u>Text</u>	<u>Page No.</u>
SECTION 5.0	AT-GRADE TRACKBED AND STATIONS -----	5.1
5.1	PROPOSED CONSTRUCTION -----	5.1
5.2	SITE CONDITIONS -----	5.1
5.3	SUBSURFACE CONDITIONS -----	5.2
5.3.1	Geologic Materials -----	5.2
5.3.2	Soil Conditions -----	5.2
5.3.2.1	Borings 1000 through 1002	5.2
5.3.2.2	Borings 1003 through 1018	5.2
5.3.2.3	Borings 1019 through 1022	5.3
5.3.2.4	Borings 1023 through 1032	5.3
5.3.2.5	Borings 1033 through 1044	5.3
5.3.2.6	Borings 1045 through 1058	5.3
5.4	SEISMICITY -----	5.3
5.5	ENGINEERING EVALUATION AND DESIGN CRITERIA	5.4
5.5.1	At-Grade Trackbed -----	5.4
5.5.1.1	Soil Properties for Static Design -----	5.4
5.5.1.2	Design Criteria -----	5.5
5.5.2	Stations -----	5.6
5.5.2.1	Soil Properties for Static Design -----	5.6
5.5.2.2	Design Criteria -----	5.6
5.5.3	Catenary Support System -----	5.7
5.5.3.1	Soil Properties for Static Design -----	5.7
5.5.3.2	Design Criteria -----	5.8
5.5.4	Park-and-Ride Areas -----	5.8
5.5.4.1	Soil Properties for Static Design -----	5.8

TABLE OF CONTENTS

(continued)

	<u>Text</u>	<u>Page No.</u>
SECTION 5.0	AT-GRADE TRACKBED AND STATIONS (continued)	
5.5	ENGINEERING EVALUATION AND DESIGN CRITERIA (continued)	
	5.5.4.2 Design Criteria -----	5.8
	5.5.4.2.1 Paving -----	5.8
5.5.5	Pedestrian Tunnel -----	
5.5.6	Widening of Existing Railroad Embankment -----	
SECTION 6.0	BIXBY CROSSING -----	6.1
6.1	PROPOSED CONSTRUCTION -----	6.1
6.2	SITE CONDITIONS -----	6.1
6.3	FIELD EXPLORATIONS AND LABORATORY TESTS	6.1
	6.3.1 Borings -----	6.1
	6.3.2 Piezometer Installation -----	6.1
	6.3.3 Geophysical Measurements -----	6.2
	6.3.4 Laboratory Testing -----	6.2
6.4	SUBSURFACE CONDITIONS -----	6.2
	6.4.1 Geologic Materials -----	6.2
	6.4.2 Soil Conditions -----	6.2
	6.4.3 Ground Water -----	6.3
6.5	SEISMICITY -----	6.3
6.6	ENGINEERING EVALUATION AND DESIGN CRITERIA	6.3
	6.6.1 Soil Properties for Static Design	6.3
	6.6.2 Design Criteria -----	6.3
	6.6.2.1 Foundations -----	6.3
	6.6.2.2 Seismic Design Data ----	6.5

TABLE OF CONTENTS

(continued)

<u>Tables</u>	<u>Page No.</u>
3-1. Summary of Borings -----	3.2
4-1. Criteria for Classification of Faults with Regard to Seismic Activity -----	4.6
4-2. Major Named Faults Considered to be Active in Southern California -----	4.7
4-3. Major Named Faults Considered to be Potentially Active in Southern California -----	4.8
5-1. Summary of Average Soil Properties for Calculations of Allowable Bearing Value of Subgrade Soils --	5.4
5-2. Summary of Soil Properties for Static Design --	5.6
5-3. Pier Foundations - Overhead Contact System ----	5.7
5-4. Summary of CBR Test Data -----	5.8
5-5. Recommended Paving Sections -----	5.10
6-1. Summary of Soil Properties for Static Design --	6.3
6-2. Peak Rock Acceleration -----	6.5

TABLE OF CONTENTS

(continued)

<u>Figures</u>	<u>Figure No.</u>
System Map -----	2-1
Mainline Route Schematic -----	2-2
Long Beach Alignment, Boring Location Plan -----	2-3 through 2-21
Fault Map -----	4-1
Geologic Map -----	4-2
Generalized Geologic Profile -----	4-3 and 4-4
Major Recorded Earthquakes -----	4-5
Recurrence Curve -----	4-6
Estimated probability of Earthquake Occurrence -----	4-7
Driven Pile Capacities -----	6-1
Pile Driving Criteria -----	6-2

TABLE OF CONTENTS

(continued)

Appendix A - Field Exploration Program

	<u>Text</u>	<u>Page No.</u>
A.1	SUMMARY -----	A.1
A.2	METHOD OF DRILLING -----	A.1
A.3	LOGGING AND SAMPLING -----	A.2
A.4	PIEZOMETER INSTALLATION -----	A.3

Tables

A-1.	Summary of Piezometer Installation and Ground Water Monitoring Data -----	A.3
------	--	-----

Figures

Figure No.

Logs of Borings -----	A-1 through A-60
Unified Soil Classification System -----	A-61
Key to Log of Borings -----	A-62

TABLE OF CONTENTS

(continued)

Appendix B - Downhole Seismic Survey

	<u>Text</u>	<u>Page No.</u>
B.1	SUMMARY -----	B.1
B.2	PROCEDURE -----	B.1
B.3	ANALYSIS -----	B.1

	<u>Figures</u>	<u>Figure No.</u>
Downhole Seismic Survey -----		B-1 through B-3

TABLE OF CONTENTS

(continued)

Appendix C - Laboratory Testing

	<u>Text</u>	<u>Page No.</u>
C.1	INTRODUCTION -----	C.1
C.2	LABORATORY TESTING PROGRAM -----	C.1
C.3	LABORATORY TESTING PROCEDURES -----	C.1
C.3.1	Moisture Content -----	C.1
C.3.2	Dry Density -----	C.1
C.3.3	Direct Shear Tests -----	C.2
C.3.4	Consolidation Tests -----	C.2
C.3.5	Compaction and C.B.R. Tests -----	C.2
C.3.6	Particle Size Distribution -----	C.3
C.3.7	Permeability Tests -----	C.3
	<u>Figures</u>	<u>Figure No.</u>
	Direct Shear Tests -----	C-1.1 through C-1.16
	Consolidation Tests -----	C-2.1 through C-2.15
	Compaction and C.B.R. Test Data -----	C-3.1 through C-3.3
	Particle Size Distribution -----	C-4.1 and C-4.2
	Permeability Tests -----	C-5.1 and C-5.2

TABLE OF CONTENTS

(continued)

Appendix D - Seismic Data

	<u>Text</u>	<u>Page No.</u>
D.1	COMPUTER SEARCH OF RECORDED EARTHQUAKES -----	D.1
D.2	SITE PERIOD CALCULATIONS -----	D.1
	<u>Tables</u>	
D-1.	Computer Printout of Earthquakes -----	Following Appendix D
	<u>Figures</u>	<u>Figure No.</u>
	Site Period Determination -----	D-1 through D-3

Section 1.0
Executive Summary

**SECTION 1.0:
EXECUTIVE SUMMARY**

1.1 INTRODUCTION

This report presents the results of the geotechnical investigation performed for the Long Beach Alignment of the proposed Long Beach-Los Angeles Rail Transit Project.

The findings and conclusions developed during this geotechnical investigation are presented herein. The first part of the report presents the text which includes data analyses, interpretative information, conclusions, and recommendations for design. The Appendices, which follow, contain the detailed results of field and laboratory programs, and provides information that supports the conclusions and recommendations presented in the main text.

The proposed Long Beach Alignment begins just south of the Los Angeles River Crossing and extends southerly along the SPTC right-of-way to just south of 27th Street, at which point the alignment extends southerly along the median of Long Beach Boulevard to Ocean Boulevard. The proposed alignment, which will be at grade, is approximately 4-1/2 miles in length.

A total of seven passenger stations are presently planned along the alignment at the following locations:

Wardlow Road	Anaheim Street
Willow Street	5th/6th Street
Hill Street	1st Street
Pacific Coast Highway	

Two park-and-ride areas are planned at the Wardlow Road and Willow Street stations. A new structure is planned over the Bixby Slough.

A pedestrian underpass is planned just south of the Los Angeles River Bridge.

1.2 DESCRIPTION OF EXPLORATION AND TESTING PROGRAMS

Field explorations consisted of subsurface drilling, sampling, and testing, piezometer installation, ground water monitoring, and geophysical testing. The laboratory testing program was conducted as the samples were obtained and brought to the laboratory.

A total of 60 borings were drilled to depths of 10 to 61 feet, for a total of 1,529 lineal feet of drilling. The drilling was performed with rotary wash-type and bucket auger-type drilling equipment.

Laboratory tests performed include moisture content and density tests, direct shear tests, consolidation tests, compaction tests, and California Bearing Ratio tests, particle size distribution, and permeability tests.

1.3 PROJECT GEOLOGY

The geologic materials that will have the greatest effect on the proposed project consist of the existing fill materials, the Recent (Holocene age) alluvial materials, and the Pleistocene terrace deposits. The Recent alluvial and Pleistocene deposits are typical of the uppermost natural soils that extend throughout most of the Los Angeles Coastal Plain.

The northern portion of the segment crosses the estimated trace of the Cherry Hill Fault, which is a part of the Newport-Inglewood Fault Zone. Due to its relationship with the active Newport-Inglewood Fault Zone, the Cherry Hill Fault is currently included within the Alquist-Priolo Special Studies Zone for fault rupture hazard studies. The California Division of Mines and Geology is currently reviewing the limits of this Special Studies Zone in this area. A draft Fault Evaluation Report (FER) will be available for review in January 1986.

1.4 SUBSURFACE CONDITIONS

The soils encountered in the borings consist of alluvial and terrace deposits, except for shallow fill materials comprising the SPTC trackbed.

The alluvial deposits consist primarily of silty sands, clayey sands, sands, silts, and clays. These deposits are generally moderately firm to firm at shallow depths but become more firm with increased depth. The terrace deposits consist primarily of silty sands, clayey sands, sands, and silts, with lesser deposits of clay. These deposits are generally firm at shallow depths.

Ground water was encountered at depths of 29 to 54 feet.

1.5 DESIGN CONSIDERATIONS

Design recommendations are presented for foundation support for the various proposed structures. The recommendations are based on the results of the field explorations and laboratory tests, the engineering analyses based thereon, and on the geologic and ground motion studies.

The existing fill soils and upper natural soils are not capable of providing the level of uniform support that is required for a low maintenance rail operation. To provide uniform support, the upper fill and natural soils should be excavated so as to permit the placement of at least one foot of properly compacted subgrade fill beneath the subballast. Proof-rolling with heavy equipment should be performed to detect any soft areas that still remain after the recommended depth of excavation is completed.

For the support of a new structure across Bixby Slough, friction piling is recommended. Pile capacities are provided for driven piling. If alternative structures are considered which require intermediate support within the slough area, additional exploration borings will be required.

The foundation support for the overhead contact system may utilize drilled cast-in-place reinforced concrete piers.

Design recommendations are also presented for the pedestrian underpass and the widening of the existing railroad embankment at the north end.

Section 2.0
Introduction

SECTION 2.0: INTRODUCTION

2.1 PROJECT LOCATION

This report presents the results of the geotechnical investigation performed along the Long Beach Alignment of the proposed Long Beach-Los Angeles Rail Transit Project.

The Long Beach-Los Angeles Rail Transit Project is a conventional light rail system that will extend along a transportation corridor from downtown Long Beach to downtown Los Angeles. The proposed system alignment, which is shown on Figure 2-1, System Map, will pass through the cities of Compton and Carson and through the unincorporated areas of Florence-Graham, Willowbrook, and Dominguez Hills in Los Angeles County. The total route will be approximately 22 miles in length, with about 15-1/2 miles of it following the existing Southern Pacific Transportation Company (SPTC) right-of-way (Wilmington and East Long Beach Branches). Much of the project route will essentially be the same as the last line operated by the Pacific Electric Railway's "Red Cars", which ceased operation in 1961. The overall project will be part at grade, part above grade (aerial), and part subway. The relative locations of these various segments are presented on Figure 2-2, Mainline Route Schematic.

The proposed Long Beach Alignment begins just south of the Los Angeles River Crossing and extends southerly along the SPTC right-of-way to just south of 27th Street, at which point the alignment extends southerly along the median of Long Beach Boulevard to Ocean Boulevard. The alignment and profile are presented on the project drawings, Figures 2-3 through 2-21, Long Beach Alignment, Boring Location Plan.

2.2 PROJECT DESCRIPTION

The proposed Long Beach Alignment will consist of double tracks at grade. A total of 7 passenger stations are presently planned along the Long Beach Alignment at the following locations:

<u>Station</u>	<u>Profile</u>
Wardlow Road	At-Grade
Willow Street	At-Grade
Hill Street	At-Grade
Pacific Coast Highway	At-Grade
Anaheim Street	At-Grade
5th/6th Street	At-Grade
1st Street	At-Grade

The existing railroad embankment at the north end will be widened to 28 feet.

A new structure is planned across the Bixby Slough near the north end of the alignment. The following four alternatives are being considered for the new structure:

1. Steel Stringer Bridge
2. Concrete Bridge
3. ARMCO Multi Plate Culverts
4. Timber Trestle

A pedestrian underpass is planned approximately 65 feet south of the Los Angeles River Bridge.

Two park-and-ride areas are planned at the Wardlow Road and Willow Street Stations.

The overhead contact system will consist of cantilevered pole structures generally located midway between the two parallel tracks. Where feasible, cast-in-place reinforced concrete pier foundations will be used. Along-track spacing of the foundations will be approximately 200 feet.

2.3 PURPOSE OF INVESTIGATION

The purpose of this geotechnical investigation was to evaluate the geotechnical conditions along the proposed alignment with regard to their possible effects on the design and construction of the planned rail transit project.

2.4 SCOPE OF WORK

The scope of work for this investigation included the following:

- o Drilling and sampling
- o Piezometer installations
- o Downhole seismic surveys
- o Laboratory testing
- o Geologic and seismic studies
- o Engineering analyses
- o Seismic engineering studies
- o Conclusions and recommendations
- o Preparation of geotechnical report.

2.5 LIMITATIONS OF INVESTIGATION

Our professional services have been performed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical engineers and geologists practicing in this or similar localities. No other warranty, expressed or implied, is made as to the professional advice included in this report. This report has been prepared for the Los Angeles County Transportation Commission (LACTC) and the Southern California Rail Consultants (SCRC) and their design consultants to be used solely in the design of the proposed facilities. The report has not been prepared for use by other parties, and may not contain sufficient information for purposes of other parties or other uses.

2.6 INSPECTION OF BORING SAMPLES

Soil samples recovered from the borings and remaining after laboratory testing are stored at the laboratory of LeRoy Crandall and Associates, 711 North Alvarado Street, Los Angeles, California 90026.

2.7 PREVIOUS INVESTIGATIONS

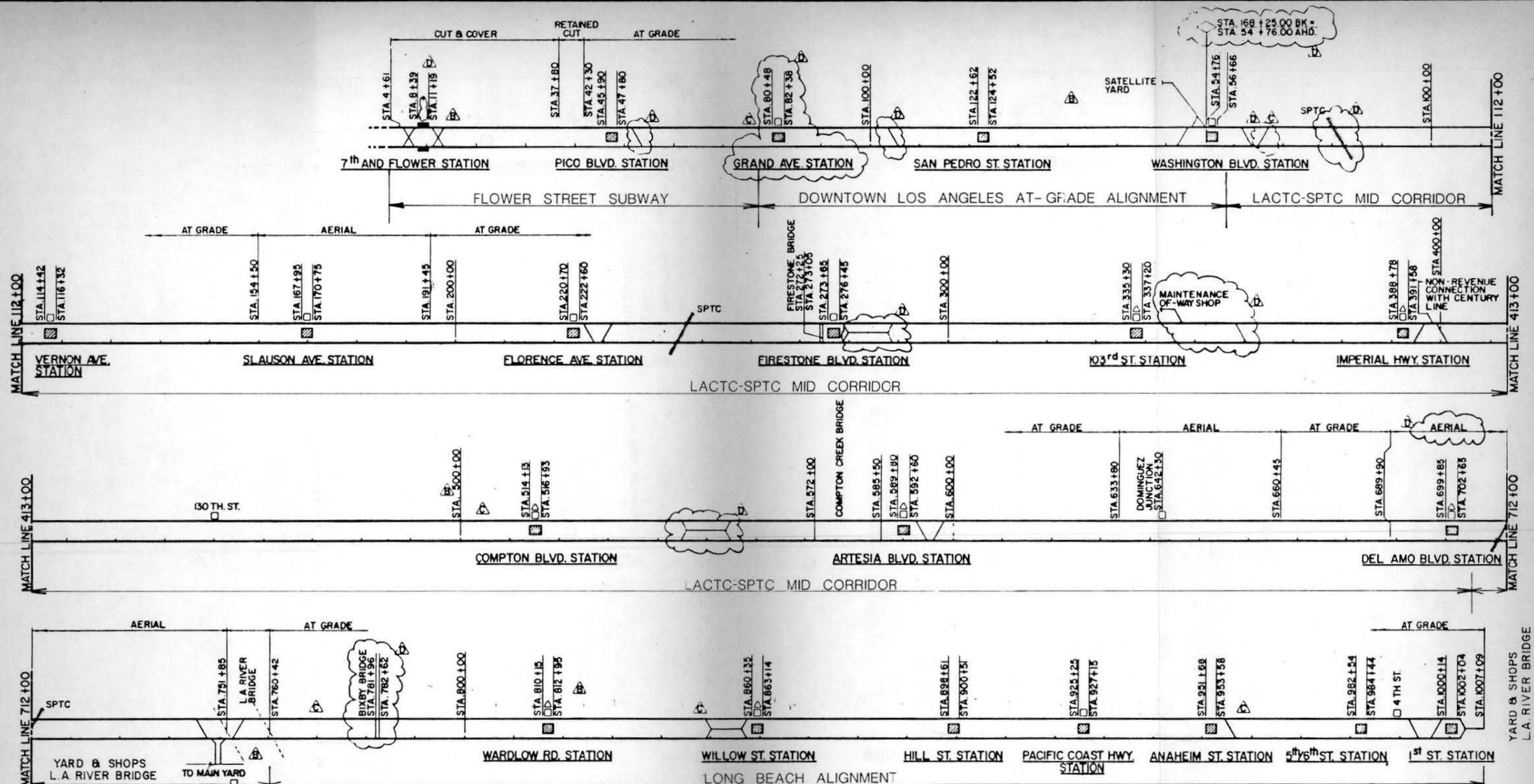
Prior geotechnical investigations performed by our firm for other proposed rail transit projects of which portions extended along alignments similar to that of this project, are covered in the following reports:

- o Report of Preliminary Geotechnical Investigation, Proposed Long Beach-Los Angeles Rapid Transit Corridor, for the Southern California Rapid Transit District, dated June 20, 1976.
- o Report of Preliminary Foundation Investigation, Proposed Rapid Transit System: Wilshire, San Gabriel Valley, San Fernando Valley, and Long Beach Corridors by the Southern California Rapid Transit District, dated April 26, 1966. (Performed investigation for Joint Venture of Kaiser Engineers and Daniel, Mann, Johnson and Mendenhall.)

Reports covering our prior work for this project are identified as follows:

- o Task 1: Library Search, dated March 6, 1985.
- o Task 2: Library Search, dated March 8, 1985.
- o Task 3: Initial Boring Program, dated March 19, 1985.
- o Task 4: Preliminary Budget Estimate and Time Schedule, dated April 18, 1985.
- o Task 5: Parameters for Seismic Analysis, Los Angeles River Bridge, dated August 1, 1985.
- o Task 6: Geotechnical Report, MC5 SPTC Railroad Relocation, dated November 27, 1985.
- o Task 7: Geotechnical Report, LACTC-SPTC Mid Corridor, dated September 23, 1985.
- o Task 8: Geotechnical Report, Flower Street Subway, dated December 6, 1985.
- o Task 9: Geotechnical Report, Main Yard and Shops, Aerial Structure and Los Angeles River Bridge, dated November 20, 1985.
- o Task 11: Geotechnical Report, Washington Boulevard Alignment, dated January 10, 1986.
- o Preliminary Environmental Risk Assessment and Site Safety Plan prepared by MED-TOX Associates, Inc., dated September 8, 1985.

JOB ADE - 85005-10



NOTES:

1. SCHEMATIC CORRESPONDS TO ALIGNMENT LA2-MC1-LB5. ALTERNATIVE MC5 INVOLVES A PROFILE MODIFICATION BETWEEN IMPERIAL HIGHWAY AND COMPTON BLVD. STATIONS.
2. LIMITS OF STATION PLATFORMS BASED ON FLOWER STREET SUBWAY 25% REVIEW DRAWINGS (10/16/85), L.A. CBD APPROACH-WASHINGTON BLVD. SKETCHES (12/2/85), MID-CORRIDOR SITE WORK & RAILROAD RECONSTRUCTION DWGS. (12/2/85), L.A. RIVER BRIDGE TO WILLOW CONCEPTUAL DESIGN (10/15/85) AND LONG BEACH BLVD. SKETCHES (12/2/85). STATION PLATFORMS SHOWN AS 190 FT. FOR INITIAL 2-CAR PLATFORM AND 280 FT. FOR INITIAL 3-CAR PLATFORM. ALL 3-CAR PLATFORMS CAN BE INCREASED TO 3 CARS IN THE FUTURE EXCEPT LONG BEACH BLVD. STATIONS.

3. LOCATIONS AND TYPES OF SPECIAL TRACKWORK PER DPD 13 TO BE CONFIRMED BY TRACKWORK DESIGNERS. POINTS OF SWITCH WILL BE ADDED IN A REVISION.
4. LRT ALIGNMENT CROSSES FIRESTONE BLVD., COMPTON CREEK, THE LOS ANGELES RIVER AND BIXBY DRAINAGE AREA ON VIADUCTS.
5. STREET CROSSOVER AT PICO, GRAND/SAN PEDRO & ANAHEIM FOR EMERGENCY USE ONLY. NO SIGNALS REQUIRED. MANUAL THROW SWITCH WITH #5 TURNOUTS, TRAILING FOR NORMAL DIRECTION OF TRAFFIC.
6. POCKET TRACKS ACCOMMODATE 6 CARS (600 FT. P.S. TO P.S. OF EQUILATERAL TURNOUTS)

LEGEND:

- ▨ PLATFORM (TYP)
- TRACTION POWER SUBSTATION
- RAILROAD GRADE CROSSING
- △ PARKING LOT

NOT UNDER CONFIG. MGMT. CONTROL



REV.	DATE	DESCRIPTION	BY	APP.
D	2/19/85	UPDATE CIVIL STATIONING AND INCORPORATE DPOS 3, 8A, 11 & 13	RR	DK
C	1/25/85	REVISED CROSSOVER AND POCKET TRACK LOCATIONS PER CR BK-022	RR	DK
B	8/23/84	REVISED & REDRAWN	RR	DK
A	5/7/85	INITIAL ISSUE	VJ	RR

DESIGNED BY
Susan Karat

DRAWN BY
V. JONASCU

CHECKED BY
P. Katsimiro

APPROVED BY
R. Rappaport

DATE
MAY 7 1985

LOS ANGELES COUNTY TRANSPORTATION COMMISSION
The Long Beach-Los Angeles Rail Transit Project

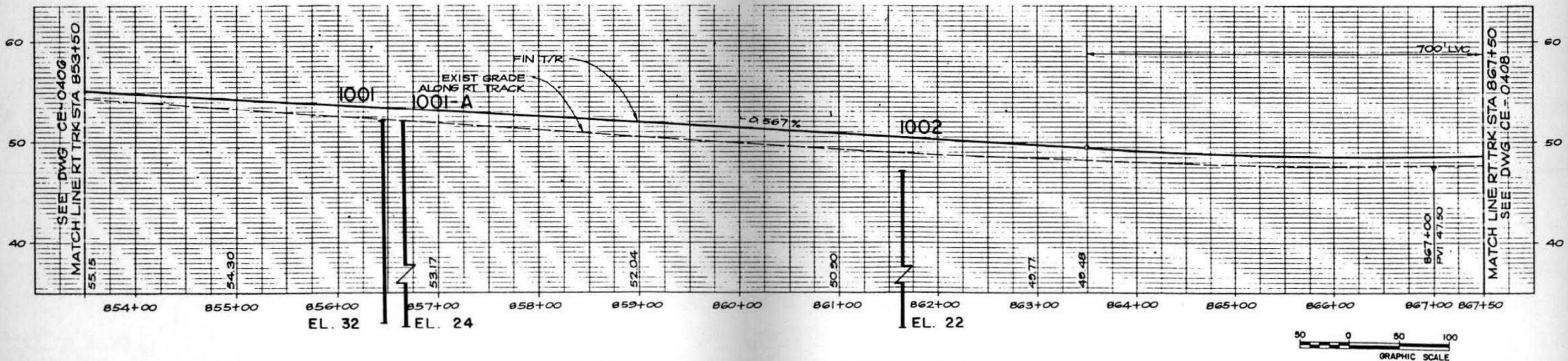
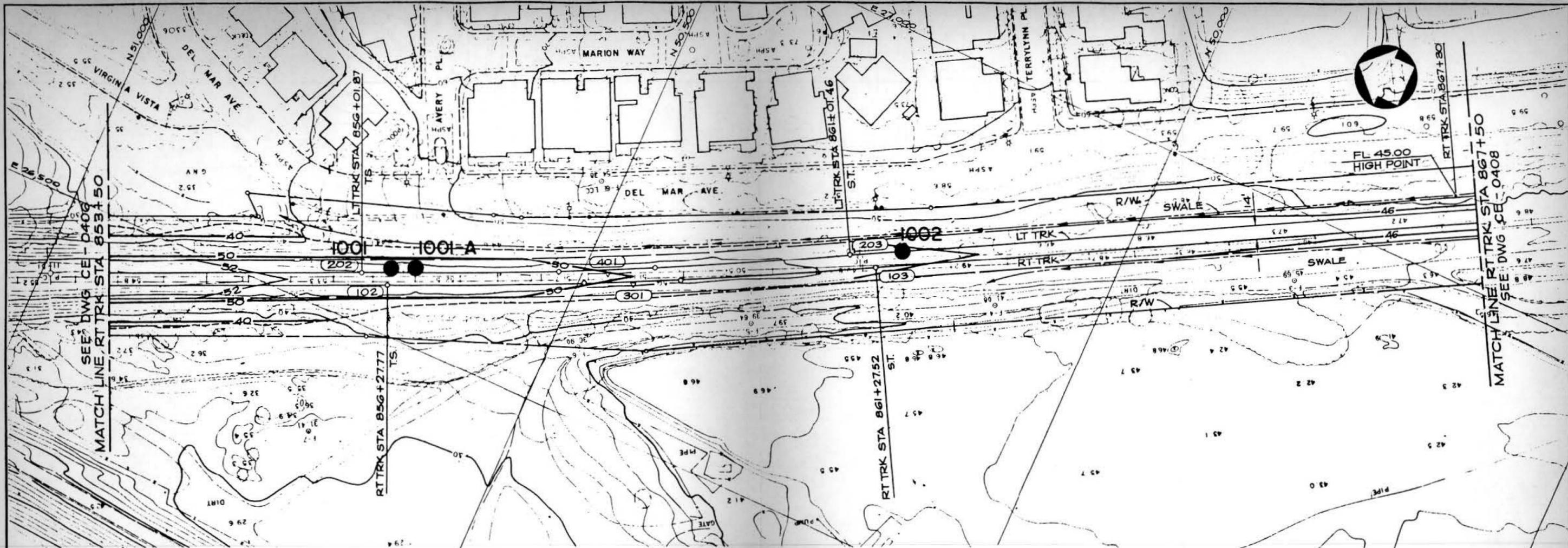
Southern California Rail Consultants

SUBMITTED: *Diane Knorr*

APPROVED: *Lyne A. Swade*

CONTRACT NO.	
DRAWING NO. SY-H-001	
REV. D	SHEET NO. 1 OF 1
SCALE 1" = 2000'	

FIGURE 2-2



REV.	DATE	DESCRIPTION	BY	APP
1/86		BORING LOCATIONS ADDED		

Information confidential: all plans, drawings, specifications, and/or information furnished herewith shall remain the property of the Los Angeles County Transportation Commission; and shall not be used for any purpose not provided for in agreements with the Los Angeles County Transportation Commission.

DESIGNED BY
B.A. SANTOS

DRAWN BY
A. ANCAJAS JR

CHECKED BY

APPROVED BY

DATE

LOS ANGELES COUNTY TRANSPORTATION COMMISSION
The Long Beach-Los Angeles Rail Transit Project

LACY

LeROY CRANDALL AND ASSOCIATES
CONSULTING GEOTECHNICAL ENGINEERS

Southern California Rail Consultants
A Joint Venture of
Parsons Brinckerhoff Quade & Douglas, Inc.
Kaiser Engineers (California) Corporation
Daniel, Mann, Johnson & Mendenhall

SUBMITTED: _____ DATE _____

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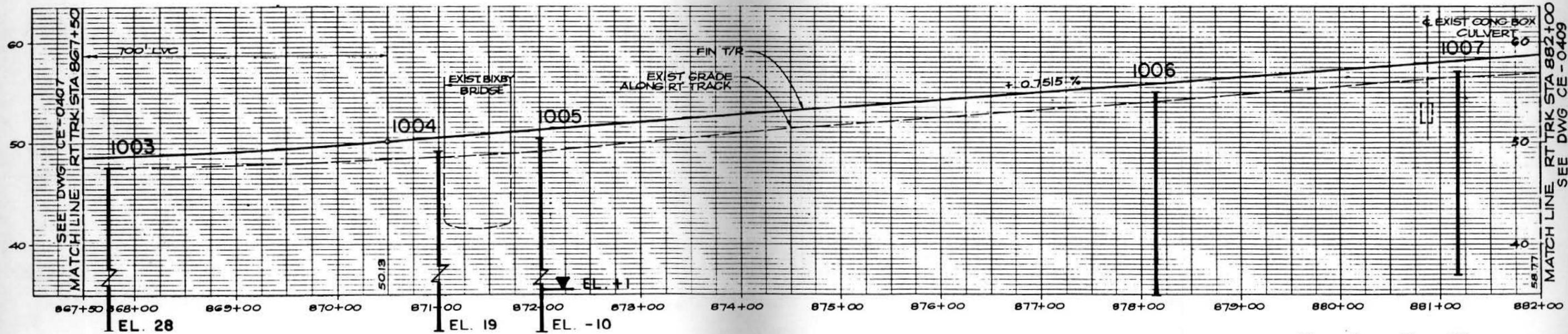
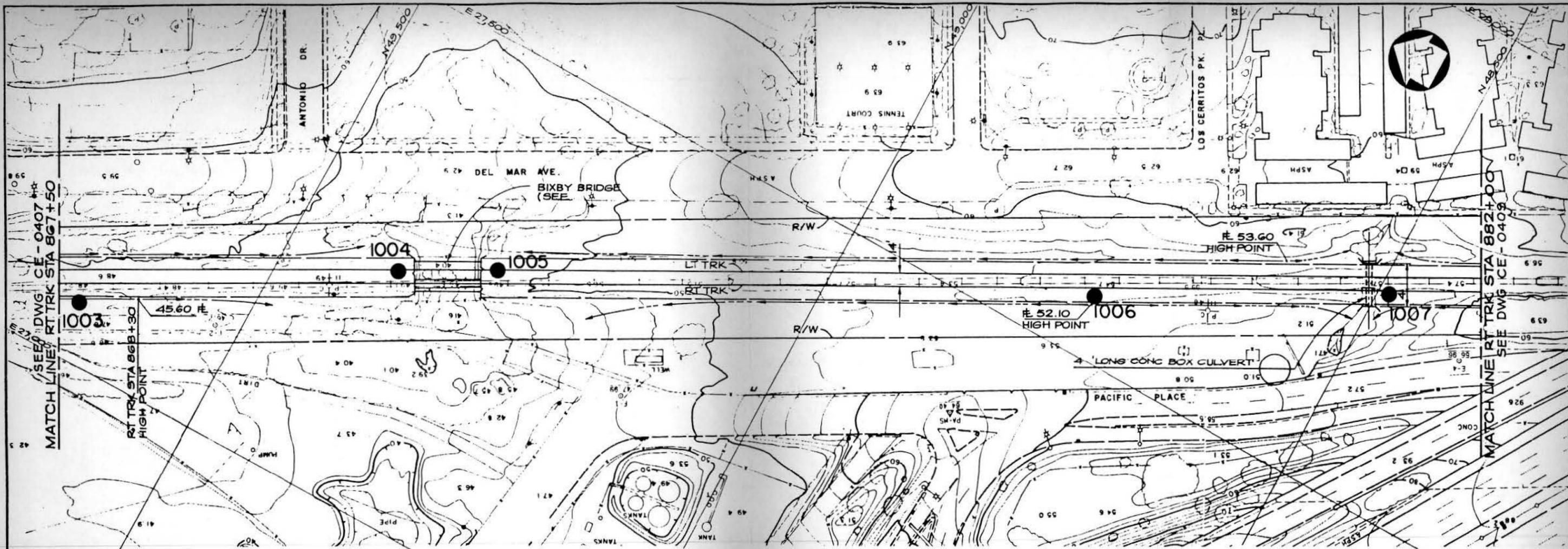
LONG BEACH ALIGNMENT
BORING LOCATION PLAN

CONTRACT NO. TW 1005
DRAWING NO.

REV. SHEET NO.

SCALE 1" = 100'

FIGURE 2-4



REV	DATE	DESCRIPTION	BY	APP
1/86		BORING LOCATIONS ADDED		

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DRAWN BY
A. ANCAJAS, JR.

CHECKED BY

APPROVED BY

DATE

LOS ANGELES COUNTY TRANSPORTATION COMMISSION
The Long Beach-Los Angeles Rail Transit Project

LeROY CRANDALL AND ASSOCIATES
CONSULTING GEOTECHNICAL ENGINEERS

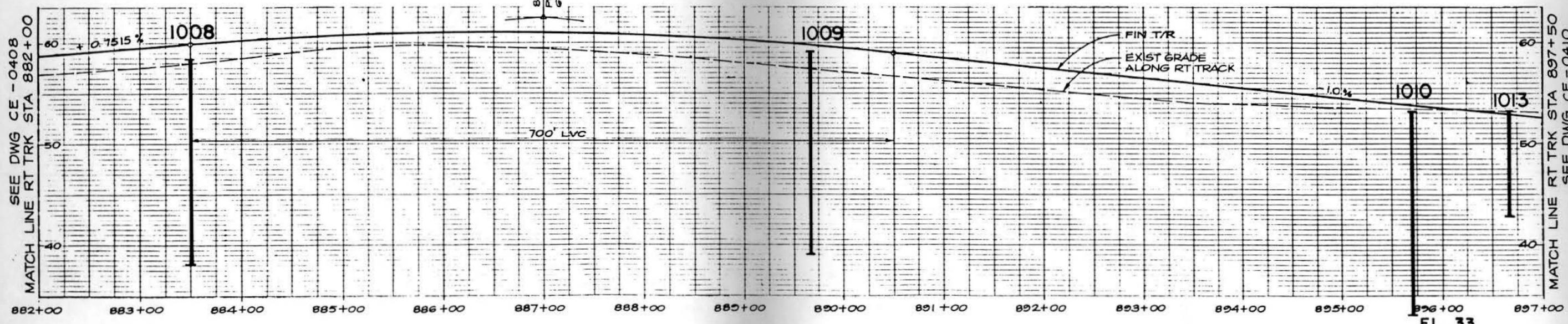
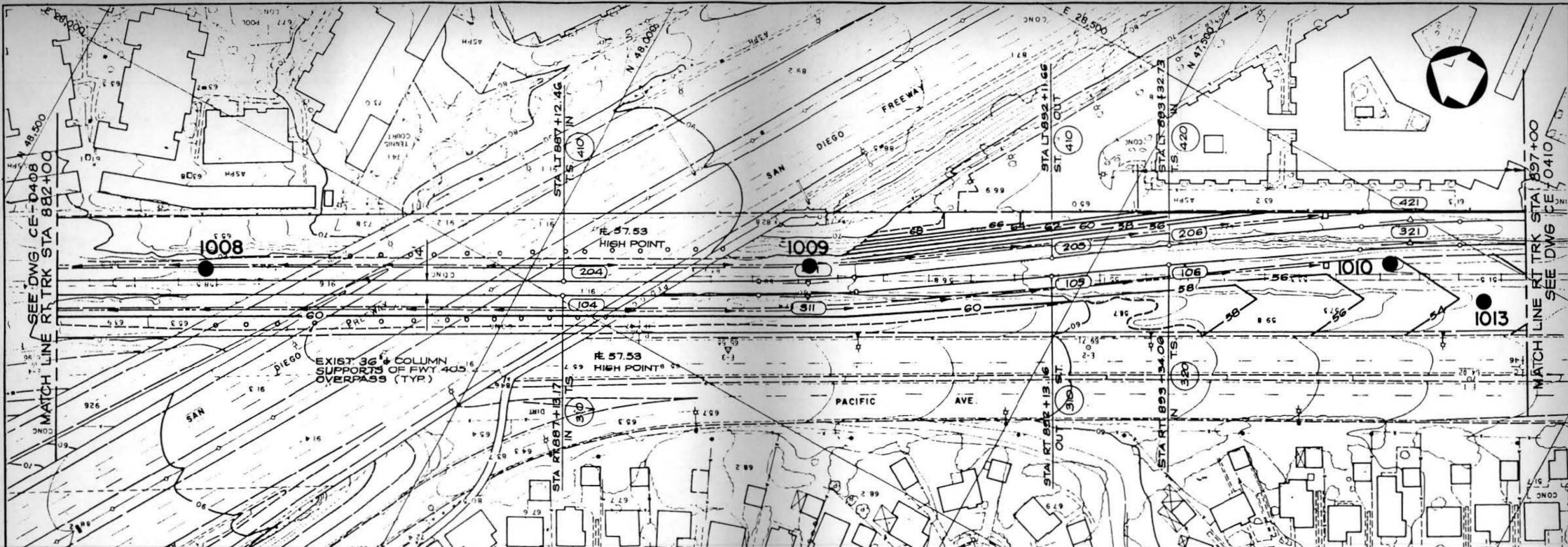
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Kaiser Engineers (California) Corporation
Daniel Mann Johnson & Mendenhall

SUBMITTED: _____ DATE _____ APPROVED: _____

**LONG BEACH ALIGNMENT
BORING LOCATION PLAN**

CONTRACT NO. TW 1005
DRAWING NO.
REV. SHEET NO.
SCALE 1" = 100'

FIGURE 2-5



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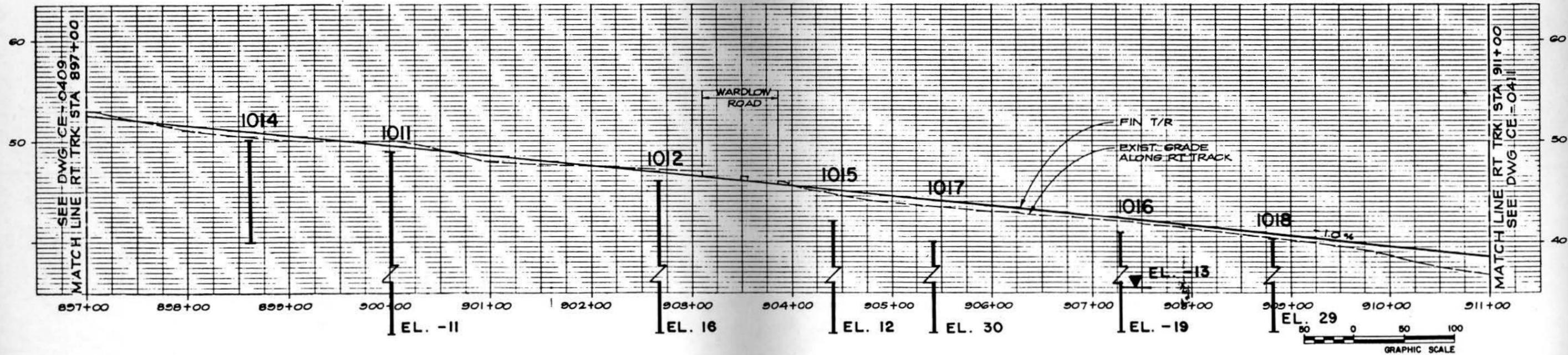
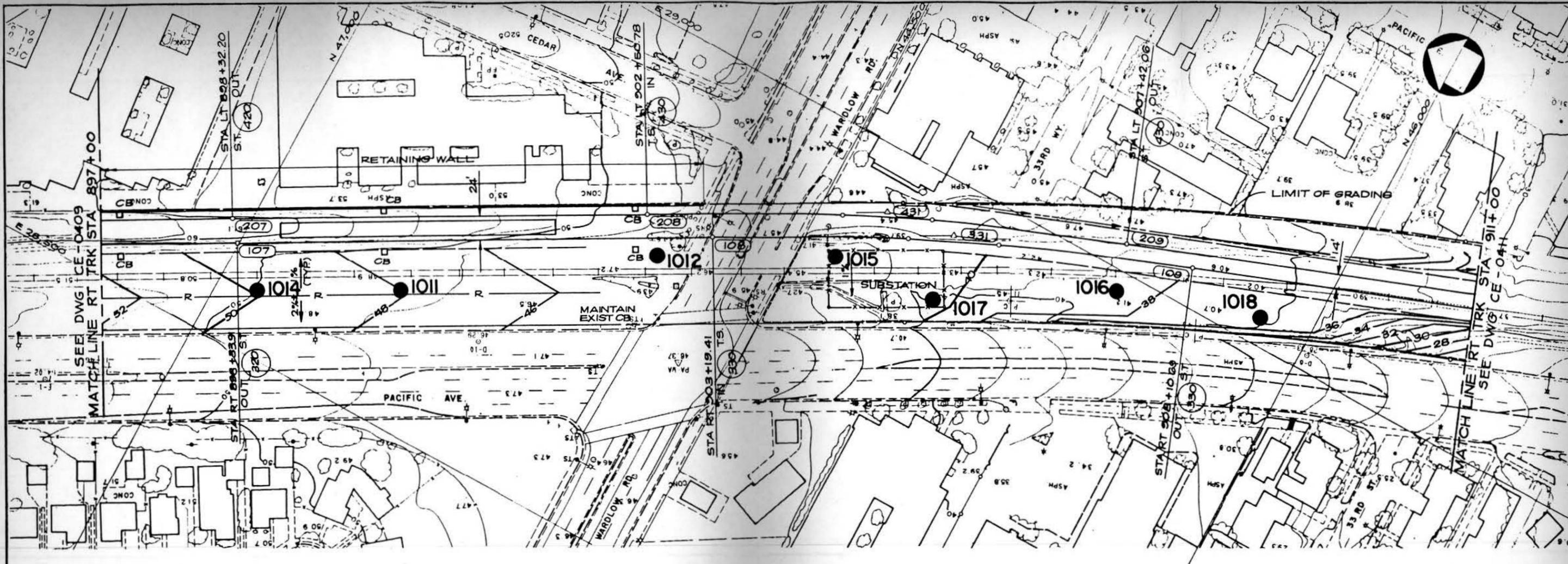
LONG BEACH ALIGNMENT
BORING LOCATION PLAN

CONTRACT NO. TW 1005
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REV. SHEET NO.

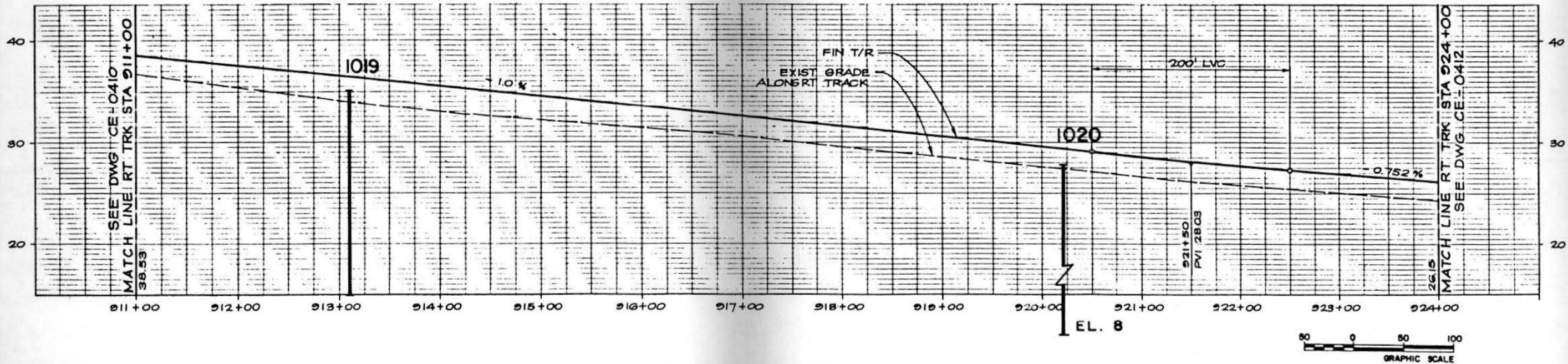
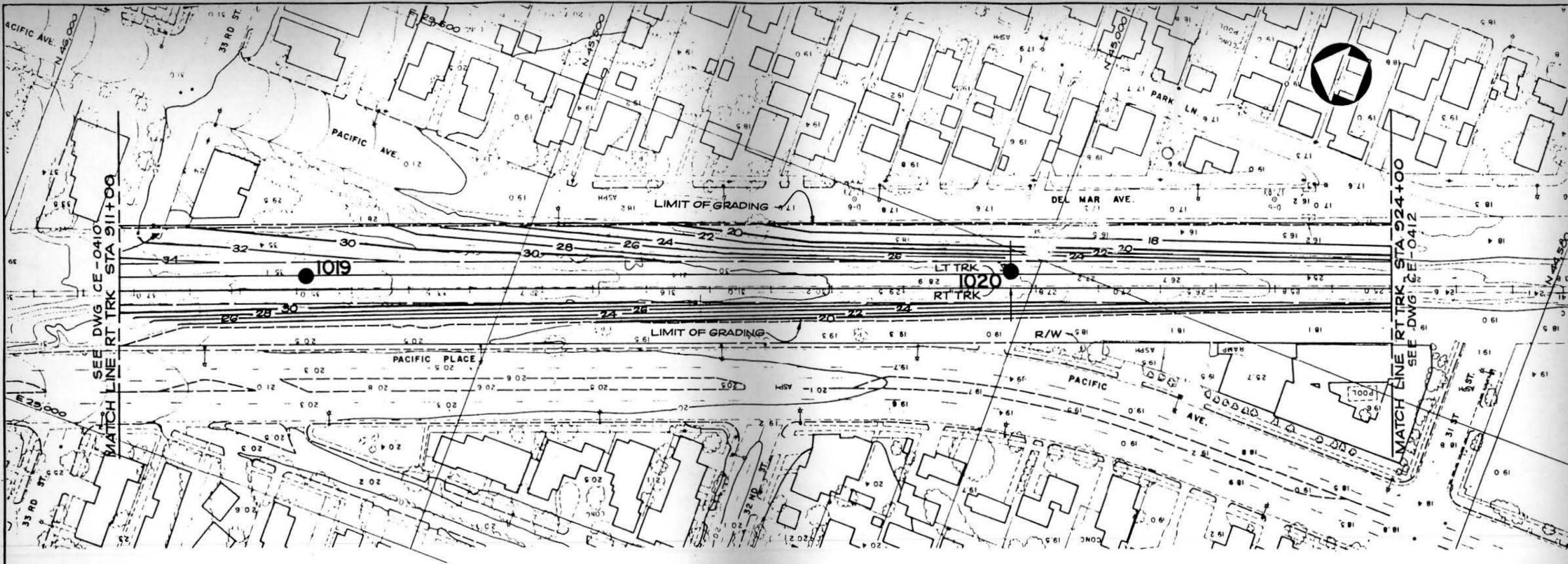
SCALE 1" = 100'

FIGURE 2-6

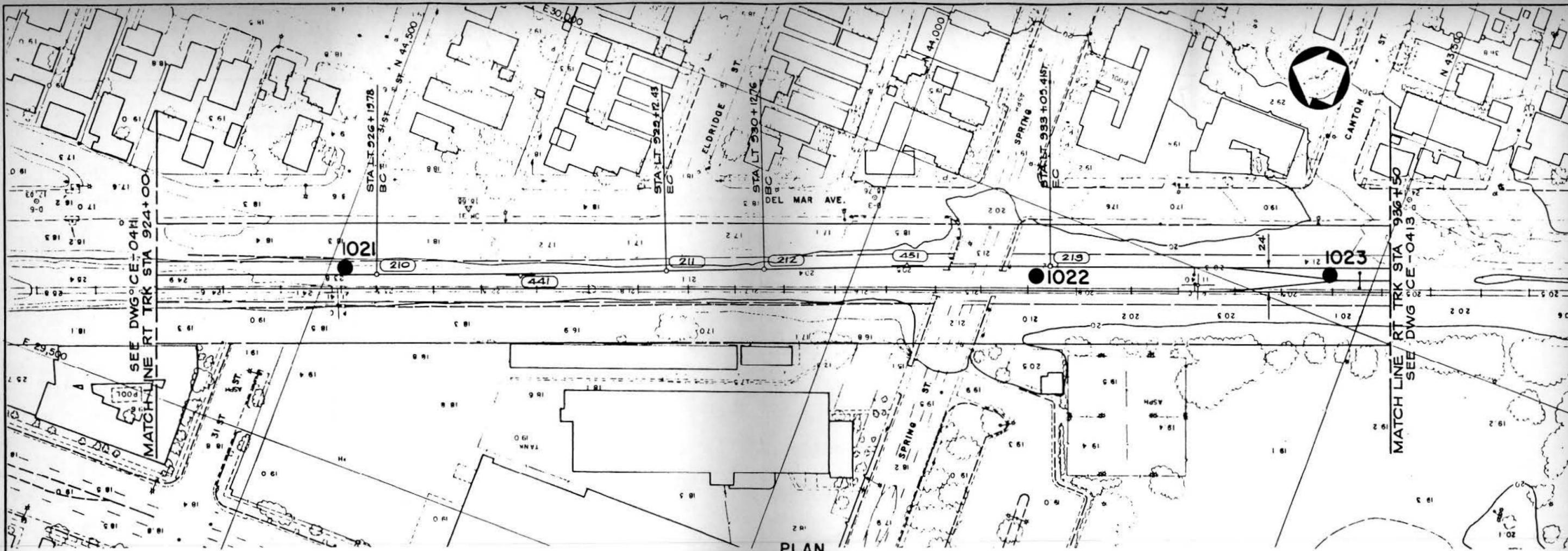


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	APP		DATE					

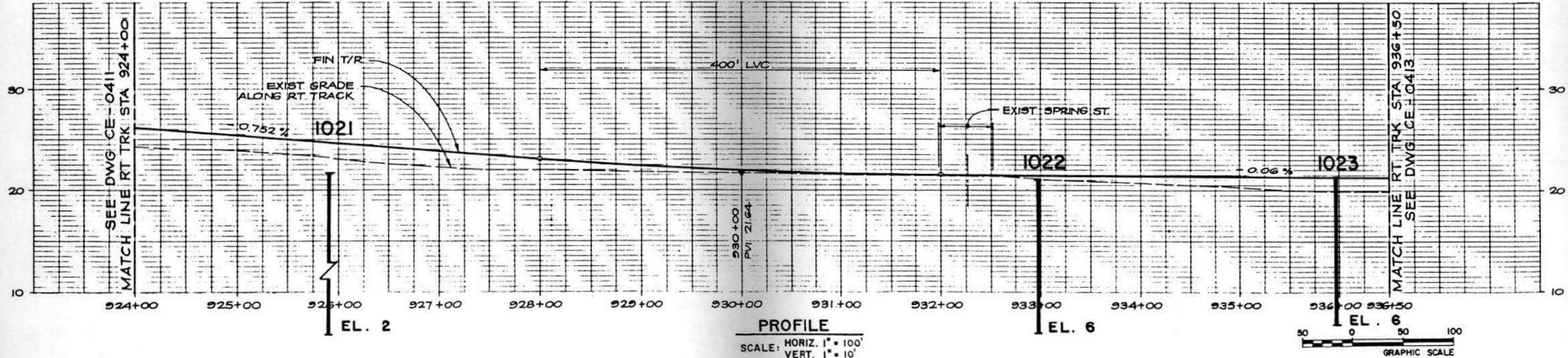
FIGURE 2-7



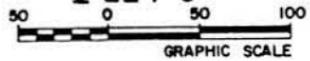
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PLAN
SCALE: 1" = 100'



PROFILE
SCALE: HORIZ. 1" = 100'
VERT. 1" = 10'



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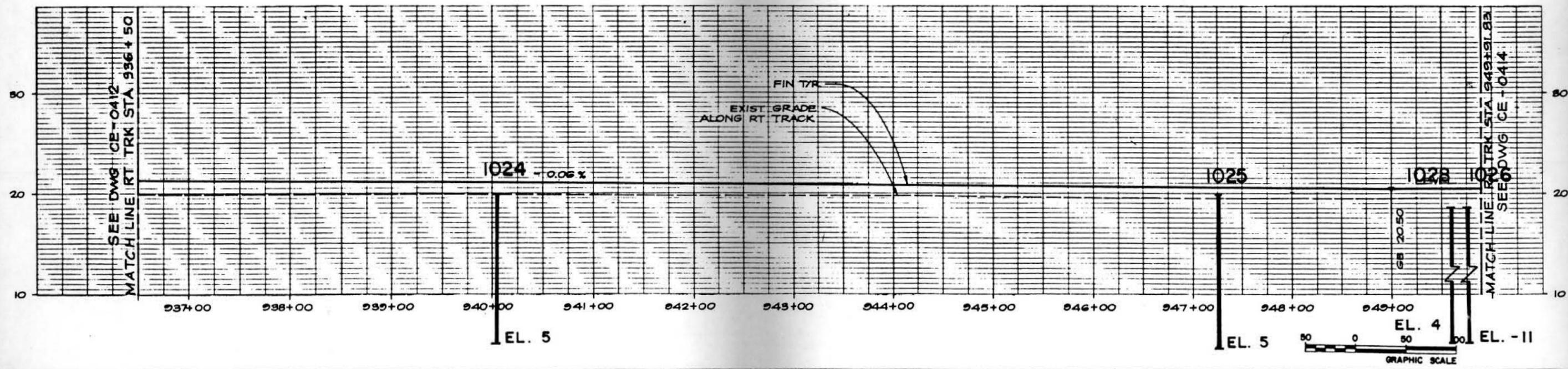
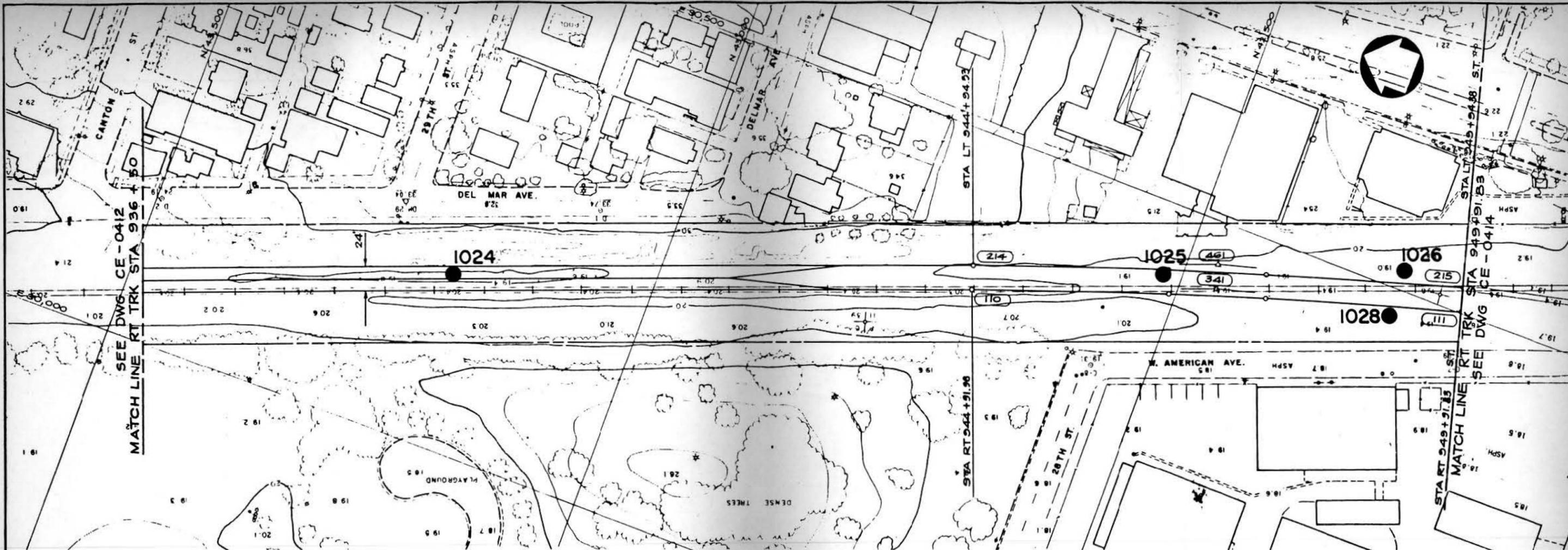
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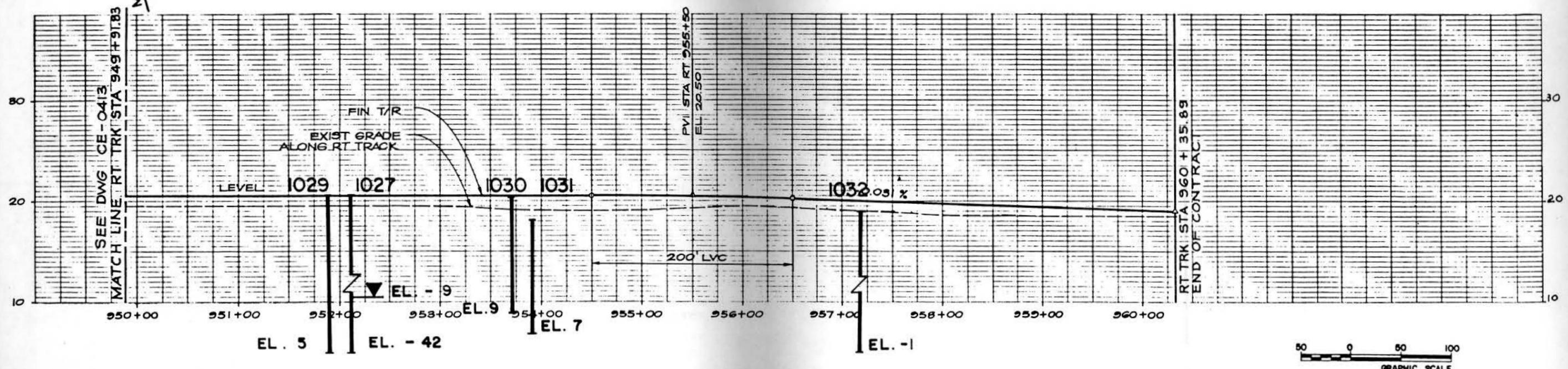
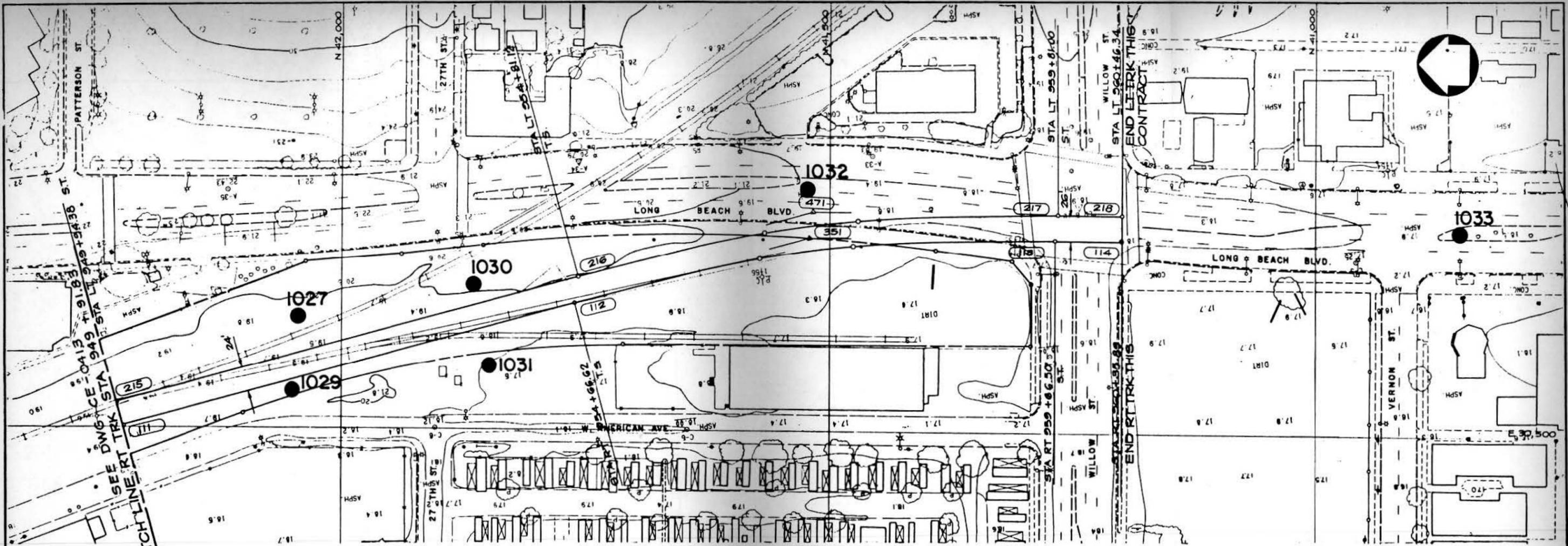
**LONG BEACH ALIGNMENT
BORING LOCATION PLAN**

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DRAWING NO.	
REV.	SHEET NO.
SCALE 1" = 100'	

FIGURE 2-9



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REV. DATE	DESCRIPTION		DRAWN BY AANCAJAS JR			LeROY CRANDALL AND ASSOCIATES CONSULTING GEOTECHNICAL ENGINEERS
			CHECKED BY	SUBMITTED: _____ DATE: _____	APPROVED: _____	SCALE 1" = 100'
			APPROVED BY			FIGURE 2-10
			DATE			



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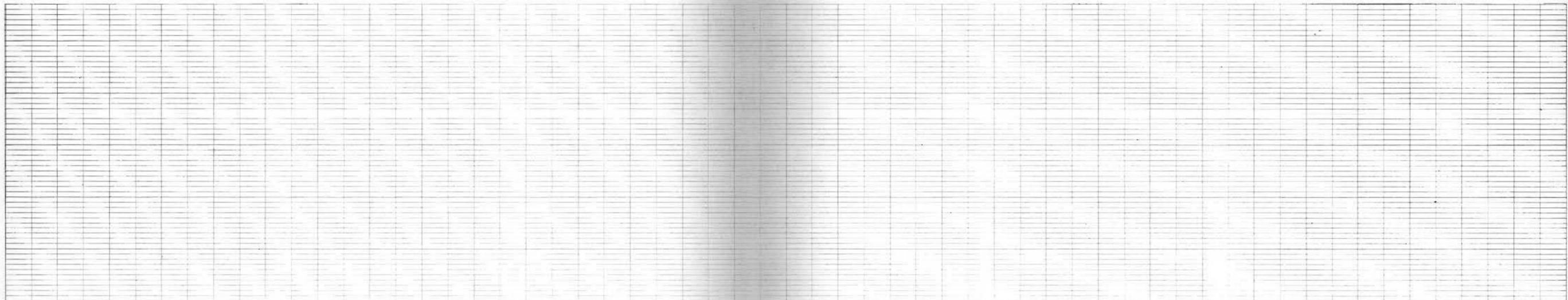
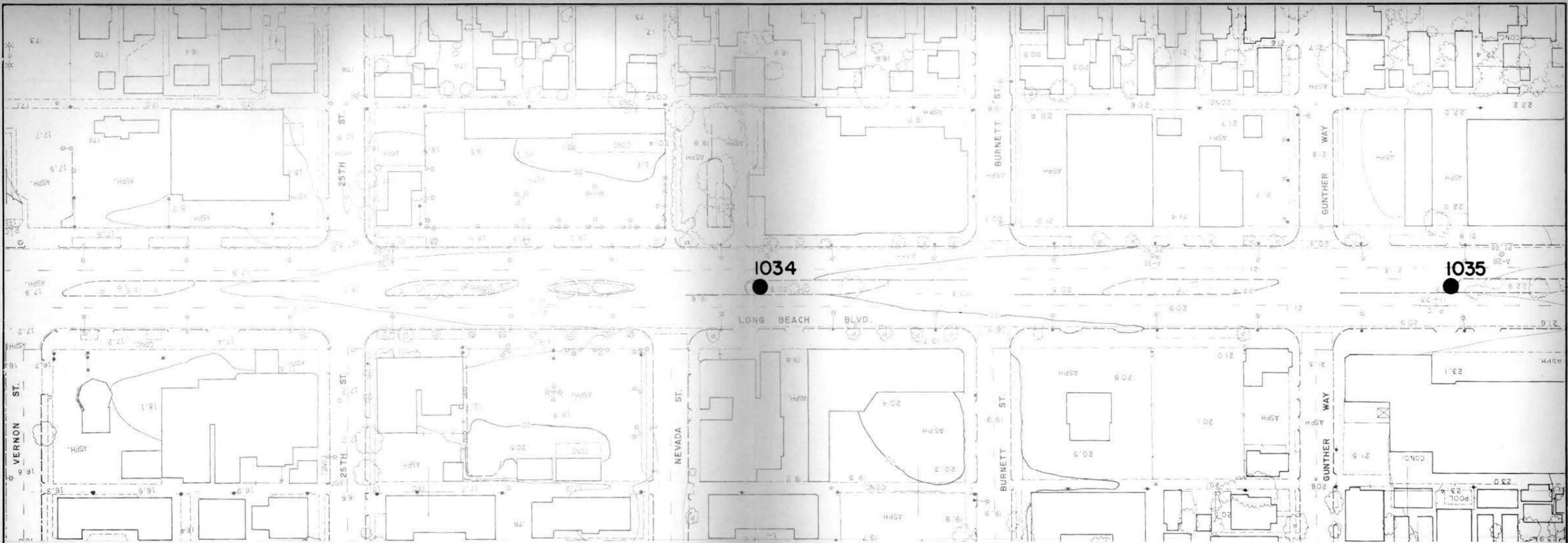
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BORING LOCATION PLAN

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DRAWING NO. _____

REV. _____ SHEET NO. _____

SCALE 1" = 100'

FIGURE 2-11



REV.	DATE	DESCRIPTION	BY	APP.
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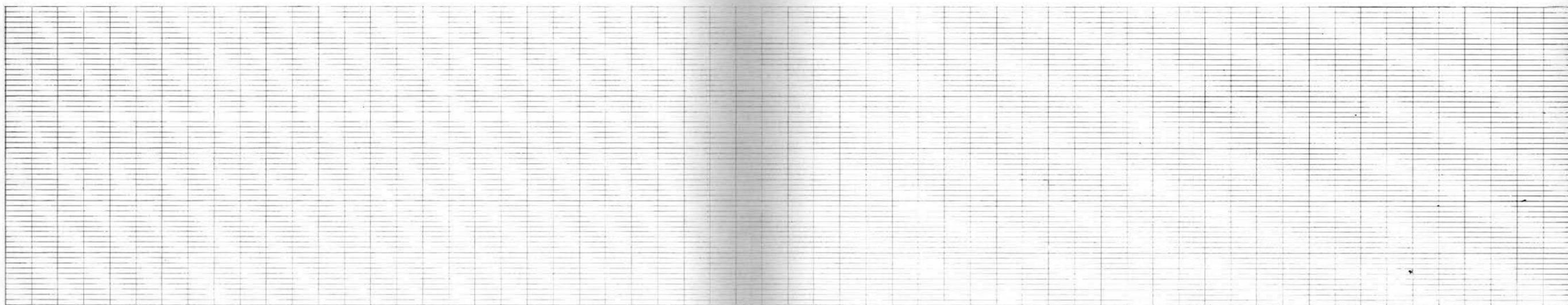
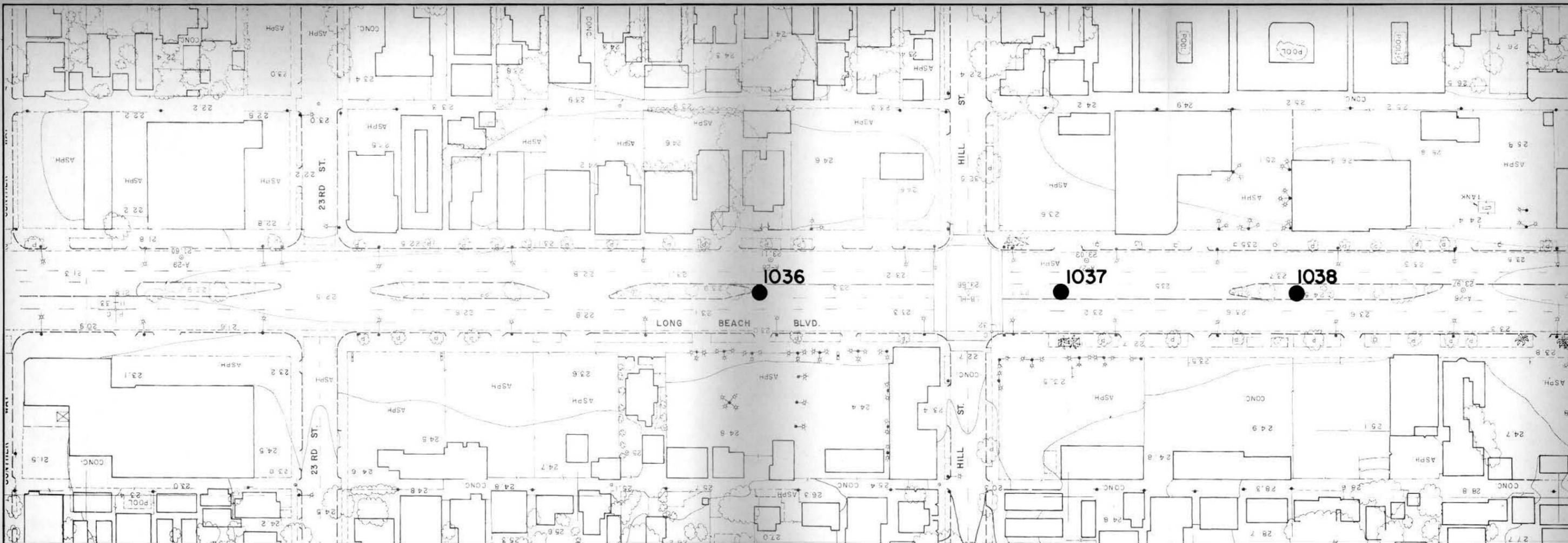
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BORING LOCATION PLAN

CONTRACT NO. TW 1005	
DRAWING NO.	
REV.	SHEET NO.
SCALE 1" = 100'	

FIGURE 2-12



REV.	DATE	DESCRIPTION	BY	APP.
1/00		BORING LOCATIONS ADDED		

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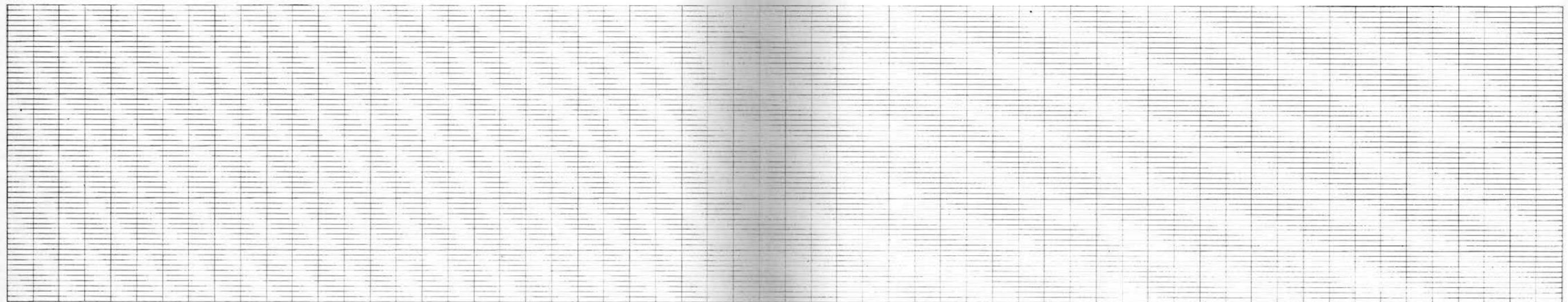
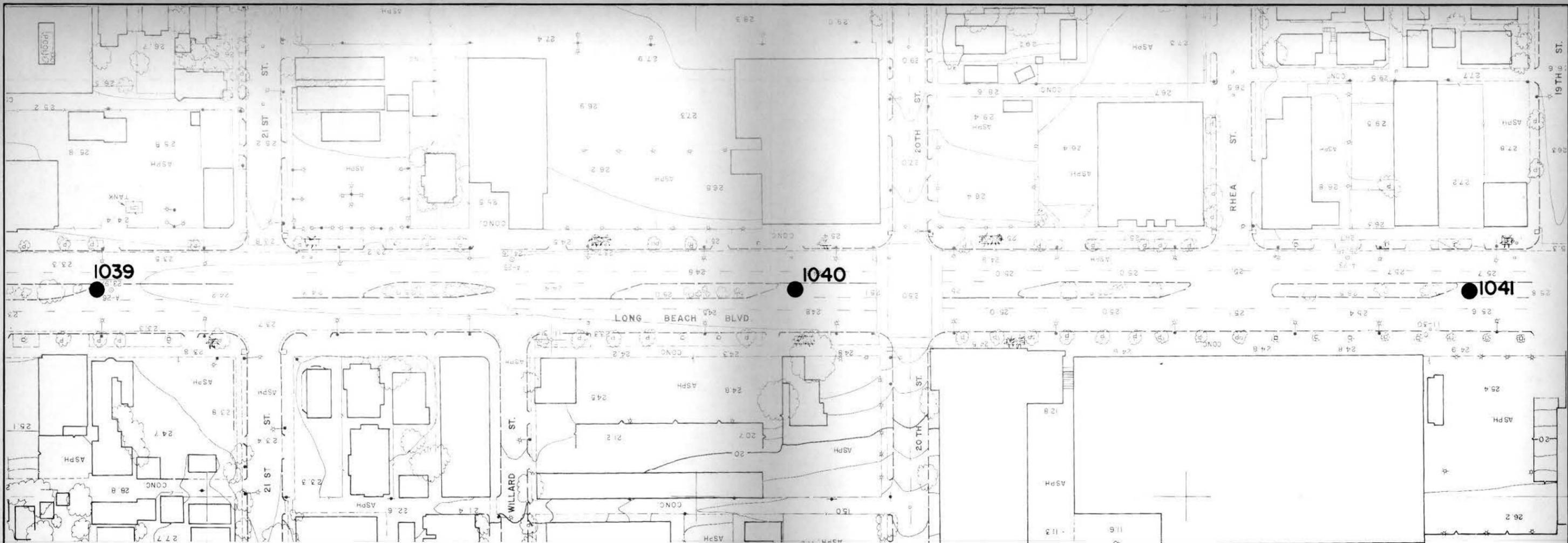
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BORING LOCATION PLAN

CONTRACT NO. T W 1005	
DRAWING NO.	
REV.	SHEET NO.
SCALE 1" = 100'	

FIGURE 2-13



REV.	DATE	DESCRIPTION	BY	APP.
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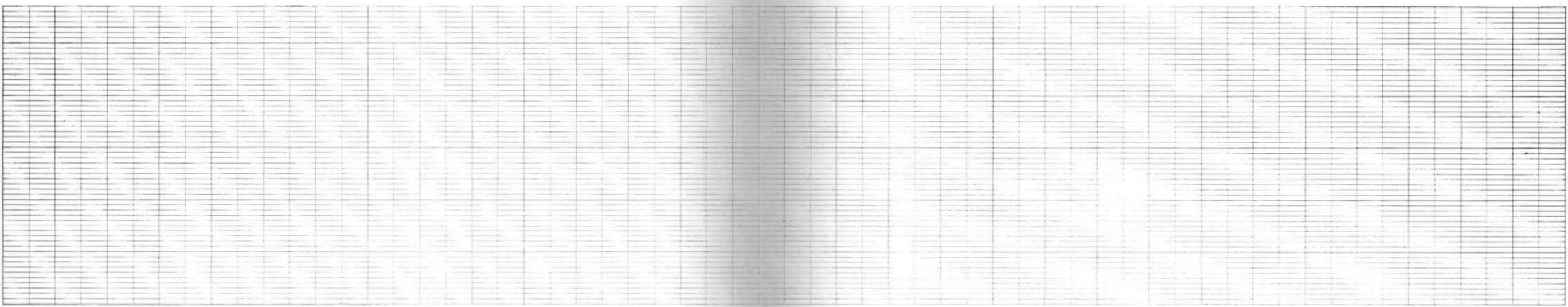
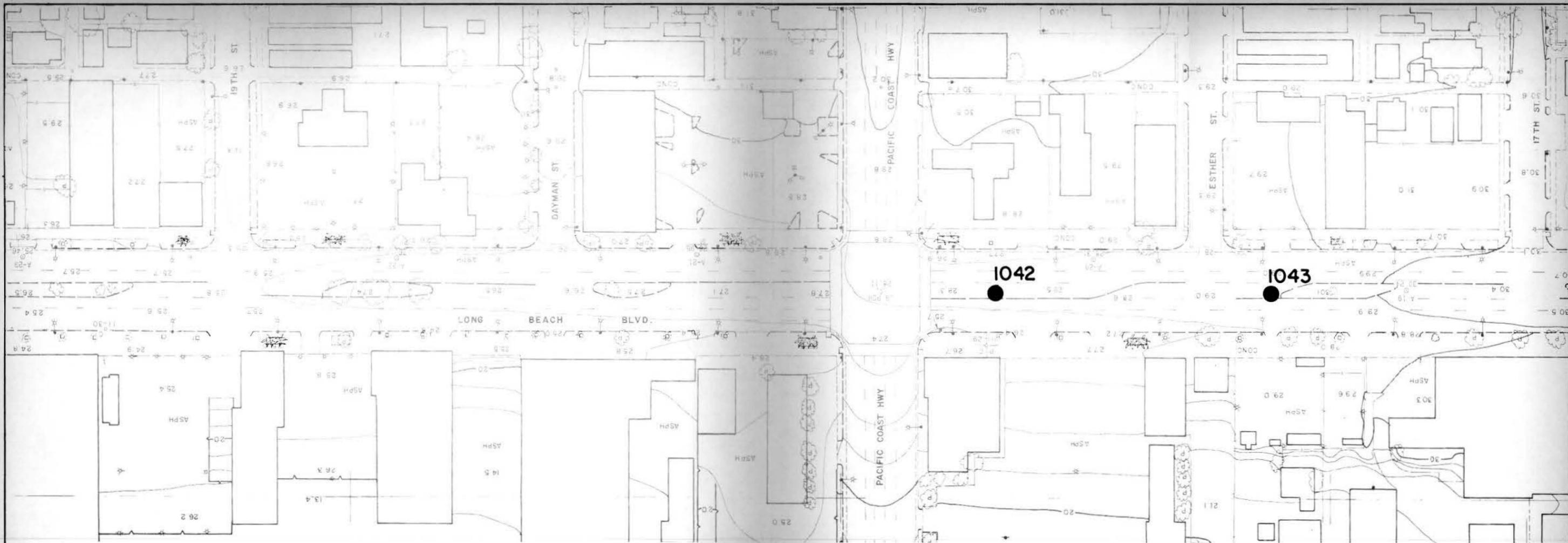
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REV. SHEET NO.
SCALE 1" = 100'

FIGURE 2-14



REV.	DATE	DESCRIPTION	BY	APP.
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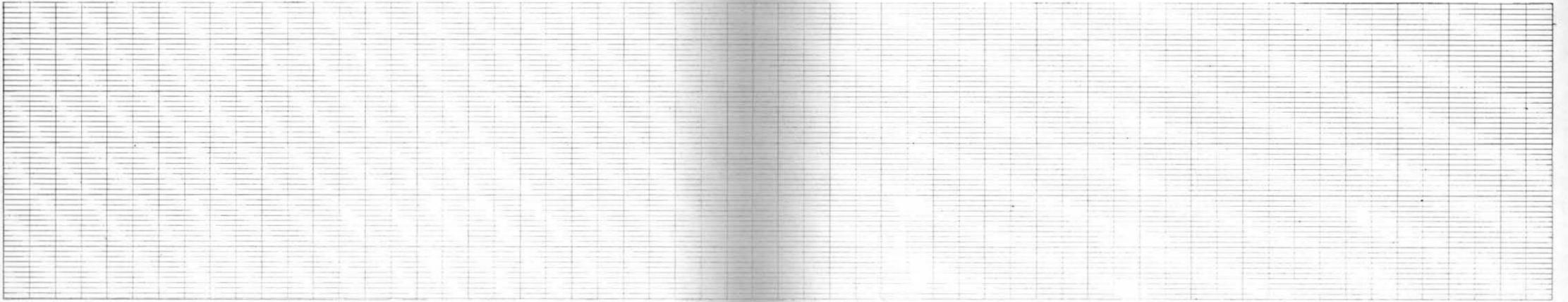
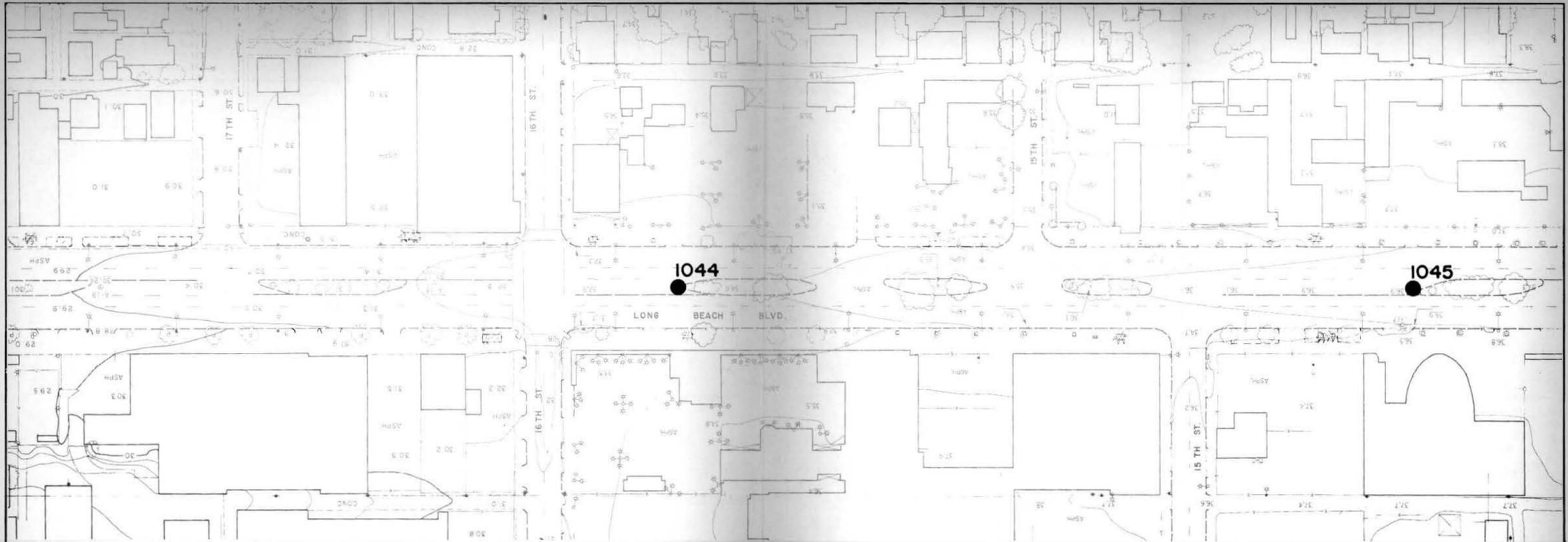
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BORING LOCATION PLAN

CONTRACT NO. TW 1005	
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REV.	SHEET NO.
SCALE 1" = 100'	

FIGURE 2-15



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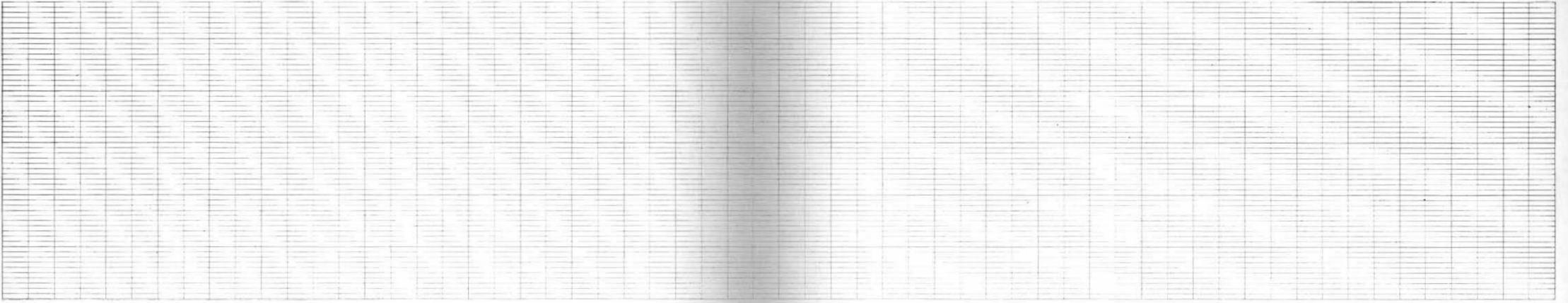
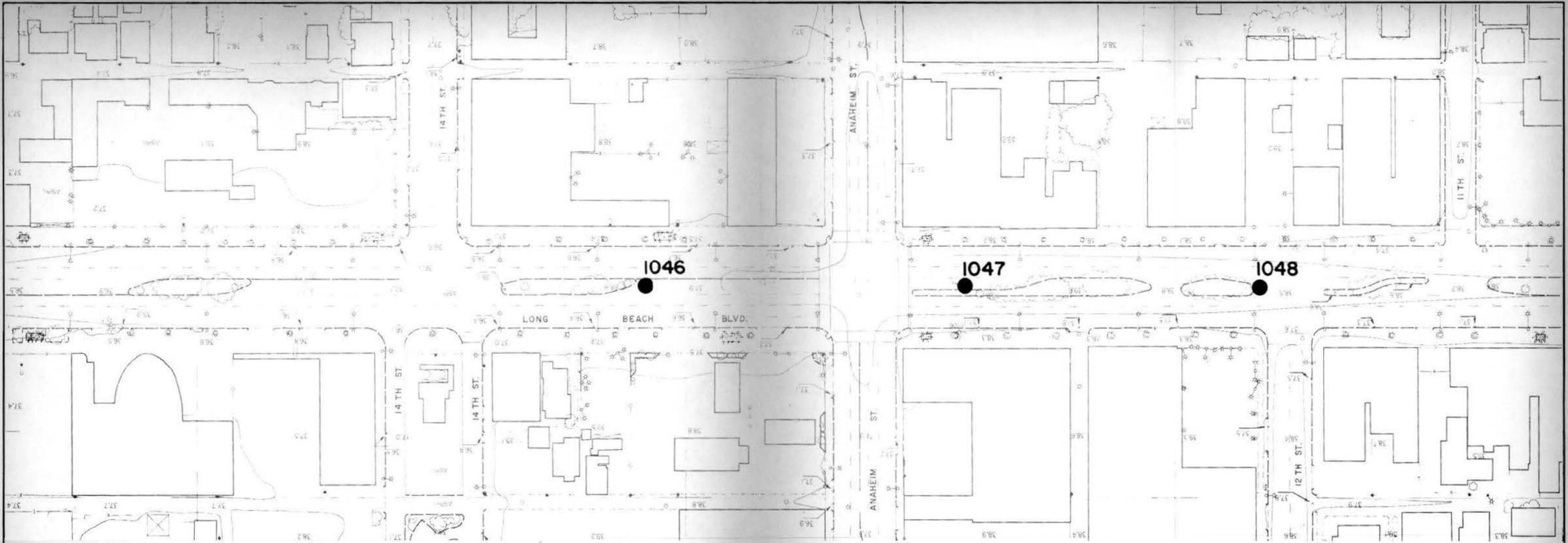
CONTRACT NO. TW 1005

DRAWING NO.

REV. SHEET NO.

SCALE 1" = 100'

FIGURE 2-16



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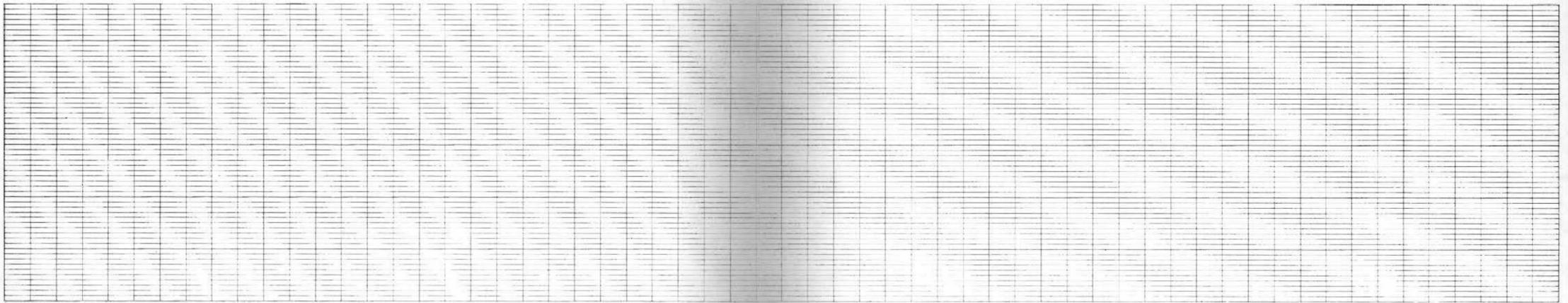
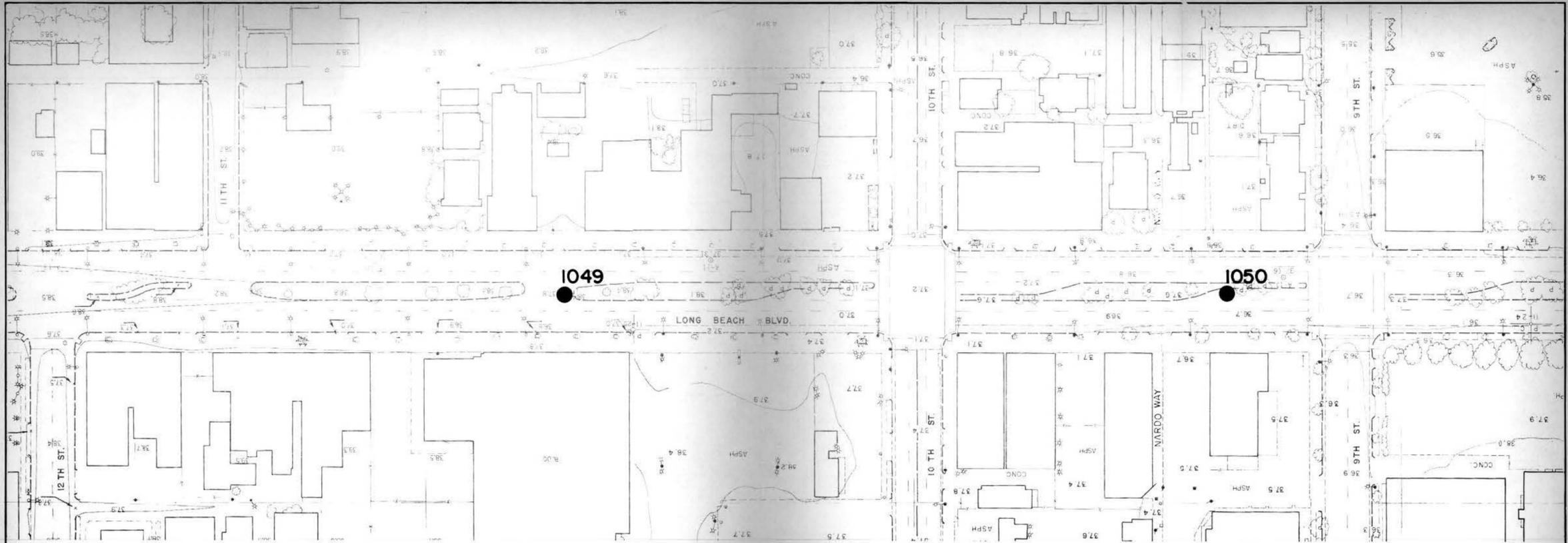
LONG BEACH ALIGNMENT
BORING LOCATION PLAN

CONTRACT NO. TW 1005
DRAWING NO. _____

REV. SHEET NO. _____

SCALE 1" = 100'

FIGURE 2-17



REV.	DATE	DESCRIPTION	BY	APP.
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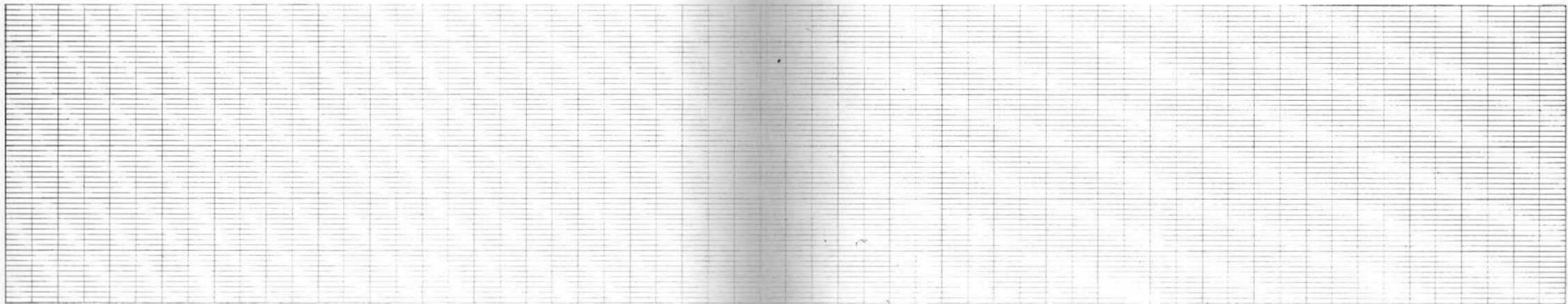
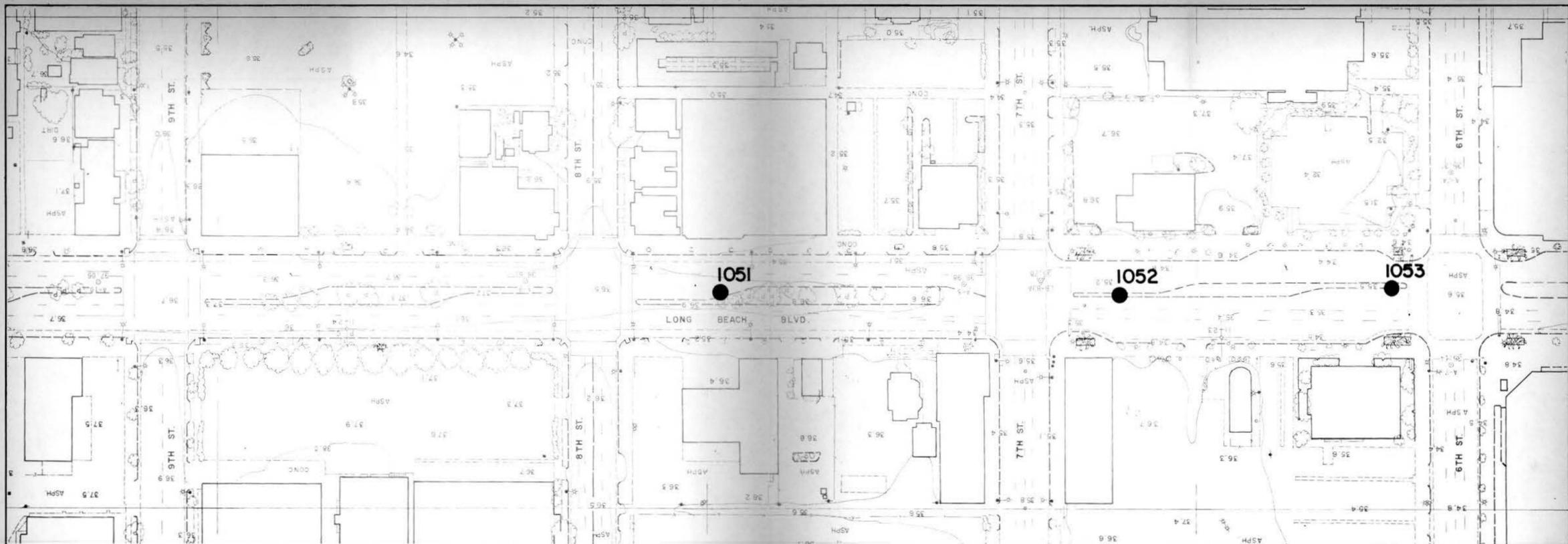
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BORING LOCATION PLAN

CONTRACT NO. TW 1005	
DRAWING NO.	
REV.	SHEET NO.
SCALE 1" = 100'	

FIGURE 2-18



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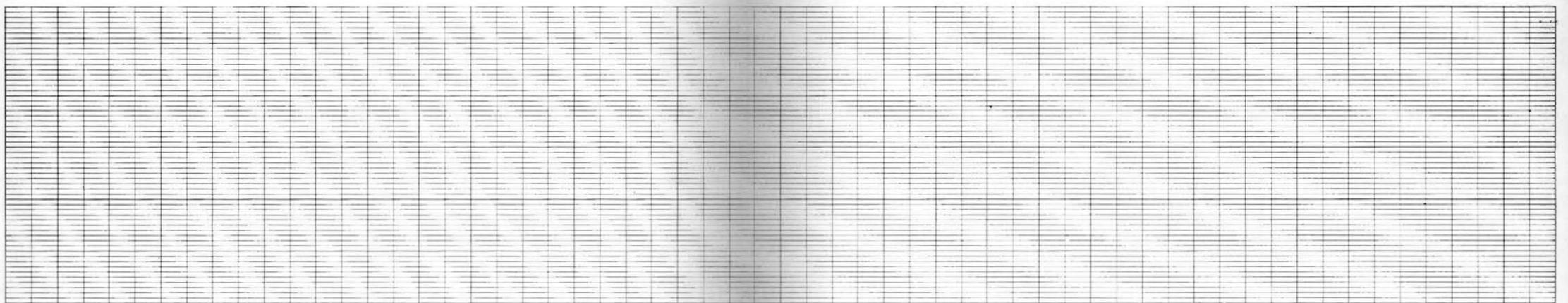
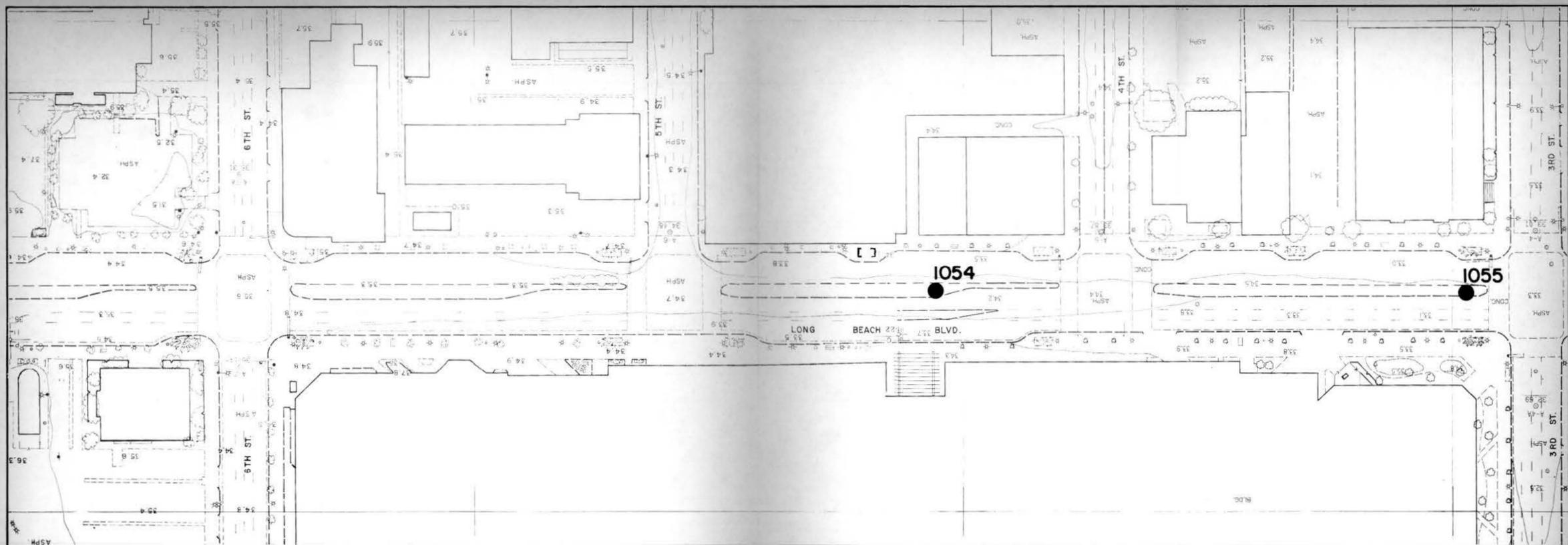
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 DRAWING NO.

REV. SHEET NO.

SCALE 1" = 100'

FIGURE 2-19



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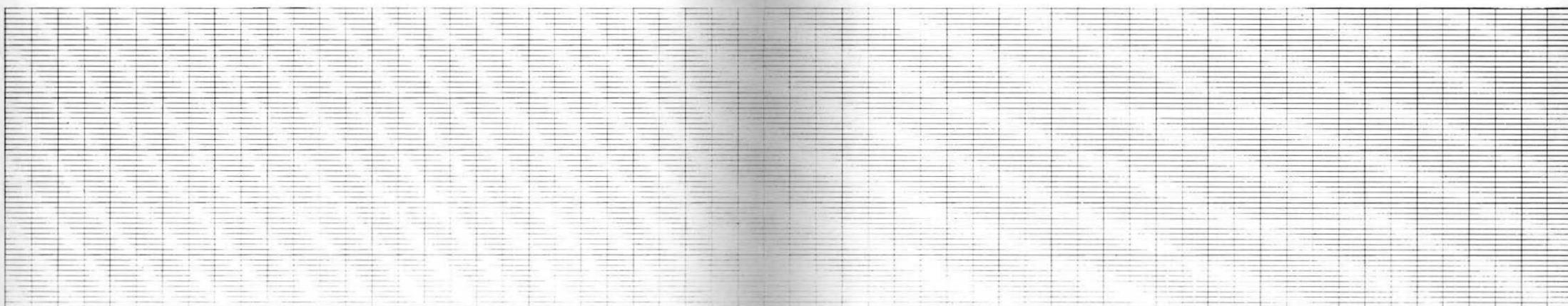
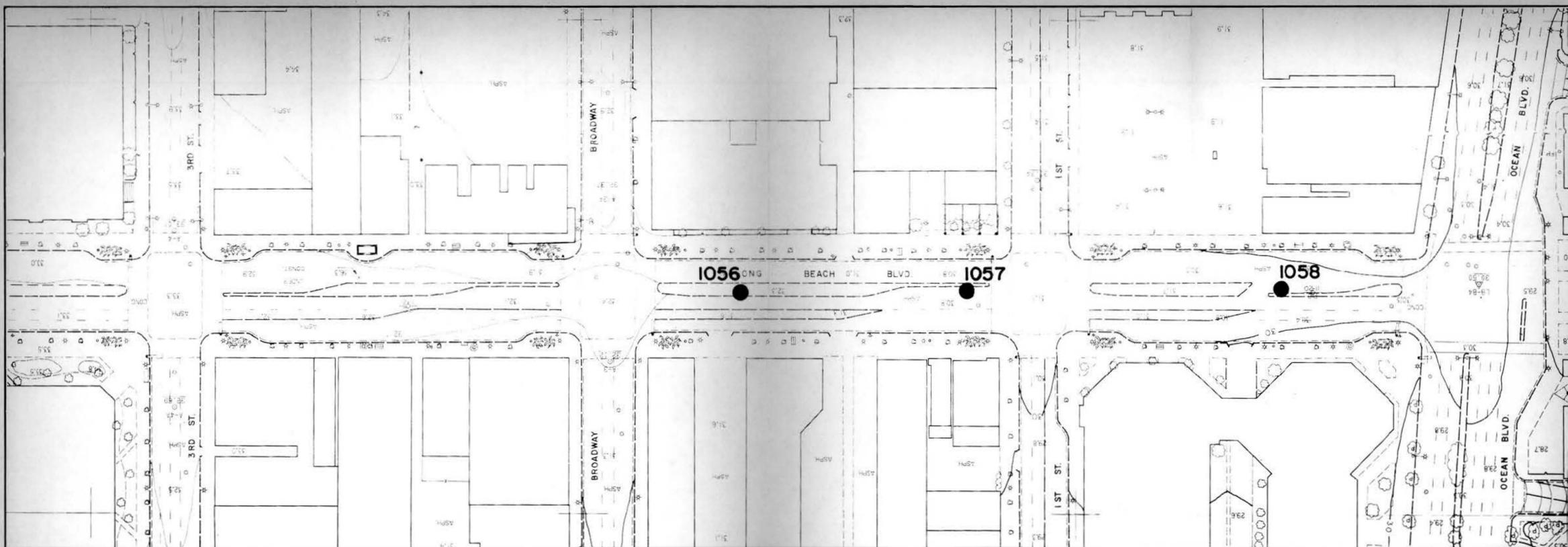
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BORING LOCATION PLAN**

CONTRACT NO. TW 1005
DRAWING NO.
REV. SHEET NO.
SCALE 1" = 100'

FIGURE 2-20



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REV.	DATE	DESCRIPTION	BY	APP.																						

FIGURE 2-21

Section 3.0
Field Explorations
Laboratory Testing

**SECTION 3.0:
FIELD EXPLORATION AND LABORATORY TESTING**

3.1 FIELD EXPLORATION PROGRAM

The field exploration program was performed in accordance with the scope of work described in the SCRC memorandum dated September 25, 1985, and our proposal dated October 2, 1985.

A detailed description of the drilling exploration program, boring logs, piezometer installations, ground water level monitoring, and downhole seismic surveys is presented in Appendices A through D.

3.1.1 Borings

A total of 60 borings were drilled at the locations shown on Figures 2-3 through 2-21. The locations and depths of borings were initially recommended by SCRC and were modified as necessary to avoid underground utilities and overhead power lines. The logs of the borings are presented in Appendix A.

The borings were drilled to depths of 10 to 61 feet, for a total of 1,529 lineal feet of drilling. The drilling was performed between October 14 and November 21, 1985. A summary of the boring locations and depths is presented in Table 3-1.

The soils encountered were logged by our field representatives, and both undisturbed and bulk samples were obtained for laboratory inspection and testing. Undisturbed samples were obtained with the Crandall sampler at depth intervals of about five feet and at major changes in soil stratigraphy. Standard penetration tests were performed in the rotary wash borings at depth intervals of approximately ten feet. Detailed descriptions of the field exploration procedures are presented in Appendix A.

3.1.2 Drilling Contractors and Equipment

The drilling was performed with rotary wash-type and bucket auger-type drilling equipment. The rotary wash borings were drilled by C & L Drilling Company who utilized a Mahew 1000 drilling rig operated by a two-man crew. Most of the auger borings were drilled by the C&L Drilling Company, who utilized a bucket-type rig operated by a two-man crew. A few auger borings were drilled by August Construction, who utilized a smaller bucket-type rig operated by a two-man crew.

Table 3-1
Summary of Borings

<u>Boring Number</u>	<u>Figure No.</u>	<u>Boring Depth (ft.)</u>	<u>Drilling Type</u>	<u>Remarks</u>
1000	2-3	36	Auger	Trackbed
1001	2-4	20	Auger	Trackbed
1001-A	2-4	28	Auger	Trackbed
1002	2-4	25	Auger	Trackbed
1003	2-5	20	Auger	Trackbed
1004	2-5	30	Auger	Trestle or Embankment
*1005	2-5	60	Rotary Wash	Culvert Drainage Channel
1006	2-5	20	Auger	Trackbed
1007	2-5	20	Auger	Culvert & Drainage Channel
1008	2-6	20	Auger	Trackbed
1009	2-6	20	Auger	Trackbed
1010	2-6	20	Auger	Trackbed
*1011	2-7	60	Rotary Wash	Possible Wardlow Station
1012	2-7	30	Auger	Possible Wardlow Station
1013	2-6	10	Auger	Park and Ride
1014	2-7	10	Auger	Park and Ride
1015	2-7	30	Auger	Planned Wardlow Station
*1016	2-7	60	Rotary Wash	Planned Wardlow Station
1017	2-7	10	Auger	Park and Ride
1018	2-7	11	Auger	Park and Ride
1019	2-8	20	Auger	Trackbed
1020	2-8	20	Auger	Trackbed
1021	2-9	20	Auger	Trackbed
1022	2-9	15	Auger	Trackbed
1023	2-9	15	Auger	Trackbed
1024	2-10	15	Auger	Trackbed and Depression

* 2" diameter PVC pipe installed.

Table 3-1
Summary of Borings
(continued)

<u>Boring Number</u>	<u>Figure No.</u>	<u>Boring Depth (ft.)</u>	<u>Drilling Type</u>	<u>Remarks</u>
1025	2-10	15	Auger	Trackbed
1026	2-10	30	Auger	Willow St. Station
*1027	2-11	61	Rotary Wash	Willow St. Station
1028	2-10	15	Auger	Park and Ride
1029	2-11	15	Auger	Park and Ride
1030	2-11	11	Auger	Park and Ride
1031	2-11	11	Auger	Park and Ride
1032	2-11	20	Rotary Wash	Trackbed
1033	2-11	15	Auger	Trackbed
1034	2-12	15	Auger	Trackbed
1035	2-12	15	Auger	Trackbed
1036	2-13	15	Auger	Trackbed
*1037	2-13	61	Rotary Wash	Hill St. Station
1038	2-13	30	Auger	Hill St. Station
1039	2-14	15	Auger	Trackbed
1040	2-14	15	Auger	Trackbed
1041	2-14	15	Auger	Trackbed
1042	2-15	30	Auger	PCH Station
*1043	2-15	61	Rotary Wash	PCH Station
1044	2-16	20	Auger	Trackbed
1045	2-16	15	Auger	Trackbed
1046	2-17	15	Auger	Trackbed
1047	2-17	30	Auger	Anaheim Station
*1048	2-17	61	Rotary Wash	Anaheim Station
1049	2-18	15	Auger	Trackbed
1050	2-18	15	Auger	Trackbed
1051	2-19	20	Auger	Trackbed
1052	2-19	30	Auger	7th St. Station
1053	2-19	60	Rotary Wash	7th St. Station
1054	2-20	15	Auger	Trackbed

* 2" diameter PVC pipe installed.

Table 3-1
Summary of Borings
(continued)

<u>Boring Number</u>	<u>Figure No.</u>	<u>Boring Depth (ft.)</u>	<u>Drilling Type</u>	<u>Remarks</u>
1055	2-20	15	Auger	Trackbed
1056	2-21	31	Auger	1st St. Station
*1057	2-21	61	Rotary Wash	1st St. Station
1058	2-21	16	Auger	Trackbed

* 2" diameter PVC pipe installed.

3.1.3 Soil Classification

The soils were classified using the Unified Soil Classification System. The field soil classifications were verified by visual inspection in the laboratory by staff engineers and further verified (as necessary) by laboratory tests.

3.2 **PIEZOMETER INSTALLATION**

After the completion of drilling Borings 1005, 1011, 1016, 1027, 1037, 1043, 1048, and 1057, a 2-inch-diameter PVC pipe was installed in each boring for future monitoring of the ground water level.

Detailed descriptions of the piezometer installations and observed water levels are presented in Appendix A.

3.3 **DOWNHOLE SEISMIC SURVEYS**

Downhole seismic surveys were performed at three locations (Borings 1005, 1027, and 1057) to determine the propagation velocities of the compression waves (P waves) and shear waves (S waves). The test procedures and results are presented in Appendix B.

3.4 LABORATORY TESTING PROGRAM

Each soil sample was first visually observed in the laboratory to verify the sample description and classification assigned by the field personnel. A laboratory testing program was then developed that would provide the soil parameters required in performing various engineering analyses. The testing program was submitted to SCRC for review prior to commencement of testing. The various tests performed include the following:

- o Moisture Content/Dry Density
- o Direct Shear
- o Consolidation
- o Compaction
- o Particle Size Distribution
- o Permeability

The test procedures and results are presented in Appendix C. The field moisture content and dry density of the undisturbed soil samples are shown to the left of the boring logs presented in Appendix A.

Section 4.0
Geology

SECTION 4.0: GEOLOGY

4.1 GENERAL

The proposed Long Beach Alignment is located in the south central part of the broad Los Angeles coastal plain. The coastal plain is drained by the Los Angeles River. The northern segment of the alignment, which is oriented in a northwest direction, overlies the basin boundary and crosses the trace of the Cherry Hill Fault. The northernmost portion is located in the Central Basin pressure area and the southern portion is located in the West Coast Basin (see Fault Map, Figure 4-1). The southern segment of the alignment, oriented parallel to the flow of the Los Angeles River, is located in the Long Beach Plain, a physiographic feature of the West Coast Basin.

The sedimentary materials which comprise the ground water basin attain a maximum thickness of approximately 1,400 feet along the Gardena Syncline near the Willow Street Station (DWR, 1961). The Quaternary sediments are underlain by Tertiary sedimentary rock; pre-Cretaceous granitic rocks, such as are found in the San Gabriel Mountains and Verdugo Mountains, and metamorphic rocks such as are exposed near the center of the Palos Verdes Hills.

4.2 GEOLOGIC MATERIALS

The uppermost natural soils along the alignment are typical of the Recent alluvium and Pleistocene terrace deposits that extend throughout most of the Los Angeles Coastal plain. The Recent alluvium is underlain by semi-consolidated Pleistocene age sediments, which comprise the major water bearing units. The Pleistocene age sediments are underlain by consolidated Tertiary and Cretaceous sedimentary rocks that extend to depths varying from about 10,000 feet near the south end of the alignment to about 20,000 feet near the north end of the alignment (U.S.G.S. Professional Paper 420-A).

4.2.1 Recent Alluvium

The Recent age alluvium generally consists of fine-grained flood plain deposits consisting of discontinuous sandy silt and clay beds with lenses of silty sand, sand, and gravel. The Recent alluvium varies in thickness along the proposed Long Beach Alignment, but is typically less than 200 feet thick. The surficial exposures of the Recent alluvium are shown on

Figure 4-2, Geologic Map. The depth and thickness of the Recent alluvium along the alignment is represented on Figures 4-3 and 4-4, Generalized Geologic Profile.

4.2.2 Pleistocene Deposits

Semi-consolidated Pleistocene flood plain, terrace, and deltaic sedimentary deposits underlie the Recent alluvium along the entire alignment, and locally attain a maximum thickness of some 1,100 feet in the vicinity of Wardlow Road and Long Beach Boulevard intersection. These deposits, comprised of the Lakewood and San Pedro Formations, consist of thick sequences of sands and gravels interbedded with finer grained sandy silts and clays. These materials were deposited in an elongated northwesterly trending basin, north of the Newport-Inglewood structural zone and include the major waterbearing units of the coastal plain.

4.2.3 Pliocene Series

The Pliocene series is represented by the Fernando Formation, Pico Formation, and the Repetto Formation. In addition, the Pico formation is subdivided into upper, middle, and lower members.

4.2.3.1 Pliocene Fernando Formation

As adapted by Lamar for the Los Angeles Basin (CDMG 1970), this formation underlies the alluvial and terrace deposits and outcrops on Bunker Hill in downtown Los Angeles. The Fernando Formation consists of massive siltstones, sandstones, and conglomerates. Rocks of the Fernando Formation beneath Bunker Hill consist primarily of massive grey siltstones. The Fernando Formation is not present, as such, in the Long Beach Alignment. It may be correlated with the upper marine part of the Pico Formation.

4.2.3.2 Pico Formation

The upper Pico Formation is generally composed of sand, silt, and clay of marine origin interbedded with marine gravels. Beds of gravels and sands range in thickness from 20 to 100 feet and are separated by beds of micaceous siltstone and clays. This member is generally considered to be poorly consolidated in a geologic sense.

Unconformably beneath this upper member are the middle and lower members of the Pico Formation. Lithologically, the middle and lower divisions are composed of greenish-grey micaceous siltstone and fine to coarse light grey feldspathic sandstone interbedded with claystone and shale.

4.2.3.3 Repetto Formation

The Repetto Formation of early Pliocene age is composed mostly of siltstone with layers of sandstone and conglomerate. If present beneath younger sediments, it represents the lower portion of the Pliocene age sediments.

4.2.4 Miocene Series

Sedimentary rocks of middle and late Miocene include the Monterey Formation in the Palos Verdes Hills, south of the alignment, the Modelo Formation in the Santa Monica Mountains north of the area, and in the Puente Formation, which underlies a substantial portion of the coastal plain, Repetto and Puente Hills. These formations consist primarily of consolidated clay shales, sandstones and conglomerates. The Miocene sequences locally attain thicknesses of up to 6,000 feet.

4.2.5 Jurassic System

The basement rocks underlying the Miocene sediments of the West Coast Basin include the Catalina Schist in the West Coast Basin; granitics, slates, and meta-volcanic rocks underlie the Central and East Coast portion of the basin. The northwest trending Newport-Inglewood Structural Zone separates these two bedrock complexes with the schist occurring on the southwest side.

4.3 **GEOLOGIC STRUCTURE**

The most significant geologic structures within the entire alignment are those associated with the Newport-Inglewood Structural Zone. This structural system extends in a northwesterly direction from Newport Mesa in Orange County to the Beverly Hills Area and is composed of an complex system of en echelon faults, anticlinal folds, and domes. Regional deformation along the Newport-Inglewood Fault Zone has resulted in the formation of local geologic features within the general area of the alignment which include, Dominguez Gap, the Long Beach Anticline, and the active Cherry Hill Fault. The Long Beach anticline located east of the alignment is a narrow, elongated, asymmetrical structure with northwesterly trend and is cut by several faults. One of the more important of these faults is the Cherry Hill Fault. The Cherry Hill Fault intersects the alignment immediately south of the shop and maintenance yards and parallels the alignment for approximately one mile. The trace of the fault extends across Dominguez Gap near the southerly end of the Mid-Corridor and disappears along the northeast flank of Dominguez Hill. The

fault extends along the southwest side of Signal Hill to the southeast. The fault trace south of Dominguez Hill apparently has not offset the Gaspar aquifer of Holocene age, and is therefore assumed to be greater than 11,000 years old.

The fault has created an effective barrier to ground water movement in the Pleistocene deposits at depth. It is included within the State Special Studies Zone for fault rupture hazard. The Cherry Hill Fault is one of the structural features currently undergoing re-review by the California Division of Mines and Geology for Alquist-Priolo classification purposes. This review may result in modification or removal of the hazard zone. Other structural features associated with the Newport-Inglewood Structural Zone are the Dominguez Anticline and Paramount Syncline, a northwest trending series of folds created by uplift associated with the faulting.

4.4 GROUND WATER

Most of the Long Beach Alignment is within the West Coast Basin as defined by the California Department of Water Resources. The northern portion of the alignment (north of the Cherry Hill Fault) lies within the Central Basin Pressure Area. Basin boundaries here are primarily controlled by the Newport-Inglewood Fault Zone of which the Cherry Hill Fault is a part.

Near the Cherry Hill Fault, the Recent alluvium is separated from the Upper Pleistocene aquifers by numerous clay aquitards. This area has been delineated as the Central Basin Pressure Area by the Department of Water Resources due to the confined nature of the Pleistocene aquifers. North of the Cherry Hill Fault, near Compton Creek, the aquifers of the Lakewood Formation are unconformably overlain by and in hydraulic continuity with the Gage Aquifer in the Holocene alluvium.

The water levels from wells that penetrate the Pleistocene aquifers indicate that the piezometric surface (static level of water in an aquifer) is typically 100 to 200 feet below ground surface in the Central Basin Pressure Area. While these levels do not represent the conditions in the Holocene Gaspar Aquifer, it is feasible that, due to improper well construction or multiple zone perforated intervals in wells, water levels from the deeper aquifers may actually approach water levels in the upper Holocene aquifer. Since no construction activities are anticipated at these depths, ground water from the Pleistocene aquifers should not pose a serious problem.

Hydraulic continuity of the aquifers of the Lakewood Formation has been disturbed by movement along the Cherry Hill Fault. The base of the Lakewood Formation, which corresponds to the Gage aquifer, has been displaced on the southwest side of the fault by younger sediments of low permeability.

Insufficient data are available to develop ground water contours representing the slope of the ground water surface in the Holocene aquifer. Our exploration borings along the proposed alignment indicate the presence of local perched ground water conditions in the upper Recent alluvium. Perched water conditions occur where isolated lenses or layers of coarser materials are underlain by impermeable or low permeability clays which restrict drainage at the base of the coarser materials.

Our recent borings suggest that current water levels are locally as shallow as 29 feet below ground surface with static water level expected to be on the order of 40 feet or more below present grade. However, some minor seepage may be encountered at shallower depths. For instance, water seepage was encountered between 23 and 25 feet below ground surface in Boring 1026.

4.5 GEOLOGIC HAZARDS

4.5.1 General

The geologic hazards along the Long Beach alignment are essentially limited to those caused by earthquakes. The major cause of damage from earthquakes is the result of violent shaking from earthquake waves; damage due to actual displacement or fault movement beneath a structure is much less frequent. No active faults are crossed by the Long Beach alignment and the hazard from fault rupture is not likely to be present. The violent shaking would occur not only immediately adjacent to the earthquake epicenter but within areas for many miles in all directions.

4.5.2 Faults

The numerous faults in Southern California include active, potentially active, and inactive faults. The criteria for these major groups, as established by the Association of Engineering Geologists (1973), are presented in Table 4-1. Table 4-2 presents a listing of active faults in Southern California with the anticipated magnitude of a maximum credible earthquake of each fault. Table 4-3 provides a similar listing for potentially active faults.

TABLE 4-1

CRITERIA FOR CLASSIFICATION OF FAULTS WITH
REGARD TO SEISMIC ACTIVITY

(From Association of Engineering Geologists,
Geology and Earthquake Hazards, 1973)

A. Active Faults: (See Table 4-2)

These faults are those which have shown historical activity since 1769. This category includes such faults as the San Andreas, San Jacinto, and Newport-Inglewood.

B. Potentially Active Faults: (See Table 4-3)

These faults are those, based on available data, along which no known historical ground surface ruptures or earthquakes have occurred. These faults, however, show strong indications of geologically recent activity. Potentially active faults can be placed in two subgroups that are based on the boldness or sharpness of their topographic features and the estimates related to recency of activity. These subgroups are:

1. Subgroup One - High Potential

- a. Offsets affecting the Holocene deposits (age less than 10 - 11,000 years).
- b. A ground water barrier or anomaly occurring along the fault within the Holocene deposits.
- c. Earthquake epicenters (generally from small earthquakes occurring close to the fault).
- d. Strong geomorphic expression of fault origin features (e.g. faceted spurs, offset ridges or stream valleys or similar features, especially where Holocene topography appears to have been modified).

2. Subgroup Two - Low Potential

This subgroup is the same as 1-a, b, or d above, with the exception that the indications of fault movement can be only determined in Pleistocene deposits (less than 1,000,000 years ago).

C. Inactive Faults:

These faults are without recognized Holocene or Pleistocene offset or activity.

TABLE 4-2

MAJOR NAMED FAULTS CONSIDERED TO BE ACTIVE (a)

IN SOUTHERN CALIFORNIA

Fault (in alphabetical order)	Date of Latest Major Activity	Maximum Credible Earthquake	Known Fault Length (e) (Miles)
Big Pine	1852	7.5 (b)	47
Coyote Creek	1968	7.2 (c)	50
Elsinore	1910	7.5 (b)	120
Garlock	(d)	7.75 (b)	170
Malibu Coast	1973	7.0 (c)	30
Manix	1947	6.25 (b)	15
More Ranch	(d)	7.5 (b)	34
Newport-Inglewood	1933	6.5 (f)	25
San Andreas Zone	1857	8.25 (b)	200+
San Ferrando Zone	1971	6.5 (b)	8
San Jacinto Zone	1968	7.5 (b)	112
Superstition Hills	1951	7.0 (b)	22
White Wolf	1952	7.75 (b)	60
Whittier	1929 (?)	7.1 (c)	30

(a) Historic movement (1769 - present).

(b) Greensfelder, C.D.M.G. Map Sheet 23, 1974.

(c) Mark (1977) Length-Magnitude relationship.

(d) Intermittent creep.

(e) Based on Division of Mines & Geology, Preliminary Report 13, 1973.

(f) Raymond Kaiser Engineers, Inc., Report of Subtask 9.6, March 1985.

TABLE 4-3

MAJOR NAMED FAULTS CONSIDERED TO BE POTENTIALLY ACTIVE (a)
IN SOUTHERN CALIFORNIA

Fault (in alphabetical order)	Maximum Credible Earthquake	Fault Length (d) (Miles)
Calico-Newberry	7.25 (b)	60
Charnock	6.6 (c)	13
*Chino	6.7 (c)	18
Cucamonga	6.5 (b)	20
*Duarte	6.3 (c)	10
Helendale	7.5 (b)	60
Northridge Hills	6.5 (b)	12
Norwalk	6.4 (c)	20
Oakridge	7.5 (b)	35
*Overland	6.2 (c)	6
Ozena	7.3 (c)	
Palos Verdes	7.0 (b)	30
Pinto Mountain	7.5 (b)	42
Raymond	6.6 (c)	15
San Cayetano	6.75 (c)	
*San Gabriel	7.5 (c)	80
*San Jose	6.5 (c)	17
Santa Cruz Island	7.2 (c)	50
Santa Monica-Hollywood	6.8 (c)	17
Santa Susana	6.5 (b)	10
Santa Ynez	7.5 (b)	100
Sierra Madre	7.5 (b)	55
Sierra Nevada	8.25 (b)	118
*Verdugo	6.8 (c)	12

(a) Pleistocene deposits disrupted.

(b) Greensfelder, C.D.M.G. Map Sheet 23, 1974.

(c) Mark (1977) Length-Magnitude relationship.

(e) Based on Division of Mines & Geology, Preliminary Report 13, 1973.

* Low Potential per A.E.G. definition.

4.5.2.1 San Andreas Fault

The San Andreas Fault is the best known and most significant fault in California. The San Andreas Fault is located on the north side of the San Gabriel Mountains. This fault is about 44 miles north-northeast of the Long Beach alignment at the nearest point on the fault, and is considered capable of producing an earthquake of magnitude 8 or greater in the Southern California region.

4.5.2.2 Newport-Inglewood System

Descriptions of subsurface displacements on faults presumably related to the Newport-Inglewood Zone are relatively commonplace in the literature. Graves (1954) indicates that several faults called "A", "B", "X", "W-1", "W-2", and "WC-2" have been identified in the Dominguez Oil Field located west of the Mid Corridor between Stations 700+00 and 800+00. These faults are low angle and may not reach ground surface due to their curved shape. Faults "W-1" and "W-2" are of interest in that several oil well casings penetrating these faults ruptured at depths between 4,000 and 7,000 feet below sea level on October 21, 1941, Castle (1969). No surface rupture was associated with this subsurface movement. This event has been called the Gardena earthquake, magnitude 4.9.

The Torrance-Gardena earthquake of November 14, 1951, had a magnitude of 5.4 on the Richter Scale. No surface ruptures were reported; however, there were numerous incidents of broken water mains and pipes. The movement occurred on an unknown fault at depth. "Pipelines appeared to be pulled loose in a north-south direction in Lomita, San Pedro and Wilmington" (Department of Water Resources Bulletin 116-3, 1967).

4.5.2.3 Cherry Hill Fault

The Cherry Hill Fault has apparently not offset Holocene deposits, and is therefore more than 11,000 years old. The fault has created an effective barrier to ground water movement in lower Pleistocene deposits. It crosses the north end of the Long Beach Alignment.

4.5.2.4 Los Alamitos Fault

The Los Alamitos Fault is a minor feature in the crystalline bedrock surface and extends upward into the lower portion of the Pleistocene deposits. The fault trends northwest-southeast and is the southeastward extension of the Paramount syncline. This fault is considered to be inactive.

4.5.3 Seismicity

The epicenters of the major recorded earthquakes in Southern California are shown on Figure 4-5, Major Recorded Earthquakes. The epicenter of the March 11, 1933, Long Beach earthquake, magnitude 6.3, was located approximately 17 miles southeast of the south end of the Long Beach alignment. This earthquake, although of only moderate magnitude, ranks as one of the major disasters in Southern California. The majority of the damage was suffered by structures which are now considered substandard construction and/or were located on filled or saturated ground.

The recurrence curve shown on Figure 4-6 indicates the seismicity of the Long Beach segment. The recurrence curve was developed based on the seismicity of the area which was determined from a computer search of a magnetic tape catalog of earthquakes. The catalog of earthquakes included those with a Richter magnitude greater than 4 compiled by the California Institute of Technology for the period 1932 to 1981, and those larger earthquakes for the period 1812 to 1931 compiled by Richter and the U. S. National Oceanic and Atmospheric Administration (NOAA).

The computer printout of the seismicity search of the Long Beach alignment is presented in Appendix D. The information listed for each earthquake found in the computer printout includes date and time in Greenwich Civil Time (GCT), location of the epicenter in latitude and longitude, quality of the epicentral determination (Q), depth in kilometers, and magnitude. Where a depth of 0.0 is given, the solution was based on an assumed 16-kilometer focal depth.

The recurrence curve was developed on the basis of the seismicity of any area having a radius of 100 kilometers. The application of the Poisson probability law to the resulting recurrence curve, as shown on Figure 4-7, Estimated Probability of Earthquake Occurrence, provides an estimate of the probability of earthquake activity that may affect the Long Beach segment.

4.5.4 Subsidence

The Long Beach alignment is located within an area of known subsidence, believed to be related to withdrawal of oil from relatively shallow producing zones of the Long Beach and Wilmington oil fields. The main area of subsidence, located on Terminal Island, has experienced a maximum total subsidence since the early 1930's of approximately 29 feet; the rate has been greatly retarded by repressurization of these zones with sea water injection. Recent reports by the City of Long Beach,

Department of Oil Properties on "Elevation Changes in the City of Long Beach" (May, 1983 - November, 1983) show rebound occurring in the area of the Long Beach alignment south of Pacific Coast Highway (PCH). Total rebound to November, 1983 is from +0.4 feet at PCH to +0.7 feet at Ocean Boulevard. As long as current efforts for subsidence control continue, no significant problems due to future subsidence along the Long Beach alignment are anticipated.

4.5.5 Liquefaction

The evaluation of the liquefaction potential of the soils along the alignment involved the estimation of the potential loss of shear strength of the saturated cohesionless soils during earthquakes that may affect the project. The significant factors that may affect liquefaction include the soil type, particle size, gradation, water level, relative density, stress history, confining pressure, intensity of shaking, and duration of shaking. Studies indicate that the liquefaction potential is the greatest where the ground water level is shallow and loose fine sands occur within a depth of 40 to 50 feet. The liquefaction potential increases as the ground acceleration and duration of shaking increase.

The City of Long Beach, Seismic Safety Element (May, 1975) indicates potential for liquefaction is small in the area of the Long Beach alignment south of Hill Street. From Hill Street to 27th Street in the area underlain by alluvium, potential for liquefaction is indicated as significant. Also, from Spring Street to 33rd Street, and in the north end (L.A. River crossing area) the potential for liquefaction is indicated as significant in the seismic safety element.

Our analysis of the boring logs indicates that the potential for soil liquefaction producing significant effects on the proposed Long Beach Alignment to be very low. Within the portions indicated as having significant potential for liquefaction defined by the Seismic Safety Element, the depth to ground water is not very shallow and the soils beneath the water are generally dense.

4.5.6 Slope Stability

The existing railroad embankment along the northerly portion of the alignment may be subjected to slumping during severe earthquake ground shaking. The remainder of the proposed alignment is located on relatively flat ground with typical gradients less than 1% (1 foot per 100 feet). No landslide stability problems are documented along the proposed alignment, and the potential for landslides along the alignment is considered negligible.

4.5.7 Tsunamis, Seiches, and Flooding

The proposed Long Beach alignment ranges in elevation from approximately 20 feet above sea level between Burnett Street and Willow Street, to approximately 75 feet above sea level near the San Diego Freeway crossing. At its closest point, the Long Beach alignment is within a few blocks north of the Pacific Ocean. The closest portions of the alignment are about 30 feet above sea level. The U. S. Army Engineers Waterways Experiment Station (May, 1974) indicates tsunami (sea waves generated by earthquakes) runup potential is less than 10 feet in elevation for a 500 year event.

With the exception of the spreading pond, the Long Beach alignment is not within a flood hazard area as designated by the Federal Emergency Management Agency. It should be noted that the Corps of Engineers are currently performing studies that evaluate Los Angeles County Flood Control Facilities to determine if their capacities for a capital storm are in fact sufficient to contain a 100-year flood.

4.5.8 Oil and Gas Fields

The northern half of the Long Beach segment is located in the Long Beach Oil Field in the area westerly of Signal Hill as shown on Figure 4-2. The southern quarter of the alignment traverses the Wilmington Oil Field. Locally, the oil fields may impact the construction of this segment of the line if oil wells or abandoned lines are encountered in the alignment. We have not identified specific locations, if any, where this will be a problem.

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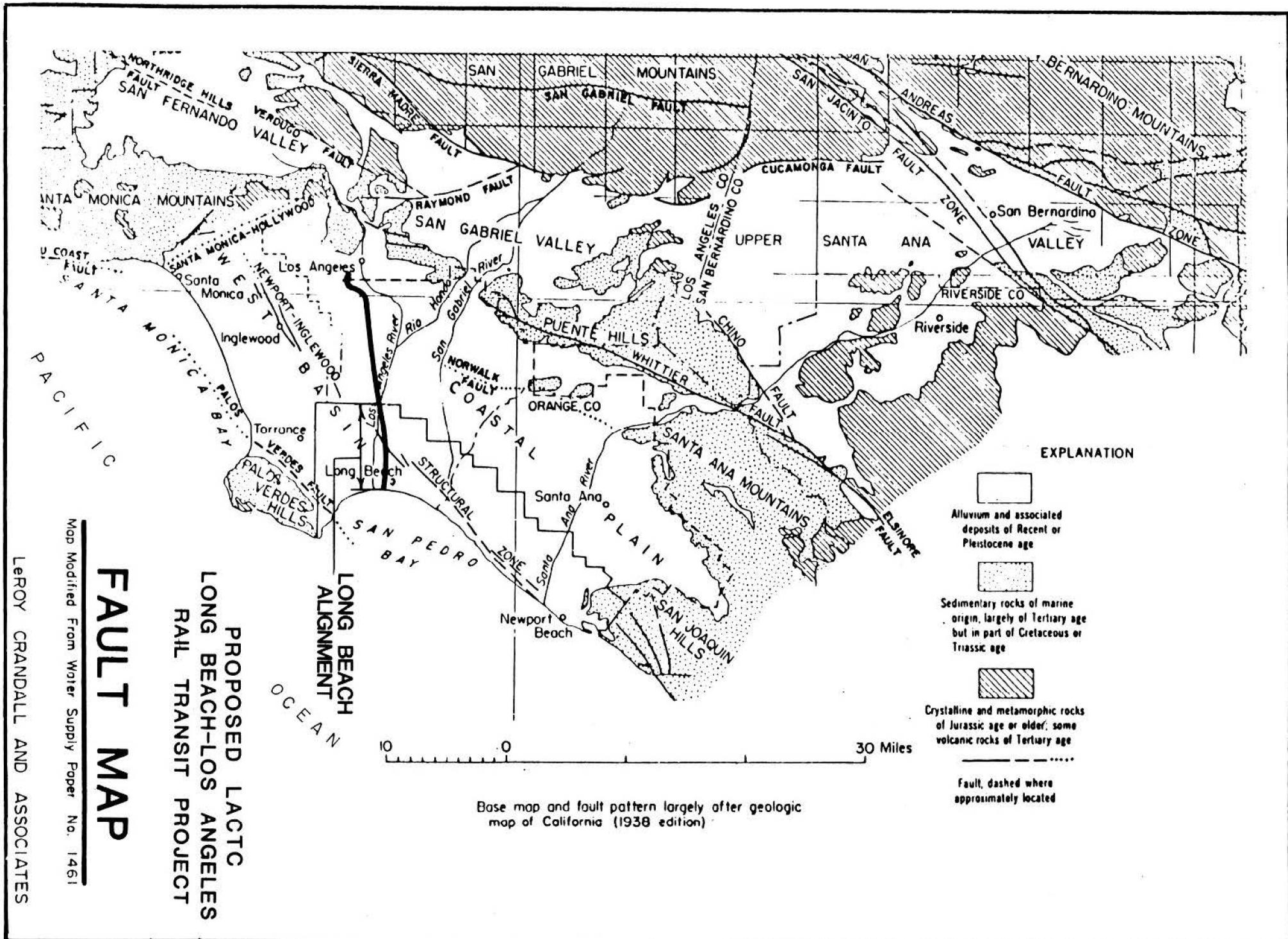
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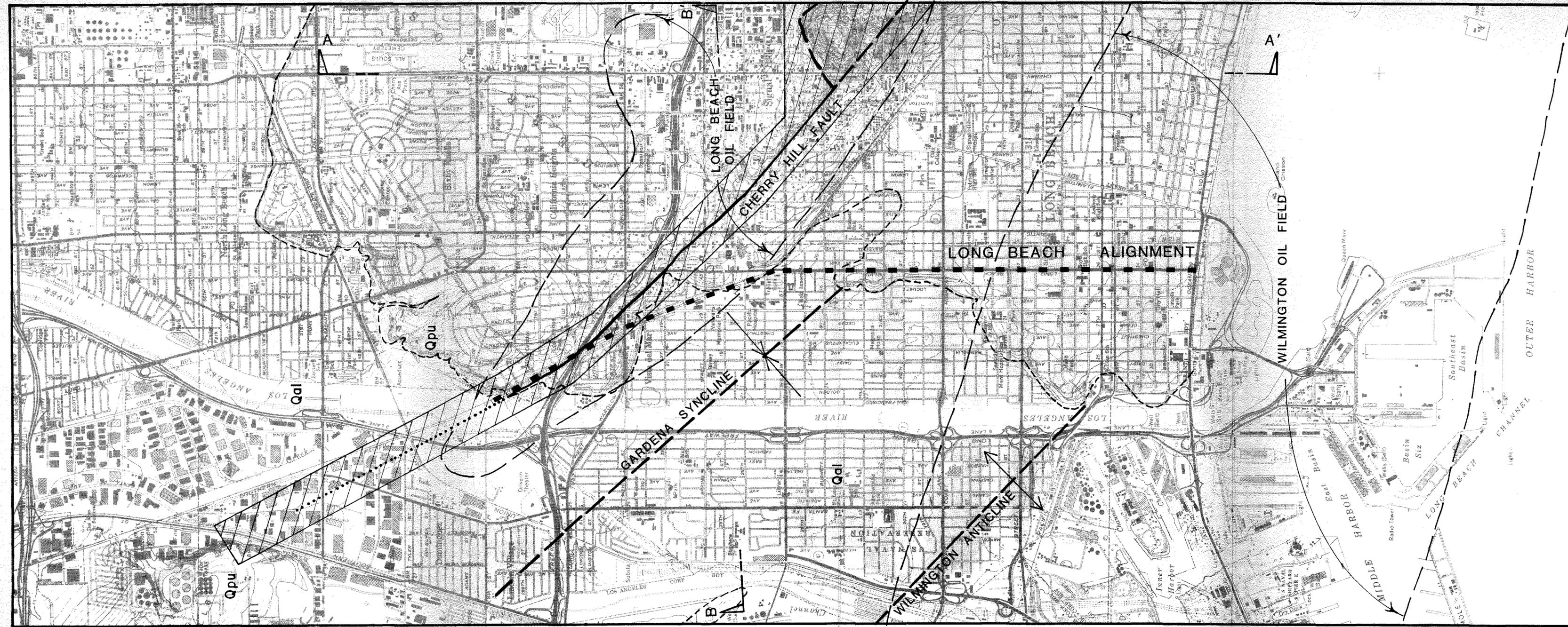
**PROPOSED LACTC
LONG BEACH-LOS ANGELES
RAIL TRANSIT PROJECT**

**LONG BEACH
ALIGNMENT**

FAULT MAP

Map Modified From Water Supply Paper No. 1461

LEROY CRANDALL AND ASSOCIATES



EXPLANATION

- PROPOSED LACTC LONG BEACH ALIGNMENT
- ▨ ALQUIST-PRIOLO SPECIAL STUDIES ZONE, CHERRY HILL FAULT; Dashed where approximate, dotted where concealed
- A A' LOCATION OF GEOLOGIC SECTION
- GEOLOGIC CONTACT LINE

- Qal RECENT ALLUVIUM
- Qpu PLEISTOCENE TERRACE
- OIL AND GAS PRODUCTIONS LIMITS

REFERENCE

BASE MAP FROM U.S.G.S. 7.5' LONG BEACH QUADRANGLE 1964, PHOTOREVISED 1981. GEOLOGY ADAPTED FROM D.W.R. BULLETIN 104, 1961.

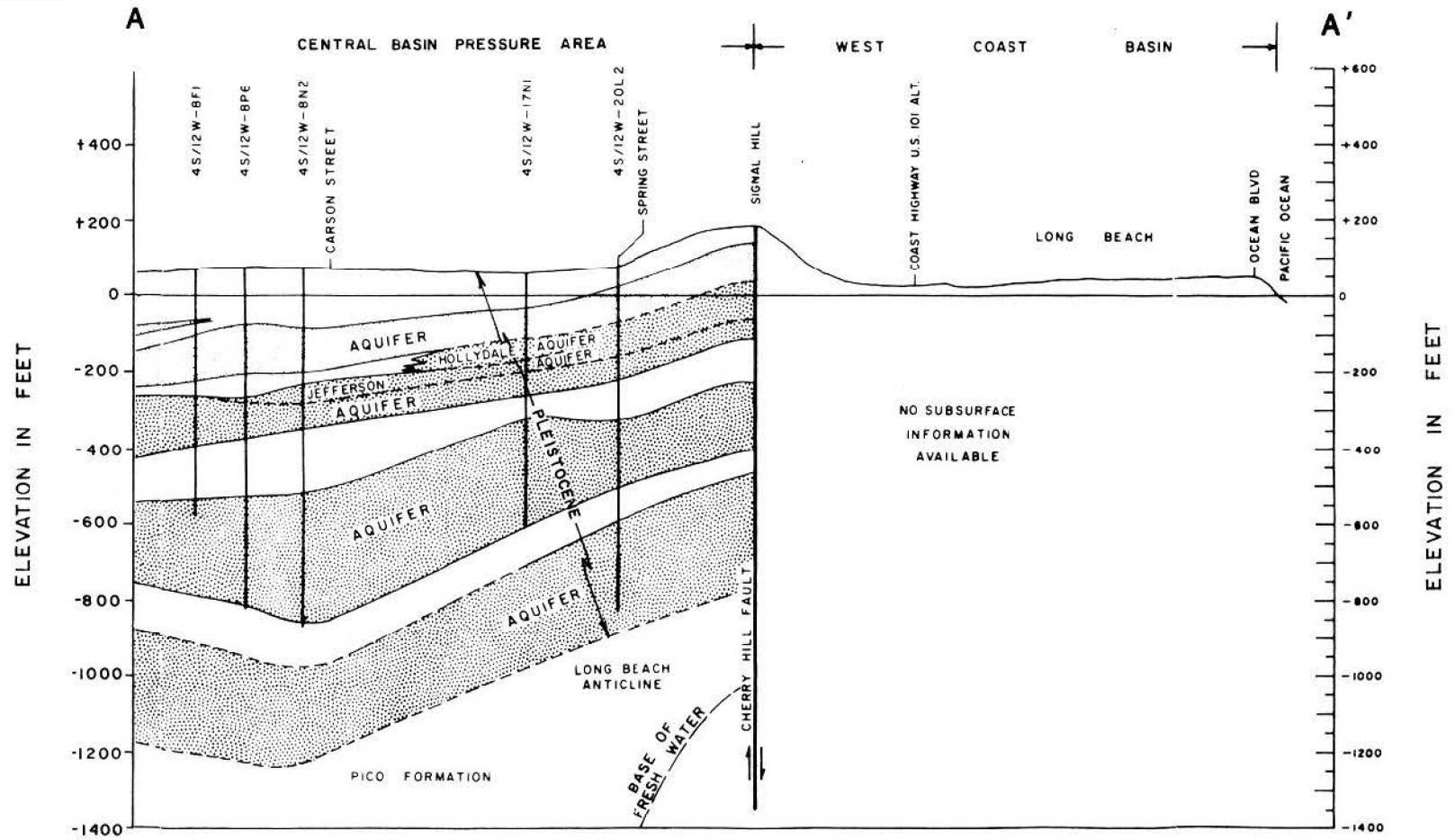
OIL FIELD REFERENCE

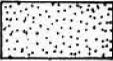
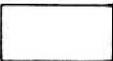
DOG REGIONAL WILDCAT MAP, 1975

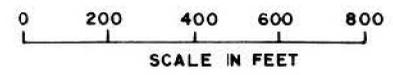


GEOLOGIC MAP

SCALE 1" = 2000'



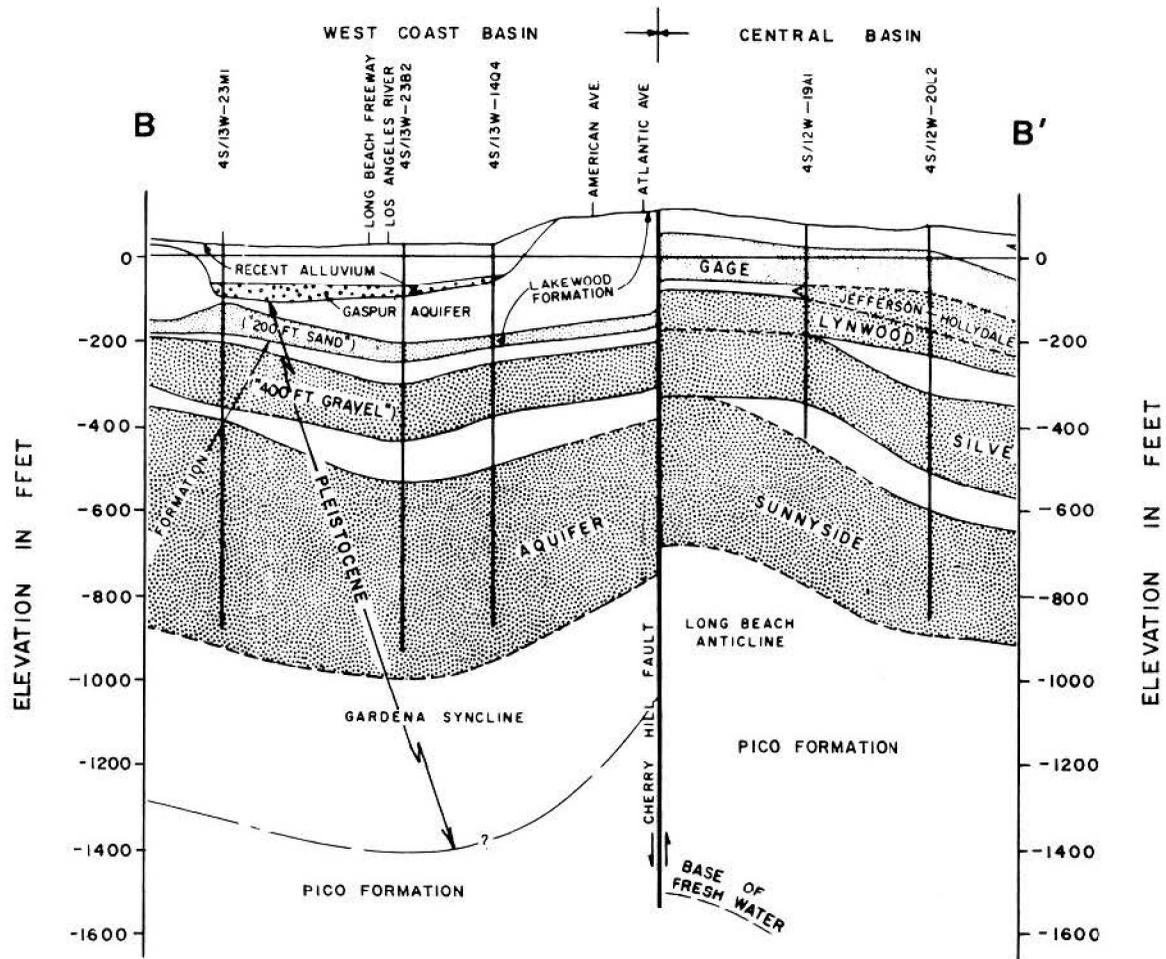
-  **AQUIFERS** - SANDS AND GRAVELS WITH SOME SILTS AND CLAYS
MODERATE TO HIGH PERMEABILITY
-  **AQUICLUDES** - GENERAL SILTS AND CLAYS
LOW PERMEABILITY
-  **FAULT** - SHOWING RELATIVE MOVEMENT

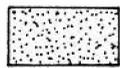
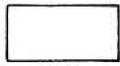


- NOTE:
1. SEE FIGURE 4-2 FOR LOCATION OF PROFILE.
 2. PROFILE MODIFIED FROM DWR BULLETIN, 104A

GENERALIZED GEOLOGIC PROFILE A-A'

LERROY GRANDALL AND ASSOCIATES
FIGURE 4-3

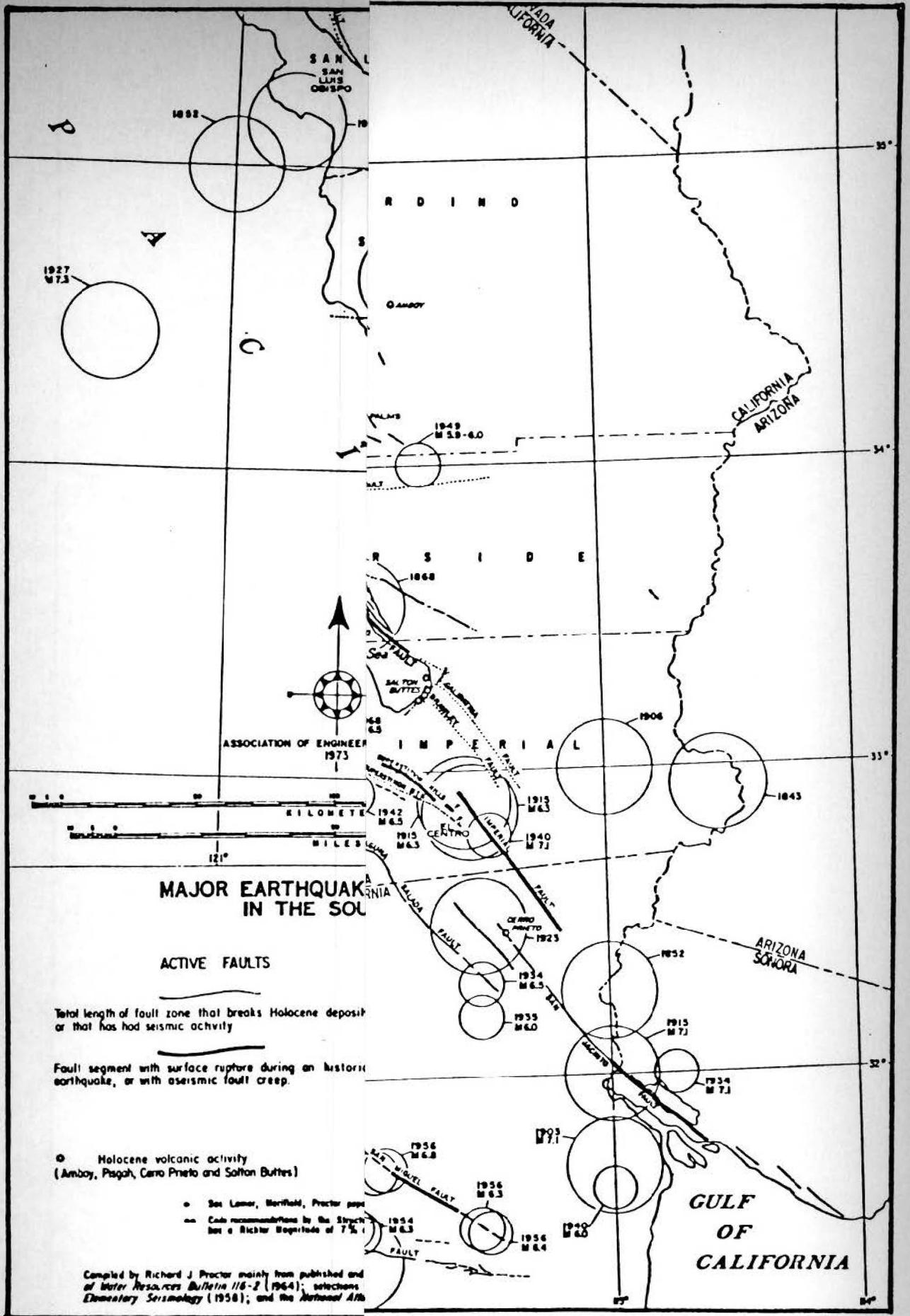


-  AQUIFERS - SANDS AND GRAVELS WITH SOME SILTS AND CLAYS MODERATE TO HIGH PERMEABILITY
-  AQUICLUDES - GENERALLY SILTS AND CLAYS LOW PERMEABILITY
-  FAULT - SHOWING RELATIVE MOVEMENT

- NOTE: 1. SEE FIGURE 4-2 FOR LOCATION OF PROFILE.
 2. PROFILE MODIFIED FROM DWR-61.

GENERALIZED GEOLOGIC PROFILE B-B'

JOB ADE-85005-10 DATE 8/11/85 DR. D.E. CHKD.

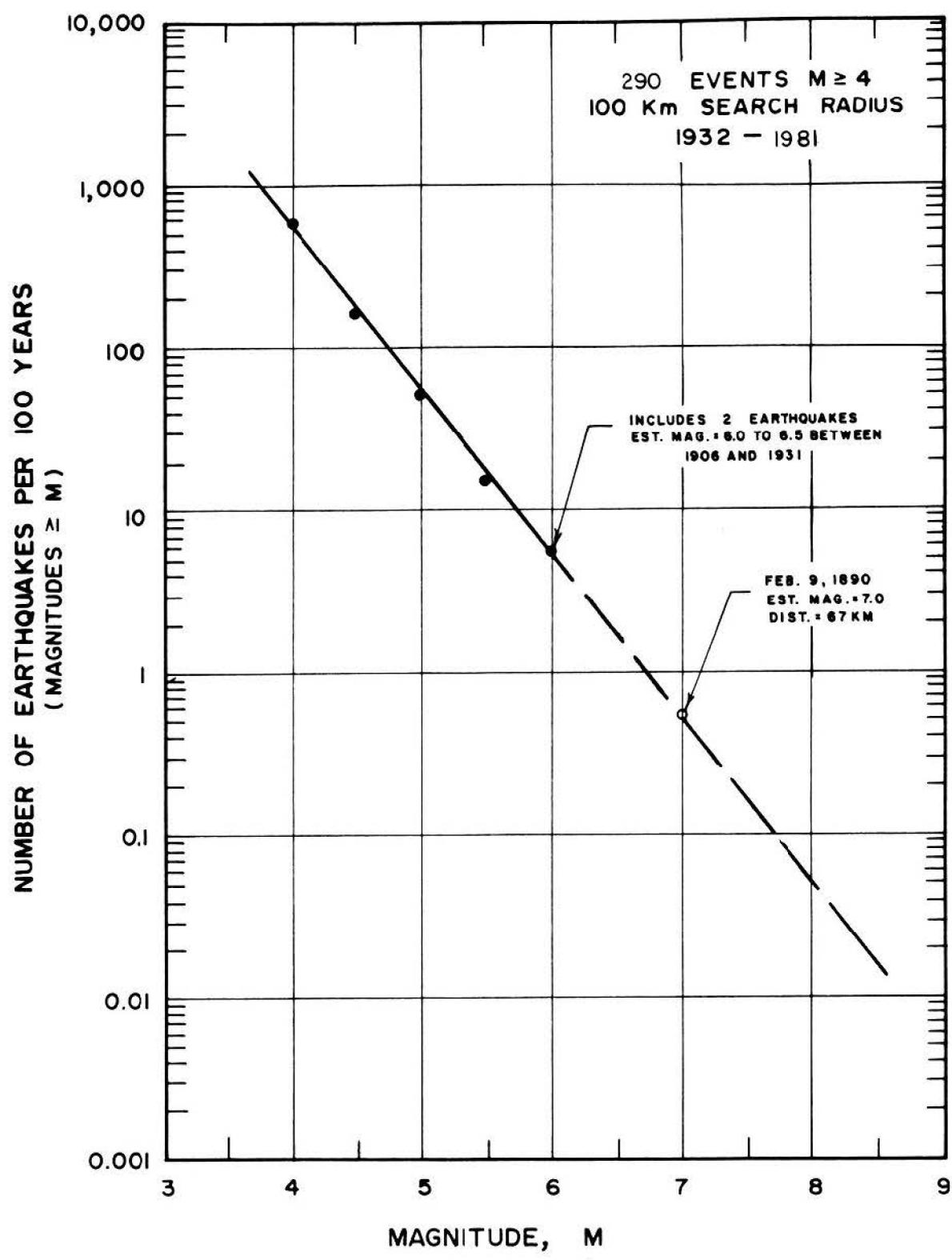


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 CONSULTING GEOTECHNICAL ENGINEERS
 LOS ANGELES, CALIFORNIA

SCALE: 1" = 30 miles

FIGURE 4-5

JOB ADE-85005-10 DATE 11/27/85 DR. JOHN O.E. W.P. CHKD



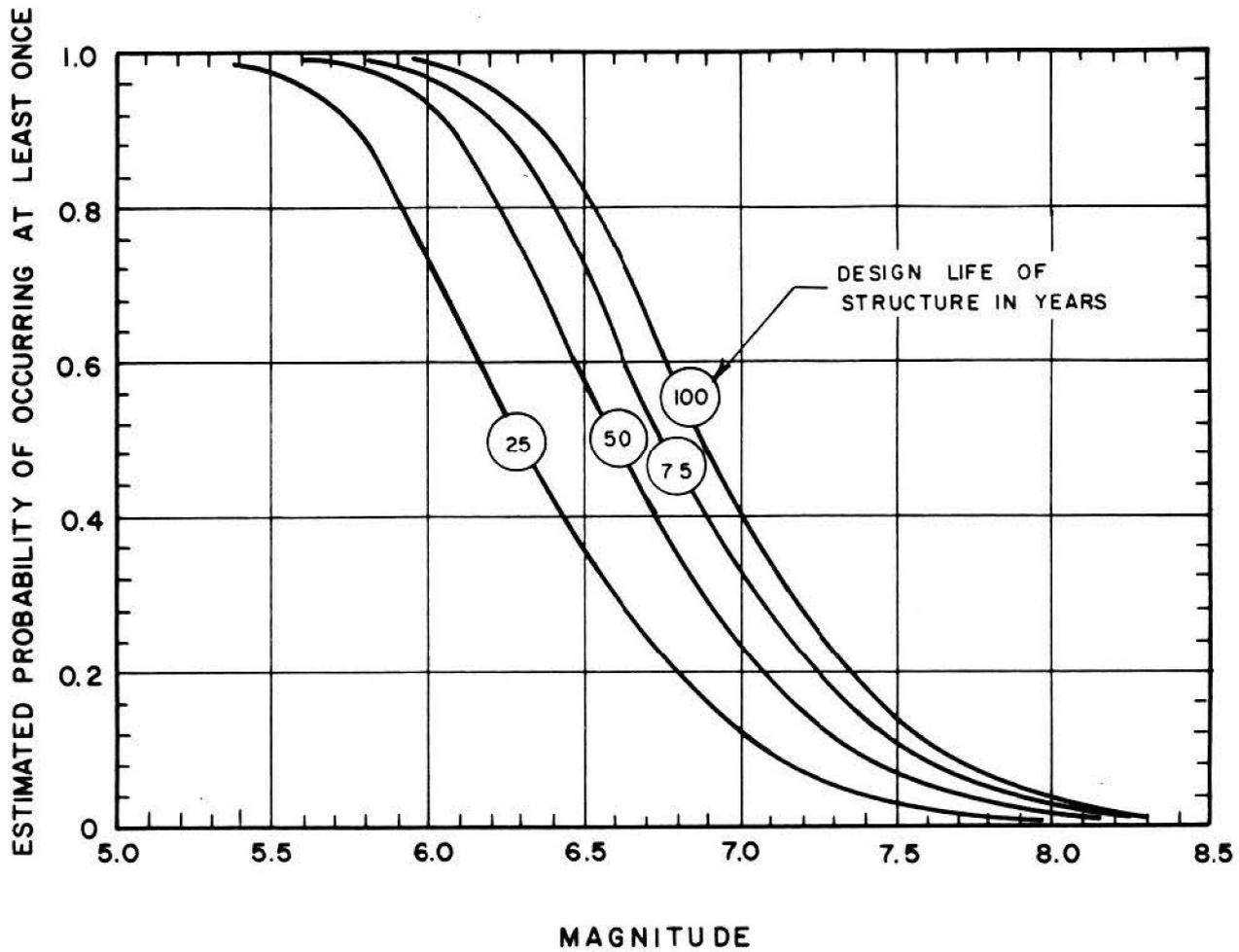
RECURRENCE CURVE

LONG BEACH

○ REPRESENTS SINGLE EVENT, AND THEREFORE HAS BEEN DISCOUNTED IN PREDICTION.

LeROY CRANDALL AND ASSOCIATES

JOB ADE-85005-10 DATE 11/27/85 DR. JOHN O.E. DM W.P. CHKD. *me*



ESTIMATED PROBABILITY
OF EARTHQUAKE OCCURRENCE
LONG BEACH

LeROY CRANDALL AND ASSOCIATES

Section 5.0
At-Grade Trackbed
And Stations

**SECTION 5.0:
AT-GRADE TRACKBED AND STATIONS**

5.1 PROPOSED CONSTRUCTION

The proposed Long Beach Alignment will begin just south of the Los Angeles River Crossing and extends southerly along the SPTC right-of-way to just south of 27th Street, at which point the alignment extends southerly along the median of Long Beach Boulevard to Ocean Boulevard. The proposed alignment, which will be at grade, is approximately 4-1/2 miles in length. As indicated on Figure 2-2, the trackbed for most of the Long Beach Alignment will be at grade or slightly raised on a berm.

A total of seven passenger stations are presently planned along the alignment at the following locations:

Wardlow Road	Anaheim Street
Willow Street	5th/6th Street
Hill Street	1st Street
Pacific Coast Highway	

The station platforms are typically 210 feet long to accommodate two 90-foot-long cars plus an additional 30 feet for queuing and future fare collection area. High-level platforms, which are at the same level as the light rail vehicle floor (39 inches above the top of rail), will be used at all station locations. The at-grade stations will have center platforms, where passengers will wait for trains arriving from either direction.

Two park-and-ride areas are planned at the Wardlow Road and Willow Street Stations.

A pedestrian underpass is planned just south of the Los Angeles River Bridge. The underpass will consist of a reinforced box section, having dimensions of 10 feet high, 10 feet wide and 80 feet long.

5.2 SITE CONDITIONS

The segment along the SPTC right-of-way from the Los Angeles River Crossing to Boring 1002 is an existing SPTC railroad embankment. The maximum difference in elevation between the top of the embankment and adjacent existing ground surface is approximately 40 feet. Fill soils to a depth of 34-1/2 feet were encountered in the area.

The site conditions along the at-grade track bed and at the proposed station locations are generally all similar south of Boring 1002 along the SPTC right-of-way to just south of 27th Street. Ballast generally covers the surface. Some underground utility lines are located within or in close proximity to the existing right-of-way. At 27th Street the alignment extends southerly along the median of Long Beach Boulevard to Ocean Boulevard. Along this segment, the alignment is generally paved and adjacent to commercial property. Underground utility lines are located within or close proximity to the existing alignment.

5.3 SUBSURFACE CONDITIONS

5.3.1 Geologic Materials

For the at-grade trackbed and stations along the Long Beach Alignment, the geologic materials within the upper 20 feet or so will have the greatest effect on the proposed construction. The materials within this limited depth comprise of recent alluvial deposits and Pleistocene terrace deposits.

5.3.2 Soil Conditions

5.3.2.1 Borings 1000 through 1002

Fill soils were encountered in the borings to depths of 34-1/2 to 5-1/2 feet. The fill soils consist primarily of silty sand and silt with lesser amounts of sand and clay. The fill soils are moderately dense. The underlying natural soils consist of sand, silty sand, and silt. The natural soils are moderately dense. The average relative compaction of the soils within the upper five feet at the subject boring locations is about 83 percent.

5.3.2.2 Borings 1003 through 1018

Ballast was encountered in three of the borings to depths of 1-1/2 feet. Fill was encountered in some of the borings to depths of 2 to 6 feet. The fills consist of sand, silty sand, clayey sand, silt, and gravel. The underlying natural soils consist primarily of clayey sand, silty sand, and silt with lesser amounts of sand and clay. The natural soils range from moderately firm to firm. The average relative compaction of the soils within the upper five feet at the subject boring locations is about 88 percent.

5.3.2.3 Borings 1019 through 1022

Ballast was encountered in three of the borings to depths of 1-1/2 feet. Fill was encountered in all the borings to depths of 4-1/2 to 9-1/2 feet. The fill soils consist of silt, silty sand, and clayey sand. The fill soils are moderately firm. The underlying natural soils consist of clayey sand, silty sand, sand, silt, and clay. The natural soils range from moderately soft to moderately firm in the borings. The average relative compaction of the soils within the upper five feet at the subject boring locations is about 87 percent.

5.3.2.4 Borings 1023 through 1032

Fill soils were encountered in all the borings, ranging from 1 to 9-1/2 feet in depth. The fill soils consist of sand, silty sand, silt, and clay. The fill soils range from moderately soft to moderately firm. The underlying natural soils consist of sand, silty sand, clayey sand, silt, and clay. The natural soils are generally moderately firm to firm, except some moderately soft clays in Borings 1028 and 1029. The average relative compaction of the soils within the upper five feet at the subject boring locations is about 88 percent.

5.3.2.5 Borings 1033 through 1044

Fill soils were encountered in some of the borings to depths of 2 to 8 feet. The fill soils consist of silty sand, silt, and clay. The fill soils are moderately soft to moderately firm. The underlying natural soils consist primarily of silt, silty sand, and sand with lesser amounts of clayey sand and clay. The natural soils are generally firm. The average relative compaction of the soils within the upper five feet at the subject boring locations is about 90 percent.

5.3.2.6 Borings 1045 through 1058

Fill soils were encountered in some of the borings to depths of 3 to 6 feet. The fill soils consist of silty sand, silt, and clay. At the boring locations, the fill soils are generally firm, but weaker soils may exist between borings. The underlying natural soils consist primarily of silt, silty sand, and sand with less amounts of clayey sand and clay. The natural soils are firm. The average relative compaction of the soils within the upper five feet at the subject boring locations is about 93 percent.

5.4 SEISMICITY

The seismicity discussed in Section 4.5.3 is applicable to the Long Beach alignment.

5.5 ENGINEERING EVALUATION AND DESIGN CRITERIA

5.5.1 At-Grade Trackbed

5.5.1.1 Soil Properties for Static Design

The soil properties presented in Table 5-1 are for soils encountered within the upper five feet at the boring locations at their in-situ condition, and also for the same soils compacted to 90 and 95 percent of maximum dry density obtainable.

Table 5-1
Summary of Average Soil Properties for Calculation of
Allowable Bearing Value of Subgrade Soils

<u>In-Situ Samples From Borings</u>	<u>Ø (deg.)</u>	<u>C (psf)</u>	<u>Moist Unit Weight (pcf)</u>	<u>Average Moisture Content (%)</u>
1000 thru 1002	25	300	115	16
1003 thru 1018	23	400	110	13
1019 thru 1022	25	300	115	15
1023 thru 1032	30	250	115	15
1033 thru 1044	30	350	115	13
1045 thru 1058	28	700	120	13
<u>Remolded Samples</u>				
<u>Clayey Sand</u>				
*90% Compaction	31	250	130	15
*95% Compaction	41	350	136	13
<u>Silty Sand</u>				
*90% Compaction	34	170	122	19
*95% Compaction	39	200	129	18
<u>Sandy Silt</u>				
*90% Compaction	29	250	129	16
*95% Compaction	30	550	135	15

* Percent compaction based on ASTM D1557-78 method of compaction.
Samples tested at increased moisture contents.

5.5.1.2 Design Criteria

o Track Support Options: Existing fill soils were encountered along the Long Beach Alignment to depths varying up to some nine feet, except along the embankment in the northern portion where fill soils extend to depths up to about 34 feet. The fill soils consist of sand, silty sand, and sandy silt, primarily with lesser amounts of clayey sand and clays. Varying amounts of debris were encountered. Based on the sampler blow counts and the densities of the soils, the fill soils and upper natural soils are generally moderately firm to firm.

To provide uniform support, the upper soils should be excavated so as to permit the placement of at least one foot of properly compacted subgrade fill beneath the sub-ballast.

If grading is performed as recommended herein, the track on grade may be supported by the conventional system consisting of ties, ballast, and sub-ballast established on firm natural soils or properly compacted fill.

The track may also be supported on the alternate track support system being considered, consisting of concrete ties and reinforced concrete leveling course over an asphaltic concrete course and a subbase.

There are other track support options that may be considered, if desired, such as in-place compaction of the subgrade soils, use of geotextile fabric, soil cement, and others.

The allowable bearing value of the compacted subgrade soils may be assumed to be 20 pounds per square inch.

o Grading: After completion of excavation to permit placement of at least one foot of compacted subgrade fill beneath sub-ballast, the exposed soils should be proof-rolled with heavy compaction equipment to detect any soft subgrade areas which, if encountered, should be removed. The upper six inches of exposed soils should be scarified and then rolled with suitable compaction equipment. The upper six inches of exposed soils should be compacted to at least 90% of the maximum density obtainable by the ASTM Designation D1557-78 method of compaction. All required fill should be placed in loose lifts not more than eight inches in thickness and compacted to at least 90%.

The on-site soils, except for debris and clay, may be used as fill material. All imported fill should consist of relatively non-expansive soils with sufficient fines (binder) to be relatively impermeable when compacted and result in a stable subgrade. The expansion index of the select material should be less than 35.

5.5.2 Stations

5.5.2.1 Soil Properties for Static Design

The soil properties presented in Table 5-2 are based on the moisture content and the dry unit weight of the soils that are presented on the boring logs in Appendix A, and the shear test results presented in Appendix C.

Table 5-2
Summary of Soil Properties for Static Design
Stations

<u>Station</u>	<u>Ø</u> <u>(deg.)</u>	<u>C</u> <u>(psf)</u>	<u>Moist Unit</u> <u>Weight</u> <u>(pcf)</u>
Wardlow	23	400	110
Willow	30	250	115
Hill	30	350	115
Pacific Coast Highway	32	150	115
Anaheim Station	35	500	120
5th/6th	35	450	120
1st	28	700	120

5.5.2.2 Design Criteria

o Foundation Support: Foundation design recommendations are presented herein for the seven proposed stations. Structural elevations and loads are not available at this time. Accordingly, the recommendations presented herein should be reviewed at such time that the structural information becomes available.

Existing fill deposits were encountered at the proposed station sites to depths varying from zero to 9-1/2 feet. Deeper fill deposits may exist between boring locations. Except at the Willow Street and Hill Street sites, the relative compaction of fill soils is greater than 90%. The relative compaction at the other two sites is less than 85%.

The upper natural soils consist primarily of sandy silt, silty sand, and sand. These soils are moderately dense to dense.

Except for the Willow Street and Hill Street sites, the proposed station structures may be supported on spread footings established in either the existing fill soils or natural soils.

Footing excavations should be carefully inspected to verify the competency of both the existing fill soils and natural soils. If the existing fill soils at the Willow and Hill Street sites are excavated and replaced with properly compacted fill, the station structures at those two sites may be supported on spread footings established on properly compacted fill.

If the grading recommendations discussed are followed and if inspection of the footing excavations is performed as recommended, the spread footings may be designed to impose an allowable bearing pressure of 2,000 pounds per square foot. The footings should be established at a depth of at least two feet below the lowest adjacent grade.

The passive resistance of the soils may be assumed to be 250 pounds per cubic foot. A coefficient of friction of 0.4 may be used between the bottom of the footings and the supporting soils.

5.5.3 Catenary Support System

5.5.3.1 Soil Properties for Static Design

Table 5-3
Pier Foundations - Overhead Contact System

<u>Borings</u>	<u>φ</u> <u>(deg.)</u>	<u>C</u> <u>(psf)</u>	<u>Moist Unit</u> <u>Weight</u> <u>(pcf)</u>	<u>Average</u> <u>Moisture</u> <u>Content</u> <u>(%)</u>	<u>Average (1)</u> <u>Friction</u> <u>(psf)</u>	<u>Passive (2)</u> <u>Pressure</u> <u>(pcf)</u>
1000 thru 1002	25	300	115	16	300	400
1003 thru 1018	23	400	110	13	450	500
1019 thru 1022	25	300	115	15	300	400
1023 thru 1032	30	250	115	15	450	500
1033 thru 1044	30	350	115	13	450	500
1045 thru 1058	28	700	120	13	500	500

Notes:

- (1) May be used to calculate downward capacities of drilled piers.
- (2) May be used to calculate lateral capacity, if used with an acceptable pole formula, such as that in the City of Los Angeles Building Code or the Uniform Building Code.

5.5.3.2 Design Criteria

The proposed use of drilled cast-in-place reinforced concrete pier foundations to provide support for the overhead contact system is considered feasible. No exceptional difficulties are anticipated in the installation of such foundations along the at-grade portions of the Long Beach Alignment. Some minor caving should be anticipated.

The soil design parameters presented in Table 5-3 may be used in the design of the pier foundations.

5.5.4 Park-and-Ride Areas

5.5.4.1 Soil Properties for Pavement Design

California Bearing Ratio tests were performed on selected samples to provide data for pavement design. The results are summarized in Table 5-4, Summary of CBR Test Results.

Table 5-4
Summary of CBR Test Data

<u>Station</u>	<u>Boring No. and Depth</u>	<u>Soil Type</u>	<u>CBR</u>	
			<u>90%*</u>	<u>95%*</u>
Wardlow Road	1013 at 5-7'	Clayey Silt	3	4
Wardlow Road	1017 at 0-2'	Silty sand	27	48
Willow Street	1030 at 3-5'	Sandy Silt	8	18

* Percent compaction based on ASTM Designation D1557-78 method of compaction.

5.5.4.2 Design Criteria

5.5.4.2.1 Paving

o General: To provide support for paving, the subgrade soils should be properly prepared. Compaction of the subgrade to at least 90%, including trench backfills, will be important for paving support. The preparation of the subgrade should be done immediately prior to the placement of the base course. Proper drainage of the paved areas should be provided since this will reduce moisture infiltration into the subgrade and increase the life of the paving.

o Subgrade Preparation: Existing fill soils should be excavated to a depth of at least one foot below the planned subgrade level in areas to be paved with asphaltic paving. After excavating as recommended, the exposed soils should be proof-rolled to determine the presence of any unsuitable deposits, and additional excavation performed if necessary to remove all unsuitable deposits. Next, the upper six inches of exposed soils should be scarified to a depth of six inches and rolled with heavy compaction equipment. The upper six inches of exposed soils should be compacted to at least 90% of the maximum density obtainable by the ASTM Designation D1557-78 method of compaction.

All required fill should be placed in loose lifts not more than eight inches in thickness, and compacted to at least 90%. The moisture content of the soils at the time of compaction should vary no more than 2% above or below optimum moisture content.

The on-site soils, less any debris or organic matter within the existing fill deposits, may be used in required fills. Any required imported fill material should consist of relatively non-expansive soils. The expansion index of the import material should be less than 35. The material should contain sufficient fines (binder material) so as to result in a stable subgrade. Imported fill material to be used beneath asphaltic paving should have a CBR value of at least 15 when compacted to 90%.

The excavation and reworking of the upper soils and the compaction of all required fill should be observed and tested by a competent geotechnical firm. Any required imported fill material should be approved for use prior to importing.

o Asphaltic Paving: To provide data for design of asphaltic paving, California Bearing Ratio tests were performed on samples of the upper soils. The results of the CBR tests are presented on Table 5-4.

The required paving thickness and base thickness will depend on the anticipated wheel loads and volume of traffic (Traffic Index). Assumed Traffic Indexes and the corresponding paving sections are presented in Table 5-5, Recommended Paving Sections.

Table 5-5
Recommended Paving Sections

<u>Station</u>	<u>Traffic Index</u>	<u>Thickness (In.)</u>	
		<u>Asphaltic Concrete</u>	<u>Base Course</u>
Wardlow Road	5	3	6
	6	4	8
	7	5	9
Willow Street	5	4	0
	6	3	5
	7	3	7

Careful inspection is recommended to verify that the recommended thicknesses or greater are achieved and that proper construction procedures are used.

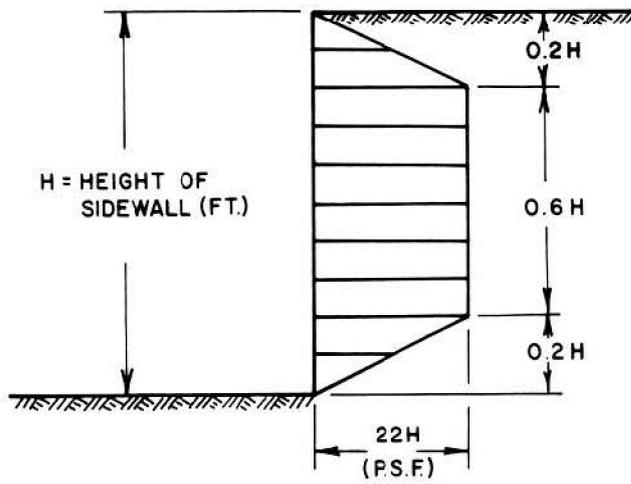
o Base Course: The base course should meet the specifications for Class 2 Aggregate Base as defined in Section 26 of the State of California, Department of Transportation, Standard Specifications, dated January, 1981. The base course should be compacted to at least 95%.

5.5.5 Pedestrian Tunnel

The proposed tunnel box section may be supported at grade on firm natural soils or properly compacted fill. The allowable bearing value of the foundation soils may be assumed as 2,000 pounds per square foot.

Lateral loads may be resisted by soil friction and by the passive resistance of the soils. A coefficient of friction of 0.4 may be used between the bottom of the box section and the supporting soils. The passive resistance of the natural soils or properly compacted backfill may be assumed to be equal to the pressure developed by a fluid with a density of 250 pounds per cubic foot. A one-third increase in the passive value may be used for wind or seismic loads. The frictional resistance and passive resistance of the soils may be combined without reduction in determining the total lateral resistance.

It is recommended that the tunnel sidewalls be designed for a trapezoidal distribution of earth pressure. The recommended pressure distribution for the case where the retained surface is level, is illustrated on the following page, with the maximum pressure equal to 22H.



In addition to the recommended earth pressure, the surcharge pressures due to rail traffic should be considered.

5.5.6 Widening of Existing Railroad Embankment

The sections at Stations 851+00, 852+00, and 853+00 indicate that the proposed widening will require sliver fills along both sides of the existing embankment.

The width of the sliver fills varies from zero to less than five feet. The toe of the sliver fills constructed at a 2:1 (horizontal to vertical) slope along the east embankment will extend beyond the right-of-way. Sufficient space appears to exist along the west side of the embankment. Retaining walls will be required if permission to extend the embankment beyond the right-of-way limits is not possible.

The construction of the narrow fills will require benching into the existing embankment as the fill progresses upwards. The purpose of the benching is to adequately anchor the sliver fills to the existing embankment and minimize future failure of the fill. The width of the benching should be sufficient to utilize conventionally-sized equipment.

Because of difficulties in obtaining well constructed narrow fills, the construction of the fills at a slope steeper than 2:1 is not desirable.

Since there appears to be more space to construct the fills along the west slope of the embankment, it is suggested that consideration be given to possible adjustment of the alignment such that the widening be performed only along the west slope.

Section 6.0
Bixby Crossing

SECTION 6.0: BIXBY CROSSING

6.1 PROPOSED CONSTRUCTION

A new structure is planned over the Bixby Slough. The following four alternatives are currently being considered.

1. Steel Stringer Bridge
2. Concrete Bridge
3. ARMCO Multi Plate Culverts
4. Timber Trestle

6.2 SITE CONDITIONS

The existing bridge across Bixby slough is of timber construction and is in poor condition. The embankment to the north and south of the bridge is about 10 feet in height. There are a number of existing utility lines beneath the existing bridge. Water was not evident within the slough area during the time of the field explorations. However, ponded water may occur during the rainy season. There is no apparent positive discharge of ponded water from this area, and there are no plans to provide drainage in the near future.

6.3 FIELD EXPLORATIONS AND LABORATORY TESTS

6.3.1 Borings

Two borings (1004 and 1005) were drilled at the two abutments to determine the subsurface conditions at the location of the proposed crossing. The borings were drilled to depths of 30 and 60-1/2 feet. No borings were drilled within the slough area.

6.3.2 Piezometer Installation

A two-inch-diameter perforated PVC pipe was installed and back-filled with gravel for use as a piezometer to monitor the ground water level at Boring 1005. Detailed descriptions of the piezometer installations and observed water levels are presented in Appendix A.

6.3.3 Geophysical Measurements

A downhole seismic survey was performed in the piezometer installation to determine the variation of compressional and shear wave velocities with depth of the underlying soils.

6.3.4 Laboratory Testing

Each soil sample was first visually observed in the laboratory to verify the sample description and classification assigned by the field personnel. A laboratory test program was then developed that would provide the soil parameters required in performing various engineering analyses. The testing program was submitted to SCRC for review prior to commencement of testing. The various tests performed include the following:

- o Moisture/Density
- o Direct Shear
- o Consolidation

The test procedures and results are presented in Appendix C. The field moisture content and dry density of the undisturbed soil samples are shown to the left of the boring logs presented in Appendix A.

6.4 SUBSURFACE CONDITIONS

6.4.1 Geologic Materials

The geologic materials at the site are identified as Pleistocene terrace deposits.

6.4.2 Soil Conditions

The two borings were drilled at the two abutments areas on top of the existing embankments. Ballast, 1-1/2 feet in thickness, was encountered in one boring. Fill was encountered in one boring to a depth of 3 feet. The upper natural soils consist of silt, silty sand, and clayey sand; underlain by sand and clay. The upper natural soils are moderately firm to firm. The soils become more firm with depth.

Since exploration borings were not drilled within the slough area, the soil conditions therein are not known.

6.4.3 Ground Water

The ground water levels were observed in Boring 1005 at depths of 47.6 and 48.7 feet on 11/1/85 and 11/26/85, respectively. It should be anticipated that these water levels will fluctuate.

6.5 SEISMICITY

The seismicity described in Section 4.5.3 is applicable to the site.

6.6 ENGINEERING EVALUATION AND DESIGN CRITERIA

6.6.1 Soil Properties for Static Design

The soil properties presented in Table 6-1 are based on the moisture content and the dry unit weight of the soils that are presented on the boring logs in Appendix A, and the shear test results presented in Appendix C.

Table 6-1
Summary of Soil Properties for Static Design
(Abutment Areas)

<u>Ø</u> (deg.)	<u>C</u> (psf)	<u>Moist Unit</u> <u>Weight</u> (pcf)
33	300	125

6.6.2 Design Criteria

6.6.2.1 Foundations

If the alternative of using multi plate culverts is seriously considered, the feasibility of using spread footing foundations, as indicated on the conceptual drawings, will need to be evaluated. The locations of the proposed footings relative to the existing utility lines and the surcharge effects on those lines should be evaluated. The use of driven friction piling should also be considered for support of the culverts. Additional explorations within the slough area will be necessary to evaluate the soil feasibility of both types of foundations. The use of culverts as indicated may possibly impact access to the utility lines should maintenance and repairs be necessary.

To provide support for the three proposed bridge and trestle alternatives, we recommend the use of piling. Because of the anticipated fluctuation of water levels within the slough area and the possibility of constructing intermediate supports within the slough area, the use of driven friction piling is recommended. Details for the driven piling are presented below. If the trestle alternative is selected, the locations of the three proposed bents relative to the existing utility lines and the impact on those lines should be carefully evaluated. Additional borings within the slough area will be required to determine allowable capacities of any piling planned therein.

o Driven Piling: The downward and upward capacities of 12- and 14-inch-square precast concrete piles are presented on Figure 6-1, Driven Pile Capacities. Dead plus live load capacities are shown; a one-third increase may be used when considering wind or seismic loads. Piles in groups should be spaced at least 2-1/2 diameters on centers, but in no event less than three feet on centers. If the piles are so spaced, there will be no reduction in the downward capacity of the piles due to group action. The capacities are based on the strength of the soils; the compressive and tensile strength of the pile section itself should be checked to verify the structural capacity of the piles. The above capacities are applicable only to piles located at the abutment areas; additional explorations within the slough area will be required to obtain soil values for development of capacities of piles that may be required for intermediate support within the slough area.

Lateral loads may be resisted by the piles. It may be assumed that the soils adjacent to a 12-inch-square concrete pile at least 20 feet long can safely resist horizontal loads imposed at the top of the pile up to 9,000 pounds. The lateral resistance of other sizes of piles may be assumed to be proportional to the width. In calculating the maximum bending moment in a pile, the lateral load imposed at the top of the pile may be multiplied by an assumed moment arm of 4-1/2 feet. For design, it may be assumed that the maximum bending moment will occur at or near the top of the pile and that the bending moment will decrease to zero at a depth of 20 feet below the pile cap. The lateral capacity and reduction in the bending moment are based in part on the assumption that any required backfill adjacent to the pile caps and grade beams will be properly compacted.

All piles should be driven to the predetermined design lengths as shown on Figure 6-1, except as may be modified on the basis of the driving criteria defined on Figure 6-2, Pile Driving Criteria.

6.6.2.2 Seismic Design Data

o Caltrans Bridge Criteria: The following seismic design data are presented for use with the latest State of California, Department of Transportation Seismic Bridge Design Criteria, dated May 1982. The seismic criteria are based on the consideration of the following factors: the distance of the site to active faults, the occurrence of a maximum credible earthquake, the seismic response of the soils at the site, and the dynamic response characteristics of the bridge structure. The combined effects of these factors result in elastic response spectra for a maximum credible earthquake. The selection of the appropriate spectra requires geotechnical input consisting of the peak expected acceleration of the bedrock or "rock-like" material at the site and the depth of the overlying alluvium. These geotechnical input data, together with the input data required of the structural engineer, are used to determine the earthquake design force.

The peak "rock" acceleration is postulated as a result of a maximum credible earthquake having a magnitude 6.5 on the Newport-Inglewood Fault. The peak "rock" acceleration at the aerial structure site is presented in Table 6-2, Peak Rock Acceleration.

Table 6-2
Peak Rock Acceleration

<u>Distance to Newport-Inglewood Fault (miles)</u>	<u>Peak Rock Acceleration (g's)</u>
<1	0.68

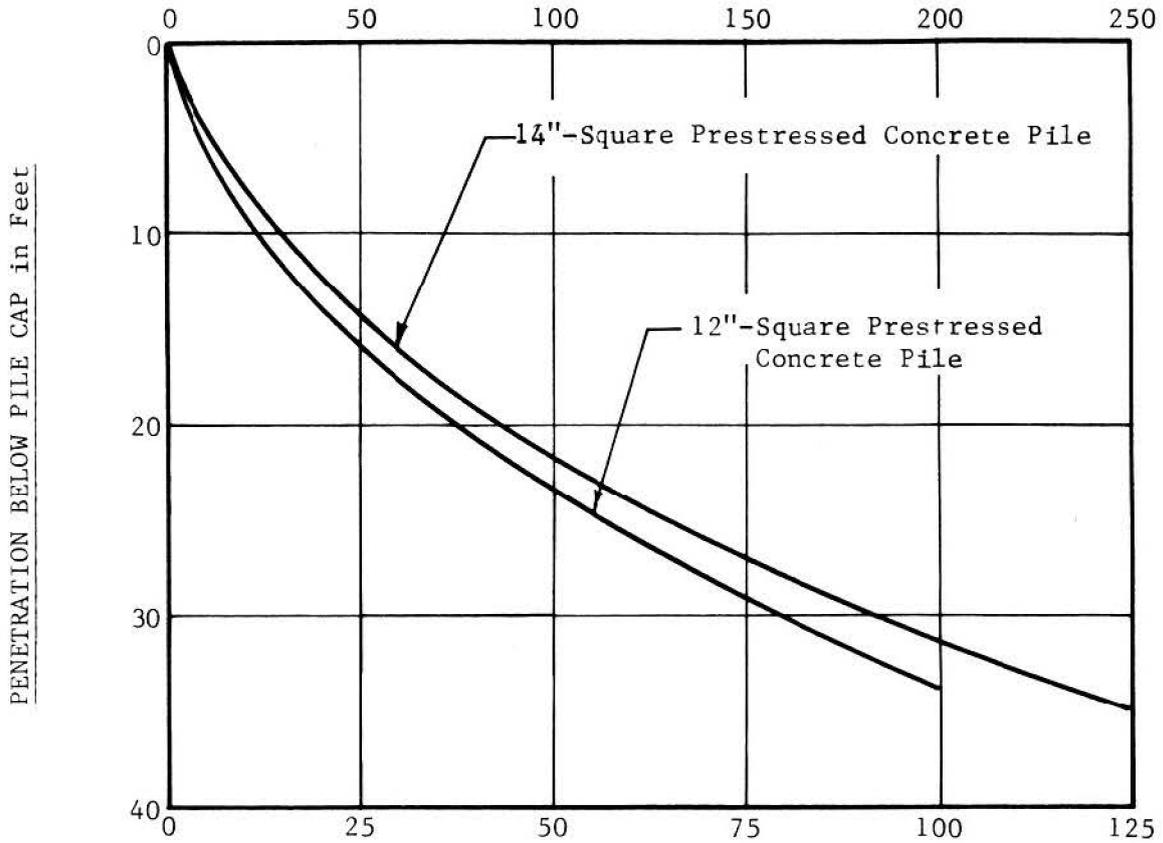
The depth to bedrock or "rock-like" material having a shear wave velocity of 2,500 feet per second may be assumed as being greater than 150 feet.

o Characteristic Site Period: The evaluation of the characteristic site period, T_s , is necessary to determine the coefficient of site-structure resonance, S , in accordance with Section of the 2312 of the 1982 edition of the Uniform Building Code. The characteristic period of the site was evaluated following the procedures suggested in SEAOC Standard No. 1, Recommended Lateral Force Requirements and Commentary, Seismology Committee, Structural Engineers Association of California, 1980.

The characteristic period of the aerial structure site, T_s , was determined as 0.8 to 1 second. The value nearest to the period of the structure should be used in determining the site-structure resonance coefficient, S .

FORM 120
JOB ADE-85005-10 DATE 12/5/85 DR. JOHN O.E. DM W.P. CHKD 1/15

DOWNWARD PILE CAPACITY in Kips



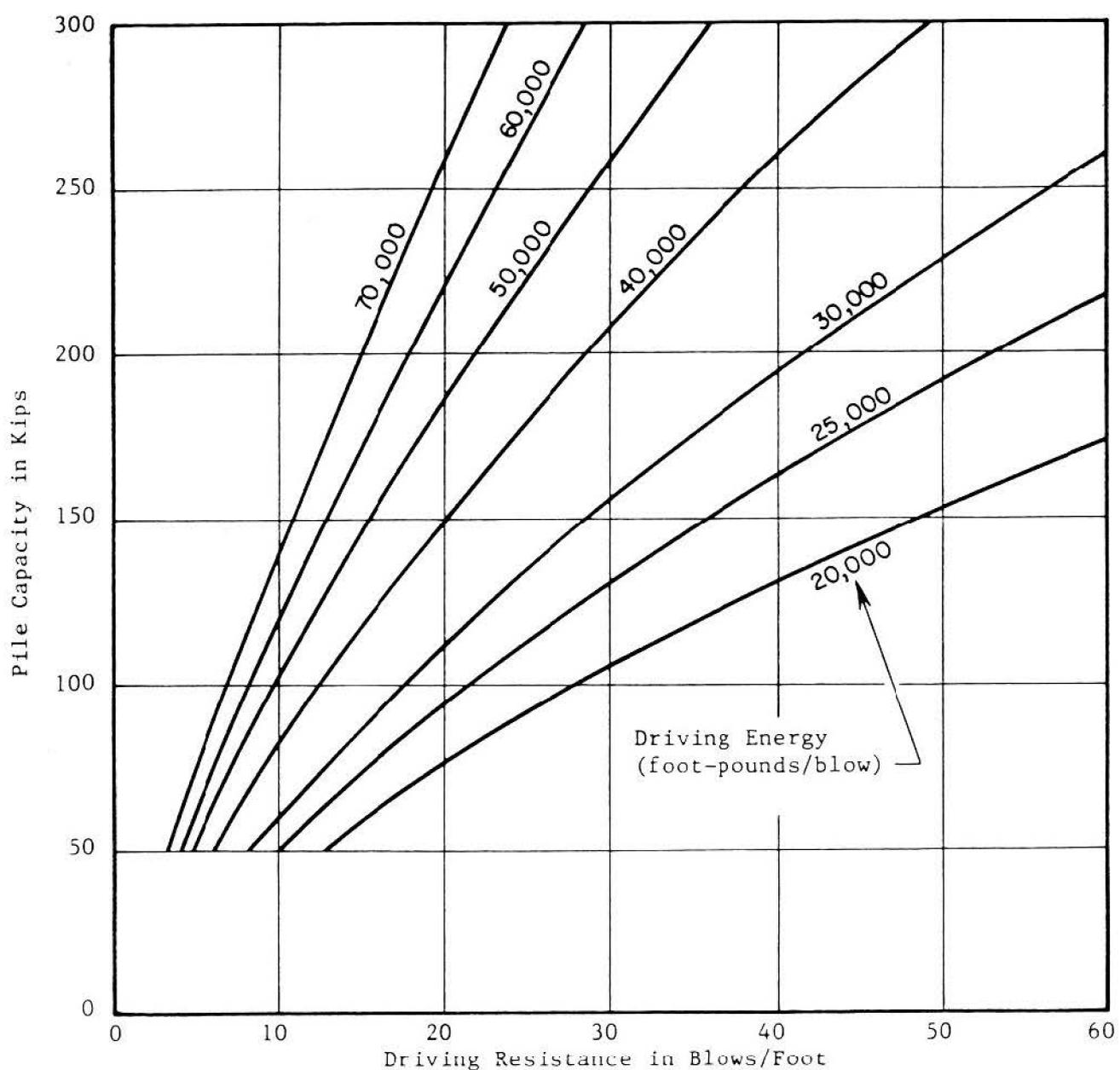
UPWARD PILE CAPACITY in Kips

NOTES:

- (1) The indicated values refer to the total of dead plus live loads; a one-third increase may be used when considering wind or seismic loads.
- (2) Piles in groups should be spaced a minimum of 3 feet, on centers.
- (3) The indicated values are based on the strength of the soils; the actual pile capacities may be limited to lesser values by the strength of the piles.

DRIVEN PILE CAPACITIES

(ABUTMENT AREAS)



NOTES:

- 1) The above driving resistance should be obtained for the last foot of driving at design pile length. If the driving resistance at the design length is less than above, the piles should be lengthened until the desired driving resistance is obtained.
- 2) As an alternate to lengthening when low driving resistance is obtained, the piles may be allowed to set overnight and the number of blows to drive the pile one inch the following day should be determined. If the restarting resistance is at least two times the above criteria, the pile may be considered satisfactory.
- 3) If driving resistance of three times the above criteria is encountered within five feet of design length, the pile driving may be stopped.

PILE DRIVING CRITERIA

LeROY CRANDALL AND ASSOCIATES

FIGURE 6-2

Appendix A
Field Exploration Program

**APPENDIX A:
FIELD EXPLORATION PROGRAM**

A.1 SUMMARY

Field explorations consisted of subsurface drilling, sampling, and testing, piezometer installation and ground water monitoring, and geophysical testing. A total of 60 exploration borings were drilled to depths ranging from 10 to 61 feet, for a total of 1,529 lineal feet of drilling. A tabulation of the borings is presented in Section 3.0 of the report; the locations of the exploration borings are shown on Figures 2-3 through 2-21. Included in this Appendix are the following:

- o Boring Logs
- o Unified Soil Classification System
- o Key to Boring Logs
- o Piezometer Installations and Ground Water Monitoring Data

A.2 METHOD OF DRILLING

The borings were drilled using rotary wash and bucket auger drilling equipment.

The rotary wash borings were drilled by C & L Drilling who utilized a Mahew 1000 drilling rig operated by a two-man crew. The borings were 5 inches in diameter. Drilling mud was used in the drilling process. The mud was removed following completion of the drilling to permit measurement of the water level.

Most of the bucket auger borings were drilled by C & L Drilling Company using a bucket-type rig operated by a two-man crew. The bucket borings were 18, 20, and 24 inches in diameter. A few auger borings were drilled by August Construction, who utilized a smaller bucket-type rig operated by a two-man crew. Raveling and/or caving occurred in some of the bucket borings as indicated on the boring logs. Casing or drilling mud was not used to extend these borings to the depths drilled.

Each of the borings was backfilled upon completion of drilling, except for those borings in which piezometers were installed.

A.3 LOGGING AND SAMPLING

The following personnel from LeRoy Crandall and Associates (LC&A) and Geotechnical Consultants Inc. (GCI) participated in the field exploration program:

Robert Chieruzzi	-	Project Manager, LC&A
Marshall Lew	-	Assistant Project Manager, LC&A
Glenn A. Brown	-	Director of Geological Services, LC&A
Do G. Mar	-	Project Engineer, LC&A
Mervin Johnson	-	Principal Engineering Geologist, LC&A
Wilford Stelts	-	Field Exploration Manager, LC&A
Gary Cito	-	Field Exploration Supervisor, LC&A
Theodore Powers	-	Field Geologist, GCI
James Thurber	-	Field Geologist, GCI
Tim Clarke	-	Field Technician, LC&A
Lowell Stelts	-	Field Technician, LC&A

The borings were logged continuously during the drilling. Undisturbed samples were obtained with the Crandall sampler at depth intervals of about five feet and at major changes in soil stratigraphy. The Crandall sampler is a 3.188 inch outside diameter, brass ring lined tube, that is driven with the kelly bar. The inside diameter of the brass rings is 2.625 inches. Bulk samples of the upper soils were obtained to permit the performance of laboratory compaction tests. Standard penetration tests were performed in the rotary wash borings at depth intervals of approximately ten feet.

The logs of the borings are presented on Figures A-1 through A-60; the depths at which undisturbed samples were obtained are indicated to the left of the boring logs. The results of the standard penetration tests (N values) are also presented in the logs.

The energy required to drive the LC&A sampler twelve inches is indicated on the logs. The energy is determined based on the following relationship:

$$E = \frac{WBS}{P}, \text{ where: } \begin{array}{l} W = \text{Driving Weight} = 450 \text{ lbs to } 1,600 \text{ lbs} \\ B = \text{No. Blows of Driving Weight} \\ S = \text{Stroke of Driving Weight} = 1 \text{ to } 2 \text{ ft.} \\ P = \text{Penetration of LC\&A Sampler} = 1 \text{ ft.} \end{array}$$

The soils are classified in accordance with the Unified Soil Classification System described on Figure A-61. An explanation of the information presented on the boring logs is presented on Figure A-62, Key to Log of Borings.

A.4 PIEZOMETER INSTALLATION

After the completion of drilling Borings 1005, 1011, 1016, 1027, 1037, 1043, 1048, and 1057, a 2-inch-diameter PVC pipe was installed in each boring for future monitoring of the ground water level.

The annulus between the pipe and boring walls was filled with sand. The pipe was perforated along different depth increments. Each piezometer was developed by air-lifting. A summary of the piezometer installations and ground water monitoring data is presented in Table A-1. Water levels are also presented on the borings logs.

Table A-1
Summary of Piezometer Installations and
Ground Water Monitoring Data

<u>Boring Number</u>	<u>Depth of Pipe (Ft.)</u>	<u>Date Installed</u>	<u>Water Depth (Ft.)</u>		
			<u>11/1/85</u>	<u>11/26/85</u>	<u>12/9/85</u>
1005	60	10/23/85	47.6	48.7	--
1011	60	10/22/85	NW	--	--
1016	60	10/15/85	54.0	--	--
1027	60	10/15/85	29.3	29.3	--
1037	60	11/12/85	--	--	31.4
1043	60	11/13/85	--	--	35.7
1048	60	11/14/85	--	--	41.0
1057	60	11/15/85	--	40.0	--

NW = No water encountered.

BORING 1000

DATE DRILLED: October 31, 1985
 EQUIPMENT USED: 24"-Diameter Bucket

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	DESCRIPTION
54							SM	FILL - SILTY SAND - fine, light greyish-brown
50	5	8.1	102	*	*	S		Sandier
		18.8	111	*	*			
		15.0	105	*	*	S		
45	10	24.0	99	*	*		SM SP ML	FILL - SILTY SAND, SAND, and SILT - greyish-brown
		18.5	115	*	*		ML	FILL - SANDY SILT - grey
40	15	14.8	120	*	*			(ENCOUNTERED CONCRETE OBSTRUCTION, BORING MOVED 10' SOUTH) Some gravel
		15.2	104	*	*			
35	20	9.8	107	*	*		SP	FILL - SAND - fine, grey 8" cobbles, few roots
		28.1	97	*	*		ML	FILL - CLAYEY SILT - few roots, grey
30	25						CL	FILL - SILTY CLAY - grey
25	30	16.9	-	*	*		ML	FILL - SANDY SILT - grey Some debris
							SM	FILL - SILTY SAND - fine, light brown Some debris
20	35						SP	SAND - fine, light brown
15	40							

NOTE: Water not encountered. No caving.

*Driving weight is hydraulically dropped. Accurate drive energy can not be computed.

LOG OF BORING

BORING 1001

DATE DRILLED: October 30, 1985
 EQUIPMENT USED: 24"-Diameter Bucket

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	ELEVATION 52
50		21.5	106	*		SM	FILL - SILTY SAND - fine, light greyish-brown
						ML	FILL - CLAYEY SILT - greyish-brown
	5	21.1	107	*	S		Lenses of Silty Sand
							Sandier
45		13.6	108	*			
		19.9	109	*	S		
	10	10.6	108	*		SM	FILL - SILTY SAND - fine, greyish-brown
40						ML	FILL - CLAYEY SILT - greyish-brown
		9.7	127	*			Layer of well graded Sand, some gravel, pieces of asphalt
35							Pieces of bone and concrete Some Sand, mottled greyish-brown (ENCOUNTERED LARGE PIPE, BORING TERMINATED AND MOVED 20' SOUTH, SEE BORING 1001-A).
20		14.5	112	*			

NOTE: Water not encountered. No caving.

*Driving weight is hydraulically dropped. Accurate drive energy can not be computed.

LOG OF BORING

JOB ADE-85005-10 DATE 11/12/85 DR. JOHN O.E. W.P. DM L/M W.P. dmh CHKD 115

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

BORING 1001-A

DATE DRILLED: October 31, 1985
 EQUIPMENT USED: 24"-Diameter Bucket

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
50						SM
	5	22.6	106	*		ML
45						
	10	16.9	115	*		SM
40						
	15	15.8	115	*		ML
35						
	20	16.0	117	*		
30						
	25	15.6	105	*		SM
25						SP
30						

ELEVATION 52

FILL - SILTY SAND - fine, mottled grey

FILL - SANDY SILT - some Clay, mottled grey

FILL - SILTY SAND - fine, grey

Layer of Clayey Silt
 Layer of gravel, pieces of asphalt

FILL - SANDY SILT - mottled greyish-brown

SILTY SAND - fine, light greyish-brown

SAND - fine, light brown

NOTE: Water not encountered. Caving below 26' (to 2½' in diameter).

*Driving weight is hydraulically dropped. Accurate drive energy can not be computed.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

BORING 1002

DATE DRILLED: October 30, 1985
 EQUIPMENT USED: 24"-Diameter Bucket

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	DESCRIPTION
45				9.6	84	*	ML	3" Railroad Gravel FILL - SANDY SILT - traces of organic matter, brown
	5			8.2	102	*		Few roots
40				10.9	110	*	S	SANDY SILT - few roots, brown
	10			15.5	124	*		CLAYEY SILT - greyish-brown
35				16.6	102	*	S	SANDY SILT - traces of shell fragments, grey
	15			11.3	104	*		
30							SM	SILTY SAND - fine, greyish-brown
25				29.6	92	*	ML	CLAYEY SILT - greyish-brown Some Sand
	25			13.1	94	*	SM	SILTY SAND - fine, light greyish-brown

NOTE: Water not encountered. No caving.

*Driving weight is hydraulically dropped. Accurate drive energy can not be computed.

LOG OF BORING

Form 123 JOB A-85005-10 DATE 10/22/85 DR. JOHN O.E. DM W.P. CHKD 1125

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
45	5	4.2	123	13			GM
		13.0	119	5			SC
40		12.8	121	5			
		13.1	123	8			
	10	13.2	120	8			
35							SM
	15	7.0	108	16			
30							
20		15.6	114	18			

ELEVATION 48

BORING 1003

DATE DRILLED: October 21, 1985
 EQUIPMENT USED: 20"-Diameter Bucket

12" Railroad Gravel
 FILL - SILTY GRAVEL - Sand and Silt matrix, some cobbles (to 10" in size), brown
 CLAYEY SAND - fine, brown
 SILTY SAND - fine, light brown
 Siltier

NOTE: Water not encountered. Caving from 15' to 19' (to 2' in diameter).

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

FIGURE A-5

Form 123 JOB A-85005-10 DATE 10/22/85 DR. JOHN O.E. DM W.P. CHKD dmh

BORING 1004

DATE DRILLED: October 21, 1985
EQUIPMENT USED: 20"-Diameter Bucket

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
49							18" Railroad Gravel - some Sand and Silt
45	5	15.5	116	3	C	ML	SANDY SILT - some Clay, brown
		14.9	117	2	S		
40	10	12.9	114	2	S		
		13.2	118	3	S		
35	15	13.5	117	3	S		
30	20	14.7	118	6	S	SC	CLAYEY SAND - fine, brown
		9.9	111	6	S	SM	SILTY SAND - fine, brown
25	25	7.6	105	6	S	SP	SAND - fine, light brown
20	30	8.5	101	16	C	S	

NOTE: Water not encountered. Caving from 24' to 29' (to 2' in diameter).

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

JOB AD E-85005-10 DATE 10/24/85 DR. JOHN O.E. W.P. DM

Form 123

CHKD dmh

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
45	5	11.6	120	8	8	SC
40	10	13.2	118	3	3	S
35	15	12.4	117	4	4	SC
30	20	13.3	120	14	14	S
25	25	11.4	106	10	10	S
20	30	9.6	116	32	32	S
15	35	11.7	114	54	54	S

ELEVATION 50

SP
FILL - SAND - coarse, large amount of gravel and cobbles, brown

SM
SILTY SAND - fine, some Clay, brown

SC
CLAYEY SAND - fine, brown

SM
SILTY SAND - fine, greyish-brown

BORING 1005

DATE DRILLED: October 22 & 23, 1985

EQUIPMENT USED: 5"-Diameter Rotary Wash

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

FIGURE A-7a

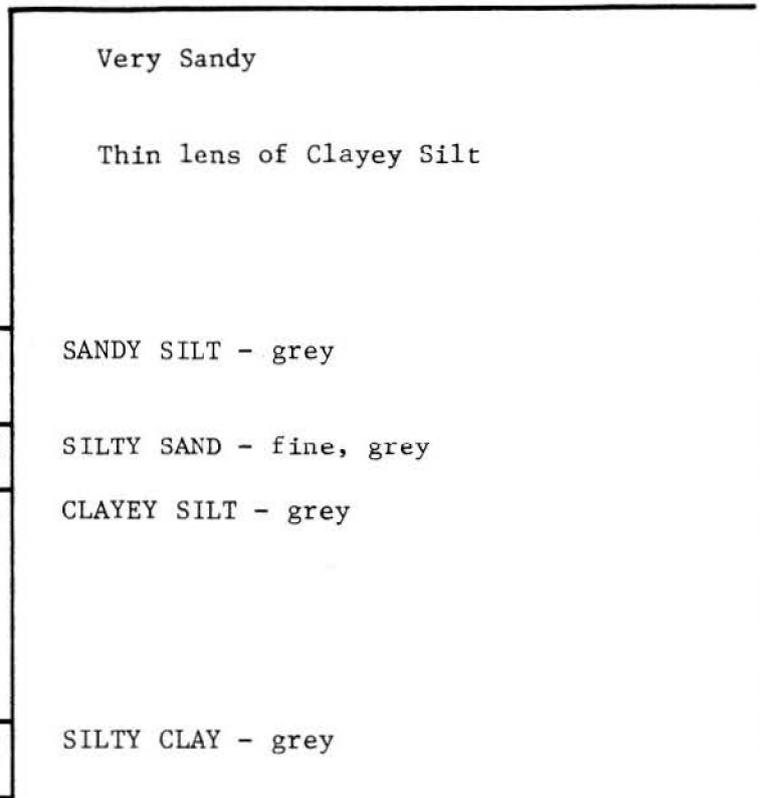
Form 124 JOB ADE-85005-10 DATE 10/24/85 DR. JOHN O.E. DM/L/W.P. CHKD MS

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

BORING 1005 (CONTINUED)

DATE DRILLED: October 22 & 23, 1985
 EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
	80					
5	45	20.2	107	60		CS
	41					
0	50	25.6	101	54		S
	30					
-5	55	29.1	97	12		
	27					
-10	60					CL
-15	65					



NOTE: Drilling mud used in drilling process. Mud removed. Installed 60' of 2"-diameter PVC pipe (perforated at 30' to 40' and 50' to 60'). Water level measured at 47.6' on 11/1/85 and at 48.7' on 11/26/85.

LOG OF BORING

LoROY CRANDALL AND ASSOCIATES

Form 123 JOB A-85005-10 DATE 10/22/85 DR. JOHN O.E. DM W.P. CHKD MS

BORING 1006

DATE DRILLED: October 21, 1985
 EQUIPMENT USED: 20"-Diameter Bucket

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	DESCRIPTION
							GM	FILL - SILTY GRAVEL - Sand and Silt matrix, brown
		11.8	118	3	s		ML	SANDY SILT - some Clay, brown
		14.8	121	10				
50	5	14.0	122	13	s			
		11.3	118	11			SM	SILTY SAND - fine, brown
45	10	9.6	116	14				
								Sandier, light brown
40	15	5.4	97	10				
35	20	4.2	113	24			SP	SAND - fine to medium, light brown

NOTE: Water not encountered. Light raveling from 15' to 20' (to 2' in diameter).

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

FIGURE A-8

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

BORING 1007

DATE DRILLED: October 21, 1985
 EQUIPMENT USED: 20"-Diameter Bucket

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
55		16.6	113	2			SW
	5	12.5	118	3			ML
50		14.7	107	2			
	10	12.8	115	2			ML
45		11.1	123	3			S
	15	13.9	122	6			
40							
20		15.4	117	6			

ELEVATION 57

FILL - SAND - well graded, about 20% gravel, light brown
 CLAYEY SILT - some Sand, brown

 SANDY SILT - some Clay, brown

NOTE: Water not encountered. No caving.

LOG OF BORING

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

BORING 1008

DATE DRILLED: October 18, 1985
 EQUIPMENT USED: 20"-Diameter Bucket

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
55		13.4	117	5	S		SP
	5	10.8	118	10			ML
		8.8	113	10	S		SM
50		5.4	99	6			
	10	9.6	103	6			
45		18.1	100	26			
	15						
40		12.6	115	22			
	20						

ELEVATION 58

FILL - SAND and SILT - fine, some gravel, brown
 SILTY SAND - fine, brown
 Light brown
 Sandier
 Layer of Silt
 Light brown and grey

NOTE: Water not encountered. Caving from 8' to 9' and 15' to 19' (to 2½' in diameter).

LOG OF BORING

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
59							
55	5	8.2	119	6			SW
		4.2	95	6			SP
		25.4	93	16			ML
		35.0	88	10			SM
50	10	26.3	101	11			
45	15	10.2	111	19			
40	20	3.1	108	24			

BORING 1009

DATE DRILLED: October 18, 1985
 EQUIPMENT USED: 20"-Diameter Bucket

ELEVATION 59

FILL - GRAVELLY SAND - some cobbles, some debris, brown
 SAND - fine to medium, light brown
 CLAYEY SILT - greyish-brown
 SILTY SAND - fine, grey
 Light grey

NOTE: Water not encountered. Slight raveling from 17' to 19'.

LOG OF BORING

Form 123 JOB A-85005-10 DATE 10/22/85 DR. R.J. O.E. W.P. CHKD. 125

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
50		2.8	102	6			SW
	5	30.9	92	5			SM
45		10.0	105	16			
	10	4.5	99	16			SP
40		3.2	109	18			SM
	15	24.6	102	8			ML
35							SM
20		11.9	110	19			

BORING IOIO

DATE DRILLED: October 18, 1985
 EQUIPMENT USED: 20"-Diameter Bucket

ELEVATION 53

FILL - GRAVELLY SAND - brown
 SILTY SAND - fine, light brown
 Layer of Clayey Silt
 Greyish-brown
 SAND - fine, light brown
 SILTY SAND - fine, grey
 CLAYEY SILT - light grey
 SILTY SAND - fine, grey

NOTE: Water not encountered. No caving.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

JOB AD E-85005-10 DATE 10/24/85 DR. JOHN O.E. W.P. CHKD. dah

BORING IO11

DATE DRILLED: October 22, 1985
 EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	DESCRIPTION
49							SM	SILTY SAND - fine, brown
	5	8.5	106	6		10c		Sandier, light brown
		9.7	105	9		s		
40	10	6.3	105	15			SP	SAND - fine, light brown
		62						Large amount of shell fragments
35	15	23.9	103	26		s	ML	SANDY SILT - some shell fragments, greyish-brown
		18.0	112	54				
30	20	67						Some Clay
		32.3	92	49			SM	SILTY SAND - fine, grey
25	25	52						
		31.6	93	17			ML	CLAYEY SILT - greyish-brown
20	30	52						Some Sand
15	35	17.1	108	54			SM	SILTY SAND - fine, brownish-grey
10	40	50						Lens of Clayey Silt Light brown

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

BORING IO11 (CONTINUED)

DATE DRILLED: October 22, 1985
 EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
	45	70 (6" pen.)	12.8	109	54		SP
	50	48	16.2	111	90		ML
	55	100	13.0	104	68		SM
	60		13.0	120	135		SM

SAND - fine to medium, light brown
 Medium to coarse
 SANDY SILT - some Clay, brown
 SILTY SAND - fine to medium, brown
 SAND - fine to medium, grey
 SILTY SAND - fine to medium, brown

NOTE: Drilling mud used in drilling process. Mud removed. Installed 60' of 2"-diameter PVC pipe (perforated at 30' to 40' and 50' to 60'). Water not measured in pipe to a depth of 60' on 11/1/85.

LOG OF BORING

Form 123 JOB A-85005-10 DATE 10/22/85 DR. JOHN O.E. DM W.P. CHKD dmn

BORING 1012

DATE DRILLED: October 21, 1985
EQUIPMENT USED: 20"-Diameter Bucket

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	ELEVATION 46
45			7.6	118	3	SW	FILL - GRAVELLY SAND - well graded, some cobbles (to 4" in size), brown
			18.4	111	6	SC	FILL - CLAYEY SAND - fine, brown
	5					SM	SILTY SAND - fine, brown
40			21.7	98	11	SC	
			9.8	108	11	S	Layer of Sandy Silt
	10		22.4	104	16		Few shell fragments
35							
	15		4.9	111	27	S	SP SAND - fine to medium, some shell fragments, light brown
30							
	20		15.5	102	22	SM	SILTY SAND - fine, greyish-brown
25						ML	SANDY SILT - greyish-brown
	25		24.3	102	11	SM	SILTY SAND - fine, greyish-brown
20							
30			8.7	94	12		

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

JOB A-85005-10 DATE 10/22/85 DR. Rd. W.P. DM O.E. CHKD dmb

BORING 1013

DATE DRILLED: October 18, 1985
 EQUIPMENT USED: 20"-Diameter Bucket

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
53							
50		3.5	104	6			SC
							SM
	5	26.5	98	11			ML
		27.1	99	6			
45		7.7	113	27			SM
	10	4.9	109	19			
40							
15							

ELEVATION 53

CLAYEY SAND - fine, brown
 SILTY SAND - fine, light brown
 CLAYEY SILT - grey
 SILTY SAND - fine, very Sandy, light grey

NOTE: Water not encountered. Caving from 8' to 9' (to 2' in diameter).

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

Form 123 JOB A-85005-10 DATE 10/22/85 DR. *rd.* O.E. DM *W.P.* *dmh* CHKD

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
45	5	10.2	111	10		SM
		2.4	95	3		
		16.3	116	13		ML
40	10	5.2	104	19		SM
35	15					

BORING 1014

DATE DRILLED: October 18, 1985
 EQUIPMENT USED: 20"-Diameter Bucket

ELEVATION 50

SILTY SAND - fine, grey

SANDY SILT - light brown and white

SILTY SAND - fine, grey

NOTE: Water not encountered. Caving from 4' to 6' (to 2½' in diameter).

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

BORING 1015

DATE DRILLED: October 17, 1985
 EQUIPMENT USED: 20"-Diameter Bucket

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	DESCRIPTION
42							18" Railroad Gravel - some Sand and Silt
40		14.2	116	3		SM	FILL - SILTY SAND - fine to medium, dark brown
	5	13.1	113	2			
35		13.9	116	2	SC	SC	CLAYEY SAND - fine, brown
	10	13.0	123	3			
30		10.9	118	3			
	15	19.1	111	13		SM	SILTY SAND - fine, greyish-brown
25							
	20	4.4	104	14		SP	SAND - fine and medium, light grey
20							
	25	24.8	102	6		SM	SILTY SAND - fine, light grey
						ML	SANDY SILT - grey
15							
	30	15.9	93	10		SM	SILTY SAND - fine, grey

NOTE: Water not encountered. No caving.

LOG OF BORING

Form 123 JOB ADE-85005-10 DATE 10/22/85 DR. JOHN O.E. W.P. CHKD

BORING 1016

DATE DRILLED: October 15, 1985
 EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	DESCRIPTION
40		16.1	104	2	100	2	ML	SANDY SILT - brown
	5	19.5	97	6	100	6	ML	
35		3.6	97	11	100	11	SP	SAND - fine, grey
	10	4.4	104	19	100	19	SP	
30		20.9	102	13	100	13	SP	
	15	39					SP	
25		9.6	96	25	100	25	S	
	20	39					S	
20		19.1	95	18	100	18	ML	SANDY SILT - greyish-brown
	15	66					ML	
15		8.2	95	32	100	32	SP	SAND - fine, grey
	10	57					SP	
10		17.0	93	23	100	23	SP	
	5	75					SP	
5		32.4	92	14	100	14	CL	SILTY CLAY - greyish-brown Thin lens of Sand

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

Form 124 JOB ADE-85005-10 DATE 10/22/85 DR. JOHN O.E. DM W.P. CHKD

BORING 1016 (CONTINUED)

DATE DRILLED: October 15, 1985
 EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
0						
	45	71	15.3	95	18	SM
	50					CL
	55	55	24.4	94	18	SP
60			14.8	109	16	

SILTY SAND - fine, greyish-brown

SILTY CLAY - greyish-brown

SAND - fine, grey

NOTE: Drilling mud used in drilling process. Mud removed. Installed 60' of 2"-diameter PVC pipe (perforated at 30' to 40' and 50' to 60'). Water level measured at 54' on 11/1/85.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
40							SM
		9.6	123	3			SM
	5	11.7	126	10			SM
35		13.8	100	24			ML
		4.5	112	5			SM
30	10	3.4	100	14			SP
25	15						

BORING 1017

DATE DRILLED: October 18, 1985
EQUIPMENT USED: 20"-Diameter Bucket

ELEVATION 40

SILTY SAND - fine and medium, dark brown

SANDY SILT - mottled brown

SILTY SAND - fine, light grey

SAND - fine to medium, some shell fragments, brown

NOTE: Water not encountered. Caving from 8' to 9' (to 2' in diameter).

LOG OF BORING

Form 123 JOB A-85005-10 DATE 10-22-85 DR. RD. O.E. DM W.P. imb CHKD MS

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
35	5	5.8	124	24		SC
		15.7	110	2		ML
		31.2	90	10		ML
		12.7	109	8		ML
30	10	14.5	105	8		ML
		20.5	111	14		
25	15					

ELEVATION 40

BORING 1018

DATE DRILLED: October 18, 1985
 EQUIPMENT USED: 20"-Diameter Bucket

CLAYEY SAND - fine, brown
 SANDY SILT - brown
 CLAYEY SILT - brown
 SANDY SILT - grey

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

Form 123 JOB ADE-85005-10 DATE 10/22/85 DR. JOHN O.E. DM W.P. CHKD MS dm

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
35						
		9.8	119	6		SM
30	5	14.9	110	3		
		15.9	110	2		ML
		15.3	114	2		ML
25	10	11.1	105	3		SC
		16.4	112	3		
20	15					CL
15	20	15.4	119	11		

BORING 1019

DATE DRILLED: October 17, 1985
EQUIPMENT USED: 20"-Diameter Bucket

ELEVATION 35

18" Railroad Gravel - some Sand and Silt

FILL - SILTY SAND - fine, some Clayey Sand, brown

FILL - CLAYEY SILT - mottled brown

FILL - SANDY SILT - brown

CLAYEY SAND - fine, brown

Layer of Silty Sand

SANDY CLAY - some Silt, brown

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
25		11.4	123	6		SC
	5	10.3	120	6		ML
20		11.5	118	3		SM
	10	4.6	98	3	s	SP
15		6.0	97	5		ML
	15	17.8	111	3		CL
10		17.6	117	5		

ELEVATION 28

BORING 1020

DATE DRILLED: October 17, 1985
EQUIPMENT USED: 20"-Diameter Bucket

18" Railroad Gravel - some Sand and Silt
FILL - CLAYEY SAND - fine to medium, brown
FILL - SANDY SILT - brown
SILTY SAND - fine, light brown
SAND - fine and medium, light brown
SANDY SILT - some Clay, grey
SILTY CLAY - grey

NOTE: Water not encountered. No caving.

LOG OF BORING

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry w.t.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
20		6.8	106	5			SM
	5	8.0	105	3			SC
15		12.8	111	3			
		12.7	121	3			
10		35.7	84	<1			CL
10							
15		18.5	113	5			
5							
20		19.1	113	6			ML

BORING 1021

DATE DRILLED: October 17, 1985
 EQUIPMENT USED: 20"-Diameter Bucket

ELEVATION 22

6" Railroad Cravel - Some Sand and Silt
 FILL - SILTY SAND - fine to medium, brown

FILL - CLAYEY SAND - fine, brown

SILTY CLAY - dark grey

SANDY SILT - some Clay, greyish-brown

NOTE: Water not encountered. No caving.

LOG OF BORING

Form 123 JOB ADE-85005-10 DATE 10/22/85 DR. JOHN O.E. DM W.P. W.P. CHKD imh

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
20			16.6	111	5	ML
	5		11.1	114	3	ML
15			12.6	119	2 s	ML
	10		43.1	82	2	CL
10			23.4	104	<1 s	CL
15			18.4	113	5	CL

BORING 1022

DATE DRILLED: October 17, 1985

EQUIPMENT USED: 20"-Diameter Bucket

ELEVATION 21

FILL - SANDY SILT - some cobbles and boulders (to 14" in size), light mottled brown
 Few cobbles
 SANDY SILT - mottled brown
 Some Clay
 SILTY CLAY - traces of roots, grey

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

BORING 1023

DATE DRILLED: October 15, 1985
 EQUIPMENT USED: 20"-Diameter Bucket

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
20						SP ML
		12.5	118	5	s	SC
	5	9.0	121	8		ML
15		13.5	122	6	s	
		15.0	113	6		ML
10		16.9	109	5		
15		16.4	113	6		

ELEVATION 21

FILL - SAND and SILT - some gravel, light brown
 CLAYEY SAND - fine to medium, brown
 SANDY SILT - brown
 CLAYEY SILT - brown

NOTE: Water not encountered. No caving.

LOG OF BORING

BORING 1024

DATE DRILLED: October 14, 1985
 EQUIPMENT USED: 24"-Diameter Bucket

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
20						
		11.1	120	10		SM
15	5	12.7	110	13	s	SM
		11.3	108	13		
10	10	18.2	105	14	s	ML
		16.3	104	13		SM
5	15	25.6	104	13		ML

ELEVATION 20

Layer of Cobbles
 FILL - SILTY SAND - fine, few gravel, some Clay, brown
 SILTY SAND - fine, light grey
 SANDY SILT - greyish-brown
 SILTY SAND - fine, greyish-brown
 CLAYEY SILT - brownish-grey

NOTE: Water not encountered. No caving.

LOG OF BORING

BORING 1025

DATE DRILLED: October 14, 1985
EQUIPMENT USED: 20"-Diameter Bucket

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft. - kips / ft.)	SAMPLE LOC.	DESCRIPTION
20							FILL - SILTY SAND - fine, brown
			12.4	110	5	S	SILTY SAND - fine, brown
15	5		13.3	118	2	SC	CLAYEY SAND - fine and medium, brown
			14.2	117	5		
			17.4	114	3		
10	10		7.9	108	6	SM	SILTY SAND - fine, light brown
			28.3	98	8	ML	CLAYEY SILT - light greyish-brown

NOTE: Water not encountered. No caving.

LOG OF BORING

Form 123 JOB ADE-85005-10 DATE 10/23/85 DR. JOHN O.E. DM W.P. W.S. im CHKD

BORING 1026

DATE DRILLED: October 14, 1985
 EQUIPMENT USED: 20"-Diameter Bucket

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	ELEVATION 19
15	5	16.2	107	2			ML	FILL - SANDY SILT - dark mottled brown Wood fragments, petroleum odor
		20.7	102	2				(ENCOUNTERED CERAMIC PIPE, BORING MOVED 10' NORTH AND 2' WEST)
		14.2	109	2	S		ML	FILL - CLAYEY SILT - brown
		29.9	91	2			CL	FILL - SILTY CLAY - some wood fragments, bluish-grey
10	10	34.4	88	2	SC			SILTY SAND - fine, bluish-grey
5	15	14.3	102	10			SP	SAND - fine, greyish-brown
0	20	16.4	114	6	S		SM	SILTY SAND - fine, bluish-grey
-5	25	23.5	107	3				Grey
-10	30	17.6	108	12			SP	SAND - fine, grey

NOTE: Water seepage encountered at 23' to 25'. 2" of water at bottom of hole at completion of drilling. No caving.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

Form 123 JOB ADE-85005-10 DATE 10/23/85 DR. JOHN O.E. W.P. CHKD 115

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
20	0					SP
						ML
						ML
	5	13.9	117	8	8	C/S
15		15.1	115	10	10	S
	10	4.5	102	5	5	C/S
		10.6	117	14	14	
10		8.2	103	8	8	
	15	31				
		8.8	102	28	28	
5		55				
	20	32.0	91	12	12	
		31.0	95	10	10	
	25	27				
		30.3	95	14	14	
	30	22				
	35					
	40					

ELEVATION 20

BORING 1027

DATE DRILLED: October 15, 1985
EQUIPMENT USED: 5"-Diameter Rotary Wash

FILL - SAND and SILT - few gravel, brown
SANDY SILT - brown
SAND - fine, light brown
Grey
Few shells
SILTY CLAY - greyish-brown
SAND - fine, grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

FIGURE A-29a

BORING IO27 (CONTINUED)

DATE DRILLED: October 15, 1985
 EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
			26.9	92	28	CL
-25	45	19				
-30	50		16.2	119	25	
-35	55	75				SP
-40	60	60	19.9	107	28	CL
-45	65					

SANDY CLAY - bluish-grey

Brown

Bluish-grey

SAND - fine, bluish-grey

SILTY CLAY - greyish-brown

Layer of Sand

NOTE: Drilling mud used in drilling process. Mud removed. Installed 60' of 2"-diameter PVC pipe (perforated at 30' to 40' and 50' to 60'). Water level measured at 29.3' on 11/1/85 and 11/26/85.

LOG OF BORING

Form 123 JOB ADE-85005-10 DATE 10/23/85 DR. JOHN O.E. DM W.P. CHKD. *MJ*

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
15		12.5	116	6		ML
15	5	10.0	111	3		SC
10		14.5	112	3		CL
10	10	27.2	94	3		SM
5		31.9	87	2		ML
5	15	14.7	104	6		SM

BORING 1028

DATE DRILLED: October 15, 1985
 EQUIPMENT USED: 20"-Diameter Bucket

ELEVATION 19

FILL - SANDY SILT - some gravel, mottled greyish-brown
 Some pieces of asphalt

CLAYEY SAND - fine to medium, brown

SILTY CLAY - grey

SILTY SAND - fine, grey

SANDY SILT - grey

SILTY SAND - fine, greyish-brown

NOTE: Water not encountered. No caving.

LOG OF BORING

Form 123 JOB ADE-85005-10 DATE 10/23/85 DR. JOHN O.E. W.P. DM W.P. CHKD dmb MS

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-tips/ft.)	SAMPLE LOC.
15	5	3.2	106	3		SP
		36.5	79	3		CL
		21.3	103	2		
10	10	33.8	86	3		
		30.8	88	3		
5	15	16.5	115	3		

BORING 1029

DATE DRILLED: October 15, 1985
 EQUIPMENT USED: 20"-Diameter Bucket

ELEVATION 20

FILL - SAND - fine, some gravel and cobbles, some chunks of asphalt, brown

SILTY CLAY - some roots, grey

Layer of Clayey Silt

Some Sand

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

BORING 1030

DATE DRILLED: October 14, 1985
 EQUIPMENT USED: 20"-Diameter Bucket

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	DESCRIPTION
20	0						SM	FILL - SILTY SAND - fine, some gravel and cobbles, brown
							ML	SANDY SILT - brown
15	5	13.1	121	10				
		11.8	114	8			S	
		1.9	100	10				SP SAND - fine, light grey
		8.5	106	5				
10	10						ML	SANDY SILT - brown
		17.8	100	14			SM	SILTY SAND - fine, light brown
5	15							

NOTE: Water not encountered. No caving.

LOG OF BORING

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

BORING 1031

DATE DRILLED: October 15, 1985
 EQUIPMENT USED: 20"-Diameter Bucket

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
15			5.9	110	8	SM
	5		11.1	111	5	SM
			13.0	111	6	
10			6.7	105	8	SP
	10		6.4	105	10	
5						
15						

ELEVATION 18

FILL - SILTY SAND - fine, large amount of gravel and debris, brown
 SILTY SAND - fine, brown

Some Clay

SAND - fine, brown
 Fine to medium

NOTE: Water not encountered. No caving.

LOG OF BORING

Form 123 JOB ADE-85005-10 DATE 11/25/85 DR. JOHN O.E. MS W.P. 115 dmb CHKD DM

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
19						
15	5	13.8	116	4		ML
		12.5	119	11	s	
10	10	14.0	114	9		ML
		12.8	120	9	s	
5	15	13.3	118	9		
		6.3	104	9		SM
0	20	26.0	97	27		ML

BORING I032

DATE DRILLED: November 21, 1985

EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION 19

3" Asphaltic Paving - 6" Concrete Slab -
6" Base Course
FILL - SANDY SILT - some Clay, brown

SANDY SILT - brown

Light brown

Very Sandy

SILTY SAND - fine, brownish-grey

CLAYEY SILT - greyish-brown

NOTE: Drilling mud used in drilling process.
Water level not established.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

BORING 1033

DATE DRILLED: November 4, 1985
 EQUIPMENT USED: 18"-Diameter Bucket

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
15		15.8	120	2		SM
	5	16.3	112	13	s	SC
		13.1	121	10		SM
	10	11.7	117	11	s	
		14.3	120	6		
5		8.1	112	11		

ELEVATION 18

FILL - SILTY SAND - fine, some shell fragments, brown
 CLAYEY SAND - fine, brown
 SILTY SAND - fine, brown

NOTE: Slight water seepage at 3'. No caving.

LOG OF BORING

Form 123 JOB ADE-85005-10 DATE 11/11/85 DR. JOHN O.E. W.P. MS MS

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
20		20.4	103	<1		SM
		12.4	122	8	s	SC
5		13.8	121	13		
15		14.4	118	6		
		14.4	115	5	s	
10						
10						SM
15		11.0	118	13		

BORING 1034

DATE DRILLED: November 4, 1985
EQUIPMENT USED: 18"-Diameter Bucket

ELEVATION 21

FILL - SILTY SAND - fine, few shell fragments, light brown
CLAYEY SAND - fine, brown

SILTY SAND - fine, greyish-brown

NOTE: Water not encountered. No caving.

LOG OF BORING

Form 123 JOB ADE-85005-10 DATE 11/11/85 DR. JOHN O.E. MS W.P. CHKD DMH

BORING 1035

DATE DRILLED: November 4, 1985
 EQUIPMENT USED: 18"-Diameter Bucket

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
20		11.1	122	5	S	SC
15	5	12.0	124	11		
10	10	12.5	119	11	S	SP
10	10	9.1	116	13		
15	15	13.0	117	8		SM
		10.4	106	13		

ELEVATION 22

5" Asphaltic Paving - 16" Base Course

CLAYEY SAND - fine, brown

SAND - fine, brown

SILTY SAND - fine, greyish-brown

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

Form 123 JOB ADE-85005-10 DATE 11/11/85 DR. JOHN O.E. W.P. CHKD

BORING 1036

DATE DRILLED: November 4, 1985
 EQUIPMENT USED: 18"-Diameter Bucket

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
20		14.4	116	6	s	
	5	12.1	119	6		
15		12.0	109	3	s	
		13.7	106	3		
10		19.6	106	10		
10		20.7	97	10		
15						

ELEVATION 23

4" Asphaltic Paving - 8" Base Course
 FILL - CLAYEY SAND - fine, reddish-brown
 SANDY SILT - brown

Greyish-brown

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

Form 123 JOB ADE-85005-10 DATE 11/18/85 DR. JOHN O.E. DM W.P. CHKD dmh

BORING 1037

DATE DRILLED: November 12, 1985
EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-tips/ft.)	SAMPLE LOC.	
23								4" Asphaltic Paving - 12" Base Course
20		21.0	116			7	ML	SANDY SILT - some Clay, brown
15	5	11.1	115			4	S	Very Sandy, greyish-brown
10	10	13.2	102			4		
10	10	50						
15	15	10.6	127			24		
5	5	56					SM	SILTY SAND - fine, brown
20	20						SP	SAND - fine, light brown
25	25	76 (9" pen)						Some Silt, few shell fragments
30	30	8.0	95			41		
35	35							Large amount of shell fragments
35	35	96						
35	35	17.9	111			41		
15	15						ML	CLAYEY SILT - grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
-20	44					
-45		22.9	104	17		
-25	86					SP
-50						
-30		22.8	104	71		
-55						
-35		25.9	101	54		
-60						
-40		21.5	104	45		
-65						

BORING I037 (CONTINUED)

DATE DRILLED: November 12, 1985

EQUIPMENT USED: 5"-Diameter Rotary Wash

Some Sand, greyish-brown

SAND - fine, greyish-brown

Lenses of Silt

Fine to medium

NOTE: Drilling mud used in drilling process. Mud removed. Installed 60' of 2"-diameter PVC pipe (perforated at 30' to 40' and 50' to 60'). Water level measured at 31.4' on 12/9/85.

LOG OF BORING

JOB ADE-85005-10 DATE 11/11/85 DR. JOHN O.E. W.P. CHKD

Form 123

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
24						SM
		17.3	100		2	
20	5	14.9	110		6	C SC
		13.3	112		3	S
		9.9	103		3	C ML
15	10	14.9	106		2	
10	15	7.2	103		10	S SM
5	20	16.6	117		14	ML
0	25	4.8	109		22	SP
-5	30	6.5	108		22	

BORING 1038

DATE DRILLED: November 4, 1985

EQUIPMENT USED: 18"-Diameter Bucket

ELEVATION 24

FILL - SILTY SAND - fine, few shell fragments, light brown

CLAYEY SAND - fine, brown

SANDY SILT - brown

SILTY SAND - fine, greyish-brown

SANDY SILT - some Clay, greyish-brown

SAND - fine, light brown

Layer of Silt

NOTE: Water not encountered. Slight raveling from 14' to 19'.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

FIGURE A-40

Form 123 JOB ADE-85005-10 DATE 11/11/85 DR. JOHN O.E. W.P. MS 7/25 CHKD dmh

BORING 1039

DATE DRILLED: November 5, 1985

EQUIPMENT USED: 18"-Diameter Bucket

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
24	0						
20	5	12.3	116	8	S		SM
15	10	13.5	117	10			
10	15	12.1	112	5	S		
15	10	10.1	109	3			
10	15	7.5	103	5			
15	15	7.9	109	14			

ELEVATION 24

6" Asphaltic Paving - 12" Base Course

SILTY SAND - fine, brown

Some Clay

Very Sandy, light brown

Light grey

NOTE: Water not encountered. Caving below 9' (to 2' in diameter).

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

Form 123 JOB ADE-85005-10 DATE 11/11/85 DR. JOHN O.E. W.P. CHKD. dmh

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BORING 1040

DATE DRILLED: November 5, 1985
 EQUIPMENT USED: 18"-Diameter Bucket

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-tips/ft.)	SAMPLE LOC.
25							
		4.8	126	18			SP CL
		11.4	115	6	S		ML
20	5	11.1	119	5			
		8.3	112	6			SM
15	10	4.9	103	8			
10	15	3.0	110	18			SP

ELEVATION 25
 5" Asphaltic Paving - 10" Base Course
 FILL - SAND and CLAY - some gravel, brown
 SANDY SILT - some Clay, brown
 SILTY SAND - fine, very Sandy, light greyish-brown
 SAND - fine, light greyish-brown

NOTE: Water not encountered. Caving from 9' to 14' (to 2' in diameter).

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

Form 123 JOB ADE-85005-10 DATE 11/11/85 DR. JOHN O.E. W.P. *MS* CHKD *DA*

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
25			12.9	116	10	CL
	5		13.2	117	8 s	SC
20			18.6	113	10	
	10		10.3	115	3	SM
15			17.8	100	5 s	
	15		6.8	120	13	SP

BORING 1041

DATE DRILLED: November 5, 1985
EQUIPMENT USED: 18"-Diameter Bucket

ELEVATION 26

5" Asphaltic Paving - 18" Base Course
FILL - CLAY - grey
CLAYEY SAND - fine, brown
SILTY SAND - fine, brown
Layer of Silt, grey
SAND - fine, light grey

NOTE: Water not encountered. Caving from 12' to 14' (to 2' in diameter).

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

Form 123 JOB ADE-85005-10 DATE 11/11/85 DR. JOHN O.E. W.P. MS 115 dmh CHKD P.H.

BORING I042

DATE DRILLED: November 5, 1985
 EQUIPMENT USED: 18"-Diameter Bucket

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
28						CL
25		10.4	108		2	SM
	5	11.2	119		2	
		11.0	111		<1	SM
	20	8.9	108		5	
	10	6.2	106		10	
	15	7.0	102		16	
		6.9	101		18	SP
	20					
	5					
	25	7.9	108		27	SM
	0					
	30	31.8	93		14	ML

ELEVATION 28

5" Asphaltic Paving - 11" Base Course

FILL - CLAY - some gravel, reddish-brown
 SILTY SAND - fine, brown

Very Sandy, light brown

SAND - fine, some shell fragments, greyish-brown

SILTY SAND - fine, light brown

CLAYEY SILT - light greyish-brown

NOTE: Water not encountered. Caving from 9' to 15' (to 2½' in diameter). Slight raveling below 15'.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

JOB ADE-85005-10 DATE 11/18/85 DR. JOHN O.E. W.P. CHKD dmh

BORING 1043

DATE DRILLED: November 13, 1985
 EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	
							3" Asphaltic Paving - 22" Base Course
25	5	10.5	129	7		ML	FILL - SILT - layers of gravel, brown
		14.6	-	5			
20	10	10.9	128	6		SM	FILL - SILTY SAND - fine, layers of gravel, brown
		6.4	104	5		SM	SILTY SAND - fine, few gravel, light brown
		15					Lenses of Clay
15	15	8.3	96	8		SP	SAND - fine, light grey
		53					
10	20	6.0	105	23			
5	25	57					Thin lenses of Sandy Clay, light greyish-brown
		8.2	113	45			Lenses of Clay, some shell fragments
0	30	100 (9 1/2" pen)					Fine to medium, some gravel and shell fragments
-5	35	20.0	104	65			Thin lenses of Clay
-10	40	100 (10" pen)					

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

BORING 1043 (CONTINUED)

DATE DRILLED: November 13, 1985

EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
-15	45		25.4	100	37		
-20	50	100 (11" pen)					
-25	55	100 (7" pen)	21.1	106	49		
-30	60		25.6	99	57		
-35	65						

Light grey

Large amount of shell fragments

Some Silt, few gravel, large amount of shell fragments

NOTE: Drilling mud used in drilling process. Mud removed. Installed 60' of 2"-diameter PVC pipe (perforated at 30' to 40' and 50' to 60'). Water level measured at 35.7' on 12/9/85.

LOG OF BORING

BORING 1044

DATE DRILLED: November 6, 1985
 EQUIPMENT USED: 18"-Diameter Bucket

ELEVATION 34

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
30	5	18.0	107	8	8	CL
		16.1	113	8		ML
25	10	18.6	103	<1	8	S
		19.4	113	11		
20	15	20.0	105	6		SM
		13.6	115	14		
15	20	5.3	95	22		SP

4" Asphaltic Paving - 12" Base Course
 FILL - CLAY - some gravel, reddish-brown
 SANDY SILT - brown
 Greyish-brown
 Few roots
 Sandier
 SILTY SAND - fine, greyish-brown
 SAND - fine, light greyish-brown

NOTE: Water not encountered. Caving from 12' to 16' (to 2' in diameter).

LOG OF BORING

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
35							3" Asphaltic Paving - 20" Base Course
	5	13.9	115	8	s		CLAYEY SILT - some Sand, brown
30		14.6	118	13			SANDY SILT - brown
	10	13.7	110	6	s		CLAYEY SILT - brown
25		19.1	110	6			SAND - fine, light grey
15		16.1	111	13			

NOTE: Water not encountered. Caving from 12' to 14' (to 2' in diameter).

LOG OF BORING

Form 123 JOB ADE-85005-10 DATE 11/11/85 DR. JOHN O.E. MS W.P. CHKD dmb

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
38						4" Asphaltic Paving - 18" Base Course
35		12.4	121	10		ML SANDY SILT - brown
	5	15.0	121	11		
30		13.2	117	8	s	
	10	12.7	121	6		
25		11.2	109	6		SP SAND - fine, brown
15		5.7	109	11		

BORING 1046

DATE DRILLED: November 6, 1985
 EQUIPMENT USED: 18"-Diameter Bucket

ELEVATION 38

NOTE: Water not encountered. Caving from 11' to 14' (to 2' in diameter).

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

JOB ADE-85005-10 DATE 11/11/85 DR. JOHN O.E. W.P. CHKD

BORING I047

DATE DRILLED: November 7, 1985
 EQUIPMENT USED: 18"-Diameter Bucket

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	DESCRIPTION
39							4" Asphaltic Paving - 20" Base Course
		12.1	125	8	c	ML	FILL - SANDY SILT - brown
35	5	10.1	118	6	s	ML	SANDY SILT - brown
		13.6	121	13			
30	10	12.5	116	8	s		
		11.1	123	8			
25	15	3.9	101	8		SM	SILTY SAND - fine, very Sandy, greyish-brown
							Some roots
20	20	2.5	113	20		SP	SAND - fine to medium, light greyish-brown
15	25	4.7	104	14			Some shell fragments
10	30	4.8	105	18			Large amount of shell fragments

NOTE: Water not encountered. Raveling from 13' to 29'.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

JOB ADE-85005-10 DATE 11/18/85 DR. JOHN O.E. W.P. DM

Form 123

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
39						
35	5	13.4	124	8		ML
		14.9	120	8		SM
		12.6	118	7	C	ML
30	10	9.7	121	8		SM
		23				
25	15	4.4	105	11	S	
		49				SP
20	20	7.7	104	25		
		56				
15	25	10.3	106	18		
		68				
10	30	11.2	104	41		
5	35	89				
0	40					

BORING 1048

DATE DRILLED: November 14, 1985
EQUIPMENT USED: 5"-Diameter Rotary Wash

ELEVATION 39

4" Asphaltic Paving - 24" Base Course

FILL - SILT - greyish-brown

FILL - SILTY SAND - fine, some gravel, greyish-brown
SANDY SILT - brown

SILTY SAND - fine, light greyish-brown

Fine to medium

SAND - fine, light grey

Light greyish-brown

Few shell fragments

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

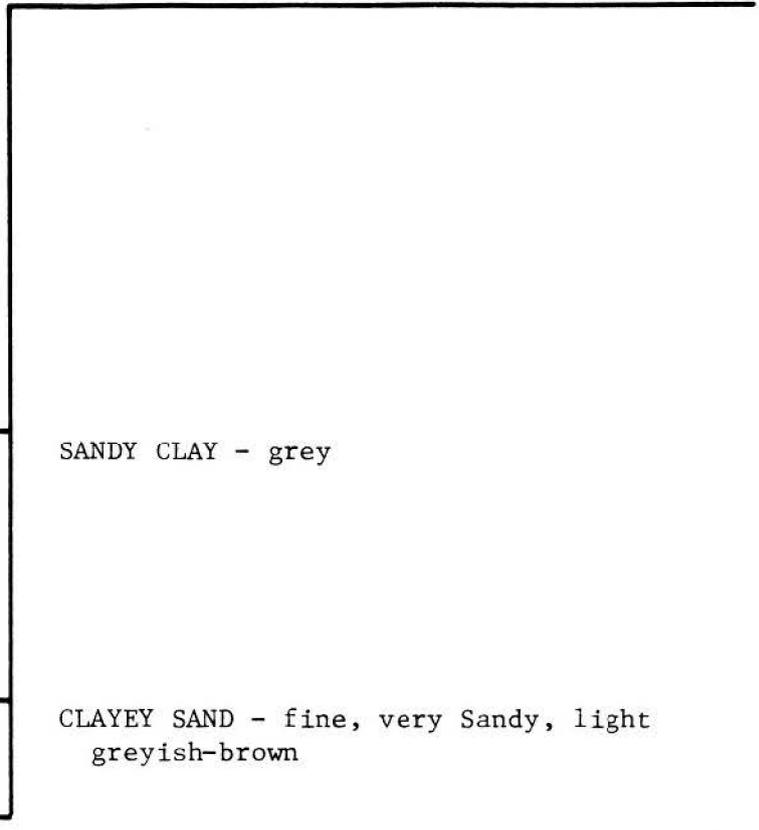
LeROY CRANDALL AND ASSOCIATES

BORING1048 (CONTINUED)

DATE DRILLED: November 14, 1985
 EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
-5	45	100 (10 ⁿ pen)	18.2	106	68		
-10	50		23.9	107	54		
-15	55	48					CL
-20	60		23.7	104	15		SC
-25	65		18.5	105	24		



NOTE: Drilling mud used in drilling process. Mud removed. Installed 60' of 2"-diameter PVC pipe (perforated at 30' to 40' and 50' to 60'). Water level measured at 41' on 12/9/85.

LOG OF BORING

BORING 1049

DATE DRILLED: November 7, 1985
 EQUIPMENT USED: 18"-Diameter Bucket

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
35		12.0	119	3	s	ML
	5	13.9	122	8		
30		13.4	117	5	s	
	10	11.7	119	5		
25		12.1	119	3		SM
15		33.0	91	11		ML

ELEVATION 38

3" Asphaltic Paving - 20" Base Course
 SANDY SILT - some Clay, brown
 SILTY SAND - fine, light greyish-brown
 CLAYEY SILT - some Sand, light greyish-brown

NOTE: Water not encountered. No caving.

LOG OF BORING

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
35			15.3	117	5	
	5		13.3	116	5 s	ML
30			12.8	117	8	
	10		11.9	109	5 s	ML
25			25.2	94	16	SM
15			8.5	111	16	

BORING 1050

DATE DRILLED: November 7, 1985
 EQUIPMENT USED: 18"-Diameter Bucket

ELEVATION 37

4" Asphaltic Paving - 26" Base Course

CLAYEY SILT - some Sand, brown

SANDY SILT - brown

SILTY SAND - fine, greyish-brown

NOTE: Water not encountered. No caving.

LOG OF BORING

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

BORING 1051

DATE DRILLED: November 7, 1985
 EQUIPMENT USED: 18"-Diameter Bucket

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
36						ELEVATION 36
35						5" Asphaltic Paving - 30" Base Course
	5	1.6	129	10		ML SANDY SILT - brown
30		11.0	124	6		
	10	11.4	123	16	S	
		10.8	120	8		
25		6.1	107	3		SM SILTY SAND - fine, light brown
	15	2.0	103	13		SP SAND - fine, light greyish-brown Layer of Silt
20		10.1	112	32		Lens of Silt

NOTE: Water not encountered. No caving.

LOG OF BORING

Form 123 JOB ADE-85005-10 DATE 11/12/85 DR. JOHN O.E. W.P. CHKD dmh

BORING 1052

DATE DRILLED: November 8, 1985
EQUIPMENT USED: 18"-Diameter Bucket

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-tips/ft.)	SAMPLE LOC.	
35							4" Asphaltic Paving - 24" Base Course
	5	15.2	118	2		CL	FILL - SANDY CLAY - mottled grey and brown
30		17.1	115	5		ML	SANDY SILT - some Clay, brown
	10	15.3	113	10	C	SM	Sandier
25		13.9	116	6		SM	SILTY SAND - fine, brown
	15	12.2	104	2	S	CL	SILTY CLAY - greyish-brown
20		20.7	108	11		SM	SILTY SAND - fine, brown
15	20	4.2	108	22		SP	SAND - fine and medium, light brown
10	25	11.9	110	13			Fine
5	30	5.6	104	20			Some shell fragments

NOTE: Water not encountered. Raveling below 20'.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

CHKD DAI

W.P. MS

O.E. DR. JOHN

DATE 11/25/85

JOB ADE-85005-10

Form 123

BORING 1053

DATE DRILLED: November 21, 1985

EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	DESCRIPTION
35	0						6" Asphaltic Paving - 27" Base Course
	5	12.0	122	9		ML	FILL - SANDY SILT - brown
30	5	11.9	126	13		ML	SANDY SILT - brown
	10	13.8	121	8	15	SM	SILTY SAND - fine, dark greyish-brown
25	10	9.4	117	5			
	15	8.2	97	15	15	ML	SANDY SILT - some Clay, grey
20	15						
	20	8.6	116	36		SP	SAND - fine, greyish-brown
15	20						Light greyish-brown
10	25	16.3	99	30			
	30						Some shell fragments
5	30						
0	35	7.7	107	36			
-5	40						Large amount of shell fragments

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

BORING I053 (CONTINUED)

DATE DRILLED: November 21, 1985

EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
-10	45		24.3	101	30	
-15	50	61				SM
-20	55		24.2	103	18	ML
-25	60	76				SP
-30	65					

Some Silty Clay lenses

SILTY SAND - fine, brown

SANDY SILT - grey

SAND - fine, medium and coarse, grey

NOTE: Drilling mud used in drilling process. Mud removed to a depth of 45' after completion of drilling. Water level measured at 35' 20 minutes after removal of mud.

LOG OF BORING

BORING I054

DATE DRILLED: November 8, 1985
 EQUIPMENT USED: 18"-Diameter Bucket

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
34						4" Asphaltic Paving - 16" Base Course
30	5	15.6	111	3	s	ML SANDY SILT - brown
		15.1	120	5		
25	10	19.0	111	2	s	ML CLAYEY SILT - brown
		11.5	115	5		ML SANDY SILT - brown
20		14.1	120	8		Greyish-brown
15		20.3	108	18		

ELEVATION 34

NOTE: Water not encountered. No caving.

LOG OF BORING

Form 123 JOB ADE-85005-10 DATE 11/19/85 DR. JOHN O.E. *W.P.* CHKD *PL*

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
33						SM
	5	12.7	123	*	s	ML
		11.2	119	*		
	5	8.2	112	*	s	SM
		4.5	100	*		SP
	10					
		4.9	110	*		

ELEVATION 33

BORING 1055

DATE DRILLED: November 15, 1985
EQUIPMENT USED: 18"-Diameter Bucket

FILL - SILTY SAND - fine, brown
Layer of gravel
SANDY SILT - brown
SILTY SAND - fine, brown
SAND - fine, brown
Light brown
Fine to medium

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

Form 123 JOB# DE-85005-10 DATE 11/19/85 DR. JOHN O.E. W.P. CHKD MS

BORING I056

DATE DRILLED: November 15, 1985
EQUIPMENT USED: 18"-Diameter Bucket

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	
30							SM	FILL - SILTY SAND - fine, light brown Layer of gravel
		15.8	115	*			CL	FILL - CLAY - brown
		12.7	117	*		S	ML	FILL - CLAYEY SILT - some Sand, brown
5		12.5	114	*		S	ML	SANDY SILT - brown
25		10.3	113	*			SM	SILTY SAND - fine, brown
10		6.4	97	*				
20		6.3	112	*			SP	SAND - fine, light brown
15		6.5	105	*				Lens of Silty Clay
20		12.8	116	*				Brown
5		18.1	110	*			ML	SANDY SILT - greyish-brown
30								
0								
35								

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

Form 123 JOB ADE-85005-10 DATE 11/19/85 DR. JOHN O.E. W.P. CHKD 1125

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
30						ML
		13.7	122	9	s	
	5	15.1	115	8		
25		19.0	107	4	C/S	ML
		25.1	101	7		
20	10	16				SM
		8.5	100	12	s	
15	15	50				SP
		10.0	111	30		
10	20	39				
		8.7	111	26		
5	25	31				CL
		22.7	104	12		
0	30					SM
		30				
-5	35	37.2	89	10		CL
40						

ELEVATION 31

6" Asphaltic Paving - 6" Base Course
 FILL - SANDY SILT - dark brown
 Some Clay
 CLAYEY SILT - brown
 SILTY SAND - fine, brownish-grey
 Fine to medium, light grey
 SAND - fine to medium, grey
 Lenses of Clay
 SILTY CLAY - light greyish-brown
 SILTY SAND - fine, light greyish-brown
 SILTY CLAY - layers of Sand, greyish-brown

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LoROY CRANDALL AND ASSOCIATES

Form 124 JOB ADE-85005-10 DATE 11/19/85 DR. JOHN O.E. DM W.P. CHKD MS

BORING 1057 (CONTINUED)

DATE DRILLED: November 15, 1985
 EQUIPMENT USED: 5"-Diameter Rotary Wash

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
-10			19.7	110	30	SP
						ML
-15	45		14.7	120	30	
			17.6	116	20	ML
-20	50					
			21.7	112	25	SM
-25	55					
			19.3	114	57	SP
-30	60					
			20.5	108	41	
65						

SAND - fine, brown
 CLAYEY SILT - greyish-brown
 SANDY SILT - some Clay, brown
 SILTY SAND - fine, greyish-brown
 SAND - fine, light grey
 Some Clay

NOTE: Drilling mud used in drilling process. Mud removed. Installed 60' of 2"-diameter PVC pipe (perforated at 30' to 40' and 50' to 60'). Water level measured at 40' on 11/26/85.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

Form 123 JOB ADE-85005-10 DATE 11/12/85 DR. JOHN O.E. DM W.P. CHKD

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

BORING 1058

DATE DRILLED: November 8, 1985
EQUIPMENT USED: 18"-Diameter Bucket

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
30	0					6" Asphaltic Paving - 18" Base Course
25	5	10.7	126	19	s	ML SANDY SILT - brown Some Clay
20	10	12.7	114	10		SM SILTY SAND - fine, light brown
15	15	4.0	108	13	s	SP SAND - fine, light greyish-brown
10	20	3.4	110	14		

NOTE: Water not encountered. Caving below 10' (to 2' in diameter).

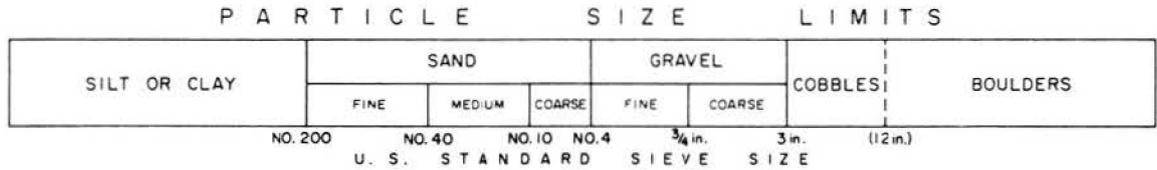
LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

ADE-85005-10

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES			
COARSE GRAINED SOILS (More than 50% of material is LARGER than No. 200 sieve size)	GRAVELS (More than 50% of coarse fraction is LARGER than the No. 4 sieve size)	CLEAN GRAVELS (Little or no fines)	GW	Well graded gravels, gravel-sand mixtures, little or no fines.			
			GP	Poorly graded gravels or gravel-sand mixtures, little or no fines.			
		GRAVELS WITH FINES (Appreciable amt. of fines)	GM	Silty gravels, gravel-sand-silt mixtures.			
			GC	Clayey gravels, gravel-sand-clay mixtures.			
	SANDS (More than 50% of coarse fraction is SMALLER than the No. 4 sieve size)	CLEAN SANDS (Little or no fines)	SW	Well graded sands, gravelly sands, little or no fines.			
			SP	Poorly graded sands or gravelly sands, little or no fines.			
		SANDS WITH FINES (Appreciable amt. of fines)	SM	Silty sands, sand-silt mixtures.			
			SC	Clayey sands, sand-clay mixtures.			
			SILTS AND CLAYS (Liquid limit LESS than 50)			ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
						CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
SILTS AND CLAYS (Liquid limit GREATER than 50)			OL	Organic silts and organic silty clays of low plasticity.			
			MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.			
			CH	Inorganic clays of high plasticity, fat clays.			
HIGHLY ORGANIC SOILS			OH	Organic clays of medium to high plasticity, organic silts.			
			Pt	Peat and other highly organic soils.			

BOUNDARY CLASSIFICATIONS: Soils possessing characteristics of two groups are designated by combinations of group symbols.



UNIFIED SOIL CLASSIFICATION SYSTEM

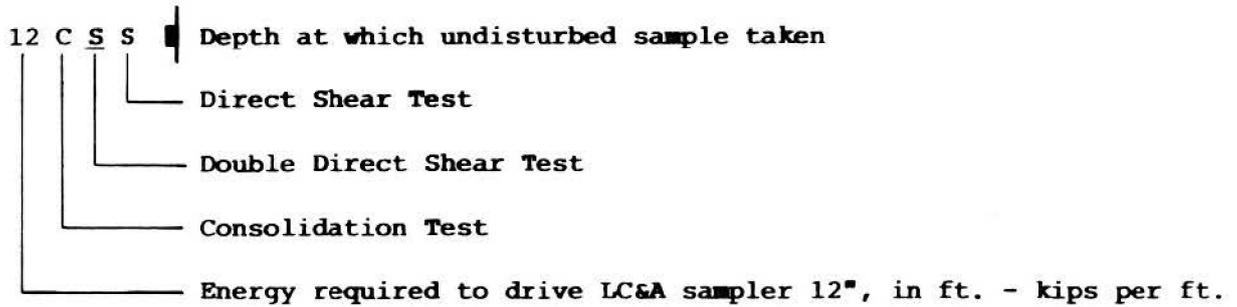
Reference:
 The Unified Soil Classification System, Corps of Engineers, U. S. Army Technical Memorandum No. 3-357, Vol. 1, March, 1953. (Revised April, 1960)

LEROY CRANDALL & ASSOCIATES

FIGURE A-61

JOB ADE-85005-10 DATE 12/6/85 DR Todd W.P. O.E. CHKD

LC&A SAMPLING: (Sampler Diameter - I.D. = 2.625"; O.D. = 3.188")



BUCKET BORINGS:

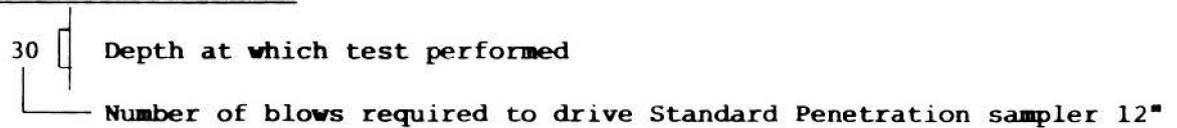
<u>Depth Increment</u>	<u>Driving Weight</u>	<u>Stroke</u>
0' to 25'	1,600 lbs.	1'
below 25'	800 lbs.	1'

ROTARY WASH BORINGS:

Driving Weight = 450 lbs.

Stroke = 1½'

STANDARD PENETRATION TEST:



CLASSIFICATION SYSTEMS:

Unified Soil Classification Systems

KEY TO LOG OF BORINGS

Appendix B

Downhole Seismic Survey

**APPENDIX B:
DOWNHOLE SEISMIC SURVEY**

B.1 SUMMARY

Downhole seismic surveys were performed in Borings 1005, 1027, and 1057. Measurements were made from the ground surface to depths of up to 60 feet in the borings.

B.2 PROCEDURE

After completion of the drilling of the borings, two-inch-diameter PVC pipe was installed in the borings, and sand backfill was placed around the pipes. Downhole seismic surveys were then performed in the pipes to determine the propagation velocities of the compressional waves (P-waves) and shear waves (S-waves).

A borehole seismometer, connected with cable to an amplifier and recorder, was lowered to the bottom of the pipe. A wooden plank was placed adjacent to the boring and weighted down with the front wheels of a vehicle. The S-waves were generated by horizontally striking the end of the plank with a sledge hammer; the P-waves were generated by vertically striking the top of the plank. The S-waves and P-waves were detected by the three orthogonal geophones of the borehole seismometer. When the measurements were completed at a given depth, the seismometer was raised to a higher level and a new set of measurements was taken.

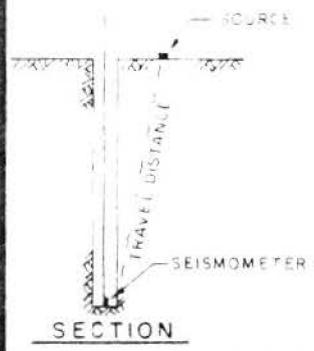
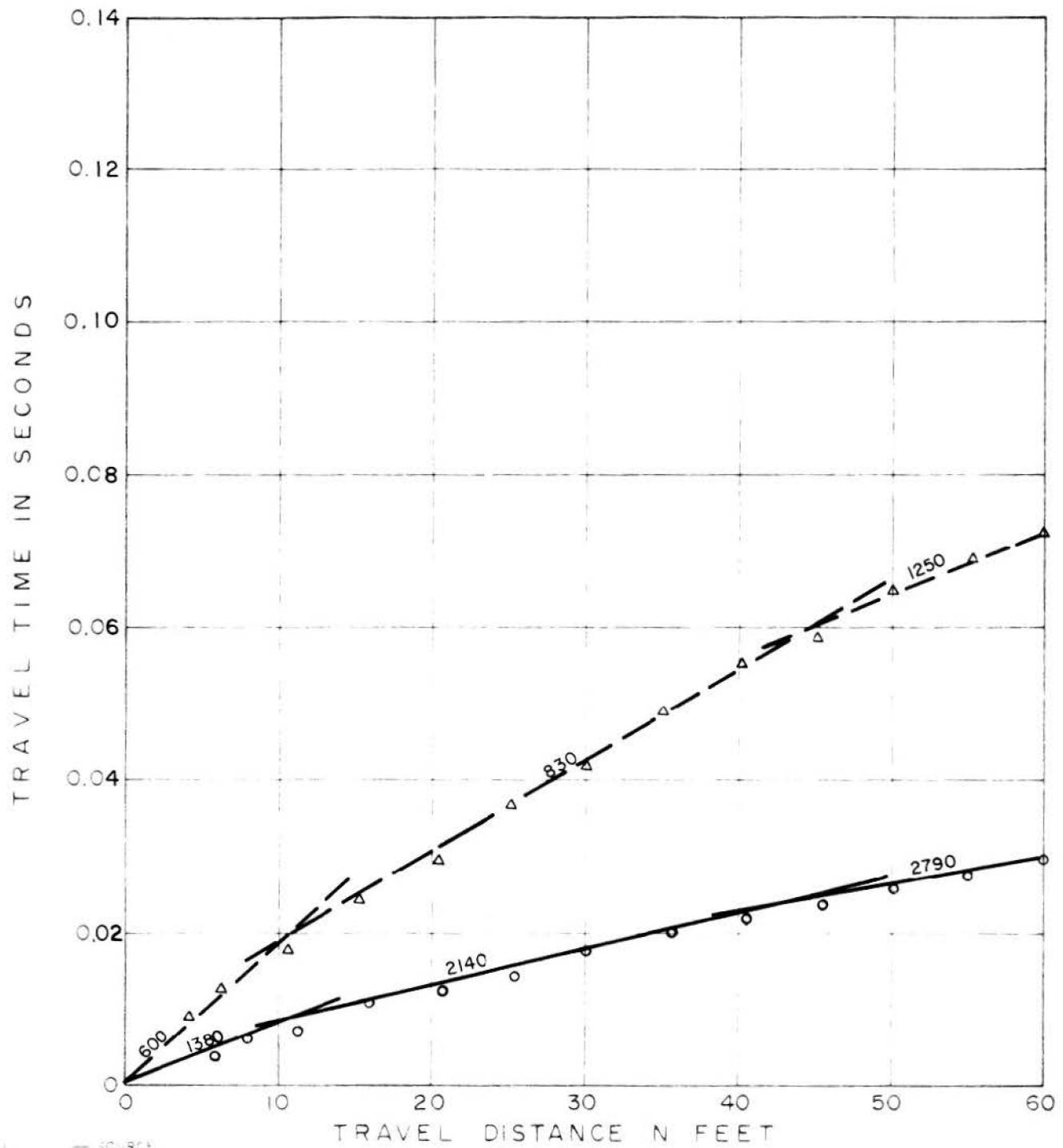
B.3 ANALYSIS

The times of first arrivals of the S-waves and P-waves were determined from the recordings and were plotted versus distance from the source on travel time curves which are presented on Figures B-1 through B-3, Downhole Seismic Survey. The propagation velocities were computed and are presented on Figures B-1 through B-3.

JOB ADE-85005-10 DATE 12/5/85 DR JOHN O.E. W.P. CHKD

KEY

- 600 —△—△— S-WAVE
- 1380 —○—○— P-WAVE
- PROPAGATION VELOCITY IN FEET/SEC.



DOWNHOLE SEISMIC SURVEY
 TRAVEL TIME CURVE
 (BORING 1005)

LeROY CRANDALL AND ASSOCIATES

FIGURE B-1

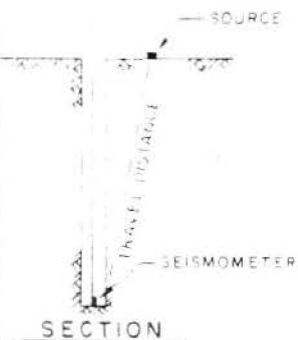
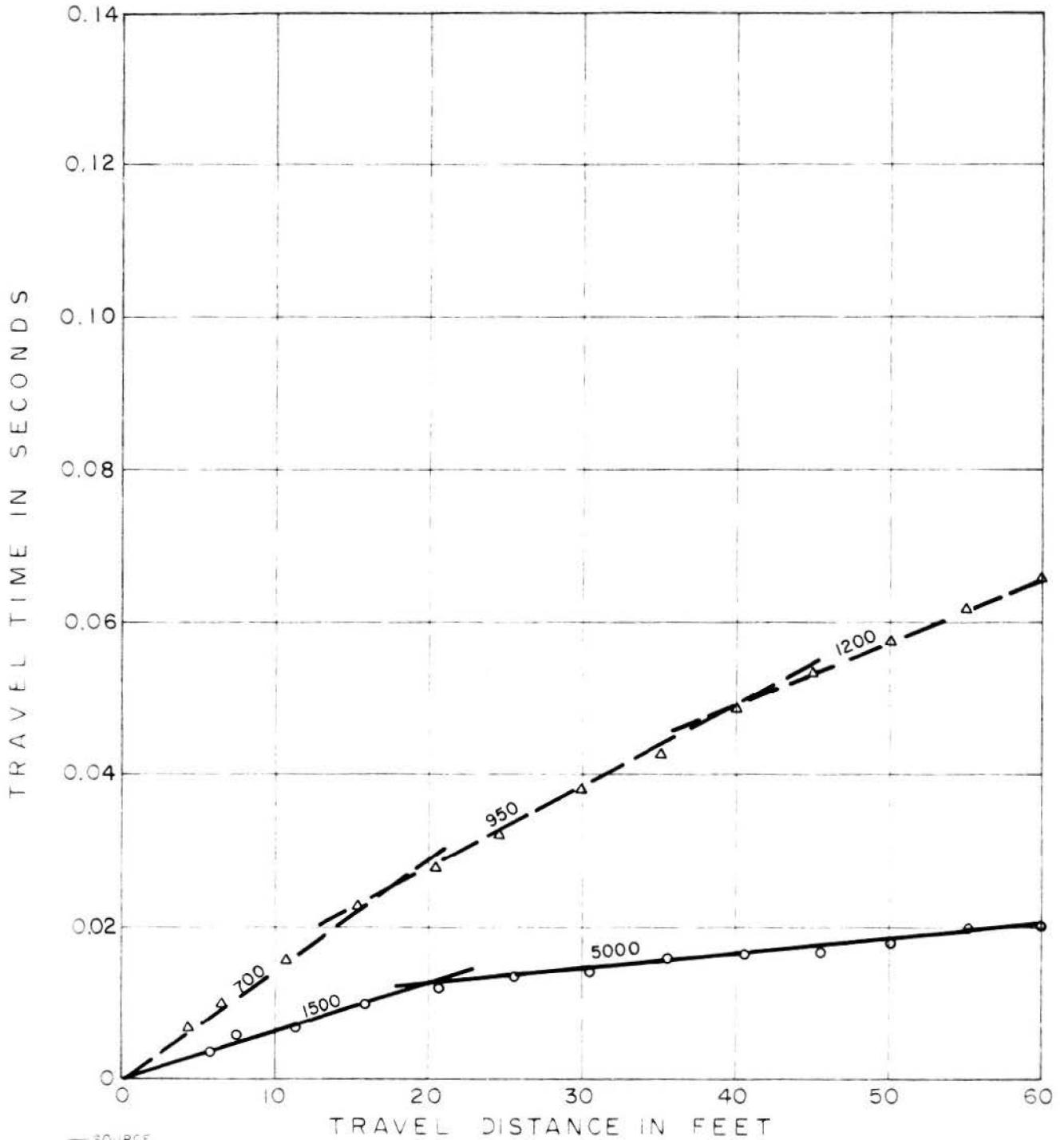
JUBADE-85005-10 DATE 12/5/85 DR JOHN O.E. WP. CHKD

KEY

700 — Δ — Δ — S-WAVE

1500 — ○ — ○ — P-WAVE

— PROPAGATION VELOCITY IN FEET/SEC.



DOWNHOLE SEISMIC SURVEY
 TRAVEL TIME CURVE
 (BORING 1027)

LeROY CRANDALL AND ASSOCIATES

FIGURE B-2

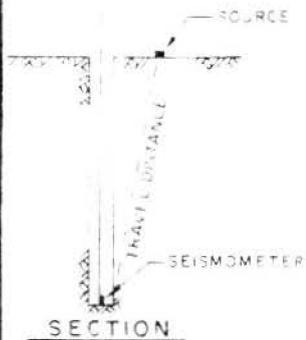
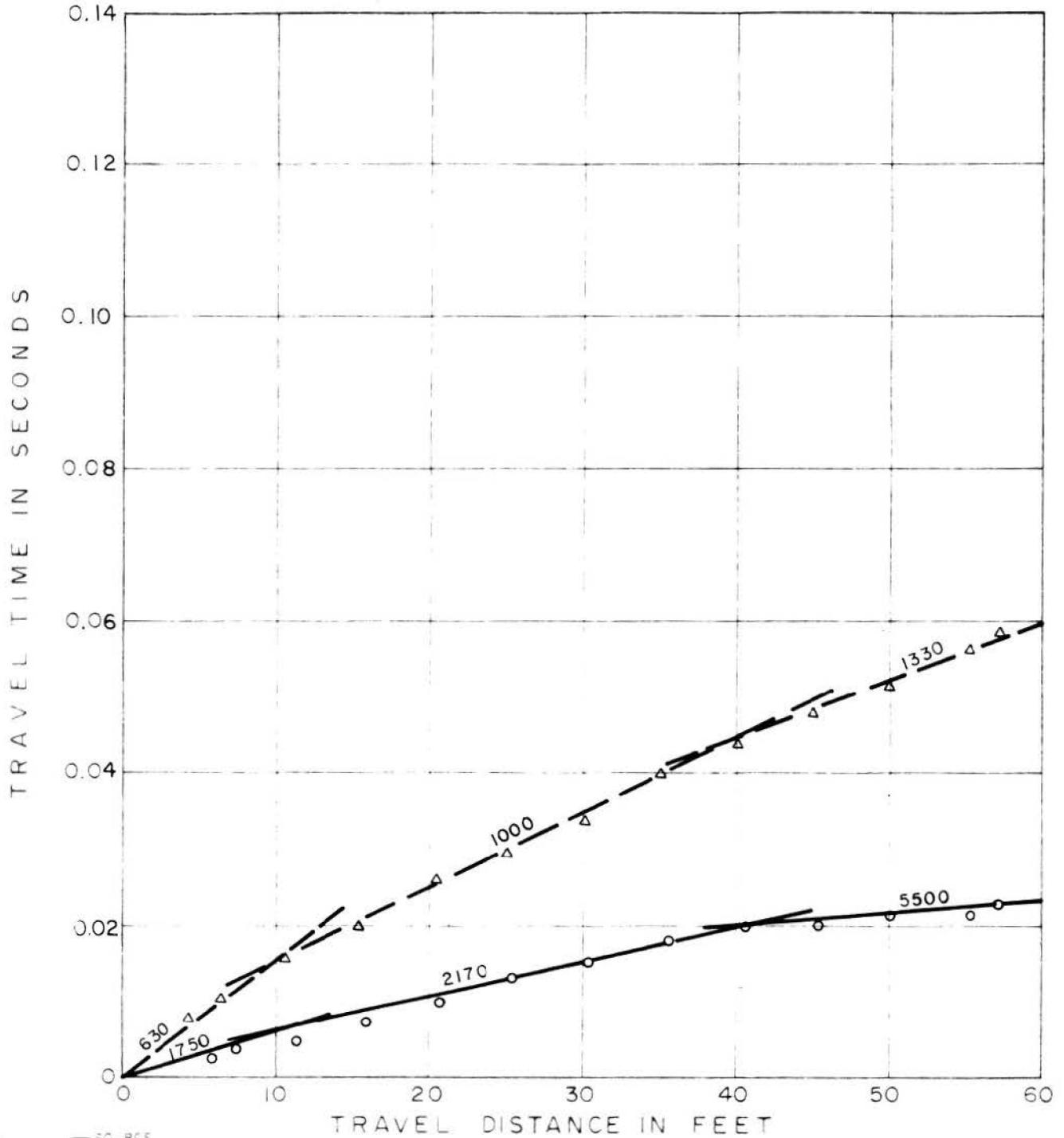
JOB ADE-85005-10 DATE 12/5/85 DR JOHN O.E. WP. CHKD

KEY

630 —Δ—Δ— S-WAVE

1750 —○—○— P-WAVE

— PROPAGATION VELOCITY IN FEET/SEC.



DOWNHOLE SEISMIC SURVEY
 TRAVEL TIME CURVE
 (BORING 1057)

LeROY CRANDALL AND ASSOCIATES

Appendix C
Laboratory Tests

**APPENDIX C:
LABORATORY TESTING**

C.1 INTRODUCTION

The laboratory testing program was directed toward a quantitative determination of the physical properties of the soils along the alignment. Each type of material was thoroughly investigated to determine the significant properties of the materials. All of the laboratory testing was performed within our office in Los Angeles.

C.2 LABORATORY TESTING PROGRAM

The laboratory program included testing of undisturbed samples, as well as tests on bulk materials. The undisturbed samples were placed in plastic bags and stored in sealed cans until ready for use, and the bulk samples were stored in plastic bags.

The first phase of the testing program consisted of determining the classification of the soils. The primary classifications were made by making a visual inspection. Representative samples were then selected for more specific studies to determine pertinent shear strength and consolidation parameters.

C.3 LABORATORY TESTING PROCEDURES

C.3.1 Moisture Content

Moisture contents were determined by weighing the material at natural moisture content, drying it in an oven at a temperature of about 230°F, weighing the completely oven-dried sample, and calculating the moisture content. Natural water contents were determined on the undisturbed samples shortly after the samples arrived at the laboratory. The results of the tests are presented to the left of the boring logs on Figures A-1 through A-60.

C.3.2 Dry Density

Dry density determinations were obtained by carefully utilizing a ring sample measuring with a known volume of the undisturbed sample, weighing the sample after it had been oven-dried, and calculating the unit weight. Results of the dry density determinations are presented to the left of the boring logs.

C.3.3 Direct Shear Tests

Direct shear tests were performed on selected undisturbed samples. The tests were performed at field and increased moisture contents and at surcharge pressures equal to the existing overburden pressures. Selected samples were tested at an increased surcharge pressure to provide more complete data. Remolded samples, compacted to 90% and 95% at optimum moisture content, were prepared for direct shear tests; these samples were tested at increased moisture contents and at different surcharge pressures. All of the samples were tested at a constant strain of 0.05 inches per minute. The yield-point values determined from the direct shear tests are presented on Figures C-1.1 through C-1.16.

C.3.4 Consolidation Tests

Undisturbed samples and remolded samples compacted to 90% and 95% at optimum moisture content were tested in consolidometers to determine the consolidation characteristics of the soils. Vertical loads were instantaneously applied in increments and the rate of vertical consolidation was measured for each increment. Each load was allowed to consolidate the sample for at least 12 hours before a new increment was added. Water was added to selected samples during the tests to illustrate the effect of moisture on the compressibility; the other samples were tested at field moisture content. The results of the consolidation tests are presented on Figures C-2.1 through C-2.16.

C.3.5 Compaction and C.B.R. Tests

The optimum moisture content and maximum dry density of the soils were determined by performing compaction tests on 9 samples. The tests were performed in accordance with the ASTM Designation D1557-78 method of compaction. This method of compaction utilizes a 1/30 cubic-foot mold, in which each of five layers of soil is compacted by 25 blows of a 10-pound hammer falling 18 inches.

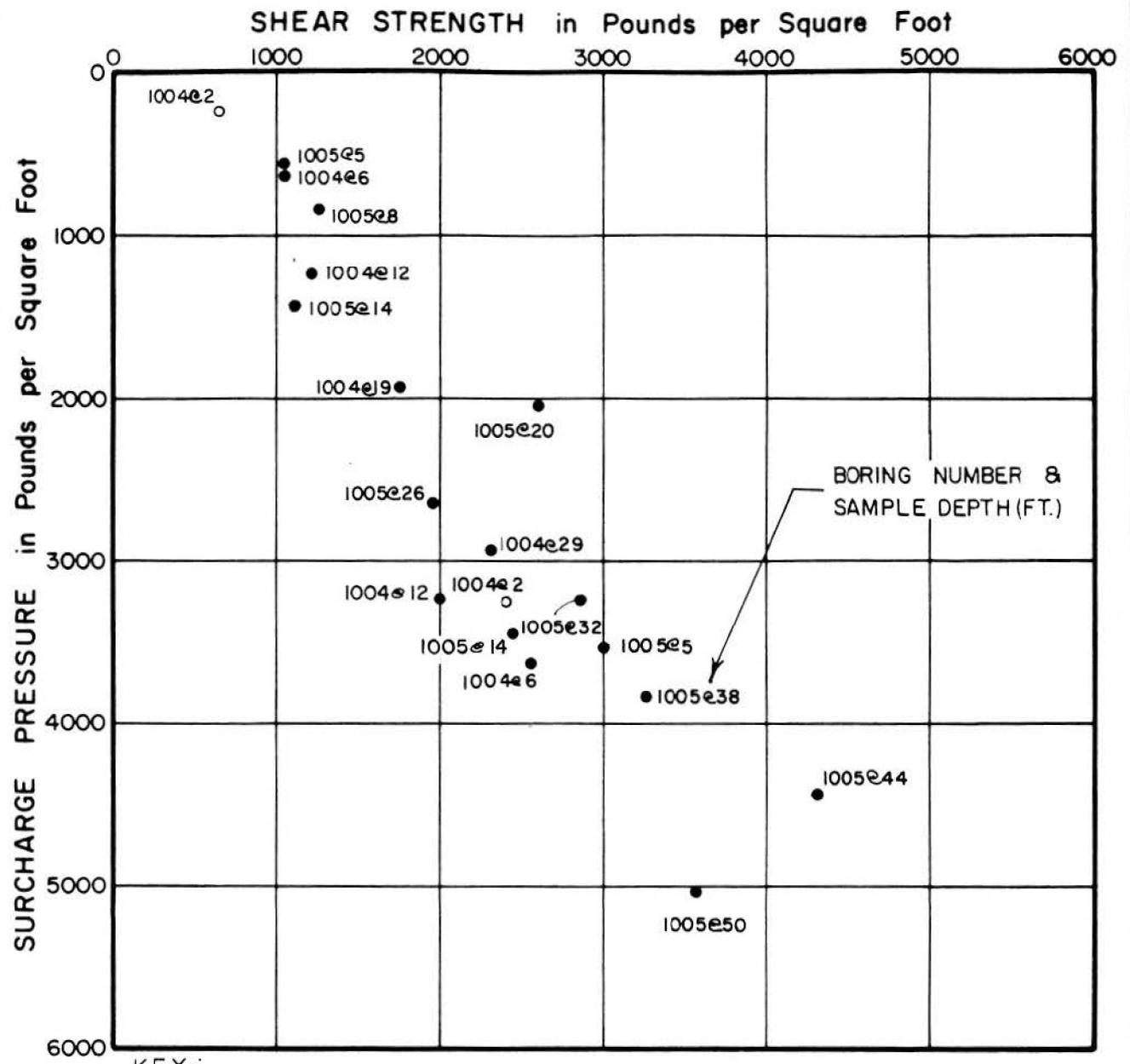
After completion of the compaction tests, California Bearing Ratio tests were performed on three of the samples in accordance with the ASTM Designation D1883-73 method. The results of the compaction and California Bearing Ratio tests are presented on Figures C-3.1 through C-3.3, Compaction and C.B.R. Test Data.

C.3.6 Particle Size Distribution

To determine the particle size distribution of the soils and to aid in classifying the soils, mechanical analyses were performed on three samples. The results of the mechanical analyses are presented on Figures C-4.1 and C-4.2.

C.3.7 Permeability Tests

Permeability tests were performed on selected undisturbed samples and remolded samples compacted to 90% and 95% at optimum moisture content to determine the coefficient of permeability of the soils. The samples were tested under a confining pressure of 200 pounds per square foot. The test results are presented on Figures C-5.1 and C-5.2.



KEY :

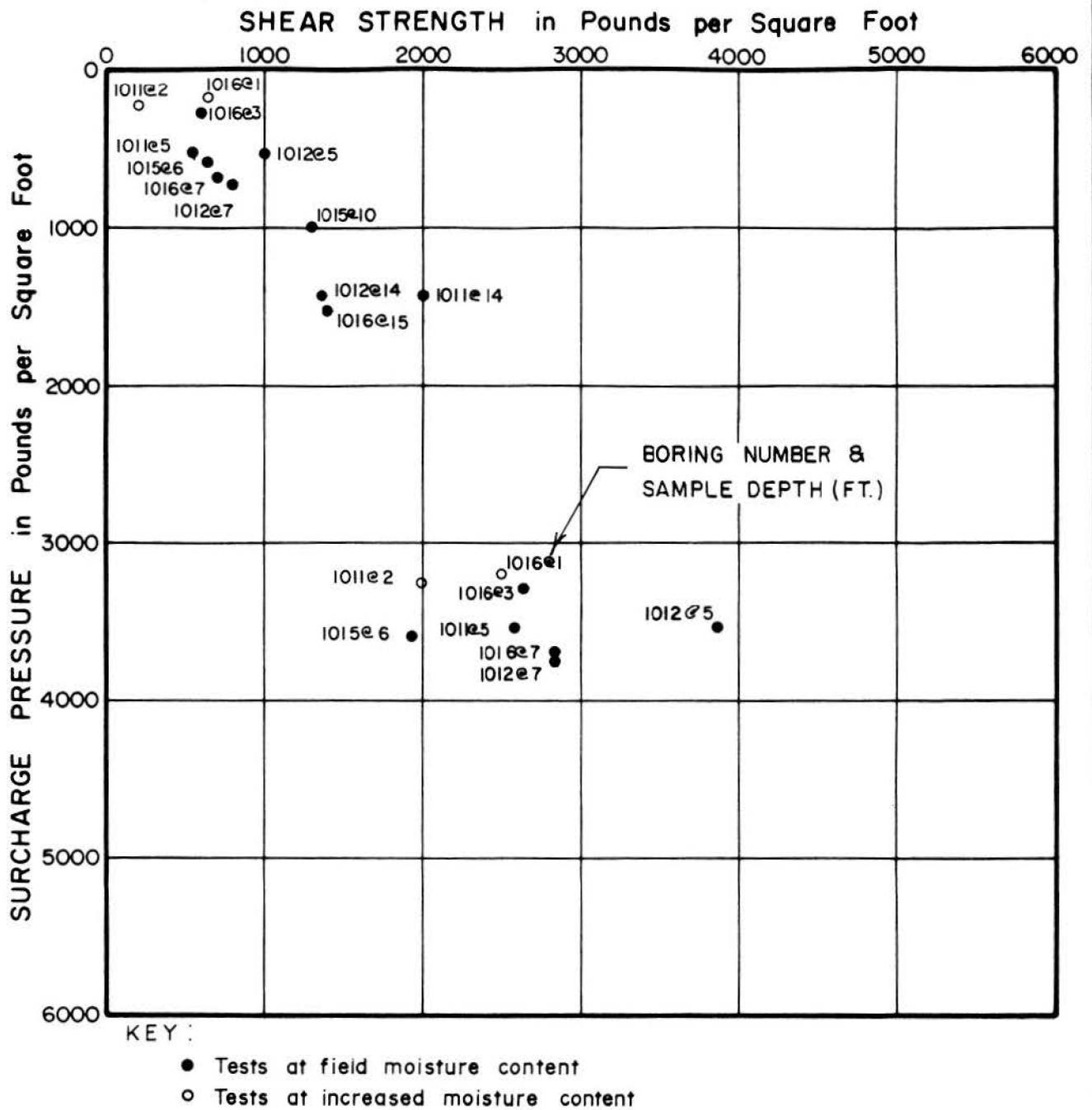
- Tests at field moisture content
- Tests at increased moisture content

DIRECT SHEAR TEST DATA

(TRESTLE)

LEROY CRANDALL & ASSOCIATES

FIGURE C-1.1

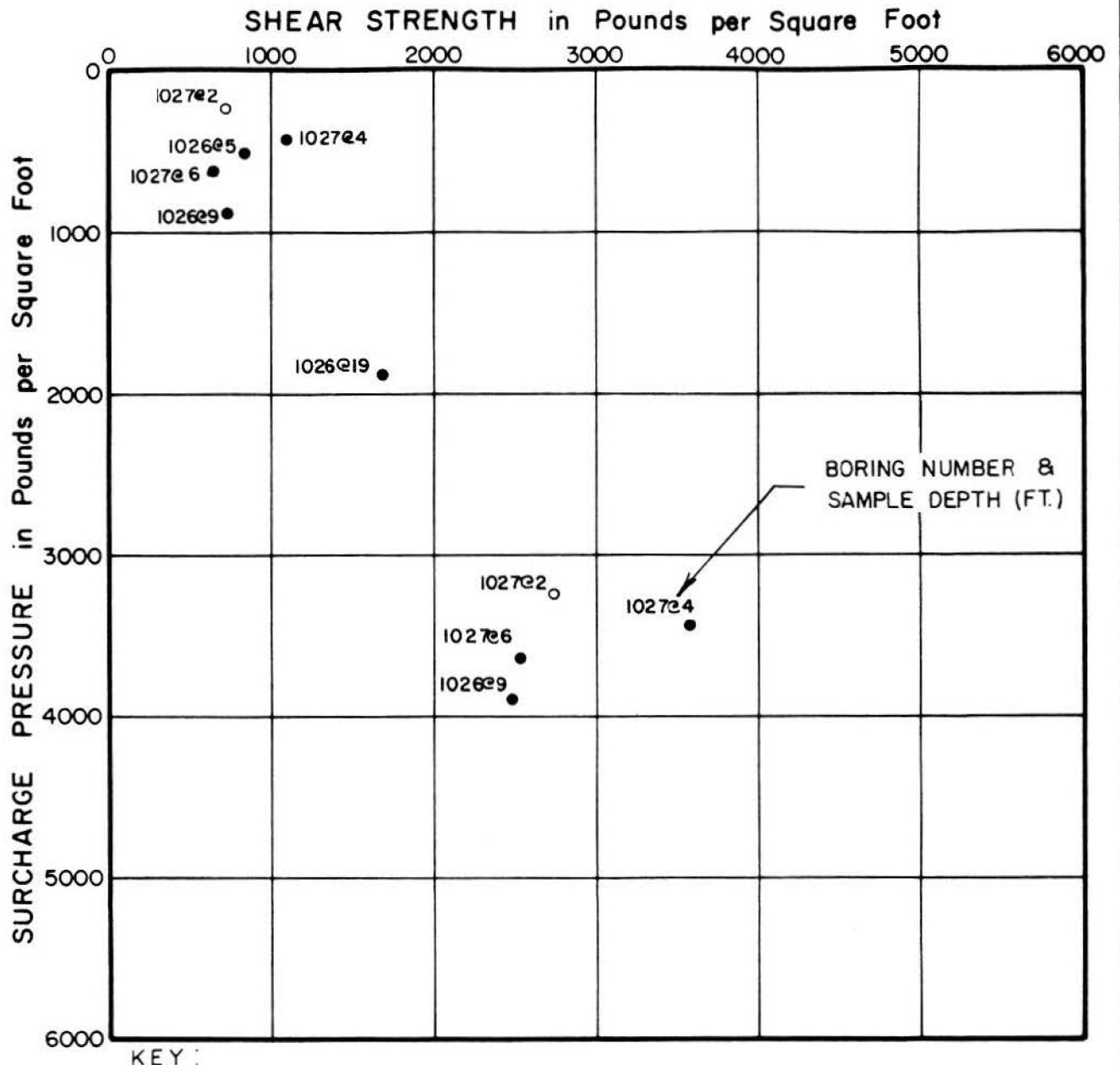


DIRECT SHEAR TEST DATA

(WARDLOW STATION)

LEROY CRANDALL & ASSOCIATES

FIGURE C-1.2

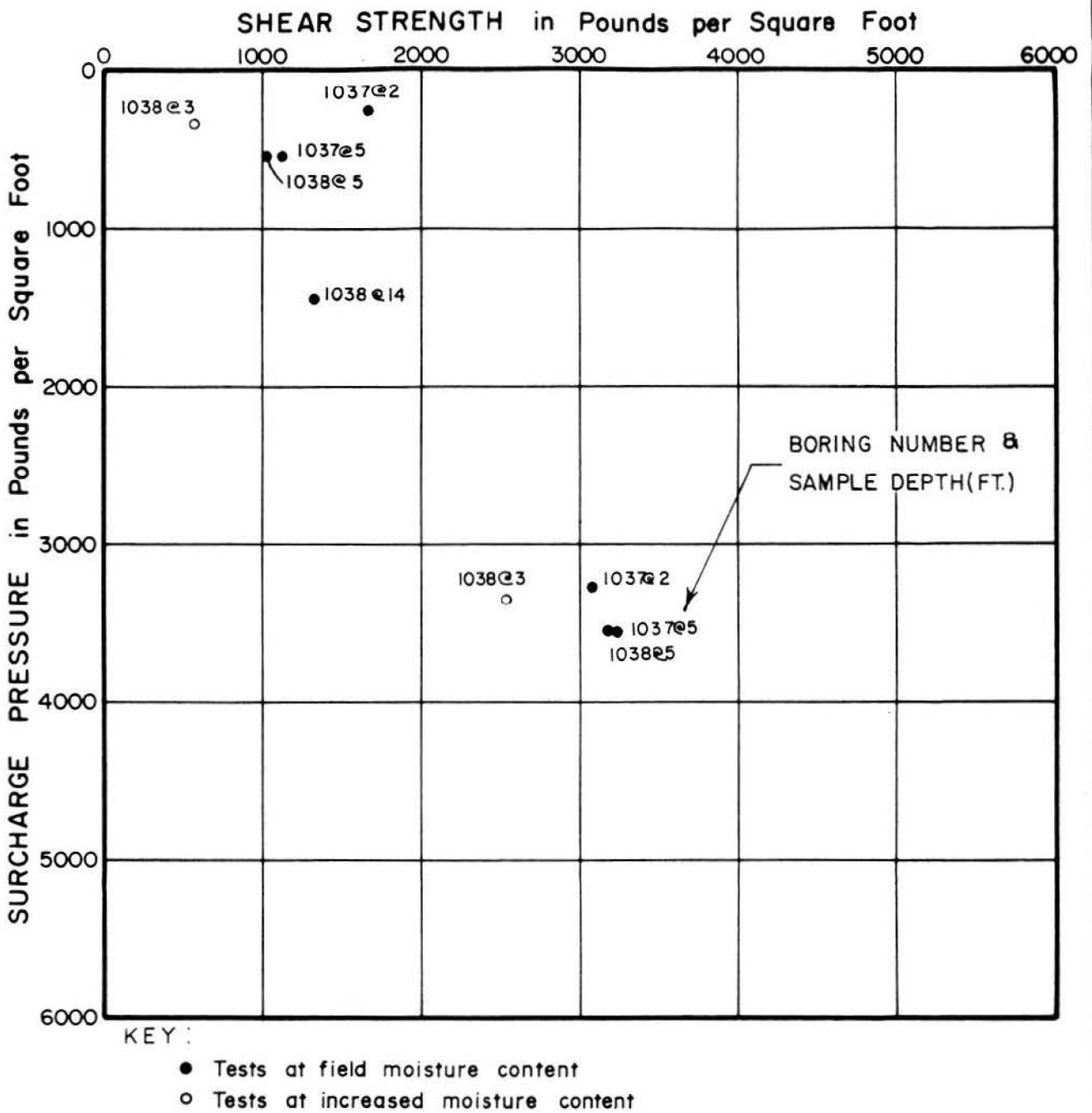


KEY :

- Tests at field moisture content
- Tests at increased moisture content

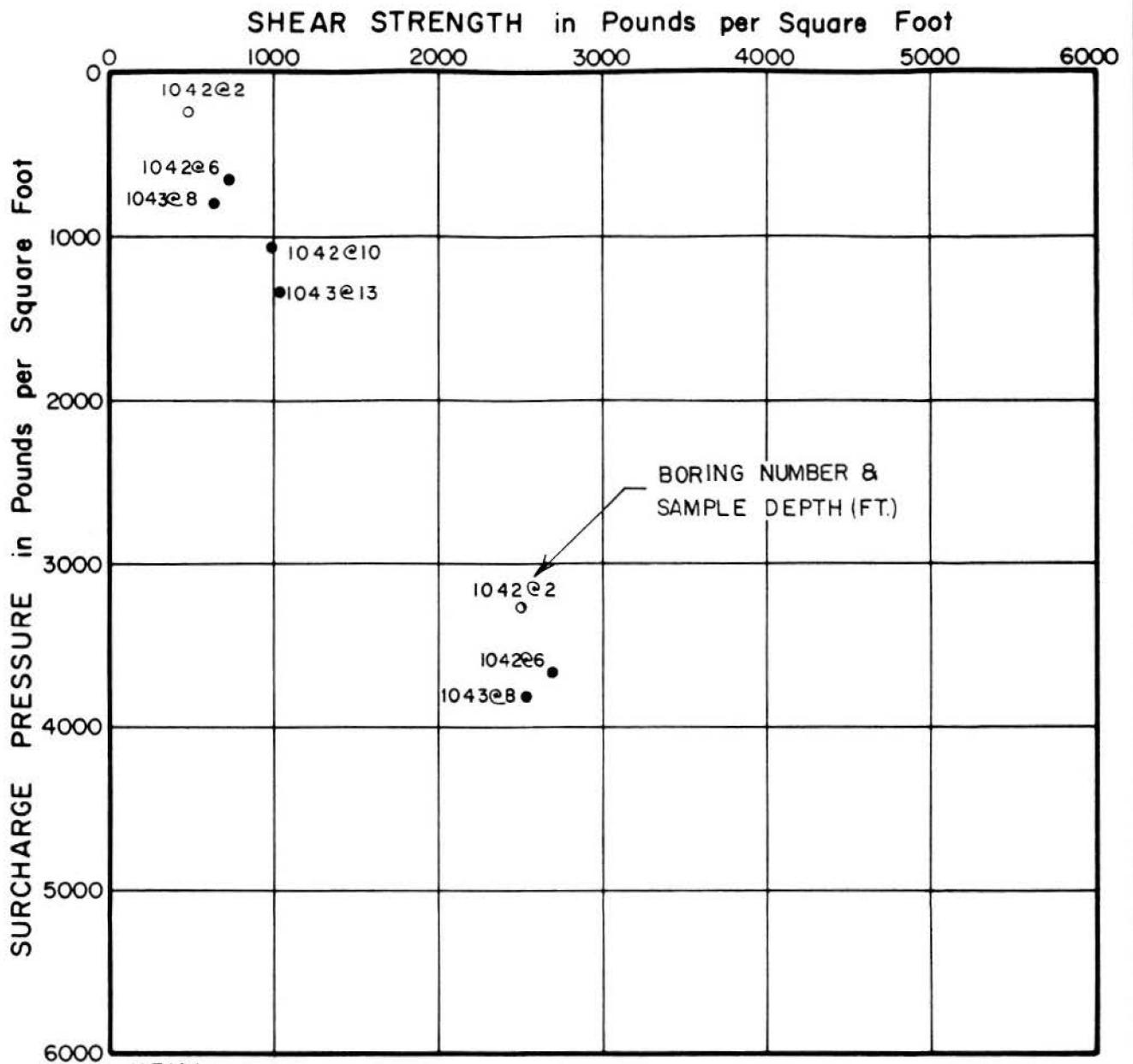
DIRECT SHEAR TEST DATA

(WILLOW STREET STATION)



DIRECT SHEAR TEST DATA

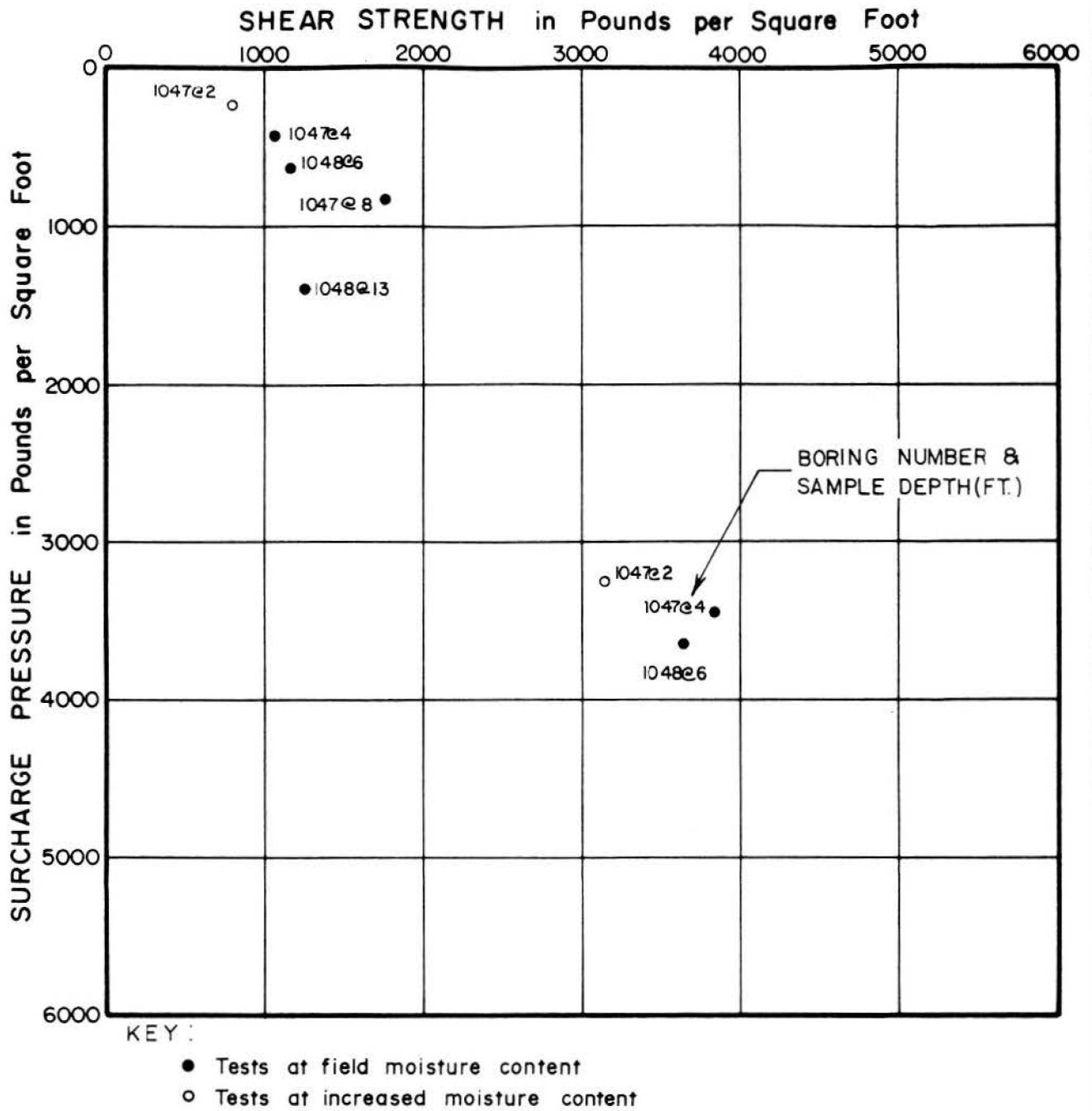
(HILL STREET STATION)



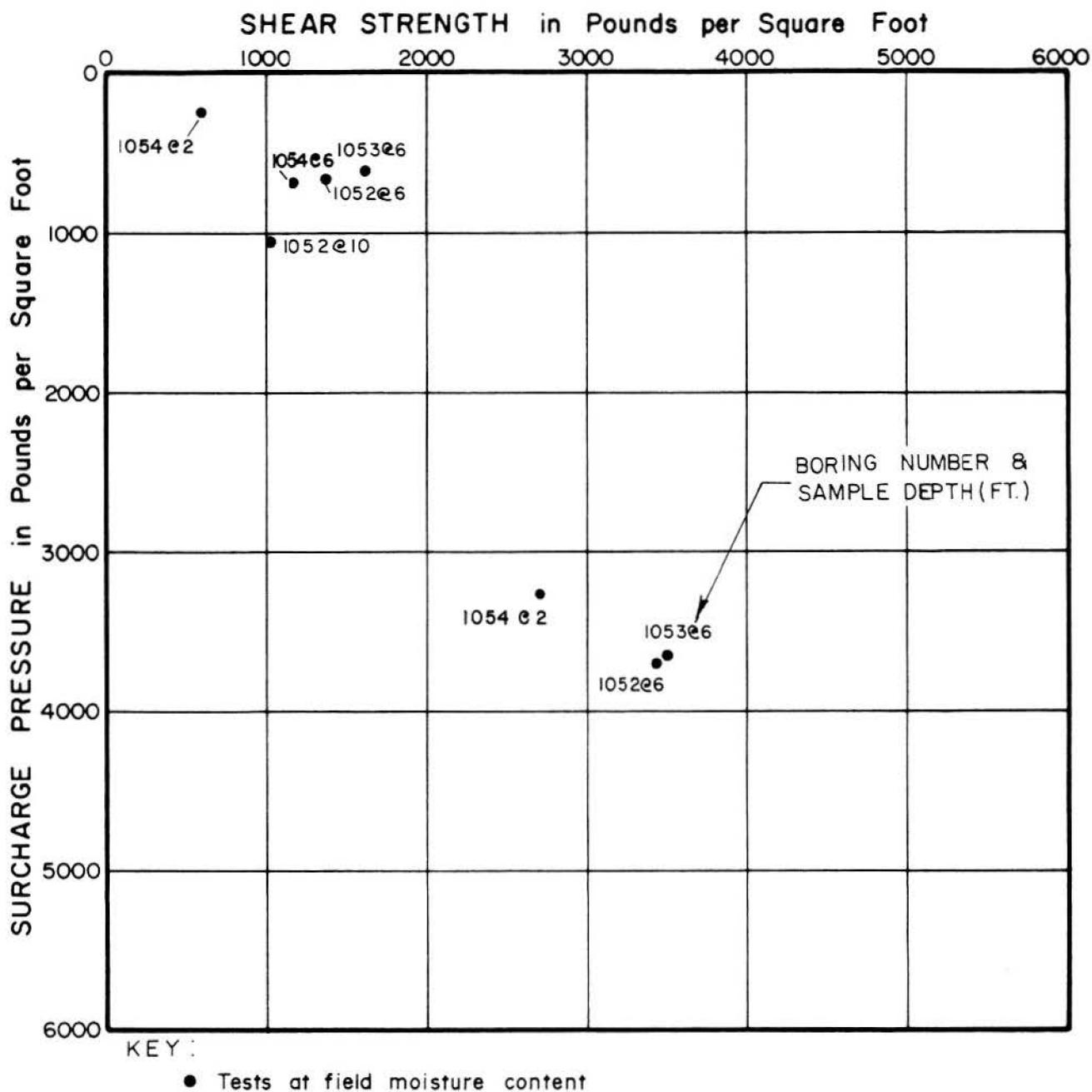
KEY:

- Tests at field moisture content
- Tests at increased moisture content

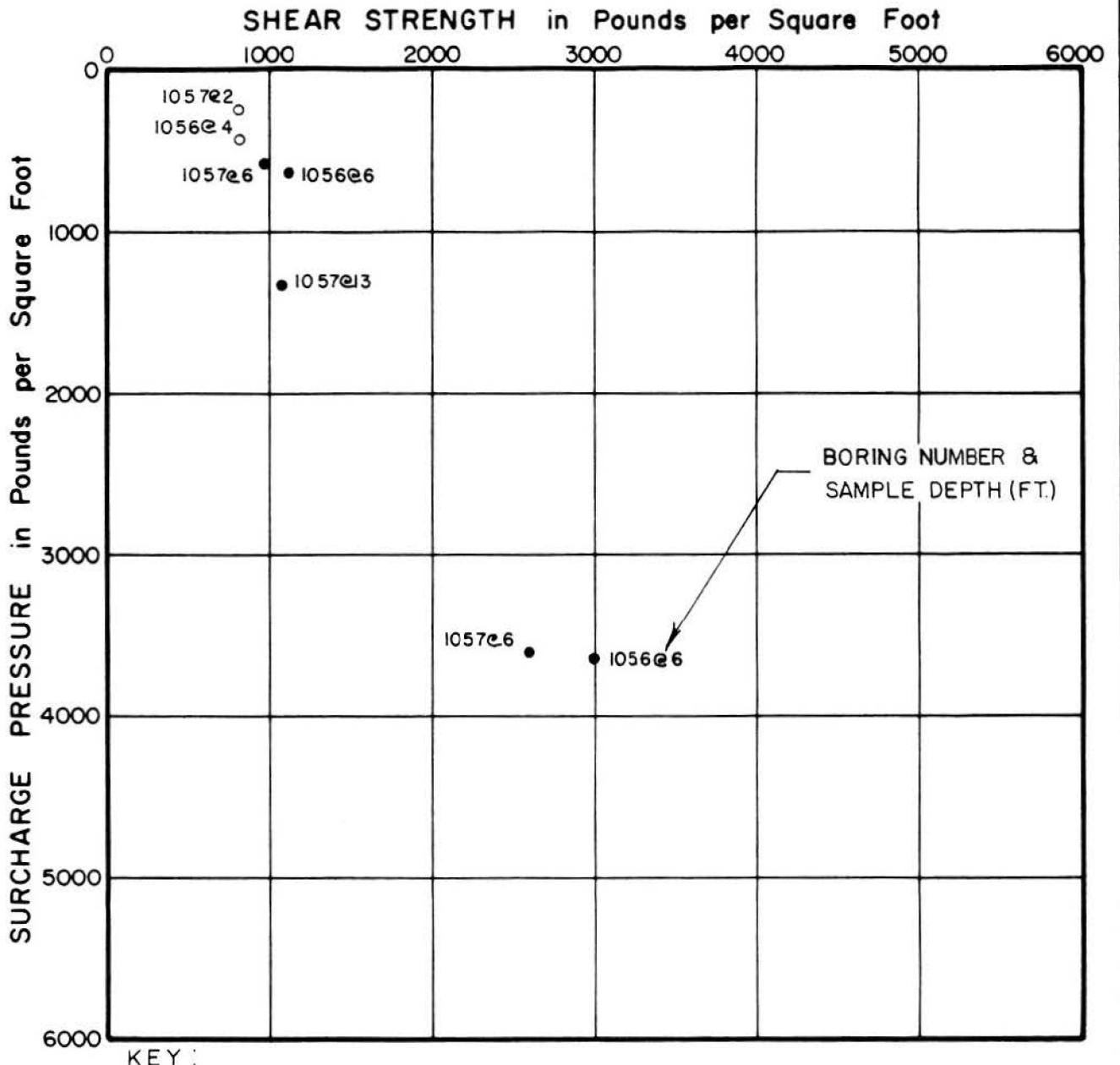
DIRECT SHEAR TEST DATA
(PACIFIC COAST HIGHWAY STATION)



DIRECT SHEAR TEST DATA
(ANAHEIM STREET STATION)



DIRECT SHEAR TEST DATA
(5 TH / 6 TH STREET STATION)



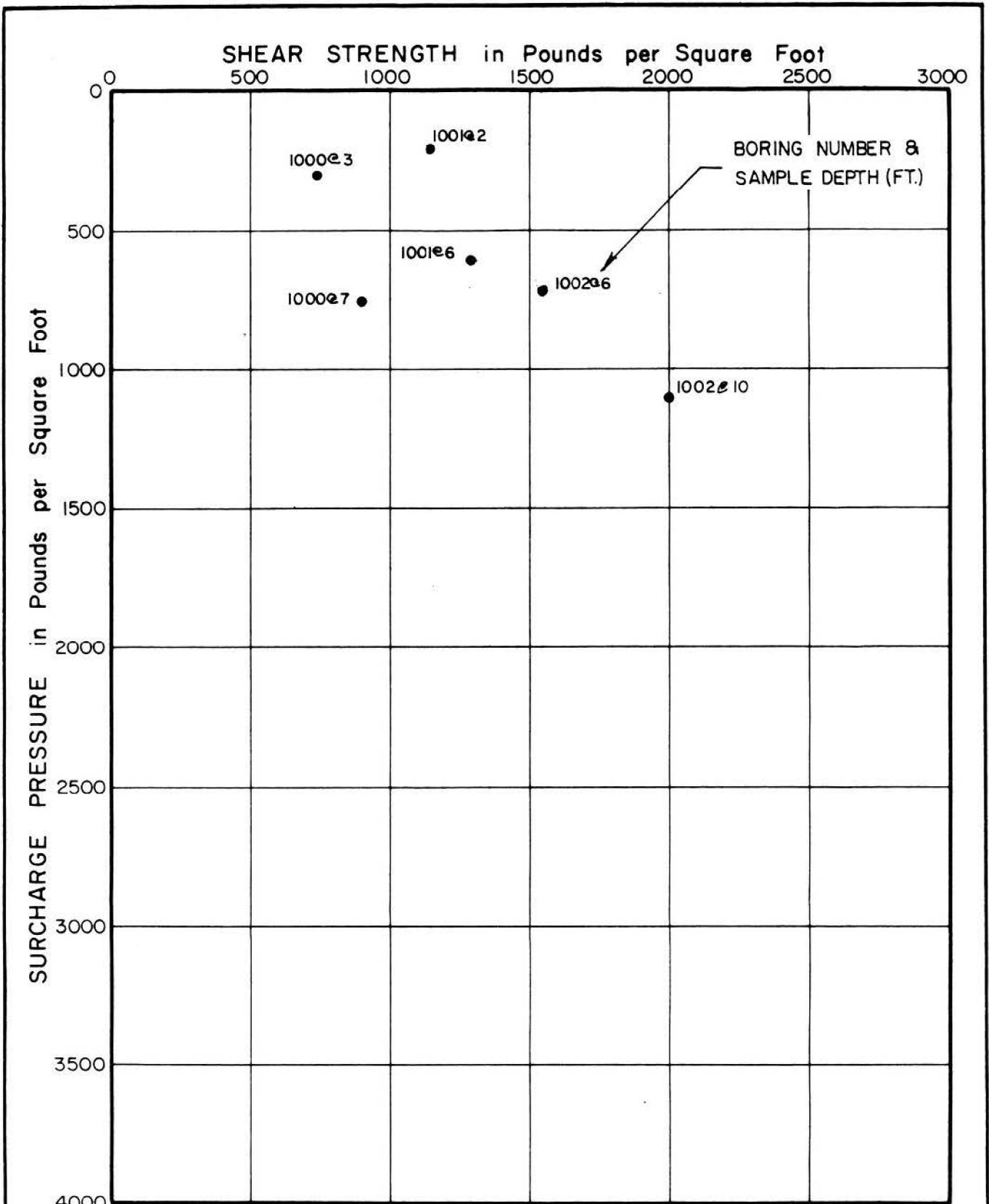
KEY:

- Tests at field moisture content
- Tests at increased moisture content

DIRECT SHEAR TEST DATA

(1 ST STREET STATION)

JOB ADE-85005-10 DATE 12/5/85 DR. JOHN O.E. L.A. CHKD. 1/2



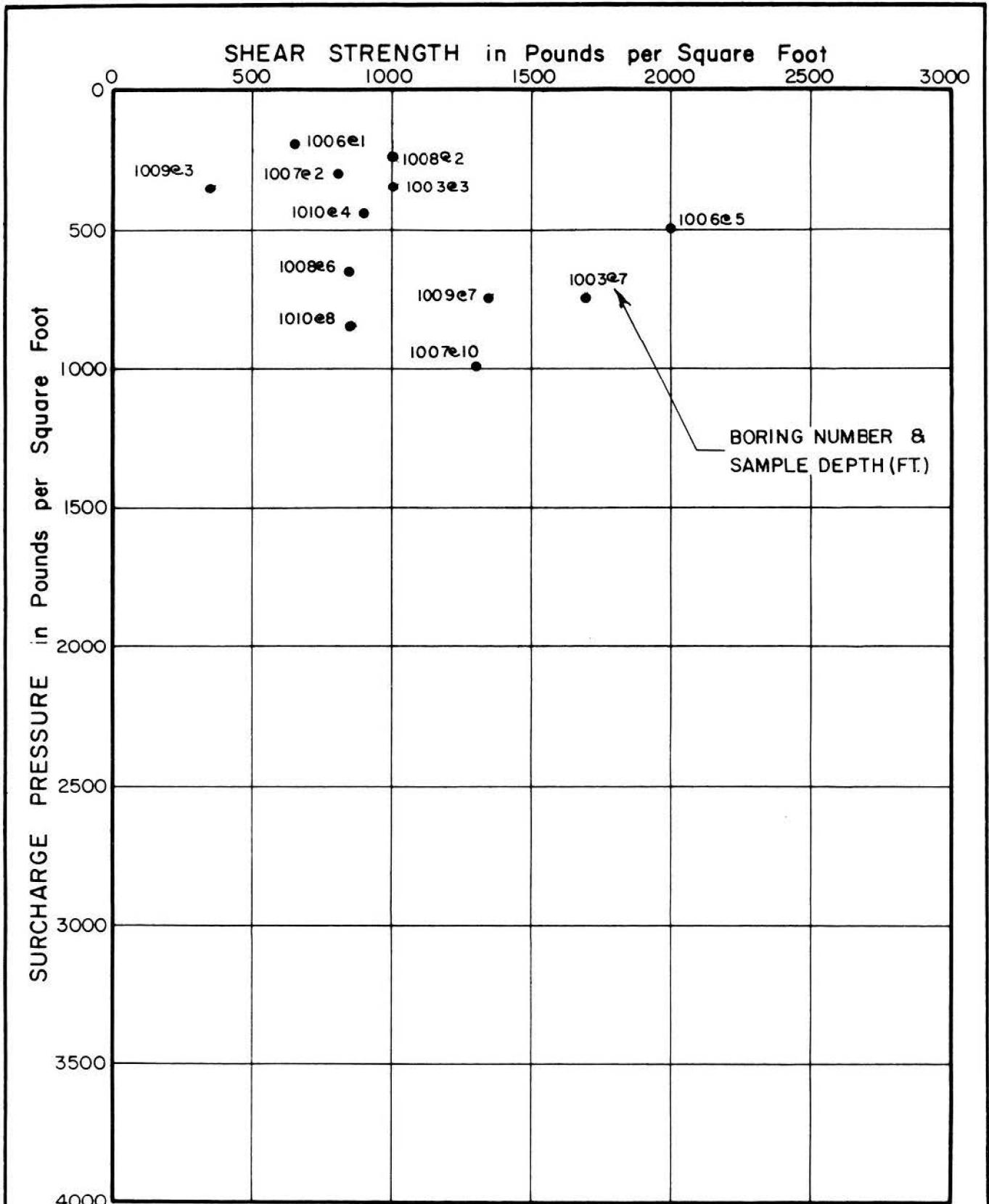
NOTE: All samples tested at field moisture content

DIRECT SHEAR TEST DATA

(OVERHEAD CONTACT SYSTEM PIER FOUNDATIONS)

LEROY CRANDALL & ASSOCIATES

JOB ADE-85005-10 DATE 12/5/85 DR. JOHN O.E. DM CHKD. MS

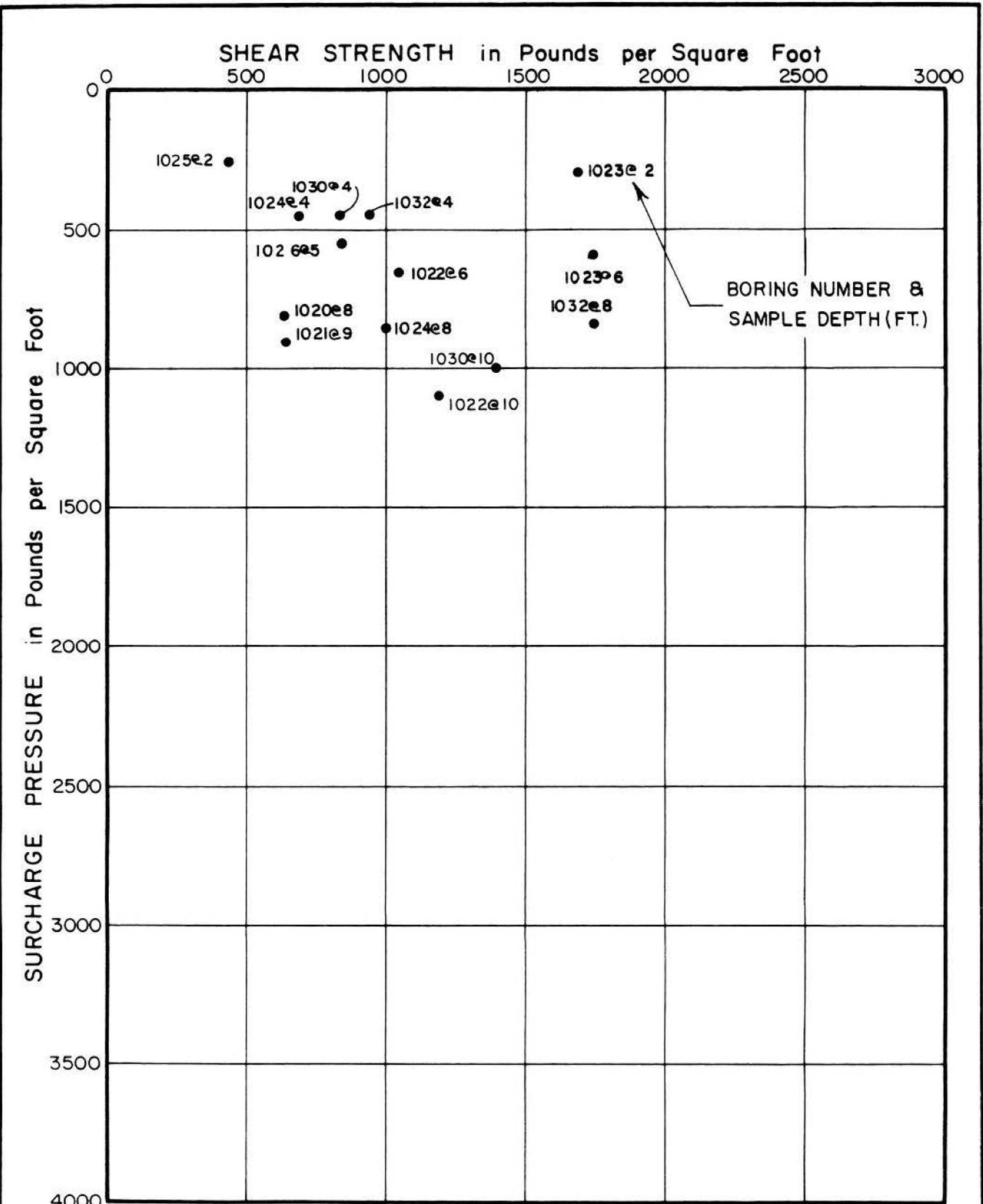


NOTE: All samples tested at field moisture content

DIRECT SHEAR TEST DATA
(OVERHEAD CONTACT SYSTEM PIER FOUNDATIONS)

LEROY CRANDALL & ASSOCIATES

JOB ADE-85005-10 DATE 12/5/85 DR. JOHN O.E. *DM* CHKD.

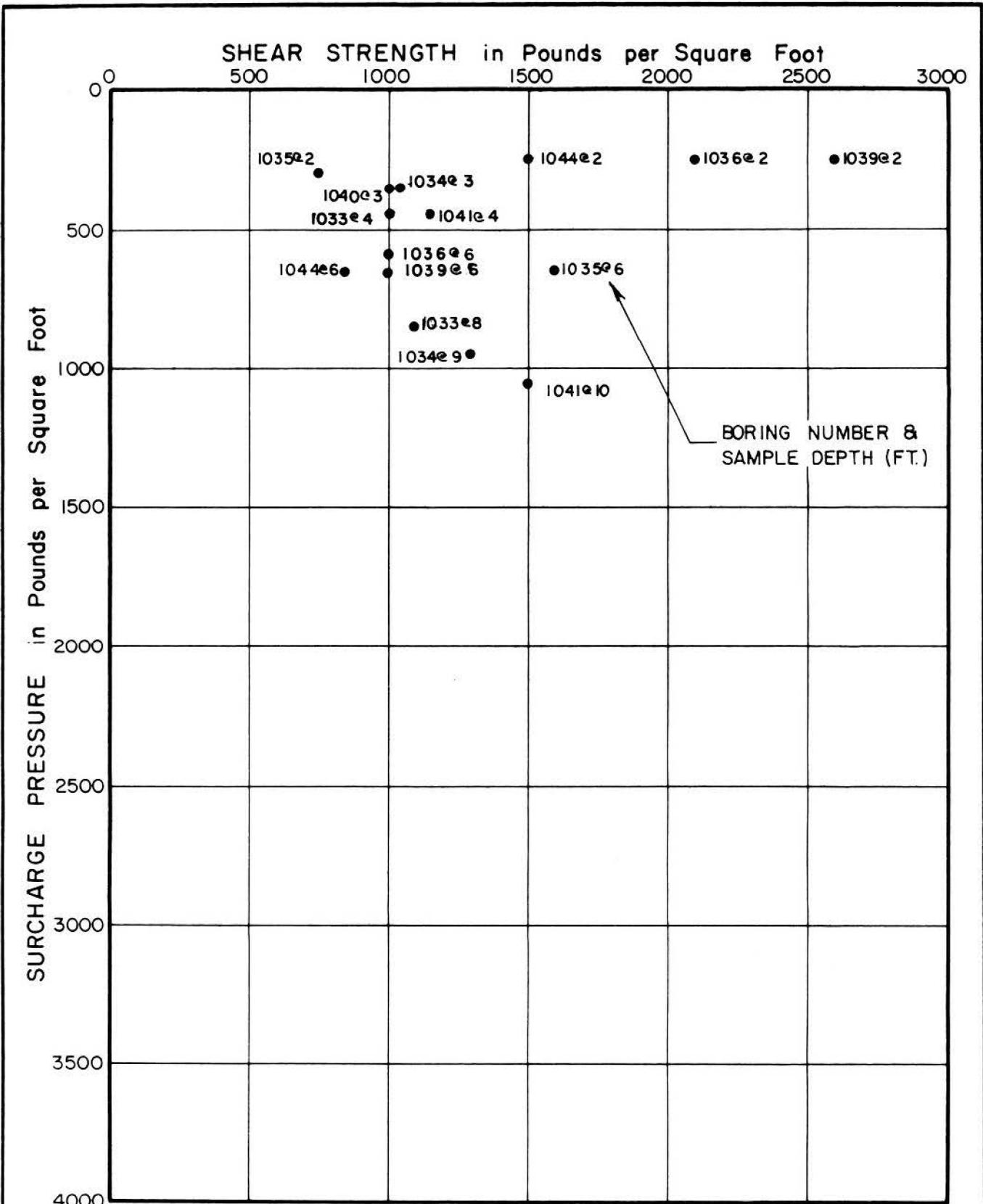


NOTE: All samples tested at field moisture content

DIRECT SHEAR TEST DATA
(OVERHEAD CONTACT SYSTEM PIER FOUNDATIONS)

LEROY CRANDALL & ASSOCIATES

JOB ADE-85005-10 DATE 12 / 5 / 85 DR. JOHN O.E. LA. CHKD. MS

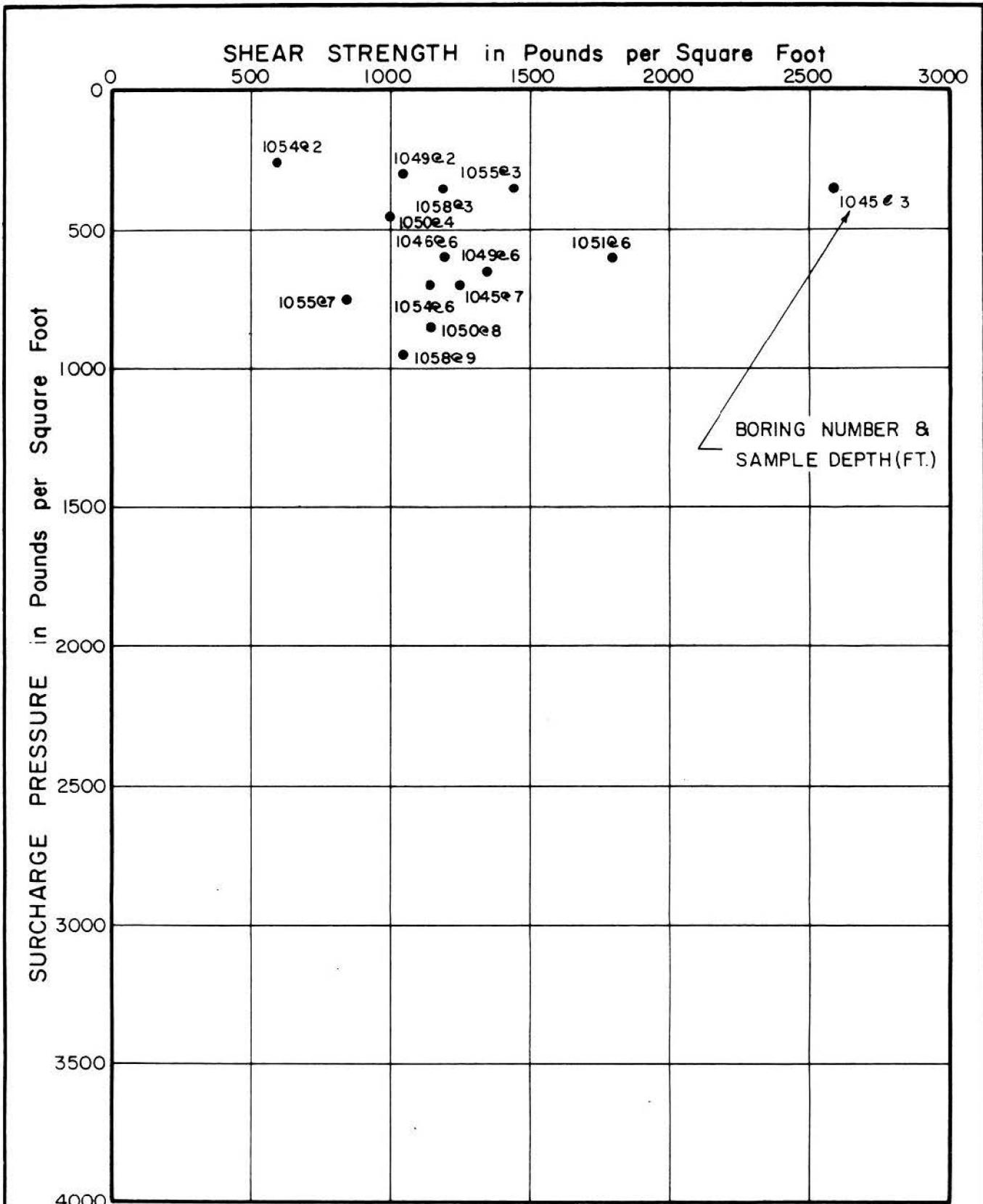


NOTE: All samples tested at field moisture content

DIRECT SHEAR TEST DATA
(OVERHEAD CONTACT SYSTEM PIER FOUNDATIONS)

LEROY CRANDALL & ASSOCIATES

JOB ADE-85005-10 DATE 12/5/85 DR. JOHN O.E. CHKD.



NOTE: All samples tested at field moisture content

DIRECT SHEAR TEST DATA
(OVERHEAD CONTACT SYSTEM PIER FOUNDATIONS)

LEROY CRANDALL & ASSOCIATES

JOB ADE-85005-10 DATE 12/2/85 DR. JOHN O.E. v/f CHKD. *[Signature]*

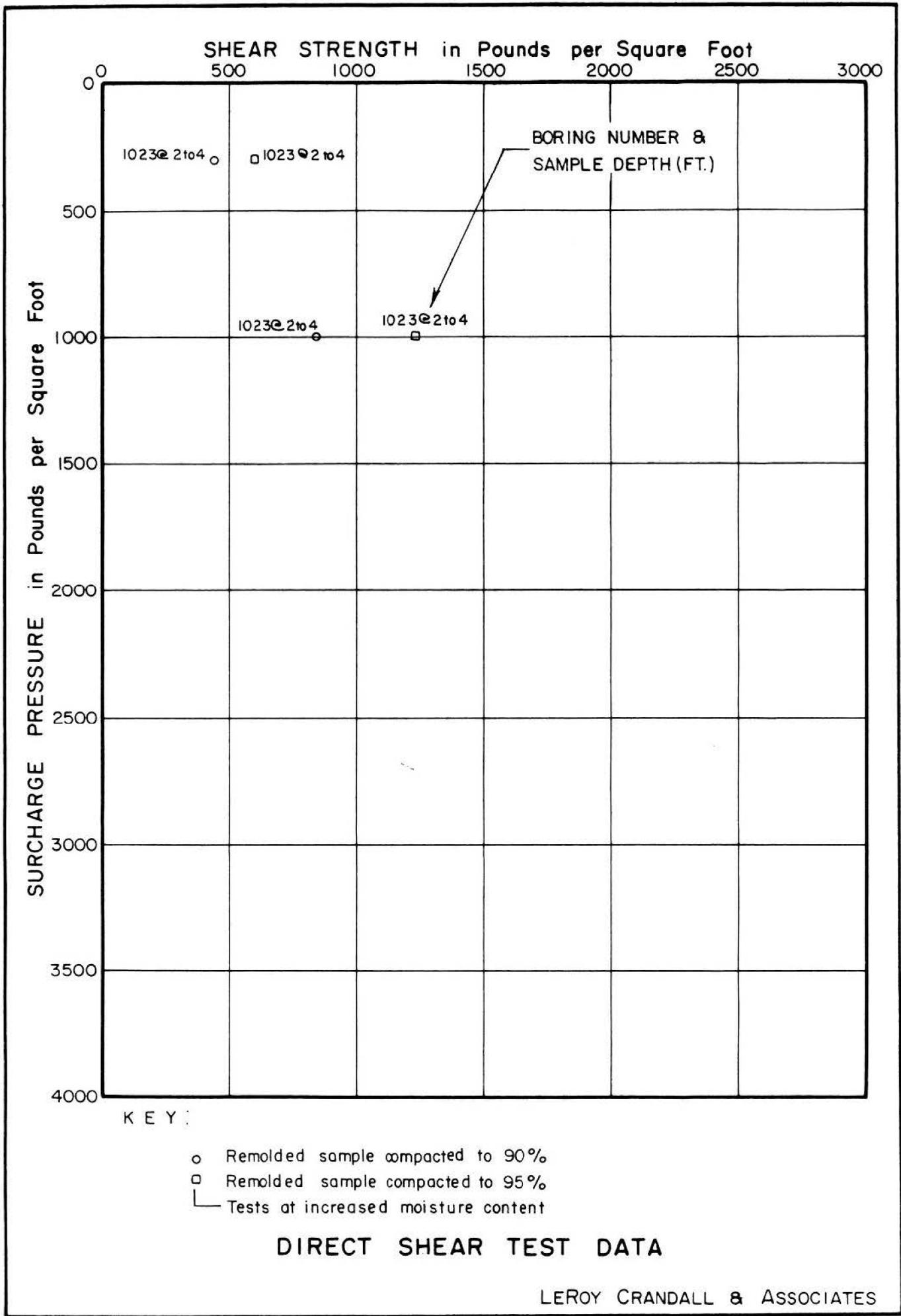
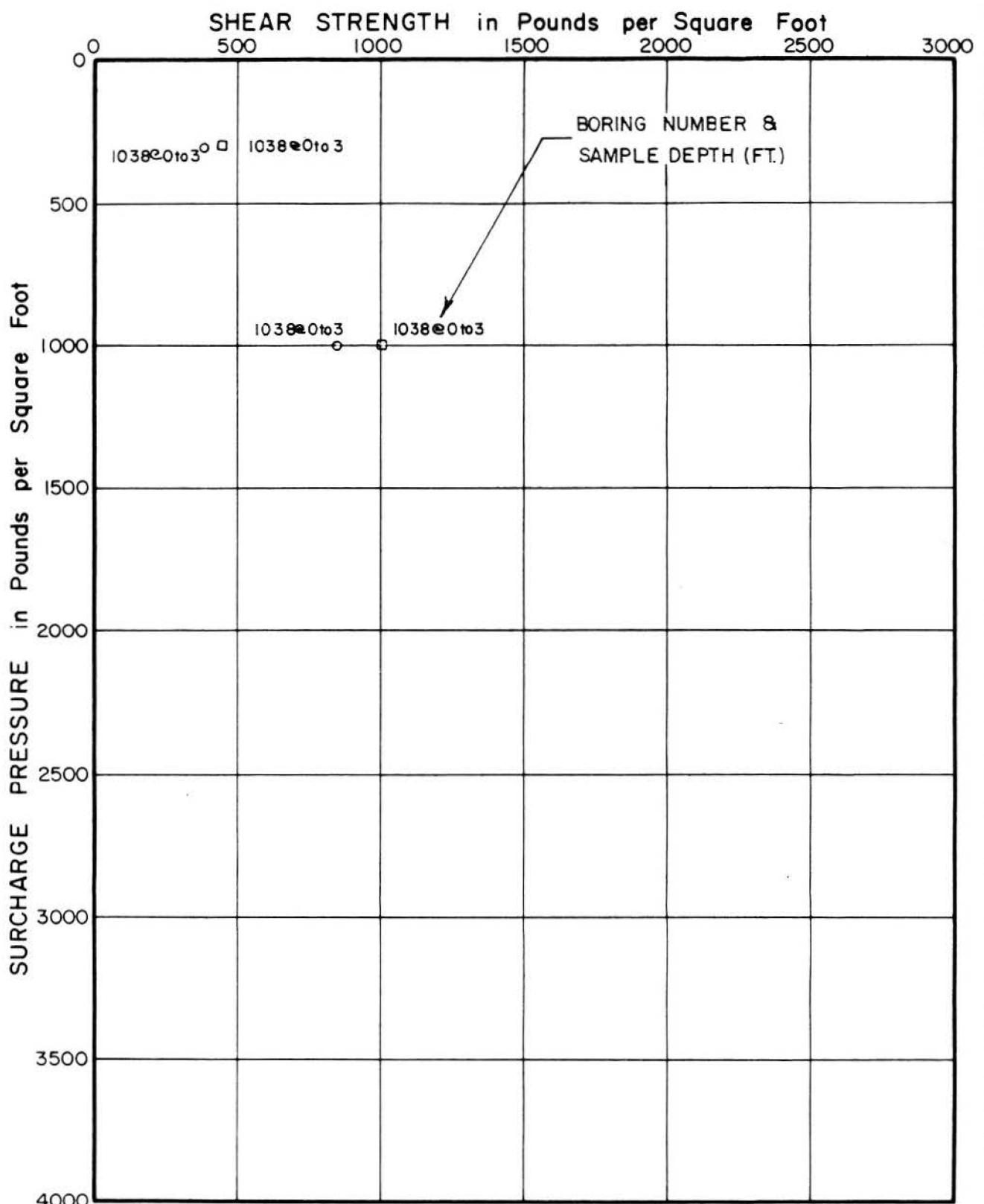


FIGURE C-1.14

JOB ADE-85005-10 DATE 12/2/85 DR. JOHN O.E. CHKD. 11/15

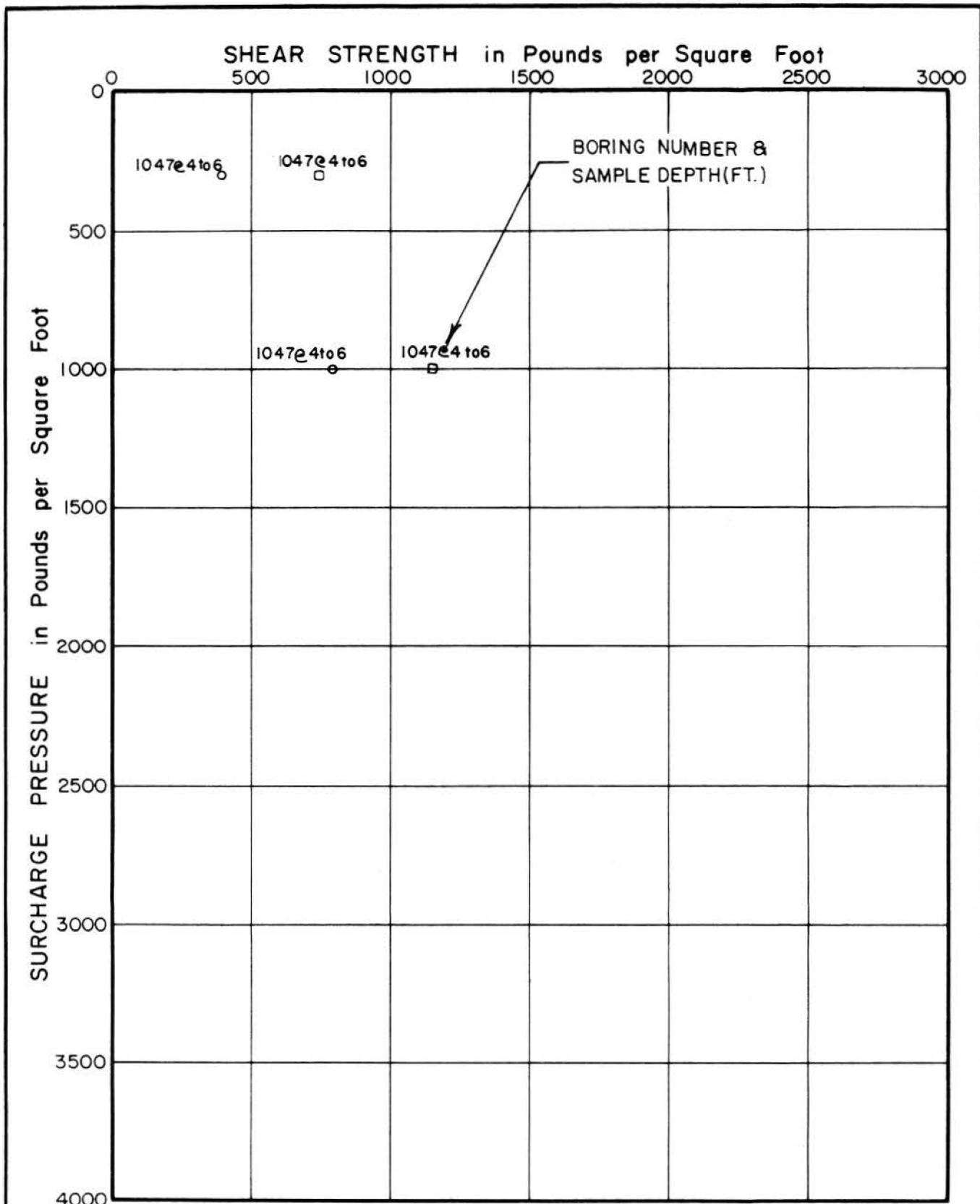


KEY:
○ Remolded sample compacted to 90%
□ Remolded sample compacted to 95%
└ Tests at increased moisture content

DIRECT SHEAR TEST DATA

LEROY CRANDALL & ASSOCIATES

JOB ADE-85005-10 DATE 12/2/85 DR. JOHN O.E. P.P. CHKD. M.J.



KEY:
○ Remolded sample compacted to 90%
□ Remolded sample compacted to 95%
└ Tests at increased moisture content

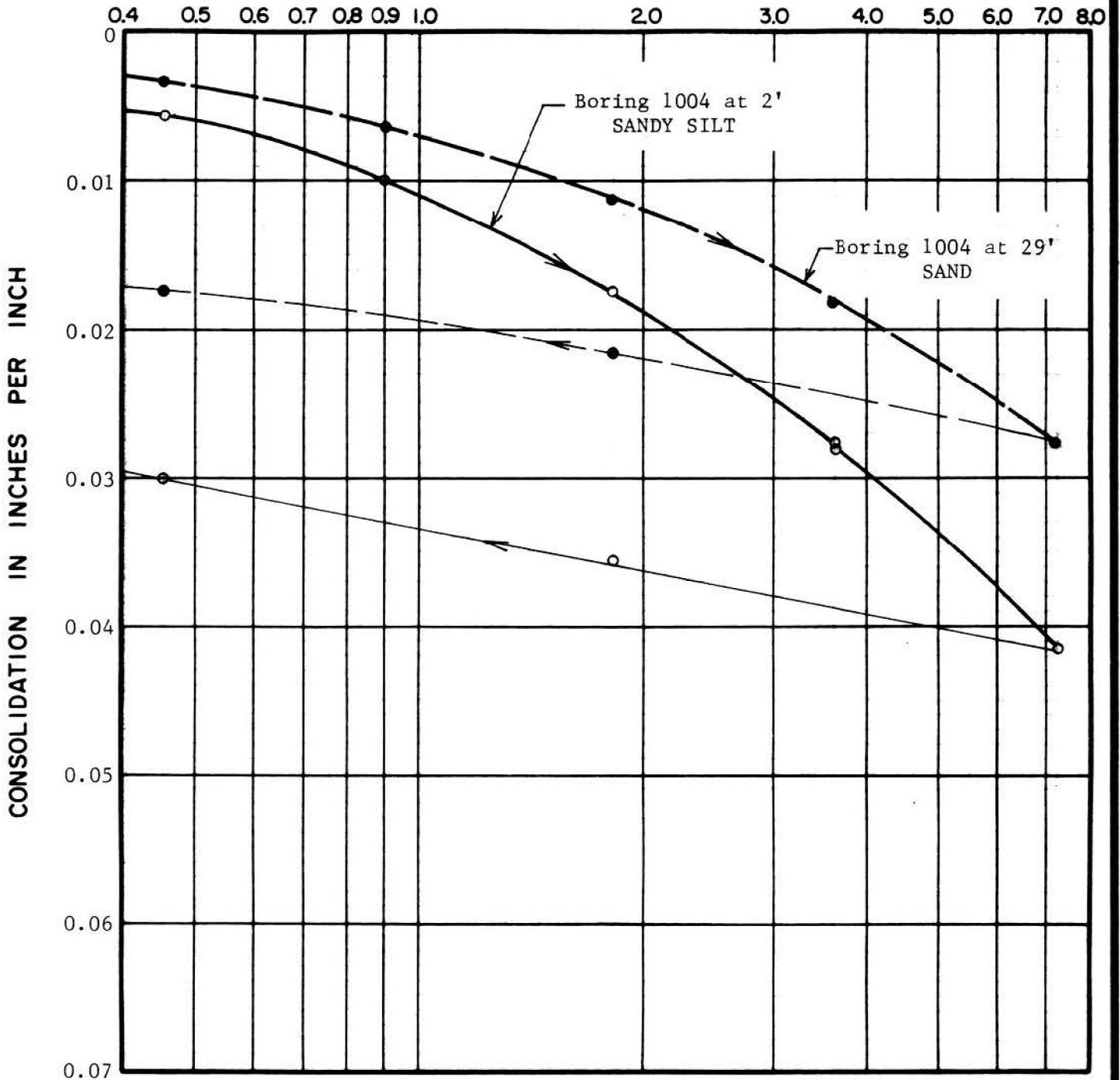
DIRECT SHEAR TEST DATA

LEROY CRANDALL & ASSOCIATES

FIGURE C-1.16

JOB ADE-85-005-10 DATE 11/30/85 DR. R.V. O.E. DM W.P. CHKD M.S.

LOAD IN KIPS PER SQUARE FOOT



NOTE: Water added to sample from 2' after consolidation under a load of 3.6 kips per square foot. The other sample tested at field moisture content.

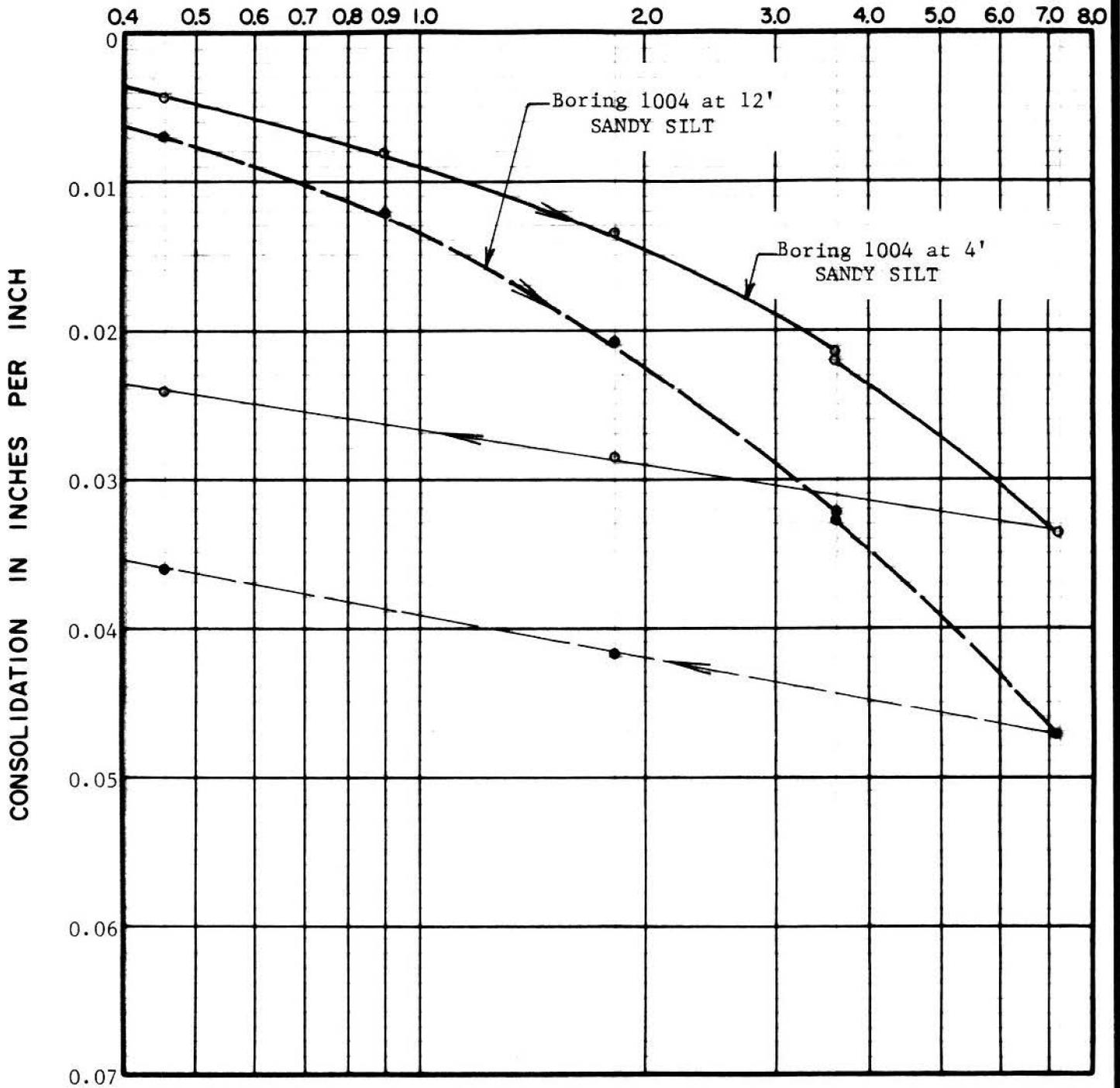
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

FIGURE C-2.1

JOB ADE-85005-10 DATE 12-20-85 DR. RU. O.E. DM W.P. CHKD

LOAD IN KIPS PER SQUARE FOOT



NOTE: Water added to samples after consolidation under a load of 3.6 kips per square foot.

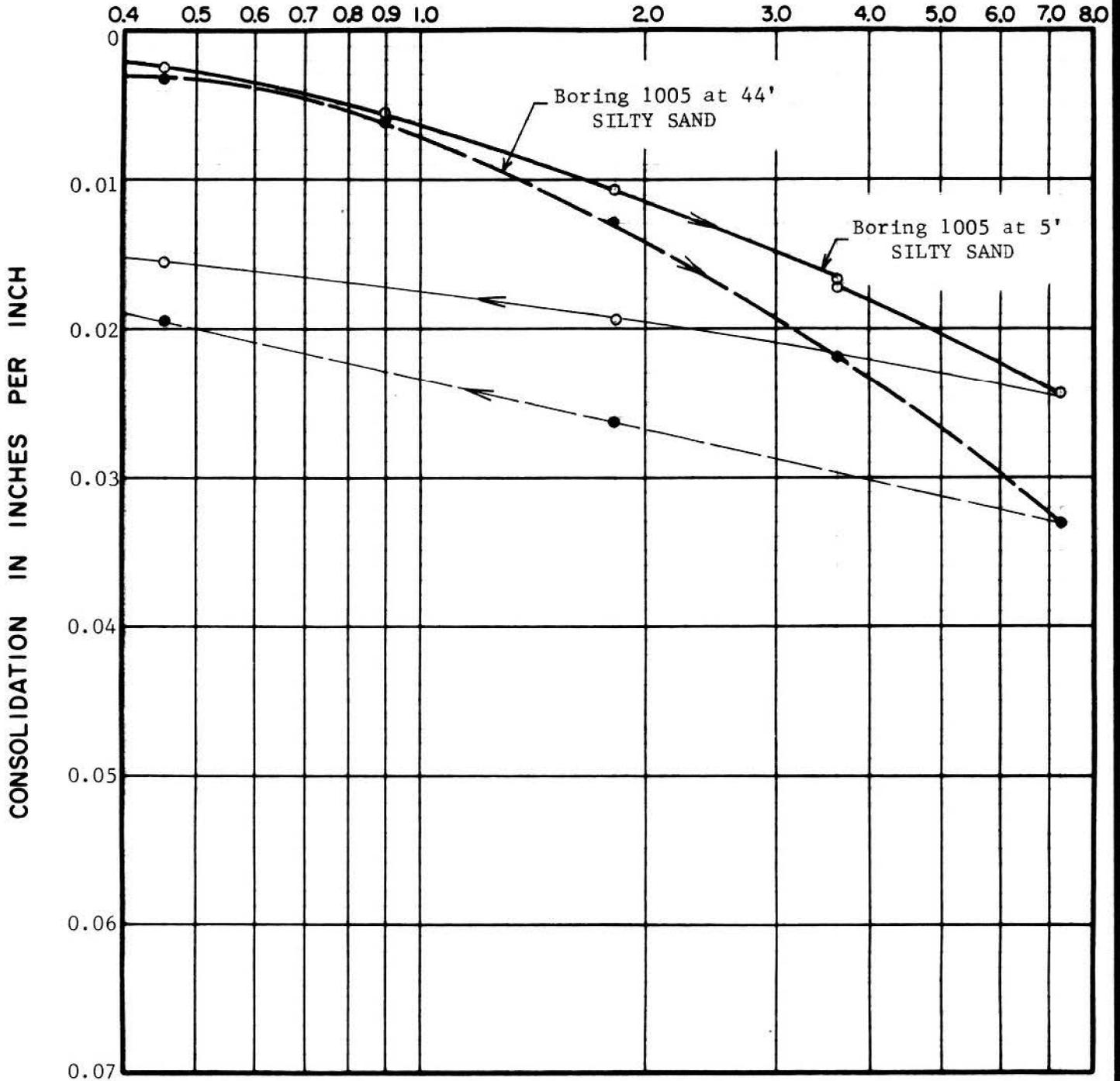
CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

FIGURE C-2.2

JOB ADE-15005-10 DATE 11/30/85 DR. RW. O.E. DM W.P. dmh CHKD MS

LOAD IN KIPS PER SQUARE FOOT



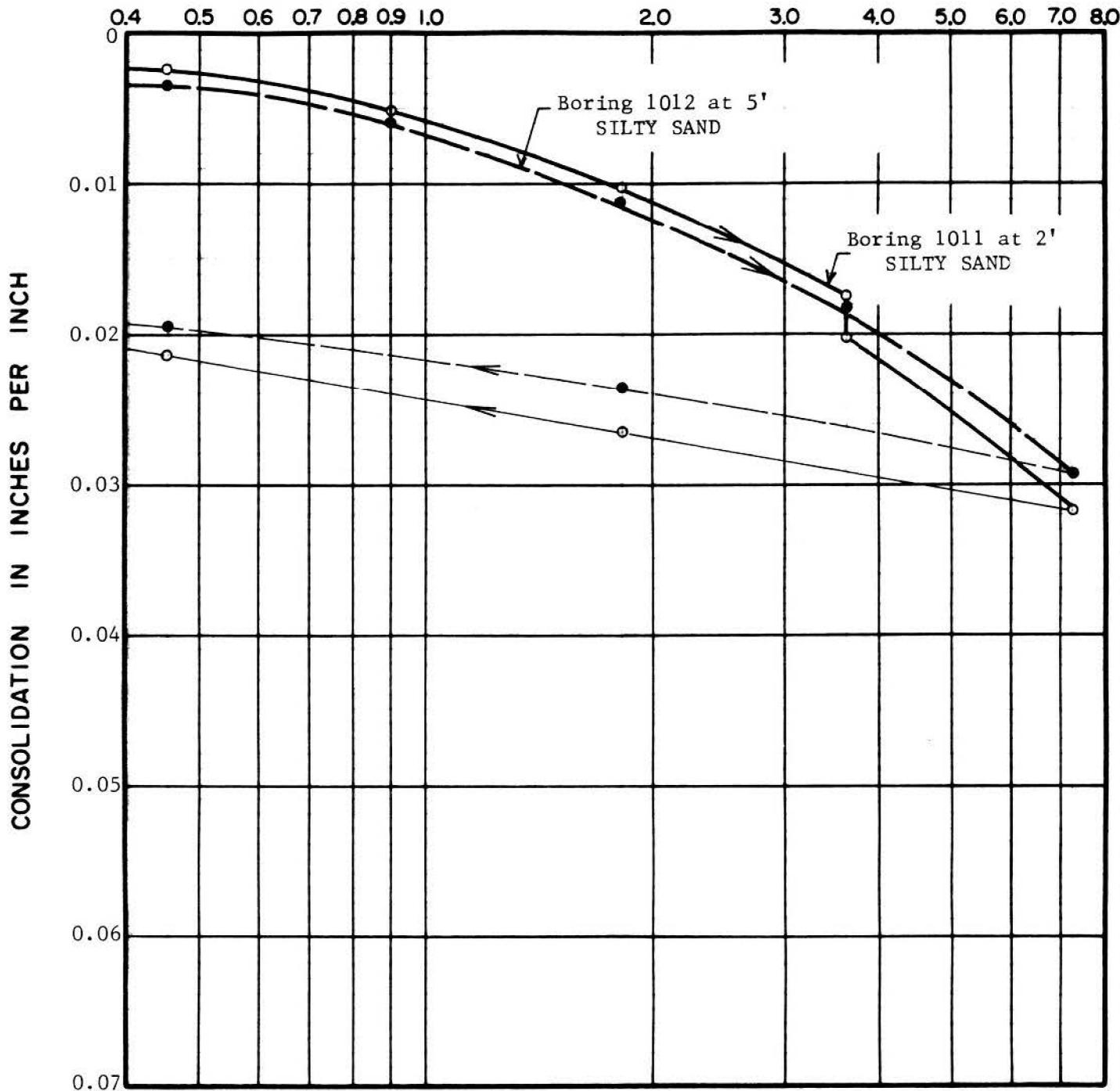
NOTE: Water added to sample from 5' after consolidation under a load of 3.6 kips per square foot. The other sample tested at field moisture content.

CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

JOB ADE-85005-10 DATE 11/30/85 DR. RU O.E. J. W.P. imh CHKD MS

LOAD IN KIPS PER SQUARE FOOT



NOTE: Water added to sample from Boring 1011 after consolidation under a load of 3.6 kips per square foot. The other sample tested at field moisture content.

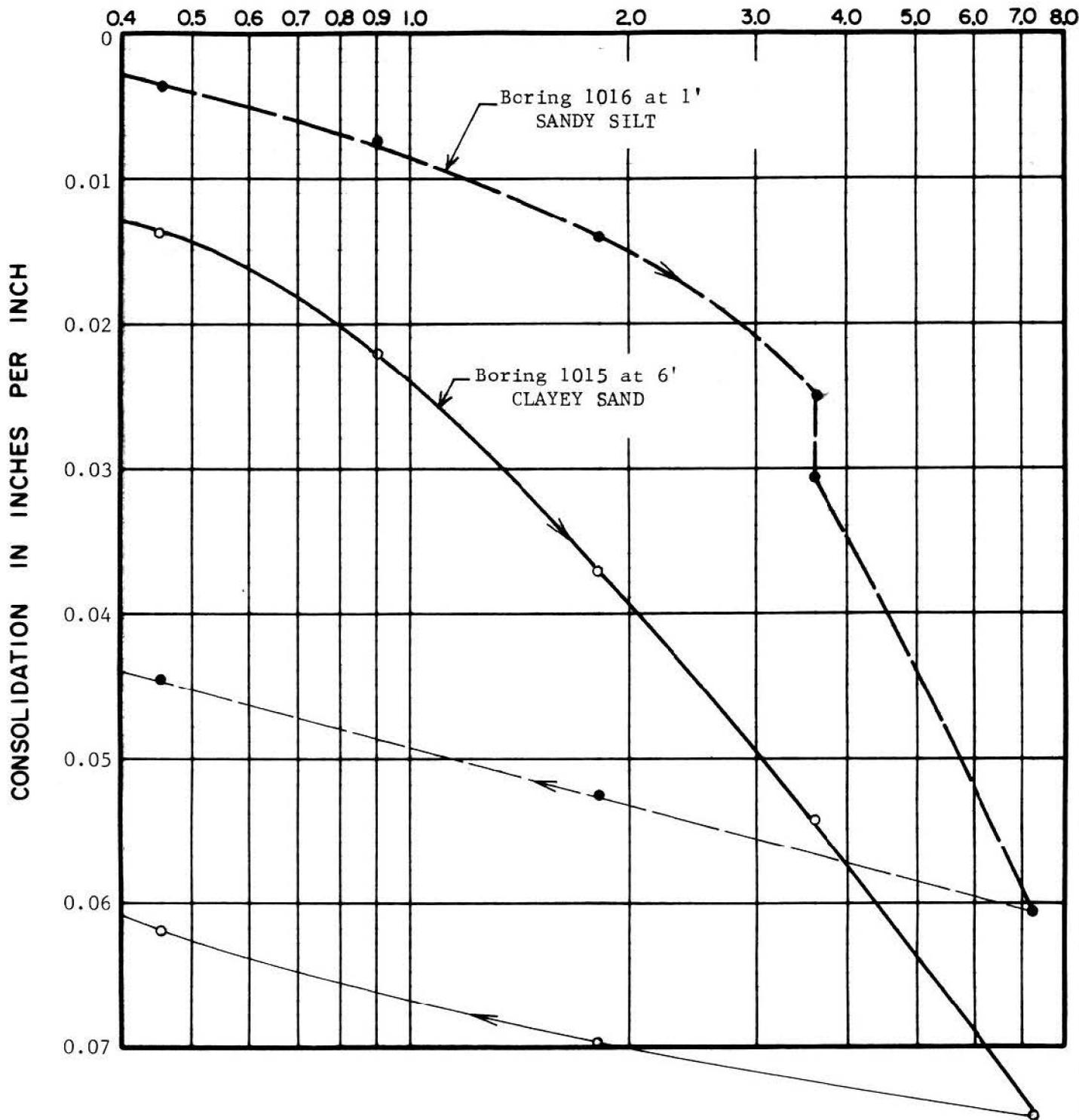
CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

FIGURE C-2.4

JOB ADE-85005-10 DATE 11/30/85 DR. RU. O.E. DM. W.P. dmh. CHKD. MS

LOAD IN KIPS PER SQUARE FOOT



NOTE: Water added to sample from Boring 1016 after consolidation under a load of 3.6 kips per square foot. The other sample tested at field moisture content.

CONSOLIDATION TEST DATA

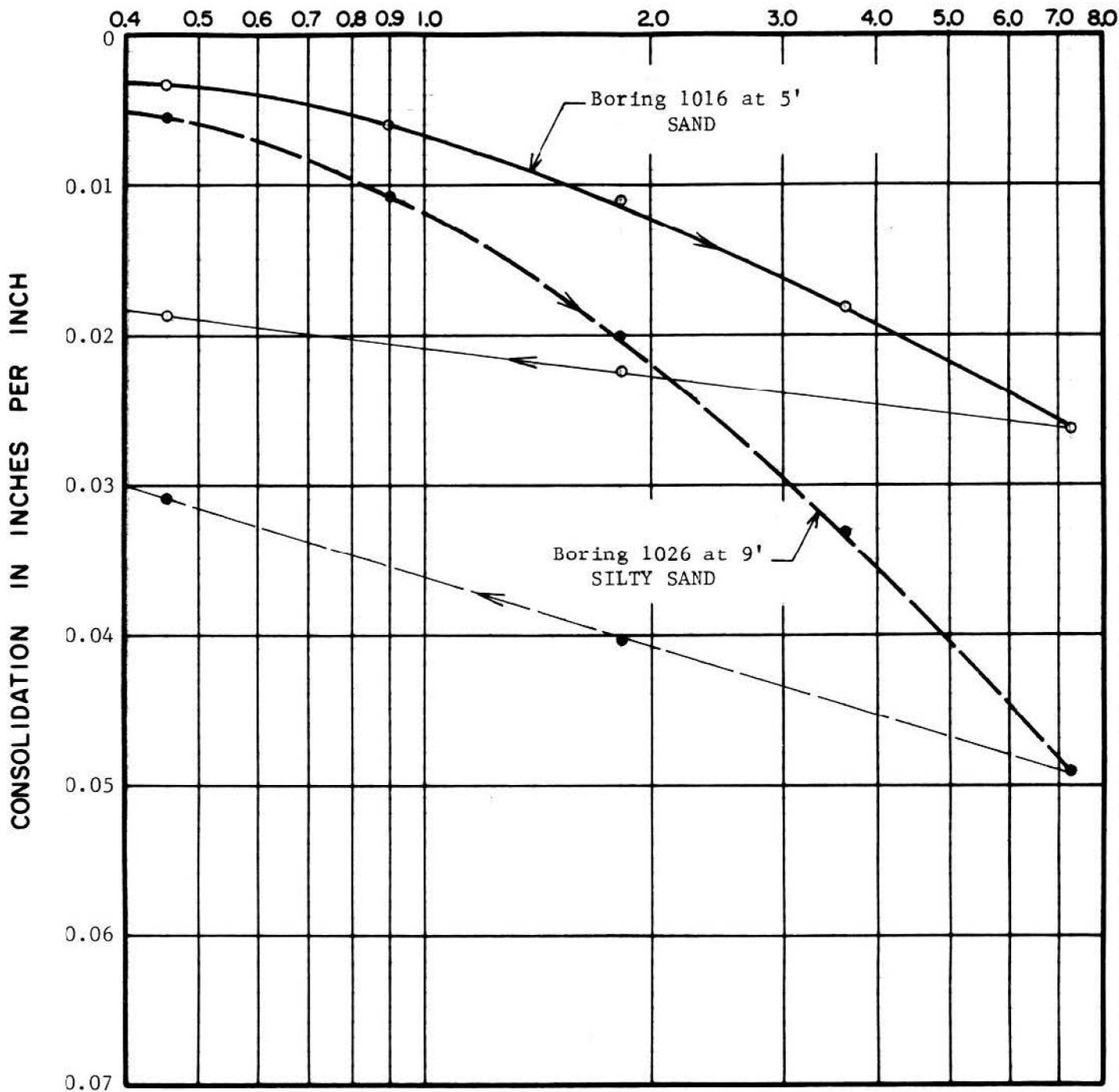
LEROY CRANDALL AND ASSOCIATES

FIGURE C-2.5

JOB ADE-85005-10 DATE 11/30/85 DR. RU. O.E. L. W.P. CHKD. imh

FORM 116

LOAD IN KIPS PER SQUARE FOOT



NOTE: Samples tested at field moisture content.

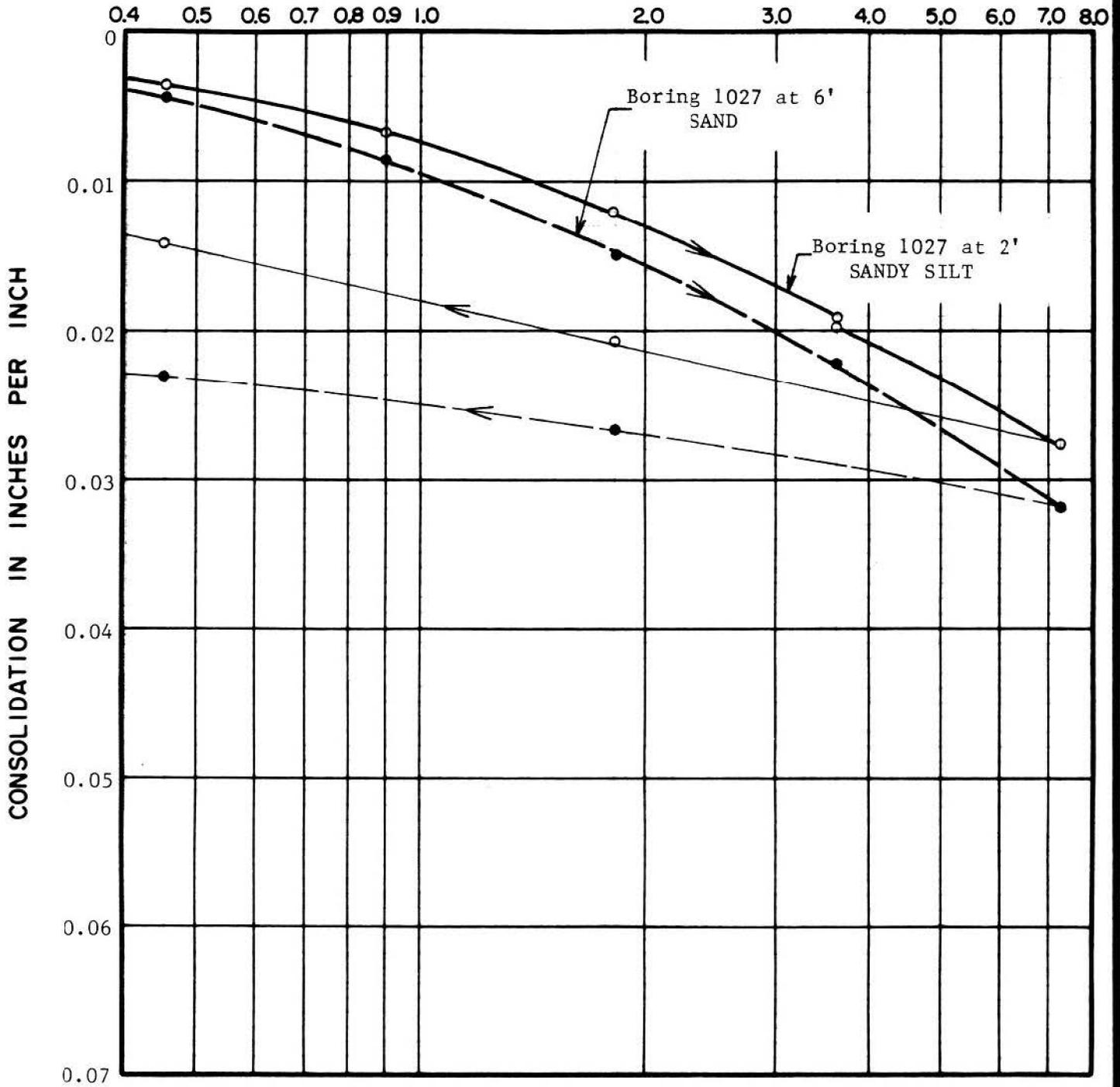
CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

FIGURE C-2.6

JOB ADE-85005-10 DATE 11/30/85 DR. RU. O.E. DIA. W.P. imh CHKD MS

LOAD IN KIPS PER SQUARE FOOT



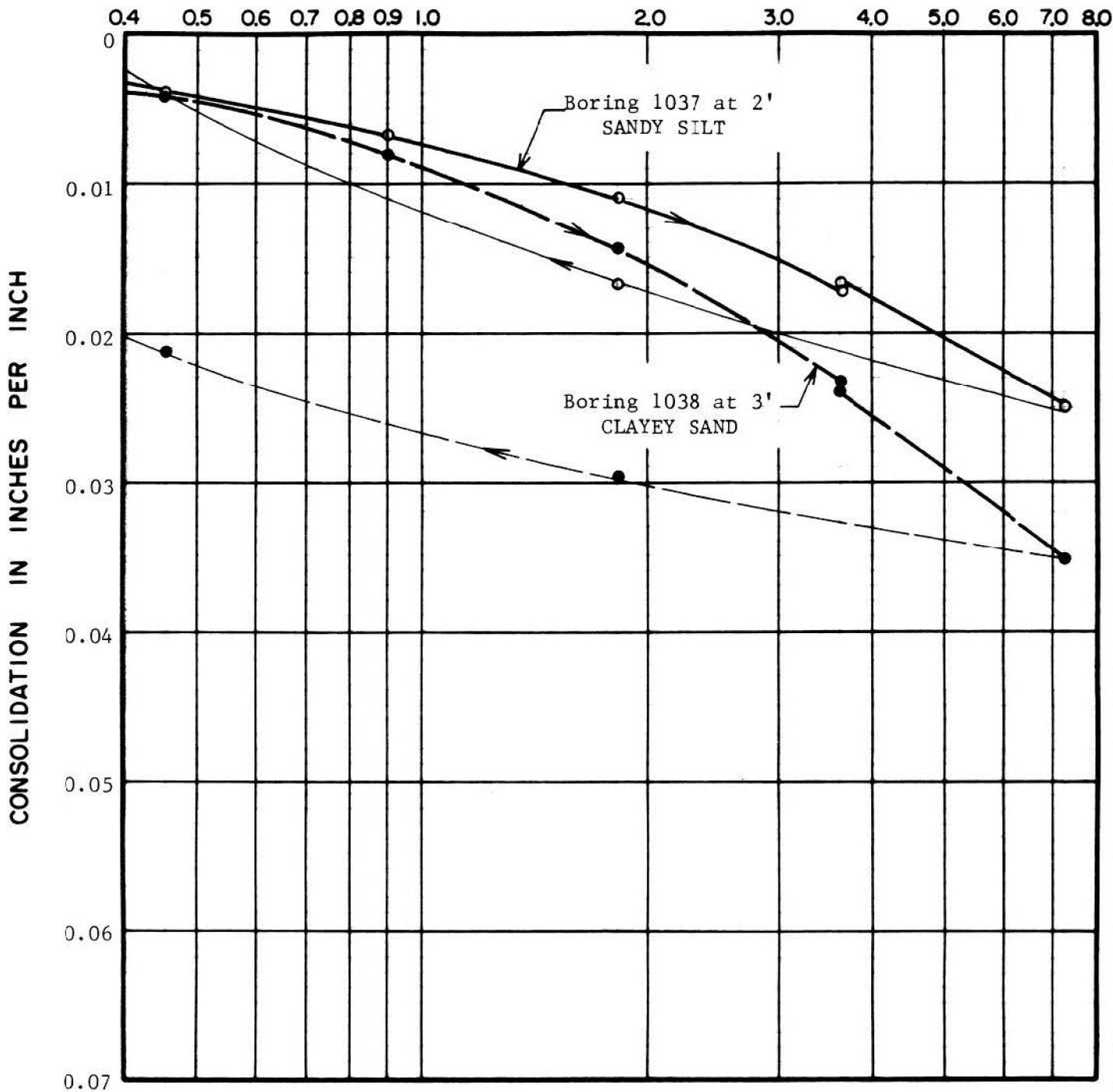
NOTE: Water added to sample from 2' after consolidation under a load of 3.6 kips per square foot. The other sample tested at field moisture content.

CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

JOB AD-85005-10 DATE 11/30/85 DR. RU. O.E. DM W.P. dmh CHKD MS

LOAD IN KIPS PER SQUARE FOOT



NOTE: Water added to samples after consolidation under a load of 3.6 kips per square foot.

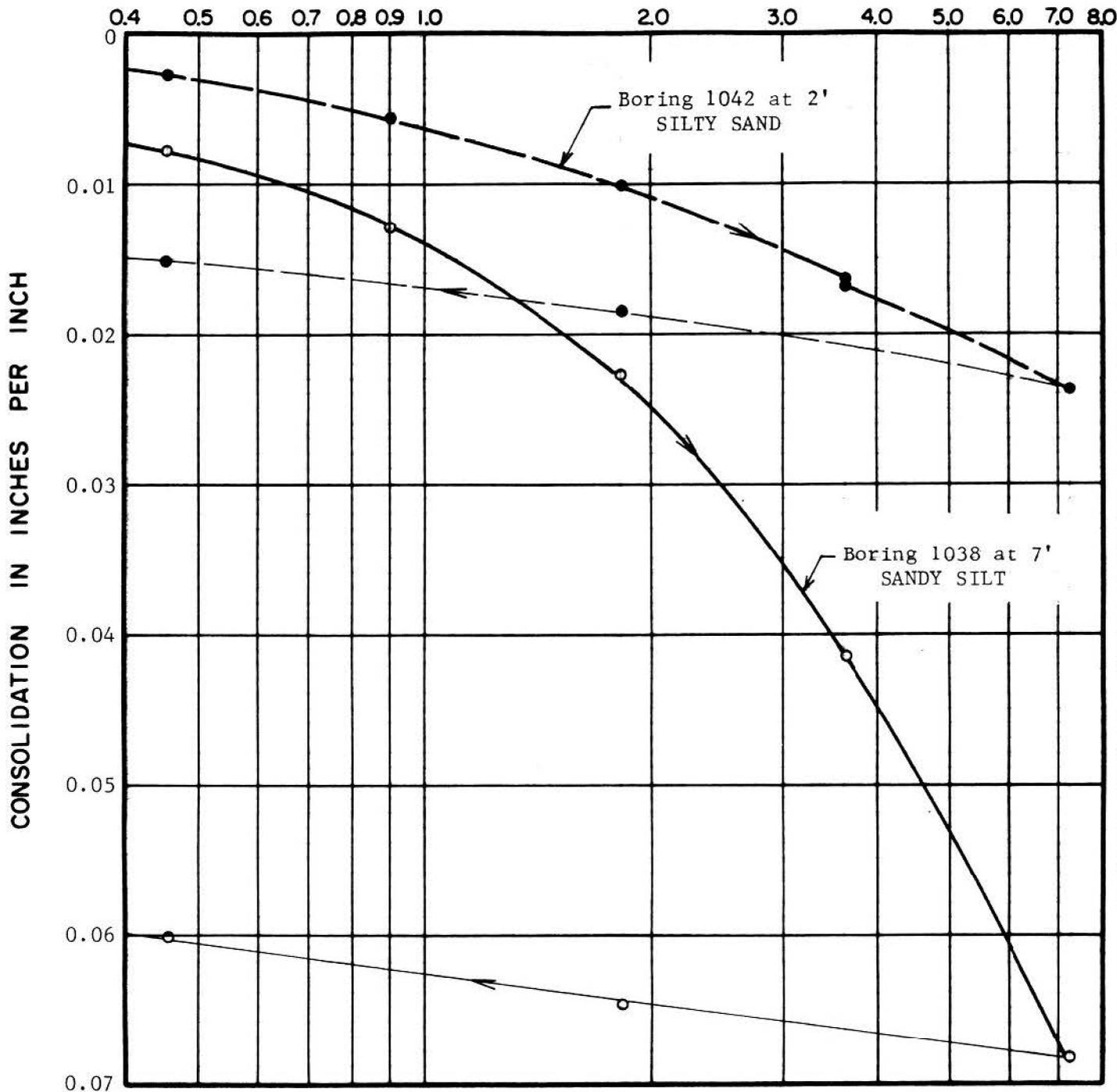
CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

FIGURE C-2.8

JOB ADE-85005-10 DATE 11/30/85 DR. REV. O.E. DM DA W.P. CHKD MS

LOAD IN KIPS PER SQUARE FOOT



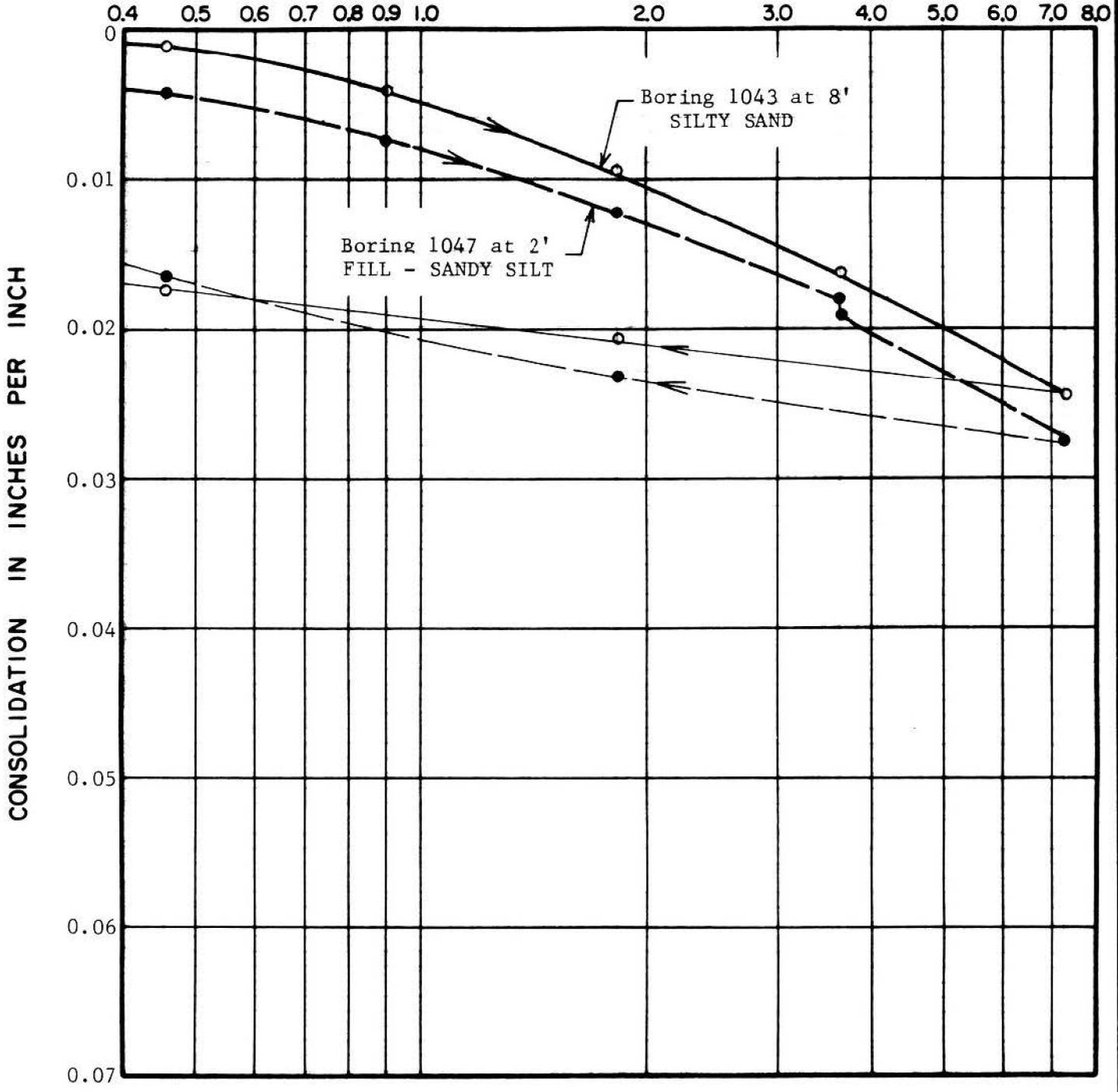
NOTE: Water added to sample from Boring 1042 after consolidation under a load of 3.6 kips per square foot. The other sample tested at field moisture content.

CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

JOB ADE-85005-10 DATE 11/30/85 DR. RU
 DM W.P. O.E.
 dmh
 CHKD
 MA

LOAD IN KIPS PER SQUARE FOOT



NOTE: Water added to sample from Boring 1047 after consolidation under a load of 3.6 kips per square foot. The other sample tested at field moisture content.

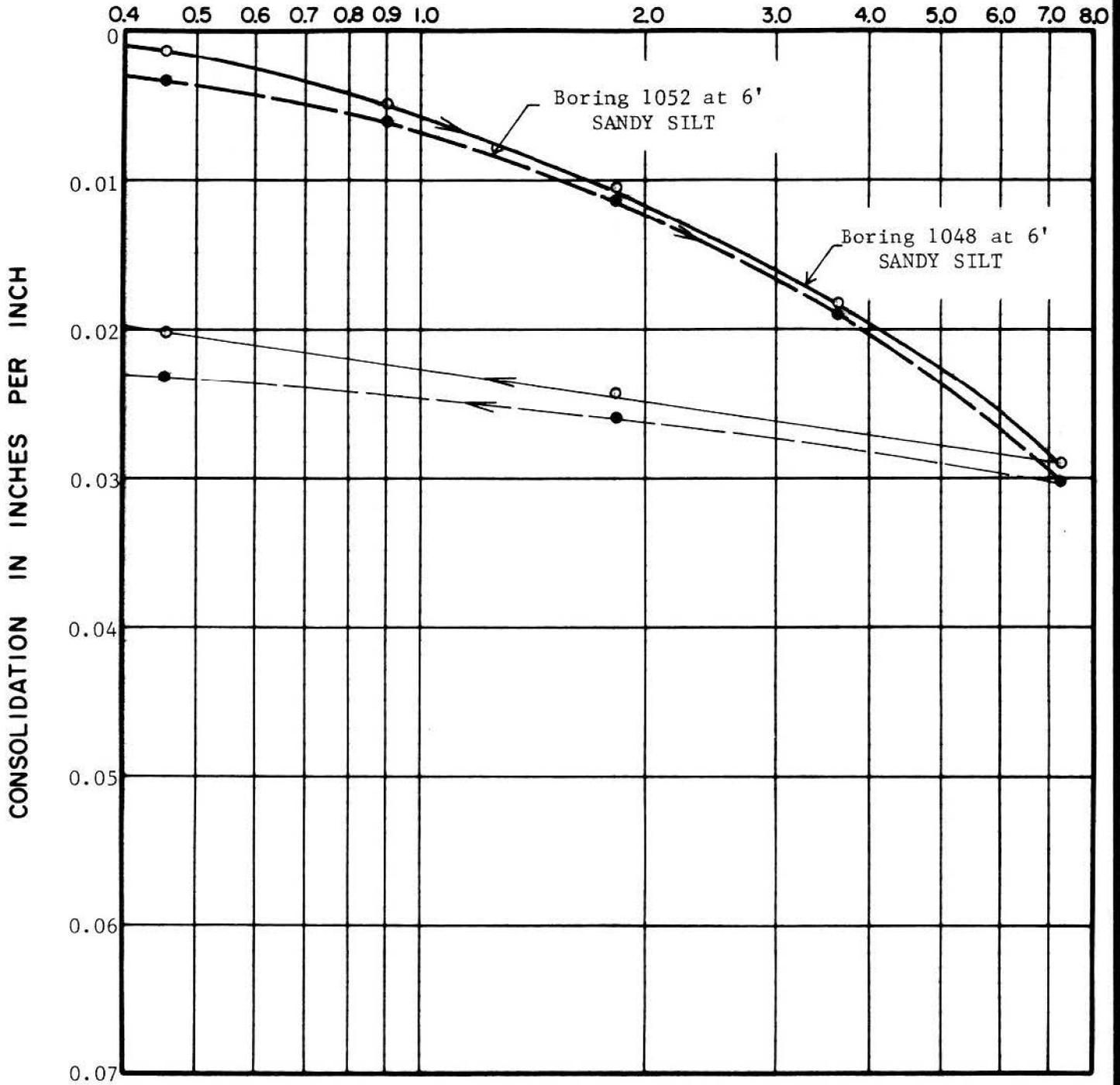
CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

FIGURE C-2.10

JOB ADE-85005-10 DATE 11/30/85 DR. RV
DM W.P. CHKD MS

LOAD IN KIPS PER SQUARE FOOT



NOTE: Samples tested at field moisture content.

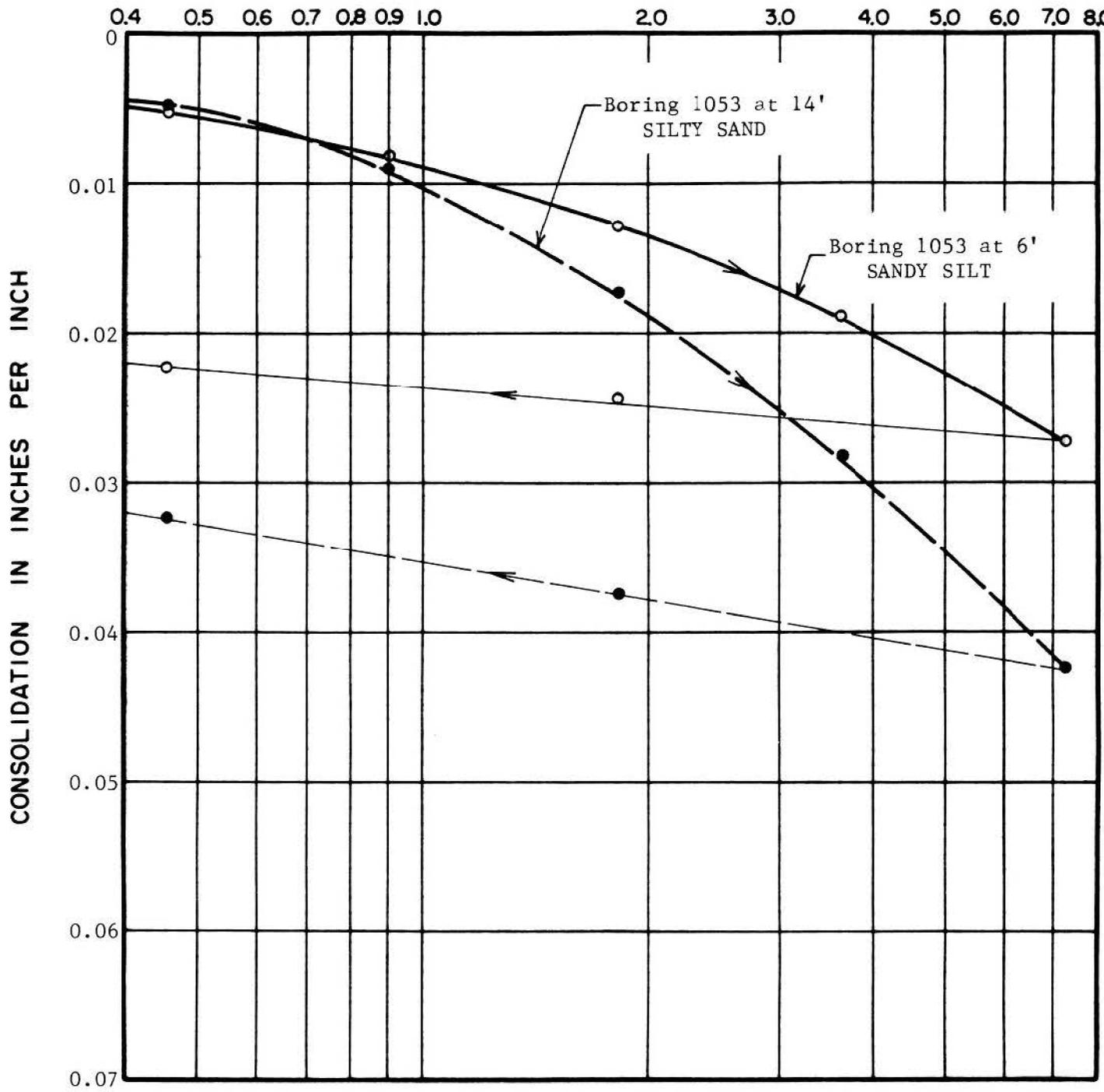
CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

FIGURE C-2.11

JOB AOE-85005-10 DATE 11/30/85 DR. RU. O.E. DM J.A. W.P. imh CHKD MJS

LOAD IN KIPS PER SQUARE FOOT



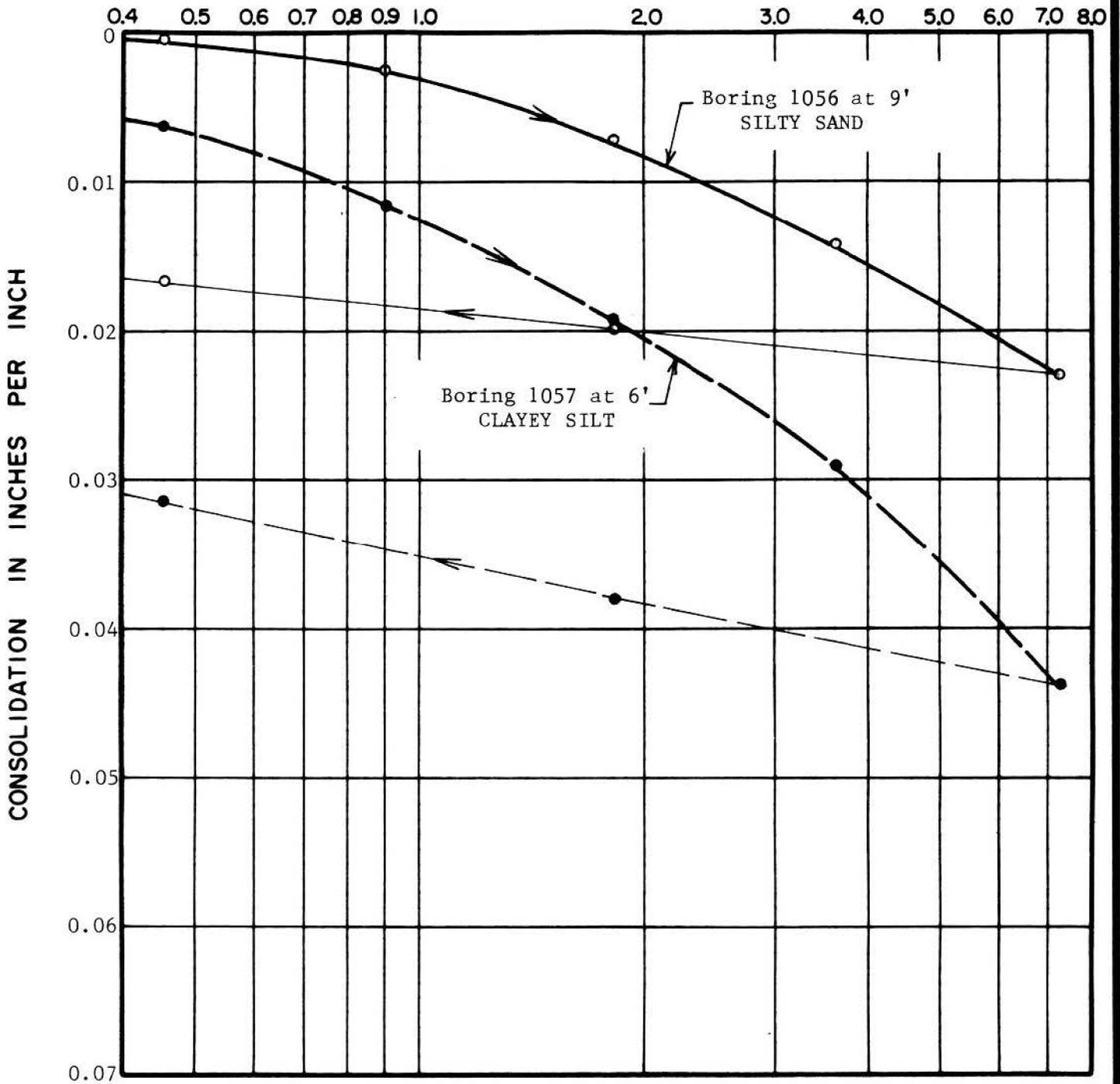
NOTE: Samples tested at field moisture content.

CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

JOB ADE-85005-10 DATE 11/30/85 DR. RW. O.E. DM W.P. CHKD MZ

LOAD IN KIPS PER SQUARE FOOT



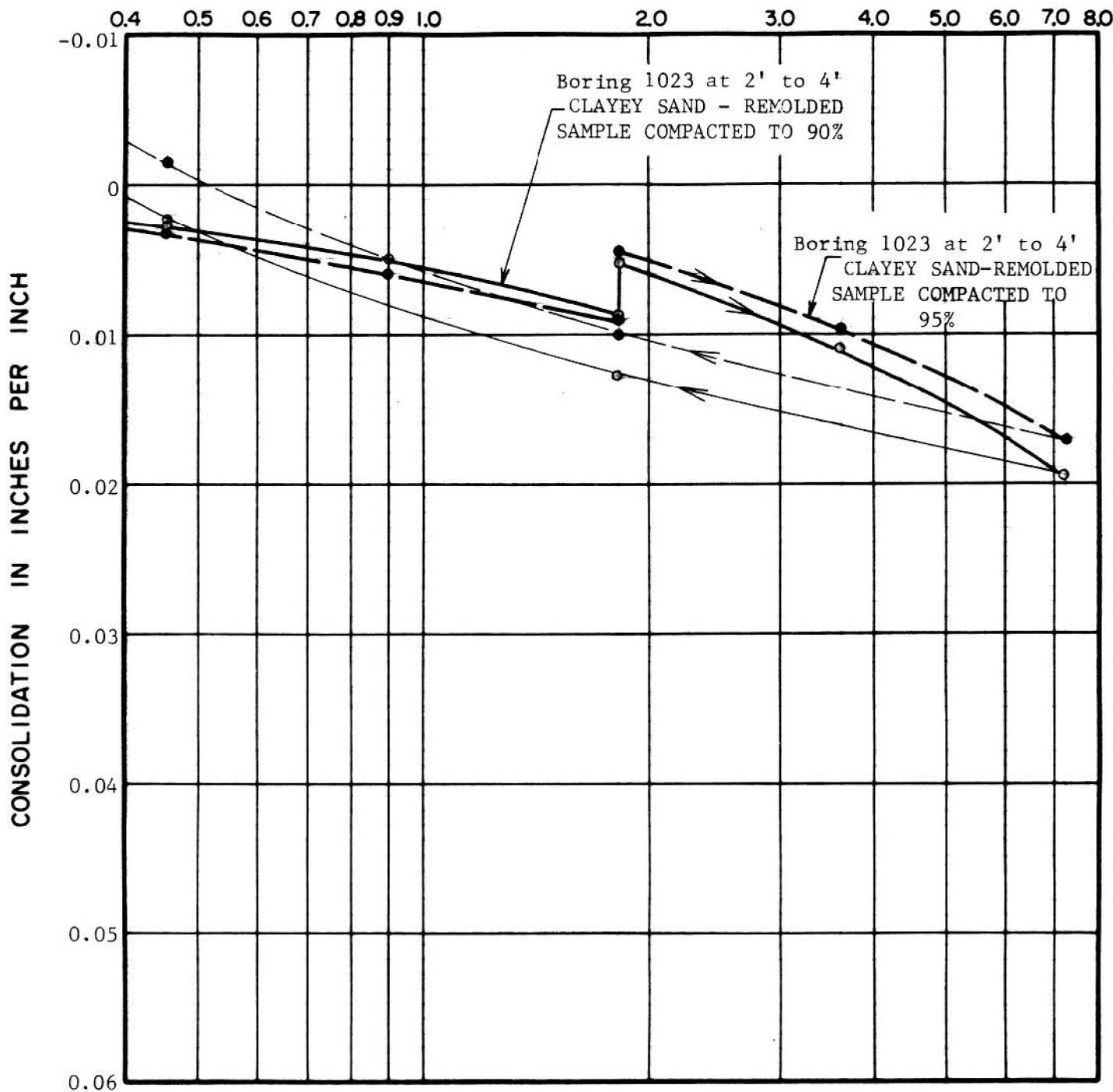
NOTE: Samples tested at field moisture content.

CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

JOB ADE-85-005-10 DATE 11/30/85 DR. RW O.E. DM 1/4 W.P. dmh CHKD MS

LOAD IN KIPS PER SQUARE FOOT



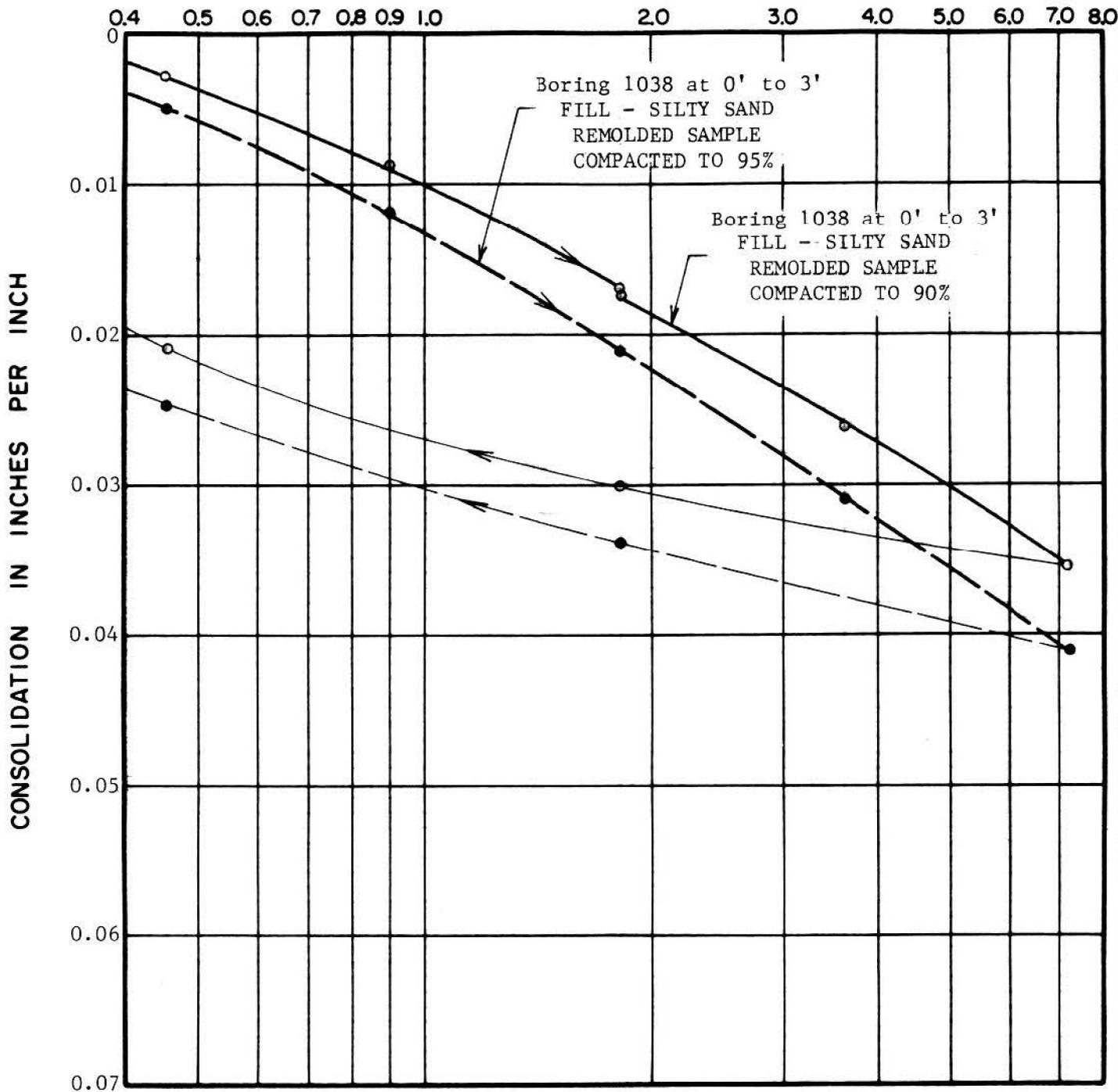
NOTE: Water added to samples after consolidation under a load of 1.8 kips per square foot.

CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

JOB ADE-85005-10 DATE 11/30/85 DR. RW. O.E. L.M. W.P. dmh CHKD MMS

LOAD IN KIPS PER SQUARE FOOT



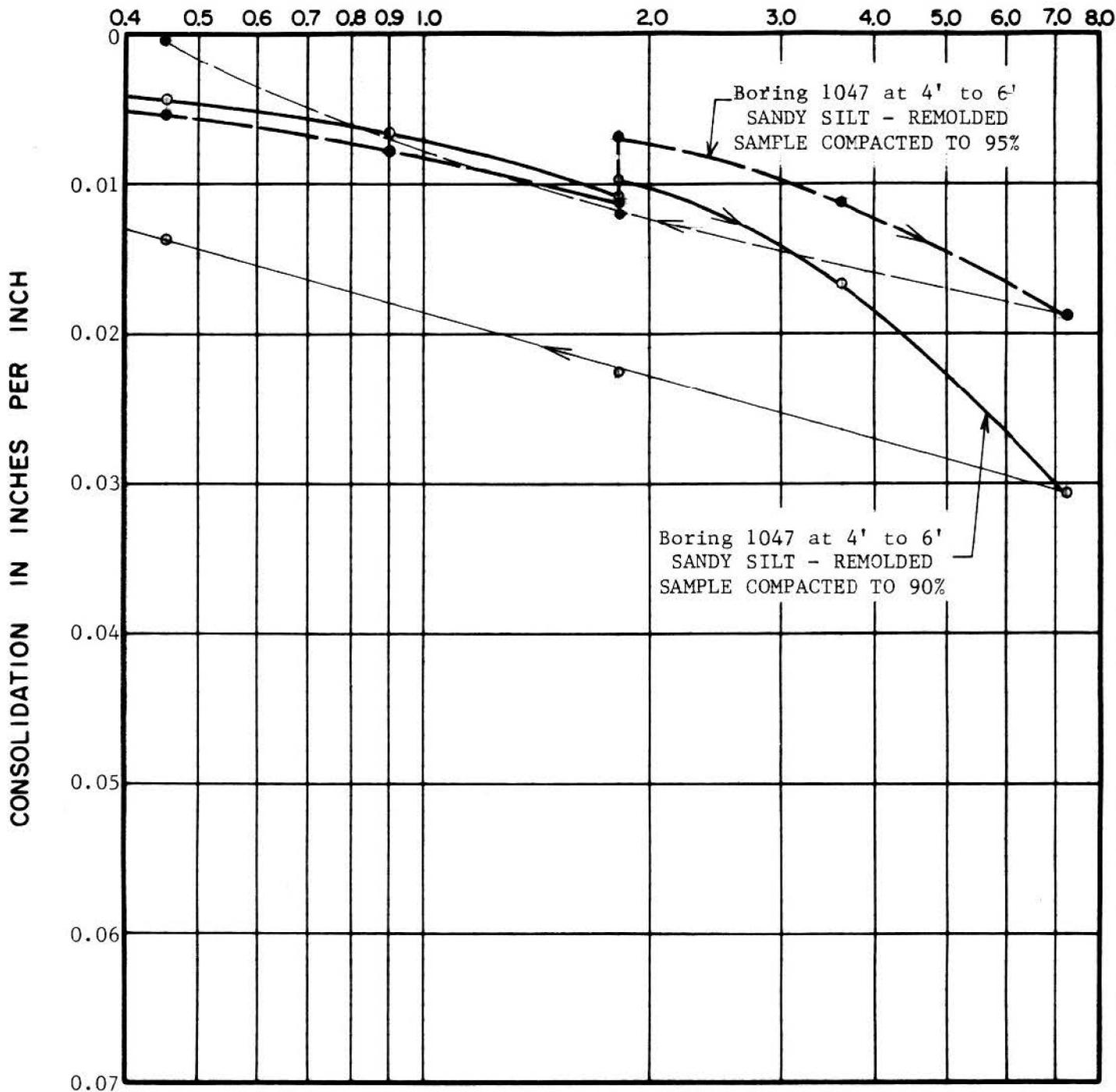
NOTE: Water added to samples after consolidation under a load of 1.8 kips per square foot.

CONSOLIDATION TEST DATA

LeROY CRANDALL AND ASSOCIATES

JOB ADE-Y5005-10 DATE 11/30/85 DR. RV. O.E. DM W.P. CHKD MS

LOAD IN KIPS PER SQUARE FOOT



NOTE: Water added to samples after consolidation under a load of 1.8 kips per square foot.

CONSOLIDATION TEST DATA

LEROY CRANDALL AND ASSOCIATES

FIGURE C-2.16

BORING NUMBER
AND SAMPLE DEPTH: 1023 at 2' to 4' 1026 at 1' to 3' 1030 at 3' to 5'

SOIL TYPE: CLAYEY SAND FILL - SANDY SILT SANDY SILT

MAXIMUM DRY DENSITY * : 131 130 131
(LBS./CU. FT.)

OPTIMUM MOISTURE CONTENT * : 9 10 10
(% OF DRY WT.)

EXPANSION (%) : - - 1.5
(FROM OPTIMUM TO SATURATED
MOISTURE CONTENT)

C. B. R. **
(% OF STANDARD)

AT 90% COMPACTION : - - 8

AT 95% COMPACTION : - - 18

* TEST METHOD: ASTM DESIGNATION D1557-70.

** TEST METHOD: ASTM DESIGNATION D1883-73.

COMPACTION AND C. B. R. TEST DATA

JOB NO. 0000 40 DATE 11/17/70 DR. O.E. W.P. CHKD

JOB A-85005-10 DATE 11/27/85 DR. O.E. DM W.P. dmh CHKD

BORING NUMBER AND SAMPLE DEPTH: 1038 at 0' to 3' 1047 at 4' to 6' 1052 at 3' to 4'

SOIL TYPE: FILL - SILTY SAND SANDY SILT FILL - SANDY CLAY

MAXIMUM DRY DENSITY * : 121 129 129
(LBS./CU. FT.)

OPTIMUM MOISTURE CONTENT * : 12 10 10
(% OF DRY WT.)

EXPANSION (%) : - - -
(FROM OPTIMUM TO SATURATED MOISTURE CONTENT)

C. B. R. **
(% OF STANDARD)

AT 90% COMPACTION : - - -

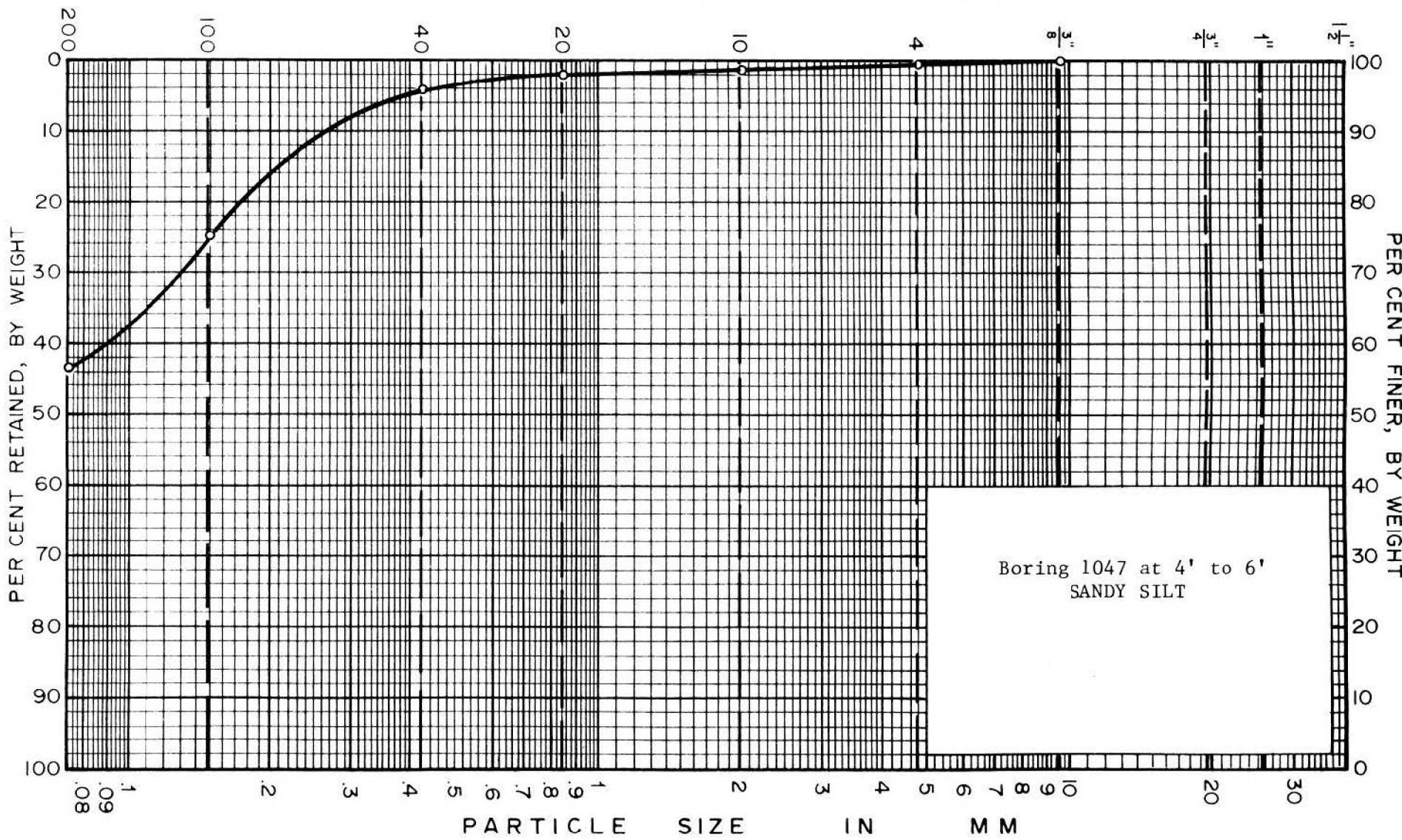
AT 95% COMPACTION : - - -

* TEST METHOD: ASTM DESIGNATION D1557-70.

** TEST METHOD: ASTM DESIGNATION D1883-73.

COMPACTION AND C. B. R. TEST DATA

U. S. SIEVE SIZE



Boring 1047 at 4' to 6'
SANDY SILT

PARTICLE SIZE DISTRIBUTION

LEROY CRANDALL AND ASSOCIATES
FIGURE C-4.1

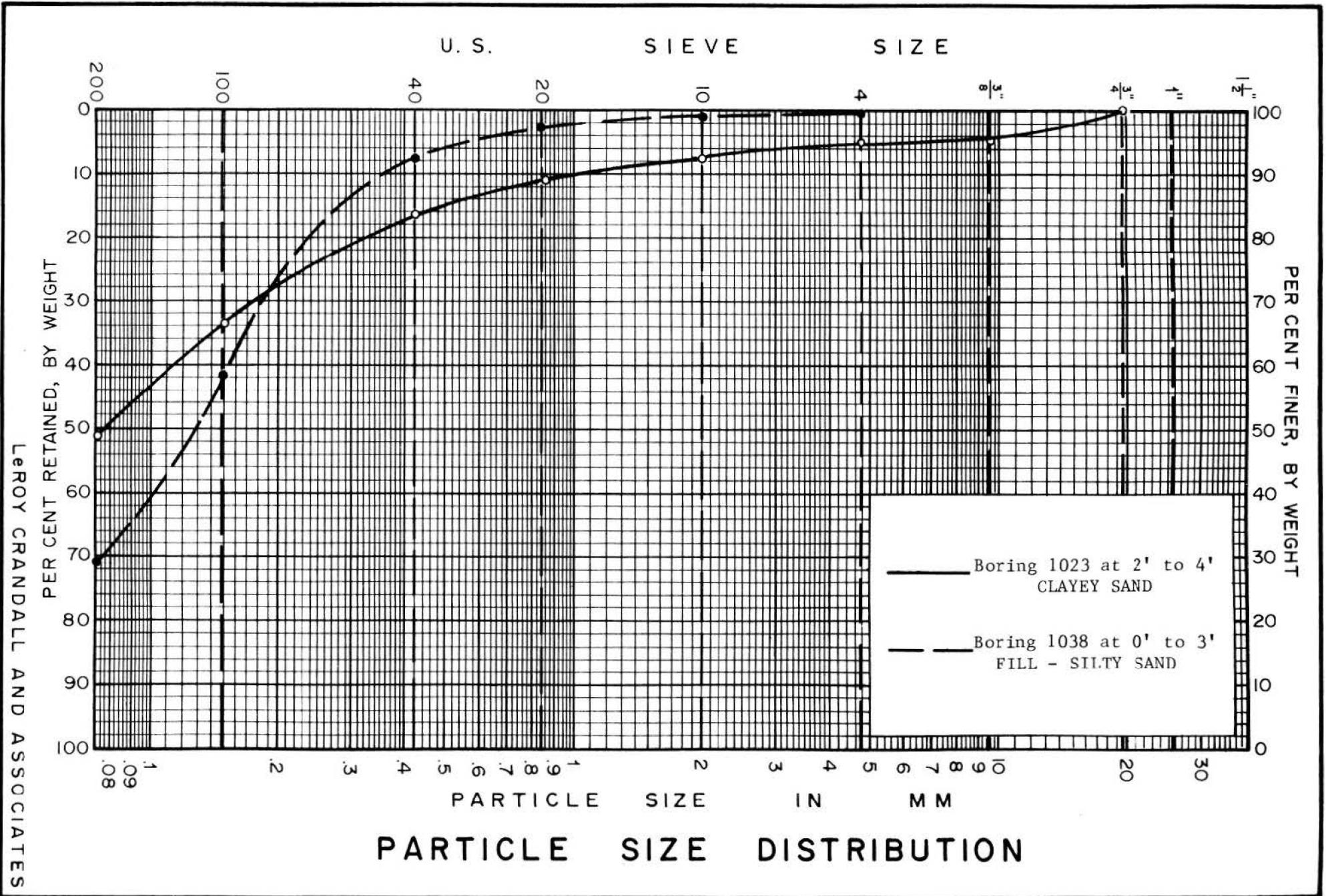


FIGURE C-4.2

LEROY CRANDALL AND ASSOCIATES

FORM 120
 JOB ADE-85005-ID DATE 11/12/85 DR O.E. DM *DA* W.P. dmh CHKD *MS*

BORING NUMBER AND SAMPLE DEPTH	SOIL TYPE	COEFFICIENT OF PERMEABILITY	
		Ft/Yr	Cm/Sec
1000 at 3'	FILL - SILTY SAND	6.7	6.5×10^{-6}
1023 at 2'	CLAYEY SAND	0.1	1.2×10^{-7}
1035 at 2'	CLAYEY SAND	0.1	1.0×10^{-7}
1038 at 1'	FILL - SILTY SAND	11.2	1.1×10^{-5}
1047 at 4'	SANDY SILT	0.6	6.2×10^{-7}

PERMEABILITY TEST DATA

(IN-SITU SAMPLES)

BORING NUMBER AND SAMPLE DEPTH	SOIL TYPE	PERCENT COMPACTION	COEFFICIENT OF PERMEABILITY	
			Ft/Yr	Cm/Sec

1023 at 2' to 4'	CLAYEY SAND	90	1.2	1.2×10^{-6}
1023 at 2' to 4'	CLAYEY SAND	96	0.2	2.3×10^{-7}
1038 at 0' to 3'	FILL - SILTY SAND	90	22.5	2.2×10^{-5}
1038 at 0' to 3'	FILL - SILTY SAND	95	9.0	8.7×10^{-6}
1047 at 4' to 6'	SANDY SILT	90	1.1	1.1×10^{-6}
1047 at 4' to 6'	SANDY SILT	96	0.3	2.5×10^{-7}

PERMEABILITY TEST DATA

(REMOLDED SAMPLES)

LEROY CRANDALL AND ASSOCIATES

FIGURE C-5.2

FORM 120 JOB ADE-85005-10 DATE 11/12/85 DR O.E. DM/W.P. dmh CHKD *MS*

Appendix D
Seismic Data

**APPENDIX D:
SEISMIC DATA**

D.1 COMPUTER SEARCH OF RECORDED EARTHQUAKES

The seismicity of the area was determined from a computer search of a magnetic tape catalog of earthquakes. The catalog of earthquakes included those compiled by the California Institute of Technology for the period 1932 to 1981 and those earthquakes for the period 1812 to 1931 compiled by Richter and the U. S. National Oceanic and Atmospheric Administration (NOAA). The computer printout of the earthquakes is presented on Table D-1. The search for earthquakes that occurred within 100 kilometers of the site indicates that 290 earthquakes of Richter magnitude 4.0 and greater occurred between 1932 and 1981; two earthquakes of magnitude 6.0 or greater occurred between 1906 and 1931; and one earthquake of magnitude 7.0 or greater occurred between 1812 and 1905.

The information listed for each earthquake found in the printout includes date and time in Greenwich Civil Time (GCT), location of the epicenter in latitude and longitude, quality of epicentral determination (Q), depth in kilometers, and magnitude. Where a depth of 0.0 is given, the solution was based on an assumed 16-kilometer focal depth. The explanation of the letter code for the quality factor of the data is presented on the first page of the table.

D.2 SITE PERIOD CALCULATIONS

The evaluation of the characteristic site period, T_s , is necessary to determine the coefficient of site-structure resonance, S , in accordance with Section 2312 of the 1982 edition of the Uniform Building Code. The characteristic periods were evaluated following the procedures suggested in SEAOC Standard No. 1, Recommended Lateral Force Requirements and Commentary, Seismology Committee, Structural Engineers Association of California, 1980.

The site period determination requires the knowledge of the shear wave velocities of the various deposits underlying the site. The shear wave velocity values presented in Appendix B were determined based on the results of downhole seismic surveys. The details and the results of the surveys are presented in Appendix B.

The average shear wave velocities that were utilized in the determination of the site periods are presented on Figures D-1 through D-3, Site Period Determination for geotechnical profiles that are judged to reflect a possible range of depths below the foundation level at which the shear wave velocity is 2,500 feet per second or greater.

TABLE D-1
Sheet 1 of 11

LIST OF HISTORIC EARTHQUAKES OF MAGNITUDE 4.0 OR
GREATER WITHIN 100 KM OF THE SITE
(CAL TECH DATA 1932-1981)

YEAR	MONTH	DAY	HR	MIN	SEC	LATITUDE	LONGITUDE	Q	DISTANCE	DEPTH	MAGNITUDE
1932	NOV	1	4	45	0	34.00 N	117.25 W	E	90	.0	4.0
1933	MAR	11	1	54	8	33.62 N	117.97 W	A	29	.0	6.3
1933	MAR	11	2	4	0	33.75 N	118.08 W	C	12	.0	4.9
1933	MAR	11	2	5	0	33.75 N	118.08 W	C	12	.0	4.3
1933	MAR	11	2	9	0	33.75 N	118.08 W	C	12	.0	5.0
1933	MAR	11	2	10	0	33.75 N	118.08 W	C	12	.0	4.6
1933	MAR	11	2	11	0	33.75 N	118.08 W	C	12	.0	4.4
1933	MAR	11	2	16	0	33.75 N	118.08 W	C	12	.0	4.8
1933	MAR	11	2	17	0	33.60 N	118.00 W	E	29	.0	4.5
1933	MAR	11	2	22	0	33.75 N	118.08 W	C	12	.0	4.0
1933	MAR	11	2	27	0	33.75 N	118.08 W	C	12	.0	4.6
1933	MAR	11	2	30	0	33.75 N	118.08 W	C	12	.0	5.1
1933	MAR	11	2	31	0	33.60 N	118.00 W	E	29	.0	4.4
1933	MAR	11	2	52	0	33.75 N	118.08 W	C	12	.0	4.0
1933	MAR	11	2	57	0	33.75 N	118.08 W	C	12	.0	4.2
1933	MAR	11	2	58	0	33.75 N	118.08 W	C	12	.0	4.0
1933	MAR	11	2	59	0	33.75 N	118.08 W	C	12	.0	4.6
1933	MAR	11	3	5	0	33.75 N	118.08 W	C	12	.0	4.2
1933	MAR	11	3	9	0	33.75 N	118.08 W	C	12	.0	4.4
1933	MAR	11	3	11	0	33.75 N	118.08 W	C	12	.0	4.2
1933	MAR	11	3	29	0	33.75 N	118.08 W	C	12	.0	5.0
1933	MAR	11	3	36	0	33.75 N	118.08 W	C	12	.0	4.0
1933	MAR	11	3	39	0	33.75 N	118.08 W	C	12	.0	4.0
1933	MAR	11	3	47	0	33.75 N	118.08 W	C	12	.0	4.1
1933	MAR	11	4	36	0	33.75 N	118.08 W	C	12	.0	4.6
1933	MAR	11	4	39	0	33.75 N	118.08 W	C	12	.0	4.9
1933	MAR	11	4	40	0	33.75 N	118.08 W	C	12	.0	4.7
1933	MAR	11	5	10	22	33.70 N	118.07 W	C	17	.0	5.1
1933	MAR	11	5	13	0	33.75 N	118.08 W	C	12	.0	4.7
1933	MAR	11	5	15	0	33.75 N	118.08 W	C	12	.0	4.0
1933	MAR	11	5	18	4	33.57 N	117.98 W	C	33	.0	5.2
1933	MAR	11	5	21	0	33.75 N	118.08 W	C	12	.0	4.4
1933	MAR	11	5	24	0	33.75 N	118.08 W	C	12	.0	4.2
1933	MAR	11	5	53	0	33.75 N	118.08 W	C	12	.0	4.0
1933	MAR	11	5	55	0	33.75 N	118.08 W	C	12	.0	4.0
1933	MAR	11	5	11	0	33.75 N	118.08 W	C	12	.0	4.4
1933	MAR	11	6	19	0	33.75 N	118.08 W	C	12	.0	4.2
1933	MAR	11	6	29	0	33.85 N	118.27 W	C	9	.0	4.4
1933	MAR	11	6	35	0	33.75 N	118.08 W	C	12	.0	4.2
1933	MAR	11	6	58	3	33.68 N	118.05 W	C	19	.0	5.5
1933	MAR	11	7	51	0	33.75 N	118.08 W	C	12	.0	4.2
1933	MAR	11	7	59	0	33.75 N	118.08 W	C	12	.0	4.1
1933	MAR	11	8	8	0	33.75 N	118.08 W	C	12	.0	4.5
1933	MAR	11	8	32	0	33.75 N	118.08 W	C	12	.0	4.2
1933	MAR	11	8	37	0	33.75 N	118.08 W	C	12	.0	4.0
1933	MAR	11	8	54	57	33.70 N	118.07 W	C	17	.0	5.1
1933	MAR	11	9	10	0	33.75 N	118.08 W	C	12	.0	5.1
1933	MAR	11	9	11	0	33.75 N	118.08 W	C	12	.0	4.4
1933	MAR	11	9	26	0	33.75 N	118.08 W	C	12	.0	4.1
1933	MAR	11	10	25	0	33.75 N	118.08 W	C	12	.0	4.0
1933	MAR	11	10	45	0	33.75 N	118.08 W	C	12	.0	4.0

NOTE: Q IS A FACTOR RELATING THE QUALITY OF EPICENTRAL DETERMINATION

A = SPECIALLY INVESTIGATED
 B = EPICENTER PROBABLY WITHIN 5 KM, ORIGIN TIME TO NEAREST SECOND
 C = EPICENTER PROBABLY WITHIN 15 KM, ORIGIN TIME TO A FEW SECONDS
 D = EPICENTER NOT KNOWN WITHIN 15 KM, ROUGH LOCATION
 E = EPICENTER ROUGHLY LOCATED, ACCURACY LESS THAN "D"
 P = PRELIMINARY

TABLE D-1
Sheet 2 of 11

YEAR	MONTH	DAY	HR	MIN	SEC	LATITUDE	LONGITUDE	Q	DISTANCE	DEPTH	MAGNITUDE
1933	MAR	11	11	0	0	33.75 N	118.08 W	C	12	.0	4.0
1933	MAR	11	11	4	0	33.75 N	118.13 W	C	9	.0	4.6
1933	MAR	11	11	29	0	33.75 N	118.08 W	C	12	.0	4.0
1933	MAR	11	11	38	0	33.75 N	118.08 W	C	12	.0	4.0
1933	MAR	11	11	41	0	33.75 N	118.08 W	C	12	.0	4.2
1933	MAR	11	11	47	0	33.75 N	118.08 W	C	12	.0	4.4
1933	MAR	11	12	50	0	33.68 N	118.05 W	C	19	.0	4.4
1933	MAR	11	13	50	0	33.73 N	118.10 W	C	12	.0	4.4
1933	MAR	11	13	57	0	33.75 N	118.08 W	C	12	.0	4.0
1933	MAR	11	14	25	0	33.85 N	118.27 W	C	9	.0	5.0
1933	MAR	11	14	47	0	33.73 N	118.10 W	C	12	.0	4.4
1933	MAR	11	14	57	0	33.88 N	118.32 W	C	14	.0	4.9
1933	MAR	11	15	9	0	33.73 N	118.10 W	C	12	.0	4.4
1933	MAR	11	15	47	0	33.75 N	118.08 W	C	12	.0	4.0
1933	MAR	11	16	53	0	33.75 N	118.08 W	C	12	.0	4.8
1933	MAR	11	19	44	0	33.75 N	118.08 W	C	12	.0	4.0
1933	MAR	11	19	56	0	33.75 N	118.08 W	C	12	.0	4.2
1933	MAR	11	22	0	0	33.75 N	118.08 W	C	12	.0	4.4
1933	MAR	11	22	31	0	33.75 N	118.08 W	C	12	.0	4.4
1933	MAR	11	22	32	0	33.75 N	118.08 W	C	12	.0	4.1
1933	MAR	11	22	40	0	33.75 N	118.08 W	C	12	.0	4.4
1933	MAR	11	23	5	0	33.75 N	118.08 W	C	12	.0	4.2
1933	MAR	12	0	27	0	33.75 N	118.08 W	C	12	.0	4.4
1933	MAR	12	0	34	0	33.75 N	118.08 W	C	12	.0	4.0
1933	MAR	12	4	48	0	33.75 N	118.08 W	C	12	.0	4.0
1933	MAR	12	5	46	0	33.75 N	118.08 W	C	12	.0	4.4
1933	MAR	12	6	1	0	33.75 N	118.08 W	C	12	.0	4.2
1933	MAR	12	6	16	0	33.75 N	118.08 W	C	12	.0	4.6
1933	MAR	12	7	40	0	33.75 N	118.08 W	C	12	.0	4.2
1933	MAR	12	8	35	0	33.75 N	118.08 W	C	12	.0	4.2
1933	MAR	12	15	2	0	33.75 N	118.08 W	C	12	.0	4.2
1933	MAR	12	16	51	0	33.75 N	118.08 W	C	12	.0	4.0
1933	MAR	12	17	38	0	33.75 N	118.08 W	C	12	.0	4.5
1933	MAR	12	18	25	0	33.75 N	118.08 W	C	12	.0	4.1
1933	MAR	12	21	28	0	33.75 N	118.08 W	C	12	.0	4.1
1933	MAR	12	23	54	0	33.75 N	118.08 W	C	12	.0	4.5
1933	MAR	13	3	43	0	33.75 N	118.08 W	C	12	.0	4.1
1933	MAR	13	4	32	0	33.75 N	118.08 W	C	12	.0	4.7
1933	MAR	13	6	17	0	33.75 N	118.08 W	C	12	.0	4.0
1933	MAR	13	13	18	28	33.75 N	118.08 W	C	12	.0	5.3
1933	MAR	13	15	32	0	33.75 N	118.08 W	C	12	.0	4.1
1933	MAR	13	19	29	0	33.75 N	118.08 W	C	12	.0	4.2
1933	MAR	14	0	36	0	33.75 N	118.08 W	C	12	.0	4.2
1933	MAR	14	12	19	0	33.75 N	118.08 W	C	12	.0	4.5
1933	MAR	14	19	1	50	33.62 N	118.02 W	C	26	.0	5.1
1933	MAR	14	22	42	0	33.75 N	118.03 W	C	12	.0	4.1
1933	MAR	15	2	8	0	33.75 N	118.08 W	C	12	.0	4.1
1933	MAR	15	4	32	0	33.75 N	118.08 W	C	12	.0	4.1
1933	MAR	15	5	40	0	33.75 N	118.08 W	C	12	.0	4.2
1933	MAR	15	11	13	32	33.62 N	118.02 W	C	26	.0	4.9
1933	MAR	16	14	56	0	33.75 N	118.08 W	C	12	.0	4.0
1933	MAR	16	15	29	0	33.75 N	118.08 W	C	12	.0	4.2
1933	MAR	16	15	30	0	33.75 N	118.08 W	C	12	.0	4.1
1933	MAR	17	16	51	0	33.75 N	118.08 W	C	12	.0	4.1
1933	MAR	18	20	52	0	33.75 N	118.08 W	C	12	.0	4.2
1933	MAR	19	21	23	0	33.75 N	118.08 W	C	12	.0	4.2
1933	MAR	20	13	58	0	33.75 N	118.08 W	C	12	.0	4.1
1933	MAR	21	3	26	0	33.75 N	118.08 W	C	12	.0	4.1
1933	MAR	23	8	40	0	33.75 N	118.08 W	C	12	.0	4.1
1933	MAR	23	18	31	0	33.75 N	118.08 W	C	12	.0	4.1
1933	MAR	25	13	46	0	33.75 N	118.08 W	C	12	.0	4.1
1933	MAR	30	12	25	0	33.75 N	118.08 W	C	12	.0	4.4
1933	MAR	31	10	49	0	33.75 N	118.08 W	C	12	.0	4.1
1933	APR	1	6	42	0	33.75 N	118.08 W	C	12	.0	4.2
1933	APR	2	8	0	0	33.75 N	118.08 W	C	12	.0	4.0

TABLE D-1
Sheet 3 of 11

YEAR	MONTH	DAY	HR	MIN	SEC	LATITUDE	LONGITUDE	Q	DISTANCE	DEPTH	MAGNITUDE
1933	APR	2	15	36	0	33 75 N	118.08 W	C	12	0	4.0
1933	MAY	16	20	58	55	33 75 N	118.17 W	C	7	0	4.0
1933	AUG	4	4	17	48	33 75 N	118.18 W	C	7	0	4.0
1933	OCT	2	9	10	18	33 78 N	118.13 W	A	6	0	5.4
1933	OCT	2	13	26	1	33 62 N	118.02 W	C	26	0	4.0
1933	OCT	25	7	0	46	33 95 N	118.13 W	C	16	0	4.3
1933	NOV	13	21	28	0	33 87 N	118.20 W	C	7	0	4.0
1933	NOV	20	10	32	0	33 78 N	118.13 W	E	6	0	4.0
1934	JAN	9	14	10	0	34 10 N	117.68 W	A	57	0	4.5
1934	JAN	18	2	14	0	34 10 N	117.68 W	A	57	0	4.0
1934	JAN	20	21	17	0	33 62 N	118.12 W	B	22	0	4.5
1934	APR	17	18	33	0	33 57 N	117.98 W	C	33	0	4.0
1934	OCT	17	9	38	0	33 63 N	118.40 W	B	28	0	4.0
1934	NOV	16	21	26	0	33 75 N	118.00 W	B	19	0	4.0
1935	JUN	19	11	17	0	33 72 N	117.52 W	B	63	0	4.0
1935	JUL	13	10	54	17	34 20 N	117.90 W	A	51	0	4.7
1935	SEP	3	6	47	0	34 03 N	117.32 W	B	84	0	4.5
1935	DEC	25	17	15	0	33 60 N	118.02 W	B	28	0	4.5
1936	FEB	23	22	20	43	34 13 N	117.34 W	A	86	0	4.5
1936	FEB	26	9	33	28	34 14 N	117.34 W	A	87	0	4.0
1936	AUG	22	5	21	0	33 77 N	117.82 W	B	35	0	4.0
1936	OCT	29	22	35	36	34 38 N	118.62 W	C	75	0	4.0
1937	JAN	15	18	35	47	33 56 N	118.06 W	B	30	0	4.0
1937	MAR	19	1	23	38	34 11 N	117.43 W	A	78	0	4.0
1937	JUL	7	11	12	0	33 57 N	117.98 W	B	33	0	4.0
1937	SEP	1	13	40	8	34 21 N	117.53 W	A	76	0	4.5
1937	SEP	1	16	35	34	34 18 N	117.55 W	A	72	0	4.5
1937	SEP	13	22	14	40	33 04 N	118.73 W	C	99	0	4.0
1938	MAY	21	9	44	0	33 62 N	118.03 W	B	26	0	4.0
1938	MAY	31	8	34	55	33 70 N	117.51 W	E	64	0	5.5
1938	JUL	5	18	6	56	33 68 N	117.55 W	A	61	0	4.5
1938	AUG	6	22	0	56	33 72 N	117.51 W	E	64	0	4.0
1938	AUG	31	3	18	14	33 76 N	118.25 W	A	8	0	4.5
1938	NOV	29	19	21	16	33 90 N	118.43 W	A	24	0	4.0
1938	DEC	7	3	38	0	34 00 N	118.42 W	B	30	0	4.0
1938	DEC	27	10	9	29	34 13 N	117.52 W	C	71	0	4.0
1939	APR	3	2	50	45	34 04 N	117.23 W	A	92	0	4.0
1939	NOV	4	21	41	0	33 77 N	118.12 W	C	8	0	4.0
1939	NOV	7	18	52	8	34 00 N	117.28 W	A	87	0	4.7
1939	DEC	27	19	28	49	33 78 N	118.20 W	A	3	0	4.7
1940	JAN	13	7	49	7	33 78 N	118.13 W	B	6	0	4.0
1940	FEB	8	16	56	17	33 70 N	118.07 W	C	17	0	4.0
1940	FEB	11	19	24	10	33 98 N	118.30 W	B	21	0	4.0
1940	APR	18	18	43	44	34 03 N	117.35 W	A	82	0	4.4
1940	JUN	5	8	27	27	33 83 N	117.40 W	E	73	0	4.0
1940	JUL	20	4	1	13	33 70 N	118.07 W	E	17	0	4.0
1940	OCT	11	5	57	12	33 77 N	118.45 W	A	24	0	4.7
1940	OCT	12	0	24	0	33 78 N	118.42 W	B	22	0	4.0
1940	OCT	14	20	51	11	33 78 N	118.42 W	B	22	0	4.0
1940	NOV	1	7	25	3	33 78 N	118.42 W	B	22	0	4.0
1940	NOV	1	20	0	46	33 63 N	118.20 W	B	20	0	4.0
1940	NOV	2	2	58	26	33 78 N	118.42 W	E	22	0	4.0
1941	JAN	30	1	34	47	33 97 N	118.05 W	A	22	0	4.1
1941	MAR	22	8	22	40	33 52 N	118.10 W	E	33	0	4.0
1941	MAR	25	23	43	41	34 22 N	117.47 W	B	81	0	4.0
1941	APR	11	1	20	24	33 95 N	117.58 W	B	59	0	4.0
1941	OCT	22	6	57	19	33 82 N	118.22 W	A	3	0	4.9
1941	NOV	14	8	41	36	33 78 N	118.25 W	A	6	0	5.4
1942	APR	16	7	28	33	33 37 N	118.15 W	C	49	0	4.0
1943	OCT	24	0	29	21	33 93 N	117.37 W	C	77	0	4.0
1944	JUN	19	0	3	33	33 87 N	118.22 W	B	7	0	4.5
1944	JUN	19	3	6	7	33 87 N	118.22 W	C	7	0	4.4
1946	FEB	24	6	7	52	34 40 N	117.80 W	C	75	0	4.1

TABLE D-1
Sheet 4 of 11

YEAR	MONTH	DAY	HR	MIN	SEC	LATITUDE	LONGITUDE	Q	DISTANCE	DEPTH	MAGNITUDE
1946	JUN	1	11	6	31	34.42 N	118.83 W	C	90	.0	4.1
1948	MAR	1	8	12	13	34.17 N	117.53 W	B	73	.0	4.7
1948	APR	16	22	26	24	34.02 N	118.97 W	B	76	.0	4.7
1948	OCT	3	2	46	28	34.18 N	117.58 W	A	70	.0	4.0
1950	JAN	11	21	41	35	33.94 N	118.20 W	A	14	.0	4.1
1951	SEP	22	8	22	39	34.12 N	117.34 W	A	86	.0	4.3
1952	FEB	10	13	50	55	33.58 N	119.18 W	C	95	.0	4.0
1952	FEB	17	12	36	58	34.00 N	117.27 W	A	88	.0	4.5
1952	AUG	23	10	9	7	34.52 N	118.20 W	A	79	.0	5.0
1954	OCT	26	16	22	26	33.73 N	117.47 W	B	67	.0	4.1
1955	MAY	15	17	3	26	34.12 N	117.48 W	A	74	.0	4.0
1955	MAY	29	16	43	35	33.99 N	119.06 W	B	83	.0	4.1
1956	JAN	3	0	25	49	33.72 N	117.50 W	B	65	.0	4.7
1956	FEB	7	2	16	57	34.53 N	118.64 W	B	90	.0	4.2
1956	FEB	7	3	16	39	34.59 N	118.61 W	A	95	.0	4.6
1956	MAR	25	3	32	2	33.60 N	119.10 W	A	87	.0	4.2
1960	JUN	28	20	0	48	34.12 N	117.47 W	A	75	.0	4.1
1961	OCT	4	2	21	32	33.85 N	117.75 W	B	41	.0	4.1
1961	OCT	20	19	49	51	33.65 N	117.99 W	B	26	.0	4.3
1961	OCT	20	20	7	14	33.66 N	117.98 W	B	26	.0	4.0
1961	OCT	20	21	42	41	33.67 N	117.98 W	B	25	.0	4.0
1961	OCT	20	22	35	34	33.67 N	118.01 W	B	23	.0	4.1
1961	NOV	20	8	53	35	33.68 N	117.99 W	B	23	.0	4.0
1962	APR	27	9	12	32	33.74 N	117.19 W	B	93	.0	4.1
1963	SEP	14	3	51	16	33.54 N	118.34 W	B	33	.0	4.2
1964	AUG	30	22	57	37	34.27 N	118.44 W	B	56	.0	4.0
1965	JAN	1	8	4	18	34.14 N	117.52 W	B	72	.0	4.4
1965	APR	15	20	8	33	34.13 N	117.43 W	B	79	.0	4.5
1965	JUL	16	7	46	22	34.48 N	118.52 W	B	80	.0	4.0
1967	JAN	3	7	37	30	33.63 N	118.47 W	B	33	.0	4.0
1967	JAN	8	7	38	5	33.66 N	118.41 W	C	26	.0	4.0
1967	JUN	15	4	58	6	34.00 N	117.97 W	B	29	.0	4.1
1969	FEB	28	4	56	12	34.57 N	118.11 W	A	85	.0	4.3
1969	MAY	5	16	2	10	34.30 N	117.57 W	B	79	.0	4.4
1969	OCT	24	20	26	43	33.34 N	119.10 W	B	99	.0	4.7
1969	OCT	27	13	16	2	33.55 N	117.81 W	B	45	.0	4.5
1969	OCT	31	10	39	29	33.43 N	119.10 W	B	94	.0	4.8
1970	SEP	12	14	10	11	34.27 N	117.52 W	A	80	.0	4.1
1970	SEP	12	14	30	53	34.27 N	117.54 W	A	79	.0	5.4
1970	SEP	13	4	47	49	34.28 N	117.55 W	A	79	.0	4.4
1971	FEB	9	14	0	42	34.41 N	118.40 W	B	69	.0	6.4
1971	FEB	9	14	1	8	34.41 N	118.40 W	D	69	.0	5.8
1971	FEB	9	14	1	33	34.41 N	118.40 W	D	69	.0	4.2
1971	FEB	9	14	1	40	34.41 N	118.40 W	D	69	.0	4.1
1971	FEB	9	14	1	50	34.41 N	118.40 W	D	69	.0	4.5
1971	FEB	9	14	1	54	34.41 N	118.40 W	D	69	.0	4.2
1971	FEB	9	14	1	59	34.41 N	118.40 W	D	69	.0	4.1
1971	FEB	9	14	2	3	34.41 N	118.40 W	D	69	.0	4.1
1971	FEB	9	14	2	30	34.41 N	118.40 W	D	69	.0	4.3
1971	FEB	9	14	2	31	34.41 N	118.40 W	D	69	.0	4.7
1971	FEB	9	14	2	44	34.41 N	118.40 W	D	69	.0	5.8
1971	FEB	9	14	3	25	34.41 N	118.40 W	D	69	.0	4.4
1971	FEB	9	14	3	46	34.41 N	118.40 W	D	69	.0	4.1
1971	FEB	9	14	4	7	34.41 N	118.40 W	D	69	.0	4.1
1971	FEB	9	14	4	34	34.41 N	118.40 W	C	69	.0	4.2
1971	FEB	9	14	4	39	34.41 N	118.40 W	D	69	.0	4.1
1971	FEB	9	14	4	44	34.41 N	118.40 W	D	69	.0	4.1
1971	FEB	9	14	4	46	34.41 N	118.40 W	D	69	.0	4.2
1971	FEB	9	14	5	41	34.41 N	118.40 W	D	69	.0	4.1
1971	FEB	9	14	5	50	34.41 N	118.40 W	D	69	.0	4.1
1971	FEB	9	14	7	10	34.41 N	118.40 W	D	69	.0	4.0
1971	FEB	9	14	7	30	34.41 N	118.40 W	D	69	.0	4.0
1971	FEB	9	14	7	45	34.41 N	118.40 W	D	69	.0	4.5

TABLE D-1
Sheet 5 of 11

YEAR	MONTH	DAY	HR	MIN	SEC	LATITUDE	LONGITUDE	Q	DISTANCE	DEPTH	MAGNITUDE
1971	FEB	9	14	8	4	34 41 N	118.40 W	D	69	.0	4.0
1971	FEB	9	14	8	7	34.41 N	118.40 W	D	69	.0	4.2
1971	FEB	9	14	8	38	34.41 N	118.40 W	D	69	.0	4.5
1971	FEB	9	14	8	53	34.41 N	118.40 W	D	69	.0	4.6
1971	FEB	9	14	10	21	34 36 N	118.31 W	B	62	.0	4.7
1971	FEB	9	14	10	28	34.41 N	118.40 W	D	69	.0	5.3
1971	FEB	9	14	16	13	34 34 N	118.33 W	C	60	.0	4.1
1971	FEB	9	14	19	50	34.36 N	118.41 W	B	64	.0	4.0
1971	FEB	9	14	34	36	34 34 N	118.64 W	C	72	.0	4.9
1971	FEB	9	14	39	18	34.39 N	118.36 W	C	66	.0	4.0
1971	FEB	9	14	40	17	34 43 N	118.40 W	C	71	.0	4.1
1971	FEB	9	14	43	47	34.31 N	118.45 W	B	60	.0	5.2
1971	FEB	9	15	58	21	34 33 N	118.33 W	B	59	.0	4.8
1971	FEB	9	16	19	26	34.46 N	118.43 W	B	75	.0	4.2
1971	FEB	10	3	12	12	34 37 N	118.30 W	B	63	.0	4.0
1971	FEB	10	5	6	36	34.41 N	118.33 W	A	68	.0	4.3
1971	FEB	10	5	18	7	34 43 N	118.41 W	A	72	.0	4.5
1971	FEB	10	11	31	35	34 38 N	118.45 W	A	68	.0	4.2
1971	FEB	10	13	49	54	34 40 N	118.42 W	A	69	.0	4.3
1971	FEB	10	14	35	27	34.36 N	118.49 W	A	67	.0	4.2
1971	FEB	10	17	38	55	34 40 N	118.37 W	A	68	.0	4.2
1971	FEB	10	18	54	42	34.45 N	118.44 W	A	75	.0	4.2
1971	FEB	21	5	50	53	34 40 N	118.44 W	A	69	.0	4.7
1971	FEB	21	7	15	12	34.39 N	118.43 W	A	68	.0	4.5
1971	MAR	7	1	33	41	34 35 N	118.46 W	A	65	.0	4.5
1971	MAR	25	22	54	10	34.36 N	118.47 W	A	66	.0	4.2
1971	MAR	30	8	54	43	34 30 N	118.46 W	A	60	.0	4.1
1971	MAR	31	14	52	23	34.29 N	118.51 W	A	61	.0	4.6
1971	APR	1	15	3	4	34 43 N	118.41 W	A	72	.0	4.1
1971	APR	2	5	40	25	34.28 N	118.53 W	A	61	.0	4.0
1971	APR	15	11	14	32	34 26 N	118.58 W	B	62	.0	4.2
1971	APR	25	14	40	7	34.37 N	118.31 W	B	63	.0	4.0
1971	JUN	21	16	1	8	34 27 N	118.53 W	B	60	.0	4.0
1971	JUN	22	10	41	19	33.75 N	117.48 W	B	66	.0	4.2
1973	FEB	21	14	45	57	34 06 N	119.03 W	B	83	.0	5.9
1974	MAR	9	0	54	32	34.40 N	118.47 W	C	70	.0	4.7
1974	AUG	14	14	45	55	34 43 N	118.37 W	A	71	.0	4.2
1976	JAN	1	17	20	13	33.96 N	117.89 W	A	32	.0	4.2
1976	APR	8	15	21	38	34 35 N	118.66 W	A	74	.0	4.6
1977	AUG	12	2	19	26	34.38 N	118.46 W	D	68	.0	4.5
1977	SEP	24	21	28	24	34.46 N	118.41 W	C	75	.0	4.2
1978	MAY	23	9	16	51	33.91 N	119.17 W	C	91	.0	4.0
1979	JAN	1	23	14	39	33.94 N	118.68 W	B	48	.0	5.0
1979	OCT	17	20	52	37	33.93 N	118.67 W	C	46	.0	4.2
1979	OCT	19	12	22	38	34.21 N	117.53 W	B	76	.0	4.1
1981	SEP	4	15	50	50	33.67 N	119.11 W	C	87	.0	5.3
1981	OCT	23	17	28	17	33.63 N	119.02 W	C	79	.0	4.6
1981	OCT	23	19	15	52	33.64 N	119.06 W	C	83	.0	4.6

**** SEARCH OF EARTHQUAKE DATA FILE 1 ****

SITE: ADE-85005-10 SCRC LONG BEACH

COORDINATES OF SITE	33 81 N 118.19 W
DISTANCE PER DEGREE	110.9 KM-N 92.6 KM-W
MAGNITUDE LIMITS	4.0 - 8.5
TEMPORAL LIMITS	1932 - 1981
SEARCH RADIUS (KM)	100
NUMBER OF YEARS OF DATA	50
NUMBER OF EARTHQUAKES IN FILE	2789
NUMBER OF EARTHQUAKES IN AREA	290

***** LEROY CRANDALL AND ASSOCIATES *****
LOS ANGELES

TABLE D-1
Sheet 7 of 11

LIST OF HISTORIC EARTHQUAKES OF MAGNITUDE 6.0 OR
GREATER WITHIN 100 KM OF THE SITE
(RICHTER DATA 1906-1931)

YEAR	MONTH	DAY	HR	MIN	SEC	LATITUDE	LONGITUDE	Q	DISTANCE	DEPTH	MAGNITUDE
1910	MAY	15	15	47	0	33.70 N	117.40 W	0	74	.0	6.0
1923	JUL	23	7	30	26	34.00 N	117.25 W	0	90	.0	6.3

***** SEARCH OF EARTHQUAKE DATA FILE 2 *****

SITE: ADE-85005-10 SCRC LONG BEACH

COORDINATES OF SITE 33.81 N 118.19 W
DISTANCE PER DEGREE 110.9 KM-N 92.6 KM-W
MAGNITUDE LIMITS 6.0 - 8.5
TEMPORAL LIMITS 1906 - 1931
SEARCH RADIUS (KM) 100
NUMBER OF YEARS OF DATA 26
NUMBER OF EARTHQUAKES IN FILE 35
NUMBER OF EARTHQUAKES IN AREA 2

***** LEROY CRANDALL AND ASSOCIATES *****
LOS ANGELES

TABLE D-1
Sheet 8 of 11

LIST OF HISTORIC EARTHQUAKES OF MAGNITUDE 7.0 OR
GREATER WITHIN 100 KM OF THE SITE
(NOAA/CDMG DATA 1812-1905)

YEAR	MONTH	DAY	HR	MIN	SEC	LATITUDE	LONGITUDE	Q	DISTANCE	DEPTH	MAGNITUDE
1890	FEB	9	4	6	0	34.00 N	117.50 W	D	67	.0	7.0

*** SEARCH OF EARTHQUAKE DATA FILE 3 ***

SITE: ADE-85005-10 SCRC LONG BEACH

COORDINATES OF SITE 33.81 N 118.19 W
DISTANCE PER DEGREE 110.9 KM-N 92.6 KM-W
MAGNITUDE LIMITS 7.0 - 8.5
TEMPORAL LIMITS 1812 - 1905
SEARCH RADIUS (KM) 100
NUMBER OF YEARS OF DATA 94
NUMBER OF EARTHQUAKES IN FILE 9
NUMBER OF EARTHQUAKES IN AREA 1

***** LEROY CRANDALL AND ASSOCIATES *****
LOS ANGELES

TABLE D-1
Sheet 9 of 11

***** SUMMARY OF EARTHQUAKE SEARCH *****

NUMBER OF HISTORIC EARTHQUAKES WITHIN 100 KM RADIUS OF SITE

MAGNITUDE RANGE	NUMBER
4.0 - 4.5	203
4.5 - 5.0	62
5.0 - 5.5	18
5.5 - 6.0	5
6.0 - 6.5	4
6.5 - 7.0	0
7.0 - 7.5	1
7.5 - 8.0	0
8.0 - 8.5	0

***** LEROY CRANDALL AND ASSOCIATES *****

LOS ANGELES

TABLE D-1
Sheet 10 of 11

*** COMPUTATION OF RECURRENCE CURVE ***

$$\text{LOG } N = A - BM$$

BIN	MAGNITUDE	RANGE	NO/YR (N)
1	4.00	4.00 - 8.50	5.82
2	4.50	4.50 - 8.50	1.76
3	5.00	5.00 - 8.50	.519
4	5.50	5.50 - 8.50	.159
5	6.00	6.00 - 8.50	.585E-01
6	6.50	6.50 - 8.50	.580E-02 NU
7	7.00	7.00 - 8.50	.588E-02 NU
8	7.50	7.50 - 8.50	.000
9	8.00	8.00 - 8.50	.000

A = 1.124 B = .5586 (NORMALIZED)
A = 4.779 0 = 1.0080 SIGMA = .339E-01

***** LEROY CRANDALL AND ASSOCIATES *****

LOS ANGELES

TABLE D-1
 Sheet 11 of 11

***** COMPUTATION OF DESIGN MAGNITUDE *****
 CONSTANT AREA

TABLE OF DESIGN MAGNITUDES

RISK	RETURN PERIOD (YEARS)				DESIGN MAGNITUDE			
	DESIGN LIFE (YEARS)				25	50	75	100
	25	50	75	100				
.01	2487	4974	7462	9949	7.96	8.15	8.24	8.29
.05	407	974	1462	1949	7.37	7.64	7.79	7.89
.10	237	474	711	949	7.08	7.36	7.52	7.63
.20	112	224	336	443	6.77	7.06	7.22	7.34
.30	70	140	210	280	6.57	6.86	7.03	7.15
.50	36	72	108	144	6.28	6.58	6.75	6.87
.70	20	41	62	83	6.05	6.34	6.52	6.64
.90	10	21	32	43	5.77	6.07	6.24	6.36

MMIN = 4.00 MMAX = 8.50
 MU = 5.58 DELTA = 2.321

***** LEROY CRANDALL AND ASSOCIATES *****
 LOS ANGELES

Boring No. 1005

Location: Bixby Bridge

Characteristic Site Period:

(1) Postulated Geotechnical Profiles Below Ground Surface:

<u>Depth Below Ground Surface (Feet)</u>	<u>Profile A Layer Thickness (Feet)</u>	<u>Shear Wave Velocity (Ft./Sec.)</u>
0 - 4	4	600
4 - 45	41	830
45 - 60	15	1250
60 - 100	40	1250*
100 - 150	50	1500*
150 - 200	50	2000*
200+	-	2500*

<u>Depth Below Ground Surface (Feet)</u>	<u>Profile B Layer Thickness (Feet)</u>	<u>Shear Wave Velocity (Ft./Sec.)</u>
0 - 10	10	600
10 - 45	35	830
45 - 60	15	1250
60 - 100	40	1250*
100 - 175	75	1500*
175 - 250	75	2000*
250+	-	2500*

*Extrapolated below 60 feet below ground surface.

(2) Range of Characteristic Site Period:

Ts = 0.8 to 1.0 sec

SITE PERIOD DETERMINATION

Boring No. 1027

Location: Willow Street Station

Characteristic Site Period:

(1) Postulated Geotechnical Profiles Below Ground Surface:

Depth Below Ground Surface (Feet)	<u>Profile A</u>		Shear Wave Velocity (Ft./Sec.)
	Layer Thickness (Feet)		
0 - 21	21		700
21 - 41	20		950
41 - 60	19		1200
60 - 100	40		1200*
100 - 150	50		1500*
150 - 200	50		2000*
200+	-		2500*

Depth Below Ground Surface (Feet)	<u>Profile B</u>		Shear Wave Velocity (Ft./Sec.)
	Layer Thickness (Feet)		
0 - 21	21		700
21 - 41	20		950
41 - 60	19		1200
60 - 100	40		1200*
100 - 175	75		1500*
175 - 250	75		2000*
250+	-		2500*

*Extrapolated below 60 feet below ground surface.

(2) Range of Characteristic Site Period:

Ts = 0.8 to 1.0 sec

SITE PERIOD DETERMINATION

Boring No. 1057

Location: 1st Street Station

Characteristic Site Period:

(1) Postulated Geotechnical Profiles Below Ground Surface:

Depth Below Ground Surface (Feet)	<u>Profile A</u>	
	Layer Thickness (Feet)	Shear Wave Velocity (Ft./Sec.)
0 - 9	9	630
9 - 40	31	1000
40 - 60	20	1330
60 - 100	40	1330*
100 - 150	50	1500*
150 - 200	50	2000*
200+	-	2500*

Depth Below Ground Surface (Feet)	<u>Profile B</u>	
	Layer Thickness (Feet)	Shear Wave Velocity (Ft./Sec.)
0 - 9	9	630
9 - 40	31	1000
40 - 60	20	1330
60 - 100	40	1330*
100 - 175	75	1500*
175 - 250	75	2000*
250+	-	2500*

*Extrapolated below 60 feet below ground surface.

(2) Range of Characteristic Site Period:

$T_s = 3/4$ to 1.0 sec

SITE PERIOD DETERMINATION

