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Geotechnical Engineering
Geology
Hydrogeology
Coastal Engineering
Hydrology
Hydraulics
Environmental Engineering

Project No. I-181-03
March 23, 2000

Boyle Engineering
7809 Convoy Court, #200
San Diego, CA 92111

Attention: Mr. Clark Fernon, Project Manager

Re: FIELD AND LAB DATA APPENDICES ADDENDA
TYPE SELECTION REPORT
VEHICULAR UNDERCROSSING
SR-56 MIDDLE SEGMENT
SAN DIEGO, CALIFORNIA

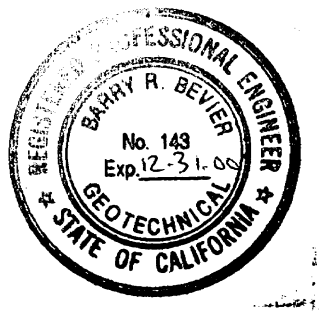
Dear Mr. Fernon:

As you requested, we are providing Appendices A and B for our previously submitted Type Selection Report for the Vehicular Undercrossing. Our report was submitted on January 22, 1999, prior to completion of the laboratory testing and test boring logs. This addendum completes our work for this bridge.

We appreciate the opportunity to work with you on this project and trust this information meets with your approval. If you have any questions, please call.

Very truly yours,
GROUP DELTA CONSULTANTS, INC.

Barry R. Bevier



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APPENDIX A
FIELD EXPLORATION

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FIELD EXPLORATION

A.1 Introduction

The subsurface conditions at the Vehicular Undercrossing site were investigated by Group Delta Consultants, Inc. (GDC) on January 11, 1999, by performing three soil borings (UAR-HSA-1 and UAR-HSA-2) to depths ranging from 13.9 to 18.4 meters. A summary of the soil borings is presented in Table A-1.

A.2 Soil Drilling and Sampling

The borings were advanced utilizing a CME 85 hollow-stem drill rig. The borings had a hole diameter of about 203.2 mm. The borings were performed by our drilling subcontractors under a continuous technical observation of a GDC field geologist, who visually inspected the soil samples, maintained detailed logs of the borings, interpreted stratigraphy, classified the soils, and obtained relatively undisturbed drive samples as well as Standard Penetration Test (SPT) samples and bag/bulk samples at about 1.5 m interval.

The soils were classified in the field and further examined in the laboratory in accordance with the Unified Soil Classification System (see Figure A-1). Field classifications were modified where necessary on the basis of laboratory test results. Detailed logs of the soil borings including blow count data and in situ moisture content and soil density are presented in Figures A-2 and A-3. Laboratory tests performed, other than the moisture content and dry density determination, are shown on the boring logs in the column "Other Tests". Descriptions and result summaries of laboratory tests performed are presented in Appendix B.

Relatively undisturbed soil samples were obtained using 76.2-mm outside diameter Modified California sampler lined with brass rings, each 25.4-mm high and 61.5-mm inside diameter. The ring and tube samplers were driven with a 63.6-kg safety hammer with an automatic release dropping 762 mm.

In addition, Standard Penetration Tests were performed in accordance with ASTM D1586-82 using a 50.8-mm outside diameter and 34.9-mm inside diameter split-spoon barrel sampler. The SPT sampler was driven with a 63.6-kg safety hammer with an automatic release dropping 762 mm. The Standard Penetration Test consists of counting the number of hammer blows it takes to drive the sampler 0.3 m into the ground. SPT blow counts are often used as an index of the relative density and resistance of the sampled materials. California drive sampler blow counts can be converted to equivalent SPT blow counts using a sampler end-area correction factor of about 0.67.

The following abbreviations are used on the logs to indicate the type of test performed:

AL Atterberg Limits Tests (Plastic and Liquid Limits)
CO Soil Corrosivity Tests (pH, Sulfates, Chlorides, and Electrical Resistivity)
WA Wash Analysis (% Passing #200 Sieve or Fines Content)

A.3 List of Attached Tables and Figures

The following tables and figures are attached and complete this appendix:

Table A-1	Soil Boring Summary
Figure A-1	Key for Soil Classification
Figures A-2 and A-3	Boring Logs (UAR-HSA-1 and UAR-HSA-2)

TABLE A-1
SOIL BORING SUMMARY
VEHICULAR UNDERCROSSING
STATE ROUTE 56, MIDDLE SEGMENT

Boring No.	Station No.*	Offset * (m)	Surface Elevation (m)	Total Depth (m)	Hole Diameter (mm)	Groundwater Depth (m)	Excavation Equipment
UAR-HSA-1	NA	NA	84.9	18.4	203.2	18.2 (perched)	CME 85 HSA
UAR-HSA-2	NA	NA	77.7	13.9	203.2	Not Encountered	CME 85 HSA

* Metric station and offset referenced from the centerline of the proposed Route 56 alignment were not surveyed.

KEY FOR SOIL CLASSIFICATION

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

PRIMARY DIVISIONS			GROUP SYMBOL	SECONDARY DIVISIONS
COARSE-GRAINED SOILS (< 50% fines content)	GRAVEL (% GRAVEL > % SAND)	CLEAN GRAVEL (Less than 5% fines)	GW	Well-graded gravel, gravel with sand, little or no fines
			GP	Poorly-graded gravel, gravel with sand, little or no fines
		"DIRTY" GRAVEL (More than 12% fines)	GM	Silty gravel, silty gravel with sand, silty or non-plastic fines
			GC	Clayey gravel, clayey gravel with sand, clayey or plastic fines
	SAND (% SAND ≥ % GRAVEL)	CLEAN SAND (Less than 5% fines)	SW	Well-graded sand, sand with gravel, little or no fines
			SP	Poorly-graded sand, sand with gravel, little or no fines
		"DIRTY" SAND (More than 12% fines)	SM	Silty sand, silty sand with gravel, silty or non-plastic fines
			SC	Clayey sand, clayey sand with gravel, clayey or plastic fines
FINE-GRAINED SOILS (> 50% fines content)	SILTS AND CLAYS (Liquid Limit less than 50)		ML	Inorganic silt, sandy silt, gravelly silt, or clayey silt with low plasticity
			CL	Inorganic clay of low to medium plasticity, sandy clay, gravelly clay, silty clay, Lean Clay
			OL	Low to medium plasticity Silt or Clay with significant organic content (vegetative matter)
	SILTS AND CLAYS (Liquid Limit 50 or more)		MH	Inorganic elastic silt, sandy silt, gravelly silt, or clayey silt of medium to high plasticity
			CH	Inorganic clay of high plasticity, Fat Clay
			OH	Medium to high plasticity Silt or Clay with significant organic content (vegetative matter)
HIGHLY ORGANIC SOILS			PT	Peat or other highly organic soils

Note: Dual symbols are used for coarse grained soils with 5 to 12% fines (ex: SP-SM), and for soils with Atterberg Limits falling in the CL-ML band in the Plasticity Chart

Borderline classifications between groups may be indicated by two symbols separated by a slash (ex: CL/CH, SW/GW).

CONSISTENCY CLASSIFICATION

COARSE GRAINED SOILS		FINE GRAINED SOILS		
Blowcount SPT[1] (CAL)[2]	Consistency	Blowcount[3] SPT[1] (CAL)[2]	Consistency	Undrained Shear Strength[3], S_u (ksf)
0-4 (0-6)	Very Loose	<2 (<3)	Very Soft	< 0.25
		2-4 (3-6)	Soft	0.25 -0.50
5-10 (7-15)	Loose	5-8 (7-12)	Firm	0.50 - 1.0
11-30 (16-45)	Med. Dense	9-15 (13-22)	Stiff	1.0 - 1.5
31-50 (46-75)	Dense	16-30 (23-45)	Very Stiff	1.5 - 2.0
>50 (>75)	Very Dense	>31 (>45)	Hard	>2.0

MOISTURE CLASSIFICATION

DRY - Absence of moisture, dusty, dry to the touch
MOIST- Damp but no visible water
WET- Visible free water, usually soil is below water table

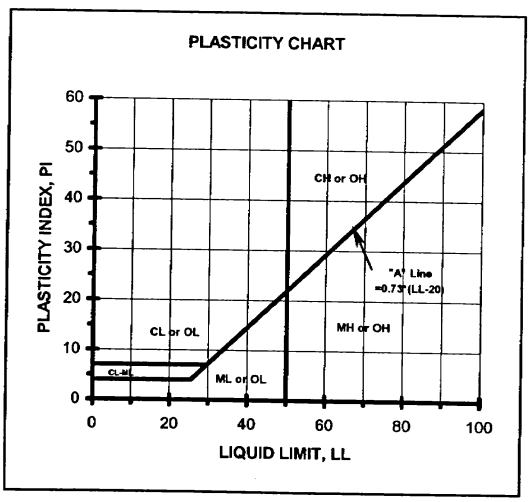
CONSISTENCY NOTES:

1. Number of blows of a 140-lb. hammer falling 30-inches to drive a 2-inch O.D. (1.375-inch I.D.) **SPT Sampler** [ASTM D-1586] the final 12-inches of driving
2. Number of blows of a 140-lb. hammer falling 30-inches to drive a 3-inch O.D. (2.42-inch I.D.) **California Ring Sampler** the final 12-inches of driving.
3. Undrained shear strength of cohesive soils predicted from field blowcounts is generally unreliable. Where possible, consistency should be based on S_u data from pocket penetrometer, torvane, or laboratory testing.

CLASSIFICATION CRITERIA BASED ON LABORATORY TESTS

Grain Size Classification

CLAY AND SILT	SAND			GRAVEL		COBBLES	BOULDERS
	Fine	Medium	Coarse	Fine	Coarse		
US Std Sieve → No. 200	No. 40	No. 10	No. 4	3/4"	3"	12"	
Grain Size (mm) → 0.075	0.425	2	4.75	19.1	76.2	304.8	



Classification of earth materials shown on the logs is based on field inspection and should not be construed to imply laboratory analysis unless so stated.

Granular Soil Gradation Parameters

Coefficient of Uniformity: $C_u = D_{60} / D_{10}$

Coefficient of Curvature: $C_C = (D_{30})^2 / (D_{10} \times D_{60})$

D_{10}= 10% of the soil is finer than this diameter

D_{30}= 30% of the soil is finer than this diameter

D_{60}= 60% of the soil is finer than this diameter

Group Symbol	Gradation or Plasticity Requirement
SW	C_u>6 and C_c between 1 and 3
GW	C_u>4 and C_c between 1 and 3
GP or SP	Clean gravel or sand not meeting requirement for GW or SW
GM or SM	Plots below "A" Line on Plasticity Chart or PI < 4
GC or SC	Plots above "A" Line on Plasticity Chart and PI > 7

Metric Unit Conversion: 1" = 25.4 mm, 1.0 ksf = 47.88 kPa

OTHER TESTS	MOISTURE (%)	DRY DENSITY (kg/m3)	PENETRATION RESISTANCE (blows/0.3m)	SAMPLE TYPE	DEPTH (meters)	DESCRIPTION OF SUBSURFACE MATERIALS	ELEVATION (meters)
						THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF ACTUAL CONDITIONS ENCOUNTERED.	84.9 ±
	10.8	1561	33	D	0	**Top Soil / Residual Clay:** **Clayey Medium to Fine Sand (SC),** loose to medium dense, brown, moist	
					1	**Sandy Lean Clay (CL),** hard, brown, moist **La Jolla Group:** **Poorly Graded Fine Sand with Silt (SP/SM),** medium dense, light brown, moist	84
	10.9		35	S	2	**Silty Fine Sand (SM),** very dense, light brown to dark brown, moist locally with strong cementation Fines content = 22%	83
CO WA			-	B			
AL	13.1	1602	100+	D	3		82
	8.8		100+	S	4		81
					5		80
	8.4	1745	100+	D	6		79
			-	B	7		78
GS	9.5		100+	S	8	Cemented sand layer from 8.2 to 8.7 m	77
			100+	D	9		76

SAMPLE TYPES:
- C Rock Core
- S Standard Split Spoon
- D Drive Sample
- B Bulk Sample
- T Tube Sample

DATE DRILLED: **01/11/1999**

EQUIPMENT/METHOD USED: **CME 85/8" HSA**

FIELD SUPERVISOR: **J. BROWN**

GROUP DELTA

PROJECT NO. I-181

STATE ROUTE 56 MIDDLE SEG. PROJECT

Vehicular Undercrossing

Log of Boring No. UAR-HSA- 1

FIGURE A-2 a

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OTHER TESTS	MOISTURE (%)	DRY DENSITY (kg/m3)	PENETRATION RESISTANCE (blows/0.3m)	SAMPLE TYPE	DEPTH (meters)	DESCRIPTION OF SUBSURFACE MATERIALS	ELEVATION (meters)
						THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF ACTUAL CONDITIONS ENCOUNTERED.	84.9 ±
					10	Becomes light gray	75
	4.3		100+	S		Cemented sand layer from 10.7 to 11.0 m	
					11		74
					12		73
	10.2	1713	100+	D			
					13		72
	12.1		100+	S	14		71
					15		70
	11.9	1846	100+	D			
					16		69
	2.0		100+	S	17	Cemented sand layer from 16.8 to 17.2 m	68
					18	Cemented sand layer from 17.8 to 18.0 m ▽	67
					19	Bottom of boring at El. 66.5 m Perched water encountered at El. 66.7 m	66

SAMPLE TYPES:
- C Rock Core
- S Standard Split Spoon
- D Drive Sample
- B Bulk Sample
- T Tube Sample

DATE DRILLED: **01/11/1999**

EQUIPMENT/METHOD USED: **CME 85/8" HSA**

FIELD SUPERVISOR: **J. BROWN**

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PROJECT NO. I-181

STATE ROUTE 56 MIDDLE SEG. PROJECT

Vehicular Undercrossing

Log of Boring No. UAR-HSA- 1

FIGURE A-2 b

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OTHER TESTS	MOISTURE (%)	DRY DENSITY (kg/m3)	PENETRATION RESISTANCE (blows/0.3m)	SAMPLE TYPE	DEPTH (meters)	DESCRIPTION OF SUBSURFACE MATERIALS	ELEVATION (meters)
						THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF ACTUAL CONDITIONS ENCOUNTERED.	77.7 ±
	10.8		17	S	0	**Top Soil:** **Silty Medium to Fine Sand (SM),** medium dense, brown, moist, with trace clay	
					1	**La Jolla Group:** **Medium to Fine Sand with Silt (SP-SM),** very dense, light brown, moist, with occasional gravels	77
	9.7	1760	100+	D	2		76
			-	B			75
	8.5		100+	S	3		
					4	With trace gravel	74
GS	13.5	1756	100+	D	5		73
						Silty Medium to Fine Sand (SM), very dense, light gray, moist, locally with strong cementation	
	11.5		100+	S	6		72
			-	B	7		71
AL GS	13.4	1719	100+	D	8		70
						Cemented sand layer from 8.5 to 8.8 m	
	12.9		100+	S	9		69

SAMPLE TYPES:
- C Rock Core
- S Standard Split Spoon
- D Drive Sample
- B Bulk Sample
- T Tube Sample

DATE DRILLED: **01/11/1999**

EQUIPMENT/METHOD USED: **CME 85/8" HSA**

FIELD SUPERVISOR: **J. BROWN**

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PROJECT NO. I-181

STATE ROUTE 56 MIDDLE SEG. PROJECT

Vehicular Undercrossing

Log of Boring No. UAR-HSA- 2

FIGURE A-3 a

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OTHER TESTS	MOISTURE (%)	DRY DENSITY (kg/m3)	PENETRATION RESISTANCE (blows/0.3m)	SAMPLE TYPE	DEPTH (meters)	DESCRIPTION OF SUBSURFACE MATERIALS	ELEVATION (meters)
						THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF ACTUAL CONDITIONS ENCOUNTERED.	77.7 ±
					10	Cemented sand layer 10 cm thick	
	17.2	1724	100+	D	11	**Silty Fine Sand (SM) to Fine Sandy Silt (ML),** very dense, mottled brown to dark gray, moist	67
					12		66
	14.4		100+	S		**Silty Medium to Fine Sand (SM),** very dense, light gray, moist	
					13		65
	15.4	1790	100+	D		Increased moisture	64
					14	Bottom of boring at El. 63.8 m Groundwater not encountered	
					15		63
					16		62
					17		61
					18		60
					19		59

SAMPLE TYPES:
- C Rock Core
- S Standard Split Spoon
- D Drive Sample
- B Bulk Sample
- T Tube Sample

DATE DRILLED: **01/11/1999**

EQUIPMENT/METHOD USED: **CME 85/8" HSA**

FIELD SUPERVISOR: **J. BROWN**

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PROJECT NO. I-181

STATE ROUTE 56 MIDDLE SEG. PROJECT

Vehicular Undercrossing

Log of Boring No. UAR-HSA- 2

FIGURE A-3 b

LBM UAR.GPJ 3-23-00

APPENDIX B
LABORATORY TESTING

APPENDIX B
LABORATORY TESTING

B.1 Introduction

Relatively undisturbed California drive samples, as well as Standard Penetration Test (SPT) samples, and bulk/bag samples were carefully sealed in the field to prevent moisture loss. All the samples were then transported to the laboratory for examination and testing. Tests were performed on selected samples as an aid in classifying the soils and to evaluate their physical properties and engineering characteristics. Details of the laboratory testing program and test results are discussed in the following sections. GDC performed most of the geotechnical laboratory testing using appropriate American Society for Testing and Materials (ASTM) and California Test Methods (CTM). Brief descriptions of the laboratory testing program and test results are presented below.

B.2 Soil Classification

The subsurface materials were classified using the Unified Soil Classification System (USCS), in accordance with ASTM Test Methods D2487-85 and D2488-84. The soil classifications are presented on the boring logs in Appendix A.

B.3 Moisture Content and Dry Density

Moisture content and dry density were determined for selected samples. The drive samples were trimmed to obtain volume and wet weight then were dried in accordance with ASTM D2216-71. After drying, the weight of each sample was measured, and moisture content and dry density were calculated. The moisture content of selected SPT samples and bulk samples were also determined. Moisture content and dry density values are presented on the boring logs in Appendix A.

B.4 Wash Analysis (Fines Content Determination)

Fines content (i.e., percent clay and silt soil fraction) was determined for selected soil samples by washing the soil samples through the #200 sieve. The fines content is an important factor for evaluating the liquefaction potential of sandy soils. The test results are presented on the boring logs.

B.5 Atterberg Limits

Liquid and plastic limits were determined for selected fine-grained soil samples or fine-grained fraction of coarse-grained soil samples (soil passing #40 sieve) showing some plasticity properties in accordance with ASTM D4318-84. Results of the Atterberg limits tests are summarized in Table B-1.

B.6 Corrosivity Tests

Selected samples were tested for corrosivity characteristics and included soluble sulfate content (CTM 417), soluble chloride content (CTM 422), minimum electrical resistivity, and pH (CTM 643). The test results are summarized in Table B-2.

B.7 List of Attached Tables and Figures

The following tables and figures are attached and complete this appendix:

Table B-1	Summary of Atterberg Limits Test Results
Table B-2	Summary of Soil Corrosivity Test Results
Figure B-1	Grain Size Distribution Test Results

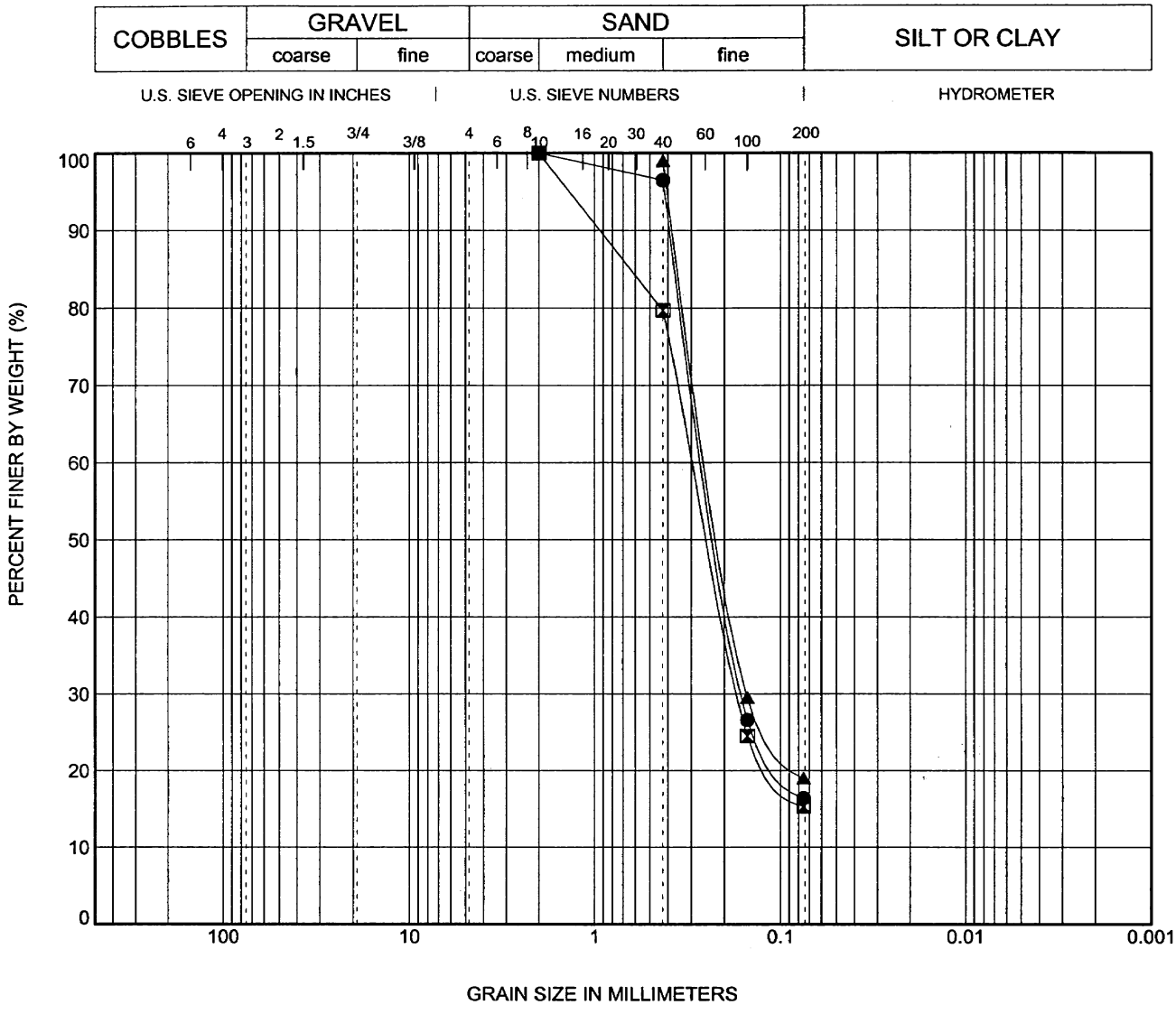
TABLE B-1
SUMMARY OF ATTERBERG LIMITS TEST RESULTS
VEHICULAR UNDERCROSSING
STATE ROUTE 56, MIDDLE SEGMENT

Boring No.	Sample Depth (m)	USCS Soil Type	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Classification of Fine-Grained Fraction *
UAR-HSA-1	3.0 – 3.2	-	-	-	-	Non-plastic
UAR-HSA-2	7.6 – 9.3	-	-	-	-	Non-plastic

*** Soil fraction passing #40 sieve**

TABLE B-2
SUMMARY OF SOIL CORROSIVITY TEST RESULTS
VEHICULAR UNDERCROSSING
STATE ROUTE 56, MIDDLE SEGMENT

Boring No.	Sample Depth (m)	pH	Water Soluble Chloride Content CTM 417 (ppm)	Water Soluble Sulfate Content CTM 422 (ppm)	Minimum Resistivity CTM 643 (Ohm-cm)
UAR-HSA-1	2.0 – 2.7	8.8	60	<10	2,900



SYMBOL	BORING	DEPTH (m)	DESCRIPTION
●	UAR-HSA- 1	7.6 - 8.0	Silty Sand (SM)
⊠	UAR-HSA- 2	4.6 - 4.7	Silty Sand (SM)
▲	UAR-HSA- 2	7.6 - 7.8	Silty Sand (SM)

SYMBOL	BORING	DEPTH (m)	D100	D60	D30	D10	LL	PL	PI	Cc	Cu
●	UAR-HSA- 1	7.6 - 8.0	2	0.247	0.158						
⊠	UAR-HSA- 2	4.6 - 4.7	2	0.293	0.166						
▲	UAR-HSA- 2	7.6 - 7.8	0.425	0.237	0.151						

GDC GRAIN SIZE METRIC UAR.GPJ GDCLOGMT.GDT 3/23/00

GROUP DELTA CONSULTANTS

GRAIN SIZE DISTRIBUTION

Group Delta Consultants, Inc.

Project: STATE ROUTE 56 MIDDLE SEG. PROJECT
Location: Vehicular Undercrossing
Number: I-181

FIGURE B-1