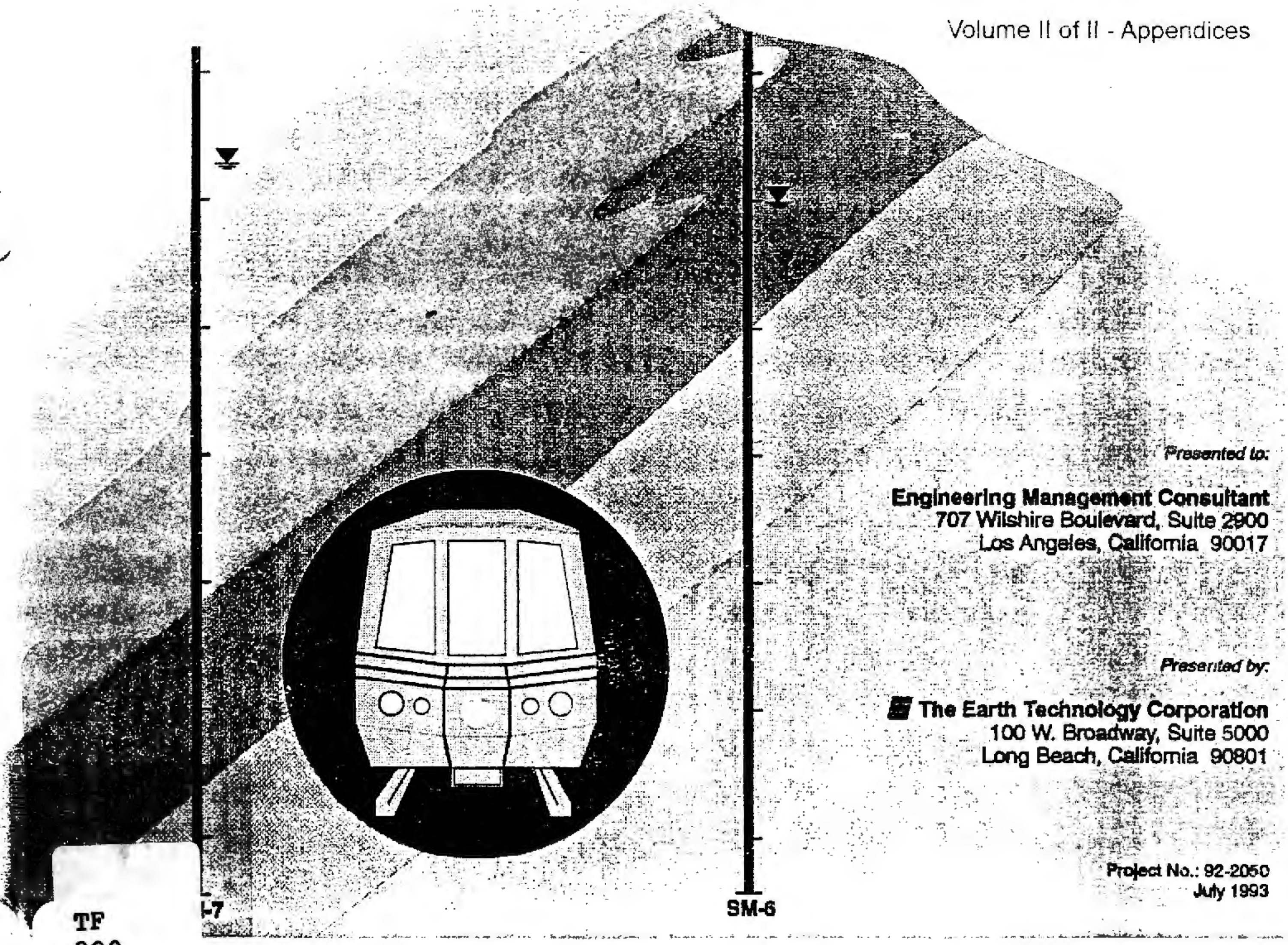
Geotechnical Investigation Report
Santa Monica Mountains
Segment 3, Metro Red Line

Volume II of II - Appendices



Presented to:

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Presented by:

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Long Beach, California 90801

Project No.: 92-2050
July 1993

GEOTECHNICAL INVESTIGATION REPORT
SANTA MONICA MOUNTAINS
SEGMENT 3, METRO RED LINE
VOLUME II - APPENDICES

Prepared for:

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LIST OF APPENDICES

APPENDIX A
BORING LOGS

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BORING LOGS

A.1 GENERAL

This appendix includes the logs of 15 borings (SM-1, SM-1A, SM-1B and SM-2 through SM-13) drilled and cored in this investigation as well as the logs of two brings (R-8 and R-9) drilled and sampled in 1989. Locations of the 15 borings performed in this investigation and the two 1989 borings with respect to the planned tunnel alignment are shown in Plate 2 of the main text. Logs and individual locations of these borings are presented in this appendix.

Explanations to the boring logs are provided in thc following sections.

A.2 EXPLANATIONS TO LOGGING OF SOIL SAMPLES OBTAINED IN THIS INVESTIGATION

Soil samples were described in accordance with the Unified Soil Classification System. Keys for soil description include the following:

o <u>Run No.</u>

The core/sample run number. Runs are counted consecutively from the top. Runs without any core/sample recovery are also counted.

o <u>Begin/End Time</u>

Start and end of each core run. The elapsed time and core length of each run are used to calculate the rate of drilling.

o <u>Core Recovery (%)</u>

The percentage of core/sample recovered for each run. It is calculated by dividing the total length core/sample recovery by the length of the core/sample run.

A.3 EXPLANATIONS TO LOGGING OF ROCK CORES OBTAINED IN THIS INVESTIGATION

The rock core logging procedures were specifically developed for this project to facilitate rockmass classifications/characterizations in accordance with the Geomechanics Classification of Joint Rock Mass (Bieniawski, 1989) and the Q-system (Barton et. al. 1974). The description for "Run No." "Begin/End Time" and "Core Recovery" are the same as those described in Section A.2. Other relevant keys/legends for rock core logging are described below:

- **RQD (Rock Quality Designation)**

RQD is defined as the sum of total length of all core pieces longer than 4 inches as a percent of the total length of rock drilled during the coring run. It is intended to reflect the in-situ fracture characteristics of the rock mass.

- **Discontinuity Frequency**

Number of natural rock discontinuities (i.e., excluding those caused by drilling or handling and excluding bedding planes) per foot for each core run. This is an indicator of in-situ fracturing characteristics of the rock.

- **Structural (Discontinuity) Descriptions**

Descriptions of all structural features or discontinuities present in the rock core. The features to be described include joints, shears, bedding and foliation. Faults may be inferred and mentioned in lithic description. The following characteristics were recorded as applicable.

Type

The type of discontinuity is designated on the log as follows:

Discontinuity Type	Designation
Joint	J
Shear	S
Bedding or foliation	B or F

Joint Set Characteristics

The number of joint sets present in the rock mass. Strongly developed parallel joints were counted as a complete joint set. In general, if there were a few "joints" that were visible or only occasional breaks in the core, they were classified as "random". Description and designation of joint set characteristics are provided below.

Description	Designation
No or few random joints	A
One joint set	B
One joint set plus random	B1
Two joint sets	C
Two joint sets plus random	C1
Three joint sets	D
Three joint sets plus random	D1
Four or more joint sets, random etc.	E
Crushed rock, soil like	F

Spacing

The spacing between (parallel) discontinuities was measured along the vertical axis of the core. For more than one joint set, the worst case was recorded in the appropriate column within the boring log. Standard terms and designations are as follows:

Spacing	Bedding Layers	Joints (Fractures)	Designation
>2m (>6.6 ft)	massive	very wide	M
0.6m to 2m (2′ to 6.6′)	thick	wide	T
0.2m to 0.6m (8" to 2′)	medium	moderately close	MM
60 to 200mm (2.4 to 8")	thin	close	TH
10 to 60mm (0.4" to 2.4")	very thin	very close	VT
10mm (0.4")	laminated	extremely close	L

Joint Roughness

Joint roughness denotes the frictional characteristics of wall contact. They were applied to the weakest joint sets. Standard descriptions and designations are as follows:

Description	Field Recognition	Designation
Very Rough	Near vertical steps and ridges occur on the discontinuity.	VR
Rough	Some ridges and side-angle steps are evident; asperities are clearly visible; surface feels very abrasive.	R
Slightly Rough	Asperities on the discontinuity surfaces are distinguishable and can be felt.	SR
Smooth	Surface appears smooth and feels smooth to the touch.	S
Slickensided	Visual evidence of polishing and movement are visible.	SK

Planarity

This denotes the surface planarity of the discontinuity. Standard descriptions and designations are as follows:

Description	Field Recognition	Designation
Discontinuous	Not continuous	D
Wavy	A moderately undulating surface, with no sharp breaks or steps.	W
Planar	A flat surface.	P
Stepped	A surface with asperities or steps. The height of the asperity should be estimated or measured.	S
Open	Separation exists between surfaces	O

Discontinuity Filling

Discontinuity filling characteristics were applied to the weakest and least favorably oriented joint set or discontinuity. Standard descriptions and designations are as follows:

Description	Approximate Separation	Designation
Tightly healed or unweathered	0	I
Slightly weathered with non-clay coating	0 to 1 mm	II
Moderately weathered with some clay coating	0 to 1 mm	III
Highly weathered with clay	0 to 1 mm	IV
Non-clay filling	1 to 5 mm	V
Clay filling	1 to 5 mm	VI
No clay filling	>5 mm	VII
Clay filling	>5 mm	VIII

Type of non-clay or clay filling is provided in lithic description.

Degree of Weathering

The degree to which the walls of a given discontinuity have weathered was estimated by the presence of a stain, relative hardness of the discontinuity wall to the parent rock, presence of a noticeable discontinuity filling, etc. Terms used to describe the degree of weathering are as follows:

Description on Log	Field Description	Designation
Fresh	No visible sign of weathering.	F
Faintly Weathered	Weathering limited to the surface of major discontinuities.	FW
Slightly Weathered	Penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.	SW
Moderately Weathered	Weathering extends throughout the rock mass but the rock material is not friable.	MW
Highly Weathered	Weathering extends throughout the rock mass and the rock material is partly friable.	HW
Completely Weathered	Rock is wholly decomposed and in a friable condition but the rock texture and structure are preserved.	CW
Residual Soil	A soil material with the original texture, structure, and mineralogy of the rock completely destroyed.	RS

Dip

The dip of the discontinuity feature is defined as the angle of the plane (in degrees) relative to the horizontal direction.

Discontinuity Sketch

A schematic sketch of observed discontinuities, depicting fracture, configuration, dip, joint sets, etc., is provided.

o **Type of Rock and Lithic Descriptions**

A standard lithological description of each rock type was recorded on the log forms. Variations from the general description were noted for each run as they occurred. The lithological descriptions included the following information:

Rock Type

Type of rock of a geologic unit.

Color

A description of the overall color of the rock, as well the color of specific minerals and matrix where applicable. Color was described using the rock color chart terminology published by the Geological Society of America. The color chart provides a standardized method to describe the color by name (e.g. dark reddish brown), hue (e.g. 5 year), value (e.g. 3) and chroma (e.g. 2).

Texture

The texture of the rock was based on the grain or crystal sizes of the predominant minerals and any matrix material present. Standard descriptions and designations are as follows:

Description/Designation	Size (mm)	Field Recognition
Very Fine-grained	<0.06	Individual grains/crystals can not be seen with hand lens
Fine-grained	0.06 to 0.2	Visible with hand lens
Medium Grained	0.2 to 0.6	Visible to naked rye
Coarse Grained	>0.6	Clearly visible

Additional textural information in terms of the presence of voids, the degree to which the voids have been filled and the nature of the filling, and for sedimentary rocks, any obvious cementation, including the mineralogy of the cement, are also presented in the core logs.

Other Descriptions

Any other information that best describes specific characteristics of the rock core. Examples include gouge material type, open voids, caving conditions, etc.

o **Packer Test Interval**

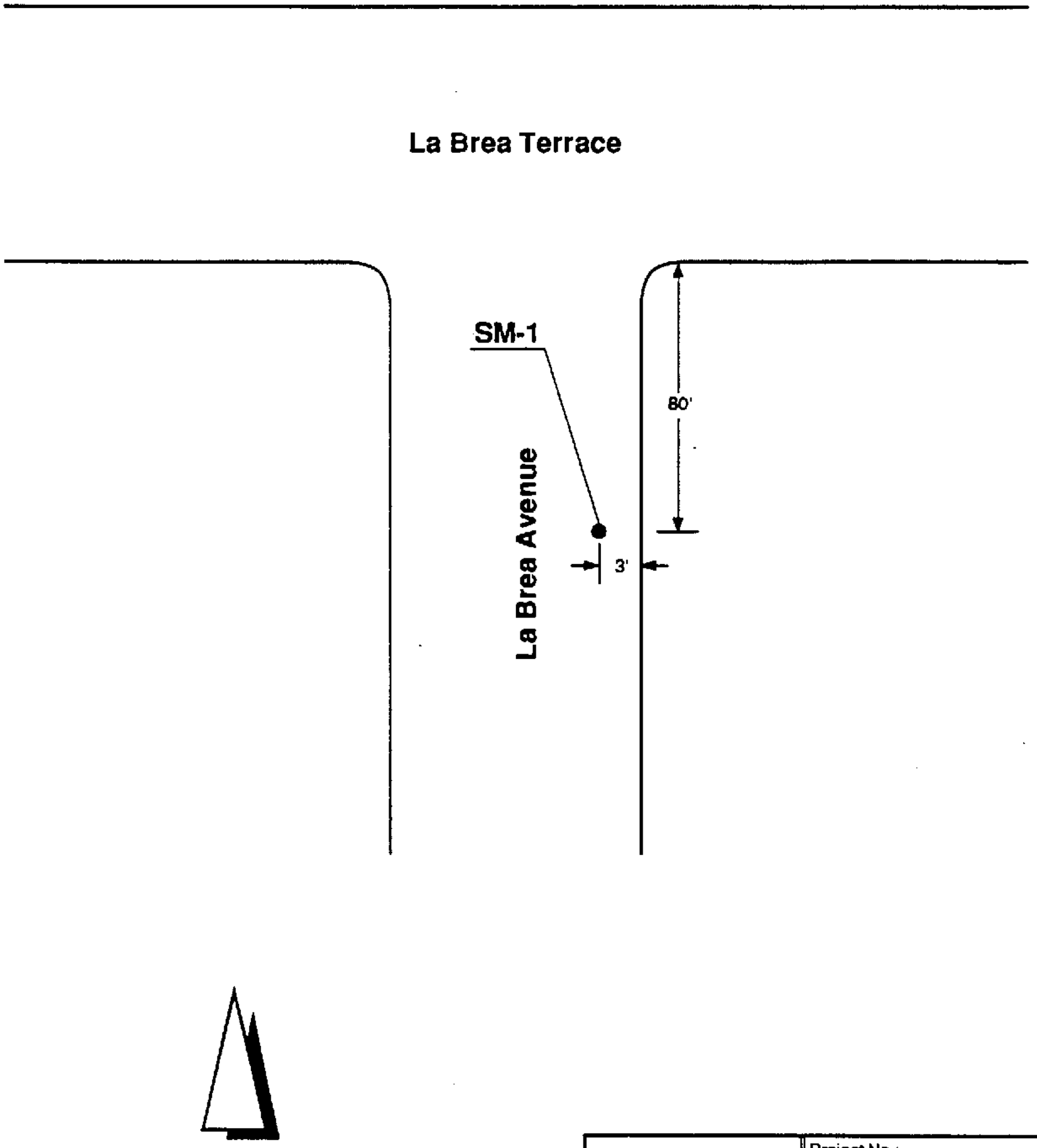
The interval (test zone) where the packer test was conducted is shown.

A.4 EXPLANATION TO LOGGING OF TWO 1989 BORINGS

The format of the logs for these two boring was somewhat different from that for the borings in this investigation. These 1989 boring logs also included core recovery, RQD, and lithic description as defined in Sections A.2 and A.3 as well as structural description which was in less detail than that in the boring logs for this investigation.

LOGS OF BORINGS DRILLED IN 1992 AND 1993

LOGS OF BORINGS DRILLED IN 1992 AND 1993



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Project No.: 92-2050
Geotechnical Investigation
Santa Monica Mountains
Segment 3, Metro Red Line

Location of Boring SM-1

Figure A-1

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LOG OF BORING SM-1

Client: PB/DMJM
Project: Metro Red Line-Segment 3
Project No.: 92-2050
Location: N4150650/E4183060
Surface Elevation (ft): 485
Boring No.: SM-1
Inclination (Deg.): 90
Bearing: NA
Depth (ft): 199.0
Depth to Water Table (ft):
Started: 11/6/92
Finished: 11/10/92
Core Dia. (in.): 2.4
No. of Core Boxes: 11
Driller: PC Exploration, Inc.
Drilling Method: Mud rotary
Fluids: Bentonite/Clear mud
Drilling Equipment: Mobile B-53
Logged By: P. Dunster
Checked By: G. Miller
Page No.: 1 of 6

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
0		11/6													**ASPHALT**	
	R1	11:34	92												**ALLUVIUM (Qal):** CLAY (CL); dark yellowish brown to moderate brown, fine grained, low plastic clay with fine- to medium-grained sand and silt, trace fine gravel-sized granodiorite clasts, massive; [drilled with punch core system equipped with tungsten carbide bit]	
5		11:37														
	R2	11:41	81													
10		11:45														
	R3	11:57	60													
15		12:02														
	R4	-	57												[driller reports soft zone between 15-17']	
															mottled light brown and moderate brown	
20		-														
	R5	12:21	100													
															mottled light olive gray	
25		12:26														
	R6	12:33	97													
															CLAY (CH); mottled light olive gray, light brown, and dark yellowish orange, medium plastic clay with silt and sand	
30		12:38														

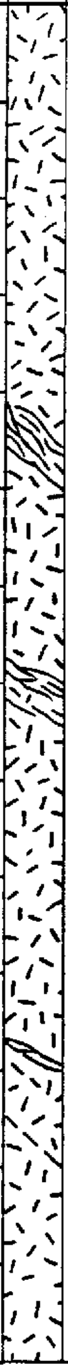
LOG OF BORING SM-1

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4150650/E4183060
Boring No.: SM-1	Page No.: 2 of 6

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
30	R7	12:48 12:56	98												ALLUVIUM (Qal): CLAY (CH); mottled light olive gray, moderate brown, and light brown, medium to high plastic clay with silt and fine- to coarse-grained sand, massive, scattered black organic flakes	
35	R8	13:31 13:41	100										60 70		grayish orange to pale yellowish brown with closely spaced caliche zones - poorly defined carbonate-lined fracture grayish orange to moderate yellowish brown	
40	R9	13:50 14:02	100										70		SILTY SAND/CLAYEY SAND (SM/SC); light brown to moderate yellowish orange, fine- to coarse-grained sand with clay and silt, some gravel-sized completely weathered granodiorite clasts, massive - caliche zone at contact	
45	R10	14:03 14:17	80	0	-	-	-	-	-	-	-	CW RS			GRANODIORITE (gd); dark yellowish orange, decomposed to fine- to coarse-grained sand with silt, some gravel-sized completely weathered granodiorite fragments, scattered carbonate and caliche flecks, massive	
	R11	14:29 14:39	100	0	-	-	-	-	-	-	-	CW RS			[core blocked off]	
50	R12	14:48 15:05	87	0	-	-	-	-	-	-	-	CW RS			no caliche pockets/zones	
55	R13	- -	100	0	-	-	-	-	-	-	-	CW RS				
	R14	- 15:55 15:59	67	0	-	-	-	-	-	-	-	CW RS			[driller changes to modified punch core] grayish orange to dusky yellow, scattered caliche flecks/zones	
60	R15	16:08 16:15	40	0	-	-	-	-	-	-	-	CW RS				
65																

LOG OF BORING SM-1B

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4150635/E4183065
Boring No.: SM-1B	Page No.: 3 of 6



Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R18	08:44 08:47	0	0	-	-	-	-	-	-	-	-			**GRANODIORITE (gd): SILTY SAND**; moderate yellowish brown and dark yellowish orange, massive, fine- to coarse-grained sand with nonelastic silt, noncalcareous cementation	
	R19	08:55 08:59	0	0	-	-	-	-	-	-	-	-			[changed to solid inner tube]	
70	R20	09:16 09:19	40	0	-	-	-	-	-	-	-	HW CW			decomposed to sand and gravel-sized fragments	70
	R21	09:28 09:32	0	0	-	-	-	-	-	-	-	-				
75	R22	09:38 09:43	80	0	-	-	-	-	-	-	-	CW RS	70		light olive brown and dusky yellow, medium grained, decomposed to fine- to coarse-grained sand with clay, massive, scattered, poorly defined clay-lined shear up to 25 mm wide @76'	75
	R23	09:49 09:53	20	0	-	-	-	-	-	-	-	CW				
80	R24	08:17 11/30 08:20	40	0	-	-	-	-	-	-	-	CW	40		- poorly defined clay-lined shear	80
	R25	08:34 08:37	100	0	-	-	-	-	-	-	-	CW			abundant discontinuous olive gray clay-lined shears up to 3 mm wide	
85	R26	08:45 08:49	72	0	-	-	-	-	-	-	-	CW				85
	R27	- 09:03	60	0	-	-	-	-	-	-	-	CW				
90	R28	09:54 09:59	30	0	-	-	-	-	-	-	-	HW	25		scattered gravel-sized granodiorite fragments, <1 mm wide clay-lined shear	90
	R29	10:32 10:45	30	0	-	-	-	-	-	-	-	HW	40		- joint	
95	R30	10:52 11:00	7	0	-	-	-	-	-	-	-	HW				95
	R31	11:13 11:22	100	0	-	-	-	-	-	-	-	FW CW			light gray, faintly weathered granodiorite fragment with healed fractures, no distinct contact with material below	
100																100

LOG OF BORING SM-1B

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4150635/E4183065
Boring No.: SM-1B	Page No.: 4 of 6

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R32	11:41 11:50	100	0	-	-	-	-	-	-	-	HW CW	30		**GRANODIORITE (gd)**; pale yellowish brown, dark yellowish brown, dusky yellow, and light olive brown, medium grained, decomposed to fine- to coarse-grained sand with clay, randomly spaced discontinuous clay seams	
	R33	12:36 12:44	100	0	-	-	-	-	-	-	-	-	80			
105	R34	13:01 13:05	50	0	-	-	-	-	-				60 70		**PUENTE FORMATION (Tp)**: SHALE; black, high plastic clay with silt, scattered quartzite intraclasts, stratified with zones of gouge parallel to bedding, pervasive undulating shears, carbonaceous; upper 15 cm marked by grayish blue gouge zone	105
	R35	- 13:43	100	100	-	S	B1	L	S SK	D W	VIII VI	SW MW	50 50 45			
110	R36	14:32 14:43	94	94	-	S	B1	L	S SK	D W	VIII VI	SW MW	40 35			110
115	R37	15:00 15:11	100	95	-	S	B1	L TH	S SK	D W	VIII VI	SW MW	60 60		- brecciated interval - 15 cm wide grayish green gouge zone with granodiorite intraclasts	115
120	R38	15:39 15:50	96	70	-	S J	A	L TH	SK S	D W	II III VI VIII	SW HW	40 40 40		dusky yellow, light olive brown, and dark yellowish brown - undulatory shears - 1' thick unsheared shale layer gouge zone, chaotic clay with discontinuous randomly oriented shears, granodiorite fragments	120
125	R39	09:00 12/1 09:16	92	92	-	-	-	-	-	-	-	SW HW			**GRANODIORITE (gd)**; grayish orange, dark yellowish brown, moderate yellowish brown, medium grained, decomposed to fine- to medium-grained sand with clay and silt, extremely closely spaced, chaotic, discontinuous shears	125
	R40	09:34 09:47	57	57	-	-	-	-	-	-	-	CW RS				
130	R41	10:02 10:13	100	100	-	S	A	L	SK	D	-	CW RS			[switched to solid inner tube]	130
	R42	10:26	100	0	-	S	A	L	-	D	-	CW RS				
135																135

LOG OF BORING SM-1

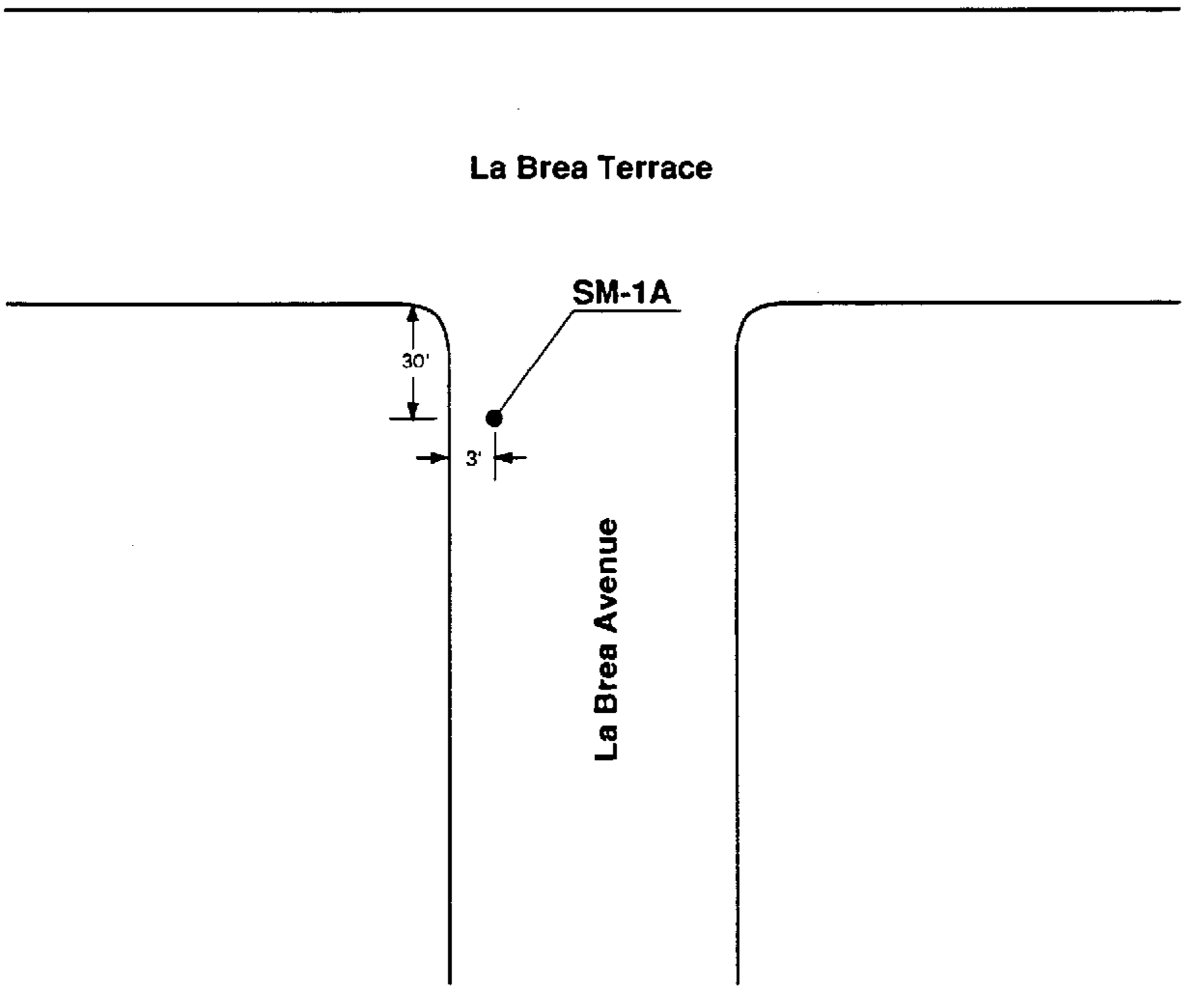
Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4150650/E4183060
Boring No.: SM-1	Page No.: 5 of 6

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R33	13:15 13:24	93												**ALLUVIUM (Qal):** CLAYEY SAND (SC); moderate reddish brown, fine- to coarse-grained sand, low plastic clay, trace gravel, massive, closely spaced, 3-8 mm wide fractures lined with white noncalcareous fine grained material	
140	R34	15:12 15:23	83										50 55		- fracture, line with white noncalcareous fine grained material	
145	R35	15:34 15:47	90													
150	R36	16:02 16:16	85										70		SANDY CLAY (CL); moderate reddish brown, plastic clay with fine- to coarse-grained sand, trace plutonic gravel- and cobble-sized clasts up to 15 cm in size, massive - slickensided shear	
155	R37	16:38 16:53	100										60			
160	R38	7:58 11/10 8:13	83													
165	R39	09:07 09:16	100													
	R40	10:08 10:14	0												[core blocked off]	
170																

LOG OF BORING SM-1

Client: PB/DMJM
Project: Metro Red Line-Segment 3
Project No.: 92-2050
Location: N4150650/E4183060
Boring No.: SM-1
Page No.: 6 of 6

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R41	10:32 10:46	0												**ALLUVIUM (Qal)**: CLAYEY SAND to SANDY CLAY (SC/CL); moderate reddish brown, fine- to coarse-grained sand and low plastic clay, some silt, trace gravel up to 1 cm in size, massive	
175	R42	11:48 11:52	100													175
	R43	12:01 12:06	94												light brown to moderate brown, trace cobble-sized granodiorite clasts	
180	R44	12:20 12:28	7												- 10 cm thick well cemented layer	180
185	R45	12:47 12:53	79												- highly friable	185
	R46	13:05 13:11	100												- 13 cm thick well cemented layer	
190	R47	13:28 13:55	83												CLAYEY SAND (SC); moderate brown, fine- to coarse-grained sand with low plastic clay, trace gravel- and cobble-sized granodiorite clasts, moderately to highly friable	190
195	R48	13:59 14:09	38													195
200															Boring terminated at 199 feet on 11/10/92. Piezometer installed on 11/11/92.	200
205																205



Not to Scale

The Earth Technology Corporation

Project No.: 92-2050
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Santa Monica Mountains
Segment 3, Metro Red Line

Location of Boring SM-1A

Figure A-2

LOG OF BORING SM-1A

Client: PB/DMJM	Project: Metro Red Line-Segment 3		Project No.: 92-2050
Location: N4150685/E4183025	Surface Elevation (ft): 492		Boring No.: SM-1A
Inclination (Deg.): 85	Bearing: N0E	Depth (ft): 180.0	Depth to Water Table (ft): 16
Started: 11/18/92	Finished: 11/21/92	Core Dia. (in.): 2.4	No. of Core Boxes: 8
Driller: PC Exploration, Inc.	Drilling Method: Mud rotary Fluids: Bentonite/Clear mud		Drilling Equipment: Mobile B-53
Logged By: P. Dunster	Checked By: G. Miller		Page No.: 1 of 6

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
0	R1	09:00 11/18 09:20	77												**ASPHALT** **ARTIFICIAL FILL (af)**: CLAY (CL); dark yellowish brown to moderate yellowish brown, dry to slightly moist, stiff,low plastic clay, with silt, some fine- to coarse-grained sand, scattered red brick fragments, moderately friable, massive [using tungsten carbide bit]	0
5	R2	10:57 11:00	0	0	-	-	-	-	-	-	-	-			very friable interval [sample washed out] **GRANODIORITE (gd)**; dusky yellow to moderate yellowish brown, medium grained, decomposed to fine- to coarse-grained sand and silt, very friable, massive	5
10	R3	11:19 11:21	32	0	-	-	-	-	-	-	-	CW				10
15	R4	11:31 11:35	0	0	-	-	-	-	-	-	-	-			very friable interval [sample washed out] [change to punch core drilling at 20']	15
20	R5	12:26 12:29	100	0	-	-	-	-	-	-	-	CW			dark yellowish orange, light brown, light to dark gray, medium grained, decomposed to fine- to coarse-grained sand and silt, very friable, faint original structures	20
	R6	12:39 12:46	71	0	-	-	-	-	-	-	-	CW				
25	R7	-	100	0	-	-	-	-	-	-	-	CW				25
	R8	- 14:32 14:42	0	0	-	-	-	-	-	-	-	-			[change to diamond impregnated bit with solid inner tube] [R8 washed out; hole caved after extracting inner tube]	
30																30

LOG OF BORING SM-1A

Client: PB/DMJM	**Project:** Metro Red Line-Segment 3
Project No.: 92-2050	**Location:** N4150685/E4183025
Boring No.: SM-1A	**Page No.:** 2 of 6

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
30	R9	15:22 15:25	0	0	-	-	-	-	-	-	-	-			**GRANODIORITE (gd)**; dark yellowish orange, light brown, light to dark gray, medium grained, decomposed to fine- to coarse-grained sand and silt, poorly cemented and very friable [R9/R10 washed out]	30
	R10	15:31 15:35	0	0	-	-	-	-	-	-	-	-				
35	R11	08:25 11/19 08:27	80	0	-	-	-	-	-	-	-	CW			[change to face discharge diamond impregnated bit with solid inner tube; 35' of 4" casing installed]	35
	R12	08:37 08:39	73	0	-	-	-	-	-	-	-	CW			dark yellowish brown moderate yellowish brown	
40	R13	08:48 08:55	47	0	-	-	-	-	-	-	-	CW	60		- fracture	40
45	R14	09:57 10:03	64	0	-	-	-	-	-	-	-	CW			black discoloration on joints, intermittent clayey zones	45
	R15	10:08 10:11	89	0	-	-	-	-	-	-	-	CW			[driller reports alternating hard and soft zones, blocked off at 48.5']	
50	R16	10:22 10:36	80	0	-	J	A B1	-	SR R	W D	III IV	HW	40 40		- light gray, unweathered granodiorite fragments	50
55	R17	11:00 11:08	0	0	-	-	-	-	-	-	-	-				55
60	R18	11:38 11:39	0	0	-	-	-	-	-	-	-	-			[change to split inner tube]	60
	R19	12:09 12:11	0	0	-	-	-	-	-	-	-	-			[R19 washed out, changed inner tube shoe to lip lock shoe]	
65																65

LOG OF BORING SM-1A

Client: **PB/DMJM**	Project: **Metro Red Line-Segment 3**
Project No.: **92-2050**	Location: **N4150685/E4183025**
Boring No.: **SM-1A**	Page No.: **3** of **6**

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R20	12:28 12:30	13	0	-	-	-	-	-	-	-	CW RS			**GRANODIORITE** (gd); light olive brown to grayish, orange, medium grained, decomposed to fine- to coarse-grained sand with silt and clay, soft, very friable	
	R21	12:37 12:39	17	0	-	-	-	-	-	-	-	CW RS				
70	R22	12:52 12:54	7	0	-	-	-	-	-	-	-	CW RS			[change to solid inner tube] [driller reports alternating soft and hard zones]	70
	R23	13:03 13:10	83	0	-	-	-	-	-	-	-	CW			medium light gray to medium dark gray mottling with oxidized completely weathered zones	
75	R24	13:29 13:34	60	0	-	-	-	-	-	-	-	HW CW				75
	R25	13:42 13:48	37	0	-	-	-	-	-	-	-	HW CW				
80	R26	14:27 14:32	40	0	-	-	-	-	-	-	-	HW CW				80
	R27	14:38 14:42	50	0	-	-	-	-	-	-	-	-			[blocked off]	
85	R28	- -	25	0	-	-	-	-	-	-	-	HW CW			- weakly foliated - 7 mm wide quartz vein	85
	R29	15:01 15:07	40	0	-	-	-	-	-	-	-	HW CW			- weakly foliated	
	R30	- -	50	0	-	-	-	-	-	-	-	-			pale blue, light to medium bluish gray, disintigrates to fine- to coarse-grained sand-sized quartz and feldspar grains and gravel-sized granodiorite clasts, 7 mm wide clay-lined seam @ 89.5'	
90	R31	16:06 16:10	40	0	-	-	-	-	-	-	-	F				90
	R32	16:20 16:26	20	0	-	-	-	-	-	-	-	F			- clay seam @ 92.5'	
95	R33	07:38 11/20 07:43	17	0	-	-	-	-	-	-	-	F				95
	R34	07:57 08:07	90	63	0.4	S	A F	TH	S	P	VIII	F	10		soft, clay-rich zone, extremely closely spaced randomly oriented clay seams	
100																100

LOG OF BORING SM-1A

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4150685/E4183025
Boring No.: SM-1A	Page No.: 4 of 6

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R35	08:12 08:16	90	0	-	S	A F	-	S SK	D	III VI	SW MW			**GRANODIORITE (gd):** grayish green, greenish gray to dark greenish gray, medium grained, some areas disintegrate to very fine- to coarse-grained sand within soft clay matrix, very friable, randomly oriented polished shears, clay-lined joints and intervals of clay gouge, alternating irregular hard and soft zones	
	R36	-	83	0	-	S	A F	-	S SK	D	III VI	SW MW				
105	R37	- 08:50 08:56	61	0	-	S	A F	-	SK	D	III	SW F				105
	R38	09:16 -	80	0	-	S	A F	-	SK	D	III VI	SW F			[change to split inner tube]	
110	R39	09:58 10:03	80	0	-	S	B1	-	SK	D W	VIII III VI		10 10			110
	R40	10:16 10:20	73	0	5	S J	B1	VT	SK SR	D W P	I III VIII	F SW	15 40		randomly oriented red clay-lined shears	
115	R41	10:31 10:37	38	0	-	S	A	VT L	SK	D	III VI	F SW MW			- soft, chaotic clay gouge	115
	R42	10:45 10:47	0	0	-	-	-	-	-	-	-	-				
120	R43	10:58 11:04	43	0	-	S J	B1	VT	SK	D P	III VI VIII	F MW	60		- scattered red clay-lined shears	120
	R44	11:16 11:18	73	0	-	S J	A	VT L	SK	D	III VI VIII	F MW	25		- 0.4 m wide sheared gouge zone, remaining core chaotic with indistinguishable structures	
125	R45	11:28 11:32	73	0	-	S J	A	VT L	SK	D P W	III VI	F MW	90 90		- <1 mm wide red clay-lined shear - <1 mm wide green clay-lined shear	125
	R46	11:40 11:45	43	0	-	S	A	L VT	SK	D	III VI	F MW			- soft, chaotic, randomly oriented polished shears	
130	R47	12:35 12:39	67	0	-	S	A	-	SK	D W	VI	F	10		- 7 mm wide clay gouge zone	130
	R48	12:47	50	0	-	-	-	-	-	-	-	-				
135																135

LOG OF BORING SM-1A

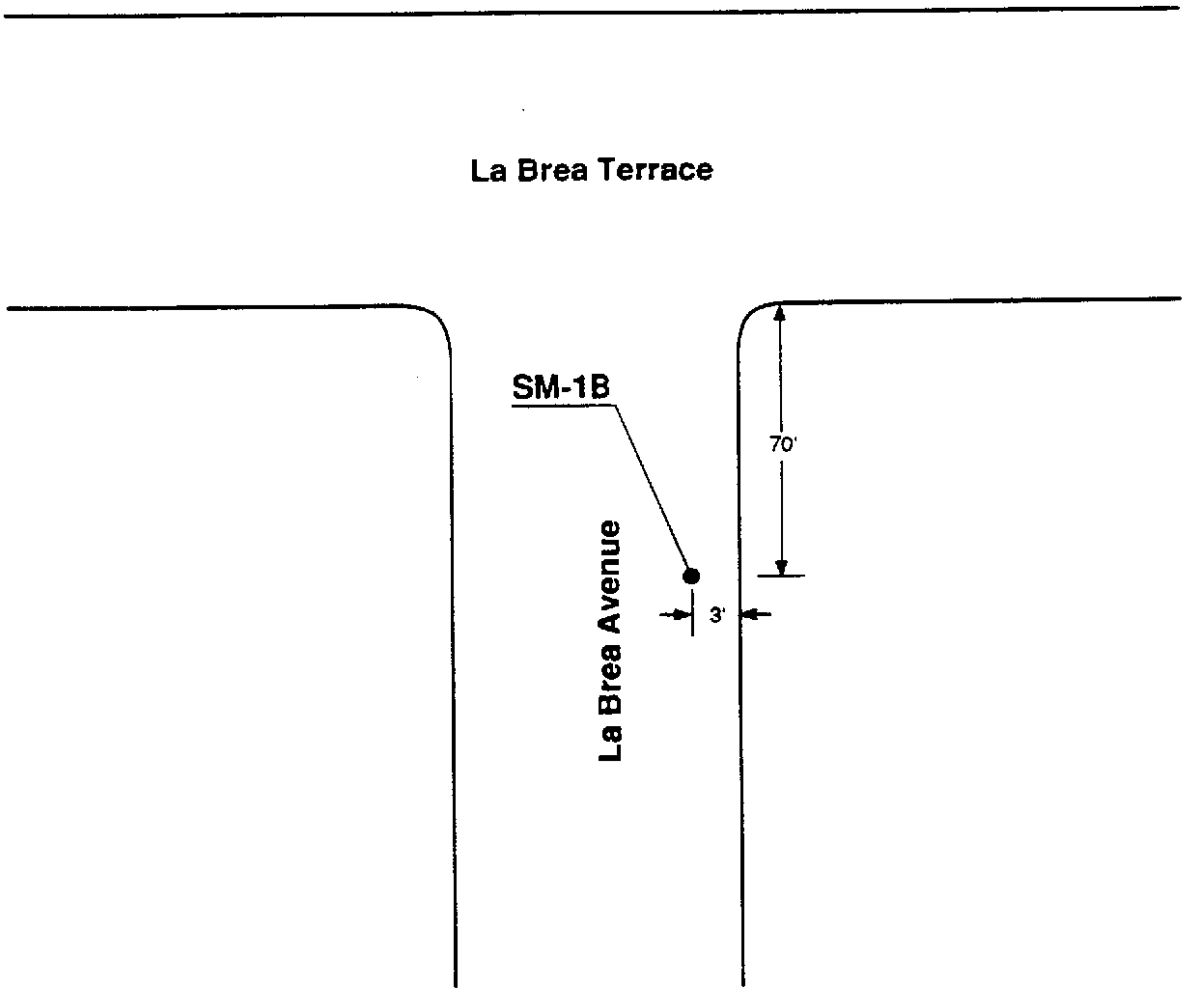
Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4150685/E4183025
Boring No.: SM-1A	Page No.: 5 of 6

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R49	12:52 13:01	100	69	-	S	A F	L VT	SK	W D P	VI VIII	F	70 60		**GRANODIORITE (gd)**: grayish green, light bluish gray, greenish gray, disintegrates to very fine- to coarse-grained sand and gravel-sized granodiorite clasts within a clay matrix, very friable, randomly oriented, discontinuous, polished shears, clay-lined joints and soft clay gouge, alternating irregular hard and soft zones, random powdery caliche zones	
140	R50	13:10 13:23	100	100	-	S	A F	L VT	SK	W D	VI	F	85 90		- up to 5 mm wide, wavy discontinuous red clay-lined shears	140
145	R51	13:36 13:48	90	13	-	S	A F	-	SK	W D	VIII VI	F	70		- 7 mm wide green clay-lined shear, soft and chaotic below	145
	R52	13:56 14:12	42	42	-	S	A F	-	SK	W D	VIII VI	F			- soft with no distinguishable structure	
150	R53	- 14:51	53	53	-	S	A F	-	SK	W D	VIII VI	F			[core blocked off] - scattered soft red clay fragments	150
155	R54	14:55 15:33	77	77	-	S	A F	-	SK	W D	VIII VI	F	20 15		- scattered red clay-lined shears	155
	R55	15:42 16:16	67	67	-	S	A F	-	SK	W D	VIII VI	F			- very closely spaced nearly vertical shears	
160	R56	16:24 08:30 11/21	50	50	-	-	F	-	SK	W	VIII	F			- clay gouge zone	160 TEST 1
	R57	08:33 08:46	100	100	-	-	F	-	SK	W	VIII	F				
165	R58	08:52 12:20	100	100	-	-	F	-	SK	W	VIII	F			- clay gouge mixed with gravel- to coarse-grained sand-sized granodiorite clasts	165
170	R59	12:29 12:43	33	0	-	-	F	-	SK	W	VIII	F				170

LOG OF BORING SM-1A

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4150685/E4183025
Boring No.: SM-1A	Page No.: 6 of 6

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		12:53											70		**GRANODIORITE (gd):** light bluish gray to medium dark gray, disintegrates to chaotic very fine- to coarse-grained sand and gravel-sized granodiorite clasts within a clay matrix, poorly cemented, very friable, randomly oriented, discontinuous, extremely closely spaced, polished shears, clay-lined joints and soft clay gouge	
	R60	13:00	87	81	-	S	F	-	SK	W	VIII	F	60			
175		13:10														175
	R61	13:23	54	0	-	J S	B1 F	TH	SK	W	VIII	F			- crystalline granodiorite fragment between two parallel shears - clay gouge	
180		13:32													Boring terminated at 180 feet on 11/21/92. Piesometer installed on 11/23/92.	180
185																185
190																190
195																195
200																200
205																205



Not to Scale

The Earth Technology Corporation

Project No.: 92-2050
Geotechnical Investigation
Santa Monica Mountains
Segment 3, Metro Red Line

Location of Boring SM-1B

Figure A-3

LOG OF BORING SM-1B

Client: PB/DMJM	Project: Metro Red Line-Segment 3	Project No.: 92-2050
Location: N4150635/E4183065	Surface Elevation (ft): 487	Boring No.: SM-1B
Inclination (Deg.): 90	Bearing: NA Depth (ft): 170.0	Depth to Water Table (ft): 13
Started: 11/23/92 Finished: 12/7/92	Core Dia. (in.): 2.4	No. of Core Boxes: 10
Driller: PC Exploration, Inc.	Drilling Method: Mud rotary Fluids: Bentonite/Clear mud	Drilling Equipment: Mobile B-53
Logged By: P. Dunster/M. Curtis	Checked By: G. Miller	Page No.: 1 of 6

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
0	R1	11/23													**ASPHALT** **ALLUVIUM (Qal)**: CLAY (CL); dark yellowish brown, low plastic clay, some silt and fine- to coarse-grained sand, massive, scattered rootlets [The upper 3 feet were drilled dry. Changed to Punch coring with tungsten carbide bit below 3 feet; using solid inner barrel]	0
5	R2	08:07 11/24	64													5
10	R3	- - -	70										70		- 5 mm wide sheared clay SANDY CLAY (CL); moderate to dark yellowish brown with olive gray mottling, low plastic clay, fine- to coarse-grained sand	10
15	R4	09:23 09:26	87												- moderate brown	15
	R5	09:30 09:35	70												mottled light brown and light olive gray, scattered black charcoal flecks	
20	R6	09:42 09:55	60													20
25	R7	10:31 10:37	90	0	-	-	-	-	-	-	-	-			[changed to split inner tube] GRANODIORITE (gd); see below	25
30																30

LOG OF BORING SM-1B

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4150635/E4183065
Boring No.: SM-1B	Page No.: 2 of 6

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
30	R8	10:50 10:56	90	0	-	-	-	-	-	-	-	CW RS			**GRANODIORITE (gd)**; dusky yellow, light olive brown, yellowish gray, and pale to dark yellowish orange, slightly moist, fine grained, decomposed to medium plastic clay with fine- to coarse-grained sand, intermittent soft calcareous zones	30
35	R9	11:10 11:19	90	0	-	-	-	-	-	-	-	CW RS			moderate yellowish brown and dark yellowish orange, massive, decomposed to fine- to coarse-grained sand with clay	35
40	R10	- 11:31	96	0	-	-	-	-	-	-	-	CW RS			pale to dark yellowish orange clayey zone	40
45	R11	11:37	19	0	-	-	-	-	-	-	-	CW			[driller indicates harder drilling]	45
	R12	12:00 12:04	67	0	-	-	-	-	-	-	-	CW				
50	R13	-	100	0	-	-	-	-	-	-	-	CW				50
	R14	- 14:51 14:54	40	0	-	-	-	-	-	-	-	CW RS			[change to diamond face discharge bit, still using split inner tube]	
55	R15	15:02 15:10	0	0	-	-	-	-	-	-	-	-			[core blocked off, caving interval]	55
60	R16	- 11/25 -	40	0	-	-	-	-	-	-	-	RS				60
	R17	08:35 08:38	52	0	-	-	-	-	-				90		- 3mm wide nearly vertical clay-lined shear [core blocked off]	
65																65

LOG OF BORING SM-1

Client: PB/DMJM

Project: Metro Red Line-Segment 3

Project No.: 92-2050

Location: N4150650/E4183060

Boring No.: SM-1

Page No.: 3 of 6

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R16	16:25 16:26	20	0	-	-	-	-	-	-	-	CW RS			**GRANODIORITE (gd)**; grayish orange to moderate yellowish brown, decomposed to fine- to coarse-grained sand with plastic clay, massive	
	R17	- 16:47	20	0	-	-	-	-	-	-	-	CW RS				
70	R18	10:56 11/7 11:03	0	0	-	-	-	-	-	-	-	-			[changed to rotary coring using diamond impregnated bit]	70
75	R19	11:26 11:32	20	0	1.0	S	A	-	SK	W	IV	CW RS	70		- closely spaced clay-lined slickensided shears	75
80	R20	11:45 11:57	52	0	-	S J	A	-	SK SR	W	IV	CW RS	50		alternating soft clayey gouge zones with gravel-sized granodiorite clasts and decomposed granodiorite	80
85	R21	12:03 12:13	60	0	-	S	A	-	SK	W	IV	CW RS	50 20 70		[driller reports hard from 83-85'] - poorly defined joints and clay-lined slickensided and polished shears - very closely spaced clay-lined, slickensided and polished shears	85
90	R22	12:22 12:35	65	0	-	J S	B1	VT L	SK SR	W	VIII	CW HW	30 30		scattered cobble-sized granodiorite fragments - 10 cm wide red clay-lined, slickensided and polished shear zone	90
95	R23	13:03 13:19	100	47	2.0	S	B	TH	SK S	W D	IV VII II	HW	30 30 30 30		**PUENTE FORMATION (Tp)**: CLAYSTONE; grayish olive to olive gray, highly plastic clay, laminated, localized extremely closely spaced slickensided and polished shear zones; interbedded sandstone at 98.5'	95
100																100

LOG OF BORING SM-1

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4150650/E4183060
Boring No.: SM-1	Page No.: 4 of 6

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R24	- 13:48	95	0	-	S B	A	-	S SK	D W	IV V VIII	HW	50 60		**PUENTE FORMATION (Tp): CLAYSTONE;** grayish olive to olive gray and dusky yellow, highly plastic clay with silt interbeds, laminated, localized extremely closely spaced slickensided and polished shear zones, iron oxide staining on siltstone interbeds	
105	R25	14:11 14:32	30	0	-	-	-	-	-	-	-	SW MW	80		dark yellowish orange and pale olive	105
110	R26	15:35 15:50	100	0	-	S B	A	L	S SK	D W	IV V VIII	SW MW	50 70 50		- sheared contact	110
	R27	9:22 9:29	100	0	-	S	A	-	S SK	D W	VIII	SW MW			dark yellowish orange, silt and clay with fine-grained sand and fine gravel-sized rock fragments, massive and chaotic	
115	R28	10:01 11/9 10:15	95	0	-	-	-	-	-	-	-	-			**ALLUVIUM (Qal): SANDY CLAY (CL);** dark yellowish orange to moderate yellowish brown, low plastic fines with fine- to coarse-grained sand and gravel-sized granodiorite clasts, massive, chaotic, punky, random polished shears	115
120	R29	10:38 10:50	88												- olive gray clay interval	120
125	R30	11:05 11:20	100												**CLAYEY to SILTY SAND (SC/SM);** moderate brown, medium grained, fine- to coarse-grained sand and low plastic fines, trace gravel up to 6 cm in size, massive and highly friable, gravel-sized clasts composed of granodiorite	125
	R31	11:34 11:38	100												grayish orange to dusky yellowish orange, faint polished shears, moderately friable	
130	R32	11:54 12:04	100										60 60 50		moderately closely spaced 7 mm wide caliche-lined joints	130
135																135

LOG OF BORING SM-1B

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4150635/E4183065
Boring No.: SM-1B	Page No.: 5 of 6

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R43	10:40 -	100	0	-	S	A	L	-	D	-	CW			**GRANODIORITE (gd)**; light olive brown, light olive gray, dark yellowish brown, moderate yellowish brown, medium grained, decomposed to fine- to medium-grained sand with clay and silt, some remnant gravel and cobble-sized fragments of granodiorite, scattered discontinuous clay-lined shears [core R43 blocked off]	
	R44	11:44	60	0	-	-	-	-	-	D	-	RS				
140	R45	11:49 12:01	100	0	-	-	-	-	-	-	-	CW RS				140
145	R46	12:15 12:24	100												**ALLUVIUM (Qal)**: CLAY (CL); yellowish brown to olive brown, dry to slightly moist, plastic clay with fine- to coarse-grained sand, trace gravel-sized granodiorite clasts, scattered powdery caliche	145
150	R47	12:40 12:53	100												grades to SANDY CLAY (CL); strong brown	150
155	R48	13:15 13:25	100												CLAYEY SAND/SANDY CLAY (SC/CH); yellowish red, dry to slightly moist, highly plastic clay, fine- to coarse-grained sand, massive, noncalcareous - yellowish brown	155
160	R49	13:45 - 12/7 -	100												SANDY CLAY (CH); dark reddish brown, dry to slightly moist, high plastic clay with medium-grained sand, trace gravel	160
	R50	-	98												- distinct contact	
165	R51	- - 11:50	98												SILTY SAND/SANDY SILT (SM/ML); yellowish red, dry to slightly moist, medium- to coarse-grained sand and low plastic silt, trace gravel, massive	165
170																170

LOG OF BORING SM-1B

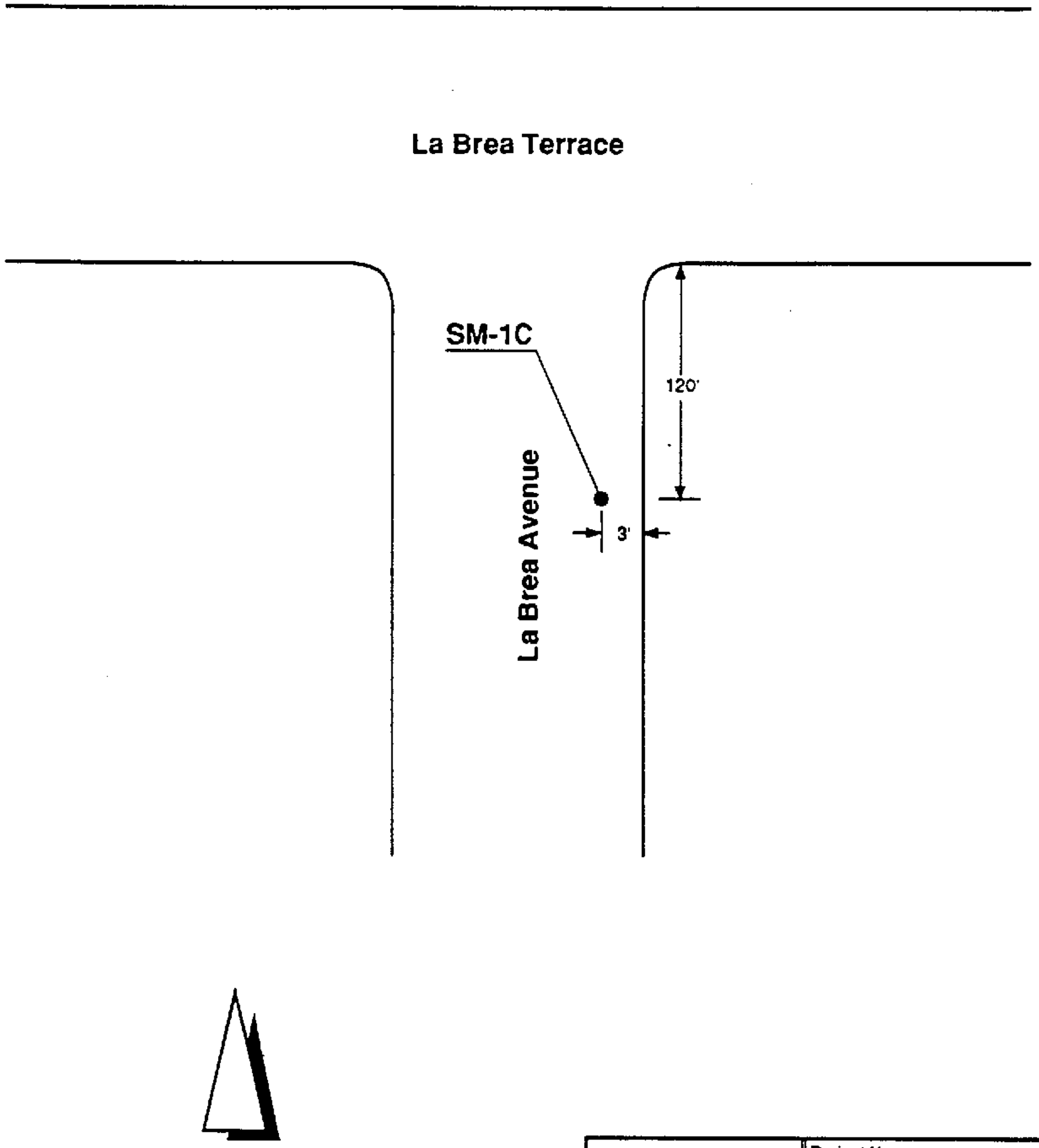
Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4150635/E4183065
Boring No.: SM-1B	Page No.: 6 of 6

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
															Boring terminated at 170.0 feet on 12-07-92. Backfilled with cement-bentonite slurry. Static water level at 13.4 feet on 12-1-92.	
175																175
180																180
185																185
190																190
195																195
200																200
205																205

LOG OF BORING SM-1B

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4150635/E4183065
Boring No.: SM-1B	Page No.: 5 of 6

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
															**GRANODIORITE (gd)**; light olive brown, light olive gray, dark yellowish brown, moderate yellowish brown, medium grained, decomposed to fine- to medium-grained sand with clay and silt, some remnant gravel and cobble-sized fragments of granodiorite, scattered discontinuous clay-lined shears (core R43 blocked off)	
	R43	10:40 -	100	0	-	S	A	L	-	D	-	CW				
	R44	11:44	60	0	-	-	-	-	-	D	-	RS				
140	R45	11:49 12:01	100	0	-	-	-	-	-	-	-	CW RS				140
	R46	12:15 12:24	100												**ALLUVIUM (Qal)**: CLAY (CL); yellowish brown to olive brown, dry to slightly moist, plastic clay with fine- to coarse-grained sand, trace gravel-sized granodiorite clasts, scattered powdery caliche	
145																145
	R47	12:40 12:53	100													
150															grades to SANDY CLAY (CL); strong brown	150
	R48	13:15 13:25	100												CLAYEY SAND/SANDY CLAY (SC/CH); yellowish red, dry to slightly moist, highly plastic clay, fine- to coarse-grained sand, massive, noncalcareous	
155															- yellowish brown	155
	R49	13:45 - 12/7	100												SANDY CLAY (CH); dark reddish brown, dry to slightly moist, high plastic clay with medium-grained sand, trace gravel	
160	R50	- -	98												- distinct contact	160
165															SILTY SAND/SANDY SILT (SM/ML); yellowish red, dry to slightly moist, medium- to coarse-grained sand and low plastic silt, trace gravel, massive	165
	R51	- -	98													
170		11:50														170



The Earth Technology Corporation

Project No.: 92-2050
Geotechnical Investigation
Santa Monica Mountains
Segment 3, Metro Red Line

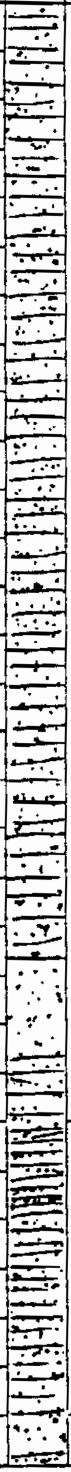
Location of Boring
SM-1C

Figure A-4

Project Name:	**Metro Rail - Los Angeles**				
Project Number:	**92-2038**	Boring Number:	**SM-1C**	Sheet 1 of 6	
Boring Location:	**1850 La Brea Ave.**	Elevation and Datum(feet):	**481.0**		
Health and Safety:	-	Date Started:	12/17/92	Date Finished:	12/17/92
Drilling Equipment:	**Failing F-10**	Total Depth (feet):	75.5	Depth to Bedrock(feet):	46.0
Drilling Method:	**Hollow Stem Auger**	Number of Samples:	47	Depth to Water (feet):	24.0
Boring Diameter:	**8-inch**	Completion Information:	**Grouted to surface**		
Hammer Information: **Downhole Hammer:140-lb and 30-inch drop.**		Logged By: G. Miller		Checked By: P. Guptill	

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples							Begin/End Time(hr)
					Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content(%)	
0		ASPHALT										
		CLAYEY SAND; dark yellowish brown (10YR 4/2), slightly moist, medium dense, medium- to coarse-grained sand, medium plastic fines, slightly micaceous, abundant weathered feldspar grains, trace gravel (plutonic)	SC	Qal								
		-----?-----?-----?										
5		- dark brown (7.5YR 3/2)			1	D	12/24/30	18"/18"				
					2	D	13/21/50	18"/18"				
					3	D	8/19/27	18"/18"				
		with very dark grayish brown mottling (10YR 3/2)			4	D	6/16/26	17"/18"				10:12
10												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: SM-1C	Sheet 2 of 6



Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
10		CLAYEY SAND; reddish brown (10YR 3/2), slightly moist, medium dense, medium- to coarse-grained sand, scattered gravel, low to medium plastic clay fines, massive	SC	Qal								10:12
					5	D	7/13/21	17"/18"				
					6	D	5/9/17	18"/18"				
					7	D	8/14/22	15"/18"				
15		with dark reddish brown mottling (5YR 3/4)										10:32
					8	D	10/14/19	18"/18"				
		reddish brown (5YR 4/3), moisture content increasing, moist to very moist, soft to medium dense			9	D	7/10/13	18"/18"				
					10	D	5/8/8	18"/18"				
20					11	D	6/8/11	18"/18"				10:59
		SANDY CLAY; brown (10YR 4/3), moist to very moist, firm, medium plastic clay, medium to coarse-grained sand, massive	CL		12	D	5/7/7	18"/18"				
					13	D	4/7/11	18"/18"				
		- moist to wet interval										
		CLAYEY SAND to SANDY CLAY; olive brown (2.5YR 4/3) with reddish brown mottling (5YR 4/4), see below	SC/CL		14	D	6/15/17	16"/18"				
25												

Project Name: Metro Rail - Los Angeles

Project Number: 92-2038 Boring Number: SM-1C Sheet 3 of 6

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND to SANDY CLAY; olive brown (2.5YR 4/3) with reddish brown mottling (5YR 4/4), medium dense to dense, medium-grained sand, some coarse- to very coarse-grained sand, low plastic fines, massive, micaceous, localized intervals of fine-grained sand	SC/CL	Qal								
					15	D	13/21/25	18"/18"				
					16	D	6/10/14	18"/18"				
					17	D	12/13/30	18"/18"				
30												11:18
					18	D	18/27/27	18"/18"				
		CLAYEY SAND; reddish brown (5YR 4/4), slightly moist, medium- to very coarse-grained sand, low plastic fines, massive; coarse-grained sand interval at 33.5'	SC		19	D	24/31/61	18"/18"			- -	
					20	D	13/36/49	18"/18"				
35		[overdrilled from 35 to 36 feet, no sample]										
					21	D	13	6"/6"				
					22	D	9/24/72	18"/18"				
		CLAYEY TO SILTY SAND; reddish brown (5YR 4/4) with light olive brown (2.5YR 5/3) bands and streaks, fine- to medium-grained sand, trace to some coarse- to very coarse-grained sand, trace gravel, nonplastic silt	SC/SM		23	D	11/37/63	18"/18"				
		SILTY SAND to SANDY SILT; yellowish brown (10YR 5/6) with very dark grayish brown (10YR 3/2), see below	SM/ML		24	D	17/44/66	18"/18"				12:00
40												

Project Name: **Metro Rail - Los Angeles**

Project Number: 92-2038 | Boring Number: SM-1C | Sheet 4 of 6

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Samples Type	Samples Blow Count	Samples Recovery	Samples RQD (%)	Samples Dry Density (pcf)	Samples Moisture Content (%)	Begin/End Time (hr)
		SILTY SAND to SANDY SILT; yellowish brown (10YR 5/6) with very dark grayish brown (10YR 3/2) mottling, patches, streaks and pockets, fine-grained sand, trace coarse- to very coarse-grained sand, scattered charcoal flecks, appears to be randomly sheared	SM/ML	Qal								12:00
							no sample taken					
					26	D	16/47/77	18"/18"				
					27	D	6/8/21	18"/18"				
45		- charcoal fragments, moist to very moist										
					28	D	7/23/52	18"/18"				
		DECOMPOSED GRANODIORITE; dark yellowish brown (10YR 4/4), very moist to wet, medium dense, very friable, medium- to coarse-grained, completely to highly weathered, extremely closely sheared and fractured, periodic intervals of alluvium-like material interspersed	SM	gd								
					29	D	9/16/27	15"/18"				
					30	D	8/11/25	16"/18"				
50		- sheared contact with alluvium-like material inclined to 60 degrees, moist to slightly moist below			31	D	13/39/46	18"/18"				12:32
					32	D	67/6" 50/0"	6"/6"				
		- slightly weathered granodiorite fragment										
		- occasional inclusions of dark reddish brown (stain) finely granular material within the granodiorite			33	D	41/6" 150/5"	11"/11"				
					34	D	31/64 100/2"	13"/13"				13:04
55												

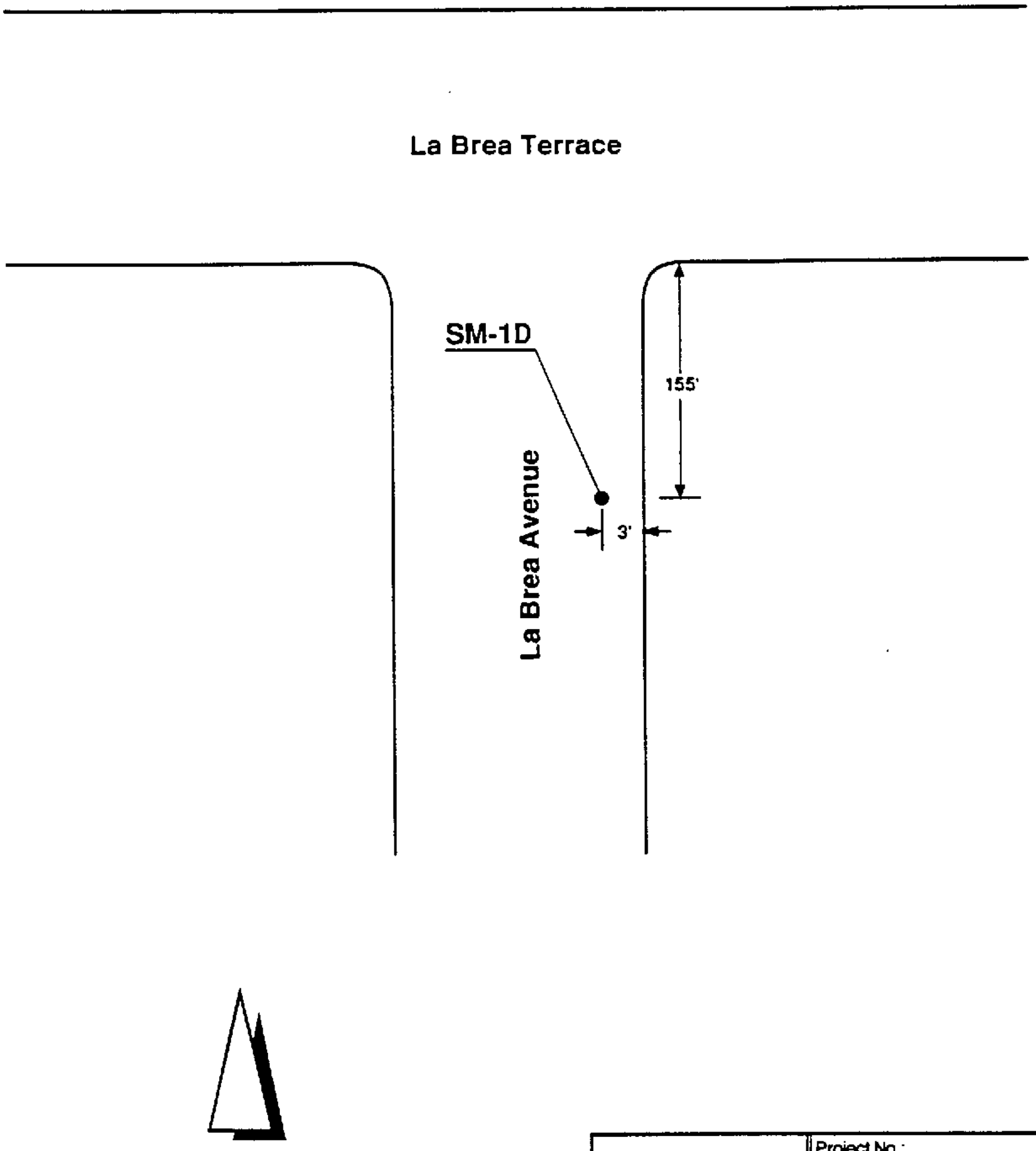
Project Name:	Metro Rail - Los Angeles			
Project Number:	92-2038	Boring Number:	SM-1C	Sheet 5 of 6

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Samples Type	Samples Blow Count	Samples Recovery	Samples RQD (%)	Samples Dry Density (pcf)	Samples Moisture Content (%)	Begin/End Time(hr)
		DECOMPOSED GRANODIORITE; dark yellowish brown (10YR 4/4), very moist to wet, medium dense, very friable, completely to highly weathered, medium- to coarse-grained, extremely closely sheared and fractured, periodic intervals of alluvium-like material interspersed		gd	35	D	22/62 100/4"	16"/16"				13:04
		- fracture surfaces stained reddish brown (2.5YR 4/4)			36	D	45 100\4"	10"/10"				
		- sheared contact										
		SILTY SAND; yellowish brown (10YR 5/4), slightly moist, medium- to very coarse-grained sand, low plastic silt, massive alluvium-like zone	SM	Qal	37	D	27/68/100	18"/18"				
60												13:29
		- localized rock fragments (quartz-rich plutonic)			38	D	22/100	12"/12"				
		- localized rock fragments (quartz-rich plutonic)			39	D	19/70/100	16"/18"				
		- sheared contact										
		WEATHERED GRANODIORITE; dark yellowish brown (10YR 4/4), moist to slightly moist, medium dense, very friable, completely to highly weathered, medium- to coarse-grained, extremely closely spaced clay-lined shears and fractures	SM	gd	40	D	11/30/75	15"/18"				
65		- clayey calcareous shear zone, inclined 60 degrees			41	D	33/100	12"/12"				
		SILTY SAND; reddish brown (5YR 4/4), dry to slightly moist, very dense, medium- to coarse-grained sand, trace gravel-sized plutonic clasts, nonplastic fines, coarsens downward, moderately friable, massive	SM	Qal								
					42	D	130\6"	6"/6"				
					43	D	66/100	12"/12"				
		- gravelly interval										
		SILTY SAND to SAND; brown (10YR 5/3), see below	SP/SM		44	D	39/100	12"/12"				14:17
70												

Project Name: Metro Rail - Los Angeles

Project Number: 92-2038 | Boring Number: SM-1C | Sheet 6 of 6

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples							Begin/End Time (hr)
					Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	
		SILTY SAND to SAND; brown (10YR 5/3), slightly moist to dry, very dense, coarse-grained sand, trace gravel, very friable, massive	SP/SM	Qal								14:17
					45	D	52/100	12"/12"				
		SILTY to CLAYEY SAND; dark reddish brown (2.5YR 3/4), slightly moist, very dense, medium-grained sand, some coarse-grained sand, trace very coarse-grained sand and gravel, nonplastic fines, moderately friable, massive	SM/SC		46	D	24/60 100\3"	15"/15"				
					47	D	19/46/75	18"/18"				
		- rounded cobble-sized plutinic rock fragment										
75												14:45
		Boring terminated at 75.5 feet. Perched groundwater encountered at 24 feet.										
80												
85												



The Earth Technology Corporation

Project No.: 92-2050
Geotechnical Investigation
Santa Monica Mountains
Segment 3, Metro Red Line

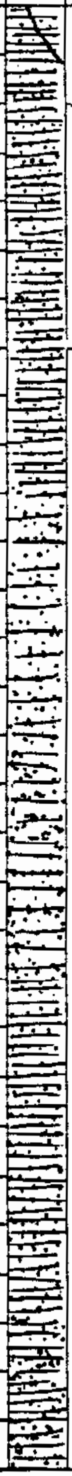
Location of Boring
SM-1D

Figure A-5

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: SM-1D	Sheet 1 of 4
Boring Location:	1850 La Brea Ave.	Elevation and Datum(feet):	476.5
Health and Safety:	-	Date Started: 12/21/92	Date Finished: 12/21/92
Drilling Equipment:	Failing F-10	Total Depth (feet): 45.5	Depth to Bedrock(feet): 33.5
Drilling Method:	Hollow Stem Auger	Number of Samples: 27	Depth to Water (feet): 41.5
Boring Diameter:	6-inch	Completion Information:	Grouted to surface
Hammer Information: Downhole Hammer:140-lb and 30-inch drop.		Logged By: G. Miller	Checked By: P. Guptill

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content(%)	Begin/End Time(hr)
0		ASPHALT										
		CLAYEY SAND to SANDY CLAY; very dark grayish brown (10YR 3/2), slightly moist, medium dense to firm, fine- to medium-grained sand, low to medium plastic fines, trace coarse-grained sand, massive	SC/CL	Qal							--	
5					1	D	9/35/50	18"/18"				9:59
					2	D	11/40/78	18"/18"				
		SANDY CLAY to CLAYEY SAND; dark brown (7.5YR 3/4), slightly moist, very hard to very dense, low plastic fines, some fine-grained sand, trace coarse to very coarse- grained sand, clay coatings on ped surfaces	CL/SC		3	D	9/67/109	14"/18"				
		- carbonate-lined shear			4	D	54/106	12"/12"				10:19
10												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: SM-1D	Sheet 2 of 4



Depth (feet)	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
10	SANDY CLAY to CLAYEY SAND; dark brown (7.5YR 3/4), slightly moist, very hard to very dense, low plastic fines, some fine-grained sand, trace coarse to very coarse- grained sand, massive, clay coatings	CL/SC	Qal								10:19
	CLAYEY SAND to SANDY CLAY; brown to strong brown (7.5YR 5/4-5/6), slightly moist, very hard to very dense, fine-grained sand, trace coarse- to very coarse-grained sand, low plastic fines, massive, irregular clay coatings on ped surfaces	SC/CL		5	D	22/105	12"/12"				
				6	D	37/73/100	18"/18"				
	CLAYEY SAND; grades to brown (7.5YR 4/4) and reddish brown (5YR 4/4), slightly moist, dense to very dense, fine- to coarse-grained sand, low plastic fines, massive, irregular clay coatings on ped surfaces	SC		7	D	29/55/97	18"/18"				
15											10:48
				8	D	22/43/70	18"/18"				
				9	D	20/30/76	18"/18"				
	grades to reddish brown (5YR 4/4)			10	D	11/15/36	13"/18"				
20	reddish brown (5YR 4/4) to yellowish red (5YR 4/6), weak to no clay coatings			11	D	22/31/62	18"/18"				11:04
				12	D	31/34/60	18"/18"				
				13	D	30/55 100/2"	14"/14"				
				14	D	48 100/4"	10"/10"				11:5
25											

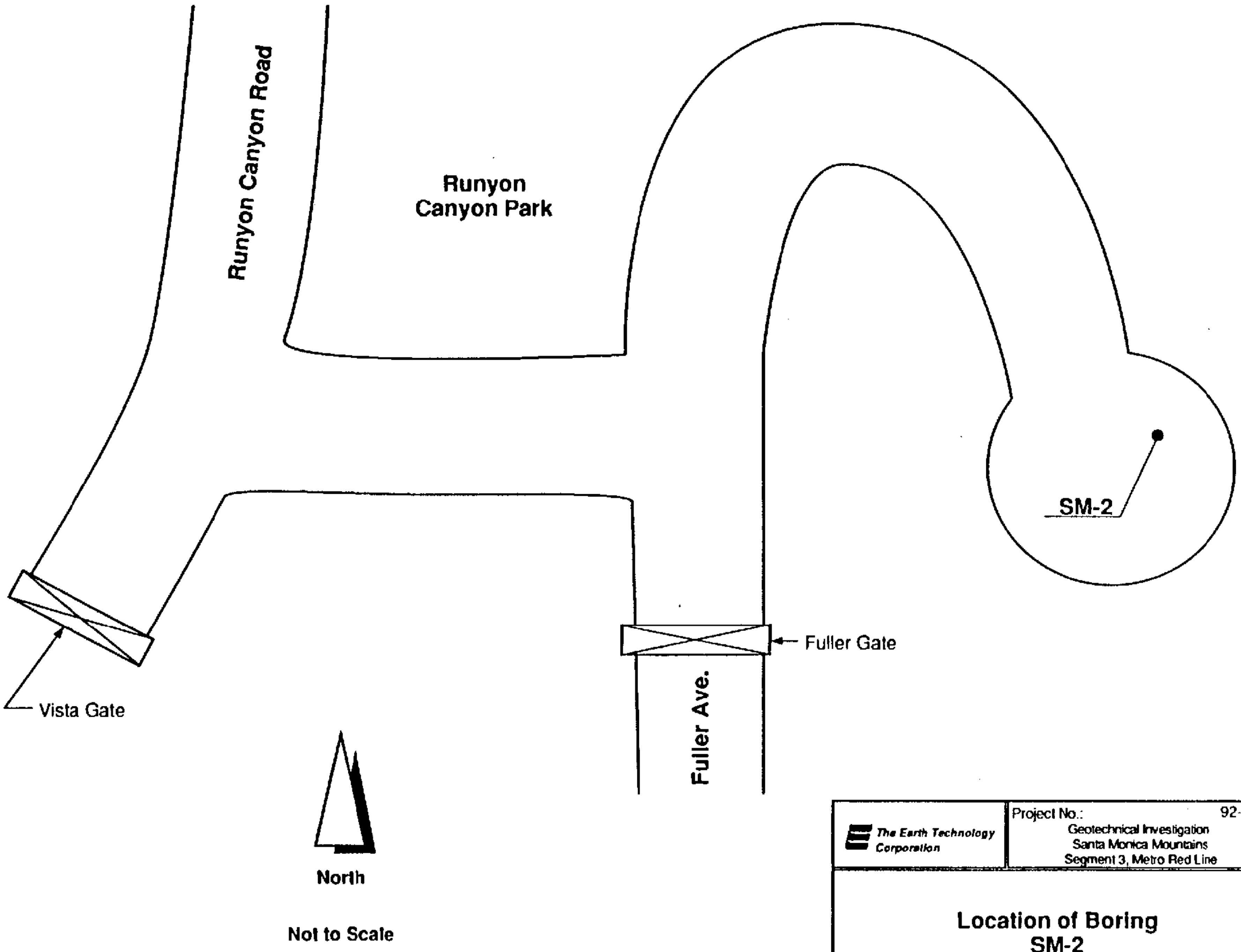
Project Name:	Metro Rail - Los Angeles				
Project Number:	92-2038	Boring Number:	SM-1D	Sheet 3	of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND; reddish brown (5YR 4/4) to yellowish brown (10YR 5/4), slightly moist, dense to very dense, fine- to coarse-grained sand, low plastic fines, massive	SC	Qal								11:55
					15	D	92/100	12"/12"				
		SILTY SAND TO SANDY SILT; grades to strong brown (7.5 YR 4/6), dry, very dense to very hard, fine- to coarse-grained sand, elastic silt, massive, clay coatings on ped surfaces, scattered manganese coatings-deposits on ped surfaces	SM/ML		16	D	57/100	12"/12"				
					17	D	46/100	12"/12"				
30		SILTY SAND; grades to yellowish brown (10YR 5/4), dry very dense, friable, fine- to coarse-grained sand, slightly elastic silt, massive	SM									12:17
					18	D	80/100	12"/12"				
		- very friable and porous interval										
					19	D	33/69/100	18"/18"			- -	
					20	D	28/100	12"/12"				
		- fault zone, carbonate-lined, sharp contact										
		GRANODIORITE; yellowish brown to olive gray, very coarse-grained, massive, very friable, extremely closely spaced, carbonate-lined/filled fractures and shears		gd								
35					21	D	59/100	12"/12"				12:38
					22	D	54/100	12"/12"				
		- reddish brown clay-lined irregular fractures			23	D	23/57/74	15"/18"				
					24	D	49/56/46	18"/18"				
40												

Project Name: **Metro Rail - Los Angeles**

Project Number: **92-2038** Boring Number: **SM-1D** Sheet 4 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Samples Type	Samples Blow Count	Samples Recovery	Samples RQD (%)	Samples Dry Density (pcf)	Samples Moisture Content (%)	Begin/End Time (hr)
		GRANODIORITE; yellowish brown to olive gray, very coarse-grained, massive, very friable, extremely closely spaced, carbonate-lined/filled fractures and shears		gd								
					25	D	9/13/16	18"/18"				
		- sharp contact, no obvious shearing										
		CLAYEY SAND; light reddish brown (5YR 6/4), moist to wet, loose to medium dense, fine- to coarse-grained sand, medium plastic fines, massive, extremely closely spaced carbonate-lined/filled irregular fractures	SC	Qal								13:11
					26	D	6/10/15	14"/18"				
		grades to strong brown (7.5YR 4/6) to yellowish red (5YR 4/6), slightly moist (moisture content decreasing downward)										
					27	D	12/27/39	18"/18"				
45												13:19
		Boring terminated at 45.5 feet. Perched groundwater encountered at 41.5 feet.										
50												
55												



The Earth Technology Corporation

Project No.: 92-2050
Geotechnical Investigation
Santa Monica Mountains
Segment 3, Metro Red Line

Location of Boring
SM-2

Figure A-6

The Earth Technology Corporation

LOG OF BORING SM-2

Client: PB/DMJM
Project: Metro Red Line-Segment 3
Project No.: 92-2050
Location: N4151304/E4182262
Surface Elevation (ft): 720
Boring No.: SM-2
Inclination (Deg.): 90
Bearing: NA
Depth (ft): 431.0
Depth to Water Table (ft): 198
Started: 9/23/92
Finished: 10/13/92
Core Dia. (in.): 2.4
No. of Core Boxes: 22
Driller: PC Exploration, Inc.
Drilling Method: Mud Rotary
Fluids: Air/Bent./Clear mud
Drilling Equipment: Ingersol-Rand 300
Logged By: D. Burke
Checked By: G. Miller
Page No.: 1 of 13

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
0		08:25 9/23 08:29													**ARTIFICIAL FILL (af)**: SILTY SAND and GRAVEL; dark yellowish brown, dry, friable [air rotary with Chris Drill (stratapax) bit]	0
5	R1	08:35 08:40	30	0	-	-	-	-	-	-	-	HW			**GRANODIORITE (gd)**: dark yellowish brown to moderate brown, coarse grained, chiefly plagioclase with biotite, quarts, and hornblende, massive with localized gneissic foliation, extremely closely spaced limonite(?) stained joints, breaks into irregularly shaped sand- and gravel-sized fragments	5
10	R2	08:56 08:58	0	0	-	-	-	-	-	-	-	CW				10
15	R3	09:05 09:06	0	0	-	-	-	-	-	-	-	CW				15
20	R4	09:09 09:12	0	0	-	-	-	-	-	-	-	CW				20
25	R5	09:18 09:19	0	0	-	-	-	-	-	-	-	CW				25
30																30

LOG OF BORING SM-2

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4151304/E4182262
Boring No.: SM-2	Page No.: 2 of 13

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
30	R6	09:27 09:30	0	0	-	-	-	-	-	-	-	HW CW			**GRANODIORITE (gd):** dark yellowish brown to moderate brown, coarse grained, chiefly plagioclase with biotite, quartz, and hornblende, massive with localized gneissic foliation, extremely closely spaced limonite(?) stained joints, breaks into irregularly shaped sand- and gravel-sized fragments	30
35	R7	09:35 09:40	40	0	>4	J	-	-	-	-	-	HW				35
40	R8	09:45 09:48	0	0	-	-	-	-	-	-	-	-				40
45	R9	09:55 09:58	70	0	>4	J	-	-	-	-	-	HW			medium gray to medium light gray, scattered crystalline calcite-lined joints or veins, limonite common on fracture surfaces	45
50	R10	10:18 10:21	18	0	>4	J	-	-	-	-	-	HW				50
55	R11	10:27 10:30	0	0	-	-	-	-	-	-	-	-				55
60	R12	10:37 10:39	56	0	>4	J	-	-	-	-	-	HW				60
65	R13	10:43	32	0	>4	J	-	-	-	-	-	HW				65

LOG OF BORING SM-2

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4151304/E4182262
Boring No.: SM-2	Page No.: 3 of 13

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
															**GRANODIORITE (gd)**: medium gray to medium light gray, coarse grained, chiefly plagioclase and biotite with quartz, and hornblende, massive with localized gneissic foliation, extremely closely spaced limonite(?) stained joints and calcite veining, breaks into irregularly shaped sand- and gravel- and cobble-sized fragments	
70	R14	10:48 10:55	40	0	>4	J	-	-	-	-	-	MW				70
75	R15	10:58 11:10	73	0	>4	J	-	-	-	-	-	MW				75
80	R16	11:12 11:19	46	0	>4	J	-	-	-	-	-	MW				80
85	R17	11:21 11:28	56	0	>4	J	-	-	-	-	-	MW				85
	R18	11:31 11:35	0	0	-	-	-	-	-	-	-					
90	R19	11:36 14:20	17	0	>4	J	-	-	-			MW			[mud rotary drilling with Chris Drill (stratapax) bit, using bentonite and clear mud]	90
95	R20	14:25 17:00	15	0	>4	J	-	-	-	-	-	MW				95
	R21	17:02 17:10	30	0	>4	J	-	-	-	-	-	MW				
100		17:12														100

LOG OF BORING SM-2

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4151304/E4182262
Boring No.: SM-2	Page No.: 4 of 13

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R22	17:18 17:20	14	0	>4	J	-	-	-	-	-	HW CW			**GRANODIORITE (gd):** medium gray to medium light gray, coarse grained, chiefly plagioclase and biotite with quartz, and hornblende, massive with localized gneissic foliation, extremely closely spaced limonite(?) stained joints and calcite veining, breaks into irregularly shaped gravel- and cobble-sized fragments	
105	R23	08:55 9/24 09:00	30	0	>4	J	-	-	-	-	-	MW				105
110	R24	09:11 09:15	6	0	>4	J	-	-	-	-	-	MW				110
115	R25	09:27 09:34	40	0	>4	J	E	VT	R SR	W P	IV	SW CW	45 20 40 20 45		extremely closely spaced clay-lined and iron oxide stained joints, breaks into irregularly shaped cobble-sized fragments 3" to 4" in size, calicite veining not evident	115
120	R26	10:45 10:48	40	0	>4	J	E	VT	R SR	W P	IV	SW CW			scattered calcite veins up to 7 mm wide	120
125	R27	11:00 11:04	36	0	>4	J	E	VT	R SR	W P	IV	SW CW	70 40		no calcite veins evident	125
130	R28	11:15 11:25	60	0	>4	J	E	VT	R SR				0 50 45 40 20 30		scattered calcite veins up to 7 mm wide	130
135	R29	11:35	76	0	>4	J	E	VT	R SR	W P	IV	SW CW				135

LOG OF BORING SM-2

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4151304/E4182262
Boring No.: SM-2	Page No.: 5 of 13

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		11:43													**GRANODIORITE (gd):** medium gray to medium light gray, medium to coarse grained, chiefly plagioclase and biotite with quartz, and hornblende, massive with localised gneissic foliation, extremely closely spaced iron oxide stained joints, scattered calcite veins	
140	R30	12:35 12:40	18	0	>4	J	E	VT	R SR	W P	IV	MW CW				140
145	R31	12:50 12:54	56	0	>4	J	E	VT	R SK	W P	VI	MW CW			reddish brown and brown clay-lined joints, coarsely crystalline calcite veins to 7 mm wide	145
150	R32	13:05 13:10	68	0	>4	J	C1	VT	R SR	P W	IV	MW CW	20 55 60		no calcite veins evident	150
155	R33	13:23 13:28	70	0	>4	J	C1	VT	R SR	P W	IV	MW CW	50 35		scattered thin calcite veins	155
160	R34	13:38 13:50	78	0	>4	J	D1	VT	R SR	P W	IV	MW CW	0 40 55		- 20 cm wide dark yellowish orange clay with gravel-sized rock fragments	160
165	R35	14:48 14:55	80	0	>2	J S	B1	VT TH	R S	P W	VIII	SW CW	55		- 0.6 m wide shear zone composed of clay gouge and scattered rock fragments - gneissic foliation inclined from 65-70 degrees	165
170	R36	15:05	38	0	>4	J	E	VT	R SK	P W	VIII	SW CW	50		- 5 cm wide clay gouge shear zone	170

LOG OF BORING SM-2

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4151304/E4182262
Boring No.: SM-2	Page No.: 6 of 13

Depth (feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
175	R37	15:11 15:30	16	0	>4	-	-	-	-	-	-	SW CW			**GRANODIORITE (gd):** medium gray to medium light gray, medium to coarse grained, chiefly plagioclase and biotite with quartz, and hornblende, massive with localised gneissic foliation, extremely closely spaced iron oxide stained joints, breaks into irregular pieces to coarse gravel-size - 0.4 m wide clayey shear zone(?)	
180	R38	15:37 15:50	70	0	>4	J	D1	VT	R SR	P W	II	SW	10 75 60 30		gneissic foliation inclined 55 degrees, no calcite veins or clay gouge evident	
185	R39	16:01 16:08	12	0	>4	J	-	VT	R SR	-	II	SW			breaks into irregular cobble-sized fragments, joint surfaces are stained	
190	R40	16:18 16:30	40	0	>4	S	-	VT	SR SK	W P	VIII II	SW CW	45		- 0.6 m wide shear zone composed of clay and rock fragments up to 3 cm in size	
195	R41	16:40 16:50	50	0	>4	S	-	VT	SR SK	W P	VIII	HW CW	40		10 cm wide pale green calcareous rock fragments within similar broken and sheared matrix - moderate yellow to light olive brown clay gouge	
200	R42	17:00 17:15	56	0	>4	J S	-	VT	R SR	S W	II VIII	SW CW SW			- vein quartz - 13 cm wide clayey shear zone gneissic foliation, chiefly biotite (50%)	
205	R43	17:20 10:30 9/25	92	0	>4	J S	D1	VT	R SR	P W	II	SW FW	5 45		coarse grained with quartz veins to 3 cm wide	

LOG OF BORING SM-2

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4151304/E4182262
Boring No.: SM-2	Page No.: 7 of 13

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		10:48											35 65		**GRANODIORITE (gd):** medium gray to medium light gray, coarse grained, chiefly biotite with plagioclase, quartz, and hornblende, massive with localized gneissic foliation, extremely closely spaced iron oxide-stained joints, scattered quartz and calcite veins, 3 cm and 7 mm wide respectively; shear zone with rock fragments to 1 cm in size, light olive brown clay	
210	R44	11:02 11:16	68	0	>4	J	D1	VT	R SR	P W	II	FW	0 50 15			210
215	R45	11:32 11:54	84	0	>4	J	D1	VT	R SR	P W	II	FW F	0 10 55 45			215
220	R46	12:49 13:34	54	0	>4	J	C1	VT	R SR	P W	II	FW F	0 60 45 0		no quartz or calcite veins evident	220
	R47		80	0	4	J	C1	VT	R SR	P W	II	F				
225	R48	14:33 14:55	92	0	5	J	C1	VT	R SR	P W	II	F				225
230	R49	14:55 10/8 14:45	100	0	>20	J S	D1	VT L	R SR SK	P S	II V	SW	30 60 10			230
	R50		50	0	-	J	D1	L VT	R SR	D S	V I	F				
235	R51	08:55 10/9 09:20	100	0	>10	J	D1	L VT	SR	D P S	II V VII	F	60 30 5			235
	R52	09:35 09:58	80	23	10	J	C1	L TH	SK SR	D S W	III V	F	40 20		< 1 mm wide slickensided joints	
240	R53	10:10	100	0	10	J	C1	L	SK	S	II	F				240

LOG OF BORING SM-2

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4151304/E4182262
Boring No.: SM-2	Page No.: 8 of 13

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		10:33				S		TH	SR	D	V		70 20 50		**GRANODIORITE (gd):** medium gray to medium light gray, medium to coarse grained, chiefly biotite with plagioclase, quartz, and hornblende, massive with localized gneissic foliation, extremely closely spaced joints, <1 mm wide slickensided shears; 5-8 cm wide shear zone composed of clay and rock fragments at 243'; 3 cm wide, white, noncalcareous mineral vein directly below	
	R54	10:47 11:00	100	54	10	J	B1	L TH	SR	P S D	V VIII	F	30			
245	R55	11:10 11:31	100	0	8	J S	C1	L TH	SR SK	S	II V	F	30 50			245
250	R56	11:40 12:10	100	39	4	J	C1	VT TH	R SR	P S	V	F	30 50 30 30 30 50		very closely spaced joints, calcareous coatings on joint surfaces	250
	R57	12:28 12:45	100	58	3	J S	B1	L MM	SR SK	P S	V VI VIII	F	30 70			
255	R58	13:08 13:21	100	13	>20	J S	B1	L TH	VR SK	P S	I VIII	F	40 40 60		- up to 5 cm wide olive black, sheared clay gouge zone	255
	R59	13:30 13:48	75	0	>10	J	C1	L TH	SK SR	S P	II	F	20 70		- 7 mm wide sheared clay gouge zone	
260	R60	13:55 14:23	52	0	>20	J	B1	L TH	SR R	D S	I	F	50 40		- 8 cm wide sheared clay gouge zone medium dark gray to dark gray, medium- to coarse-grained granodiorite fragmented into irregular fine to coarse gravel-sized pieces, frquent intervals of clay gouge	260
265	R61	14:37 14:58	40	0	>20	J	B1	L TH	SR R	D S	I	F	40 50			265
270	R62	15:24 15:50	0	0	-	-	-	-	-	-	-	-				270
275	R63	16:00	30	0	-	-	-	-	-	-	-	-				275

LOG OF BORING SM-2

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4151304/E4182262
Boring No.: SM-2	Page No.: 9 of 13

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
															GRANODIORITE (gd): medium dark gray to dark gray, medium to coarse grained, chiefly biotite with plagioclase, quartz, and hornblende, massive with localised gneissic foliation, very closely spaced iron oxide stained joints, abundant clay- and white noncalcareous mineral-lined shears, intervals of clay gouge	
280	R64	16:08 16:23	20	0	10	J S	B1	VT	SR SK	P S	I II	F	30			280
285	R65	16:33 16:45	60	0	>20	J S	B1	L VT	SR S	P S	I VI VIII	F	70 50			285
290	R66	17:02 17:23	84	0	>10	J S	B1	L TH	SK S SR	D P S	I	F	70 70		- 0.4 m wide shattered zone	290
295	R67	17:50 08:45 10/10	81	0	>20	J	-	L VT	SR R	D P S	I	F			- 0.3 m wide shattered zone	295
300	R68	09:11 09:27	85	0	>20	J S	B1	L VT	SR SK	P S	I VIII V	F	40 50 40 40 20		- infilled with clay and noncalcareous white material - 3 cm wide sheared clay seam	300
305	R69	09:58 10:15	67	0	>20	J S	B1	L VT	SR SK	D P S	I VIII V	F	40 90 40		extremely closely spaced clay and calcite-lined joints - 7 mm wide slickensided clay-lined shear	305
310	R70	10:43 11:00	89	0	>20	J S	B1	L TH	SK SR S	D P S	I VI	F	30 80			310

LOG OF BORING SM-2

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4151304/E4182262
Boring No.: SM-2	Page No.: 10 of 13

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
		11:24											80		**GRANODIORITE (gd):** medium dark gray to dark gray, medium to coarse grained, chiefly biotite with plagioclase, quartz, and hornblende, massive with localized gneissic foliation, very closely spaced joints, abundant < 1 mm wide, clay- and white noncalcareous mineral-lined shears; @ 310.3', dense black mineral-lined shears and joints	
	R71		100	0	7	J S	B1	L TH	SK SR	W S D	I V	F	40 50 70			
315	R72	12:04 12:32	93	10	>10	J	B1	L TH	SR	D S W	I V	F	40 60 60		- 0.3 m wide shattered zone with white noncalcareous infilling	315
320	R73	12:45 13:11	100	0	>10	J S	B1	L TH	SR SK	D S W P	I V VIII	F	30 60 60 90		- 13 mm wide, vertical, clay-lined shear	320
	R74	13:23 13:50	100	0	8	J	B1	VT TH	SR	S D	I V	F	50 90		chiefly plagioclase with quartz, biotite, and hornblende	
325	R75	14:06	60	0	-	J	B1	-	SR	S D	I	F	90		- pale green chlorite/serpentine-lined shear	325
330	R76	14:19 14:42	80	0	>20	J S	B1	L TH	SK SR	D	I V	F	60 60 70 50		- 0.3 m wide shattered zone - 0.3 m wide shattered zone - 0.3 m wide shattered zone	330
	R77	14:56 15:09	100	0	-	J	B1	L TH	SR	D S	I V	F	60 70		extremely closely spaced joints lined with chlorite/serpentine and white noncalcareous material	
335	R78	15:20 15:38	86	19	>10	J	C1	L TH	SR	D S	I V	F	30 30 30		- 20 cm wide shattered zone	335
340	R79	15:50 16:05	92	11	6	J S	B1	L TH	SR SK S	S	I V VIII	F	60 30		- 0.3 m wide shattered zone - 7 mm wide slickensided clay-lined shear - localized gneissic foliation inclined 80 degrees	340
	R80	16:11 16:39	100	0	>10	J	C1	L TH	SR	D S	I V	F	60 50 40		coarse grained - 0.3 m wide shattered zone	
345	R81	16:51	85	0	>10	J	B1	L	SR	D	I	F	40			345

The Earth Technology Corporation

LOG OF BORING SM-2

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4151304/E4182262
Boring No.: SM-2	Page No.: 11 of 13

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
		17:07						TH		S	V		40 40 90 40		**GRANODIORITE (gd)**: medium dark gray to dark gray, coarse grained, chiefly biotite with plagioclase, quartz, and hornblende, massive with localized gneissic foliation, very closely spaced, chlorite/serpentine- and white noncalcareous mineral-lined joints and shears	
350	R82	06:50 10/11 07:26	100	19	8	J	B1	L MM	SR S	D P S	I V	F	30 30 30 50 30			350
	R83		0		-	-	-	-	-						medium to fine grained	
355	R84	08:03 08:25	100	10	-	J S	B1	L TH	S SR SK	D P S	I VI V	F	30 80 80 50		- shattered zone, rock fragmented into irregular pieces to small cobble size	355
360	R85	08:40 09:05	86	0	-	J S	B1	L TH	S SR SK	D P	I II VI	F	30 30 60 30		- slickensided shear - clay-lined joint - clay-lined joint	360
	R86	09:20 09:44	100	0	9	J	B1	L TH	SK SR S	P	I V	F	25 40		coarse grained - thin white noncalcareous material lining joint	
	R87		100	0	-	J	-	VT	SR	W	I	F			- slickensided at tip	
365	R88	11:50 12:22	100	15	>20	J S	C1	L TH	SR S SK	W S	I V	F	20 40		- slickensided shears generally < 1 mm wide [driller indicates caving at 365']	365
370	R89	12:36 12:54	78	11	>20	J S	E	L TH	SR S SK	P W	I VIII V	F	30 60 80		- shattered interval - sheared clay seam parallel gneissic foliation	370
	R90	13:08	83	0	>20	J	E	L VT	SR SK	W S	I V	F	80 40 30		- thin, vertical, discontinuous clay-lined shear	
375	R91	13:40 14:04	79	12	>20	J S	B1	L TH	SR SK	S D W D	I VIII	F	80 10		- shattered zone	375
380	R92	14:20	100	0	8	J S	D1	L VT	SR S SK	D W P	I VI V	F	50 30		- 2 parallel, 7 mm wide clay-lined shears	380

LOG OF BORING SM-2

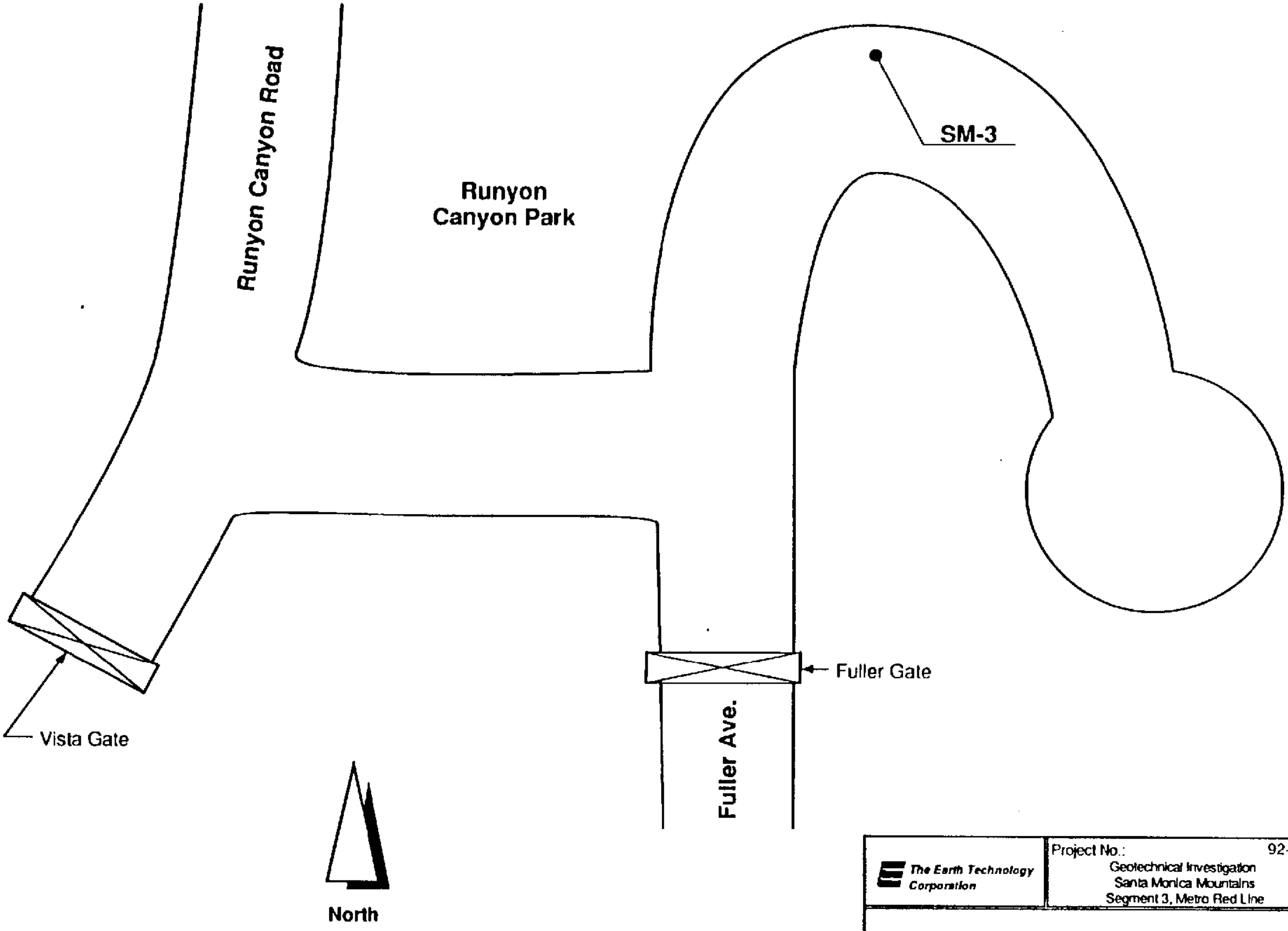
Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4151304/E4182262
Boring No.: SM-2	Page No.: 12 of 13

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		14:38													**GRANODIORITE (gd)**: medium dark gray to dark gray, coarse grained, chiefly biotite with plagioclase, quartz, and hornblende, massive with localised gneissic foliation, very closely spaced clay-, chlorite/serpentine-, and white noncalcareous mineral-lined joints and shears [driller reports at this depth borehole is prone to caving]	
	R93	14:50 15:08	100	11	13	J S	C1	L TH	SR S SK	D W P	I VI	F	70 40 60			TEST 1
385	R94	15:22 15:48	100	9	>10	J S	B1	L TH	SR S SK	S W	I V	F	30 70 30		- slickensided nearly vertical shear	385
	R95	16:09 16:17	50	0	-	J S	-	-	SR SK	W	I V	F	30			
390	R96	12:33 10/12 12:54	79	0	>10	J S	E	L VT	SR SK	D W	I VI	F	60 60 20			390
395	R97	13:15 13:40	73	17	-	J	B1	L VT	SR	W	I	F	50 20 70			395
400	R98	15:00 15:18	100	0	>10	J S	B1	L TH	SR SK	D W P S	I VIII V	F	35 90		- 0.3 m wide extremely closely spaced shear zone	400
	R99	15:30 15:53	100	15	>10	J S	B1	L TH	SR SK	D W S	II V	FW	40 70 40		light brown discoloration on fracture surfaces - slickensided shears < 0.5 mm wide	
405	R100	 16:25	100	0	10	J S	C1	L TH	SK S SR	D W S	II V	FW	45 10		rare brown discoloration on fracture surfaces	405
410	R101	16:35 17:03	100	55	8	J S	B1	L MM	SK S SR	D W P S	II VI	FW	60 70 20			410
	R102	17:15 17:45	100	0	>10	J S	B1	L VT	SR	W	II V	FW	70 50 80		brown discoloration common	
415	R103	08:22	100	0	>10	J	B1	L	SR	W	VIII	FW				415

LOG OF BORING SM-2

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4151304/E4182262
Boring No.: SM-2	Page No.: 13 of 13

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		10/13 08:42				S		VT	S SK	P			60 40		**GRANODIORITE (gd)**: mottled light gray to dark gray, medium to coarse grained, chiefly biotite with plagioclase, quartz, and hornblende, massive with localized gneissic foliation, very closely spaced iron oxide stained, clay-, chlorite/serpentine- and white noncalcareous mineral-lined joints and shears; vertical clay-lined shear at 415'	
420	R104	09:00 09:29	100	9	10	J S	B1	L TH	SR SK	D S	II VIII	FW	50 80 30			420
	R105	09:42 10:02	100	17	10	J S	B1	L TH	SR SK	D W	II VI	FW	60 50		- 7 mm wide clay-lined joint - 5 cm wide shear zone with clay	
425	R106	10:16 10:45	74	0	>20	J S	B1	L VT	SR SK	D W	I VI	FW	40 60 40 40		brown discoloration no longer evident - 3 mm wide clay-lined joint - thin aphanitic mafic vein (basalt?), scattered pyrite	425 TEST 2
430	R107	11:00	70	0	>20	J S	B1	L	SR SK	D P	I VIII	FW	80 40		- 3 cm wide clay- and gravel-lined shear zone	430
435 440 445 450		11:15													Boring terminated at 431 feet on 10/13/92.	435 440 445 450



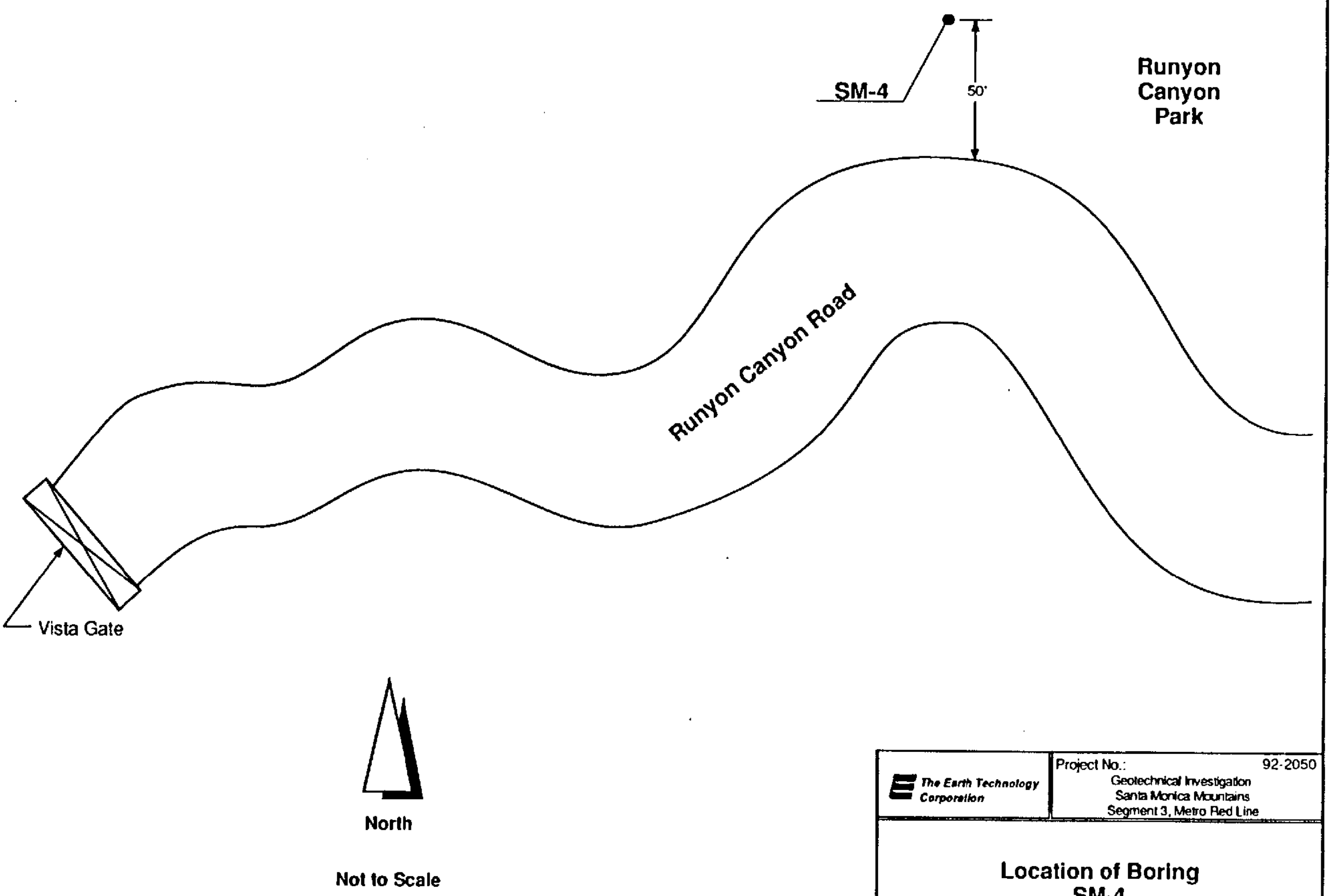
Not to Scale

The Earth Technology Corporation

Project No.: 92-2050
Geotechnical Investigation
Santa Monica Mountains
Segment 3, Metro Red Line

Location of Boring SM-3

Figure A-7



The Earth Technology Corporation

Project No.: 92-2050

Geotechnical Investigation
Santa Monica Mountains
Segment 3, Metro Red Line

Location of Boring SM-4

Figure A-8

LOG OF BORING SM-3

Client: PB/DMJM	Project: Metro Red Line-Segment 3	Project No.: 92-2050
Location: N4152110/E4181964	Surface Elevation (ft): 686	Boring No.: SM-3
Inclination (Deg.): 90	Bearing: NA Depth (ft): 394.0	Depth to Water Table (ft): 43
Started: 9/27/92 Finished: 10/12/92	Core Dia. (in.): 2.4	No. of Core Boxes: 29
Driller: PC Exploration, Inc.	Drilling Method: Mud rotary Fluids: Bentonite/Clear mud	Drilling Equipment: Mobile B-53
Logged By: D. Burke	Checked By: G. Miller	Page No.: 1 of 12

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
0		9/27													**ALLUVIUM (Qal); ARKOSIC SAND**; medium brown, fine- to coarse-grained sand with silt, some gravel, loose and uncemented, massive, angular to subrounded clasts consist of granodiorite [drilling with Chris Drill (stratapax) bit]	0
5	R1	14:20	30	0											[drive sample with 140 lb hammer; Sample S1:Blow Counts-1/1/1, bulk sample] - [driller indicated harder at 7']	5
10		14:25														10
	R2	14:39	53	0	-	J	-	-	-	-	-	HW MW			**GRANODIORITE (gd)**: dark gray, medium grained, chiefly biotite with plagioclase, quartz, and hornblende, massive with localized gneissic foliation, extremely closely spaced iron oxide stained joints	
		14:42														
	R3		70	0	-	J	-	-	-	-	-	HW MW				
	R4	15:36	43	0	>3.3	J	E	VT	R SR	P W	II	HW			[change to diamond impregnated drill bit at 12.5']	
15		15:47														15
	R5	15:57	100	0	>5	J	E	VT TH	SR S	W P	VII	SW MW	20 65 15		coarse grained, extremely closely spaced, medium gray clay-lined and iron oxide stained joints	
		16:18														
20	R6	10:13 9/28	100	0	-	-	-	-	-	-	-	-				20
	R7	10:38	58	0	>5	J	E	VT	R SR	P W	II	HW MW	50 55 60		chiefly plagioclase, quartz, biotite and hornblende	
		10:53														
25	R8	11:35	85	0	>5	J	D1	VT	R SR	P W	II	HW MW	15 70 65 10 65			25
		11:45														
	R9	11:56	27	0	-	J	-	-	-	-	-	MW				
30																30

LOG OF BORING SM-3

Client: PB/DMJM
Project: Metro Red Line-Segment 3
Project No.: 92-2050
Location: N4152110/E4181964
Boring No.: SM-3
Page No.: 2 of 12

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
30		12:01														30
	R10	12:15 12:30	42	0	>5	J	D1	VT	R SR	P W	II	MW SW	10 15 70 20 70 60		**GRANODIORITE (gd)**: medium dark gray, coarse grained, chiefly plagioclase, quartz, biotite and hornblende, massive, very closely spaced iron oxide stained joints	
35	R11	12:37 12:57	100	15	>5	J	C1	VT TH	R S	P W	II	MW HW	25 30 65 35 50 0		- zone of extremely closely spaced fractures	35
40	R12	13:11 13:28	85	0	>5	J	C1	VT TH	R S	P W	II	MW SW	20 55 25 55 45 50		chiefly quartz, plagioclase, biotite and hornblende	40
45	R13	13:38 14:08	100	0	>4.4	J	C1	VT TH	R S	P W	II VII	SW	30 60 25 20		medium to coarse grained - 7 mm wide medium brown clay-lined joint	45
50	R14	14:17 1[illegible]:38	100	29	4.9	J	C1	VT TH	R S	P W	II	SW FW	15 40 75		coarse grained, chiefly biotite and plagioclase with quartz and hornblende, gneissic	50
	R15	1[illegible]:53 15:13	100	30	3.7	J	C1	VT TH	SR S	P W	II	SW FW	80 70 65 10		- 7 mm wide calcite-lined joint	
55	R16	15:23 15:40	100	0	>6.7	J	C1	VT TH	SR S	P W	I	SW FW	70 55 45 45			55
60	R17	15:49 16:03	44	0	>5.7	J	E	VT	SR S	P W	V	SW F	85		very closely spaced, up to 7 mm wide, calcite-lined joints	60
	R18	16:14 16:30	100	0	>6.7	J	E	VT	SR S	P W	V	SW F				
65	R19	16:40	75	0	4.8	J	D1	VT	SR	P	II	SW			- 5 cm wide shear zone, medium brown clay with rock fragments	65

LOG OF BORING SM-3

Client: PB/DMJM

Project: Metro Red Line-Segment 3

Project No.: 92-2050

Location: N4152110/E4181964

Boring No.: SM-3

Page No.: 3 of 12

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		16:56							S	W	V	F	60 30 45 75		**GRANODIORITE (gd):** medium dark gray, coarse grained, chiefly plagioclase, biotite, quartz and hornblende, massive, very closely spaced, up to 7 mm wide calcite-lined joints	
70	R20	17:05 17:17	100	0	>6.7	J	D1	VT	SR S	P W	II V	MW SW	30 45 25 55			70
75	R21	08:02 9/29 08:21	100	0	>4	J	D1	VT	R S	P W	II V	SW F	10 15 20 75 60			75
	R22	08:29 08:36	100	0	3	J S	B1	VT TH	RS S	P W	II VIII	F CW	15 15 30		- 8 cm wide shear zone, medium brown clay	
80	R23	08:49 08:57	88	0	4.8	J	C1	VT TH	R S	P W	II	F MW	35 30 55 70		- 1 cm wide calcite-lined joint	80
85	R24	09:09 09:33	100	16	>4	J	C1	VT TH	R S	P W	II	F SW	60 10 25 45		chiefly plagioclase and biotite with quartz and mafic minerals	85
90	R25	09:49 10:17	96	0	>4	J	C1	VT TH	SR S	P W	II	SW	30 20 40 35		altered to variably pale colored clay with relict quartz and calcite veins, very friable	90
	R26		40	0	3	J	C	TH	SR	P	II	FW	25		unaltered	
	R27		100	0	4	J	C	TH	SR	P	II	FW				
	R28	13:00 13:16	100	0	7	J	C1	TH VT	SR S	P W	II	FW F	70 45 40			
95	R29	13:24 13:48	88	0	>5	J	D1	VT TH	SR S	P W	II	FW F	40 45 85		- 13 mm wide calcite-lined joint	95
	R30		20	0	-	-	-	-	-	-	-	F				
100	R31	15:05	96	0	4.4	J	C1	VT	SR	P	II	FW	45		[changed to new diamond impregnated bit]	100

LOG OF BORING SM-3

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4152110/E4181964
Boring No.: SM-3	Page No.: 4 of 12

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		15:21						TH	S	W			60 50		**GRANODIORITE (gd):** medium dark gray, coarse grained, chiefly plagioclase, biotite, quartz and hornblende, massive, very closely spaced, up to 7 mm wide calcite-lined joints	
	R32		100	0	4	J	C	VT	SR	P	II	F				
	~~R33~~		~~100~~	~~100~~	~~0~~							~~F~~				
105	R34	07:15 9/30 07:29	100	17	4.7	J	C1	VT TH	S SR	P W	II	F HW	20 30 70			105
	R35	07:43 08:01	100	0	>5	J	C	VT TH	S SR	P	II	F	30 70 50 45 35 30			
110	R36	08:09 08:26	100	23	3.4	J	C1	VT MM	S SR	P	II	F	20 65 65 20			110
115	R37	08:50 09:11	86	0	3.4	J	C1	VT TH	S SR	P	II	F	65 35 70 30		- 15 mm wide quartz vein	115
120	R38	09:23 09:41	100	0	4.2	J	C1	VT TH	S SR	P	II	F	25 20 65 20 60 70 50			120
125	R39	09:54 10:18	44	0	3.2	J	D	VT TH	S SR	P W	II	F	85 50 45 50 25 55 45			125
	R40	10:26 10:37	100	0	5.2	J	D	VT TH	S SR	P W	II	F	15 25 65			
130	R41	10:46 11:02	100	0,	>10	J	D	VT TH	S SR	P W	II	F	15 20 45 85 50			130
135	R42	09:26 10/5	100	0	>5	J	D	VT	R S	P W	II V	F FW	10 25			135

LOG OF BORING SM-3

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4152110/E4181964
Boring No.: SM-3	Page No.: 5 of 12

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		09:42											65 20 70		**GRANODIORITE (gd)**: medium gray to medium dark gray, coarse grained, chiefly plagioclase, biotite, quarts and hornblende, massive, very closely spaced up to 7 mm wide calcite-lined joints	
140	R43	09:51 10:12	94	0	>4	J	D	VT TH	R S	P W	II V	F FW	25 85 60 80 25 30			140
145	R44	10:24 10:57	86	0	>4	J	C1	VT TH	R S	P W	II V	F FW	20 65 70 30 55			145
150	R45	12:25 12:33	85	0	>5	J S	C1	VT TH	R S	P W	II V	F FW SW MW			- 20 cm wide shear zone, partially altered to grayish blue green clay, iron oxide stain on nearby joints	150
155	R46	12:43 13:02	96	32	>4	J	C1	VT MM	R S	P W	II V	F FW				155
	R47	13:11 13:39	100	15	>5	J	D	VT TH	R S	P W	II V	F FW	85 35 65 40 70			
160	R48	13:48 14:06	93	17	4.7	J	C1	VT TH	R S	P W	II V	F FW			dark yellowish green mineral (chlorite?) on some fracture surfaces, calcite on others	160
	R49		90	90	0	-	-	-	-	-	-	F FW				
165	R50	14:38 15:22	98	0	>4	J	D	VT TH	R S	P W	II V	F FW	85 70 85 70			165
170	R51	15:40	80	10	4.3	J	D1	VT	R	P	II	F	25			170

LOG OF BORING SM-3

Client: PB/DMJM
Project: Metro Red Line-Segment 3
Project No.: 92-2050
Location: N4152110/E4181964
Boring No.: SM-3
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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description								Sketch	Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)			
		16:10						TH	S	W	V	FW	85 65 30 50		**GRANODIORITE (gd):** medium dark gray, coarse grained, chiefly plagioclase, biotite, quarts and hornblende, massive, very closely spaced calcite- and chlorite(?)-lined joints	
	R52	16:24 16:42	100	35	2	J	C	TH MM	SR S	P	II V	F FW	40 50 70			
175	R53		80	40	1	J	B	TH	SR	P	II V	F FW	40			175
	R54		0	0	-	-	-	-	-	-	-	-				
	R55	08:20 10/6 09:06	100	17	3.4	J	C1	TH	SR S	P	II V VIII	F FW	25 45 65 20		- 7 mm wide clay seam with rock fragments	
180	R56	09:35 09:57	100	0	>5.7	J	C1	VT TH	SR S	P W	II V	F FW	85 10 15 70 65			180
185	R57	10:08 10:35	85	0	>5	J	D	VT	R S	P W	II V	F FW MW	15 65 20 70 85		- 8 cm wide sone of rock fragments to 12 mm in sise with green clay	185
	R58	11:05 11:30	100	20	6	J	D	VT TH	R S	P W	II V	F FW MW	30 25 65			
190	R59	11:41 11:50	75	0	6	J	D	VT TH	SR S	P W	II	F FW	55 35 70		- 0.4 m wide sone of fractured rock with green clay	190
195	R60	12:07 12:27	95	0	>5	J	D	VT TH	SR S	P W	II	F FW			- 10 cm wide sone of fractured rock	195
	R61	12:56 13:19	90	0	>5	J	C1	VT TH	SR S	P W	II V	F FW	30 40 65 25 60 25		- 12 mm wide crystalline calcite-lined joint	
200	R62	13:30 14:10	82	16	>4	J	C1	VT TH	R S	P W	II V	F FW	40 45 55 15 20		- 15 cm wide sone of fractured rock, rock fragments to 13 mm in sise	200
205																205

LOG OF BORING SM-3

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4152110/E4181964
Boring No.: SM-3	Page No.: 7 of 12

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description								Sketch	Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)			
	R63	14:20 14:43	100	0	6.8	J	C1	VT TH	SR S	P W	II V	F FW MW	25		GRANODIORITE (gd): medium dark gray, coarse grained, chiefly plagioclase, quartz, biotite and hornblende, massive with very closely spaced, up to 7 mm wide calcite-lined joints; @ 207', 10 cm wide zone of, fractured rock, rock fragments to 13 mm in size	
	R64	15:50 16:05	100	0	>10	J	C1	VT TH	R S	P W	II	F FW	35 30			
210	R65	16:13 16:26	95	0	>5	J	C1	VT TH	R S	P W	II	F FW	30 65		- 15 cm wide zone of vein quartz and granodiorite fragments with clay	210
	R66	16:43 16:53	100	0	>4.7	J	C1	VT TH	R S	P W	II	F FW	20 65			
215	R67	17:02 17:34	84	0	>4	J	C1	VT TH	R S	P W	VIII V	F FW	45 40 65 70		- 1 cm wide greenish gray clay-lined joint	215
220	R68	07:53 10/7 08:13	100	0	>6.7	J	C1	VT TH	R S	P W	II	MW HW	30 65		- very closely fractured quartz vein - 20 cm wide greenish gray clay in weathered, fractured rock	220
	R69	08:23 08:38	100	25	6	J	C1	VT TH	R S	P W	II	F FW	35 55			
	R70	08:46 09:00	100	65	3	J	B1	VT MM	SR S	P W	V	MW FW	10		- 7 mm wide clay seam	
225	R71	09:10 09:40	95	23	>5	J	B1	VT TH	SR S	P W	V	F FW	45 85 35 20 20		- 13 mm wide clay seam with calcite	225
230	R72	09:52 10:09	100	0	>5	J	C1	VT	SR S	P W	II V	F SW	40 65		- fractured quartz vein with calcite	230
235	R73	10:20 11:01	100	20	3.6	J	C1	TH MM	R S	P W	II	F FW	40 45		metasomatized zone consisting of aphanitic feldspar and quartz veins within altered bluish green granodiorite	235
	R74	11:43 12:10	0	0	-	-	-	-	-	-	-	-				
240	R75	13:15	20	0	0.8	J	C	TH	SR				75			240

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LOG OF BORING SM-3

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4152110/E4181964
Boring No.: SM-3	Page No.: 8 of 12

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		13:30											10		**GRANODIORITE (gd):** medium dark gray, coarse grained, chiefly plagioclase, biotite, quartz and mafic minerals, massive, very closely spaced, up to 3 mm wide green tinted calcite-lined, locally tightly healed joints	
	R76	14:20 14:38	100	67	2	J	C	VT MM	SR	P	I	F	40			
245	R77	14:48 15:29	100	0	>5	J	D1	VT TH	R S	P W	I	F	20 35 60 65		- 8 cm wide extremely closely jointed quartz vein - 13 cm wide quartz vein	245
	R78	15:57 16:08	90	25	3	J	C1	TH	SR S	P W	I	F	55 60		medium to coarse grained, gneissic foliation	
250	R79	16:19 16:35	100	0	>5	J	D	VT TH	SR S	P	I	F	85 70 75			250
	R80		30	0	-	-	-	-	-			F				
	R81	07:58 10/8 08:14	100	0	>5	J	D	VT TH	R S	P W	I II	F	35 85 70		plagioclase and quartz with biotite and hornblende, generally massive [driller reports increased water loss]	
255	R82	08:20 08:47	100	25	2.5	J	C1	TH	R SR	P W	I	F	45 50			255
	R83	09:01 09:30	76	0	0.4	J	C1	TH	SR	P W	II	F	45 80		- 1 mm wide calcite-lined joint	
	R84		100	100	0	-	-	-	-			F				
260	R85	10:07 10:37	100	20	3	J	C1	TH	SR S	P	II	F FW	50 40		- 3 mm wide calcite-lined joint	260
	R86		100	0	6	J	D	TH	SR R	P W	II	F	30			
265	R87	11:17 12:21	100	58	1	J	C	TH MM	R S	P W	II	F	25 75		coarse grained, distinctly gneissic	265
	R88	12:34 13:17	100	18	>5	J	D	TH VT	SR S	P W	II	F	65 20 85 50		- 3 cm wide quartz vein - 7 mm wide greenish gray clay-lined joint no gneissic texture	
270	R89	13:38 14:10	100	65	2.5	J	C	TH MM	R SR	P	II	F	60 55		faint gneissic foliation, inclined 45 degrees, with calcite and chlorite(?) on fractures	270
275	R90	14:22	93	0	>6.7	J	D	TH VT	R SR	P W	II	F	45 85			275

LOG OF BORING SM-3

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4152110/E4181964
Boring No.: SM-3	Page No.: 9 of 12

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R91	15:03 15:23 16:04	100	20	4.5	J	D	TH	R S	P W	II	F FW	25 15 20 65		**GRANODIORITE (gd):** medium dark gray, coarse grained, chiefly plagioclase, quartz, biotite and hornblende, generally massive, locally faintly gneissic, very closely spaced, up to 7 mm wide calcite- and chlorite-lined joints; 8 cm wide fractured pale green aphanitic mineral vein with calcite at 276' and 2 cm wide quartz vein at 277'	
280	R92	16:20 16:35	100	0	4.5	J	D	TH	R S	P	II	F	25 65			280
	R93	08:23 10/9 08:40	100	0	>7.5	J	D	TH VT	R S	P	II	F	60 20 70			
285	R94	08:50 09:26	100	0	>5	J	D	TH VT	SR S	P W	II VI	F	25 55 85 50 20 50		- 3 cm wide extremely closely fractured quartz vein with clay very closely fractured with calcite, chlorite, and clay on some surfaces	285
	R95	09:30 10:12	100	0	5.3	J	D	TH VT	R S	P W	II	F	20 70 85 40		gneissic foliation, inclined 60 degrees	
290	R96	10:55 11:09	100	0	2.7	J	C	TH	SR	P	II	F	40 10			290
	R97	13:15 13:27	100	30	3	J	C	TH VT	SR S	P W	II	F	5 15 65		generally massive [driller changes to new diamond impregnated bit]	
295	R98	13:37 14:23	100	54	1.6	J	B1	TH MM	SR S	P	II	F	50 50 60 70 20		- 1 mm wide calcite and chlorite(?)-lined joints - scattered tightly healed calcite-lined joints	295
300	R99	14:37 14:55	100	56	2.8	J	C1	TH MM	SR S	P W	II	F	40 45 55		- 13 mm wide calcite-, chlorite(?)- and moderate reddish brown clay-lined joints	300
	R100	15:09 15:22	100	85	0.5	J	A	MM	S	P	II	F	20		- faintly gneissic interval - 1 mm wide calcite and chlorite(?)-lined joint	
305	R101	15:34 16:07	100	80	1.2	J	B1	MM TH	S SR	P	II	F	45 45 65 40 10		- 13 mm wide calcite-lined joint - 7 mm wide tightly healed calcite-lined joint	305
	R102	16:20	100	50	2.3	J	B	TH MM	S SR	P	II	F	40		- 1 mm wide calcite- and chlorite(?)-lined joints	
310																310

LOG OF BORING SM-3

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4152110/E4181964
Boring No.: SM-3	Page No.: 10 of 12

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		16:38											45		**GRANODIORITE (gd)**: medium dark gray, coarse grained, chiefly plagioclase, quartz, biotite and hornblende, generally massive, locally faintly gneissic, very closely spaced, calcite- and chlorite(?)-lined joints; 5 cm wide calcite- and dark grayish green clay-lined joints with rock fragments @ 311'	
	R103	16:50 17:12	100	23	4.3	J	C1	TH VT	-	-	-	-	10 85 40			
315	R104	17:22 17:37	100	0	>8	J	C1	VT TH	R SR	P W	II	F FW	30 45		- 10 cm wide feldspar vein	315
	R105	08:12 10/10 08:30	29	0	-	J	-	-	-	-	II	F FW			- 13 mm wide calcite-lined joint	
320	R106		100	0	-	-	-	-	-	-	-	F				320
	R107	10:36 11:24	89	17	2	J	C1	TH VT	R SR	P W	II	F	10 15 90 55			
325	R108	11:33 12:05	100	28	2.8	J	C1	VT TH	SR S	P W	II	F MW	35 40 55 40		- 15 cm wide fractured zone of crushed rock with bluish green clay chiefly plagioclase and biotite with quartz and hornblende	325
330	R109	12:16 12:31	100	0	>8	J	C1	VT TH	R S	P W	II	F	70 65 35 35			330
	R110	12:45 13:15	100	44	2.2	J	D	VT MM	SR S	P W	II	F	40 60 50 30		calcite on healed and loose fractures, chlorite on loose fractures	
335	R111	13:30 14:04	100	17	4.3	J	D	VT TH	SR S	P W	II	F	25 65 70 30		abundant 7 mm wide calcite- and chlorite(?)-lined joints	335
	R112	14:19 14:48	100	70	1.5	J	B1	TH MM	R SR	P W	II	F	25 20		faintly gneissic, chiefly plagioclase with quartz, biotite and hornblende	
340	R113		100	0	2	J	B	TH	R	W	I	F	70			340
345	R114	16:12 16:48	100	20	3	J	C1	TH	R S	P W	II	F	45 45 45 55		- 3 cm wide calcite- and grayish green clay-lined joint - 7 mm wide calcite- and grayish green/reddish brown clay-lined joint	345

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LOG OF BORING SM-3

Client: PB/DMJM

Project: Metro Red Line-Segment 3

Project No.: 92-2050

Location: N4152110/E4181964

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Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R115	17:00 17:50	98	72	1.4	J	C1	TH MM	R S	P S	II VII	F	20 55 30 40 5		**GRANODIORITE (gd)**: medium dark gray, coarse grained, chiefly plagioclase, quartz, biotite and hornblende, faintly gneissic, very closely spaced, calcite- and chlorite-lined joints - dark gneissic banding inclined 40 degrees	TEST 1
350	R116	07:11 10/11 07:23	95	0	>5	J	D	VT TH	R S	P S	II	F HW	15 40 40 60 20		- 10 cm wide extremely closely fractured zone with pale grayish green gouge - 5 cm wide crushed rock zone	
355	R117	14:34 14:54	100	0	4.4	J	C1	TH	R S	P W	II	F	50 45 45 55 45		one joint set parallels gneissic foliation - 13 mm wide quartz vein - 7 mm wide calcite- and chlorite(?)-lined joint	
360	R118	15:11 15:27	100	37	2.7	J	B1	TH MM	SR S	P	II	F	20 25 55 10		scattered 13 mm wide tightly healed calcite-lined joints and 7 mm wide calcite- and chlorite(?)-lined loose joints	
365	R119	15:44 16:10	100	60	1.3	J	B1	TH MM	R S	P S	II	F	45 50 25 50 60		- 13 mm wide aphanitic grayish green tightly healed gouge(?) zone	
370	R120	16:20 16:42	100	0	3.8	J	C1	TH	R S	P S	II	F	50 50 50 70		- 0.3-3 cm wide tightly healed gouge zone - 0.3-3 cm wide tightly healed gouge zone some joints parallel to gneissic foliation, inclined from 50 to 70 degrees	
	R121		100	60	6	J	D	TH	R S				30			
	R122	17:17 17:35	97	0	2.7	J	C1	TH	R S	P W	II	F	25 60		- thin calcite and chlorite on fracture surfaces	
375 380	R123	07:39 10/12 08:03	95	62	0.5	J	B1	VT TH	S	P	V	F	60 35 75 60 40		- 0.3-3 cm wide tightly healed gouge zone	

LOG OF BORING SM-3

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4152110/E4181964
Boring No.: SM-3	Page No.: 12 of 12

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R124	08:16 09:02	95	35	3	J	C1	VT	SR	P	V	F	60 50 80		**GRANODIORITE (gd):** medium dark gray, coarse grained, chiefly plagioclase, quartz, biotite and hornblende, locally faintly gneissic, very closely spaced, calcite- and chlorite(?)-lined joints	
385	R125	09:23 09:31	94	42	3	J	C1	VT TH	SR	P	V	F	45 60 80			385 TEST 2
390	R126	10:04 10:47	100	0	4.4	J	C1	VT	S	P	VIII	F	40 60 80 20		- 3 cm wide clay seam - 3 cm wide clay seam	390
	R127	11:51 12:10	100	0	5.5	J	C1	VT	R	W	V	F	10 60			
395															Boring terminated at 394 feet on 10-12-92.	395
400																400
405																405
410																410
415																415

LOG OF BORING SM-4

Client: PB/DMJM	Project: Metro Red Line-Segment 3	Project No.: 92-2050
Location: N4153637/E4181268	Surface Elevation (ft): 960	Boring No.: SM-4
Inclination (Deg.): 90	Bearing: NA Depth (ft): 626.0	Depth to Water Table (ft): 97
Started: 9/8/92 Finished: 10/6/92	Core Dia. (in.): 2.4	No. of Core Boxes: 45
Driller: PC Exploration, Inc.	Drilling Method: Mud rotary Fluids: Bentonite/Clear mud	Drilling Equipment: Mobile B-80
Logged By: P. Smith	Checked By: G. Miller	Page No.: 1 of 19

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
0	R1	17:16 9/8 17:23													**ARTIFICIAL FILL (af)**: SILT to SAND (SM/ML); dark yellowish brown, fine- to very fine-grained sand, slightly elastic silt, trace cobbles up to 25 cm in size, very loose and uncemented, massive, abundant animal burrows in upper 3 feet [drilling with surface set diamond bit]	0
5		17:28 17:36													ARKOSIC SAND; dark yellowish brown, fine- to coarse-grained sand with silt, some cobbles, loose and uncemented, massive, angular to subrounded clasts consisting of granodiorite	5
10	R2	17:39 17:44														10
	R3															
	R4	07:41 9/9 07:54	100	27	2.8	J	B1	TH	S	P	IV	CW	30 60		**GRANODIORITE (gd)**: very pale yellow to moderate brown, medium to coarse grained, chiefly plagioclase with quartz, biotite and hornblende, massive, very closely spaced clay-lined joints	
15	R5	07:57 08:17	100	18	4.0	J	C1	VT	S	P	IV	CW	30 50 10 20 60			15
20	R6	08:23 08:46	100	0	-	J	A	VT	SR	P	IV	CW	0 0 80 0 70 30		completely disintegrated to coarse-grained sand with fines from 20-38.5'	20
25	R7	08:53 09:13	100	0	-	J	A	VT	SR	P	IV	CW	0 60 0 40 0 78			25
30																30

LOG OF BORING SM-4

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4153637/E4181268
Boring No.: SM-4	Page No.: 2 of 19

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
30	R8	09:30 09:48	100	0	-	J	A	VT	SR	W	IV	CW	0 40 80		**GRANODIORITE (gd):** very pale yellow to moderate brown, medium to coarse grained, chiefly plagioclase with quartz, biotite and hornblende, massive, extremely closely spaced clay-lined joints	30
35	R9	09:52 10:14	100	0	-	J	A	VT	SR	P	IV	CW	40 70			35
	R10	10:24 10:37	89	50	3.3	J	B1	VT	SR	P	III	SW	40 50		very closely spaced clay-lined joints	
40	R11	10:47 11:13	88	0	4.3	J	C1	VT	SR	P	III	SW	20 30 50 18		- felsic dike	40
45	R12	11:21 11:40	97	60	2.8	S	C1	VT	SK	P	III VII	SW	50 80 60 30 80 20			45
50	R13	11:47 12:03	100	14	6.3	S	C1	VT	SK	P	III	SW	40 60 30 40			50
	R14	12:08 12:25	92	25	1.3	S	B1	VT	SK	P	VIII	SW	80 30 30		7 mm wide, slickensided clay seam within a light gray altered zone; rock is light gray below this interval	
55	R15	12:30 12:57	100	0	3.7	S	B1	VT	SK	P	III	SW	30 20 0 50			55
60	R16	13:03 -	100	36	4.0	S	B1	VT	SK	P	VIII	SW	50 40 30			60
65	R17	- 13:53	98	14	3.7	J	C1	VT	SR	P	III	SW	30 50		- 4 cm wide clayey zone with subangular gravel-sized granodiorite fragments	65

LOG OF BORING SM-4

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4153637/E4181268
Boring No.: SM-4	Page No.: 3 of 19

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R18	17:20 17:40	100	13	7.6	J	C1	VT	SR	P	III	SW	70 30		**GRANODIORITE (gd):** light gray, medium to coarse grained, chiefly plagioclase with quartz, biotite and hornblende, massive, very closely spaced iron oxide stained and clay-lined joints	
70	R19	17:47 18:04	34		4.3	S	B1	VT	SK	P	III	SW	80 40 0			70
	R20	08:00 9/10 08:14	70	0	-	J	A	VT	R	P	III	MW	80		extremely closely spaced clayey fracture zone from 70.5-76' [change to diamond impregnated bit]	
75	R21	08:21 08:40	83	0	-	-	A	VT	S	P	VIII	CW			- pegmatite?	75
80	R22	08:55 09:10	100	41	4.9	J	C1	VT	S	P	II	SW	30 50 60		greenish gray, medium to fine grained, rare clay-lined fractures	80
	R23	09:17 09:34	100	56	7.1	J	C1	VT	S	P	V	F	50 10 20 40			
85	R24	09:43 09:54	100	0	8.0	S	D1	VT	SK	P	V	F	50 30		medium to coarse grained, trace pyrite mineralization on fracture surfaces	85
90	R25	10:03 10:12	100	0	6.4	S	D1	VT	SK	P	VII	F	40 20			90
	R26	10:17 10:25	100	0	7.3	S	B1	VT	SK	P	V	F	30 60			
	R27	10:31 10:49	100	33	4.3	S	C1	VT	SK	P	V	F	70 60 40			
95	R28	10:59 11:16	100	38	3.7	J	C1	VT	R	P	V	F	15 30 50			95
100	R29	11:24	100	67	2.3	J	C1	TH	R	P	I	F	40			100

LOG OF BORING SM-4

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4153637/E4181268
Boring No.: SM-4	Page No.: 4 of 19

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
		11:54											30 50		**GRANODIORITE (gd)**: light gray to greenish gray, medium to coarse grained, chiefly plagioclase with quartz, biotite and hornblende, massive, very closely spaced tightly healed joints, rare pyrite mineralization on joint surfaces	
	R30	12:10 12:27	100	40	5.2	J	C1	VT	R	P	I	F	10 80 50			
105	R31	12:36 13:07	100	43	6.2	S	D1	VT	SK	P	I	F	30 80 60 0		localised iron oxide staining of joint surfaces weakly foliated	
110	R32	13:13 13:50	85	13	4.5	J	C1	VT	R	P	I	F	35 50 70			
	R33	14:01	100	0	7.0	J	B1	VT	R	P	I	F	70		extremely closely spaced joints from 115-132'	
115	R34	14:07 14:17 14:29	100	0	9.6	J	C1	VT	R	P	I	F	40 70 10			
120	R35	15:01 15:23	100	20	6.0	J	C1	VT	R	P	I	F	70 40 0		[driller adds polymer - clear mud - to drilling fluid]	
	R36	15:31 15:41	33	0	-	J	A	VT	R	W	I	F	30 70		localised iron oxide staining on joint surfaces - 0.3 m wide clay-lined fracture zone	
125	R37	16:26 16:46	48	0	-	J	A	VT	SR	P	I VI	F	80 60		[driller adds polymer - clear mud - to drilling fluid]	
130	R38	16:52 17:18	75	0	4.0	J	C1	VT	SR	P	I	F	0 70 40 30			
135																

LOG OF BORING SM-4

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4153637/E4181268
Boring No.: SM-4	Page No.: 5 of 19

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R39	07:55 9/11 08:22	100	56	6.3	S	C1	VT	SK	P	VIII	F	40 10		**GRANODIORITE (gd):** light gray to greenish gray, medium to coarse grained, chiefly plagioclase with quartz, biotite and hornblende, massive, with localized weakly foliated zones, very closely spaced iron oxide stained and clay-lined joints; @138' (2) 7 mm wide sheared clay seams	
140	R40	08:29 08:55	96	50	3.8	S	C1	VT	SR	P	VI	F	20 40 10			140
	R41	09:03 09:18	100	29	8.5	S	C1	VT	SK	P	VI	F	40 70			
145	R42	09:36 09:59	100	0	4.4	S	C1	VT	SK	P	VI	F	30 70 50		- calcite-lined joint	145
150	R43	10:05 10:35	100	22	8.0	S	C1 F	VT	SK	P	VI	F	40 0 60		- 0.3 m wide extremely closely fractured pegmatite zone - 0.3 m wide extremely closely spaced clay gouge zone	150
	R44	10:40 11:00	50	0	4.3	S	B1	VT	SK	P	VI	F	45 70 0			
155	R45	11:09 11:39	100	0	6.4	S	C1 F	VT	SK	P	VIII	F	60 80 30		- 0.5 m wide extremely closely spaced clay gouge zone	155
160	R46	11:44 11:55	54	0	3.5	S	B1	VT	SK	P	VIII	F	30 70			160
	R47	12:01 12:16	94	10	8.7	S	C1	VT	SK	P	VI	F	40 70 30			
165	R48	12:24 12:49	94	17	6.4	S	C1	VT	SK	P	VI	F	40 20 30		- 7 mm wide dike	165
	R49	12:56	100	18	6.0	S	C1	VT	SK	P	VI	F	0 70 40			
170																170

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Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4153637/E4181268
Boring No.: SM-4	Page No.: 6 of 19

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description								Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)		
													50 20 30	**GRANODIORITE (gd):** light gray to greenish gray, medium to coarse grained, chiefly plagioclase with quartz, biotite and hornblende, trace pyrite, massive with local gneissic foliation, very closely spaced clay- and chlorite-lined joints and shears	
	R50	13:28 13:36	100	0	7.0	J	A	VT	R	P	VI	F	55		
175	R51	13:49 13:57	94	0	6.3	J	C1	VT	SR	P	I	F	40 80 30		175
	R52	14:18 14:25	100	36	3.7	J	C1	VT	SR	P	I	F	30 50 70	weak gneissic foliation	
180	R53	14:50 15:04	100	28	4.0	J	B1	VT	SR	P	I	F	40		180
	R54	15:18 15:26	83	8	4.3	S	C1	VT	SR	P	VI	F	70 80 40		
185	R55	15:46 15:54	100	0	8.0	J	C1	VT	R	P	I	F	20 35 70		185
	R56	16:12 08:29 9/12	100	0	9.0	S	B1	VT	SK	P	VI	F	70 0	- 12 mm wide dike bounded by slickensided surfaces	
190	R57	08:45 08:53	89	23	3.8	S	D1	VT	SK	P	VI	F	50 30 10 40 60	extremely closely spaced clay-lined fracture zone from 194-202.5' with rock fragments up to 3 cm in size and clay gouge	190
195	R58	09:20 09:31	31	0	-	-	F	-	-	-	-	-			195
200	R59	09:45 10:15	87	0	-	-	F	-	-	-	-	-	60	- 2 sheared clay seams, slickensided	200
205	R60	10:34 10:43 10:55	86	12	2.8	J	C1	VT	R	P	I	F	50 30 50	very closely spaced joints	205

LOG OF BORING SM-4

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4153637/E4181268
Boring No.: SM-4	Page No.: 7 of 19

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R61	11:05 11:34	100	27	6.0	S	C1	VT	SK	P	VI	F	40 35 55 30		**GRANODIORITE (gd):** light gray to greenish gray, medium to coarse grained, chiefly plagioclase with quartz, biotite and hornblende, trace pyrite, massive with local gneissic foliation (205-215'), pegmatites and xenoliths, very closely spaced clay- and chlorite-lined joints and shears	
210	R62	11:43 12:00	100	0	5.2	J	C1	VT	R	P	I	F	70 30			210
	R63	12:12 12:34	90	0	8.4	J	C1	VT	R	P	I	F	85 70 40			
215	R64	12:41 13:20	13	0	-	-	-	-	-	-	-	-			extremely closely fractured zone with rock fragments up to 3 cm in size	215
220	R65	13:27 13:37	80	0	4.4	J	A	VT	SR	P	I	F	30		medium to fine grained	220
	R66	14:17 14:32	100	0	8.7	J	A	VT	SR	P	I	F	70		- 0.5 m wide extremely closely spaced fracture zone	
225	R67	14:48 15:13	100	15	4.9	S	C1	VT	SK	P	VI	F	60 40 70 50			225
230	R68	15:23 15:43	94	31	4.0	J	C1	VT	R	P	I	F	20 50 10		- 5 cm wide mafic xenolith	230
	R69	08:46 9/13 09:10	100	0	8.6	J	C1	VT	R	P	V	F	75 50 40 50		joints lined with light colored noncalcareous material	
235	R70	09:31 10:00	100	17	7.7	S	C1	VT	SK	P	I	F	30 60 50 35			235
240	R71	10:12	100	8	7.3	S	C1	VT	SK	P	V	F	40			240

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Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4153637/E4181268
Boring No.: SM-4	Page No.: 8 of 19

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
													80 70		**GRANODIORITE (gd):** light gray to greenish gray, medium to coarse grained, chiefly plagioclase with quartz, biotite and hornblende, trace pyrite, massive with local gneissic foliation, pegmatite dikes and xenoliths, very closely spaced chlorite- and light colored noncalcareous mineral-lined joints and shears; stricking lack of mafic minerals between 242-285; 3 cm wide pegmatite dike inclined 50 degrees at 242.5'; 3 cm wide pegmatite dike inclined 20 degrees at 247'	
	R72	10:42 10:50	100	0	8.0	J	B1	VT	SR	P	V	F	40 50			
245	R73	11:02 11:36	100	0	8.2	S	C1	VT	SK	P	V	F	20 15 40 30			245
250	R74	12:09 12:18	23	0	-	-	-	-	-	-	-	-	20		extremely closely fractured zone with rock fragments up to 3 cm in size	250
255	R75	12:55 13:06	20	7	1.2	J	B1	VT	R	P	I	F	35			255
260	R76	13:35 13:47	42	12	3.3	J	C1	VT	R	P	I	F	10 50 60		[drill rod chatter]	260
265	R77	14:01 15:09	100	19	5.3	J	B1 F	VT	SR	P	I	F	30		[change to tungsten carbide drill bit, water loss between 265-268'] extremely closely fractured zone between 266-274.5' with rock fragments up to 3 cm in size and clay gouge	265
27	R78	15:41 15:50	93	0	-	-	F	-	-	-	-	-				270
	79	16:08 16:16	89	0	-	-	F	-	-	-	-	-	20 40			
	R80	16:36 07:36	100	0	-	-	F	-	-	-	-	-	75			
275																275

LOG OF BORING SM-4

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4153637/E4181268
Boring No.: SM-4	Page No.: 9 of 19

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R81	08:01 08:10	77	0	4.8	S	C1	VT	SK	P	V	F	30 60		**GRANODIORITE (gd):** light gray to greenish gray, medium to coarse grained, chiefly plagioclase with quartz, biotite and hornblende, trace pyrite, massive with local gneissic foliation, pegmatite dikes and xenoliths, very closely spaced chlorite- and light colored noncalcareous mineral-lined joints and shears; stricking lack of mafic minerals between 242-285	
	R82	08:30 08:37 9/14	100	0	13.2	S	C1	VT	SK	P	V	F	30 70			
280	R83	08:52 09:01	38	0	8.0	J	B1	VT	SR	P	V	F	50 90		[drill rig chatter]	280
	R84	09:23 09:33	100	0	7.2	S	C1	VT	SK	P	V	F	80 95			
285	R85	09:49 09:58	100	0	6.0	S	C1	VT	SK	P	V	F	90 50		- very fine-grained pyrite crystals	285
	R86	10:25 11:01	83	0	9.0	J	C1	VT	R	P	I	F	50 70		[adding bentonite to drilling fluid]	
290	R87	11:10 11:15	100	0	7.3	J	B1	VT	R	P	I	F	60			290
	R88	12:05 14:01	92	0	6.0	J	B1	VT	R	P	I	F	15 70 50		[change to surface set diamond drill bit, rig chatter continues]	
295	R89	14:40 14:48	77	30	4.0	J	B1	VT	R	P	I	F	40 0			295
	R90	15:21	100	0	9.0	J	A	VT	R	P	I	F	70		[adding more bentonite to drilling fluid]	
300	R91	08:42 9/15	100	58	4.3	J	C1	VT	R	P	I	F	50 30			300
	R92	09:17	100	50	5.0	J	B1	VT	R	P	V	F	40			
	R93	10:07	100	47	6.0	J	C1	VT	R	- P	- V	- F	30 45		- very fine-grained pyrite crystals	
305	R94	10:49	100	0	-	J	A	VT	R	P	I	F				305
	R95	11:40	91	0	-	-	-	-	-	-	-	-			extremely closely fractured to rock fragments up to 3 cm in size, slickensided surfaces, scattered pyrite	
	R96	12:25 12:30	100	0	9.6	J	B1	VT	R	P	I	F	50			
310																310

LOG OF BORING SM-4

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4153637/E4181268
Boring No.: SM-4	Page No.: 10 of 19

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		13:23											40		**GRANODIORITE (gd)**: light gray to greenish gray, medium to coarse grained, chiefly plagioclase with quartz, biotite and hornblende, trace pyrite, massive with localized gneissic foliation, pegmatile dikes and xenoliths, very closely spaced chlorite- and light colored noncalcareous mineral-lined joints and shears	
	R97	13:34 14:48	100	40	4.0	S	C1	VT	SK	P	VI	F	60 25			
	R98	07:52 9/16	100	0	4.0	S	B1	VT	SK	P	VI	F	35			
315	R99	08:06 08:16 08:38	88	27	3.2	S	C1	VT	SK	P	VI	F	30 85 60		- weak gneissic foliation inclined 35 degrees, possible xenolith	315
320	R100	08:49 09:22	100	55	2.2	S	C1	VT	SK	P	VI	F	40 20 35			320
325	R101	09:31 10:03	100	75	2.8	S	C1	TH	SK	P	VIII	F	40 35		[driller indicates drilling mud is thinning as a result of incoming groundwater]	325
330	R102	10:19 10:45	100	22	5.6	S	C1	VT	SK	P	VIII	F	50 20 50		- clay seam mafic minerals are absent, greenish color becomes dominant, material is softer and broken to gravel sizes in some zones	330
335	R103	10:59 11:23	100	24	4.0	S	C1	VT	SK	P	VIII	F	30 65 30		- 12 mm wide tightly healed joint	335
340	R104	11:34 12:01	100	53	4.0	S	C1	VT	SR	P	V	F	60 30 55			340
345	R105	12:14	100	80	2.2	S	C1	VT	SK	P	V	F	70			345

LOG OF BORING SM-4

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4153637/E4181268
Boring No.: SM-4	Page No.: 11 of 19

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		12:14											50 35 20		**GRANODIORITE (gd):** light gray to greenish gray, medium to coarse grained, chiefly plagioclase with quartz, biotite and hornblende, trace pyrite, massive with localized gneissic foliation, pegmatite and xenoliths, very closely spaced chlorite-, calcite- and light colored noncalcareous mineral-lined joints and shears; 1 mm wide calcite-lined joint at 346.5'	
350	R106	12:58 13:34	100	87	2.0	S	B1	TH	SK	P	VIII	F	40 35 45		- 7-12 mm wide vein with 5-10 cm wide altered zone adjacent	350
355	R107	13:47 14:34	27	0	-	S	-	-	SK	P	VI	F			BASALT DIKE; dark gray, aphanitic, locally tightly healed, closely spaced slickensided fractures lined with chlorite, scattered zeolites and pyrite GRANODIORITE; light gray to greenish gray, medium to coarse grained, chiefly plagioclase with quartz, biotite and hornblende, trace pyrite, massive with localized gneissic foliation, pegmatite and rare xenoliths, very closely spaced chlorite- and light colored noncalcareous mineral-lined joints and shears	355
360	R108	13:47 9/21 14:04	83	28	5.7	S	B1	VT	SK	P	VI	F	75 30 40			360
	R109	14:15 14:38	43	0	.9	J	B1	MM	S	P	V	F	20 35 60		closely spaced and locally tightly healed joints	
365	R110	14:49 15:08	89	89	2.7	S	C1	TH	SK	P	V	F	30			365
370	R111	11:23 9/22 11:44	100	38	2.8	S	C1	VT	SK	0	VII	F	15 50 40		- 12 mm wide, discontinuous, open and crystalline calcite-lined vertical joint [driller indicates water loss]	370
	R112	11:55 12:09	14	14	.93	J	B1	TH	SR	P	I	F	15 45 50		[driller adds polymer to drilling fluid]	
375	R113	12:22 12:34	92	33	6.0	J	B1	VT	SR	P	I	F	30 40			375
380	R114	13:36 13:54	83	25	5.3	S	C1	VT	SK	P	VI	F	60 30		- grooved and slickensided shear	380

LOG OF BORING SM-4

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4153637/E4181268
Boring No.: SM-4	Page No.: 12 of 19

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R115	14:58	100	33	10.0	J	B1	VT	S	P	I	F	10		**GRANODIORITE (gd):** light gray to greenish gray, medium to coarse grained, chiefly plagioclase with quartz, biotite and hornblende, trace pyrite, massive with local gneissic foliation, pegmatite dikes and xenoliths, very closely spaced chlorite- and calcite-lined joints and shears; gneissic foliation inclined 45 degrees @ 384'	
	R116	08:19 9/23 08:48	100	37	3.0	S	C1	VT	SK	P	VI	F	0 50 20			
385	R117	08:53 09:15	100	60	3.6	S	D1	VT	SK	P	VI	F	60 15 40		closely spaced slickensided and grooved shears, some lined with chlorite, material adjacent ot shear surfaces altered	385
390	R118	09:26 09:54	93	73	1.6	S	C1	TH	SK	P	VI	F	75 60 50		[driller adds polymer to drilling fluid]	390
395	R119	10:09 10:30	100	73	3.2	S	C1	VT	SK	P	VI	F	30 40 60		slickensided surfaces throughout, some lined with chlorite	395
400	R120	10:39 11:02	100	53	5.6	S	D1	VT	SK	P	VI	F	35 40 40			400
405	R121	11:14 11:34	100	30	4.6	S	D1	VT	SK	P	VI	F	50 15 65			405
410	R122	11:44 12:00	100	13	8.8	S	C1	VT	SK	P	VI	F	30 70		- calcite-lined joint	410
	R123	12:08 12:22	100	0	6.0	S	C1	VT	SK	P	VI	F	60 80			
415																415

LOG OF BORING SM-4

Client: PB/DMJM
Project: Metro Red Line-Segment 3
Project No.: 92-2050
Location: N4153637/E4181268
Boring No.: SM-4
Page No.: 13 of 19

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R124	12:33 12:57	100	8	5.8	S	C1	VT	SK	P	VI	F	30 25 60		**GRANODIORITE (gd):** light gray to greenish gray, medium to coarse grained, chiefly plagioclase with quartz, biotite and hornblende, trace pyrite, massive with local gneissic foliation, pegmatite dikes and xenoliths, very closely spaced, slickensided and grooved, chlorite- and calcite-lined joints and shears	
420	R125	13:14 13:39	100	32	7.0	S	D1	VT	SK	P	VIII	F	50 70 30		- 15 cm wide zone of chlorite- and clay-lined fractures	
425	R126	13:49 14:15	100	33	4.6	S	D1	VT	SK	P	VI	F	40 70			
430	R127	14:25 14:53	100	32	3.8	S	D1	VT	SK	P	VI	F	20 60 40			
435	R128	15:01 15:22	100	33	5.2	S	C1	TH	SK	P	VI	F	60			
440	R129	15:33 16:08	100	52	3.6	S	C1	VT	SK	P	VI	F	40 50 20		closely spaced joints and shears	
445	R130	16:12 16:45	100	48	3.0	S	C1	VT	SK	P	VI	F	50 30 60			
450	R131	16:57 17:21	43	0	3.7	S	C1	VT	SK	P	VI	F	70 50 40			

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LOG OF BORING SM-4

Client: **PB/DMJM**	Project: **Metro Red Line-Segment 3**
Project No.: **92-2050**	Location: **N4153637/E4181268**
Boring No.: **SM-4**	Page No.: **14 of 19**

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R132	10:29 9/24 11:02	100	68	2.2	S	C1	VT	SK	P	VI	F	45 30 50		**GRANODIORITE (gd):** light gray to greenish gray, medium to coarse grained, chiefly plagioclase with quartz, biotite and hornblende, trace pyrite, massive with local gneissic foliation, pegmatite dikes and xenoliths, closely spaced chlorite- and calcite-lined joints and shears	
455	R133	11:13 11:42	100	58	2.4	S	D1	VT	SK	P	VIII	F	35 60 60			455
460	R134	11:55 12:55	100	40	3.6	J	D1	VT	SR	P	V	F	30 60 80		- 0.3 m wide extremely closely brecciated zone lined, tightly healed with chlorite	460
465	R135	13:09 13:42	100	68	2.4	J	C1	VT	R	W	V	F	40 50			465
470	R136	13:52 14:23	100	60	1.8	J	C1	TH	SR	P	V	F	40 20 30		aphanitic from 470-478', possibly completely altered basalt(?)	470
475	R137	14:33 15:02	100	77	1.6	S	C1	MM VT	SK	P	VI	F	35 80		[drill rod chatter] medium to coarse grained interval	475
480	R138	15:12 15:44	100	67	1.4	S	B1	VT	SK	P	VI	F	0 60		faulted contact @ 480.2', between medium to coarse grained above, aphanitic below, fine grained interval continues to 491'	480
485																485

LOG OF BORING SM-4

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4153637/E4181268
Boring No.: SM-4	Page No.: 15 of 19

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R139	15:55 16:29	100	83	0.8	J	A	MM	R	P	V	F	10 60		**ALTERED BASALT**: light gray to greenish gray, aphanitic, chiefly plagioclase, closely spaced chlorite- and calcite-lined joints and shears	
490	R140	16:39 17:12	100	75	2.2	J	C1	VT	R	P	V	F	35 40		faulted contact **GRANODIORITE (gd)**: light gray to greenish gray, coarse grained, chiefly plagioclase with quartz, biotite, and hornblende	490
495	R141	07:43 9/25 08:24	100	32	3.6	S	D1	VT	SK	P	VI	F	20 40 30		- 0.3 m wide extremely closely spaced chlorite- and clay-lined fracture zone	495
500	R142	08:36 09:18	100	8	3.4	S	C1	VT	SK	P	VI	F	30 50 30		grades to aphanitic altered [drill rod chatter]	500
505	R143	09:37 10:15	100	17	5.4	S	C1	VT	SK	P	VI	F	20 50 10 40		very closely spaced joints	505
510	R144	11:02 12:01	100	43	2.8	S	C1	VT	SK	P	VI	F	15 30 20		closely spaced joints	510
515	R145	12:13 12:51	100	80	1.6	S	B1	VT	SK	P	VI	F	30 60 60			515
520																520

LOG OF BORING SM-4

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4153637/E4181268
Boring No.: SM-4	Page No.: 16 of 19

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R146	13:03 13:34	100	87	1.6	J	C1	TH	SR	P	V	F	50 20		**GRANODIORITE (gd):** light gray to greenish gray, medium to coarse grained, chiefly plagioclase with quartz, biotite and hornblende, trace pyrite, massive with localised gneissic foliation and pegmatite dikes and xenoliths, very closely spaced, tightly-healed, chlorite-, calcite- and feldspar(?)-lined joints and shears	
525	R147	13:56 14:29	100	27	3.2	S	C1	VT	SK	P	VIII	F	45 30 15		clay gouge and breccia, matrix supported	525
530	R148	14:40 15:03	100	0	4.5	S	B1	VT	SK	P	VIII	F	40 70		very closely spaced clay-lined shears - 3-10 cm wide clay-lined, slickensided and grooved brecciated intervals	530
	R149	15:15 15:31	100	0	11.5	S	A	VT	SK	P	VIII	F	60 70		- 3-10 cm wide clay-lined, slickensided and grooved brecciated intervals	
535	R150	15:43 16:05	100	30	6.4	S	B1	VT	SK	P	VIII	F	20		- 3-5 cm wide clay-lined joint - 3-5 cm wide clay-lined joint	535
540	R151	16:38 17:02	100	52	2.9	S	C1	VT	SK	P	VIII	F	80 30		- 12 mm wide clay seam - 0.3 m wide crushed zone with clay matrix	540
	R152	08:10 9/26 08:38	100	52	3.0	S	C1	VT	SK	P	VI	F	70 60		intermittent crushed zones with clay matrix	TESTS
545	R153	08:50 09:07	100	0	2.8	S	B1	VT	SK	W	VI	F	25 60			545
550	R154	09:19 10:08	100	0	5.8	S	B1	VT	SK	P	VIII	F	50 40		intermittent crushed zones with clay matrix	550
555	R155	10:19 10:42	69	19	1.7	J	A	VT	R	W	V	F	80		[lost all circulation]	555

LOG OF BORING SM-4

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4153637/E4181268
Boring No.: SM-4	Page No.: 17 of 19

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R156	11:43 12:15	100	75	1.8	J	B1	VT TH	R	W	VI	F	40 30 50		**GRANODIORITE (gd):** light gray to greenish gray, medium to coarse grained, chiefly plagioclase with quartz, biotite and hornblende, trace pyrite, massive with localized gneissic foliation, very closely spaced, tightly healed, chlorite- and calcite-lined joints and shears	
560	R157	12:27 12:43	100	100	0	-	-	-	-	-	-	-			[loose circulation, add bentonite]	560
	R158	14:39 14:59	100	100	1.1	J	B1	MM	R	W	I	F	70 30		coarse grained	
565	R159	08:31 9/27 09:29	97	58	1.8	S	C1	TH	SK	P	VI	F	70 65			565
570	R160	10:09 10:54	95	82	1.0	S	B1	TH	SR	P	VI	F	30 40		- chlorite- and calcite-lined fractures [slow progress, becoming much harder, poor circulation, adding additional bentonite]	570
575	R161	9/28	83	0	9.3	J	B1	VT	R	P	V	F	70			575
	R162	09:01 09:42	72	61	4.7	J	B1	VT	R	P	V	F	60			
580	R163	10:04 10:47	94	73	1.8	J	B1	VT	SR	P	V	F	30 40			580
	R164		100	100	0.5	-	-	-	-	-	I	F				
	R165	10:03 9/29 10:18	100	100	0.5	J	A	MM	R	W	I	F	35		[replace old for new diamond impregnated bit] - 8 cm wide dark banded gneissic foliation inclined from 20-40 degrees	
585 590	R166	10:39 12:06	100	63	1.2	J	B1	HT	R	W	V	F	20 75 25			585 590

LOG OF BORING SM-4

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4153637/E4181268
Boring No.: SM-4	Page No.: 18 of 19

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R167	12:21 13:01	93	57	2.4	J	B1	VT	SR	P	V	F	40 45		**GRANODIORITE (gd)**: light gray to greenish gray, coarse grained, chiefly plagioclase with quartz, biotite and hornblande, trace pyrite, gneissic foliation inclined from 25-35 degrees, very closely spaced, tightly healed, chlorite- and calcite-lined joints and shears	
	R168	13:23 14:02	90	43	2.8	J	B1	VT	SR	P	V	F	25 65			
595	R169	14:19 15:38	100	70	2.2	J	C1	TH	SR	W	V	F	35 60 30		gneissic foliation inclined from 35-40 degrees - 7 mm wide chlorite-lined tightly healed joint	595
600	R170	15:52 9/30 09:39	90	64	1.4	J	A	MM	SR	P	VI	F	30 70		gneissic foliation inclined from 20-30 degrees	600 TEST 2
605	R171	09:49 10:47	52	0	5.5	J	B1	VT	R	P	VI	F	70 20			605
610	R172	11:07 10/5 11:32	100	100	1.0	J	A	MM	R	P	V	F	0 65		gneissic foliation inclined 25 degrees, fine grained between 607.5-608', closely spaced joints [added polymer]	610
	R173	11:45 12:27	100	88	1.0	J	B1	MM	R	P	V	F	70 45			
615	R174	12:40 13:43	100	96	1.0	J	A	MM	R	P	V	F	60 70			615 TEST 1
620	R175	14:05 15:04	100	100	1.1	J	A	MM	R	P	V	F	70		gneissic foliation inclined 30 degrees unfractured from 620-624'	620
	R176		100	100	0.0	-	-	-	-	-	V	F				
625	R177	07:43 10/6	100	100	0.3	S	A	MM	SK	P	VI	F	20		numerous tightly healed 7 mm wide chlorite-lined joints	625

The Earth Technology Corporation

LOG OF BORING SM-4

Client: PB/DMJM

Project: Metro Red Line-Segment 3

Project No.: 92-2050

Location: N4153637/E4181268

Boring No.: SM-4

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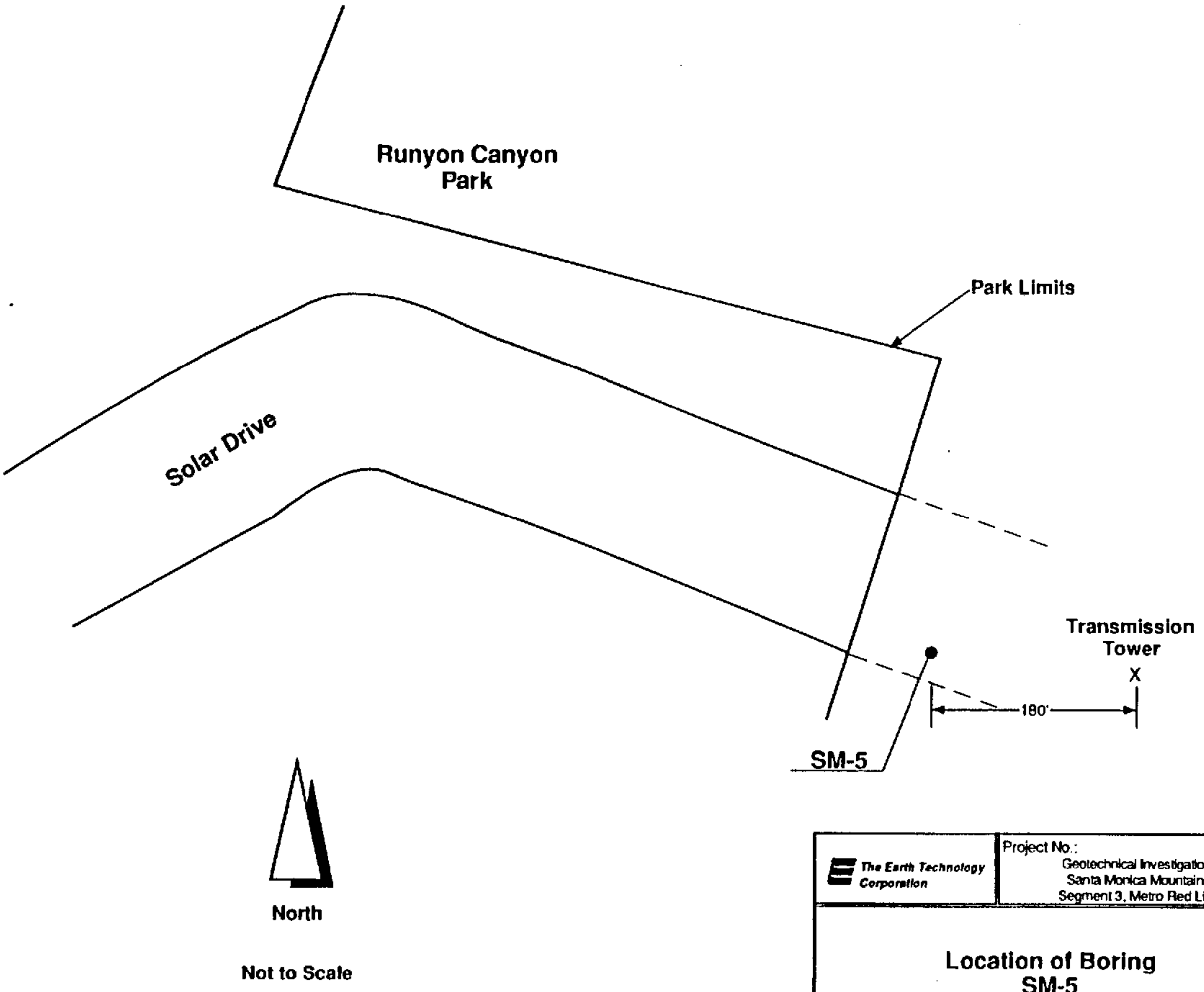
Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		08:33													**GRANODIORITE** (gd): see above	
															Boring terminated at 626 feet on 10/6/92.	
630																630
635																635
640																640
645																645
650																650
655																655
660																660



The Earth Technology Corporation

Project No.: 92-2050
Geotechnical Investigation
Santa Monica Mountains
Segment 3, Metro Red Line

Location of Boring SM-5

Figure A-9

LOG OF BORING SM-5

Client: PB/DMJM	Project: Metro Red Line-Segment 3	Project No.: 92-2050
Location: N4154583/E4181052	Surface Elevation (ft): 1226	Boring No.: SM-5
Inclination (Deg.): 90	Bearing: NA / Depth (ft): 890.0	Depth to Water Table (ft):
Started: 10/8/92 / Finished: 12/2/92	Core Dia. (in.): 2.4	No. of Core Boxes: 58
Driller: PC Exploration, Inc.	Drilling Method: Mud Rotary Fluids: Bentonite/Clear mud	Drilling Equipment: Longyear 38
Logged By: M. Curtis	Checked By: G. Miller	Page No.: 1 of 26

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
0	R1	11:13 10/8	32												**ARTIFICIAL FILL (af):** SILT/SAND/GRAVEL [using diamond impregnated bit]	0
5		12:00													**CHICO FORMATION (Kc):** CONGLOMERATE; matrix supported, fine to coarse gravel and cobbles to 20 cm, clasts are rounded, composed of plutonics, quartzite and basalt, matrix consists of dark yellowish orange fine- to coarse-grained sand that is weakly cemented and very friable, massive	5
	R2	12:14	0	0	-	-	-	-	-	-	-	CW				
10																10
		12:30														
	R3	12:34	0	0	-	-	-	-	-	-	-	-				
15																15
		12:50														
	R4	13:05	40	0	-	-	-	-	-	-	-	CW				
20																20
25																25
		13:21											30			
	R5	13:06	90	90	-	-	-	-	-	-	-	CW				
30																30

LOG OF BORING SM-5

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4154583/E4181052
Boring No.: SM-5	Page No.: 2 of 26

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
30															**CHICO FORMATION (Kc): CONGLOMERATE;** matrix supported, fine to coarse gravel and cobbles to 20 cm, clasts are rounded, composed of plutonics, quartsite and basalt, matrix consists of dark yellowish orange fine- to coarse-grained sand that is poorly cemented and very friable, massive	30
	R6	14:04 14:08	90	20	1	J	A	TH	R	P W	II	CW HW				
35													70 50		**SANDSTONE;** moderate yellowish brown, medium- to coarse-grained sand, some silt, trace gravel, poorly cemented, moderately friable, massive, moderately closely spaced joints	35
	R7	14:25 14:42	80	7	-	-	-	-	-	-	-	CW HW				
40															**CONGLOMERATIC SANDSTONE;** moderate yellowish brown, medium- to coarse-grained sand with fine to coarse gravel (20-30%), well cemented, weakly friable, massive, moderately closely spaced joints, rounded clasts composed of quartsite, plutonics, and basalt	40
	R8	14:58 15:14	90	17	2	J	B1	TH	R	P W	V	CW			- cobbles 0.3 m in size	
45													35		**CONGLOMERATE;** matrix supported, fine to coarse gravel and cobbles to 20 cm, clasts are subrounded and sheared, composed of plutonics, quartsite, sandstone, basalt and rare slate, matrix consists of moderate brown to moderate yellowish brown, fine- to coarse-grained sand that is poorly cemented and very friable, massive	45
	R9	15:30 15:40	100	72	0.4	J	A	MM	SR	P	V	HW	25			
50																50
	R10	15:55 16:02	90	0	>5	J	E	VT	SR	P W	II	HW	60		**CONGLOMERATIC SANDSTONE;** moderate yellowish brown, fine- to coarse-grained sand with gravel(30-40%) up to 8 cm long, well cemented, weakly friable, massive, moderately closely spaced joints, rounded and sheared clasts composed of quartsite, plutonics, and basalt	
55																55
	R11	16:20 16:30	98	73	0.6	J	B1	MM	SR	P	II	MW	40		clasts up to 10 cm	
60													70			60
	R12	16:48 -	100	53	1	J	C1	MM	SR	P W	II	MW	40		clasts up to 5 cm	
65																65

LOG OF BORING SM-5

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4154583/E4181052
Boring No.: SM-5	Page No.: 3 of 26

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		17:06													**CHICO FORMATION (Kc):** CONGLOMERATIC SANDSTONE; moderate yellowish brown, fine- to coarse-grained sand with gravel (30%) up to 5 cm, well cemented, weakly friable, massive, moderately closely spaced joints, rounded and sheared clasts composed of quartzite, plutonics, basalt and rare slate - shears within clasts are parallel to joint set - 0.4 m thick completely weathered, very friable, gravelly sandstone layer	
	R13	10/10	100	67	-	B	-	M	-			MW				
70	R14	15:49 16:05	93	36	3.5	J	A	TH L	SR R	P D	II	MW HW	58 52			70
75	R15	16:16 16:30	67	10	2.5	J	A	TH	SR	P	II	HW	60 60		scattered clasts up to 15 cm	75
80	R16	16:45 17:01	75	17	3	J	B1	TH	SR	P	II	HW	60 70 50			80
85	R17	17:10 17:25	67	0	3	J	A	VT	SR R	P D	II V	HW				85
90	R18	07:58 10/12 08:15	88	22	-	-	-	-	R	P	II	HW	70		clasts up to 2 cm, almost all clasts are sheared	90
95	R19	08:23 08:38	40	15	5	J	C1	VT	R	P	II	HW				95
100	R20	08:49	85	22	1.2	J	B1	VT	SR	P	II	MW	30		CONGLOMERATE; matrix supported, fine to coarse gravel and cobbles, clasts are rounded and sheared, composed of	100

LOG OF BORING SM-5

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4154583/E4181052
Boring No.: SM-5	Page No.: 4 of 26

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
105	R21	09:04 09:19	88	0	1	J	B1	TH	R SR	P S	II	MW	70 50		plutonics, quartzite and basalt, matrix consists of mottled grayish orange and light gray fine- to coarse-grained sand and silt that is poorly cemented and very friable, massive	105
110	R22	09:34 09:44	88	23	8	J	B	TH	SR	P W	V	SW	60		very regular closely spaced joint set, joints 2 mm wide, lined with calcite and iron stained CONGLOMERATIC SANDSTONE; medium gray, fine- to medium-grained sand with coarse -grained sand, gravel, and cobbles, well cemented, weakly friable, massive	110
115	R23	10:01 10:11	100	32	1	J	A	MM TH	SR	P	II V	SW	18 70 35		CONGLOMERATE; matrix supported, fine to coarse gravel and cobbles to 20 cm, clasts are rounded and locally sheared, composed of plutonics, quartzite and basalt, matrix consists of dark yellowish orange fine- to coarse-grained sand that is poorly cemented and very friable, massive, very closely to moderately closely spaced calcite-lined joints - 0.7 m thick sandstone layer at 117'	115
120	R24	10:27 10:37	72	33	2	J	A	TH	R	P W D	II	SW	80 72			120
125	R25	10:55 11:05	15	0	5	J	A	VT	SR R	S P	II	SW			very friable interval	125
130	R26	11:16 11:35	60	10	2	J	A	VT	SR	S W	II	SW FW	80			130
135	R27	11:46 12:00	87	50	2	J B	-	-	L	-	-	FW	60		SANDSTONE; moderate yellowish brown, fine- to medium-grained sand, locally rare silt laminae, weakly cemented, moderately	135

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Client: PB/DMJM	Project: Metro Red Line-Segment 3
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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		12:20											80 75		friable, generally massive, moderately closely spaced joints	
140	R28	13:36 13:46	100	34	2.5	J B	B1	TH	SR	P	II	FW	45 65 70		- parts along silt laminae CONGLOMERATIC SANDSTONE; medium gray, medium- to coarse-grained sand with fine to coarse gravel, well cemented, weakly friable, massive	140
145	R30	13:54 14:16	100	72	0.6	J	B1	TH	SR	P	II VI	FW			- 4 mm wide clay-lined fracture CONGLOMERATE; matrix supported, fine to coarse gravel and cobbles to 20 cm, clasts are rounded and sheared, matrix consists of medium gray fine- to coarse-grained sand and silt	145
150	R31	14:21 14:34	100	50	0.8	J	C1	TH	SR	P	II	FW	45		SANDSTONE; medium light gray, fine to medium-grained sand, some silt, trace gravel at 148', well cemented, weakly friable, massive, unfractured CONGLOMERATE; matrix supported, fine to coarse gravel and cobbles (60-70%) to 20 cm, clasts are rounded and sheared, composed of plutonics, quartzite, basalt and slate, matrix consists of medium gray fine- to coarse-grained sand and silt that is moderately cemented and slightly friable, massive, moderately closely spaced joints	150
155	R32	14:44 15:02	100	50	0.6	J	A	MM	SR	P	II	FW	40 80 60			155
160	R33	15:13 15:30	100	60	0.6	J	B1	TH	S	P	II	FW	50 30 70		60-80% clasts up to 5 cm long - stretched and sheared slate clast within silt matrix - scattered cobbles to 10 cm	160
165	R32	15:46 16:05	100	42	0.4	J	A	MM	SR	P	II	FW	60		50-60% clasts up to 10 cm CONGLOMERATIC SANDSTONE; medium gray, fine- to coarse-grained sand, some gravel and cobbles, well cemented, weakly friable, massive, moderately closely spaced joints, subrounded clasts composed of quartzite, plutonics, and basalt	165
170	R33	16:24	100	73	0.6	J	A	MM	SR	P	-	F	70 50		- 20 cm thick sandstone layer	170

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		16:45													**CHICO FORMATION (Kc):** CONGLOMERATIC SANDSTONE; medium gray, medium- to coarse-grained sand with fine to coarse gravel, well cemented, weakly friable, massive - .6 m thick sandstone layer with silt laminae	
175	R34	16:54 17:10	100	76	1	J	B	TH	SR	S P	II	F	65 35 55		CONGLOMERATE; matrix supported, fine to coarse gravel and cobbles to 20 cm, clasts are rounded and sheared, composed of plutonics, quartzite and basalt, matrix consists of medium gray, fine- to coarse-grained sand that is poorly cemented and very friable, massive, closely spaced joints	175
180	R35	17:26 17:42	100	62	1.2	J	A	TH	SR	S P	II	F	45 75		ARKOSIC SANDSTONE; moderate yellowish brown, grades from medium- to fine-grained sand with silt, weakly cemented, moderately friable, massive, very closely spaced irregular joints below 183'	180
185	R36	08:22 10/13 08:40	97	67	1.8	J	C1	TH	R	P	V	F	60 23 60 70		trace rounded gravel-sised volcanic clasts up to 5 cm	185
190	R37	08:55 09:10	100	27	3.8	J	C1	VT TH	SR	S P	I	F	60 20 50 60		trace subangular to subrounded gravel-sised volcanic clasts up to 2 cm	190
195	R38	09:23 09:37	88	45	2.6	J	C1	VT	R	W	I	F	50 40 30 60		CONGLOMERATE; matrix supported, fine gravel (70%) from 1 to 6 cm, clasts are subrounded, composed of plutonics, quartzite and basalt, matrix consists of medium gray fine-grained sand that is moderately cemented and friable, massive, closely spaced, healed, calcite-lined joints	195
200	R39	09:54 10:10	85	33	2.2	J	A	VT TH	S	P	I	F	70 50		- 0.3 m thick sandstone layer - scattered cobbles to 20 cm	200
205	R40	10:17	87	13	1.6	S	A	VT	SK	S P	VIII	F				205

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
210	R41	10:25 10:43	83	0	1.6	S	B1	VT TH	S	P	VIII	F	60 60 50 30		**CHICO FORMATION (Kc): CONGLOMERATE;** matrix supported, fine to coarse gravel and cobbles (70%) to 12 cm, clasts are rounded to subrounded, composed of plutonics, basalt and slate, matrix consists of medium gray fine- to coarse-grained sand that is poorly cemented and very friable, massive, closely spaced clay- and calcite-lined joints; scattered 3 cm wide slickensided and polished clay seams from 205.5-207'	210
215	R42	10:59 11:14	100	37	2.2	S	A	VT TH	SR	W	I	F	30 60		50% clasts and fine- to coarse-grained sand - 0.3 m thick fine- to coarse-grained arkosic sandstone layer CONGLOMERATIC SANDSTONE; medium gray, fine- to coarse-grained sand with gravel (50%) to 2 cm, well cemented,	215
220	R43	11:32 11:49	83	0	2.8	J	A	VT	R	D	I	F			weakly friable, massive, moderately closely spaced joints, subrounded to subangular clasts composed of plutonics, basalt and slate, closely spaced calcite-lined, healed joints - 0.3 m thick sandstone layer	220
225	R44	12:05 12:15	100	32	2.6	J	B1	VT	S	P W	I	F	40 50 60			225
230	R45	12:32 13:03	100	60	-	S	B1 F	VT	SK	P	VI	F	70 50 50		extremely closely sheared zone, slickensided and striated, clasts are sheared and slickensided CONGLOMERATE; matrix supported, fine to coarse gravel and cobbles (50-60%) to 12 cm long, clasts are subrounded to subangular, composed of plutonics, basalt and slate, matrix consists of medium gray	230
235	R46	13:22 13:46	92	0	-	S	A F	VT	SK	P	VIII	F			fine- to coarse-grained arkosic sand that is poorly cemented and very friable, massive, extremely closely spaced, slickensided and polished clay- and calcite-lined joints - 0.3 m thick sheared claystone layer	235
240	R47	14:00 14:15	100	0	4.4	S	C1	VT	SK	P	VI	F	40 80 60		- 0.3 m thick sandstone layer	240

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
													50		**CHICO FORMATION (Kc): CONGLOMERATE;** matrix supported, fine to coarse gravel and cobbles (50-70%) to 8 cm, clasts are subrounded to subangular, composed of plutonics, basalt and slate, matrix consists of medium gray fine- to coarse-grained arkosic sand that is moderately cemented and weakly friable, massive, extremely closely spaced, slickensided and polished clay- and calcite-lined joints	
245	R48	14:32 14:45	100	42	2.4	S	A	VT TH	R	W	I	F	70 50			
250	R49	14:58 15:15	100	77	1.4	J	B1	TH	SR	P	I	F	70 40		45% clasts up to 13 cm	
255	R50	15:29 15:42	100	35	3.2	S	B1	VT	SK	P	I	F	30 55 20		- sandy interval	
260	R51	16:01 16:15	100	30	2	J	A	VT TH	R	W	I	F	50		80% clasts up to 8 cm, poorly cemented and very friable (clasts are loose in matrix)	
265	R52	16:31 16:46	100	28	4.8	J	C1	VT	R	W P	I	F	50 40 30 20		70% clasts up to 5 cm, poorly cemented and very friable	
270	R53	17:04 08:08 10/14	100	90	1	S	B1	TH MM	SK	P	I	F	40 30 20		75% clasts up to 5 cm - slickensided surfaces - slickensided surfaces	
275	R54	08:23 08:34	100	92	1.2	J	A	TH	VR	S D	I	F	20		80% clasts up to 5 cm	

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
280	R55	08:52 09:11	100	33	1.4	S	A	VT	SK	P	I	F	70		**CHICO FORMATION (Kc): CONGLOMERATE;** matrix supported, fine to coarse gravel and cobbles (75%) to 20 cm, clasts are subrounded to subangular, composed of plutonics, basalt and slate, matrix consists of fine- to coarse-grained sand that is poorly cemented and very friable, closely spaced joints and shears; slickensided surface @ 278', crushed and friable below	280
285	R56	09:28 09:38	100	55	2	S	B1	VT TH	SK	P	I	F	5 30 80 60		40% clasts - basalt clast to 13 cm - slickensided surfaces	285
290	R57	09:50 10:05	100	63	2.4	S	B1	VT TH	SK	P	VIII	F	30 40 50		- 0.6 m thick sandstone layer, fine to medium grained - 17 cm long plutonic clast - 15 cm wide sheared clay seam	290
295	R58	10:22 10:31	100	77	1.2	J	B1	VT TH	R	W S	I	F	80 30		60% clasts up to 5 cm	295
300	R59	10:43 10:57	100	67	1.8	J	A	TH VT	R	S	I	F	30 40		50-60% clasts up to 8 cm	300
305	R60	11:11 11:21	100	55	2.2	J	B1	VT TH	SR	P	I	F	70 60 40		extremely closely fractured, crushed and friable 40-60% clasts up to 20 cm - granodiorite clast to 20 cm	305
310	R61	13:38 11:26 10/20	100	100	0.4	J	A	MM	S	P	III	F	40 30		60-80% clasts up to 5 cm - 2 mm wide clay-lined joint - 3 cm long imbricated slate clasts	310

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
															**CHICO FORMATION (Kc):** See above	
315	R62	11:47 12:00	100	97	1.2	J	B1	TH	SR S	P	II	F	80 60 20		SANDSTONE; medium light gray, coarse-grained sand with fine-grained sand and gravel up to 5 cm, poorly cemented, moderately friable, massive, closely spaced joints; 1 mm wide calcite-lined joint @ 311'	315
320	R63	12:15 12:30	100	85	1.4	J	C1	TH	S SR	P S	II III	F	60 40		CONGLOMERATIC SANDSTONE; medium light gray, grades from fine-grained sand to small cobbles, well cemented, weakly friable, massive, moderately closely spaced joints, rounded clasts composed of quartzite, granodiorite, and basalt - 2 mm wide clay-lined joint	320
325	R64	12:48 13:00	100	97	0.2	J B	A	M	S	P	II	F	20		CONGLOMERATE; matrix supported, fine to coarse gravel and cobbles (60-70%) to 8 cm, clasts are rounded, composed of plutonic, quartzite and basalt, matrix consists of medium gray fine- to coarse-grained sand that is poorly cemented and very friable, massive; 20 cm thick conglomeratic sandstone layer @ 325'	325
330	R65	13:17 13:33	100	98	0.6	J	A	MM	SR	P	II	F	60 45		50-60% clast up to 1 cm CONGLOMERATIC SANDSTONE; medium light gray, fine- to medium-grained sand, some gravel, well cemented, weakly friable, massive, moderately closely spaced	330
335	R66	13:48 14:00	82	82	1.4	J	B1	TH	SR	P	II	F	50		joints, rounded clasts composed of quartzite, plutonics, and basalt - vesicular basalt clast up to 15 cm 30-40% clasts up to 3 cm	335
340	R67	14:20 14:32	92	57	2.2	J	A	TH	R S	S P	II V	F	80 75		40-60% clasts up to 1 cm - 25 cm thick sandstone layer	340
345	R68	14:50 15:09	100	32	>5	J	C	VT L	SR	S P	II V	F	60		CONGLOMERATE; matrix supported, fine to coarse gravel and cobbles (60%) to 8 cm, clasts are subrounded, composed of plutonics, quartzite and slate, matrix	345

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	
350	R69	15:24 07:51 10/21	100	23	5	J B	B1	VT	SR	P S	II VI	F	58 30		
355	R70	08:06 10:25	53	8	5	J	-	-	-	-	-	-	40 75		
	R71	10:46	100	0	-	-	-	-	-	-	-	-			
	R72		50	0											
360	R73	13:45	98	46	2	J B	A	MM	SR	P	VI	F	58		
365	R74	14:01 14:10	100	83	1	J	B1	TH	SR	P	II V	F	20		
370	R75	14:25 14:40	100	67	0.8	J	C1	TH	S	P	V	F	40 60 15		
375	R76	14:54 15:08	100	95	0.8	J	B1	MM	S	P	II VI	F	50 50 48		
380	R77	15:26 15:41	100	97	0.8	J	B1	MM	S	P W	V VI	F	15 55		

Lithic Description

consists of medium dark gray fine-grained sand and silt that is poorly cemented and very friable, massive, extremely closely spaced joints below 344'

SILTY SANDSTONE; medium gray, fine-grained sand and silt, poorly cemented, very friable, massive, very closely spaced clean and clay-lined joints
- (3) 5 mm wide intersecting clay-lined fractures

CONGLOMERATIC SANDSTONE; medium dark gray, fine-grained sand and silt with gravel (10-20%) up to 8 cm, well cemented, weakly friable, massive, moderately closely spaced joints, rounded clasts composed of quartzite, plutonics, and basalt
- clasts show shearing and warping, shears lined with calcite
- shattered and sheared quartzite clast

CONGLOMERATE; matrix supported, fine to coarse gravel, trace cobbles, clasts are subrounded and sheared, composed of plutonics, quartzite and slate, matrix consists of medium gray fine-grained sand and silt that is poorly cemented and very friable, massive, closely spaced joints
- 5 mm wide clay-lined joint

50% clasts up to 8 cm

70% clasts up to 8 cm, generally slate and plutonic clasts

- matrix composed of grayish yellowish green silt and sand

70-80% clasts up to 10 cm

- imbricated clasts

matrix medium gray to greenish gray
- plutonic clasts to 15 mm
- scattered basalt clasts to 8 cm

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
385	R78	15:56 16:08	100	93	1.5	J	B1	TH	SR	P W	II	F	40 45 65		**CHICO FORMATION (Kc):** CONGLOMERATIC SANDSTONE; greenish gray and medium gray, fine-grained sand with silt and fine to coarse gravel, well cemented, weakly friable, massive, moderately closely spaced joints, rounded clasts composed of slate, quartzite, plutonics, and rare basalt - scattered irregular 1 mm wide calcite-lined joints	385
390	R79	16:21 16:35	100	72	1.6	J	C1	MM	SR	P	II	F	60 30 50 70		CONGLOMERATE; matrix supported, fine to coarse gravel and cobbles (80%), clasts are subrounded and sheared, composed of plutonics, quartzite and slate, matrix consists of medium gray fine-grained sand and silt that is well cemented and moderately friable, massive, closely spaced joints - 3 clean and tightly healed parallel joints	390
395	R80	16:50 17:03	100	65	1.2	J	A	TH	S	P	V II	F	45 50 65		clasts up to 25 cm - 3 mm wide clay-lined joint cobbles and gravel	395
400	R81	17:17 08:03 10/22	100	83	0.6	J	A	MM	SR	P	II	F	58		- parts along bedding ARKOSIC SANDSTONE; medium light gray, fine-grained sand, some silt, trace gravel, well cemented, weakly friable, massive, widely spaced joints	400
405	R82	08:18 08:30	100	57	0.6	J	A	MM	SR	P	II VI	F	62 50 50		- scattered shattered cobbles - 1 mm wide healed clay-lined joint - 0.5 m thick coarse-grained sand and contorted silt with very thin clay interbeds, parts on beds	405
410	R83	08:42 09:00	93	17	40	J	C1	VT	SR	P S	II	F	60 80		with coarse-grained sand-sized slate particles - 0.6 m thick sandstone layer with 6 parallel joints - shattered quartzite clast to 7 mm	410
	R84	09:12 09:23	92	0	-	-	-	-	-	-	-	-			CONGLOMERATE; matrix supported, gravel up to 5 cm, clasts are subrounded and sheared, composed of plutonics, quartzite and slate, matrix consists of medium gray	
415	R85	09:30 09:42	94	47	3	J	C1	VT	SR	P	II	F				415

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
											V		70		coarse- to fine-grained sand and silt that is moderately cemented and weakly friable, massive, closely spaced joints	
420	R86	10:00 10:29	97	65	0.4	J	A	MM	SR	P	II	F	50 20		CONGLOMERATE; matrix supported, gravel (70%), trace cobbles up to 5 cm, matrix consists of medium gray coarse- to medium-grained sand and silt	420
425	R87	10:44 10:56	100	52	2	J	B1	TH	S SR	P W	II V VI	F	50 60 50 80		CONGLOMERATIC SANDSTONE; medium gray, fine-grained sand with silt and fine to coarse gravel, well cemented, weakly friable, massive, closely spaced joints, rounded clasts composed of slate, quartzite, and plutonics - 2 mm wide clay-lined joint - 3 mm wide clay-lined joint	425
430	R88	11:13 11:29	100	37	2.2	J	D1	VT	SR	P W	V VI	F	45 70 50 60			430
435	R89	11:44 12:25	88	47	0.6	J	A	MM	SR	P	VI	F	50		- 0.4 m thick, completely sheared and shattered conglomerate layer - 25 cm wide, extremely closely sheared and clay-lined fracture zone	435
440	R90	- 13:06	96	33	1.8	J S	C1	TH	SR	P	III	F	65 60 40		30-50% clasts - 2 cm wide clay-lined slickensided shear - 3 cm wide clay- and gravel-lined slickensided shear	440
445	R91	13:42 14:18	100	20	1	J	B1	TH	SR	P	V	F	58		CONGLOMERATE; matrix supported, gravel from 1-5 cm, clasts are rounded, composed of plutonics, quartzite, basalt and slate, matrix consists of dark gray fine- to coarse-grained sand	445
450	R92	14:35 14:53	79	23	>10	J S	A	VT	-	-	VIII	F			BRECCIATED CLAYSTONE; medium dark gray, plastic clay, trace gravel, very weakly cemented, very closely sheared; [driller indicated that hole "squeezes" onto the rods]	450

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
													58		CHICO FORMATION (Kc):	
455	R93	15:20 17:10	98	40	0.6	J B	A	MM TH	SR	P	II	F	75 50 58 70		CONGLOMERATIC SANDSTONE; medium gray, fine- to coarse-grained sand, some gravel and silt, well cemented, weakly friable, massive with localised graded bedding, very closely spaced joints, rounded clasts from coarse-grained sand to gravel consist of plutonics and sheared and warped slate and quartsite	455
460	R95	17:30 16:40 10/26	89	17	1.4	J	A	TH	SR	S	II	F	62		50% clasts up to 6 cm; [drilling switched to NQ core using diamond impregnated bit] - 10 cm thick sandstone layer - 0.4 m wide extremely closely spaced joints within soft gray clay gouge sone	460
465	R96	16:59 14:54 10/27	95	44	2	J S	B1	TH	SR	S	II V	F	80 60 30		- 2 mm wide open and calcite-lined joint 40% clasts - 6 cm wide extremely closely sheared and slickensided siltstone layer	465
470	R97	15:16 15:45	33	0	3.5	J S	A	VT	S	P	VI	F	40 70		[core blocked off by sheared quartsite clasts] - 2 mm wide gray clay-lined slickensided shear	470
475	R98	16:10 16:36	89	17	3	J	C1	VT	S	P	VIII	F	50 80		- (2) 6 mm wide clay-lined joints	475
	R99	16:59	100	75	0	B	-	M	-	-	-	F			CONGLOMERATE; matrix supported, gravel from 1-5 cm, clasts are rounded, matrix consists of dark gray fine- to coarse-grained sand	
480	R100	10/28 10:11	100	27	3	J	D1	TH	S	P W	II	F	22 78 85		- quartsite cobble to 15 cm SANDSTONE; medium light gray, fine- to medium-grained sand, some silt and coarse-grained sand, trace fine gravel, poorly cemented, moderately friable, massive, closely spaced joints	480
485	R101	10:29 12:05	86	0	2	J S	C1	TH	S	P W	II VI	F	70 60		- cobbles from 10 cm to 15 cm	485

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		12:25											70		**CHICO FORMATION (Kc): See above** CONGLOMERATE; matrix supported, fine to coarse gravel and cobbles (60-80%) to 5 cm, clasts are rounded and sheared, composed of plutonics, quartzite, slate and basalt, matrix consists of medium dark gray, fine- to coarse-grained sand and silt that is poorly cemented and very friable, massive	
490	R102	12:45	97	67	0.6	J	B1	MM	SR	S	VI	F	60 50			490
495	R103	13:00 13:23	74	55	0.6	J	C1	TH	SR	S	II	F			- dark greenish gray clay-lined shear CLAYEY SILTSTONE; olive black, elastic silt and plastic clay, well cemented, massive, scattered irregular joints	495
500	R104	13:42 14:13	83	59	0.8	J B	A	TH VT	S	P	VI	F	70 58 58		50-60% clasts up to 2 cm - 2 mm wide gray clay-lined joint - 8 cm thick fine-grained sandstone layer - 0.3 m thick fine-grained sandstone layer	500
	R105	14:29 14:48	100	38	5	J	A	VT L	R	W D S	V	F			- 0.3 m thick dark gray gravelly siltstone layer - 0.3 m wide extremely closely sheared zone with sheared slate cobble to 8 cm, calcite-lined joints	
505	R106	15:00 15:30	100	33	1	J	A	TH	SR	P	II	F	50		70% clasts up to 2 cm - 15 cm thick sandstone layer	505
510	R107	15:40 15:55	91	79	2	J B	B1	TH	SR	P	II	F	65 30		50-60% clasts up to 1 cm - 15 cm thick irregular olive black siltstone layer - 15 cm plutonic clast	510
515	R108	16:16 16:35	100	55	1.1	J	A	TH	SR	P S	II	F	25 85		60-70% clasts - 1 mm wide clay-lined joint	515
520	R109	16:51 07:10 10/29	66	29	1.5	J	B1	TH	SR	P S	II	F			- 15 cm thick sandstone layer	520

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LOG OF BORING SM-5

Client: PB/DMJM

Project: Metro Red Line-Segment 3

Project No.: 92-2050

Location: N4154583/E4181052

Boring No.: SM-5

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		07:23													**CHICO FORMATION (Kc): CONGLOMERATE;** matrix supported, fine to coarse gravel (60-70%), trace cobbles, clasts are rounded, sheared and warped, composed of plutonics, quartsite, basalt and slate, matrix consists of medium dark gray fine- to coarse-grained sand	
	R110	07:44 07:55	100	56	0.2	J S	A	TH	SR	P	II VIII	F	70			
525	R111	08:07 08:14	83	50	2	J	B1	VT	S	P	II	F			- 2 cm wide olive gray clay-lined shear - 15 cm wide conglomeratic sandstone layer	525
530	R112	08:34 08:52			2.2	J	C1	VT	S SR	P S	II	F			50% clasts up to 8 cm	530
535	R113	09:14 11/3 09:34	88	12	1.4	J	C1	TH	S	P	VI	F	35 60		- 20 cm thick sandstone layer - 3 mm wide clay-lined joints 50% clasts up to 5 cm	535
	R114	10:22	89	89	0	-	-	MM	-	-	-	F			- 30-40% clasts up to 1 cm	
540	R115	10:27 10:54 11:18	95	72	0.8	J	A	TH	S	P	III	F	56 60		70-90% clasts up to 5 cm, clast supported - 1 mm wide clay-lined joint	540
545	R116	11:40 11:54	97	52	1	J	B1	TH	SR	P W	VI	F	50		- contorted bedding matrix supported, greenish gray silt BRECCIA; matrix supported, gravel up to 5 cm, clasts are angular and sheared, matrix consists of reddish brown clay and coarse-grained sand	545
550	R117	15:44 16:10	89	11	0	S	-	-	-	W	-	F	40		CONGLOMERATE; matrix supported, cobbles with interstitial gravel (80%), clasts are rounded, sheared and warped, matrix consists of silt and clay, very closely sheared	550
	R118	11:30 11/4 11:38	100	95	0	S	-	-	-	W	-	F	50		GRAVELLY GOUGE; grayish red, high plastic clay with silt, some coarse-grained sand and gravel, clasts are rounded, sheared and warped, very closely spaced chaotic and undulatory shears	
555	R119	12:04	77	65	0	S	-	-	-	W	-	F				555

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LOG OF BORING SM-5

Client: PB/DMJM	Project: Metro Red Line-Segment 3
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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Lithic Description	Packer Test Interval
													48 70	**CHICO FORMATION (Kc): GRAVELLY GOUGE;** grayish red, high plastic clay with 30% gravel-sized, sheared and shattered plutonic clasts to 5 cm, completely sheared	
		12:16													
	R120	15:47 11/10	97	65	1	J F	A	MM	SR R	S	V	F MW	50	CLAYSTONE; dark greenish gray, very fine grained, well cemented, closely spaced 2 mm wide calcite-lined joints	
560														**GRANODIORITE (gd):** light gray and pale green, medium grained, quartz, feldspar, and biotite with local chlorite alteration, trace pyrite, massive with local gneissic foliation	560
		16:41											70		
	R121	10:40	80	53	1.2	J F	B1	TH	SR	W D S	V	MW	80 85	- 5 mm wide wavy calcite-lined joint - irregular and discontinuous calcite-lined and iron stained joints	
565															565
		11:17													
	R122	14:11	100	0	10	J	C1	VT	SR	S	VI V	MW		completely altered, generally greenish gray adjacent joints, scattered calcite-lined joints	
570															570
		14:36												- 3 mm wide chlorite(?)-lined joint	
	R123	15:17	98	42	1.4	J	C1	TH	SR	S W	VII	MW		- 15 mm wide chlorite(?)-lined joint	
575														- 22 mm wide wavy altered zone adjacent 1 mm wide calcite -lined joint	575
		15:35													
	R124	16:10	92	0	5	J	A	VT L	SR	S W	VII VIII	HW		very closely spaced clay-lined joints up to 20 mm wide, joints locally surrounded by alteration	
580															580
		16:30												- 5 mm wide calcite-lined joint	
	R125	16:52	100	15	5	J	E	VT L	SR	S W	VII VIII	HW		joints infilled with clay and calcite, completely friable	
585															585
		17:05													
	R126	07:40 11/12	100	25	3	J	C1	VT	SR	S P	VII VIII	HW		moderately friable and blocky, joints primarily lined with calcite and clay - 7 mm wide calcite-lined joint	
590															590

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
		07:54											70		**GRANODIORITE (gd):** white and pale green, medium grained, quartz, feldspar, and chlorite/biotite, trace pyrite, massive with localized gneissic foliation, closely spaced clay- and calcite-lined joints; rough joint @ 591' with steps up to 3 mm high	
595	R127	08:21	94	22	3	J	D1	VT	SR	S P	VII	MW	68 55		generally pale green with scattered white to light gray quartz and feldspar grains	595
600	R128	08:35 09:22	100	67	1.2	J	A	TH	S	P	VI V	SW	30 45 66		- 3 mm wide clay-lined joint with 7 mm wide chlorite zone adjacent, scattered 1 mm wide, tightly healed chlorite-lined chaotic joints dusky yellowish green and white	600
605	R129	09:40 10:05	100	77	2	J	B1	TH	SR S	P	V	SW	60 80 60		1.5 m thick zone with 60 degree dipping joints fine grained	605
610	R130	10:20 10:47	100	89	30	J	E	VT	S	P W	VII	SW	55 48 28		medium grained, greenish gray and white - localized gneissic foliation - 5 mm wide calcite-lined and open joint	610
615	R131	11:00 13:14	100	100	5	J	E	VT	S	P	VII	FW	60 40 70		- set of 5, 5 mm wide calcite-lined joints - set of 2, 7 mm wide calcite-lined joints - 10 mm wide calcite-lined joint offset 5 mm by 6 mm wide chlorite- and calcite-lined joint	615
620	R132	13:23 13:58	100	52	4	J	D1	VT	S SR	P W	VII	FW	78 48 80		- 5 mm wide calcite-lined joint very closely spaced calcite- and chlorite-lined joints, some locally tightly healed	620
625	R133	14:11 14:40	100	71	3	J	D1	VT	SR R	P S	VII	FW	85		- 2-10 mm wide calcite-lined joint - 12 mm wide calcite-lined joint - 0.3 m wide extremely closely spaced fracture zone, joints up to 25 mm wide	625

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Client: PB/DMJM	Project: Metro Red Line-Segment 3
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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description								Sketch	Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)			
630	R134	15:02 16:00	100	76	2	J	C1	VT	SR	P	VII	FW	20 60		**GRANODIORITE (gd):** white and dark grayish green, medium grained, altered quartz, feldspar, and chlorite/biotite, trace pyrite, massive with localized gneissic foliation, closely spaced clay- and calcite-lined joints; steps up to 10 mm high along rough 3 mm wide calcite lined joint at 625'	630
635	R135	16:17 16:33	100	45	2	J	B1	VT	SR	P S	VII	FW	40 87		- 7 mm wide calcite-lined joint	635
	R136	16:45	100	100	2	J F	A	TH	SR				15		- 2 cm thick gneissic banding, irregular chaotic calcite-lined joints	
640	R137	11/18 09:23	100	32	4	J	B1	VT	S	P	V VI	FW	85		1 m thick fracture zone with 12 parallel joints up to 1 mm wide, calcite- and clay- lined, inclined from 55-62 degrees	640
645	R138	09:39 09:57	100	23	2.5	J	C1	VT	S				80 40 80		- scattered tightly healed discontinuous joints	645
650	R139	10:11 10:46	100	42	2.6	J F	D1	VT	S SR	S D P	II III	FW	25 65		- 35 mm wide white quartz vein - 1 mm wide calcite-lined joint	650
655	R140	10:59 11:19	100	7	3	J F	D1	VT	S	P D	II	FW	70 60		- (2) 5 mm wide pink calcite-lined joints surrounded by chlorite halo - localized gneissic banding	655
660	R141	11:33 14:05	100	43	2.8	J F	C1	VT	S	P D	I II	FW	30 40 65		- parts along 5.5 cm thick gneissic foliation - healed up to 2 mm wide calcite-lined joint - scattered discontinuous tightly healed discontinuous calcite-lined joints	660

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
		14:20											80		**GRANODIORITE (gd):** white and dark grayish green, medium grained, altered quartz, feldspar, and chlorite/biotite, trace pyrite, massive with localised gneissic foliation, closely spaced clay- and calcite-lined joints	
665	R142	14:40 14:55	100	69	1	J	B1	TH	S	P	II	F	45 80 35		- discontinuous quartz vein - 2.5 cm wide gneissic foliation	
670	R143	15:24 15:34	100	63	0.8	J	A	TH	S	P	I	F	55 82 50		- tightly healed chlorite-lined joint - faint-green chlorite-lined joint white and greenish black	
675	R144	16:16 16:31	100	86	0.6	J	A	MM	S	P	VII	F	45 66		moderately closely spaced, tightly healed chlorite-lined, up to 10 mm wide joints	
680	R145	16:50 17:05	100	80	0.6	J	A	MM	S	P	I VII	F	70 42		- 3 mm wide, tightly healed, calcite- and chlorite-lined joint - 8 mm wide calcite-lined joint - parts along gneissic foliation	
685	R146	07:51 11/19 08:15	100	92	1	J	B1	MM	S	P	VII	F	30 50		- 20 mm wide fracture zone, 3 mm wide calcite-lined joint with chlorite halo	
	R147	08:28 08:35	100	50	0.4	J	A	TH	S	P	VII	F	40		- 10 mm wide calcite- and chlorite-lined joint	
690	R148	09:20 09:36	100	57	1.2	J	A	TH	S R	P S	V	F	80		closely spaced, tightly healed, up to 3 mm wide calcite- and chlorite-lined joints - 10 mm wide rough calcite-lined joint with 10 mm high steps	
695	R149	09:55	100	66	0.6	J	A	MM	SR	S	V	F	50		- 20 cm wide, chaotic, tightly healed, chlorite-lined fracture zone	

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R150	10:17 10:30	100	100	0	F	-	-	-	-	-	F	45		**GRANODIORITE (gd):** white and greenish black, medium grained - gneissic foliation	
700	R151	10:40 11:03	100	76	0.8	J F	A	MM	S	P	V	F	40 60 45		- 7 mm wide translucent pale green mineral-lined joint - 2 mm wide chlorite-lined joint	700
705	R152	11:23 11:39	100	95	1	J	A	MM	S	P	V VII	F	50 15 35 70		- 2 mm wide chlorite-lined joint	705
710	R153	11:54 13:52	100	59	1	J	B1	TH	SR	P	V	F	5 45		closely spaced, locally tightly healed, up to 5 mm wide, calcite-, chlorite- and pale green mineral-lined joints - 3 mm wide open and crystalline calcite-lined joint	710
715	R154	14:01 14:25	100	89	1	J	A	TH	S	P	I V	F	55 35 40		- 10 mm wide, tightly healed, calcite-lined joint	715
720	R155	14:37 14:59	100	93	1.2	J	A	TH	S SR	P S	VII	F	40 70 30 45		- 20 mm wide, tightly healed, light green mineral-lined joint - mafic mineral-lined joint - 30 mm wide gneissic foliation - 50 mm wide, tightly healed, light green mineral-lined joint	720
725	R156	15:13 15:34	100	55	1.2	J	B1	TH	S	W P	VII	F	40		- 12 mm wide, tightly healed, light green mineral-lined joint - 30 mm wide, tightly healed, light green mineral-lined joint	725
	R157	15:53	100	100	0	-	-	-	-	-	-	F				
730	R158	11/20 08:56	100	57	2.1	J	C1	TH	SR	W S	V	F	45 35		- 0.3 m wide highly altered zone composed chiefly of feldspar, light green mineral, and chlorite	730

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
															**GRANODIORITE (gd): white and greenish black, medium grained**	
735	R159	09:05 09:25	100	48	1	S	C1	TH	SR	W P	V	F	50 40		- 15 cm wide fracture zone lined with chlorite - arcuate joints lined with serpentine	735
740	R160	09:38 10:43	100	54	2	J	B1	TH	SR	S	V	F	60 40 50		- 2 mm wide, rough and stepped, chlorite-lined joint	740
745	R161	10:57 11:20	100	46	1.6	J F	C1	TH	S	P	V	F	40 45			745
750	R162	11:30 12:08	100	56	1.4	J F	B1	TH	S SR	P S	V	F	50 20		- 15 cm wide fine-grained grayish olive green alteration zone - 15 cm wide fine-grained grayish yellow green alteration zone with coarse crystalline calcite - parts along foliation - scattered pyrite grains to 1 mm	750
755	R163	12:20 14:15	100	66	2	J	C1	TH	S	W P	V	F	48 55 78		locally tightly healed, chaotic joints lined with chlorite and light green mineral	755
760	R164	14:27 14:47	100	46	3	J	D1	VT	S	W P	V	F	20 48		- irregular quartz seam	760
765	R165	15:02 15:37	100	14	2	J	C1	TH	S	W P D	V	F	70 50		- abundant light green minerals	765

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		15:49											44		GRANODIORITE (gd): white and greenish black, medium grained, altered quartz, feldspar, and chlorite/biotite, trace pyrite, massive with localized gneissic foliation, closely spaced serpentine/chlorite- and calcite-lined joints, locally tightly healed	
770	R166	16:26 16:45	100	71	1.4	J	A	TH	SR	P S	V	F	68 65 40		- 10 mm wide, tightly healed, chlorite-lined joint crosscut by 2 mm wide irregular and wavy calcite-lined joint	770
775	R167	09:00 11/21 09:15	100	69	1.8	J	B1	TH	S	P	I V	F	58 70		- chlorite alteration at contact BASALT DIKE; medium dark gray, aphanitic, moderately closely spaced chlorite-lined joints, vesicles filled with chlorite and white zeolite	775
	R168	09:33 09:37	100	0	3	J	B	VT	S	P	II	MW	60		- granodiorite inclusion to 0.3 m	
780	R169	10:00 10:06	100	38	>5	J	D1	VT	R	S D	II V	MW	30		- granodiorite inclusion to 13 cm - fractures are locally tightly healed - granodiorite inclusion to 8 cm	780
785	R170	10:44 10:57	100	40	1.3	J	C1	TH	SR	P S D W	V	SW	40 70 55		- granodiorite inclusion to 10 cm GRANODIORITE: white and grayish green, medium grained, altered quartz, feldspar, and chlorite/biotite, trace pyrite, massive with localized gneissic foliation, closely spaced chlorite- and calcite-lined joints, locally tightly healed, and up to 6 mm wide	785
790	R171	11:37 11:50	100	52	2	J	B1	TH	S SR	P S D W	V VII	F FW	50 9		- 13 mm wide, tightly healed, chlorite-lined joint closely spaced, irregular and discontinuous light brown calcite-lined joints up to 1 cm wide	790
795	R172	12:08 12:22	100	50	2	J	C1	TH	S	P S	V	F	20 60 14		- 3 mm wide discontinuous calcite-lined joint white and greenish black	795
	R173	12:54 13:00	100	54	1.2	J	B	TH	S	P	VII	F	32			
800	R174	13:20	100	43	2.1	J	D1	TH	S	P	V	F	50 20		- 12 mm wide mafic minerals and chlorite-lined fracture set	800

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		13:34											65		**GRANODIORITE (gd)**; white and greenish black, medium grained, altered quartz, feldspar, and chlorite/biotite, trace pyrite, massive with localized gneissic foliation, closely spaced chlorite- and calcite-lined joints, locally tightly healed, up to 6 mm wide	
805	R175	13:50 14:05	100	41	2.4	J	C1	TH	SR	P S	I V	F	30 51		- gneissic foliation to 5 cm	805
810	R176	15:40 15:55	100	38	2.9	J	A	TH	S	P W	V VII	F	60 45 60		- chlorite-lined joint to 15 mm white, light gray and greenish gray	810
815	R177	16:10 16:30	100	40	1.8	J	A	TH	SR	P D	V	F	40 65 55		- 3 mm wide calcite-lined and open joint	815
820	R178	08:44 11/23 09:00	100	38	2.3	J	E	TH	S	P	V VII	F	60 72 40		- 20 mm wide, calcite- and chlorite-lined joint	820
825	R179	09:28 09:45	98	45	2 5 0	F J	B1	TH VT L	S SR	P S W	V VIII	F	48 30 70		- gneissic foliation extremely closely spaced clay/chlorite- and calcite-lined fracture zone	825
830	R180	10:10 10:30	100	71	1.4	J	B1	TH	S	P W	VII	F	50 20		close to very closely spaced, up to 7 mm wide, tightly healed, calcite- and chlorite-lined joints - 0.4 m wide fracture zone, low angle joint set up to 2 mm wide, lined with calcite and chlorite	830
835	R181	12:42 13:00	100	58	3	J	B1	TH	S SR	P S	V	F				835

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R182	09:07 09:21	100	87	1.4	J	A	TH	S	P	VII	F	30 45		**GRANODIORITE (gd):** white and greenish black, medium grained	
840	R183	11:42 11:58	100	83	1.2	J F	B1	MM	SR	P S W	VII I	F	15 55 40		- >1 mm wide wavy joint with chlorite below - 12 cm wide, tightly healed, chlorite-lined fracture zone	840
845	R184	12:11 12:33	100	98	0.4	J	C1	MM	SR	S W	I VII	F	15 40		- 2 mm wide, tightly healed, chlorite-lined joint - 20 mm wide, tightly healed, chlorite-lined joint - scattered, tightly healed, up to 4 mm wide chlorite- and calcite-lined microfaults	845
850	R185	13:00 13:18	100	95	1.4	J	C1	TH	SR	S P W	VII	F	70 50 13		- 3-5 mm wide, chlorite-lined rough joint, steps up to 2 mm high	850
855	R186	13:35 13:51	100	97	1	J	B1	MM	SR	S P	V VII	F	30 60		- 5 mm wide, chlorite-lined joint - 10 mm wide, tightly healed, chlorite-lined joint	855
860	R187	14:15 14:31	100	66	2.1	J S	D1	TH	S SK	W P	VII	F	40 60 80 23		- scattered up to 12 mm wide, tightly healed, chlorite-lined joints - 10 cm wide, chlorite-lined shear zone	860
865	R188	14:52 15:06	100	86	2.1	J	C1	TH	S	W D O	VII	F	40 75		- 3 mm wide, tightly healed, chlorite-lined joint - 15 mm wide, chlorite-lined joint crosscut by tightly healed calcite-lined joint - 3 mm wide open joint	865
870	R189	15:29	100	83	1.6	J	B1	TH	S	P	VII	F	30 45		- 25 mm wide, tightly healed, chlorite-lined joint black with very light gray and white	870

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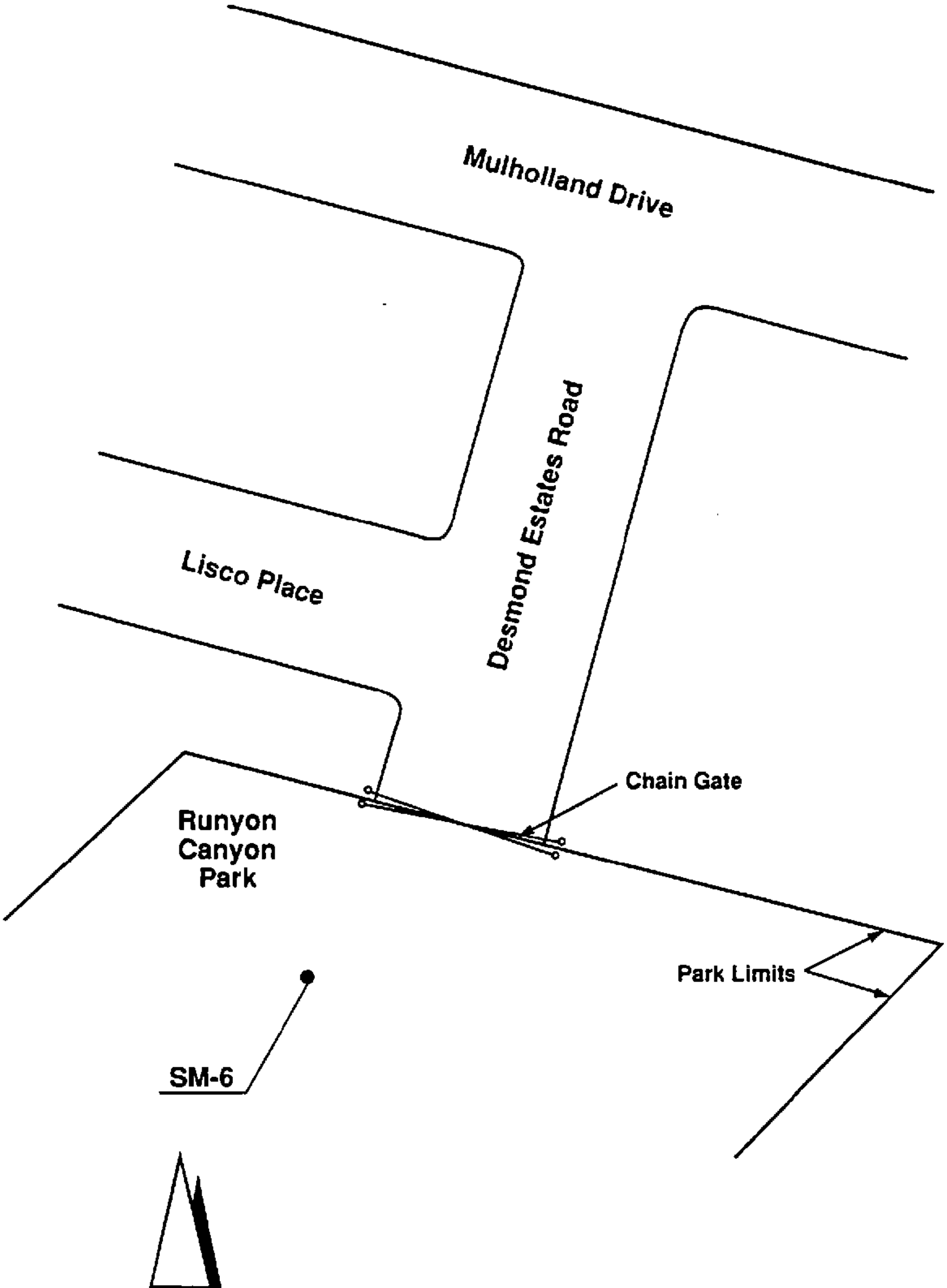
Project No.: 92-2050	Location: N4154583/E4181052
Boring No.: SM-5	Page No.: 26 of 26

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
		15:40											20		GRANODIORITE (gd): black with very light gray and white, medium grained, altered quartz, feldspar, and chlorite/biotite, trace pyrite, massive with localised gneissic foliation, closely spaced chlorite- and calcite-lined joints	
875	R190	07:44 12/2 08:00	100	86	2.7	J	C1	VT	S	P W	VII V	F	20 30 15		- 10 mm wide, chlorite-lined joint	875
880	R191	08:27 08:40	100	76	>5	J S	D1	TH VT	S	P W D	V VII	F	40 50 60		white, light gray and black, scattered tightly healed , closely spaced, up to 3 mm wide microfaults	880
885	R192	08:59 09:16	100	91	1.2	J	B1	TH	S	P	V	F	30 35 70		very closely spaced fracture zone lined with tightly healed chlorite-lined joints and shears - 22 mm wide very pale orange calcite-lined joint	885
890	R193	09:36 09:55	100	92	1.5	J F	A	TH	S	P	V	F	65 35 25		irregular, up to 5 mm wide white calcite-lined joints	890
895 900 905															Boring terminated at 890 feet on 12-3-92.	895 900 905



The Earth Technology Corporation

Project No.: 92-2050
Geotechnical Investigation
Santa Monica Mountains
Segment 3, Metro Red Line

Location of Boring
SM-6

Figure A-10

LOG OF BORING SM-6

Client: PB/DMJM	Project: Metro Red Line-Segment 3	Project No.: 92-2050
Location: N4155041/E4180771	Surface Elevation (ft): 1180	Boring No.: SM-6
Inclination (Deg.): 90	Bearing: NA Depth (ft): 830.0	Depth to Water Table (ft): 75
Started: 9/10/92 Finished: 10/7/92	Core Dia. (in.): 2.4	No. of Core Boxes: 56
Driller: PC Exploration, Inc.	Drilling Method: Rotary Mud Fluids: Bentonite/Clear mud	Drilling Equipment: Longyear 38
Logged By: M. Curtis	Checked By: G. Miller	Page No.: 1 of 24

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
0 5	R1	16:36 9/10 16:42	0	0	-	-	-	-	-	-	-	-			**ARTIFICIAL FILL (af):** GRAVELLY SILT; pale yellowish brown, fine- to coarse-grained, low elastic silt with gravel and fine- to coarse-grained sand [using diamond impregnated bit]	0 5
	R2	16:45 16:59	0	0	-	-	-	-	-	-	-	-				
10	R3	17:06 17:15	8	0	-	-	-	-	-	-	-	-			**CHICO FORMATION (Kc):** CONGLOMERATE; dark yellowish orange matrix, coarse grained, well rounded gravel and small cobbles with fine-grained sand and clay, noncalcareous cement, massive, clasts composed of granitics and quartzite, matrix supported	10
15	R4	17:24 17:32	50	0	-	-	-	-	-	-	-	-				15
20	R5	17:40 17:49	97	37	1.2	J	C1	MM	SR	P	VI	CW	35		- 0.25 m thick sandstone layer	20
25	R6	7:43 9/11 7:58	0	0	-	-	-	-	-	-	-	-				25
30	R7	8:46	83	10	0.6	J	B1	MM	SR	P	II	CW	20			30

LOG OF BORING SM-6

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4155041/E4180771
Boring No.: SM-6	Page No.: 2 of 24

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Lithic Description	Packer Test Interval
30		8:52												**CHICO FORMATION (Kc): CONGLOMERATE;** dark yellowish orange matrix, coarse grained, rounded to subrounded gravel and small cobbles with fine- to coarse-grained sand, trace silt and clay, noncalcareous cement, massive, clasts composed of granitics, and quartsite and metamorphics, matrix supported	30
35	R8	9:00 9:18	87	27	3.0	J B	A	TH MM	SR	P	III	CW	90	- thin vertical bedding within conglomeratic sandstone layer	35
														[driller over-reamed borehole while setting surface casing, no core between 37.5-38.5']	
40	R9	13:00 13:11	88	30	0.1	J	A	MM	S	P	III	CW HW	65	medium dark gray matrix - gravel-sised clasts are fractured, infilled with clay?	40
45	R10	13:20 13:35	86	23	-	B	-	M T	-	-	-	HW		mottled medium dark gray and dark yellowish orange matrix trace cobbles up to 0.3 m in diameter	45
50	R11	13:40 13:49	100	61	0.6	J B	B1	MM TH	SR	P	VI	HW MW	35 55	gravels imbricated along bedding	50
55	R12	14:00 14:11	100	0	0.2	S	A	T	SR	S	V	MW	90	schist and granitic clasts cobbles show sheared stress fractures extending through multiple clasts	55
60	R13	14:24 14:34	100	40	0.8	J	A	TH	SP	P D	III	MW		**CONGLOMERATIC SANDSTONE;** mottled dark yellowish orange and medium light gray, fine- to coarse-grained arkosic sand with fine gravel, poorly (silica) cemented, massive	60
65	R14	14:43	100	39	0.2	J	C1	MM VT	SR	P S	II	MW	30		65

The Earth Technology Corporation

LOG OF BORING SM-6

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4155041/E4180771
Boring No.: SM-6	Page No.: 3 of 24

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
		14:50											40 70		**CHICO FORMATION (Kc):** CONGLOMERATIC SANDSTONE; mottled dark yellowish orange and medium light gray, fine- to coarse-grained arkosic sand with fine gravel, poorly (silica(?) cemented, massive, very closely spaced fractures from 66-67.5'	
70	R15	15:06 15:15	90	22	0.2	J	A	MM	SR	P	II	MW	60		CONGLOMERATE; medium gray matrix, cobbles with gravel, some fine-grained sand and silt, noncalcareous cement, massive, clasts composed of granitics and quartzite clasts are sheared and friable, matrix supported	70
75	R16	15:29 15:35	100	30	0.4	J	A	MM	SR	P	II	SW	50		CONGLOMERATIC SANDSTONE; medium light gray, fine- to medium-grained sand with fine gravel and silt, poorly (silica(?) cemented, massive	75
80	R17	15:48 15:58	100	52	2.0	J	C1	TH	SR S	P S	II V	SW	50 60		- 3 mm wide healed fracture trace cobbles up to .3 m in diameter	80
85	R18	16:07 16:16	95	35	1.0	J	B1	TH	SR	P	II	FW	50 70 50			85
90	R19	16:48 17:00	53	10	1.0	J	A	M	SR	S	V	FW	65		- 0.4 m thick conglomerate layer	90
95	R20	17:08 17:20	52	0	0.2	B	A	M	SR	P	I	FW	60		- 3 mm wide clay layer parallel to locally thin bedding	95
100	R21	10:37 9/12	82	29	0.6	J	A	MM	R SR	S W	II	F	80 38		CONGLOMERATE; medium light gray matrix, cobbles with gravel	100

LOG OF BORING SM-6

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4155041/E4180771
Boring No.: SM-6	Page No.: 4 of 24

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		10:50													**CHICO FORMATION (Kc): CONGLOMERATE;** medium light gray matrix, cobbles witb gravel, some fine-grained sand and silt, noncalcareous cement, massive, rounded clasts up to .5 m in diameter, composed of granites, quartzite, and mafic plutonics, matrix supported	
105	R22	10:56 11:10	90	16	0.7	J	A	TH	SR	S P	II	F	70 60 48			105
110	R23	11:20 11:28	87	0	2.0	J	B1	TH VT	S SR	P W	II	F	30 80		predominantly gravel with coarse- to fine-grained sand, trace cobbles, well (silica) cemented poorly cemented, highly friable, very fine-grained sand and silt matrix	110
115	R24	11:43 11:54	95	47	0.2	J	B1	M	SR	P	II	F	80		- 0.5 m diameter granitic cobble with stepped stress fractures throughout predominantly cobbles, some gravel within a very fine-grained sand and silt matrix	115
120	R25	12:01 12:12	63	0	0.2	J	A	MM	SR	P	II	F	35			120
125	R26	12:20 12:37	73	12	1.0	J	C	TH	SR	S P	II V	F	40			125
130	R27	12:40 12:52	73	25	0.8	J B	B1	TH L	R	S P	II	F	80 70 40		ARKOSIC SANDSTONE; medium light gray, fine- to medium-grained sand with silt, poor silica cement, laminated bedding	130
135	R28	12:58	40	0	-	J	-	-	-	-	-	F	70			135

LOG OF BORING SM-6

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4155041/E4180771
Boring No.: SM-6	Page No.: 5 of 24

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		13:10													**CHICO FORMATION (Kc):** CONGLOMERATE; medium light gray matrix, gravel and small cobbles with fine- to medium-grained sand, trace silt, poorly cemented, completely friable, massive, moderately closely spaced joints, clasts composed of granitics and quartzite, clast supported, matrix supported at 138'	
140	R29	13:14 13:23	77	8	0.6	J	A	TH	SR R	S	II	F			- 3 mm wide black clay-lined feature	40
145	R30	13:25 13:34	60	0	1.5	J	B1	TH	SR	S	II	F	45 80		- 15 cm thick fine- to medium-grained sandstone layer	45
150	R31	13:49 13:56	82	8	0.8	J	A	MM	SR	P	II	F	45			50
155	R32	14:05 14:15	98	31	1.0	J	A	TH	S	P	II	F	30		subrounded to subangular clasts - 0.4 m thick arkosic sandstone layer	55
	R33	14:20	100	44	3.0	J	B1	TH	S	P	II	F	24			
160	R34	8:42 9/14 8:50	100	62	0.6	J	B1	MM	SR	P S	II	F	60 70		CONGLOMERATIC SANDSTONE; medium light gray, fine- to medium-grained sand with rounded cobbles up to 20 cm in diameter, some gravel, trace silt, weak silica cement, massive, moderately closely spaced joints	60
165	R35	9:02 9:15	100	32	2.0	J	C1	TH	SR S	S P	II	F	72		CONGLOMERATE; medium light gray matrix, gravel and small cobbles with fine- to medium-grained sand, trace silt, noncalcareous cement, massive, rounded clasts composed of granitic quartzite, and basalt, closely space joints, clast supported	65
170	R36	9:18	40	17	3.0	J S	B	TH	SR SK	P	VI	F			zone of very closely spaced fractures	170

LOG OF BORING SM-6

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4155041/E4180771
Boring No.: SM-6	Page No.: 6 of 24

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		9:29											75		CHICO FORMATION (Kc):CONGLOMERATE; matrix medium light gray, coarse grained, gravel and small cobbles with fine- to medium-grained sand, trace silt, noncalcareous cement, massive, subrounded clasts composed of granitics and mafic plutonics, very closely spaced clay-lined shears, clast supported	
175	R37	9:35 9:45	37	0	5.0	J S	A	VT	SR	-	VI VIII	F			- 5 mm wide dark greenish gray clay-lined irregular shear	175
180	R38	9:55 10:06	90	65	1.6	J	B1	TH	S	P S	II	F	40 40 55		40 cm wide, gray, fine- to medium-grained sandstone layer with very closely spaced clay-lined joints - 10 cm wide fracture zone	180
185	R39	10:12 10:23	100	35	2.2	J	C1	TH	S SR	P	II	F	40 25 55 70		matrix supported	185
190	R40	10:32 10:45	93	0	3.0	J	C1	TH	SR	P D	V VI	F			CONGLOMERATIC SANDSTONE; medium light gray, fine- to medium-grained sand with rounded gravel and silt, poorly (silica) cemented, massive, closely spaced joints lined with white calcite ARKOSIC SANDSTONE; medium gray, fine- to medium-grained sand with silt, trace gravel, poorly (silica) cemented, massive, very closely spaced random joints	190
195	R41	10:51 11:05	92	0	3.0	J	C1	VT	SR	S D	II	F	80 60 70 70			195
200	R42	12:00 12:09	98	37	4.0	J	C1	VT	SR	S D	II V	F			- 2 large (1 cm and 2 cm) calcite deposits along joints	200
205	R43	12:21	60	0	3.4	J	C1	TH	SR	S D	II	F			- 5 mm wide clay-lined shear	205

The Earth Technology Corporation

LOG OF BORING SM-6

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4155041/E4180771
Boring No.: SM-6	Page No.: 7 of 24

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
		12:40											70 75 70		**CHICO FORMATION (Kc): ARKOSIC** SANDSTONE; medium gray, fine- to medium-grained sand with silt, trace gravel, poorly (silica) cemented, massive, very closely spaced random calcite-lined joints	
210	R44	13:02 13:18	88	38	0.6	J	B1	TH	S	P	II V	F	40 40 30		CONGLOMERATE; medium gray, fine-grained sand and dark gray silt matrix, gravel with cobbles, noncalcareous cement, massive, rounded clasts composed of granodiorite, plagioclase-rich and mafic-rich plutonics, and quartzite, clast supported	210
215	R45	15:00 15:12	97	50	1.2	J B	B1	TH MM	SR	P S	II	F	25 70 60 60 40		- 5 cm wide slickensided, grooved and sheared silt interval	215
220	R46	15:23 15:36	97	48	0.6	J B	A	MM L	SR	S	II	F	62 40		- 10 mm thick clayey sandstone layer ARKOSIC SANDSTONE; medium light gray, fine- to medium-grained sand with silt, poorly (silica) cemented, laminated bedding from 221', massive below, moderately closely spaced joints	220
225	R47	15:41 15:59	100	42	1.4	J	A	MM	SR	S P	II	F	50 65 70 25		CONGLOMERATE; medium gray matrix, gravel and small cobbles with fine-grained sand and silt, noncalcareous cement, massive, rounded clasts composed of granitics and quartzite, clast supported	225
230	R48	16:03 16:16	100	30	1.6	J	C1	TH	SR	S P	II	F	60 60 28		- 20 cm thick sandstone layer, very closely jointed	230
235	R49	16:20 16:35	95	53	0.4	J	A	TH	S	P	II VIII	F	40 60 70		- 0.4 m wide granite boulder - 2.5 cm wide clay-lined joint	235
240	R50	16:44	100	33	2.0	J	B1	TH	S SR	P W	II	F	40		ARKOSIC SANDSTONE; medium light gray, fine- to medium-grained sand with silt, poorly (silica) cemented, massive, closely spaced joints	240

LOG OF BORING SM-6

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4155041/E4180771
Boring No.: SM-6	Page No.: 8 of 24

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		16:55											35 58		see above CONGLOMERATE; medium gray matrix, coarse grained, well grounded gravel and small cobbles with fine-grained sand and silt, noncalcareous cement, massive	
245	R51	17:00 17:14	100	62	>10	J	D1	VT	SR R	D W	V VII	F	40 40		CONGLOMERATIC SANDSTONE; medium light gray, fine- to medium-grained sand with gravel, trace silt, poorly (silica) cemented, massive, very close to extremely closely spaced calcite-lined joints up to 6 mm in width	245
	R52	17:20	100	100	3.0	J	A	VT	SR	D W	V	F			- 0.4 m thick sandstone layer	
250	R53	17:28 17:55	75	31	2.0	J	B1	VT	SR R	D W	II V	F	40 60 60- 70			250
255	R54	18:00 18:10	100	71	1.3	J	B1	VT	R	W D	II	F	30 40 35 30			255
	R55	9:24 9/15 9:31	100	0	2.0	J	B1	VT	SR	W P	II	F	30 20 40			
260	R56	10:02 10:20	100	77	>10	J	D1	L	R	W D	II	F			CONGLOMERATE; medium light gray matrix, cobbles with gravel, some fine-grained sand and silt, noncalcareous cement, massive, rounded clasts composed of granitics and quartzite, very close to extremely closely spaced, irregular and chaotic, >1 mm wide, calcite-lined stress fractures visible within clasts, faintly visible within matrix, clast supported; 20 cm wide granite cobble @ 264'	260
265	R57	10:48 11:00	87	17	-	B	-	M	-	-	-	F			jointing within clasts very faint	265
270	R58	11:18 11:37	88	48	0.4	J	A	TH	SR	P	II	F	70 20			270
275	R59	11:45	100	8	1.6	J	B1	TH	SR	P	II	F				275

LOG OF BORING SM-6

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4155041/E4180771
Boring No.: SM-6	Page No.: 9 of 24

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
		12:10											50 45		**CHICO FORMATION (Kc):** CONGLOMERATE; medium light gray matrix, cobbles and gravels with fine-grained sand and silt, silica and poorly (calcareous) cemented, massive with localized clast imbrication, clasts composed of granodiorite and quartzite, scattered very closely spaced zones of >1 mm wide calcite-lined joints; localized soft sediment deformation within sandy siltstone layer @ 279'	
280	R60	13:48 13:56	100	52	1.0	J	A	TH	SR R	P S	II	F	50 55 40			280
285	R61	14:20 14:40	98	70	1.0	J	B1	MM	SR	P	II V	F	75 35 50 60			285
	R62	15:01 15:10	100	22	0.5	J	A	TH	SR	P W	II	F	60		grades to matrix supported, 60-70% clasts	
290	R63	11:51 9/22 12:00	98	26	1.1	J	A	MM	SR S	P W	II	F	40 40		- rare quartz monzonite gravel-sized clasts	290
295	R64	12:11 12:19	91	44	1.6	J	C1	TH	S	P	II V	F	60 60 45 40		clast sizes up to 8 cm in diameter clast sizes up to 3 cm in diameter	295
300	R65	12:27 12:43	63	16	2.1	J	A	TH	SR	P W	VI	F	65-70		clast sizes up to 8 cm in diameter - 1 mm wide dark gray clay-lined undulatory joint	300
305	R66	13:50 14:04	100	50	1.2	J	B1	TH	S SK	P	II V	F	45 50 30		clasts composed of red fine-grained sandstone, olive gray slate and granodiorite; localized soft sediment deformation within sandy silt matrix 0.7 m thick, light gray, fine- to coarse-grained sandstone layer - 4 cm thick zone of soft sediment deformation	305
310	R67	14:35	93	47	1.0	J	C1	TH	S	P	VI V	F	20 40		CONGLOMERATIC SANDSTONE; medium light gray, fine- to medium-grained sand with cobbles and small boulders up to 0.4	310

LOG OF BORING SM-6

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4155041/E4180771
Boring No.: SM-6	Page No.: 10 of 24

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		14:47											40		m in diameter, some gravel and silt **CHICO FORMATION (Kc):** CONGLOMERATIC SANDSTONE; medium light gray, fine- to medium-grained sand with cobbles and small boulders up to 0.4 m in diameter, some gravel and silt, poorly (silica and carbonate) cemented, massive with loaclised laminated siltstone interbeds, rounded clasts composed of quartz monzonite, granodiorite, and quartzite	
315	R68	14:57 15:12	100	40	0.6	J	A	MM	SR R	W	II	F				315
320	R69	15:18 15:35	100	95	-	B	A	MM L	-	-	-	F	70 65		clast sizes up to 4 cm in diameter, scattered slate clasts - .5 m thick sandstone layer - interbedded siltstone laminae	320
325	R70	15:40 15:53	100	77	-	B	A	M	-	-	-	F			- 2 quartz monzonite cobbles up to 15 cm in diameter	325
330	R71	16:06 16:11	88	38	0.6	J	A	MM	SR	P	II VI	F	50 45		[driller noted that subsurface conditions got "sticky." Core blocked off twice during run]	330
335	R72	16:20 16:32	100	42	0.6	J	A	MM	S	P	II	F	30 70 60		- 0.5 m thick sandstone layer, trace gravel 40-50% gravel and cobble clasts	335
340	R73	7:33 9/23 7:47	100	55	0.4	J	A	MM	SR	P	II	F	35 60		- 25 cm thick coarse-grained sandstone layer CONGLOMERATE; medium gray matrix, gravel and cobbles with coarse- to fine-grained sand, trace silt, poorly (silica) cemented, massive, rounded clasts composed of granodiorite, quartz monzonite, quartzite, and slate, massive, matrix supported; 8 cm wide sheared slate clast at 341'	340
345	R74	8:01	100	73	-	B	A	M	-	-	-	F			- irregular siltstone layer up to 15 cm thick	345

LOG OF BORING SM-6

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4155041/E4180771
Boring No.: SM-6	Page No.: 11 of 24

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		8:15													**CHICO FORMATION (Kc): CONGLOMERATE;** medium gray matrix, coarse grained, gravel and cobbles with coarse- to fine-grained sand, trace silt, silica and poorly (calcareous) cemented, massive, rounded clasts composed of granodiorite, quartz monzonite, quartzite, and slate, massive, matrix supported	
350	R75	8:30 9/23 8:40	100	95	0.2	B J	A	M	S	P	V	F	60		- 3 mm thick siltstone layer with imbricated gravel below parallel to bedding	350
355	R76	8:55 9:10	100	95	>10.0	J	C1	TH	R	W D	I	F			very closely spaced irregular and chaaotic joints up to 1.5 mm wide lined with calcite - 25 cm diameter cobble	355
360	R77	9:33 9:40	100	89	>5.0	J	A	VT	R	W D	I	F			40-50% gravel- and cobble-sized clasts	360
	R78	10:27 10:39	100	88	2.0	J	B	VT	S	P	III	F			increase in slate clasts	
365	R79	10:56 11:13	97	65	1.0	J	B1	TH	S	P	II	F	70 60 50		50-60% gravel- and cobble-sized clasts	365
370	R80	13:01 13:16	100	47	0.4	J	A	MM	SR	P W	II	F	45		60-70% gravel- and cobble-sized clasts	370
375	R81	13:30 13:40 14:00 14:06	100	94	0.6	J B	B1	TH	SR	P	II	F	80 60			375
380	R82	14:22	100	92	0.4	J	B1	TH	SR	P	II V	F	70 20		50-60% gravel- and cobble-sized clasts	380

LOG OF BORING SM-6

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4155041/E4180771
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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		14:40													CHICO FORMATION (Kc): CONGLOMERATE; medium gray matrix, gravel and cobbles with coarse- to fine-grained sand, trace silt, poorly (silica) cemented, weakly friable, massive, rounded clasts composed of granodiorite, quartzite, slate and rare quartz monzonite, massive, matrix supported	
385	R83	14:59 15:04 15:15 15:21	100	97	0.2	J	A	MM	S	P	VI	F	50		SANDSTONE; medium light gray, fine- to medium-grained sand with coarse-grained sand-sized clasts of slate, poorly (silica) cemented, faint laminated bedding	385
390	R84	15:45 16:10	100	85	0.8	J	B1	TH	S	P	I II	F	85 40 50		CONGLOMERATIC SANDSTONE; medium gray, fine- to medium-grained sand with gravel, some cobbles, trace silt, poorly (silica) cemented, massive, subrounded clasts composed of quartzite, basalt, granodiorite and slate, closely spaced joints	390
395	R85	16:25 16:47	100	100	0	B	-	M	-	-	-	F			40% gravel-sized clasts, unfractured	395
400	R86	7:37 9/24 7:55	100	93	0.4	J B	B	TH MM L	S	P	VI	F	70 67 50 60		30-40% gravel-sized clasts up to 3 cm in size - interbedded silt laminae - parting along 1 mm thick claystone layer - localized imbricated clasts	400
405	R87	8:05 8:21	100	73	2.0	J	B1	TH	SR	P W	III V	F	80 60 70		30% gravel-sized clasts up to 5 cm in size closely spaced fractures up to 3 cm wide lined with white calcite infilling around disjointed gravel and sand grains - 8 cm vesicular basalt clast - 18 cm quartz monzonite clast with abundant stress fractures	405
410	R88	9:32 9:52	100	68	2.0	J	E	VT	SR S	P	V	F	30-25 40		gravel-sized clasts up to 2 cm in size	410
415	R89	10:03	100	77	1.2	J	D1	VT	SR S	P	II	F	50 50		20-30% subrounded gravel-sized imbricated clasts up to 1 cm in size	415

LOG OF BORING SM-6

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4155041/E4180771
Boring No.: SM-6	Page No.: 13 of 24

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
420	R90	10:25 11:01	100	98	1.2	J B	B1	TH VT	S	P	VI	F	50 45 40 35 35		**CHICO FORMATION (Kc):** CONGLOMERATIC SANDSTONE; medium light gray, fine- to coarse-grained sand with gravel and cobbles, trace silt, poorly (silica and carbonate) cemented, massive, subrounded clasts composed of quartzite, vesicular basalt, granodiorite, quartz monzonite, and slate, closely spaced joints	420
425	R91	11:21 11:35	100	74	0.8	J	A	TH	SR	P	II	F	60 80 70		20% gravel-sized clasts up to 1 cm long	425
430	R92	12:01 12:20	100	93	0.4	J	B	TH	SR	P	VI	F	30 75 60		subangular clasts up to 4 cm long within dark gray sandy silt matrix	430
435	R93	12:38 12:48	100	100	0.4	J	A	MM	SR	P	II	F	45 50		matrix composed of fine- to medium-grained sand and silt matrix composed of medium- to coarse-grained sand and silt	435
440	R94	13:02 14:45	100	100	0.2	J	A	MM	S	P	I	F	70		matrix composed of fine- to medium-grained sand and silt, localized fine crossbedding 20 cm thick cyclic stratification of fine- to medium-grained sand and gravel with medium grained sand	440
445	R95	15:05 15:15	100	83	0.8	J	B1	TH	SR	P	II	F			30-40% gravel- and cobble-sized clasts up to 8 cm in size	445
450	R96	15:38 15:51	100	40	-	J	-	-	-	-	-	F			40-50% gravel-sized clasts consisting of quartz monzonite and granodiorite	450

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Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4155041/E4180771
Boring No.: SM-6	Page No.: 14 of 24

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		16:14											30		**CHICO FORMATION (Kc):** CONGLOMERATIC SANDSTONE; medium light gray, fine- to coarse-grained sand with gravel and cobbles, trace silt, poorly (silica) cemented, weakly friable, massive, subrounded clasts composed of quartzite, vesicular basalt, granodiorite, quartz monzonite, and slate, closely spaced joints; 10 mm wide silty sand gouge zone @ 453'	
455	R97	16:30 17:00	100	57	1.2	J	C1	TH	SR	P	II	F	40 70 35			455
460	R98	7:36 9/25 8:00	100	77	0.8	J	A	TH	SR	P	II	F	60 40 50 70		40% gravel-sized imbricated clasts up to 1 cm in size fine- to medium-grained sand - localized silt laminae	460
465	R99	8:36 8:31	100	62	2.0	J	C1	TH	SR	P	II V	F	50		30% gravel-sized clasts composed chiefly of slate, basalt, and quartzite - 5 mm wide crystalline calcite-lined joint - bladed gravels show imbrication	465
470	R100	8:48 9/25 9:15	100	20	4.0	J	D1	VT	S	P	II	F	65		SANDSTONE; medium light gray, fine- to medium-grained sand, trace silt and gravel, poorly (silica) cemented, massive, extremely to very closely spaced joint set, clean and smooth, and some calcite-lined up to 2 mm wide - 10 cm quartzite cobble	470
475	R101	9:27 10:02	100	90	0.4	J	A	TH	S	P	II V	F	60 60		CONGLOMERATIC SANDSTONE; gry., fine- to coarse-grd. sand w/ gravel and cobbles CONGLOMERATE; coarse grd., gravel and small cobbles	475
480	R102	10:18 10:52	100	82	0.6	J	A	MM	S SR	P	II	F	60 35 80		SANDSTONE; fine- to med.-grained sand with silt, trace gravel - 0.3 m thick conglomerate layer	480
485	R103	11:03	100	50	1.0	J	A	TH	SR S	P	II VI III	F			CONGLOMERATIC SANDSTONE	485

LOG OF BORING SM-6

Client: PB/DMJM

Project: Metro Red Line-Segment 3

Project No.: 92-2050

Location: N4155041/E4180771

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		11:29											55 70		**CHICO FORMATION: CONGLOMERATIC SANDSTONE**; fine- to coarse-grained sand with gravel and cobbles	
490	R104	11:42 12:02	100		2.0	J F	B1	MM VT	S	P	II VIII	F	65 40 50 50		SANDSTONE; medium light gray, fine- to coarse-grained sand with silt, poorly cemented, massive, closely spaced joints - 0.3 m wide, extremely closely spaced gouge zone?	490
495	R105	13:47 14:12	100	83	5.0	J	D1	VT TH	SR S	P	VIII II I	F	50 50 70 40 30		- 0.4 m wide, extremely closely spaced gouge zone?	495
500	R106	14:30 14:51	100	69	0.2	J B	A	MM L	S	P	I	F	70 35		- 0.5 m thick conglomeratic sandstone layer - - - 2 cm wide undulatory laminated siltstone and sandy siltstone layers	500
505	R107	15:05 15:28	100	78	0	B	-	M	-	-	-	F			CONGLOMERATE; medium gray matrix, cobbles with gravel, some fine-grained sand, poorly cemented, massive, subangular clasts averaging 8 cm in size are composed of granodiorite, quartzite, slate and quartz monzonite, generally clast supported, clasts may contain inherent fractures	505
510	R108	15:49 16:11	100	40	0.8	J	A	TH	SR	P W	V	F	50 20 65 50		60-70% gravel-sized clasts	510
515	R109	16:25 17:00	100	93	0.6	J	B1	MM	S	D P	VIII V	F	60 40 40		- 4-8 mm wide light brown clay-lined, discontinuous and healed joint - 20 cm thick very fine-grained sandstone layer CONGLOMERATIC SANDSTONE; fine- to coarse-grd. sand w/ gravel and cobbles, subrounded clasts composed of qrtzite, vesicular basalt, granodiorite, qrts. monzonite, and slate	515
520	R110	17:10	100	93	0.4	J	A	MM	SR	P	II	F	60		- 0.3 m thick sandstone layer	520

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Client: PB/DMJM	Project: Metro Red Line-Segment 3
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Boring No.: SM-6	Page No.: 16 of 24

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
															CHICO FORMATION (Kc): CONGLOMERATE; medium dark gray matrix, coarse grained, gravel with cobbles and fine- to medium-grained sand, poorly cemented, massive, subangular clasts (60%) ranging from 2-10 mm in size composed of granodiorite, quartzite, slate, quartz monzonite, and basalt, matrix supported, 25 mm thick silty sandstone layer @ 524'	
525	R111	17:40 8:54 9/26	100	67	0.6	J	A	MM	SR	P	II	F	50 58			525
530	R112	9:18 9:31	100	30	1.8	J	B1 F	TH VT	SR S	P	II I	F	60 40		**CONGLOMERATIC SANDSTONE;** medium light gray, fine- to medium-grained sand with cobbles, poorly cemented, massive, rounded clasts	530
535	R113	9:59 10:08	100	82	1.0	J	C1	TH	SR	P	II	F	62 40 60 45		**CONGLOMERATE;** medium dark gray matrix, gravel with cobbles and fine- to medium-grained sand, poorly cemented, massive, subangular clasts (60%) ranging from 2-10 mm in size composed of granodiorite, quartzite, slate, quartz monzonite, and basalt, matrix supported; at 533', all joints are tightly healed; 10 cm thick sandstone layer at 536'	535
540	R114	10:43 11:00	93	93	0.2	J	A	MM	-	-	-	F	10		50% gravel-sized clasts average 1 cm in size - 0.5 m thick coarse-grained sandstone layer	540
545	R115	11:30 11:48	100	63	0.2	J	A	T	SR	P	-	F	60 62		clast supported, 75% gravel-sized clasts ranging from 1-8 cm in size are imbricated	545
550	R116	12:30 12:52	100	61	0.4	J B	B	TH VT	SR	P	II	F	38 45 60		60-70% gravel-sized clasts up to 5 cm in size prominent clast imbrication	550
555	R117	13:25 13:49	100	95	0.2	J	A	M	S	P	I	F			- tightly healed joint	555

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Client: PB/DMJM	Project: Metro Red Line-Segment 3
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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
															**CHICO FORMATION (Kc): CONGLOMERATE;** medium gray matrix, gravel and small cobbles with coarse- to fine-grained sand, poorly cemented, massive, clasts composed of granodiorite, quartzite, slate, basalt, and rare gneiss, clast supported to 559', matrix supported below	
560	R118	14:20 14:43	100	70	0.6	J	A	TH	SR	P	II	F	75 70			560
565	R119	15:10 15:28	33	8	-	J	-	-	S	P	II	F	50		- 8 cm chert clast with calcite-lined stress fractures [driller mislatched core tube and subsequently ground up 1 m of core left in the rods]	565
570	R120	15:55 10:45 9/27	100	100	0.8	J	A	MM	S	P	II	F			**SANDSTONE:** medium light gray, grades from coarse to fine-grained sand at 568.5' to medium- to fine-grained sand with gravel and silt, silica cement, massive, scattered irregular discontinuous calcite-lined tightly headed joints	570
575	R121	11:06 11:39	100	93	0.4	J B	B	TH L	SR	S	II	F	45 45 65		**CONGLOMERATE;** coarse grained gravel and small cobbles with coarse- to fine-grained sand **CONGLOMERATIC SANDSTONE;** medium light gray, very fine-grained sand with gravel, silica cement, massive, rounded clasts composed of quartzite, vesicular basalt, granodiorite, quartz monzonite, and slate	575
580	R122	12:01 12:07	100	90	1.2	J	B1	TH	S	P	II	F			- sharp contact grades from very fine- to medium-grained sand - 10 cm angular clasts	580
585	R123	12:38 8:00 9/28	100	100	1.0	J	C1	VT TH	S	P	II	F	16 60 40		**CONGLOMERATE;** medium dark gray matrix, cobbles and gravel with fine- to coarse-grained sand grading to silt, poorly cemented, massive, subrounded clasts composed of granodiorite, quartzite, slate, and basalt, some clasts exhibit stress fractures and offsets up to 10 mm, stress fractures are tightly healed, clast supported	585
590	R124	8:29 8:44	100	75	1.2	J B	C1	TH	SR	P	II	F	60 60		parts along bedding, imbricated clasts	590

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Client: PB/DMJM	Project: Metro Red Line-Segment 3
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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
		9:09													CONGLOMERATIC SANDSTONE; medium light gray, fine- to coarse-grained sand with silt, gravel, and cobbles	
595	R125	9:21 9:51	100	95	0.4	J	B	MM	SR	P	II	F	55 50 55		SANDSTONE; medium light gray, very fine-grained sand with silt, trace gravel, poorly cemented, massive, closely spaced joints	595
600	R126	10:12 10:42	100	100	1.0	J	B1	TH	SR	P S	II	F	30 60		CONGLOMERATE; medium dark gray matrix, gravel and small cobbles with fine- to medium-grained sand and silt, poorly cemented, massive, clasts composed of granodiorite, quartzite, and slate, matrix supported - 0.3 m thick sandstone layer	600
605	R127	10:54 11:34	100	50	3.0	J	D1	VT TH	S	P	III II	F	35 70 40		- 0.3 m wide extremely closely spaced, up to 1 mm wide clay-lined fracture zone within sandy siltstone layer 50-60% gravel-sized clasts averaging 3 cm in size - 0.3 m wide extremely closely spaced, up to 1 mm wide clay-lined fracture zone within sandy siltstone layer	605
610	R128	11:48 12:18	100	65	1.2	J	C1	TH	S	P	II	F	60 48 65 80		SANDSTONE; medium light gray, fine- to medium-grained sand with silt, trace gravel, poorly cemented CONGLOMERATE; medium dark gray matrix, coarse grained, gravel (70-80%) with fine- to medium-grained sand and silt, trace cobbles, poorly cemented, massive, rounded clasts composed of slate, quartzite, and granodiorite, clast supported	610
615	R129	13:50 14:20	100		1.5	J	B1	TH	SR	P	II	F	60 70 70 30			615
620	R130	8:28 9/29 9:48	100	31	2.0	J	C1	TH	SR	P D	II	F			matrix supported, 50-60% gravel- and cobble-sized clasts up to 5 cm in size showing stress fractures and imbrication	620
625	R131	9:07	100	52	1.8	J	B1	VT	SR	P D W	II	F	70 60 38 32		70-80% cobbles and gravel 8-13 cm in size	625

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Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4155041/E4180771
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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		9:40											45		**CHICO FORMATION (Kc): CONGLOMERATE;** medium dark gray matrix, coarse grained, gravel and small cobbles with fine- to coarse-grained sand, poorly cemented, massive, clasts composed of granodiorite, quartzite, and slate, matrix supported	
630	R132	9:50 -	100	11	3.0	J	B1	VT	SR	P D W	II VIII	F	80 40 60 25 40		- 0.3 m thick conglomeratic sandstone layer	630
	R133	10:35 11:03	100	30	10	J	D1	VT	SR R	P S W	II VI	F	45 60 75		70-80% gravel-sized clasts up to 3 cm in size	
635	R134	11:30 11:48	100	62	2.5	J	C1	VT	SR R	P W	II V	F	80 40		50-60% gravel-sized clasts up to 6 cm in size	635
640	R135	12:02 12:42	100	50	1.2	J	B1	TH	SR	P S	II	F	56 55 30 40		70-80% gravel-sized clasts up to 4 cm in size - 5 cm thick sandstone layer	640
645	R136	13:28 14:00	98	65	3.0	J	E1	VT TH	S SR	P S	II	F	40 50		60-70% gravel-sized clasts up to 5 cm in size, matrix composed of coarse-grained sand and silt **SANDSTONE;** medium light gray, locally grades from coarse- to fine-grained sand with silt, trace gravel, poorly cemented, massive with scattered siltstone laminae, very closely spaced, tightly healed, up to 1 mm wide calcite-lined joints	645
650	R137	14:20 14:50	100	53	0.4	J B	A	MM TH L	S	P	IV VI	F	50 30 50 50		parts along microfaulted clay laminations - 9 cm thick siltstone layer	650
655	R138	15:10 15:38	100	62	2.1	J	D1	TH	S	P	VI	F	19 56 60		medium- to coarse-grained sand - scattered gravel up to 5 cm in size - 8 cm wide extremely closely fractured zone	655
660	R139	15:55	78	18	1.5	J S	B1	TH	SR	S P	III II	F				660

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
													40		**CHICO FORMATION (Kc): SANDSTONE;** medium light gray, locally grades from coarse- to fine-grained sand with silt, trace gravel, noncalcareous cement, massive with scattered siltstone laminae, very closely spaced, tightly healed, up to 1 mm wide calcite-lined joints	
665	R140	16:20 -	93	38	1.4	S J	B1	L VT	SR	P	VIII II	F	60 80 60		- 5 cm wide clay gauge zone CONGLOMERATE; medium gray matrix, coarse grained, gravel with small cobbles, some fine- to medium-grained sand and silt, noncalcareous cement, massive, rounded and locally imbricated clasts (60-70%) composed of granitics, quartzite, slate, and basalt, clasts exhibit intense stress fracturing, matrix supported; 2 mm thick clay laminae at 668'	665
670	R141	16:59 8:56 9/30	100	67	1.0	J B	A	MM VT	S	P	II	F	60 60 42		- parts along bedding	670
675	R142	9:24 9:50	100	57	0.6	J	B1	TH	SR	P	II III	F	70 50		clasts range from 3-10 cm in size, irregular fractures and voids surrounding clasts infilled by calcite - parting along claystone laminae - 0.4m thick coarse-grained sandstone layer	675
680	R143	10:18 10:38	100	78	0.8	J	B1	TH	S	P	II	F	45 50 70 50		70-80% gravel-sized clasts up to 5 cm in size - tightly healed stress fracture shows 1 cm offset on gravel-sized quartzite clast	680
685	R144	11:08 11:21	100	87	0.6	J	C1	MM	R SR	P D	II	F	70 40		60-70% gravel-sized clasts up to 3 cm in size - irregular calcite-lined joint up to 4 mm wide with open voids up to 1 mm wide	685
690	R145	11:56 12:06	100	41	2.0	J	D1	TH	SR	P	II	F	35 55 62		50-70% gravel-sized clasts up to 6 cm in size - 25 cm thick sandstone layer - 3 mm wide claystone laminae - 2 mm wide calcite-lined joint with open voids up to 1 mm wide	690
695	R146	12:48 13:03	100	51	2.0	J	B1	TH	SR S	P W	II V	F				695

The Earth Technology Corporation

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Client: PB/DMJM	Project: Metro Red Line-Segment 3
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Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
															**CHICO FORMATION (Kc):** CONGLOMERATE; medium light gray matrix, coarse grained, gravel with small cobbles up to 6 cm in size, some fine- to medium-grained sand and silt, noncalcareous cement, massive, rounded clasts (60-70%) composed of granodiorite, quartzite, slate, quartz monzonite, and basalt, very closely spaced joints	TEST 1
700	R147	13:40 8:42 10/5	100	72	>5.0	J	A	VT	R	D S	V VII	F				700
705	R148	9:21 10:00	100	40	5.0	J	B1	TH	SR R	S P	II V	F			gravel-sized clasts range from 1-6 cm in size, matrix medium- to coarse-grained sand	705
710	R149	10:29 11:20	100	27	>5.0	J	C1	VT	SR	S P	II V	F			40-50% gravel-sized clasts up to 3 cm in size - 25 cm wide extremely closely spaced fracture zone above 0.7 m thick very fine-grained sandstone layer 60-70% gravel-sized clasts up to 3 cm in size, matrix grades to silt	710
715	R150	11:48 12:08	100	33	2.0	J	C1	TH	S SR	P S	II	F			60-80% gravel-sized clasts up to 6 cm in size, clasts are deformed and warped - 6" thick sandstone layer	715
720	R151	12:42 13:10	100	51	>5.0	J	B1	VT L	SR	P S	II	F			50% gravel- and cobble-sized clasts composed of granodiorite and quartzite up to 10 cm in size SILTSTONE; greenish black, low plastic silt, some fine-grained sand, trace gravel, well developed noncalcareous cement, extremely closely spaced 0.5 mm wide calcite-lined, tightly healed joints, gravel-sized clasts are faint and appear to meld with the matrix	720
725	R152	13:42 14:04	100	23	>10.0	J	A	VT	SR	P S D	II V	F HW	30 60		- erosional contact with grayish green claystone layer 6 cm above contact	725
730	R153	14:44 14:59	100	85	1.6	J F	C1	TH	S	P	II	MW	35 20		**GRANODIORITE (gd):** white and grayish green, medium grained, quartz, feldspar, and chlorite, massive with localized gneissic foliation, closely spaced clay- and calcite-lined joints	730

LOG OF BORING SM-6

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4155041/E4180771
Boring No.: SM-6	Page No.: 22 of 24

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
													50 50 60		**GRANODIORITE (gd):** white and grayish green, medium grained, quartz, feldspar, and chlorite, gneissic foliation, closely spaced clay- and calcite-lined joints	
735	R154	15:43 16:07	100	100	2.1	J F	A	TH	S	P	V VI	MW	50 20 30 40 45		- 2 mm wide pale green healed clay-lined joint - 2 mm wide pale green healed clay-lined joint	735
740	R155	16:43 17:08	100	67	1.2	J F	A	MM	S	W	III VI	MW SW	70 50 50 50 72		massive structure, moderately closely spaced joints are wavy and irregular - gneissic interval, foliation	740
745	R156	17:48 8:20 10/6	100	83	3.0	J F	A	TH	SR	W	V VI	MW SW	60 50 50 20 55 70		- 15 cm wide tightly healed fracture zone	745
750	R157	8:45 9:00	100	13	6.0	J	E	VT	SR	W D	V VI	MW	50 40 60 80		extremely closely spaced joints, some clay- and calcite-lined and others clean, stepped and sheared	750
755	R158	9:36 9:50	100	33	>5	J	C1	TH VT	SR	W D	VII	MW	80 40 70 87		closely spaced joints, 2 cm wide calcite-lined and open joint @752.7' - 15 cm wide zone of extremely closely spaced joints	755
760	R159	10:30 10:48	100	52	3.0	J	D1	TH	SR	W D	VIII	MW	50 48 70 85 58		faintly gneissic - 7 mm wide medium light brown to white calcite-lined joint	760
765	R160	11:12 13:15	100	100	3.1	J	B1	TH	SR	W	V VII	MW SW				765

LOG OF BORING SM-6

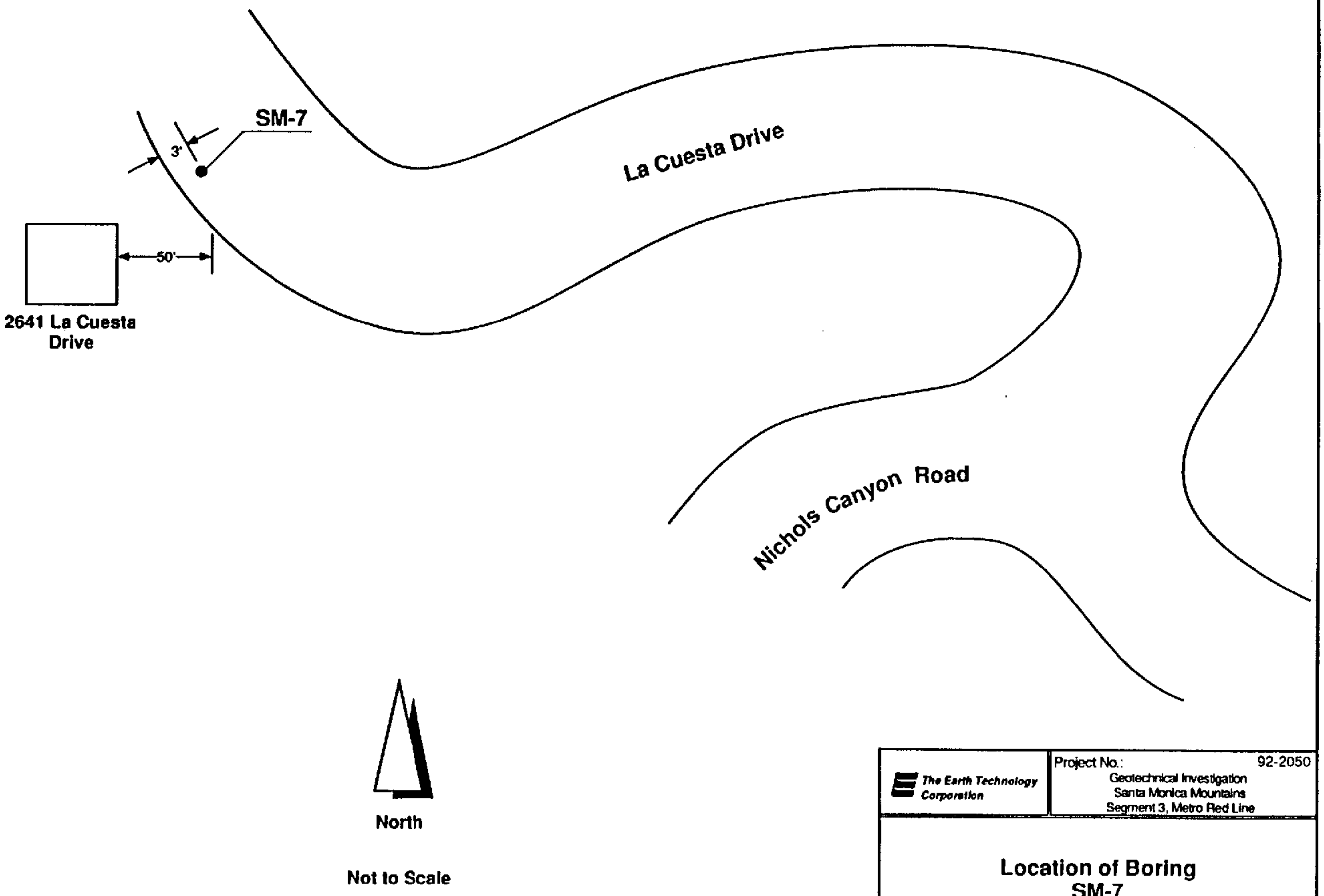
Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4155041/E4180771
Boring No.: SM-6	Page No.: 23 of 24

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
													70 50		**GRANODIORITE (gd):** white and grayish green, medium grained, quartz, feldspar, and chlorite, massive with localized gneissic foliation, moderately closely spaced clay- and calcite-lined joints	
770	R161	13:45 13:55	100	43	3.0	J	C1	TH	SR	W D	V VII	SW	45 50-80 35 40 50		- 7 mm wide open and crystalline calcite-lined joint - 5 cm thick pale green chlorite alteration zone cut by slickensided joint - 2-5 mm wide, irregular and wavy calcite lined joint	770
775	R162	14:30 14:42	100	100	1.2	J	B1	MM	SR	W P	V	SW			localized tightly healed and altered joints	775
780	R163	15:01 15:35	100	100	0.8	J	A	MM	SR	W D	III	SW	30 45		closely spaced, irregular, healed and altered joints	TEST 2 780
785	R164	15:59 16:15	100	100	0.8	J	A	MM	SR S	W P	V	SW	70 30 50		moderately closely spaced joints tighlty healed and altered fracture zone, faint deformation and swirls which lack mafic minerals	785
790	R165	16:38 16:50	100	93	2.0	J	C1	TH	SR	W D	V VI	SW	25 40 35		tightly healed and altered fracture zone, irregular plagioclase phenocryst shows offset and deformation	790
795	R166	17:25 7:49 10/7	100	92	2.5	J F	C1	TH	SR	W P	V III	SW	55 28 35 45		- irregular calcite-lined joint varies in width from 5-12 mm wide	795
800	R167	8:18 8:42	100	90	3.0	J F	B1	TH	SR R	P O	VII V	SW	70 25		- 20 mm wide coarse crystalline calcite-lined joint with up to 15 mm wide open cavities	800

LOG OF BORING SM-6

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4155041/E4180771
Boring No.: SM-6	Page No.: 24 of 24

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
805	R168	9:10 9:22	100	60	3.0	J	D1	TH	SR	P W O	VII	SW			GRANODIORITE (gd): white and dark grayish green, medium grained, massive with localised gneissic foliation - 25 mm wide coarse crystalline calcite-lined joint with up to 15 mm wide open cavities - 20 mm wide coarse crystalline calcite-lined joint with up to 10 mm wide open cavities	805
810	R169	9:45 10:00	100	59	2.6	J	B1	TH	S SR	P W	II	SW			- discontinuous, tightly healed and altered joint zone	810
815	R170	10:42 11:00	100	62	2.0	J	C1	TH	S SR	P W	VII	SW			- 20 mm wide calcite-lined joint - up to 15 mm wide calcite-lined joint - 10 mm wide branching calcite-lined joint	815
820	R171	11:22 11:40	100	35	1.2 6	J	B1	TH VT	SR S	P S	V	SW F			BASALT DIKE; dark greenish gray to greenish black, aphanitic, massive	820
825	R172	12:10 13:02	100	68	0.6 3.0	J F	C1	TH	SR	P	V	SW			GRANODIORITE (gd):dark grayish green and white grading to grayish green within bake zone, medium grained, quartz, feldspar, and chlorite, massive with localised gneissic foliation, closely spaced calcite-lined joints	825
	R173	13:40 14:06	100	57	1.8	J	A	TH	SR	P W D	VII	SW			- 6 cm wide medium light gray fat clay seam - 13 cm wide basalt dike	
830		14:25													Boring terminated at 830 feet on 10-7-92.	830
835																835



The Earth Technology Corporation

Project No.: 92-2050

Geotechnical Investigation
Santa Monica Mountains
Segment 3, Metro Red Line

Location of Boring SM-7

Figure A-11

The Earth Technology Corporation

LOG OF BORING SM-7

Client: PB/DMJM	Project: Metro Red Line-Segment 3	Project No.: 92-2050
Location: N4155721/E4180137	Surface Elevation (ft): 1100	Boring No.: SM-7
Inclination (Deg.): 90	Bearing: NA Depth (ft): 743.0	Depth to Water Table (ft): 156
Started: 8/11/92 Finished: 9/22/92	Core Dia. (in.): 2.4	No. of Core Boxes: 45
Driller: PC Exploration, Inc.	Drilling Method: Mud rotary Fluids: Bentonite/Clear mud	Drilling Equipment: Mobile B-53
Logged By: D. Burke	Checked By: G. Miller	Page No.: 1 of 22

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
0		08:27 8/11 08:42													**LAS VIRGENES SANDSTONE (Tlv):** SILTY SANDSTONE; very pale orange, coarse-grained arkosic sand with silt, scattered gravel to 12 mm , very friable, massive, subrounded clasts consist of schist and quartzite	0
	R1	08:37 8/12	0	0	-	-	-	-	-	-	-	-				
5	R2	08:43 10:10	42	8	-	-	-	-	-	-	-	-	65		indistinct bedding - schist clast, > 8 cm in size	5
10	R3	10:15 10:40	62	14	-	-	-	-	-	-	-	-	30		- - -	10
15	R4	10:45 11:05	34	0	-	-	-	-	-	-	-	-			CONGLOMERATIC SANDSTONE; very pale orange, coarse-grained sand and gravel with silt, massive to thinly bedded, very closely spaced joints, subrounded clasts composed of schist, quartz and quartzite	15
20	R5	11:14 12:15	36	12	-	-	-	-	-	-	-	-			clasts to 4 cm	20
25	R6	12:22 12:30	92	15	3.2	J	B1	TH	S	W	III	MW	50 20		- weathered schist clast, 15 cm in size	25
30	R7	12:44 12:59	18	0	-	-	-	-	-	-	-	MW				30

LOG OF BORING SM-7

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4155721/E4180137
Boring No.: SM-7	Page No.: 2 of 22

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
30															**LAS VIRGENES SANDSTONE (Tlv):** CONGLOMERATIC SANDSTONE; very pale orange, coarse-grained sand and gravel, cobbles to 4 cm, with silt, massive to thinly bedded, very closely spaced joints, subrounded clasts composed of schist and quartzite	30
35	R8	13:09 13:42	24	0	-	-	-	-	-	-	-	MW			light brown, very coarse-grained sand, clasts to 5 cm in size	35
40	R9	14:05 16:25	35	0	-	-	-	-	-	-	-	MW			clasts consist of reddish brown fine-grained porphyritic granite and greenish gray quartzite	40
45	R10	17:03 09:52 8/13	94	26	2.2	J	C1	VT TH	R	P W	II	SW	65 30 60 30		SIMI CONGLOMERATE (Tsc): grayish blue green, well rounded variably colored igneous and metamorphic gravels and cobbles within a very coarse arkosic sandstone matrix	45
	R11	10:02 10:20	50	0	1.5	J S	B	VT	R	P	II	MW	85		- 0.3 m wide shear zone streaked pale reddish purple	
50	R12	10:25 10:40	83	6	2.3	J	C1	VT TH	R	P W	II	MW	30			50
55	R13	10:50 11:11	75	0	2.8	J	C1	VT TH	R	P W	II I	SW	80 30		- zones of well sorted coarse-grained sandstone	55
60	R14	11:25 11:43	89	20	2	J	C1	VT TH	R	P W	I	SW F	70 25			60
65	R15	12:03 12:15	100	67	1.6	J	C	TH MM	SR S	P	I	SW F				65

LOG OF BORING SM-7

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4155721/E4180137
Boring No.: SM-7	Page No.: 3 of 22

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description								Sketch	Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)			
	R16	12:37 13:55 14:02	100	50	1.5	J	B1	TH	SR	P	I	F	30		**SIMI CONGLOMERATE (Tsc):** CONGLOMERATE; grayish blue green, medium- to coarse-grained sand and gravel, cobbles to 4 cm, with silt, massive to thinly bedded, closely spaced joints, subrounded clasts composed of volcanics, plutonics, schist, and quartzite	
70	R17	14:15 14:35	94	64	1	J	B1	TH MM	SR S	P	I	F	65 20		clasts to 0.3 m in size 1 m thick coarse-grained sandstone interval	70
75	R18	14:51 16:13	100	46	1.8	J	B1	MM VT	SR S	P	I	F	25 40			75
80	R19	15:32 15:52	100	44	1.4	J	C1	TH	R SR	P	I	F	30 45 40-60		- 0.6 m wide tightly healed shear zone, matrix is streaked, clasts are broken	80
85	R20	16:28 16:46	92	46	1.4	J	C1	VT TH	R SR	P	VI	F	50 35		1.2 m thick coarse-grained sandstone	85
90	R21	17:03 17:25	100	64	1	J	C	TH	R	P	VI	F	40 40		- possible soft sediment deformation shown by convoluted matrix	90
	R22	8/14	100	40	2	J	B	TH	SR	P	VI	F	25			
95	R23	08:46 09:10	100	75	1.8	J	B	TH	SR	P	VI	F	35 60		massive	95
100	R24	09:37	100	67	0.7	J	B	TH MM	SR	P	VI	F	55 45			100

LOG OF BORING SM-7

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4155721/E4180137
Boring No.: SM-7	Page No.: 4 of 22

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R25	09:52 10:10 10:26	85	85	0.5	J	B	MM	SR	P	VI	F	35		**SIMI CONGLOMERATE (Tsc):** CONGLOMERATE	
105	R26	11:46 12:05	46	24	0.6	J	B1	MM	SR	P W	VI	F	55 80		SANDSTONE; grayish blue green, medium- to coarse-grained sand, with gravel, cobbles to 4 cm, silt, massive, moderately closely spaced joints, subrounded clasts composed of plutonic, metamorphic, and volcanic, closely spaced joints	105
110	R27	13:02 13:15	82	50	0.8	J B	B1	MM	SR SK	P	VI	F	60 45 45			110
115	R28	15:20 15:31	93	73	0.4	J	B	MM	S SK	P	VI VIII	F	55 50		coarse-grained sand	115
120	R29	15:44 15:57	96	96	1	J	B1	TH MM	S SK	P	VI	F	15 65		3 cm wide clay gouge zone, grayish brown below, with gravel to 5 cm in size very coarse-grained sand, trace to no gravel	120
125	R30	16:08 16:22	98	51	1.3	J	C1	TH	S SK	P	VI VIII VI	F	25 65 35		- 0.3 m brecciated grayish brown clay-lined shear zone with laminated fine-grained sandstone	125
130	R31	16:55 17:10	100	70	0.8	J S	B1	TH MM	S SK	P	VIII VI	CW F	15 20		- 0.3 m brecciated grayish brown clay-lined shear zone with laminated fine-grained sandstone	130
135	R32	17:45	100	76	1.8	J S	C1	TH MM	S SK	P W	VI VIII	F HW	20 55			135

LOG OF BORING SM-7

Client: PB/DMJM	**Project:** Metro Red Line-Segment 3
Project No.: 92-2050	**Location:** N4155721/E4180137
Boring No.: SM-7	**Page No.:** 5 of 22

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		18:00											0		**SIMI CONGLOMERATE (Tsc): SANDSTONE;** grayish blue green, very coarse-grained sand with scattered gravel, cobbles to 4 cm, silt, massive, moderately closely spaced joints, subrounded clasts composed of plutonic, volcanic, quartzite and schist; 0.7 m wide sheared conglomerate layer and 0.7 m wide sheared conglomerate layer, clasts to 8 cm in size at 135' and 137'	
140	R33	09:23 8/15 09:38	94	40	1.4	S J	B1	TH MM	S SK	P W	VIII	HW F	35 60			140
	R34	10:29 10:35	56	0	1.2	J	B1	TH	R SR	P W	VI	F	50 45 30			
145	R35	11:07 11:20	100	44	2	J	B1	TH VT	SR	P	VI	F	55 30			145
150	R36	11:37 11:52	44	8	1.2	J	B1	TH VT	SR S	P W	VI	F	20 25		very coarse sand to fine gravel	150
155	R37	12:11 12:26	92	26	1.2	J	B1	TH VT	R S	P	VI	F	50 35 45		shattered quartzite clasts	155
	R38	13:09 13:15	73	27	1.3	J	B	TH VT	SR	W	VI	F	30			
160	R39	13:38 13:50	90	35	1.3	J	B1	TH	R	P	VI	F	45			160
165	R40	14:39 14:55	100	37	1.4	J	C	TH MM	SR SK	P	VI	F	25 25		- 0.4 m thick medium-grained sandstone layer - clasts to 8 cm in size	165
170	R41	15:18	98	44	1	J	B1	TH MM	SR SK	P W	V	F	15 80			170

LOG OF BORING SM-7

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4155721/E4180137
Boring No.: SM-7	Page No.: 6 of 22

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Lithic Description	Packer Test Interval
														SIMI CONGLOMERATE (Tsc): CONGLOMERATIC SANDSTONE; grayish blue green, very coarse-grained sand and gravel, cobbles to 15 cm, with silt, massive, moderately closely spaced joints, subrounded clasts composed of quartzite, plutonic, volcanic, and schist	
175	R42	15:37 16:09	80	10	2.4	J	B1	TH VT	R S	P W	VI	F	55		175
180	R43	16:26 16:50	80	38	1.4	J	B1	MM TH	SR SK	P	VI	F	35 20 30	SANDSTONE; grayish blue green, very coarse-grained sand, scattered gravel, cobbles to 4 cm, silt, massive, moderately closely spaced joints, subrounded clasts composed of quartzite, plutonic, volcanic, and schist	180
185	R44	17:03 17:18	100	68	1	J	B1	MM TH	SR	P	VI	F	30 50 35	- faint bedding	185
190	R45	17:35 08:40 8/16	100	96	0.8	J	C	MM	R SR	P W	VI	F	50 40	CONGLOMERATIC SANDSTONE; grayish blue green, coarse- to very coarse-grained sand and gravel, cobbles to 15 cm, some silt, massive, moderately closely spaced joints, subrounded clasts composed of quartzite	190
195	R46	08:52 09:17	82	56	1	J	C1	MM TH	R S	P W	VI	F	70 30 30		195
	R47	09:38 11:12	43	0	-	-	-	-	-	-	-	F	55	- 1.5 m wide gravel shattered in altered blue green clay matrix	
200	R48	11:28 11:52	88	16	1.6	J	B1	R RS	TH VT	P	VI	F	55 30		200
205	R49	13:01 13:27	33	0	-	-	-	-	-	-	-	F			205

LOG OF BORING SM-7

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4155721/E4180137
Boring No.: SM-7	Page No.: 7 of 22

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R50	13:40 13:56	35	0	-	-	-	-	-	-	-	F			**SIMI CONGLOMERATE (Tsc):** CONGLOMERATE; matrix supported, fine- to coarse-sheared and shattered gravel and cobbles to 0.3 m, subrounded clasts composed of quartzite, matrix consists of bluish green very coarse to coarse-grained sand and clay that is poorly cemented and very friable, clasts readily separate from matrix, massive	
	R51	14:05	60	0	-	-	-	-	-	-	-	F				
210	R52	09:18 8/17	49	0	-	-	-	-	-	-	-	F				210
215	R53	09:40 09:55	75	0	-	-	-	-	-	-	-	F			- quartzite clasts to 0.3 m, all clasts shattered	215
220	R54	10:17 11:11	100	0	1.8	J		VT TH	R S	P W	V	F			grayish green matrix	220
	R55	11:37 12:29	90	0	-	-	-	-	-	-	-	F				
	R56	12:39	60	0	-	-	-	-	-	-	-	F				
	R57	12:56	0	0								F				
	R58	13:03 13:18 13:25	50	0	-	-	-	-	-	-	-	F				
225	R59	15:19 15:32 16:08	60	0	-	-	-	-	-	-	-	F				225
230	R60	16:36 17:13	60	20	-	-	-	-	-	-	-	F				230
	R61	17:27 17:38	100	0	-	-	-	-	-	-	-	F				
235	R62	17:55 07:35 8/18	92	0	-	-	-	-	-	-	-	F				235
	R63	07:49 08:02	100	0	-	-	-	-	-	-	-	F				
240	R64	08:23 08:38	70	0	-	-	-	-	-	-	-	F				240

LOG OF BORING SM-7

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4155721/E4180137
Boring No.: SM-7	Page No.: 8 of 22

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
		08:54													**SIMI CONGLOMERATE (Tsc):** CONGLOMERATE; matrix supported, fine- to coarse-sheared and shattered gravel, cobbles, and boulders to 0.3 m, subrounded clasts composed of quartzite, matrix consists of grayish green very coarse to coarse-grained sand and clay that is poorly cemented and very friable, clasts readily separate from matrix, massive, localized boulders to 0.5 m in size at 242'	
	R65	09:22	100	0	-	-	-	-	-	-	-	F				
	R66	09:36 09:50 10:03	100	0	-	-	-	-	-	-	-	F				
245	R67	10:18 10:34	100	0	-	-	-	-	-	-	-	F				245
250	R68	10:50 11:07	100	0	-	-	-	-	-	-	-	F			cobbly	250
	R69	11:20	0	0	-	-	-	-	-	-	-	F				
	R70	11:25 13:38 13:57	100	0	-	-	-	-	-	-	-	F				
255	R71	14:10 14:28	100	0	-	-	-	-	-	-	-	F				255
260	R72	15:10 15:20	100	0	-	-	-	-	-	-	-	F				260
	R73	15:35 15:40	100	0	-	-	-	-	-	-	-	F				
265	R74	16:13 16:23	32	0	-	-	-	-	-	-	-	F				265
	R75	16:45	70	0	-	-	-	-	-	-	-	F				
	R76	16:53 17:07 17:19	60	0	-	-	-	-	-	-	-	F				
270	R77	07:42 08:00	71	0	-	-	-	-	-	-	-	F				270
275	R78	08:30	98	30	2.2	J	C1	TH	R S	P W	VI	F	40			275

LOG OF BORING SM-7

Client: PB/DMJM	Project: Metro Red Line-Segment 3
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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		08:49											30		**CHICO FORMATION (Kc):** CONGLOMERATIC SANDSTONE; grayish green, very coarse-grained sand and sheared gravel, cobbles to 5 cm, with silt, poorly cemented, very friable, massive, moderately closely spaced joints, subrounded clasts composed of quartzite and schist	
280	R79	09:12 09:26	90	0	1.8	J	B1	TH	SR S	P	VI	F	40 30			280
285	R80	09:40 09:58	100	100	0.4	J	C	MM T	SR	P	VI	F	60 30		SANDSTONE; grayish green, very coarse-grained sand with sheared and scattered gravel, cobbles to 15 cm, silt, moderately friable, massive, moderately closely spaced joints, subrounded clasts composed of quartzite and schist	285
290	R81	10:59 11:15	100	20	1.4	J	C1	TH	SR S	P	VI	F	25 30		clasts consists chiefly of schist - faint bedding	290
295	R82	11:40 12:00	100	0	0.6	J S B	C	TH	SR S	P W	VI	F	45		- zone of sheared matrix and shattered clasts - faint bedding	295
	R83	12:20 12:25	100	0	0.5	J	B	TH	SR	P	VI	F				
300	R84	12:45 13:10	100	10	2.3	J	C1	VT TH	SR S	P	VI	F	65 45 45			300
305	R85	13:36 13:52	95	13	1.8	J	C1	VT TH	SR S	P	VI	F	60 60		- schist clasts CONGLOMERATIC SANDSTONE; grayish green, very coarse-grained sand and gravel, cobbles to 15 cm, schist and quartzite clasts	305
	R86	09:04 09:08	100	0	3.5	J	C1	TH	SR S	P W	VI	F	40 30			
310	R87	09:25	100	36	2	J	C1	TH	SR	P	VI	F	55			310

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Project: Metro Red Line-Segment 3
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Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
									SK	W	VIII		55 55		**CHICO FORMATION (Kc):** CONGLOMERATIC SANDSTONE; grayish blue green, very coarse-grained sand and gravel, cobbles between 15-30 cm, with silt, massive, closely spaced joints, subrounded clasts composed of granitic, quartzite and schist	
315	R88	09:41 10:00	100	0	2.2	J	D	TH	SR SK	P W	VI VIII	F	30 30		- poorly cemented	315
320	R89	10:13 10:28	73	0	>6.7	J S	B1	VT	SK SR	P	VIII	F	60 60		- 0.5 m wide shear zone with 7 mm wide clay-lined joints	320
325	R90	10:36 10:59	88	0	3	S J	D	VT	SK SR	P W	VIII VI	F	70 55		very coarse-grained sand, clasts to 3 cm in size, mostly metamorphics	325
330	R91	11:10 11:24	92	0	3	J	D	VT	SK SR	P W	VI VIII	F	5 10 75		CONGLOMERATE; matrix supported, fine- to coarse sheared gravel and cobbles to 0.3 m, subrounded clasts composed of granite, gneiss and schist, matrix consists of grayish green very coarse to coarse-grained sand and clay that is poorly cemented, massive	330
335	R92	11:38 12:21	100	0	2	J	C1	VT TH	SK SR	P W	VI	F	30 60 55		- granitic clasts to 30 cm	335
	R93	12:36 13:07	100	25	2.5	J	B1	TH	SR S	W	VI	F	70		- schist and gneiss clasts to 12 cm	
340	R94	13:15 13:30	80	0	2.8	J	C1	VT TH	S SK	P	VIII VI	F	65			340
	R95	13:46 13:51	100	0	2	J	C1	TH	SR S	P	VI	F	30			
345	R96	14:00 14:12	100	0	2.2	J	C1	TH	SR	P	VI	F				345

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Client: PB/DMJM	Project: Metro Red Line-Segment 3
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Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
									S	W			25 60 25		**CHICO FORMATION (Kc):** CONGLOMERATE; matrix supported, fine- to coarse sheared gravel and cobbles to 0.3 m, subrounded clasts composed of granite, gneiss and schist, matrix consists of grayish green very coarse to coarse-grained sand and clay that is poorly cemented and very friable, massive	
350	R97	14:28 14:57	100	66	1.8	J	C1	TH MM	S	P	VI	F	20 10 20		sharp contact CONGLOMERATIC SANDSTONE; medium gray, very coarse-grained sand to fine gravel, and silt, massive, closely spaced joints, subrounded clasts composed of granite, gneiss, quartzite and schist	350
355	R98	15:15 15:47	100	32	2	J	C1	TH VT	SR S	P	VI	F	45 60		- faint bedding	355
360	R99	16:05 16:20	100	40	1.4	J	C1	TH VT	R S	P	VI	F	75 20 30			360
365	R100	16:38 17:00	100	42	1.6	J	C1	TH VT	SR S	P	VI	F	15 40			365
370	R101	17:20 17:35	100	12	2.4	J B	C1	TH VT	SR S	P	VI	F	30 30 25		- faint bedding	370
375	R102	17:54 07:36	100	30	3	J	D	VT TH	SR SK	P	VI VIII	F	5 10 30			375
380	R103	07:51 08:46	90	0	2.3	J	D	VT	SR	P	VI	F				380

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Client: PB/DMJM	Project: Metro Red Line-Segment 3
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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
								TH	S						**CHICO FORMATION (Kc):** as above, sheared gravel and cobbles with dark gray clay at contact	
	R104	09:00 09:15	100	0	3	J	C1	TH	S	P	VI	F	65 55		CONGLOMERATE; matrix supported, fine- to coarse gravel and cobbles to 15 cm, subrounded clasts composed of porphyritic granitics and quartzite, matrix consists of dark gray very coarse to coarse-grained sand and clay that is poorly cemented and very friable, massive, clasts readily separate from matrix	
385	R105	09:25 09:38	100	0	2	J	B	TH	S	W	VI	F	10			385
	R106	09:53 10:07	100	0	-	-	-	-	S	W	VI	F				
390	R107	10:17 10:35	100	0	>2	J	B1	TH	SR S	P W	VI	F	60		quartzite and granite clasts to 0.3 m in size are offset by tightly healed joints, some quartzite clasts are shattered	390
395	R108	11:08 11:28	100	0	>2	-	-	-	S	W	VI	F			- 0.7 m boulders composed of granite and quartzite clasts, some are shattered	395
400	R109	12:00 12:56	100	0	>2.5	-	-	-	S	W	VI	F				400
	R110	13:30 10:17	95	0	>5	-	-	-	S	W	VI	F			clasts to 15 cm composed of quartzite and metavolcanics	
405	R111	10:26 10:42	100	0	>10	-	-	-	S	W	VI	F				405
410	R112	11:14 11:27	100	0	>2.2	-	-	-	S	W	VI	F				410
415		11:44														415

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Client: PB/DMJM

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Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R113	12:15 12:30	100	0	>4	-	-	-	S	W	VI	F			**CHICO FORMATION (Kc):** CONGLOMERATE; matrix supported, fine- to coarse gravel and cobbles to 0.3 m, subrounded clasts composed of granite, gneiss, quartzite and schist, matrix consists of dark gray very coarse to coarse-grained sand and clay that is moderately cemented, massive, large round clasts readily separate from matrix	
	R114	12:45 13:06	100	47	1.3	J	B1	TH	S	P	VI	F	85 50			
420	R115	13:21 13:46	100	8	2.8	J	C1	TH MM	SR S	P	VI	F	30 60		SANDSTONE; medium gray, very coarse-grained sand, trace gravel, poorly cemented and very friable, massive, closely spaced, 7 mm wide calcite-lined joints	420
425	R116	14:00 14:30	100	40	3.4	J	C1	TH VT	SR S	P W	VI	F	80 30 30		well cemented, calcite veining throughout	425
430	R117	14:45 15:14	100	0	2.2	J	C1	TH VT	R S	P W	VI	F	40 45 65		veins to 12 mm wide - faint bedding	430
435	R118	15:47 16:10	100	0	>4	J	-	-	S	W	VI	F			CONGLOMERATIC SANDSTONE; medium gray, very coarse-grained sand, some gravel to 9 cm, and silt, poorly cemented and massive, closely spaced joints, subrounded clasts composed of granite, gneiss, shattered quartzite and schist	435
440	R119	16:25 16:45	100	0	3	J S	B1	-	SR S	P W	VI VIII	F	30 45 40		- 15 cm wide shear zone clasts to 15 cm	440
445	R120	08:15 08:28	84	0	3.3	J	-	-	SR S	P W	VI VIII	F				445
450																450

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Client: **PB/DMJM**	Project: **Metro Red Line-Segment 3**
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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R121	08:47 08:58	100	0	>3.3	-	-	-	S	W	VI	F			**CHICO FORMATION (Kc): CONGLOMERATE;** matrix supported, fine- to coarse gravel and cobbles to 0.4 m, subrounded clasts composed of granite, gneiss, basalt and shattered quartzite, matrix consists of dark gray very coarse to coarse-grained sand and clay that is poorly cemented, massive, closely spaced joints, clasts readily separate; 10 cm wide shear zone @ 451'; shattered quartzite clast healed with dolomite(?) at 453'; 0.5 m thick very coarse-grained sandstone layer at 456'	
455	R122	09:11 09:32	100	0	3	J	C1	TH VT	SR S	P W	VI	F	85			455
460	R123	09:50 10:00	100	0	>3.3	J S	B1	TH VT	SR S	P W	VI VIII	F	80		[driller reports water loss while coring beginning with R123 and decreasing to R129] clasts to 15 cm - 20 cm wide shear zone	460
465	R124	10:25 10:42	100	28	1	J	B1	TH	SR S	P	VI	F	20		quartzite, granite, gneiss, schist, basalt, and silicic volcanic clasts to 8 cm - 0.4 m wide shattered zone	465
470	R125	10:55 11:12	100	0	>2	J S	B1	TH VT	SR S	P	VI VIII	F	55 60		- 0.3 m wide shear zone with clay gouge clasts to 15 cm	470
475	R126	12:17 12:33	100	40	1.8	J	B1	TH VT	SR S	P W	VI	F	25 45 30		clasts to 8 cm - 0.8 m quartzite boulder, shattered and healed	475
480	R127	12:48 13:08	100	0	>2	J	C1	TH VT	SR S	P W	VI	F	50 10 30		- 1 m thick very coarse-grained sandstone layer - 0.5 m wide, extremely closely fractured zone	480
485	R128	13:23	100	0	1.8	J	C1	TH VT	SR S	P W	VI	F	75 20 30		clasts to 15 cm	485

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R129	13:45 13:58 14:20	100	14	1.8	J	C1	TH	SR S	P W	VI	F	35 30 40		CHICO FORMATION (Kc): CONGLOMERATE; matrix supported, fine- to coarse- gravel and cobbles to 15 cm, subrounded clasts composed of granite, gneiss, schist, basalt and shattered quartzite, matrix consists of dark gray very coarse to coarse-grained sand and clay that is poorly cemented, massive, large round clasts readily separate from matrix; 0.4 m quartzite clast @ 490'	
490	R130	14:32 14:55	100	16	>2	J	C1	TH VT	SR S	P W	VI	F	40 50 60		clasts to 8 cm	490
495	R131	15:10 15:27	83	0	>2.5	J S	C1	TH VT	SR SK	P W	VI VIII	F	70		- 15 cm wide shear zone	495 - -
500	R132	15:42 16:10	94	0	1.8	J	C1	TH VT	SR S	P W	VI	F	45		- faint bedding	500
505	R133	16:30 16:55	100	0	2	J	C1	TH VT	SR S	P W	VI	F	15 20 30			505
510	R134	17:05 15:25	100	0	>3.3	S	-	VT	-	P W	VIII	F				510
	R135	12:15 12:45	90	0	>5	J	C1	VT	R SK	S P	VI	F			[change to NQ coring]	
515	R136	13:20 14:00	30	0	1	J	C1	VT	R	W P	VI	F			very closely spaced clay-lined shears medium gray to medium light gray, clasts to 8 cm	515
520	R137	14:50	50	0	1	J	C1	VT	SR S	W P	VI	F				520

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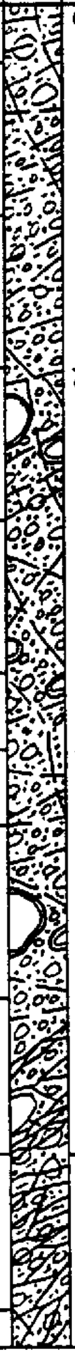
Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R138	15:10 16:25	100	0	4.7	J	C1	VT	SR S	W P	VI	F			**CHICO FORMATION (Kc):** CONGLOMERATIC SANDSTONE; medium gray to medium light gray, very coarse-grained sand, some gravel to 9 cm, and silt, moderately cemented, massive, closely spaced joints, subrounded clasts composed of granite, gneiss, quartzite and schist	
	R139	16:35 11:20 11:35	100	0	2.3	J	C1	VT	SR S	W P	VI	F				
525	R140	12:00 12:18	88	0	>2.5	J	C1	VT TH	SR S	W P	VI	F	40			525
530	R141	12:42 12:55	100	0	>2.5	J	C1	VT TH	SR S	W P	VI	F			clasts to 0.3 m consisting of granite and quartzite, clasts readily separate from matrix	530
535	R142	13:10 13:33	5	0	>2.5	J	C1	VT TH	SR S	W P	VI	F	30 75			535
	R143	13:52 14:06	25	0	-	-	-	-	-	-	-	F				
540	R144	15:18 15:30	100	0	3	J	C1	VT	SR S	W P	VI	F	30		clasts to 8 cm	540
545	R145	15:51 16:36	100	53	1.3	J	B1	TH	SR S	W P	VI	F	15 10		- 0.3 m quartzite clast	545
	R146	16:44 17:00	93	0	2	J S	B1	VT	SR SK	W P	VI	F	65 70		- 8 cm wide slickensided shear, possibly associated with soft sediment deformation - 8 cm wide slickensided shear	
550	R147	08:35 08:55	58	0	>5	J S	B1	VT	SR SK	W P	VI	F	30- 80		BRECCIA; matrix and clasts shattered and sheared, clay slickensides to 5 cm thick	550
555	R148	09:10	100	58	1.5	J	B1	TH	SR	W	VI	F	70			555

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
		09:30							SK	P			10		**CHICO FORMATION (Kc): BRECCIA**; matrix and clasts shattered and sheared, clay slickensides to 5 cm thick	
560	R149	09:43 09:52	100	67	1.7	J	B1	TH	SR SK	W P	VI	F	65 30			560
	R150	10:10 10:44	100	33	1.8	J	B1	TH MM	SR SK	P W	VI	F	40 65		CONGLOMERATE; matrix supported, fine- to coarse-gravel and cobbles to 8 cm, angular to subrounded clasts composed of granite, volcanics, schist and quartzite, matrix consists of medium gray to medium light gray very coarse to coarse-grained sand and clay that is poorly cemented, massive, large rounded clasts readily separate	
565	R151	11:03 11:23	100	53	1.5	J	B1	TH	SR	P W	VI	F	30 45		clasts to 15 cm	565
570	R152	12:00 12:12	60	0	1.4	J	B1	TH	SR S	P W	VI	F	15 60		- 0.3 m boulder clasts to 8 cm, moderately cemented	570
575	R153	12:35 12:55	85	40	1.3	J	B1	TH MM	SR S	P W	VI	F	40 10		poorly cemented	575
580	R154	13:15 13:30	75	0	1.5	J	C1	TH	SR S	W P	VI	F	55 35			580
	R155	14:40 14:55	80	0	2.8	J	B1	TH VT	SR	W	I	F			clasts to 10 cm	
585	R156	15:15 15:40	100	65	1.5	J	B1	TH MM	SR	W	VI	F	55		clasts to 15 cm - faint bedding	585
590	R157	15:56	100	78	1.1	J	B1	TH MM	SR	W	I	F	55		- faint bedding	590

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
595	R158	16:25 17:00	100	0	>2.5	J	B1	TH VT	SR S	W P	VI	F	10 45		**CHICO FORMATION (Kc): CONGLOMERATE;** matrix supported, fine- to coarse sheared gravel and cobbles to 8 cm, subrounded clasts composed of granite, volcanics, gneiss, schist and shattered quartzite, matrix consists of medium gray to medium light gray very coarse to coarse-grained sand and clay that is poorly to moderately cemented and very friable, massive, large round clasts readily separate	595
	R159	17:25 11:38	98	35	1.8	J	B1	TH VT	SR S	P W	VI	F	65		clasts to 15 cm	
600	R160	12:00 12:22	100	100	0	-	-	-	-	-	-	F			clasts to 10 cm - no discontinuities	600
605	R161	12:35 13:00	89	27	1.6	J S	B1	TH	SR SK	W P	VI	F	70 35		- 3 cm wide shear zone with clay gouge	605
610	R162	13:25 14:16	87	42	1.1	J B	C1	TH MM	SR S	W P	VI	F	40		- faint bedding	610
	R163	14:50 08:09	93	27	2	S J	C1	TH	SR SK	P W	VI	F	45 50		clasts to 15 cm, generally shattered	
615	R164	08:30 08:51	100	27	2.9	J	C1	TH VT	SR	P W	VI	F	30 45			615
620	R165	09:20 09:40	93	0	>2.2	J	C1	TH VT	SR S	W P	VI	F	15 30 50		- 1 m thick very coarse-grained arkosic sandstone layer clasts to 10 cm	620
625	R166	10:02 10:47	100	22	1.8	J	C1	TH	SR	W	VI	F				625

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
								VT	S	P			75		**CHICO FORMATION (Kc):** CONGLOMERATE; matrix supported, fine- to coarse- gravel and cobbles to 10 cm, angular to subrounded clasts composed of granite, volcanics, gneiss, schist and quartzite, matrix consists of medium gray to medium light gray very coarse to coarse-grained sand and clay that is moderately cemented, massive, large cobbles and local boulders readily separate from matrix; gouge zone @ 627'; clasts to 0.3 m @ 632'	
630	R167	11:09 12:07	98	0	1.8	J	B1	TH	SR	W	I	F	70			630
635	R168	12:32 12:47	100	50	1.8	J	B1	TH	SR	W P	I	F	30 20			635
640	R169	13:13 13:35	80	31	1.6	J	B1	TH	R SR	W P	I	F	25 30			640
645	R170	14:05 14:37	100	67	1.3	J	B1	TH MM	R SR	W P	VI	F	70 60		- 3 cm wide, sheared clay gouge	645
	R171	15:18 16:15	100	0	3	J	B1	TH VT	SR	P	I	F	20		medium dark gray, matrix chiefly silt	
650	R172	16:25 16:48	67	44	0.7	J	B1	TH MM	SR	P	VI	F	20		rounded to subrounded clasts	650
	R173	17:20 08:08	89	77	0.3	J	A	MM	R	S	I	F	15			
655	R174	08:20 09:05	100	38	1.5	J	C1	TH VT	R S	S P	VI	F	30 15 10		- 1 mm wide dolomite-lined joints	655
660	R175	09:32 09:53	73	0	1.6	J	B1	TH	R	S	I	F				660

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Project No.: 92-2050	Location: N4155721/E4180137
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Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
								VT		P			40 15		**CHICO FORMATION (Kc): CONGLOMERATE;** matrix supported, fine- to coarse sheared gravel and cobbles to 5 cm, subrounded to rounded clasts composed of granite, basalt, gneiss, schist and shattered quartzite, matrix consists of medium dark gray very coarse to coarse-grained sand and silt that is moderately cemented and moderately friable, massive	
665	R176	10:20 10:38	100	40	2.4	J	C1	TH VT	R SK	S P	VI	F	70 60			
670	R177	11:10 11:29	87	13	3.3	J	C1	TH VT	R S	S P	VI	F	55 25 40		clasts to 5 cm, moderately cemented	
675	R178	12:00 08:23	91	31	1.6	J	C1	TH VT	R S	S P	VI	F	70 80		clasts to 15 cm, poorly cemented	
680	R179	08:50 09:20	100	0	2.9	J	D1	TH VT	R SK	W P	VI VIII	F	30 50 80			
685	R180	09:55 10:19	100	0	2.4	J	C1	TH VT	R SK	S P	VIII	F	75 60		- 0.5 m thick very coarse-grained sandstone layer, some gravel to 3 cm - 3 cm wide brecciated and sheared clay gouge clasts to 15 cm	
690	R181	10:46 11:18	91	0	2	J	B1	TH VT	R SR	S P	VI	F	40 20			
695	R182	11:42 12:01	80	0	2.7	J	C1	VT TH	R S	W P	VIII	F	65 70		**CONGLOMERATIC SANDSTONE;** medium light gray to dark gray, very coarse-grained sand, some gravel to 3 cm, and silt, moderately cemented, massive, closely spaced joints, subrounded clasts composed of granite, basalt, gneiss, schist, quartzite, and volcanics	

LOG OF BORING SM-7

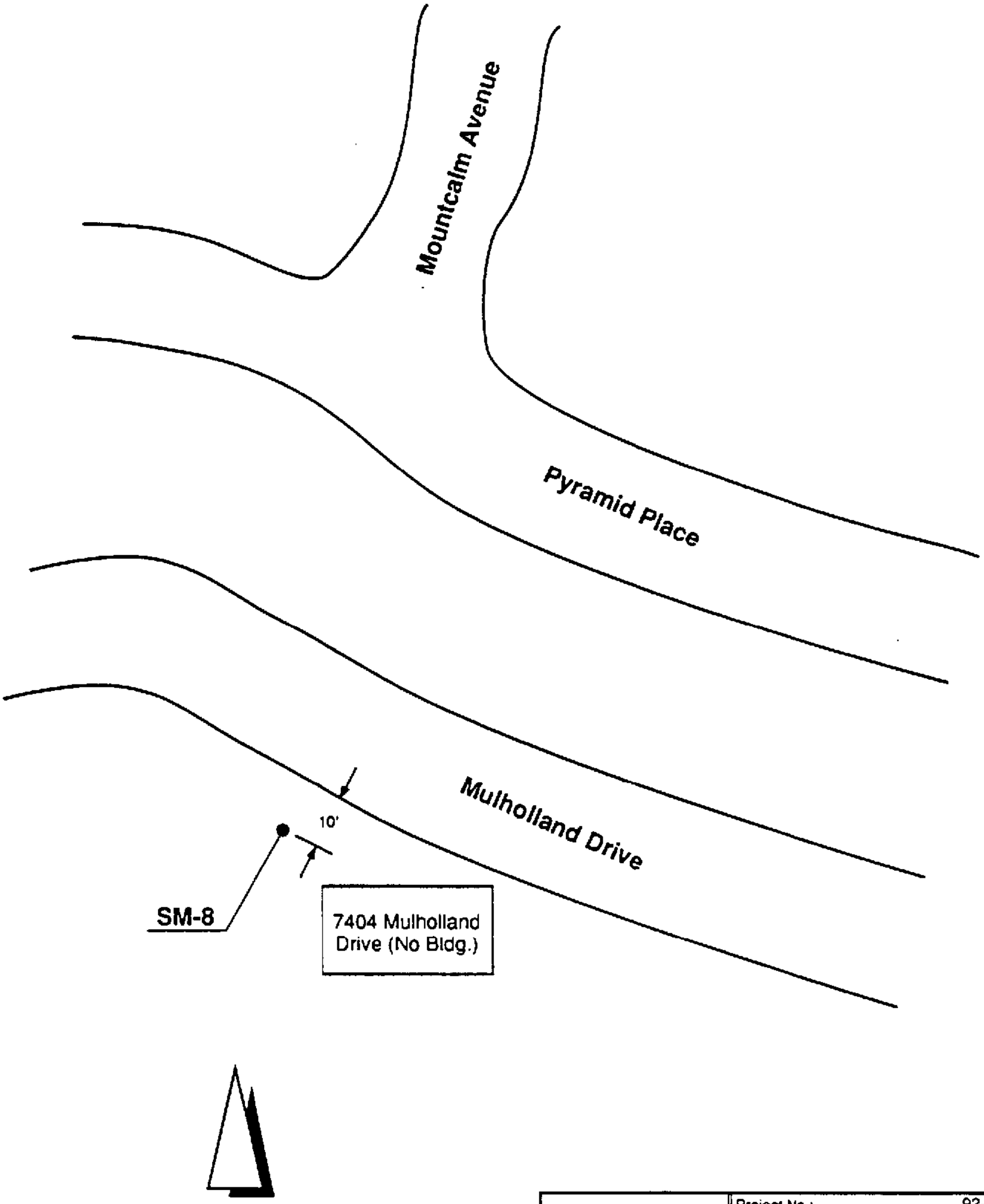
Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4155721/E4180137
Boring No.: SM-7	Page No.: 21 of 22

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R183	12:28 13:17 13:40	87	0	>4.4	J	C1	VT	R SR	W P	VI	F	60 70 55		**CHICO FORMATION (Kc):** CONGLOMERATIC SANDSTONE; medium light gray to dark gray, very coarse-grained sand, some gravel to 3 cm, and silt, moderately cemented, massive, closely spaced joints, subrounded clasts composed of granite, basalt, gneiss, schist, volcanics, and quartzite	
700	R184	14:06 14:40	100	100	2.3	J	B	TH MM	R SR	SW	I	F	25 10		CONGLOMERATE; matrix supported, fine- to coarse sheared, deformed and rehealed gravel and cobbles to 8 cm, subrounded to rounded clasts composed of granite, basalt, gneiss, schist and quartzite, matrix consists of medium light gray to dark gray very coarse to coarse-grained sand and silt that is moderately cemented, massive	700
705	R185	15:18 15:50	87	76	2.3	J	B	TH MM	R SR	W P	VI	F	70		clasts to 5 cm	705
710	R186	16:32 16:58	100	58	1.3	J	C	VT MM	R SR	W P	VI	F	30 75			710
715	R187	17:18 17:47	98	47	2.7	J	B1	MM TH	R SR	W P	VI	F	5 30 60			715
720	R188	08:27 08:50	94	0	>2.9	J	B1	VT TH	R SR	S P	VI	F	55 50		clasts to 15 cm, poorly to moderately well cemented, quartzites shattered	720
	R189	10:03 10:34	98	20	2.4	J	C1	VT TH	R SR	S P	VI	F	60 50		clasts to 8 cm, well cemented	
725 730	R190	11:05	100	64	1.3	J	B1	VT TH	R SR	P W	VI	F	40 10		clasts to 15 cm	725 730

LOG OF BORING SM-7

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4155721/E4180137
Boring No.: SM-7	Page No.: 22 of 22

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R191	11:37 11:58 12:35	98	64	1.3	J	B1	TH MM	R S	P W	VI	F	60 50		**CHICO FORMATION (Kc): CONGLOMERATE;** matrix supported, fine- to coarse sheared gravel and cobbles to 10 cm, subrounded to rounded clasts composed of granite, basalt, gneiss, schist, volcanics, and quartzite, matrix consists of medium light gray to dark gray very coarse to coarse-grained sand and silt that is well cemented and weakly friable, massive; @ 734.5', 0.5 m thick very coarse-grained sandstone layer	
735	R192	13:00 13:55	93	51	1.8	J	B1	TH VT	R S	S W	VI	F				735
740																740
															Boring terminated at 743 feet on 9/22/92. HQ Casing left in hole between 360 and 512 feet.	
745																745
750																750
755																755
760																760
765																765



The Earth Technology Corporation

Project No.: 92-2050
Geotechnical Investigation
Santa Monica Mountains
Segment 3, Metro Red Line

Location of Boring
SM-8

Figure A-12

The Earth Technology Corporation

LOG OF BORING SM-8

Client: PB/DMJM	Project: Metro Red Line-Segment 3	Project No.: 92-2050
Location: N4156725/E4179930	Surface Elevation (ft): 1175	Boring No.: SM-8
Inclination (Deg.): 90	Bearing: NA Depth (ft): 787.5	Depth to Water Table (ft): 141
Started: 8/12/92 Finished: 9/9/92	Core Dia. (in.): 2.4	No. of Core Boxes: 59
Driller: PC Exploration, Inc.	Drilling Method: Mud rotary Fluids: Bentonite/Clear mud	Drilling Equipment: Longyear 38
Logged By: M. Curtis	Checked By: G. Miller	Page No.: 1 of 23

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
0	R1		50	0	-	-	-	-	-	-	-	-			**ARTIFICIAL FILL (af):** SILTY SAND; moderate yellowish brown, fine- to coarse-grained sand with silt, trace concrete fragments; 15 cm asphalt cap	0
	R2	11:45 8/12 12:02	40	0	-	-	-	-	-	-	-	-			[Diamond impregnated bit to 100 feet]	
5	R3	12:09 13:05	38	0	-	-	-	-	-	-	-	-			SAND; dark yellowish brown, fine grained	5
	R4		100	0	-	-	-	-	-	-	-	-			GRAVEL; dark yellowish brown, gravel-sized basalt, plutonic, and asphalt fragments	
	~~R5~~		~~100~~	~~0~~												
10	R6	15:23 15:45	60	8	14	J	B	VT	R	S	VII	HW	20		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT; dusky yellowish brown, aphanitic, highly altered, massive, extremely closely spaced joints	10
15	R7	16:23 16:40	67	11	-	J	E F	VT	R	W S	II VII	HW			- chaotic random, sheared, smooth, joints [core recovery is generally as gravel-sized clasts]	15
	R8	16:50 17:05	0	0	-	-	-	-	-	-	-	-				
20	R9	17:15 17:30	0	0	-	-	-	-	-	-	-	-				20
25	R10	08:10 8/13 08:35	100	40	6	J	C1	VT	R	S	II	HW	30 25		- joints infilled with white to clear crystalline calcite and clay	25
	R11	08:52	98	50	3	J S	A	TH	SR	P	I II	SW				
30																30

LOG OF BORING SM-8

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4156725/E4179930
Boring No.: SM-8	Page No.: 2 of 23

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
30															**MIDDLE TOPANGA FORMATION (Ttv):** BASALT; grayish green to dark greenish gray, aphanitic, highly altered, brecciated, very close spaced iron-oxide stained, calcite- and chlorite-lined joints, chaotic irregular serpentine-lined shears, scattered white zeolites	30
35	R12	09:12 09:25	100	50	0.8	J	C1	TH	SR R SK	W P	II	SW	15 70		- 10 cm thick brecciated zone with soft white matrix - 15 cm thick brecciated zone with soft white matrix - 2 mm wide chlorite-lined joint	35
40	R13	09:45 10:38	100	90	20	J S	A	VT L	R SK	D W	II	MW				40
45	R14	11:07 11:24	100	72	10	J S	B1 A	VT TH	SR SK	W P	II	MW SW	5 50 20			45
50	R15	11:44 13:05	100	43	15	J	A	VT	SR	W P	II	MW			brecciated clasts range from 0.5-5 cm in size, matrix supported	50
	R16	13:24 12:40 8/14	100	87	2	J	A	MM	S SR	W P	II	SW	5 20			
55	R17	13:02 13:08	100	72	20	J S	D1	VT L	SK S SR	W	V II	MW	32 40		massive, unbrecciated - 1.5 mm wide chlorite-lined sheared joint - 0.5 mm wide irregular and undulating chlorite-lined joint	55
60	R18	13:24 15:26	93	33	2	J	B1	TH	S SK	W	II	MW	25 55		- 0.5 mm wide chlorite-lined joint - 10 cm wide brecciated zone - completely altered, sheared and wavy chlorite zone	60
65	R19	15:40 17:38	100	48	6	J	A	TH	S	W	II	MW	40			65

LOG OF BORING SM-8

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4156725/E4179930
Boring No.: SM-8	Page No.: 3 of 23

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description								Sketch	Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)			
		17:50											30		**MIDDLE TOPANGA FORMATION (Ttv):**	
	R20	08:10 8/15	100	100	3	J	B1	VT	R	W P	II	MW	30		BASALT; greenish black to medium dark gray, aphanitic, highly altered, massive, locally vesicular, very closely spaced chlorite-lined joints, scattered white zeolites	
70	R21	08:20 08:25 08:40	100	87	3	J	C1	TH	SR S	P	II	SW	60		- irregular longitudinal joints	70
75	R22	08:45 09:02	100	60	2	J	B1	TH	S	P	II	SW FW	70 60 60		- scattered white zeolite-filled vesicles with discontinuous veins	75
80	R23	09:15 09:24	100	100	2	J	B1	MM	SR	P	II	FW	38 40			80
85	R24	09:35 09:45	100	100	0.6	J	A	T	S	P	II	FW F	50 25 20		- scattered white zeolite-filled vesicles up to 1 mm in size	85
90	R25	09:52 10:02	100	100	0.2	J	A	T	SR	P	II	F	10		- scattered white zeolite-filled vesicles up to 1-3 mm in size	90
95	R26	- 10:14	100	100	2 0.3	J	B1	VT T	SR	P	II	FW	40 60			95
100	R27	10:57	100	90	0	J	A	MM	SR	P S	II	F			[change to surface set diamond bit]	100

LOG OF BORING SM-8

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4156725/E4179930
Boring No.: SM-8	Page No.: 4 of 23

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Lithic Description	Packer Test Interval
		11:12											40	**MIDDLE TOPANGA FORMATION (Ttv):** BASALT; greenish black to medium dark gray, aphanitic, highly altered, massive, moderately closely spaced chlorite-lined joints, scattered white zeolites	
105	R28	11:18 11:32	100	100	1	J	B	TH	S SR	P	II	F	20 20		105
110	R29	11:45 12:02	100	100	1	J	A	TH	SR	P W	II	FW	30 20 30	- scattered irregular zeolite-filled vesicles	110
115	R30	12:49 13:00	100	100	0.6	J	B1	MM	SR	P D	II	FW		- scattered white zeolite-filled vesicles and discontinuous veins - irregular joints, discontinuous and chaotic	115
120	R31	13:34 13:46	100	79	0.8	J	B1	TH	SR	P	II	FW SW	40 70	- scattered irregular white zeolite-filled vesicles	120
125	R32	13:55 14:05	100	57	2	J	A	TH	SR R	P S	II	SW	35 20 45		125
130	R33	14:12 14:23	100	83	1.2	J	C1	TH	SR S	P	II	FW	75 30	- scattered irregular white zeolite-filled vesicles	130
135	R34	14:40	100	95	0.8	J	A	TH	S SK	P	II	F			135

Sketch

LOG OF BORING SM-8

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4156725/E4179930
Boring No.: SM-8	Page No.: 5 of 23

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Lithic Description	Packer Test Interval
													40	**MIDDLE TOPANGA FORMATION (Ttv):** BASALT; greenish black to medium dark gray, aphanitic, highly altered, massive, moderately closely spaced chlorite-lined joints, scattered white zeolite-filled vesicles	
140	R35	14:54 15:07	100	77	1	J	B1	TH	S SK	D P	II	F			140
145	R36	15:18 15:33	100	100	0.8	J	A	MM	S	P	II	SW MW	30 25	- scattered irregular white zeolite-filled vesicles - 3 cm thick grayish red zone (denoting basalt flow top?) irregular grayish red contact	145
150	R37	15:43 08:05 8/16	100	97	0.2	J	A	T	S	P	II	F	50	- color grades to brownish gray then to olive gray scattered vesicles filled with chlorite and white zeolite	150
155	R38	08:22 08:31	100	92	1.4	J	B1	TH	SR	P	II	FW	30 50 60	- very closely spaced joint set grayish red discoloration	155
160	R39	08:44 09:10	98	62	1.6	J	C1	TH	SR	P	II	FW	75 35	thin grayish red discoloration, very closely spaced joint set at 158', scattered zeolite-filled vesicles up to 10 mm in size color grades to greenish black	160
165	R40	09:29 09:36	100	93	1	J	C1	TH	SR SK	P S	II	FW	60 45 25	- sheared and slickensided joint grayish red discoloration, zeolite-filled vesicles increase	165
170	R41	09:52 10:02	100	93	1	J	A	TH	SR	P			50		170

Sketch

LOG OF BORING SM-8

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4156725/E4179930
Boring No.: SM-8	Page No.: 6 of 23

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		10:19													**MIDDLE TOPANGA FORMATION (Ttv):** BASALT; grayish red to olive red, aphanitic, highly altered, massive, moderately closely spaced chlorite-lined joints, abundant white zeolite- and chlorite-filled vesicles	
175	R42	10:26 10:40	100	100	1	J	A	MM	SR	P	II	F	10 60 15		- zeolites decrease near base of flow grayish red discoloration zone, increase in zeolite-filled vesicles	175
180	R43	10:54 11:18	100	93	1.2	J	B1	TH	SR	P	II	F			decrease in zeolite-filled vesicles	180
185	R43	08:04 8/17 08:19	100	100	1	J	C1	TH	S SR SK	P	II	F	35 70 40		irregular, thin grayish red discoloration zone, increase in zeolite-filled vesicles	185
190	R44	08:34 08:50	100	95	1	J	C1	TH	SR	P S	II	F	50 70		- very closely spaced slickendsided and chlorite-lined joint set irregular, thin grayish red discoloration zone, flow top, increase in zeolites and calcite-filled vesicles	190
195	R45	08:55 09:11	98	98	1	J	A	TH MM	S	P	II	F	26 42 38		generally greenish black, rare to no zeolites and vesicles	195
200	R46	09:52 10:04	100	24	0.8	J	A	MM	S	P	II	F			- 7 mm wide calcite-filled vesicle	200
205	R47	10:14	100	83	0.6	J	B1	TH	SR	P	II	F	20 50			205

LOG OF BORING SM-8

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4156725/E4179930
Boring No.: SM-8	Page No.: 7 of 23

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
		10:26											60 30		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT; olive black to greenish black, aphanitic, massive, moderately closely spaced chlorite-lined joints, scattered white zeolite-filled vesicles	
210	R48	10:34 10:47	87	45	0.4	J	C1	TH	SR	P	II	FW	50 30			210
215	R49	11:12 11:30	100	93	1	J	A	TH	SR	P	II	FW	20 40 60 40		increase in calcite-filled amygdules	215
220	R50	13:26 14:00	100	95	0.6	J	A	MM	S	P	II	F	40 20 10		- irregular calcite-lined vein - scattered coarse grained green (olivine?) phenocrysts	220
225	R51	14:08 -	95	37	8	J	B1	VT	SR	P S	II	FW SW			black and dark greenish gray globular mottling (pillows), very closely jointed - grayish red lining on joints	225
230	R52	15:25 15:45	100	93	1.4	J	A	TH	SR S	P	II	F	60 30 40			230
235	R53	15:50 16:35	100	100	1	J	B1	TH	SR S	P	II	F	30 38 35			235
240	R54	16:40	100	100	1	J	A	TH MM	S	P	II	F	35			240

LOG OF BORING SM-8

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4156725/E4179930
Boring No.: SM-8	Page No.: 8 of 23

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
						Structural/Discontinuity Description										
		17:00											40 65		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT; dark greenish gray to olive black, aphanitic, highly altered, massive, moderately closely spaced chlorite-lined joints, scattered white zeolites; basalt flow top at 241' indicated by grayish red color change	
245	R55	17:06 17:20	100	88	0.8	J	B1	TH	SR	P	II	F	60 35 50		- discontinuous white calcite-lined veins	245
250	R56	08:37 8/18 08:40	100	92	0.4	J	B1	MM	SR S	P	II	F	35 25		abundant green (olivine?) phenocrysts irregular thin mottled brownish black and black discoloration zone (pillows), increase in white calcite-filled vesicles	250
255	R57	08:54 09:09	100	90	0.4	J	A	MM	SR	S	II	F	45 40		- 2' thick zone of calcite-filled vesicles - 5 mm wide calcite- and chlorite-lined joint	255
260	R58	09:34 09:49	100	90	0.4	J	A	MM	SR	P	II	F	50 50			260
265	R59	09:52 10:05	100	87	1.3	J	A	TH	SK	S	II	F	80 45 60		- slickensided joint with striations dipping 20 degrees	265
270	R60	10:11 10:37	97	97	0.2	J	A	T	SR	P	II	F	70		irregular thin mottled brownish black and black discoloration zone (pillows) - irregular fracture/vein with calcite infilling	270
275	R61	11:40	100	100	0.8	J	A	TH	SR S	S P	II	F	30			275

LOG OF BORING SM-8

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4156725/E4179930
Boring No.: SM-8	Page No.: 9 of 23

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		12:00											25		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT; dark greenish gray to dark gray, aphanitic, highly altered, vesicular, very closely spaced random and chaotic chlorite and calcite-lined joints, rare calcite vein infilling	
280	R62	13:00 13:15	100	95	6	J	C1	VT	SR R	S	V	FW				280
	R63	13:19 13:30	44	0	-	-	-	-	-	-	-	-			[driller ground up core into gravels]	
285	R64	15:05 15:18	100	48	8	J	C1	VT	SR	S P	II	F	50 25		abundant <1 mm wide healed joints	285
290	R65	15:25 15:45	100	73	8	J	C1	VT	SR	S P	II V	F	60 55 60			290
295	R66	16:03 16:25	100	63	2	J	B1	VT	SR	S P	II	F	18 80			295
300	R67	16:30 16:55	100	97	1.8	J	C1	TH	SR	P	II	F	70 60			300
305	R68	17:03 17:18	100	37	1.2	J	C1	TH	SR	P S	II V	F	40 50 30			305
310	R69	07:55 8/19 08:15	100	0	2.2	J	C1	VT	SR	P S	II	F	87 60			310

LOG OF BORING SM-8

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4156725/E4179930
Boring No.: SM-8	Page No.: 10 of 23

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R70	08:28 08:40	100	0	1.5	J	B1	VT	SR	P D	II V	FW	70		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT; dark greenish gray to greenish black, aphanitic, vesicular, closely spaced chlorite-lined joints, vesicles lined with calcite and chlorite; evenly spaced joint set from 311-315'	
315	R71	09:10 10:15	90	83	1.2	J	B1	TH	SR R	W P	II V	F	20 30 65			315
320	R72	08:20 8/25 08:57	94	80	1.1	J S	C1	TH	R SK	S	V I	FW F	25 65		- scattered healed joints - 0.5 mm high stepped joint offset by horizontal shear	320
325	R73	10:15 10:22	95	90	0.2	J	A	T	R	W S	V	FW F	35 0		- 7 mm wide joint	325
	R74	10:36 10:38	100	100	1.2	J	A	MM	-	W S	V VII	F	80		- vesicular	
330	R75	11:18 11:26	100	90	2.6	J S	C1	TH MM	SR SK	W S	V VI VII	FW	70 0 30		- 5 mm wide discontinuous, healed and irregular white zeolite-lined joint - clay-lined joint	330
335	R76	11:34 11:45	100	92	1.6	J S	C1	TH	R SR SK	W S	V I	FW	20 70 0 70 20		massive with no vesicles, closely spaced rough, slickensided and locally healed joints	335
340	R77	12:36 12:45	100	62	1.4	J S	C1	T TH	SR SK R	W S	II V	F	45 60		very closely spaced joints, lined with chlorite vesicular below	340
345	R78	12:55	100	100	0.4	J S	A	MM	SR SK	W S	II I	F	10			345

LOG OF BORING SM-8

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4156725/E4179930
Boring No.: SM-8	Page No.: 11 of 23

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Lithic Description	Packer Test Interval
		13:10											10	**MIDDLE TOPANGA FORMATION (Ttv):** BASALT; dark greenish gray to greenish black, aphanitic, vesicular, moderately closely spaced chlorite-lined joints, vesicles filled with dark yellowish green mineral (chlorite?) and white zeolite	
350	R79	13:38 13:52	100	100	0.6	J S	C	MM	SR S	W S	I II	F	60	closely spaced slickensided and polished chlorite-lined shears up to 3 mm wide, massive with scattered vesicles	350
355	R80	14:02 14:14	100	100	1.2	J S	B1	MM	SR SK	W S	I II	F FW	60	- few vesicles	355
360	R81	14:25 14:38	100	100	1	S	B1	MM	SR SK	W S	I	F	20 30 60	- scattered vesicles	360
365	R82	15:22 15:38	100	100	1.2	J	A	T MM	R SR	W S	I II	F	20 70 30	- shear surfaces - crushed zone	365
370	R83	15:53 16:05	100	58	3.6	S	C1	TH	SR SK	W S	I II	P	40 30 40	- shears lined with chlorite	370
375	R84	16:15 16:37	100	82	1.8	J S	C1	VT TH	SR SK	W S	I II	F	25	vesicular, filled with zeolite	375
380	R85	16:48	100	94	1.2	J S	B1	TH MM	SR SK	S	I	F	30 10		380

LOG OF BORING SM-8

Client: PB/DMJM
Project: Metro Red Line-Segment 3
Project No.: 92-2050
Location: N4156725/E4179930
Boring No.: SM-8
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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		17:01											10 50		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT; dark greenish gray to greenish black, aphanitic, vesicular, closely spaced chlorite-lined joints, vesicles filled with calcite and chlorite	
385	R86	17:17 17:29	100	96	1.2	S	B1	MM	SR SK	S	I	F	30 45 60 10		- 0.4 m thick slickensided shear zone extremely closely spaced, longitudinal, up to 1 cm wide, white zeolite veins	385
390	R87	09:30 8/26 09:42	100	50	1.6	J S	B1	TH MM	SR SK	S	I II	F	80 60 20		- >0.5 mm steps along rough joint	390
395	R88	09:46 10:05	100	100	0.2	J	A	T	VR	S	I	F			- scattered white zeolite-lined veins and filled amygdules up to 8 mm wide	395
400	R89	10:12 10:30	100	100	0.4	J S	A	T	R SK	W S	I	F	25 60 20		brecciated, fragments to 16 mm in size, matrix supported	400
405	R90	10:40 10:53	92	84	0.4	J S	A	TH T	SR SK	W S	I	F	60 20		generally massive, scattered light green and white zeolite-filled veins up to 8 mm wide	405
410	R91	11:13 11:31	100	88	0.2	S	A	L MM	SK VR	S	I	F	20		brecciated, matrix supported - extremely closely sheared zone	410
415	R92	11:41	100	100	0.4	J	A	MM	R VR	S	I	F	60			415

LOG OF BORING SM-8

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4156725/E4179930
Boring No.: SM-8	Page No.: 13 of 23

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
													10		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT BRECCIA; dark greenish gray to greenish black, aphanitic, clasts within fine-grained matrix, closely spaced chlorite-lined joints, breccia fragments from 16 mm to 5 cm in size, scattered white seolite-lined veins, rare vesicules	
420	R93	11:54 12:10	98	92	0.4	J	A	TH	R SR	S	I	F	40 50			420
425	R94	12:24 12:40	100	100	0.6	J	A	MM	R	W S	I	F	10 40			425
430	R95	12:53 13:07	98	92	1.2	J S	B1	TH MM	SK SR	W S	I V	F	20 40 40			430
435	R96	13:20 13:57	100	100	0.2	J	A	T	SR R	S	V	F FW	35		- 3 mm wide slickensided joint - calcite-lined, slickensided joint	435
440	R97	14:10 14:22	98	98	0.6	J	B	TH	R	S W	I	F	40 40			440
445	R98	14:36 14:51	98	84	1.2	J	B1	TH MM	R	S	I	F	40 60			445
450	R99	15:06 15:17	98	98	1.2	J S	A	T MM	R SK	S	I	F				450

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Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4156725/E4179930
Boring No.: SM-8	Page No.: 14 of 23

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
															**MIDDLE TOPANGA FORMATION (Ttv):** BASALT BRECCIA; dark greenish gray to greenish black, aphanitic, composed of fragments suspended in fine-grained matrix, brecciated, closely spaced chlorite-lined joints, brecciated fragments to 5 cm in size, scattered white zeolite-lined veins, rare vesicles	
	R100	15:31 15:45	100	92	0.4	J	A	TH	SR R	P	I II	F				
455													15		- 3 mm wide light green and white lined joint	455
															- 12 cm wide extremely closely sheared zone	
	R101	15:54 16:04	100	86	1	J S	B1	TH MM	SR SK	P S	I	F				
													0		massive and unbrecciated interval	
460																460
													60			
													40			
	R102	16:17 16:35	98	98	0.2	J	A	T	R SR	S	I	F				
													50			
465																465
													40			
	R103	16:53 07:49 8/27	100	100	0.2	J	A	T	SR	W S	I	F				
470													30			470
													45		- 3 mm wide zeolite healed joint	
	R104	08:02 08:14	94	94	0	-	-	-	-	-	-	-			no fractures	
475																475
															- tightly healed joint	
													25			
	R105	08:31 08:40	100	100	1	J	A	TH MM	SR	W S	I V	F	20		mostly matrix with scattered fragments	
480													35			480
	R106	09:27	100	60	2	J	C1	TH MM	R SR	P S	I V	F	30			
															- minor alteration between fragments	
485																485

LOG OF BORING SM-8

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4156725/E4179930
Boring No.: SM-8	Page No.: 15 of 23

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
		09:42											80		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT BRECCIA; dark greenish gray to greenish black, aphanitic, composed of breccia fragments suspended in a fine-grained matrix, closely spaced chlorite-lined joints, brecciated fragments to 5 cm in size, scattered white and pale green noncalcareous-lined veins , rare vesicles	
	R107	09:56	100	100	0.4	J	C	MM	SR	W S	I II	F	20			
490													60			490
		10:11														
	R108	10:25	100	92	0.6	S J	B1	TH T	SR SK	W S	I II	F	35			
495													50		finely veined with calcite and zeolite	495
		10:39											35			
	R109	10:52	100	94	0.8	J	C1	TH MM	SR SK	W S	I II	F	40		- very closely spaced, tightly healed veins, lined with zeolite	
500																500
		11:07											70			
	R110	11:20	100	90	1	S	B1	L MM	SK	S W	I II	F	30			
505																505
		11:35											60		- 20 cm wide extremely closely fractured zone	
	R111	11:47	100	97	0.4	S J	A	TH	SK SR	W S	I	F	50			
510																510
		12:03											25			
	R112	12:15	100	100	0.4	J	A	TH T	SR SK	W S	I V	F	50			
515																515
		12:31														
	R113	12:44	96	96	0.6	J	A	MM	SR VR	W	I V	F	35			
520																520

LOG OF BORING SM-8

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4156725/E4179930
Boring No.: SM-8	Page No.: 16 of 23

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
															**MIDDLE TOPANGA FORMATION (Ttv):** BASALT BRECCIA; dark greenish gray to greenish black, aphanitic, composed of breccia clasts within a fine-grained matrix, closely spaced chlorite-lined joints, brecciated clasts to 5 cm in size, scattered white noncalcareous-lined veins, rare vesicles; 15 cm wide extremely closely sheared zone @ 523'	
525	R114	13:00 -	100	72	0.4	J	A	L MM	R	W S	I	F	80		- joints up to 7 mm wide	525
530	R115	13:28 -	100	86	1.2	J	B1	TH MM	SR	S	I	F	50 70 0		veining more common	530
535	R116	16:55 08:15 8/28	100	100	0.6	J S	B1	MM T	SR S SK	P S	I V	F	60 40 42		rare veining - tightly healed joints up to 3 mm wide	535
540	R117	08:26 -	100	100	1	J	B	TH	SR MM	P S	I II	F	20 50 10		- joints less than 1 mm wide	540
545	R118	09:11 10:00	100	87	0.6	J	A	L T	R SR	S	I II	F	70 20 30		- 3 cm wide, light green, altered shear zone - 1 cm wide slickensided joint	545
550	R119	10:25 10:35	100	100	1	J	B1	MM	SR R S	W S	I	F	30 20 45			550
555	R120	11:00 11:10	100	86	1.2	J	C1	TH MM	R S	W S	I II	F	70 30			555

LOG OF BORING SM-8

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4156725/E4179930
Boring No.: SM-8	Page No.: 17 of 23

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
													30 50		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT BRECCIA; dark greenish gray to greenish black, aphanitic, composed of plagioclase, pyroxene, olivine, closely spaced slickensided chlorite-lined joints, matrix soft and altered, scattered, white zeolite-lined veins	
560	R121	11:31 11:50	96	86	1	J S	B1	TH MM	S SK	W S	I II	F	0 20			560
565	R122	12:05 12:39	100	79	2.2	S	C1	VT TH	SK	W S	I	F	30 60 30		- irregular contact	565
570	R123	12:55 13:30	100	36	2.4	J	B1	TH	R SR	W S	I	F	15 70		**LOWER TOPANGA FORMATION (Ttl):** SANDSTONE; light gray to medium dark gray, coarse-grained sand, rare shell fragments fine-grained sand	570
575	R124	13:40 13:59	100	73	1.2	J	A	VT MM	SR VR	S	I	F	35 60		fine- to coarse-grained sand - 8 cm thick basalt dike - 8 cm thick basalt dike - very rough stepped joint - 3 cm thick basalt dike	575
580	R125	14:06 14:24	100	62	1.8	J	B1	TH	S SR	P S	I	F	35 30		-discontinuous extremely closely spaced nearly vertical fracture zone	580
585	R126	14:34 14:46	100	84	1.8	J	B1	TH	SR S	S P	I II	F	20 40		dark gray - >1 mm wide, tightly healed calcite-lined joints	585
	R127	14:56	100	100	0	-	-	-	-	-	-	-			[drill chatter]	
590	R128	10:35 8/29	92	84	0.8	J S	A	TH T	SR SK	S	I	F				590

LOG OF BORING SM-8

Client: PB/DMJM	**Project:** Metro Red Line-Segment 3
Project No.: 92-2050	**Location:** N4156725/E4179930
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Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
													0 60		**LOWER TOPANGA FORMATION (Ttl):** SANDSTONE; light gray to dark gray, coarse-grained sand, well cemented, massive, moderately closely spaced generally sheared and tightly healed calcite-lined joints up to 3 mm wide, rare shell fragments	
595	R129	10:45 11:16	100	100	0.4	J	A	MM T	R SR	S	I	F	0 10			
600	R130	11:26 13:25	100	100	0	B	A	T	-	-	I	F			all fractures appear to be healed, recemented with calcium carbonate	
605	R131	13:31 14:28	90	90	0	B	A	T	-	-	I	F				
610	R132	14:35 14:53	100	100	0.4	S	A	MM T	SK S	P S	I II	F	20 40			
615	R133	15:00 15:14	100	100	0.4	S J	A	T	SK R	P S	I II	F	40 25		- joints up to 7 mm wide - irregular contact	
620	R134	15:22 15:35	98	98	0.2	J	A	T	R	S	I	F	25 40		SILTSTONE; dark gray, moderately elastic silt, massive, well cemented and dense, very closely spaced tightly healed joints up to 1 cm wide - 15 mm wide gouge zone	
625	R135	15:50 16:28	97	97	1.7	B J	A	TH T	SR	W P	III	F	60		SANDSTONE; moderate bluish gray, fine- to medium- grained sand with silt, massive and moderately friable, closely spaced clay-lined fractures	

The Earth Technology Corporation

LOG OF BORING SM-8

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4156725/E4179930
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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		17:39											35 28		**LOWER TOPANGA FORMATION (Ttl):** SANDSTONE; moderate bluish gray, fine- to coarse- grained sand with silt, wavy and undulating thin bedding with locallised thick bedding, moderately friable, closely spaced clay-lined fractures	
630	R136	10:52 8/31 11:07	100	90	0	B	A	T	S	P	0	F	50		- scattered cobble- and gravel-sized quartzite clasts	630
635	R137	11:20 11:36	100	100	0.2	J	A	T	S	P	I	F	40		greenish gray, fine-grained sand, scattered discontinuous clay-lined joints - scattered large gravel-sized clasts - dark yellowish brown clay laminae	635
640	R138	11:46 11:39	98	55	0.2	B J	A	TH L M	S	P	II	F	60		fine- to coarse-grained sand with silt CONGLOMERATE; matrix supported, fine to coarse gravel and cobbles to 10 cm in size, clasts are rounded and composed of quartzite, matrix consists of greenish gray fine-grained sand and silt, poorly cemented and very friable	640
645	R139	12:18 12:30	100	50	0	B	A	M	S	P	II	F	65		CONGLOMERATIC SANDSTONE; greenish gray, fine- to coarse-grained sand, some gravel with silt, poorly cemented, moderately friable, massive, rounded clasts composed of quartzite	645
650	R140	12:52 13:08	97	57	0.6	J B	B1	T	SR S	W	II	F	60 70 40		SANDSTONE; greenish gray, fine- to medium-grained sand with silt, trace gravel, poorly cemented, moderately friable, massive, widely spaced clay-lined fractures	650
655	R141	13:20 13:37	100	100	0.2	B J	A	TH	S	P	I	F	30 45		- faint bedding	655
660	R142	14:06	100	100	0	B	A	T	S	P	I	F				660

LOG OF BORING SM-8

Client: PB/DMJM
Project: Metro Red Line-Segment 3
Project No.: 92-2050
Location: N4156725/E4179930
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Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Packer Test Interval
													60	
665	R143	14:21 14:35	100	100	0.8	J B	B1	MM	S	P	II	F	70 60	665
670	R144	14:51 15:12	100	100	0	B	A	T M	-	-	-	F		670
675	R145	15:25 15:41	100	100	0.2	B	A	TH	S	P	I II	F	60 45 40	675
680	R146	15:50 16:28	100	100	0.6	B J	A	TH	S	P	II	F	30 40	680
685	R147	16:43 16:53	100	100	0.2	B J	A	TH	-	-	-	F	60 60	685
690	R148	17:10 08:34 9/1	100	97	1	B J	B1	TH	S	P	II	F	50 60 70	690
695	R149	08:49 10:25	100	51	2	J B	C1	MM T	SR SK	S P	II	F		695

Sketch

Lithic Description

LOWER TOPANGA FORMATION (Ttl): SANDSTONE; greenish gray, fine- to medium-grained sand with silt, trace gravel, poorly cemented, moderately friable, massive, wide spaced clay-lined fractures

CONGLOMERATIC SANDSTONE; greenish gray, fine- to medium-grained sand with rounded cobbles, gravel and silt, poorly cemented, moderately friable, massive, wide spaced clay-lined fractures

with cobbles

SANDSTONE; greenish gray, fine-grained sand with silt, trace gravel, poorly cemented, moderately friable, massive, widely spaced clay-lined fractures, localized soft sediment deformation at 679' and 680'

- moderately closely spaced microfaults > 1 mm wide
- faintly laminated

dark greenish gray

- scattered cross-cutting microfaults and soft sediment deformation

LOG OF BORING SM-8

Client: PB/DMJM	Project: Metro Red Line-Segment 3
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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
		10:40											45 55		**LOWER TOPANGA FORMATION (Ttl):** SANDSTONE; greenish gray, fine-grained sand with silt, trace gravel, poorly cemented, moderately friable, massive, widely to moderately closely spaced clay-lined fractures, 8 cm thick dark greenish gray discolored zone at 696'[core lost between 695-696']	
700	R150	11:00 11:11	88	62	0.9	J B	A	MM L VT	S	P	II	F	45		laminated bedding, scattered sandy siltstone interbeds up to 2 cm thick	700
705	R151	11:50 12:13	100	100	0	B	A	L	S	P	I	F			discontinuous microfaulting offsetting bedding up to 1 mm	705
710	R152	12:49 13:06	100	100	0.4	J B	A	L MM	S	P	I	F	42 20 80		- gravelly - gravelly - faint crossbeds below gravel beds	710
715	R153	13:31 13:44	100	95	0.6	B J	C1	L VT	-	-	I	F	42 70 50		faintly laminated to massive bedding - 8 cm thick sandy gravel layer	715 TEST 1
720	R154	14:07 14:19	100	100	0.4	B	A	L	-	-	I	F	52		fine- to medium-grained sand, medium light gray - 0.5 mm wide silt-lined joint	720
725	R155	14:42 14:54	100	100	0.2	B	A	TH	-	-	-	F	70		- slickensided joint	725
	R156		100	100	-	-	-	-	-	-	-	-			CONGLOMERATIC SANDSTONE; medium light gray, fine- to coarse-grained sand, some fine- to coarse gravel, trace cobbles, poorly cemented, moderately friable, massive, unfractured	
730	R157	11:13 9/2	100	90	0	B	A	TH	-	-	-	F	40			730

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Client: PB/DMJM	Project: Metro Red Line-Segment 3
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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
													40		**LOWER TOPANGA FORMATION (Ttl):** CONGLOMERATIC SANDSTONE; medium light gray, fine- to coarse-grained sand, some fine- to coarse gravel, trace cobbles, composed of sandstone, siltstone, basalt and granitics	TEST 2
735	R158	11:32 11:50	100	17	0	B J	B	TH	S	P	III	F	40 52 60		SILTSTONE; 20 cm thick layers of medium bluish gray, grayish brown and medium bluish gray, trace fine-grained sand, poorly cemented, laminated at contact, thinly bedded below	735
740	R159	12:07 12:30	100	100	7.5	B	A	TH VT	-	-	I	F	42		SANDSTONE; medium light gray, fine- to medium-grained sand, with silt, poorly cemented, moderately friable, massive, unfractured - discontinuous tightly healed joint coarse- to fine- grained sand, thinly bedded	740
745	R160	12:47 14:46	100	95	0.8	B J S	A	TH MM	SR	P	III VI	F	42 35 50		1 m thick conglomeratic sandstone layer - clay seam	745
750	R161	15:20 15:25	100	76	1.2	S B J	C1	TH MM	SK SR	P	II	MW HW F	80 30 70 35		- 6 cm thick siltstone layer below cobble zone - 8 mm wide slickensided shear zone above 15 cm thick sandy siltstone layer - 0.4 m thick coarse-grained sandstone layer, very friable - scattered siltstone laminations	750
755	R162	15:50 16:00	100	97	0	B	-	TH L	-	-	-	F	40		laminated to very thinly bedded - 0.3 m thick soft sediment deformation zone	755
760	R163	16:16 16:57	84	84	0.8	J B S	B1	MM	SR SK	P S	II	F	47		coarse-grained sand fine- to medium-grained sand SILTY SANDSTONE; dark bluish gray with olive brown mottling, very fine-grained sand with silt, very friable, massive	760
765	R164	17:12 08:12 9/3	98	98	2	J	B1	TH	SR	P	I II	F				765

The Earth Technology Corporation

LOG OF BORING SM-8

Client: PB/DMJM

Project: Metro Red Line-Segment 3

Project No.: 92-2050

Location: N4156725/E4179930

Boring No.: SM-8

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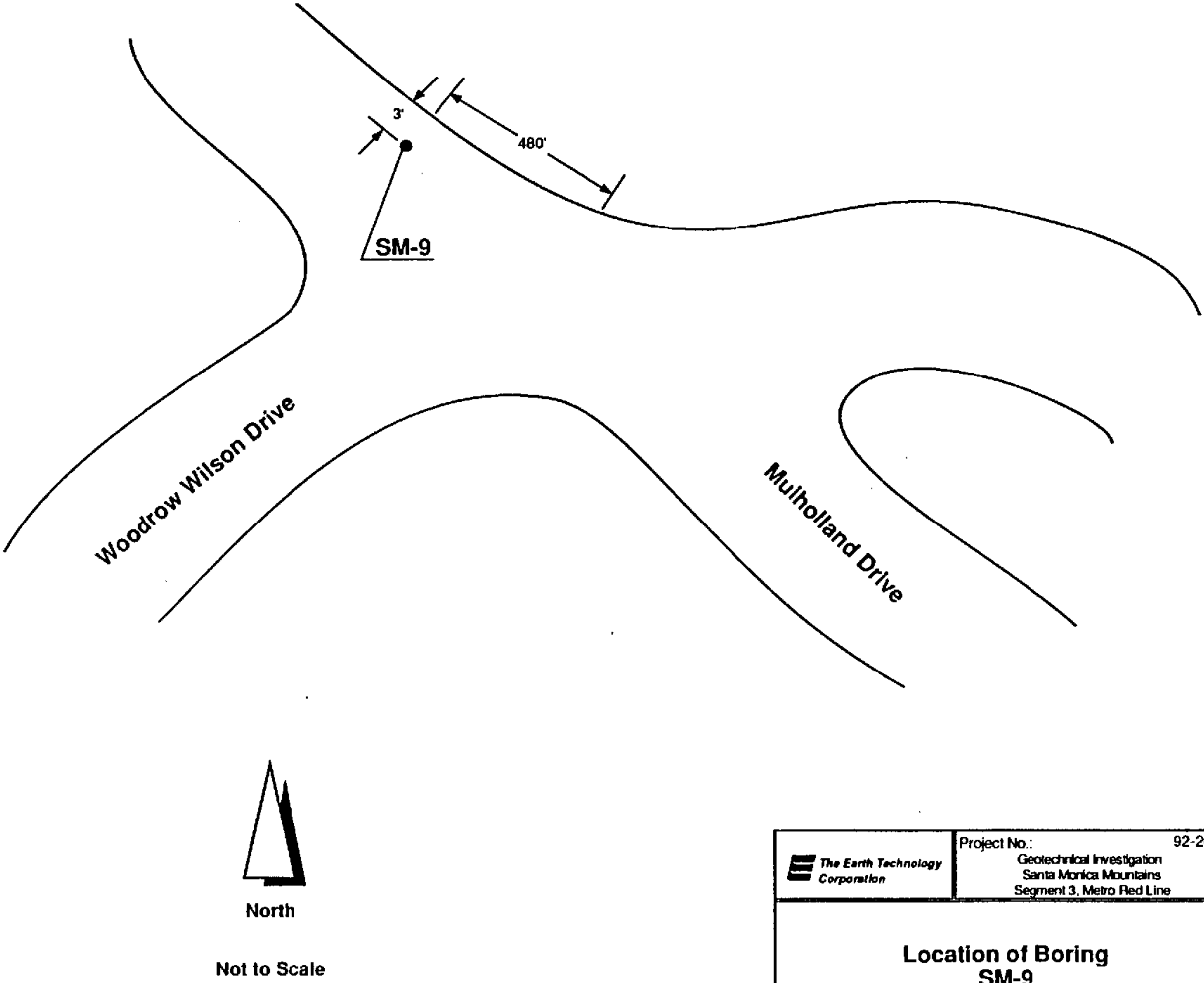
Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
		08:49											35 40		**LOWER TOPANGA FORMATION (Ttl):** **SILTY SANDSTONE**	
770	R165	09:02 09:30	84	78	0.4	J B S	C1	MM	SR SK	P	II	F			SANDSTONE; medium light gray, fine- to coarse-grained sand, well cemented, weakly friable, massive, unfractured SANDY SILTSTONE; dark bluish gray, low plastic silt with very fine-grained sand, some 10 cm thick irregular claystone interbeds that are slickensided, well cemented, massive to medium bedding	770 TESTS
775	R166	09:49 10:00	100	100	0	B J	-	TH	-	-	-	F	57 20		- moderate olive brown discoloration along bedding - gradational contact SILTY SANDSTONE; dark bluish gray, very fine-grained sand, some silt within mottled zones, well cemented, weakly friable, massive, localized soft sediment deformation	775
780	R167	10:21 10:40	100	100	0.6	B J	A	L VT	S	P	I	F	65 80		- laminated, micaceous ARKOSIC SANDSTONE; medium light gray, fine- to medium-grained sand with silt, trace coarse-grained sand, coarse-grained sand shows imbrication, well cemented, weakly friable, very thin to thinly bedded, micaceous	780
785	R168	10:58 11:10	100	100	0.4	B J	A	VT MM	S	P	II	F				785
790 795 800															Boring terminated at 787.5 feet on 9/9/92.	790 795 800



The Earth Technology Corporation

Project No.: 92-2050
Geotechnical Investigation
Santa Monica Mountains
Segment 3, Metro Red Line

Location of Boring SM-9

Figure A-13

LOG OF BORING SM-9

Client: PB/DMJM	Project: Metro Red Line-Segment 3	Project No.: 92-2050
Location: N4157855/E4179223	Surface Elevation (ft): 1112	Boring No.: SM-9
Inclination (Deg.): 90	Bearing: NA Depth (ft): 693.0	Depth to Water Table (ft): 104
Started: 8/12/92 Finished: 9/2/92	Core Dia. (in.): 2.4	No. of Core Boxes: 50
Driller: PC Exploration, Inc.	Drilling Method: Mud rotary Fluids: Bentonite/Clear mud	Drilling Equipment: Mobile B-80
Logged By: P. Smith	Checked By: G. Miller	Page No.: 1 of 20

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
0		8/12													**COLLUVIUM (Qcol):** CLAYEY SILT; grayish brown, moist, soft and loose, low plastic fines, some fine-grained sand [drilled with Chris Drill (stratapax) bit]	0
5															**SILTY GRAVEL;** grayish brown, moist, medium dense, angular gravel and elastic silt, trace fine-grained sand	5
															MIDDLE TOPANGA FORMATION (Ttv): BASALT BRECCIA; dusky yellowish - - brown, brecciated rock fragments range in size from 1 mm to 3 cm, highly altered, very friable, extremely closely spaced zeolite- or clay-lined joints and shears	
10		03:27														10
	R1	11:11	40	0	-	J S	E F	L	S	P		HW				
15		11:15														15
	R2	11:52	37	0	-	J S	E F	L	S	P		HW				
20		11:54														20
	R3	12:09	60	0	-	J S	E F	L	S	P		MW			gradational color change to olive gray	
		12:15														
	R4	12:25	49	0	-	J S	E F	L	S	P		SW	45			
25		12:34														25
	R5	13:54	79	0	-	J S	F E	L	S	P		SW	60			
		14:25														
	R6	15:37	100	93	2.3	J	C1	VT	S	P	VI	F	40- 60			
		16:13														
30																30

LOG OF BORING SM-9

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4157855/E4179223
Boring No.: SM-9	Page No.: 2 of 20

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
30	R7	16:18 17:18	100	94	2.8	J	C1	VT	S	P	II	FW F	35		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT BRECCIA; olive gray, brecciated rock fragments range in size from 1 mm to 3 cm, highly altered, very friable, very closely spaced zeolite- or clay-lined joints and shears	30
35	R8	07:39 8/13 08:07	95	52	4	J	C1	VT	S SR	P	II	F	65		- 7-12 mm wide zeolite?-lined joint	35
	R9		90	0	10.8	J	C1	VT	S	P	II	FW	60			
	R10	08:49 09:11	98	87	4.5	J	C1	VT	S SR	S P	II	FW	60		- iron oxide stained joints	
40	R11	09:41 10:36	95	60	3.4	J	C1	VT	SR	P	II	F	55			40
45	R12	10:44 11:27	100	78	5.2	J	C1	VT	SR	P	I	F	60 30		- 7-12 mm wide zeolite?-lined joint	45
50	R13	11:33 11:53	100	87	3.2	J	C1	VT	SR	P	I	F	65 25			50
55	R14	12:56 13:47	92	53	7	J	D1	VT	SR	P	I	F	70 40 20			55
60	R15	13:54 14:54	98	98	2.3	J	C1	VT	SR	P	I	F	70 10		closely spaced irregular fractures	60
	R16	15:24 15:40	44	33	3.3	J	C1	VT	SR	P	I	F	70		[change to diamond impregnated drill bit]	
65																65

LOG OF BORING SM-9

Client: PB/DMJM

Project: Metro Red Line-Segment 3

Project No.: 92-2050

Location: N4157855/E4179223

Boring No.: SM-9

Page No.: 3 of 20

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R17	07:48 8/14 08:35	88	86	3.2	J	D1	VT	SR	P	I	F	30 50 70		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT BRECCIA; olive gray, brecciated rock fragments range in size from 1 mm to 3 cm, highly altered, very friable, closely spaced zeolite- or clay-lined joints and shears	
70	R18	08:40 09:13	100	82	2.8	J	C1	VT	SR	O	V	F	40 70		- (2) 7 mm wide open joints partially lined with zeolite?	70
75	R19	09:19 09:45	88	60	3.6	J	C1	VT	SR	0	VII	F	60 40		- locally tightly healed joints - grayish brown clay (?) coating on joint surfaces	75
80	R20	09:51 10:35	86	58	3	J S	C1	VT	SR	W	V	F	70 40		light bluish gray zeolite? infills joints and vugs, alternates between white and transluscent bluish gray	80
85	R21	10:45 11:23	100	90	3.2	J	D1	VT	SR	O	VII	F	30 40 70		- 7-12 mm wide open joint partially lined with zeolite crystals	85
90	R22	11:29 12:21	100	61	3.4	J	D1	VT	SR	P	VII	F	30 40 60		[driller reports water loss]	90
95	R23	13:49 14:39	87	79	3	J	C1	VT	VR	S	V	F	30 60			95
100																100

LOG OF BORING SM-9

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4157855/E4179223
Boring No.: SM-9	Page No.: 4 of 20

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R24	14:40 15:38	100	48	3.3	J	C1	VT	SR	W	V	F	40 70		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT BRECCIA; light olive gray and bluish gray, brecciated rock fragments range in sise from 1 mm to 3 cm, highly altered, extremely closely spaced seolite- or clay-lined joints and shears	
105	R25	15:52 16:06	88	38	4	J	C1	VT	SR	P	V	F	40 70		massive basalt, highly fractured, fractures filled with seolite and bluish green mineral	105
	R26	16:46	96	50	4.7	J	C1	VT	SR	W	V	F	35 70			
110	R27	16:52 17:17	100	60	6	J	C1	VT	VR	S	VII	F	70 40		very closely spaced joints with seolite infilling	110
	R28	17:27 17:37	100	72	8	J	D1	VT	VR	S	V	F	70 30			
115	R29	18:06 18:22	58	0	5	J	B1	VT	SR	W	VII	F	40		brecciated interval	115
	R30	08:03 8/15 08:30	100	47	6.7	S	C1	VT	SR	W	V	F	30 70			
120	R31	08:59 09:25	100	33	4	S	F	VT	SR	W	V	F	50 70		basalt breccia, closely spaced clay- and seolite-lined joints, extensively sheared with clay	120
125	R32	09:30 09:49	100	30	4.8	S	F	VT	SR	P	V	F	70 25		- [mild rig chatter]	125
130	R33	09:54 10:09	100	33	4	S	D1	VT	SR	W	V	F	40 90		- irregular, nearly vertical grooved and slickensided shear	130
	R34		88	46	7	S	C1	VT	SR	W	V	F	50			
135	R35	10:44	93	59	4.9	S	D1	VT	SR	W	V	F	70			135

LOG OF BORING SM-9

Client: PB/DMJM
Project: Metro Red Line-Segment 3
Project No.: 92-2050
Location: N4157855/E4179223
Boring No.: SM-9
Page No.: 5 of 20

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		11:43											35 70		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT BRECCIA; light olive gray, brecciated rock fragments range in size from 1 mm to 3 cm, highly altered, closely spaced zeolite- or clay-lined joints and shears [@ 137' change to diamond impregnated drill bit then after no progress back to Chris Drill (stratapax) bit]	
	R36	12:48 13:08	52	52	2	J	C1	VT	VR	S	V	F	50 30			
140	R37	14:24 15:08	100	100	5	J	D1	VT	VR	S	V	F	30 50 70			140
	R38	15:13 16:05	100	100	6.4	J	C1	VT	VR	S	V	F	50 60			
145	R39	07:59 8/17 09:41	100	50	9	J	C1	VT	VR	W	VII	F	60 70		very closely spaced joints [switch to diamond surface set drill bit] - 7 mm wide tightly healed joint lined with white zeolite?	145
150	R40	10:22 10:39	92	85	4.6	S	D1	VT	VR	W	V	F	35 70		closely spaced joints [switch to new stratapax bit]	150
	R41	10:46	58	58	6	J	C1	VT	VR	S	V	F	45			
155	R42	10:56 11:00 11:20	95	25	4.2	S F	D1	VT	SR	W	V	F	35 60		[driller indicates water loss] - 0.7 m wide extremely closely sheared zone	155
160	R43	11:44 12:15	98	60	2.6	J	E	VT	SR	P	V	F	35 70			160
165	R44	13:27 14:18	95	42	4	S	D1	VT	SR	W	V	F	40 50 70		- 15 cm wide extremely closely fractured zone	165
170																170

LOG OF BORING SM-9

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4157855/E4179223
Boring No.: SM-9	Page No.: 6 of 20

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R45	14:34 15:01	82	45	6.6	J	C1	VT	SR	P	V	F	60 30		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT BRECCIA; light olive gray, brecciated rock fragments range in size from 1 mm to 3 cm, highly altered, very friable, very closely spaced zeolite-lined joints	
175	R46	15:07 15:22	95	92	7.6	J	C1	VT	SR	W	VII	F	60 70			175
180	R47	15:30 15:45	100	63	3.2	J	C1	VT	R	S	V	F	50 60		extremely closely fractured zone	180
185	R48	15:52 16:07	100	72	3.4	J	C1	VT	SR	P	V	F	70 40			185
190	R49	16:13 16:22	100	70	5.2	J	D1	VT	SR	P	VII	F	70 40 50			190
195	R50	16:31 16:45	100	87	9.2	S	D1	VT	SR	W	V	F	70 40 50		very closely spaced joints	195
200	R51	16:51 17:04	70	63	3	J	C1	VT	VR	S	V	F	70 80		moderately closely spaced joints	200
205																205

LOG OF BORING SM-9

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4157855/E4179223
Boring No.: SM-9	Page No.: 7 of 20

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R52	07:27 8/18 07:33	100	54	2.5	S	C1	VT	SR	W	V	F	40 80		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT BRECCIA; olive gray, brecciated rock fragments range in size from 1 mm to 3 cm, highly altered, very friable, closely spaced zeolite-lined joints and shears	
210	R53	07:43 07:54	54	54	4	S	B1	VT	SR	W	V	F	50		- 0.4 m wide, very closely sheared zone	210
	R54	07:58 08:19	100	100	10	J	C1	VT	SR	W	VII	F	30 50		massive basalt, very closely spaced joints with zeolite infilling	
215	R55	08:25 08:48	90	80	6	J	C1	VT	SR	W	VII	F	30 60		brecciated basalt	215
220	R56	08:57 09:21	100	83	9.6	J	D1	VT	SR	W	V	F	30 60 70		massive basalt, very closely fractured with zeolite infilling	220
225	R57	10:30 10:42	100	80	6.8	J	C1	VT	SR	W	V	F	20 40			225
230	R58	10:48 11:16	100	85	5.4	J	D1	VT	SR	P	VII	F	30 40 60			230
235	R59	11:22 11:41	90	68	20	J	C1	VT	VR	W	VII	F	40 60		very close to extremely closely spaced joints - breecciated interval	235
240																240

LOG OF BORING SM-9

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4157855/E4179223
Boring No.: SM-9	Page No.: 8 of 20

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R60	12:33 12:59	100	24	2.8	S	C1	VT	SR	W	VII	F	50 60		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT; olive gray, highly altered, closely spaced zeolite-lined joints and shears; @ 242-245' extremely closely fractured zone [switch to surface set diamond bit at 243.2']	
	R61	13:04 13:13	100	0	-	J	C1	VT	VR	S	V	F	40 60			
245	R62	13:19 13:38	93	90	8.4	J	D1	VT	SR	W	VII	F	40 70		massive basalt, very closely spaced joints	245
250	R63	15:47 16:15	95	85	4.2	J	D1	VT	SR	W	VII	F	50 70			250
255	R64	16:42 17:04	100	70	6.6	J	C1	VT	VR	O	V	F	30 50		- scattered zeolite- with calcite-lined joints	255
260	R65	17:13 17:34	85	62	4.6	J	C1	VT	SR	O	VII	F	70 30		- open joint partially lined with crystalline calcite	260
265	R66	07:24 8/19 07:46	100	75	4.6	S	C1	VT	SR	O	VII	F	40 70		- 15 cm wide shear zone with zeolite? and minor pyrite within open joints	265
270	R67	07:58 08:17	100	92	7	J	C1	VT	SR	O	VII	F	30 60		- scattered open and partially zeolite?-lined joints	270
275																275

LOG OF BORING SM-9

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4157855/E4179223
Boring No.: SM-9	Page No.: 9 of 20

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R68	08:29 09:08	100	100	3.4	J	B1	VT	R	W	VII	F	60		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT BRECCIA; olive gray, brecciated rock fragments range in size from 1 mm to 3 cm, closely spaced zeolite- and chlorite-lined joints and shears	
280	R69	09:20 10:00	100	100	2.6	J	C1	VT	R	S	VII	F	30 70			280
285	R70	10:47 11:26	100	82	4	S	A	VT	SR	W	VII	F	40		- very closely sheared zone	285
290	R71	11:36 12:19	98	78	9.6	J	B1	VT	VR	W	VII	F	70		very closely spaced joints	290
295	R72	12:32 13:24	100	80	5.2	J	B1	VT	R	W	V	F	70			295
300	R73	10:49 8/24 11:12	100	100	8.2	S	D1	VT	SR	W	V	F	25 40 70		shears are slickensided [change to tungsten carbide drill bit]	300
305	R74	11:34 11:55	100	37	9.8	S	C1	VT	SR	P	V	F	40 70			305
310																310

LOG OF BORING SM-9

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4157855/E4179223
Boring No.: SM-9	Page No.: 10 of 20

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R75	12:07 12:27	90	88	7.2	J	C1	VT	SR	W	V	F	50 70		MIDDLE TOPANGA FORMATION (Ttv): BASALT BRECCIA; olive gray, brecciated rock fragments range in size from 1 mm to 3 cm, closely spaced tightly healed zeolite- and chlorite-lined joints and slickensided shears	
315	R76	12:40 13:05	100	100	2.1	J	B1	VT	VR	S	V	F	35		basalt fragments contained in a fine grained chloritized(?) matrix, clasts contain few filled vesicles, many healed fractures filled with white zeolite	315
320	R77	13:16 13:42	94	94	3.3	S	C1	VT	SR	W	V	F	50			320
325	R78	13:57 14:17	97	94	1.6	S	B1	VT	SR	W	V	F	50			325
330	R79	14:28 14:51	100	85	2.2	S	C1	VT	SR	W	V	F	60 70			330
	R80	15:04 15:13	100	80	.6	J	A	MM T	SR R	W S	V	F	45			
335	R81	15:21 15:55	98	78	1.4	J S	B1	MM	SK	S	V	F	60- 90		- rock fragments appear rounded - 0.3 m wide, very closely fractured zone	335
340 345	R82	16:03 16:30	100	92	0.8	J	B1	MM	R	S	V	F	40		rock fragments are angular to subrounded, clasts contain few vesicules filled with white zeolite	340 345

LOG OF BORING SM-9

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4157855/E4179223
Boring No.: SM-9	Page No.: 11 of 20

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R83	16:43 17:08	100	92	0.4	J S	B1	MM T	SK	S	V	F	75 75		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT BRECCIA; olive gray, brecciated angular to sub rounded rock fragments ranging in size from 1 mm to 3 cm, contained in a fine grained matrix, very friable, closely spaced tightly healed zeolite- and chlorite-lined joints and slickensided shears	
350	R84	17:19 17:46	100	88	1.4	J S	C1	MM	SK	S	V	F	90 55 55			350
355	R85	07:45 8/25 08:16	100	100	1.7	J	A	MM	R	S	V	F	0			355
360	R86	08:31 09:00	100	95	1.6	J	B1	MM	R	S	VI	F	30 60-70 70		- matrix has flow-like texture	360
365	R87	09:16 09:55	100	90	1.2	J S	B1	TH	SK	W	V	F	15 70 40		- slickensided joints - matrix has flow-like texture	365
370	R88	09:58 10:36	100	95	1.2	J S	B1	TH	SK	P	VII	F	30 50			370
375	R89	11:01 11:38	95	93	3.4	J	D1	VT	R	S	VII	F	70 60 40			375
	R90	11:50	100	95	2.8	J	D1	TH	SR	W	V	F	30			
380																380

LOG OF BORING SM-9

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4157855/E4179223
Boring No.: SM-9	Page No.: 12 of 20

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
													50 70 20		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT BRECCIA; olive gray, brecciated angular to sub rounded rock fragments range in size from 1 mm to 5 cm, contained in a fine grained matrix, closely spaced tightly healed zeolite- and chlorite-lined joints and slickensided shears	
385	R91	12:16 12:38	100	83	2.4	J	B1	VT	SR	P	V	F	30 30			385
390	R92	13:07 13:16	88	77	2.4	S	B1	VT	SK	W	VII	F	30 30			390
395	R93	13:44 13:58	97	97	3	J	C1	VT	R	W	V	F	50 70 50 70		breccia has little to no matrix, rock fragments bounded by healed fractures lined with zeolites?	395
400	R94	14:20 14:29	100	93	3	J	B1	VT	R	P	V	F	50 50 50			400
405	R95	14:53 15:05	100	83	2.4	J	C1	VT	R	W	V	F	50 90 50 60		- 0.3 m wide extremely closely fractured zone	405
410	R96	15:33 15:44	100	87	2.4	S	C1	VT	SK	O	VII	F	50 70 30 30		- extremely closely sheared zone	410
415	R97	16:10 16:20	100	88	1.8	S	C1	VT	SK	W	V	F	50 30			415

LOG OF BORING SM-9

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4157855/E4179223
Boring No.: SM-9	Page No.: 13 of 20

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
													0 30 50		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT BRECCIA; olive gray, brecciated and vesicular with angular to subrounded rock fragments which range in size from 1 mm to 3 cm, closely spaced tightly healed zeolite- and chlorite-lined joints and slickensided shears, vesicules filled with zeolites and chlorite(?); 3-4 mm open joint partially lined with crystalline calcite at 420'; clasts suspended in fine matrix below 422'; matrix supported	
420	R98	16:45 16:57	95	85	3	S	D1	VT	SR	O	VII	F	30 60 30			420
425	R99	17:31 07:24 8/26	100	82	3.2	J	C1	VT	R	S	V	F	70 30 50			425
430	R100	08:24 12:40	88	87	2.4	J	C1	VT	SR	P	VIII	F	50 15 30 50		- extremely closely fractured, clay-lined	430
435	R101	13:16 13:31	100	78	2.4	J	C1	VT	SR	P	VII	F	50 20 50 40		- extremely closely fractured	435
440	R102	13:59 14:13	100	77	1.4	S	C1	VT	SK	W	V	F	30 50 30		- extremely closely fractured	440
445	R103	14:44 14:57	97	97	2	J	C1	MM	R	W	V	F	30 20 50		very little matrix, clast supported	445
450	R104	15:29 15:34	100	100	1.4	J	B1	MM	R	W	VII	F	40			450

LOG OF BORING SM-9

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4157855/E4179223
Boring No.: SM-9	Page No.: 14 of 20

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Lithic Description	Packer Test Interval
													20	**MIDDLE TOPANGA FORMATION (Ttv):** BASALT BRECCIA; olive gray, brecciated angular to sub rounded rock fragments range in size from 1 mm to 5 cm, closely spaced, randomly oriented, tightly healed zeolite- and chlorite-lined joints and slickensided shears	
		16:07											35		
	R105	16:17	100	98	2.8	J	B1	MM	VR	P	VIII	F	30		
455													40		455
		16:43											25		
	R106	16:52	100	92	4.4	S	D1	VT	R	W	V	F	50		
460													20	increase in amount of matrix, matrix supported	460
		17:27											30		
	R107	08:09 8/27	98	97	2.2	S	B1	MM	SR	P	VII	F	50		
465													70		465
													10		
		08:40												below shear, very little matrix, clast supported	
	R108	08:51	100	77	3.6	S	D1	VT	S	P	VII	F	30		
470													60		470
		09:18											50	- 0.3 m thick very closely fractured zone	
	R109	09:27	100	93	3	J	D1	VT	R	P	VII	F	70		
475													50		475
		10:00											30		
	R110	10:09	100	97	1.6	J	C1	VT	R	S	VII	F	55 40	increase in amount of matrix, matrix supported	
480															480
		10:46											20		
	R111	10:56	93	83	2	J	B1	VT	R	S	V	F	30		
		11:15											60		
485															485

LOG OF BORING SM-9

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4157855/E4179223
Boring No.: SM-9	Page No.: 15 of 20

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R112	11:33 12:13	90	73	2.6	S	C1	VT	SK	P	VII	F	80 70 80		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT BRECCIA; olive gray, brecciated angular to sub rounded rock fragments range in size from 1 mm to 5 cm, clasts supported by fine-grained matrix, closely spaced, randomly oriented, tightly healed zeolite- and chlorite-lined joints and slickensided shears, scattered zeolite? and chlorite-lined amygdules	
490	R113	12:22 13:15	99	95	2.6	J	C1	TH	SR	P	V	F	20 50 30			490
495	R114	13:20 14:00	87	87	6	J	C1	VT	SR	P	VII	F	30 70 30		little to no matrix, very closely spaced joints, clast supported	495
500	R115	14:05 14:30	98	95	3.6	J	C1	VT	SR	P	VII	F	30 60 10		closely spaced joints	500
505	R116	14:39 15:12	94	94	1.6	J	C1	TH	S	W	V	F	30 50		matrix supported	505
510	R117	15:24 15:55	97	82	1.4	S	A	TH	SK	P	V	F	40 30		clast supported, amygdules filled with zeolite	510
515	R118	16:06 16:35	100	100	2.8	S	C1	VT	SK	P	V	F	50 30 30			515
520																520

LOG OF BORING SM-9

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4157855/E4179223
Boring No.: SM-9	Page No.: 16 of 20

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R119	16:44 17:19	88	65	1.4	S	B1	VT	S	P	VII	F	50 70 30		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT BRECCIA; olive gray, brecciated angular to sub rounded rock fragments range in size from 1 mm to 5 cm, clast supported, closely spaced, randomly oriented, tightly healed zeolite- and chlorite-lined joints and slickensided shears, scattered zeolite and chlorite-lined amygdules	
525	R120	07:25 8/28 07:59	100	87	1.6	S	B1	VT	S	P	V	F	20 30 50		matrix supported	
530	R121	08:09 08:39	97	37	.6	S	B1	VT	S	P	V	F	70		- very closely fractured zone with shears and horizontal grooves	
535	R122	08:53 09:31	100	65	2	S	B1	VT	SR	P	V	F	70 80			
540	R123	09:43 10:21	100	92	.6	J	C1	MM	R	W	V	F	50 65		moderately closely spaced joints - rare amygdules - very closely fractured zone	
545	R124	10:34 11:17	100	82	2.4	S	C1	MM	SR	P	VII	F	50 30 50 40			
550	R125	11:30 12:10	73	73	1.6	J	C1	TH	SR	P	V	F	30 50 30			
555																

LOG OF BORING SM-9

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4157855/E4179223
Boring No.: SM-9	Page No.: 17 of 20

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R126	12:21 12:55	100	100	1.5	J	B1	MM	R	W	V	F	70 10		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT BRECCIA; olive gray, brecciated angular to sub rounded rock fragments range in size from 1 mm to 5 cm, matrix supported, closely spaced, randomly oriented, tightly healed zeolite- and chlorite-lined joints and slickensided shears, scattered zeolite? and chlorite-lined amygdules	
560	R127	13:06 13:50	100	82	1.8	S	C1	VT	SR	P	VII	F	70 55			560
565	R128	14:01 14:43	100	73	3.8	S	D1	VT	SR	P	V	F	40 20 60		several 15 cm wide extremely closely fractured, crushed zones	565
570	R129	14:52 15:37	100	70	2.8	J	C1	VT	R	W	V	F	50 70			570
575	R130	15:48 16:23	100	100	1.5	J	C1	TH	SR	P	V	F	40 80			575
580	R131	08:24 8/29 09:05	100	92	1.2	J	B1	TH	S	W	V	F	30 60 0		- 15 cm wide extremely closely fractured, crushed zone	580
585	R132	09:16 09:58	100	100	.8	S	B1	MM	SK	P	V	F	30 35 30		- grooved shear	585
590	R133	10:09	100	100	1	S	B1	MM	SK	P	V	F	0		- nearly vertical, irregular joint	590

LOG OF BORING SM-9

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4157855/E4179223
Boring No.: SM-9	Page No.: 18 of 20

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		10:55											35 15		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT BRECCIA; olive gray, brecciated angular to sub rounded rock fragments range in size from 1 mm to 5 cm, matrix supported, closely spaced, randomly oriented, tightly healed zeolite- and chlorite-lined joints and slickensided shears, scattered zeolite? and chlorite-lined amygdules	
595	R134	11:06 11:50	100	65	2.4	S	C1	VT	SK	P	V	F	50 40 30		- 0.3 m wide crushed zone, extremely closely fractured	595
600	R135	12:03 12:37	100	80	1.2	S	B1	VT	SK	P	V	F	50 30 50		- 0.3 m wide crushed zone, extremely closely fractured	600
605	R136	12:51 13:29	100	70	1.6	S	B1	VT	SK	P	V	F	0 30 60			605
	R137		100	78	4	J	A1	VT	R	W	V	F				
610	R138	14:12 14:39	100	69	2.1	S	C1	VT	SK	P	V	F	40 80			610
615	R139	14:51 15:25	95	95	1.6	J	B1	TH	R	P	V	F	40 10		scattered amygdules	615
620	R140	15:28 16:14	100	82	2.6	J	B1	VT	VR	S	V	F	80 0 40			620
625	R141	16:26	98	93	2	S	C1	VT	SK	P	V	F	50			625

LOG OF BORING SM-9

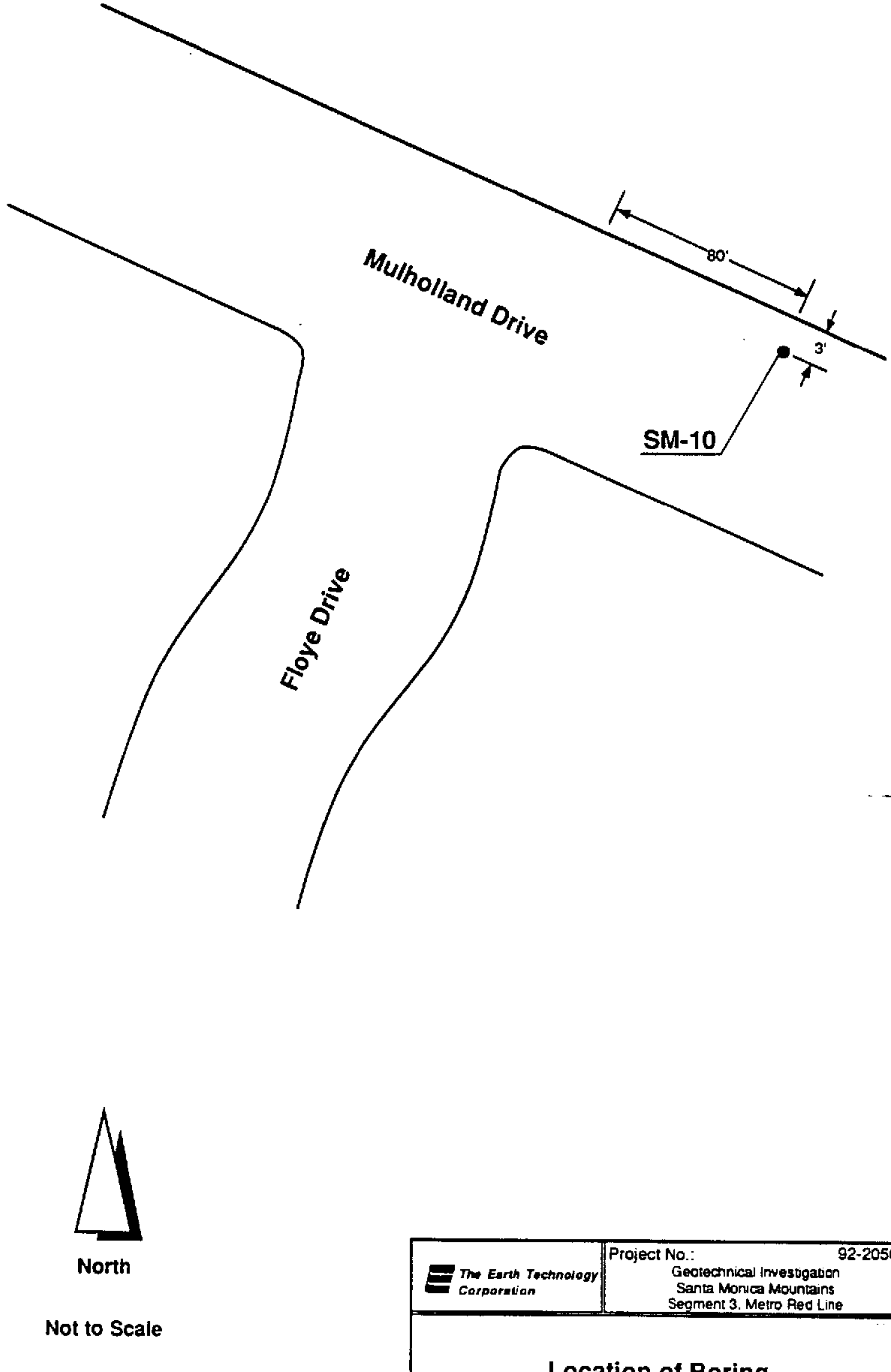
Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4157855/E4179223
Boring No.: SM-9	Page No.: 19 of 20

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		16:59											70 25		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT BRECCIA; olive gray, brecciated angular to sub rounded rock fragments range in size from 1 mm to 5 cm, matrix supported, closely spaced, randomly oriented, tightly healed zeolite- and chlorite-lined joints and slickensided shears, scattered zeolite? and chlorite-lined amygdules	TEST 1
630	R142	07:32 8/31 08:05	100	95	1	S	C1	MM	SK	P	V	F	40 50		- 1 mm wide grooved shear - 1 mm wide grooved shear	630
635	R143	16:49 17:14	88	86	1.6	S	B1	TH	SK	W	V	F	40		close to very closely spaced shears	635
640	R144	07:52 9/1 08:27	100	70	3.1	S	D1	VT	SK	P	V	F	30			640 TEST 2
645	R145	08:39 09:16	90	90	1.6	S	B1	TH	SK	P	V	F				645
650	R146	13:39	100	89	2	S	C1	VT	SK	P	V	F				650
655	R147	14:15 14:26	100	80	1.2	S	A1	TH	SK	W	V	F	60 0 0			655
660	R148	15:02 15:14	95	95	.8	S	B1	VT	SK	W	VII	F	60 75		abundant tightly healed joints	660

LOG OF BORING SM-9

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4157855/E4179223
Boring No.: SM-9	Page No.: 20 of 20

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
													0		**MIDDLE TOPANGA FORMATION (Ttv):** BASALT BRECCIA; olive gray, brecciated angular to sub rounded rock fragments range in size from 1 mm to 3 cm, matrix supported, closely spaced, randomly oriented, tightly healed zeolite- and chlorite-lined joints and slickensided shears, scattered zeolite? and chlorite-lined amygdules	
	R149	15:43 15:53	100	89	.7	S	B1	TH	SK	P	V	F	30 10			
665	R150	16:14 16:29	85	85	1.4	S	B1	TH	SK	P	V	F	70 40			665
670	R151	16:57 17:07	100	56	.4	S	B1	VT	SK	P	V	F	0 20			670
675	R152	17:27 07:23 9/2	92	73	1.4	J	C1	TH	SR	P	V	F	60 0 45			675
680	R153	07:58 08:09	100	63	2.6	S	C1	VT	SK	P	V	F	80 60 50		- 15 cm wide crushed zone, extremely closely fractured - 15 cm wide crushed zone, extremely closely fractured	680 TEST 3
685	R154	08:35 08:48	97	85	2	S	B1	VT	SK	P	V	F	60 30 35		- 15 cm wide crushed zone, extremely closely fractured	685
690	R155	09:15 10:16	100	90	1.2	J	A1	MM	VR	S	V	F	15 0			690
695		10:42													Boring terminated at 693 feet on 9/2/92	695



The Earth Technology Corporation

Project No.: 92-2050
Geotechnical Investigation
Santa Monica Mountains
Segment 3, Metro Red Line

Location of Boring
SM-10

Figure A-14

LOG OF BORING SM-10

Client: PB/DMJM
Project: Metro Red Line-Segment 3
Project No.: 92-2050
Location: N4158960/E4178709
Surface Elevation (ft): 1147
Boring No.: SM-10
Inclination (Deg.): 90
Bearing: NA
Depth (ft): 703.0
Depth to Water Table (ft): 84
Started: 10/17/92
Finished: 11/7/92
Core Dia. (in.): 2.4
No. of Core Boxes: 50
Driller: PC Exploration, Inc.
Drilling Method: Mud rotary
Fluids: Bentonite/Clear mud
Drilling Equipment: Mobile B-80
Logged By: P. Smith
Checked By: G. Miller
Page No.: 1 of 21

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
0	R1	- 10/19 -	50	0	0.75	J	B1	VT	R	W S	II	HW	40		**ASPHALT** [diamond impregnated bit] **UPPER TOPANGA FORMATION (Ttucg):** CONGLOMERATE; matrix supported, fine to coarse gravel and cobbles (60%), clasts are angular to subrounded, composed of plutonics, quartsite, slate, basalt and shale, matrix consists of pale yellowish brown to dusky yellow fine- to coarse-grained sand that is poorly cemented and very friable, massive, moderately closely spaced iron oxide stained joints	0
5	R2	07:46 10/20 08:07	63	48	0.4	J	A	MM	R	W	II	HW	65		- granitic clast, 8 cm in sise - siltstone clast, 8 cm in sise, 5 mm wide open vertical joint	5
10	R3	08:13 08:31	88	83	0.7	J	A	MM	R	W S	II	HW	20 50 30		SANDSTONE; dusky yellow, medium- to coarse-grained sand, trace angular to subrounded gravel-sized clasts composed of plutonics, quartsite, slate, basalt and shale, friable, massive, scattered tightly healed iron oxidised joints	10
15	R4	- 09:20	100	72	1.2	J	A	TH	R	W S	II	HW	20 40		CONGLOMERATE; matrix supported, fine to coarse gravel to 3 cm, angular to subrounded clasts composed of plutonics, quartsite, slate, basalt and shale, matrix consists of pale yellowish brown to dusky yellow fine- to coarse-grained sand	15
20	R5	10:16 10:30	100	90	0.8	J	B1	TH	R	W S	II	HW	80 60 50		SANDSTONE; dusky yellow, medium- to coarse-grained sand with angular to subrounded gravel-sized clasts composed of plutonics, quartsite, slate, basalt and shale, friable, massive, scattered tightly healed iron oxidised joints - siltstone clast, 15 cm in sise	20
25	R6	10:40 10:55	100	100	1.2	J	A	TH	R	-	II	HW	70 60 55			25
30																30

LOG OF BORING SM-10

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4158960/E4178709
Boring No.: SM-10	Page No.: 2 of 21

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
30	R7	11:05 11:20	100	33	2.6	J	C1	VT	SR	P	III	HW	40 60 50		**UPPER TOPANGA FORMATION (Ttu):** SANDSTONE; dusky yellow, medium- to coarse-grained sand, some angular to subrounded gravel-sized clasts up to 8 cm in size, composed of plutonics, quartzite, slate, basalt and shale, friable, massive, scattered tightly healed iron oxidized joints	30
35	R8	11:25 11:40	100	95	0.8	J	B1	MM	SR R	P	III	SW	40 30		medium dark gray with angular to subrounded gravel	35
40	R9	11:50 12:09	100	92	1.5	J	B	TH	SR	P	II	SW	40 20		light olive gray gravel (30%) to 4 cm in size	40
45	R10	12:18 12:35	100	93	0.8	J	A	TH	R	P W	II	SW	20 70		medium dark gray	45
	R11	12:43 13:05	100	40	2.4	J	A	VT	R	W S	II	SW	50		conglomeratic sandstone layer with clasts up to 5 cm in size	
50	R12	13:54	81	78	0.6	J	A	TH	R	W S	II	SW	40		[change to new bit]	50
55	R13	14:02 14:21	82	43	4	B	B1	VT	S	P	VIII	HW	71		light olive gray, very thinly bedded - 15 cm wide extremely closely fractured sone with clay	55
60	R14	15:42 16:00	100	97	0.8	J	B	TH MM	SR	P	I	SW	40 40 40		massive	60
65																65

LOG OF BORING SM-10

Client: **PB/DMJM**	Project: **Metro Red Line-Segment 3**
Project No.: **92-2050**	Location: **N4158960/E4178709**
Boring No.: **SM-10**	Page No.: **3 of 21**

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R15	16:09 16:24	100	67	1	J	B	TH	SR	P	II	SW	35 40 40		**UPPER TOPANGA FORMATION (Ttu):** SANDSTONE; dusky yellow, medium- to coarse-grained sand with rare angular to subrounded gravel-sized clasts composed of plutonics, quartzite, slate, basalt and shale, friable, massive, scattered tightly healed iron oxidized joints	
70	R16	16:33 16:46	100	55	3	J B	B	VT TH	SR	P	II	SW HW	40 30		light olive gray interval gravel up to 3 cm in size conglomerate layer, clasts up to 13 cm in size, matrix supported fine- to very fine-grained sand, medium bedded, inclined 55 degrees	70
75	R17	16:50 17:04	100	38	1.8	J B	B1	TH VT	SR	P	II	HW	40 40 50 60			75
80	R18	17:15 17:28	100	53	1.6	J	C	TH	SR R	P	II	HW SW	30 60 40 30			80
85	R19	- 10/21 08:10	100	88	0.4	S	A	MM	SK	P	VI	HW	60		- 3 mm wide slickensided clay seam gravel up to 5 cm in size	85
90	R20	08:18 08:39	100	68	1.4	J	B	TH MM	SR	P	II	HW SW	65 25 50			90
95	R21	08:50 -	100	52	1.8	S	C	TH	S	P	VI	HW SW	40 60 40 35			95
100																100

LOG OF BORING SM-10

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4158960/E4178709
Boring No.: SM-10	Page No.: 4 of 21

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R22	09:12 09:25	93	0	2.6	S	C1	VT	S	P	VI	SW	60 35 70		UPPER TOPANGA FORMATION (Ttu): SANDSTONE; light olive gray to medium dark gray, medium- to coarse-grained sand, trace angular to subrounded gravel with clasts up to 8 cm in size and composed of plutonics, quartzite, slate, basalt and shale, friable, massive, scattered tightly healed iron oxidised joints and clay seams; 1 mm wide slickensided clay seams between 101-103'	
105	R23	12:15 12:35	100	92	0.8	S	B	MM	S	P	VI	SW	70			105
110	R24	12:42 -	100	32	1.6	B	B1	VT TH	S SR	P	I	FW	70 40		- thin shale or lignite fragments oriented parallel to bedding	110
115	R25	13:12 13:31	100	100	0	B	-	MM	-	-	-	F	65		unfractured, medium bedding, inclined 65 degrees	115
120	R26	13:38 13:57	100	100	0	B	-	MM	-	-	-	F	65		slightly coarser-grained sand with scattered clasts to 1 cm in size	120
125	R27	14:10 14:29	100	100	0	B	-	MM	-	-	-	F				125
130	R28	14:38 15:02	100	100	0.2	J	A	MM	R	W	I	F	35		CONGLOMERATIC SANDSTONE; medium dark gray, medium- to coarse-grained sand and angular to subrounded gravel-sized clasts	130
135																135

LOG OF BORING SM-10

Client: PB/DMJM

Project: Metro Red Line-Segment 3

Project No.: 92-2050

Location: N4158960/E4178709

Boring No.: SM-10

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R15	16:09 16:24	100	67	1	J	B	TH	SR	P	II	SW	35 40 40		**UPPER TOPANGA FORMATION (Ttu):** SANDSTONE; dusky yellow, medium- to coarse-grained sand with rare angular to subrounded gravel-sized clasts composed of plutonics, quartzite, slate, basalt and shale, friable, massive, scattered tightly healed iron oxidized joints	
70	R16	16:33 16:46	100	55	3	J B	B	VT TH	SR	P	II	SW HW	40 30		light olive gray interval gravel up to 3 cm in size conglomerate layer, clasts up to 13 cm in size, matrix supported	70
75	R17	16:50 17:04	100	38	1.8	J B	B1	TH VT	SR	P	II	HW	40 40 50 60		fine- to very fine-grained sand, medium bedded, inclined 55 degrees	75
80	R18	17:15 17:28	100	53	1.6	J	C	TH	SR R	P	II	HW SW	30 60 40 30			80
85	R19	- 10/21 08:10	100	88	0.4	S	A	MM	SK	P	VI	HW	60		- 3 mm wide slickensided clay seam gravel up to 5 cm in size	85
90	R20	08:18 08:39	100	68	1.4	J	B	TH MM	SR	P	II	HW SW	65 25 50			90
95	R21	08:50 -	100	52	1.8	S	C	TH	S	P	VI	HW SW	40 60 40 35			95
100																100

LOG OF BORING SM-10

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4158960/E4178709
Boring No.: SM-10	Page No.: 4 of 21

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R22	09:12 09:25	93	0	2.6	S	C1	VT	S	P	VI	SW	60 35 70		**UPPER TOPANGA FORMATION (Ttu):** SANDSTONE; light olive gray to medium dark gray, medium- to coarse-grained sand, trace angular to subrounded gravel with clasts up to 8 cm in size and composed of plutonics, quartzite, slate, basalt and shale, friable, massive, scattered tightly healed iron oxidized joints and clay seams; 1 mm wide slickensided clay seams between 101-103'	
105	R23	12:15 12:35	100	92	0.8	S	B	MM	S	P	VI	SW	70			105
110	R24	12:42 -	100	32	1.6	B	B1	VT TH	S SR	P	I	FW	70 40		- thin shale or lignite fragments oriented parallel to bedding	110
115	R25	13:12 13:31	100	100	0	B	-	MM	-	-	-	F	65		unfractured, medium bedding, inclined 65 degrees	115
120	R26	13:38 13:57	100	100	0	B	-	MM	-	-	-	F	65		slightly coarser-grained sand with scattered clasts to 1 cm in size	120
125	R27	14:10 14:29	100	100	0	B	-	MM	-	-	-	F				125
130	R28	14:38 15:02	100	100	0.2	J	A	MM	R	W	I	F	35		**CONGLOMERATIC SANDSTONE;** medium dark gray, medium- to coarse-grained sand and angular to subrounded gravel-sized clasts	130
135																135

LOG OF BORING SM-10

Client: **PB/DMJM**

Project: **Metro Red Line-Segment 3**

Project No.: **92-2050**

Location: **N4158960/E4178709**

Boring No.: **SM-10**

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R29	15:11 15:36	100	100	1	J	A	MM	S	P S	I	F	30 50 50		**UPPER TOPANGA FORMATION (Ttu):** CONGLOMERATIC SANDSTONE; medium dark gray, medium- to coarse-grained sand and angular to subrounded gravel-sized clasts composed of plutonics, quartzite, slate, basalt and shale, friable, massive, scattered tightly healed iron oxidized joints; siltstone clast, 20 cm in size with pyrite inclusions @ 138'	
140	R30	15:46 16:03	100	68	2	J	B	VT	S	P	I	F	60 20 75		SANDSTONE; light olive gray to medium dark gray, medium- to coarse-grained sand, trace gravel, friable, massive, scattered tightly healed iron oxidized joints and clay seams - siltstone layer	140
145	R31	16:13	100	87	0.4	J	A	MM	VR	D	I	F	0		gradational CONGLOMERATE; matrix supported, fine to coaarse gravels (70%) to 18 cm , angular to subrounded clasts composed of plutonics, quartzite, slate, hasalt and shale, matrix composed of medium dark gray, medium- to coarse-grained sand, friable, massive, scattered tightly healed iron oxidized joints	145
150	R32	16:39 17:05	100	93	1.8	J	A	TH	VR	D	I	F	0 0		gradational	150
155	R33	17:12 17:32	100	90	0.6	J	A	MM	R	P W	I	F	46 30		SANDSTONE; medium dark gray, medium- to coarse-grained sand, trace angular to subrounded gravel, friable, massive, scattered tightly healed iron oxidized joints and clay seams	155
160	R34	07:29 10/22 07:47	100	92	1.2	J B	A	TH	R S	D W	I	F	30 20		- scattered gravels to 15 cm	160
165	R35	08:01 08:19	100	100	0	-	-	MM	-	-	I	F	45		CONGLOMERATIC SANDSTONE; medium dark gray, medium- to coarse-grained sand and angular to subrounded gravel-sized clasts to 15 cm composed of plutonics, quartzite, slate, basalt and shale, friable, massive, unfractured	165
170																170

LOG OF BORING SM-10

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4158960/E4178709
Boring No.: SM-10	Page No.: 6 of 21

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R36	08:35	100	100	0.4	J B	A	TH MM	VR	D	I	F	30 40		**UPPER TOPANGA FORMATION (Ttu):** CONGLOMERATIC SANDSTONE; medium dark gray, medium- to coarse-grained sand and angular to subrounded gravel-sized clasts to 15 cm composed of plutonics, quartzite, slate, basalt and shale, friable, massive, moderately closely spaced joints	
175	R37	09:33	100	90	1.8	J	B	VT	S	P	I	F	40		becomes cobbly	175
180	R38	09:43 10:04	100	100	0.6	J	B	TH MM	S	P	I	F	20 30		SANDSTONE; medium dark gray, medium- to coarse-grained sand, rare gravels, friable, massive, moderately closely spaced tightly healed iron oxidized joints and clay seams	180
185	R39	10:14 10:35	85	30	2.2	S	B	TH VT	SK	P	VI	F	40 85 50 60		- 7 mm wide slickensided and grooved clay seam - 15 cm wide shale layer, sheared	185
190	R40	10:44 11:10	100	65	2.6	B	B	VT	S	P	VIII	F	80 65		- 0.5 m thick, dark gray laminated shale interbed with scattered microfaults	190
195	R41	11:20 11:37	100	63	1.6	S	A	TH VT	SK	P	VI	F	60 80 70		- 3-7 mm wide slickensided and grooved clay seam - 0.3 m thick, moderately well cemented, very closely fractured shale	195
200	R42	11:46 12:05	100	100	0.2	J	A	MM	SR R	P	I	F	40			200
205																205

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Client: PB/DMJM
Project: Metro Red Line-Segment 3
Project No.: 92-2050
Location: N4158960/E4178709
Boring No.: SM-10
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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R43	12:16	100	100	0	B	-	MM	-	-	-	F			**UPPER TOPANGA FORMATION (Ttu):** SANDSTONE; medium dark gray, medium- to coarse-grained sand, friable, massive, unfractured - slickensided clay seam up to 3 mm wide, gravelly below	
210	R44	13:08	92	92	0.6	S	A	MM	SK	P	VI	F	20 20 30			210
215	R45	13:17 13:41	100	100	0.4	S	B	MM	SK	P	VI	F	30 35		- 1 mm wide slickensided and grooved clay-lined joint - 1 mm wide slickensided and grooved clay-lined joint	215
220	R46	13:50 14:13	100	90	1.4	S	B	MM TH	SK	P	VI	F	40 30		- 15 cm wide extremely closely spaced slickensided and grooved clay-lined fracture zone.	220
225	R47	15:14 15:33	78	7	4.4	S	B1	VT	SK	P	VIII	F	45 15 30 55		- basalt cobble 0.3 m in size, zeolite-filled vesicles, chlorite-lined fractures - 3 cm wide slickensided and grooved clay seam - 7 mm wide slickensided and grooved clay seam	225
230	R48	09:29 10/23 09:48	92	8	3.4	S	C1	VT	SK	P	VIII	F	70 40 40 10		- (2) 7-12 mm wide slickensided and grooved clay seams	230
235	R49	10:00 10:28	100	58	1.6	S	C1	TH	SK	P	VIII	F	80 25 60 35		- 3 cm thick dark gray sheared shale layer	235
240																240

LOG OF BORING SM-10

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4158960/E4178709
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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R50	10:38 10:59	92	20	4.6	S	C1	VT	SK	P	VIII	F	40 50 60 70		**UPPER TOPANGA FORMATION (Ttu):** SANDSTONE; medium dark gray, medium- to coarse-grained sand, trace zones of subangular to subrounded gravel and cobble, clasts from 0.1-20 cm in size, friable, massive, scattered tightly healed iron oxidized joints and clay seams - 3 cm thick sheared dark gray shale layer	
245	R51	11:10 11:31	97	42	2.2	S	C1	VT	SK	P	VIII	F	70 60 40		- 3 cm thick dark gray shale layer, sheared surface	245
250	R52	11:42 12:02	92	28	3.2	S	C	VT	SK	P	VI	F	30 40 50		- 1 mm wide slickensided clay-lined joint	250
255	R53	12:59 13:16	100	63	1.2	S	B	TH VT	SK	P	VI	F	30 70		- 1 mm wide slickensided clay-lined joint	255
260	R54	13:28 13:50	100	100	0.6	J	B	MM	SR R	P	V	F	65 70		- 1 mm wide calcite-lined joint above basalt cobble	260
265	R55	14:02 -	100	48	2.4	S	C1	-	SK	P	VIII	F	30 5 40		- (2) 3 cm thick slickensided shale layers	265
270	R56	- 15:01	100	77	2	S	C1	-	SK	P	VIII	F	25 70 50		- 12 mm thick slickensided shale layer	270
275																275

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Client: **PB/DMJM**	Project: **Metro Red Line-Segment 3**
Project No.: **92-2050**	Location: **N4158960/E4178709**
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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R57	15:13 15:38	100	100	0	B	-	MM	-	-	-	F			**UPPER TOPANGA FORMATION (Ttu):** **SANDSTONE; medium dark gray, medium- to coarse-grained sand, trace subangular to subrounded gravel and cobble, clasts between 0.1-20 cm in size, moderately friable, massive, moderately closely spaced calcite-lined joints and clay seams**	
280	R58	15:47 16:16	91	85	0.8	J	B	MM TH	R	P W	I	F	35 15		clasts up to 10 cm in size	280
285	R59	16:27 16:58	100	93	0.6	J	B	MM	R	P	I	F	30 20			285
290	R60	08:18 10/24	100	85	1.2	S	B	TH	SR	P	VI	F	45 35		- 1 mm wide calcite-lined joint - (2) 1 mm wide clay-lined slickensided joints	290
295	R61	08:58 09:21	100	93	0.6	J	B	MM	SR	P	I	F	60 25 60			295
300	R62	09:50 10:19	97	75	1.6	S	B	TH	SK	P	VIII	F	40 40		moderately closely spaced shears are grooved and polished - 8 cm wide slickensided clay seam	300
305	R63	10:31 11:00	100	48	2	S	B	TH	SK	P	VI	F	30 30			305
310																310

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Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4158960/E4178709
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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description							Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering				
	R64	11:43 12:13	100	67	1.4	J B	B	TH VT	SR S	P	I	F	40 50 65		**UPPER TOPANGA FORMATION (Ttu):** SANDSTONE; medium dark gray, medium- to coarse-grained sand, trace subangular to subrounded gravel and cobbles, clasts between 0.1-20 cm in size, moderately friable, massive, moderately closely spaced calcite-lined joints and clay seams	
315	R65	12:32 12:56	100	100	0	B	-	MM		-	-	F			medium-grained sand, unfractured	315
320	R66	13:11 13:37	100	100	0.4	J	A	MM	R	P	I	F	30		moderately closely spaced joints	320
325	R67	13:48 14:18	100	10	0.6	J	B	MM	R	P W	I	F	50 60 30			325
330	R68	14:58 15:27	100	100	0.4	J	A	MM	R	W	I	F	65 35			330
335	R69	15:40 16:11	100	77	1	J	B	TH MM	R SR	P D	I	F	60		some gravel up to 5 cm in size	335
340	R70	16:22 16:50	100	75	0.8	J	A	TH	R SR	P D	I	F	35 70 20			340
345																345

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Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4158960/E4178709
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Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R71	07:48 10/26 08:18	100	60	0	B	-	MM	-	-	-	F			**UPPER TOPANGA FORMATION (Ttu):** SANDSTONE; medium dark gray, medium- to coarse-grained sand, trace subangular to subrounded gravel and cobbles, clasts between 0.1-20 cm in size, moderately friable, massive, moderately closely spaced calcite-lined joints and clay seams	
350	R72	08:34 09:05	100	75	1	J	B1	MM TH	R	P	I	F	15 30 40		CONGLOMERATIC SANDSTONE; medium dark gray, medium- to coarse-grained sand, subangular to subrounded gravel and cobbles (40-50%), clasts up to 12 cm in size composed of plutonics, quartzite, slate, basalt and shale, weakly friable, massive, moderately closely spaced calcite-lined joints and clay seams	350
355	R73	10:07 10:31	100	63	2.2	S	B1	VT	SK	P	VIII	F	35 40 60		- 8 cm thick slickensided shale layer	355
360	R74	10:44 11:10	100	55	2.4	J	B1	VT	S	P	VI	F	40 50 35		closely spaced clay-lined joints up to 3 mm wide, becomes cobbly with rare boulders - serpentinized amygduloidal basalt boulder to 0.5 m in size - granitic boulder to 20 cm in size	360
365	R75	11:24 11:44	100	87	1.2	S	C	TH	SK	P	VI	F	30 60		- 7 mm wide slickensided shale layer SANDSTONE; medium dark gray, medium- to coarse-grained sand, trace subangular to subrounded gravel and cobbles, clasts between 0.1-20 cm in size, moderately friable, massive, moderately closely spaced calcite-lined joints and clay seams	365
370	R76	11:55 12:17	100	100	0	B	-	MM	-	-	I	F			unfractured interval	370
375	R77	12:28 12:50	100	55	1.2	J	C	TH VT	R	W	I	F	80 85 35		moderately closely spaced joints, two sets inclined at 85 and 30 degrees	375
380																380

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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R78	13:51 14:13	100	85	0.6	S	A	MM TH	R	W	VI	F	85 40		UPPER TOPANGA FORMATION (Ttu): SANDSTONE; medium dark gray, medium- to coarse-grained sand, trace subangular to subrounded gravel and cobbles, clasts between 0.1-20 cm in size, moderately friable, massive, moderately closely spaced slickensided and grooved clay- and calcite-lined joints and shears	
385	R79	14:25 14:50	100	62	1.4	S	A	MM VT	SK	P	VIII	F	75		- 0.3 m wide completely altered, sheared and jointed granitic boulder	385
390	R80	15:01 15:29	97	83	1	S	B	TH	SK	P	VI	F	25 50 40		with cobbles (30%) - 1 mm wide slickensided clay-lined shear	390
395	R81	15:42 16:11	100	32	2.4	S	B1	TH VT	SK	P	VIII	F	30 50 45		cobble clasts up to 20 cm in size - 5 cm thick shale layer, faintly sheared, trace gravels	395
400	R82	10/27	100	52	-	S	A	TH	SK	P	VIII	F	30		- 3 cm thick sheared shale layer, adjacent to 1 mm wide calcite-lined joint	400
	R83	07:28 08:00 08:29	100	81	1	J	A	TH	SR S	P W	V	F	60		- 20 cm quartzite cobble adjacent to 1 mm wide calcite-lined joint	
405	R84	08:45 09:18	100	87	0.8	J	A	TH	R	W	V	F	35		- 1 mm wide calcite-lined joint, gravelly below	405
410	R85	09:29 09:56	100	78	0.6	S	A	TH	SK	P	VIII	F	40 10 60		- 1 mm wide calcite-lined joint - 12 mm wide slickensided and faintly grooved	410
415																415

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Client: PB/DMJM	Project: Metro Red Line-Segment 3
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Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R86	10:10 10:36	100	100	0.4	J	B1	MM	R	W	I	F	50 25		**UPPER TOPANGA FORMATION (Ttu):** SANDSTONE; medium dark gray, medium-grained sand, trace subangular to subrounded gravel and cobbles, clasts between 0.1-15 cm in size, moderately friable, massive, moderately closely spaced calcite-lined joints and clay seams	
420	R87	10:48 11:07	100	73	0.2	S	A	MM	SK	P	VIII	F	70		- 7-12 mm wide dark gray slickensided highly plastic sheared clay seam	420
	R88	11:26 11:42	100	100	0.2	S	A	TH	R SR	P	I	F	55		- sheared joint surface	
425	R89	12:24 12:39	100	67	0.2	S	A	TH	SK	P	VI	F	60			425
	R90	12:54	90	86	0.8	S	A	TH VT	R SK	W	I	F	50 70		- 1 mm wide slickensided and grooved clay-lined shear - clean, closed joint with polished and grooved surface	
430	R91	13:31 14:03	100	100	0.2	J	A	MM	VR	W D	I	F	40			430
435	R92	15:10 15:44	100	75	1.2	S	B1	TH VT	SK	P	VIII	F	50 15 30		moderately closely spaced clean to rare clay-lined, slickensided and grooved joints - 7 mm wide dark gray clay-lined, slickensided and grooved joints	435
440	R93	15:55 16:24	100	70	1.2	S	A	TH MM	SR S	P	VI	F	50 30			440
445	R94	07:31 10/28 08:01	100	100	0.2	J B	A	MM	R	P	I	F	70			445
450																450

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Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R95	08:13 08:43	100	100	0	B	-	T	-	-	-	F			**UPPER TOPANGA FORMATION (Ttu):** SANDSTONE; medium dark gray, medium- to coarse-grained sand, some subangular to subrounded gravel and cobble zones, clasts between 0.1-15 cm in size, moderately friable, massive, moderately closely spaced calcite-lined joints and clay seams; 0.5 m thick conglomeratic sandstone layer at 451'	
455	R96	08:53 09:18	100	100	0.2	J	A	MM	SR	P	I	F	65		- 1 mm wide calcite-lined joint	455
460	R97	09:32 -	100	100	0.4	S	B	T TH	SK	P	VI	F	25 25		- 1-3 mm wide clay- and calcite-lined, sheared joint - 1-3 mm wide clay- and calcite-lined, sheared joint	460
465	R98	- 10:41	100	100	0	B	-	T	-	-	-	F			- 3 mm wide tightly healed calcite-lined joint thickly bedded	465
470	R99	10:53 11:23	100	100	0.2	S	A	T MM	SR	W	VI	F	30		- 3 mm wide tightly healed calcite-lined joint - 3 mm wide slickensided and grooved clay-lined joint	470
475	R100	11:35 12:00	97	97	0.2	J	A	T MM	R	P W	I	F	35			475
480	R101	12:13 12:37	100	100	0.2	J	A	T MM	R	W	I	F	70		- locally faint thin bedding inclined 65 degrees	480
485																485

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Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Lithic Description	Packer Test Interval
	R102	13:32 13:55	97	97	0.2	S	A	T MM	SK	P	VI	F	20	**UPPER TOPANGA FORMATION (Ttu):** SANDSTONE; medium dark gray, medium- to coarse-grained sand, trace subangular to subrounded gravel and cobbles, clasts between 0.1-15 cm in size, moderately friable, massive, moderately closely spaced clay- and calcite-lined joints and shears; < 1 mm wide slickensided and polished clay-lined joint at 487'	
490	R103	14:08 14:28	100	100	0.3	S	A	MM	SK	P	VI	F	60	- (2) < 1 mm wide clay-lined joints	490
	R104	14:41 14:51	100	67	0.7	S	A	TH	SK	P	VI	F	65	closely spaced slickensided and grooved shears between 1-12 mm wide	
495	R105	15:04 15:34	100	32	2	S	C	VT	SK	P	VI	F	55 35 55 50		495
500	R106	15:51 16:29	100	95	1	S	B1	TH	SK	P	I	F	60 50 25	moderately closely spaced joints	500
505	R107	08:24 11/3 08:52	100	92	0.4	S	B	MM	SK	P	VI	F	35	- (2) 1 mm wide slickensided, striated and polished clay-lined shears unfractured	505
510	R108	09:06 09:34	100	100	0	B	-	M	-	-	-	F		scattered plutonic and basaltic cobble-sized clasts	510
515	R109	11:26 11:58	100	100	0	B	-	M	-	-	-	F			515
520															520

LOG OF BORING SM-10

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4158960/E4178709
Boring No.: SM-10	Page No.: 16 of 21

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R110	12:16 12:44	100	100	0.4	J	B	MM	R	P	I	F	45 60		**UPPER TOPANGA FORMATION (Ttu):** SANDSTONE; medium dark gray, medium- to coarse-grained sand, some subangular to subrounded gravel and cobbles, clasts between 0.1-15 cm in size, moderately friable, massive, moderately close to widely spaced calcite-lined joints and clay seams	
525	R111	12:55 13:20	100	100	0.2	J	A	MM	R	P	I	F	60			525
530	R112	13:37 14:02	100	100	0.2	J	A	T MM	R	P	I	F	70			530
535	R113	14:19 14:52	100	95	0.4	S	A	MM	SK	P	I	F	70 30 30 60		- numerous tightly healed joints - slickensided and striated joints	535
540	R114	15:09 15:36	100	100	0.4	J	B	TH MM	R	P W	I	F	30		- pale red volcanic? clast, 10 cm in size	540
545	R115	15:53 16:14	100	95	0.2	J	A	T	R	P W	I	F	70			545
550	R116	07:51 11/4 08:14	100	100	0.4	S	A	T	SK	P W	VI	F	70 20			550
555																555

LOG OF BORING SM-10

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4158960/E4178709
Boring No.: SM-10	Page No.: 17 of 21

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R117	08:31 08:54	100	100	0	B	A	M	-	-	I	F			**UPPER TOPANGA FORMATION (Ttu):** SANDSTONE; medium gray to medium dark gray, medium- to coarse-grained sand, trace subangular to subrounded gravel and cobbles, clasts between 0.1-20 cm in size, well cemented and weakly friable, massive, rare tightly healed calcite-lined joints	
560	R118	09:20 09:38	100	100	0.2	J	A	T	R	W	I	F	10		some gravel (10%)	
565	R119	10:03 10:27	100	100	0.4	J	A	MM	SR R	P W	I	F	25 10		medium grained, gravel-sized clasts range from 2-5 cm in size	
570	R120	10:53 11:12	100	100	0	B	A	T	-	-	I	F			- 0.3 m thick conglomeratic sandstone layer, gravel clasts (40%) composed of plutonics, quartzite, and volcanics	
575	R121	11:38 12:02	100	83	0.6	S J	B	MM	SK R	W D	VI	F	80 70 10		moderately cemented	
580	R122	12:30 12:52	100	100	0.6	J	A	MM	SR R	P W	I	F	5 80 15		- light bluish gray volcanic cobble, 15 cm in size	
585	R123	13:30 14:09	100	100	0	-	A	T	-	-	I	F			- medium gray cobble, 15 cm in size	
590																

LOG OF BORING SM-10

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4158960/E4178709
Boring No.: SM-10	Page No.: 18 of 21

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Lithic Description	Packer Test Interval
	R124	14:30 15:05	95	95	0.8	J	B1	MM	R SR	D P W	I	F	0 40 5 30	**UPPER TOPANGA FORMATION (Ttu):** CONGLOMERATIC SANDSTONE; medium gray to medium dark gray, fine- to coarse-grained sand with subangular to subrounded gravel and cobbles, volcanic clasts between 0.1-10 cm in size, well cemented and weakly friable, massive, rare tightly healed calcite-lined joints	
595	R125	15:30 16:18	100	100	0.4	S J	B	MM	SK SR	P	V I	F	20 20	medium light gray to medium gray, coarse-grained sand with fine-grained sand interbeds - scattered cobbles up to 20 cm in size composed of plutonics and vesicular basalt	595
600	R126	07:50 11/5 08:23	98	98	0.2	S	A	T	SK	W	I	F	70	SANDSTONE; light gray to medium gray, coarse-grained sand, well cemented (calcareous) and weakly friable, massive, rare tightly healed calcite-lined joints	600
605	R127	08:44 09:17	100	92	0.6	S	B1	T TH	SK	W P D	VI	F	20 70	- 20 cm wide shear zone, faint bedding below	605
610	R128	09:37 10:21	98	78	1	S J	B1	TH T	SK SR	P W	I VI	F	40 40 30	medium- to coarse-grained sand with trace gravel - 25 cm wide amygduloidal basalt clast	610
615	R129	13:23 13:56	100	100	1	J S	C1	MM TH	R SK VR	P W D	I VI	F	30 35 20	CONGLOMERATIC SANDSTONE; medium gray, coarse-grained sand, subangular to subrounded gravel clasts to 3 cm in size, clasts composed of plutonic, volcanic, and quartzite, well cemented and weakly friable, massive, closely spaced calcite-lined joints [change to new diamond impregnated drill bit]	615
620	R130	14:17 15:24	100	100	0.4	S J	A	T MM	SK R	P W	VI	F	60 5	medium-grained sand	620
625															625

Sketch

LOG OF BORING SM-10

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4158960/E4178709
Boring No.: SM-10	Page No.: 19 of 21

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R131	15:41 16:13	97	97	0	B	A	M	-	-	-	F			**UPPER TOPANGA FORMATION (Ttu):** CONGLOMERATIC SANDSTONE; medium gray to dark gray, medium- to coarse-grained sand, subangular to rounded gravel and cobbles composed of granite and basalt, well cemented and weakly friable, massive, unfractured	
630	R132	07:21 11/6 07:48	100	100	0	B	A	M	-	-	-	F				630
635	R133	08:04 08:27	100	100	0	B	A	M	-	-	-	F			- shale cobble to 8 cm in size	635
640	R134	08:46 09:15	100	100	0	B	A	T	-	-	-	F			- 2 faint bedding planes or tightly healed joints(?)	640
645	R135	09:33 10:02	100	100	0	B	A	M		-	-	F				645
650	R136	10:19 10:41	100	100	0	B	A	T		-	-	F	70 70		- 3 cm thick fine- to medium-grained sandstone layer - 3 cm thick fine- to medium-grained sandstone layer, shell fragments	650
655	R137	10:58 11:25	100	100	0.4	S	B	T TH	R SR	P W	I	F	20		- 2 slickensided and grooved joints	655
660																660

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LOG OF BORING SM-10

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4158960/E4178709
Boring No.: SM-10	Page No.: 20 of 21

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R138	11:48 12:29	100	100	0.2	S	A	T	R SR	W	I	F			**UPPER TOPANGA FORMATION (Ttu):** SANDSTONE; medium gray to medium dark gray, medium- to coarse-grained sand, some subangular to subrounded gravel and cobbles, clasts between 0.1-15 cm in size, well cemented and weakly friable, massive, unfractured to very widely spaced calcite-lined joints	
665	R139	13:02 13:31	100	100	0.2	J	A	T	R SR	P	I	F	35 25		- granitic clast to 15 cm, grooved and slickensided shear along upper surface CONGLOMERATIC SANDSTONE; medium gray to medium dark gray, medium- to coarse-grained sand, subangular to subrounded cobbles and small boulders to 0.5 m in size, composed of granitics and basalt, well cemented and weakly friable, massive, rare tightly healed 1 mm wide calcite-lined joints	665
670	R140	13:48 14:27	100	100	0.2	J	A	T TH	SR	P	I	F	40 20			670
675	R141	14:48 15:30	100	100	0	B	A	M	-	-	-	F			SANDSTONE; medium gray to medium dark gray, medium- to coarse-grained sand, trace subangular to subrounded gravel and cobbles, clasts between 0.1-10 cm in size, well cemented and weakly friable, massive, unfractured	675
680	R142	07:55 11/7 08:21	100	100	0	B	A	M	-	-	-	F				680
685	R143	08:40 09:13	100	100	0	B	A	T	-	-	-	F	65		- dark gray, laminated fine-grained sandstone interval	685
690	R144	09:29 10:01	100	100	0	B	A	T	-	-	-	F	65- 70		- dark gray, laminated and swirled fine-grained shaly interval medium- to coarse-grained sand with cobbles	690
695																695

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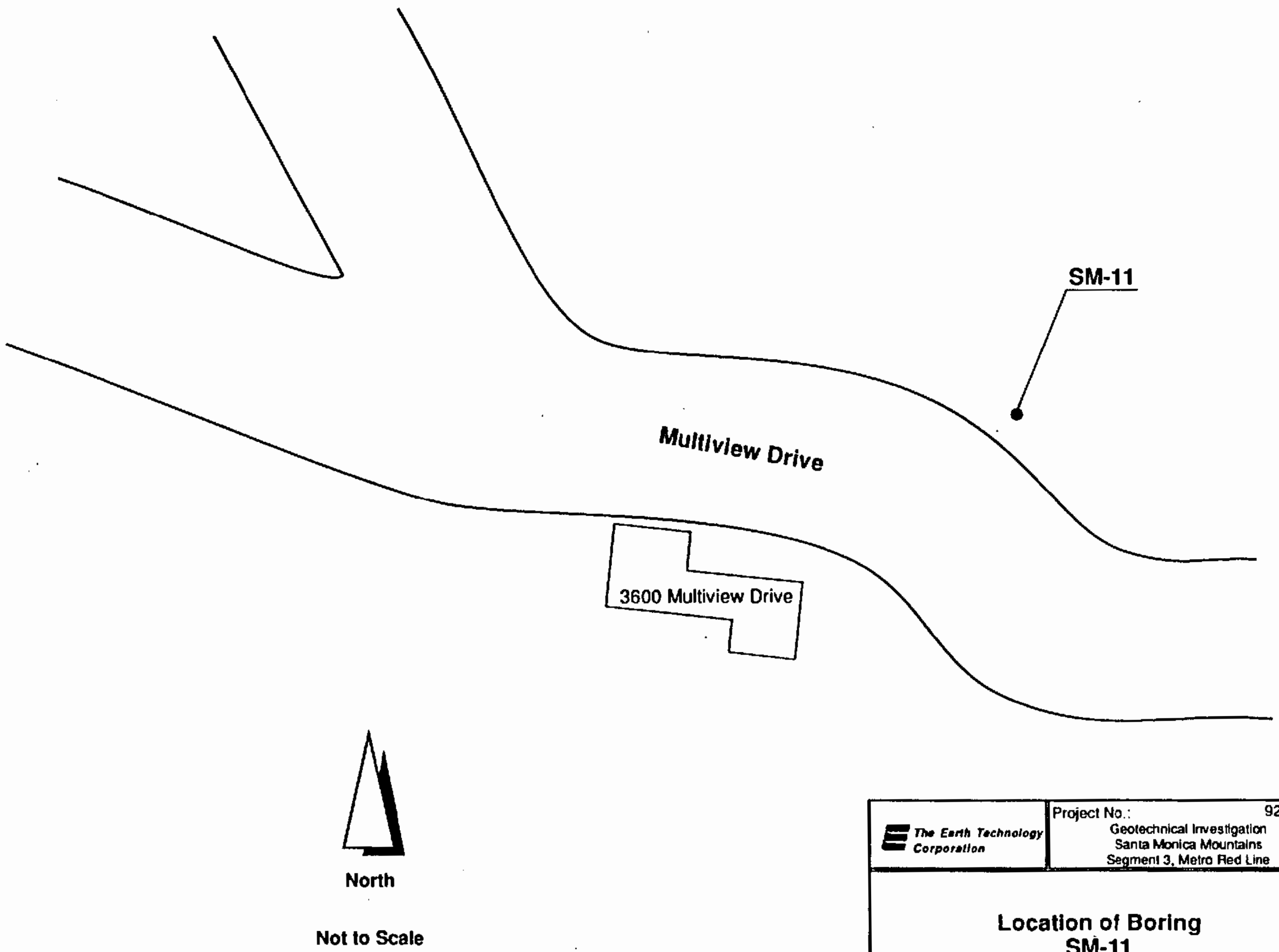
LOG OF BORING SM-10

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4158960/E4178709
Boring No.: SM-10	Page No.: 21 of 21

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R145	10:45	35	35	0	B	A	M	-	-	-	F		▨	**UPPER TOPANGA FORMATION (Ttu):** SANDSTONE; medium gray to medium dark gray, medium- to coarse-grained sand, with subangular to subrounded gravel and cobbles, clasts between 0.1-15 cm in size, rare clasts to 40 cm, well cemented and weakly friable, massive, unfractured - no recovery from 698-703'	
700		10:45 11:07														700
		11:48													Boring terminated at 703 feet on 11/07/92.	
705																705
710																710
715																715
720																720
725																725
730																730



The Earth Technology Corporation

Project No.: 92-2050
Geotechnical Investigation
Santa Monica Mountains
Segment 3, Metro Red Line

Location of Boring SM-11

Figure A-15

LOG OF BORING SM-11

Client: PB/DMJM	Project: Metro Red Line-Segment 3	Project No.: 92-2050
Location: N4160178/E4178320	Surface Elevation (ft): 778	Boring No.: SM-11
Inclination (Deg.): 90	Bearing: NA Depth (ft): 307.0	Depth to Water Table (ft):
Started: 10/19/92 Finished: 10/24/92	Core Dia. (in.): 2.4	No. of Core Boxes: 24
Driller: PC Exploration, Inc.	Drilling Method: Mud rotary Fluids: Bentonite/Clear mud	Drilling Equipment: Mobile B-53
Logged By: P. Dunster	Checked By: G. Miller	Page No.: 1 of 9

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
0		12:45 10/19													**ALLUVIUM (Qal):** SILT; moderate yellowish brown, fine grained, slightly elastic silt, friable, massive; [drilled with hollow stem auger from 0-25'; sampler driven with 140 lb. down hole hammer]	0
	S1														[Sample S1:Blow Counts-6/8/11]	
5																5
															CLAYEY SILT; dark yellowish brown, fine-grained, elastic silt and clay, friable, massive	
	S2														**UPPER TOPANGA FORMATION (Ttu):** SILTY SANDSTONE; pale yellowish brown to dark yellowish brown, fine- to medium-grained sand with silt, friable, laminated, very closely space joints, highly to moderately weathered	
10															[Sample S2: Blow Counts-7/14/28]	10
	S3														[Sample S3: Blow Counts-12/18/29]	
15																15
	S4														[Sample S4 recovered about 5 cm]	
20																20
	S5														[Sample S5: Blow Counts-20/1"]	
25	R1	10/20	100	48	3	J B	A	TH	SR R	W S	II	MW SW	30 80		[change to diamond impregnated core bit] pale to dark yellowish orange, grayish orange and moderate brown, coarse-grained sand with silt, closely spaced silt-lined joints	25
	R2	09:16 09:30	83	28	0.7	B J	A	L MM	SR S	P W	II	MW SW	65		SANDSTONE/SILTSTONE; see below	
30																30

LOG OF BORING SM-11

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4160178/E4178320
Boring No.: SM-11	Page No.: 2 of 9

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
30	R3	09:57 10:11	87	34	0.4	B J	A	L MM	SR S	P W D	II	SW	50		UPPER TOPANGA FORMATION (Ttu): SANDSTONE/SILTSTONE; light olive brown and grayish orange, coarse-grained sand and silt, friable, laminated with sandstone and siltstone interbeds, widely spaced joints, black stained and oxidised surfaces, scattered moderate red gravel-sised shale intraclasts	30
35	R4	10:21 10:48	100	69	0.45	B J S	A	L T	SR S SK	P S D	II VI	SW F FW	40 70		medium light gray to medium dark gray, olive gray, medium- to coarse-grained sand and silt, unoxidised, scattered slickensided shears parallel to bedding	35
	R5	11:18 11:31	96	69	0	B S	A	L MM	S SK	P D	I VI	F	50 50			
40	R6	11:55 12:15	95	42	0.8	B J S	A	L MM	S SK SR R	P S D	I VI VIII	F	50 50		convoluted bedding, rare flame structures - 3 cm wide sheared and polished clay-lined shear	40
45	R7	12:25 12:45	88	73	0.2	B J	A	L T	SR S	D P S	I VIII	F	50		- 7 mm wide sheared and polished clay-lined shear SANDSTONE; medium light gray to medium dark gray, medium- to coarse-grained sand, moderately cemented and friable, massive, unfractured	45
50	R8	13:02 13:21	97	78	0.2	B J S	A	L T	SR S	P D	I VI	F	50 50		SILTSTONE/SANDSTONE; medium light gray to medium dark gray, olive gray, fine- to medium-grained sand and silt with clay, friable, laminated with sandstone and shale interbeds, widely spaced joints, scattered gravel-sised shale intraclasts, scattered slickensided shears parallel to bedding	50
55	R9	13:27 13:41	100	93	0.2	B J S	A	L T	SR S SK	P D	I VI	F	50 50		- 3 mm wide, sheared and polished clay-lined shear, surface parallel bedding	55
60	R10	13:50 14:05	95	92	0.2	B J S	A	L MM	S SK	D P	I VI	F	50 50			60
65																65

LOG OF BORING SM-11

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4160178/E4178320
Boring No.: SM-11	Page No.: 3 of 9

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R11	14:14 14:28	98	80	0.2	J B	A	VT MM	SR S	D P S O	I	F	50 70		**UPPER TOPANGA FORMATION (Ttu):** SILTSTONE/SILTY SANDSTONE; see above **SANDSTONE;** medium light gray to medium dark gray, medium- to coarse-grained sand, moderately cemented and friable, massive, widely spaced open fractures, scattered gravel-sized siltstone intraclasts	
70	R12	15:05 15:17	97	63	1.4	J	B1	L MM	SR S	D P W O	I	F	50 90 50		- open joint **SILTSTONE/SANDSTONE;** medium light gray to medium dark gray, olive gray, fine- to coarse-grained sand and silt with clay, friable, very thinly bedded to laminated, widely spaced joints, scattered shale intraclasts, infrequent slickensided shears parallel to bedding	70
75	R13	15:30 15:42	97	78	0.5	J B	A	L MM	S	D P W	I	F	20 50 0		- open joint - 15 cm wide extremely closely fractured zone, crushed zone	75
80	R14	15:46 16:06	70	45	1	J B	A	L MM	S	D P W	I	F	50			80
85	R15	16:14 16:28	100	95	0	B	A	L MM	S	D W P	I	F	50 60 50		- 15 cm wide extremely closely fractured zone parallel to bedding within shale interbed, crushed zone - flame structure	85
90	R16	16:36 16:52	93	62	0.5	B J S	A	L MM	SK S SR	D P S	I	F	60 50 30		- localized crossbedding - 0.5 mm wide clay-lined, slickensided shear - pink shale laminae - 0.3 m thick silty sandstone layer - 7 mm high stepped joint	90
95	R17	17:03 17:15	95	60	1.6	B J S	A	L MM	SK S SR	D P S W	I VIII	F	50 45 90 60		- 15 cm wide extremely closely fractured zone parallel to bedding within shale interbed, crushed zone **SILTY SANDSTONE;** medium light gray to medium dark gray	95
100																100

LOG OF BORING SM-11

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4160178/E4178320
Boring No.: SM-11	Page No.: 4 of 9

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R18	08:33 10/21 08:50	97	73	0.6	B J	A	L MM	S SR	D P W	I	F	30 50		**UPPER TOPANGA FORMATION (Ttu):** SILTY SANDSTONE; medium light gray to medium dark gray, fine- to coarse-grained sand with silt, trace clay, friable, very thinly bedded, with shaley interbeds, widely spaced joints, scattered shale intraclasts and black coal-like fragments, localised flame structures (soft sediment deformation)	
105	R19	08:58 09:06	100	67	1	B J	A	L MM	S SR	D P W	I	F	40 50 70		- carbonaceous layer	105
110	R20	09:15 09:24	100	100	0.4	B J	A	MM	S SR	D P S	I	F	50		- bedding plane offset 7 mm - abundant localised moderate red gravel-sized siltstone intraclasts	110
115	R21	09:46	100	93	0.4	B J	A	MM	SR	S W	I	F	30 45		- siltstone laminae offset 5 mm	115
120	R22	09:55 10:09	100	77	0.2	B J	A	L MM	R S	D S P	I	F	30 40-50		- siltstone laminae offset 5 mm - 5 mm wide rough and stepped joint - coal intraclast - very thin sandstone dike crosses bedding - parting along bedding	120
125	R23	10:17 10:27	100	47	1	B J	A	L MM	R S	D W P S	I	F	50 70 50		- vertical, tightly healed joint - localised very friable, extremely sheared sand zone - 7 mm wide, rough and stepped joint	125
130	R24	10:35 10:47	100	100	0	B	A	MM	S	S R	I	F	50		parts easily along bedding planes	130
135																135

LOG OF BORING SM-11

Client PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4160178/E4178320
Boring No.: SM-11	Page No.: 5 of 9

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R25	10:47 11:12	100	100	0.2	J	A	MM T	SR	W	I	F	75		**UPPER TOPANGA FORMATION (Ttu):** CONGLOMERATIC SANDSTONE; light gray to dark gray, fine- to coarse-grained sand with gravel, moderately cemented and moderately friable, massive, closely spaced joints	
140	R26	11:22 11:31	93	93	0	B J	A	MM T	SR	W	I	F	50 30		SILTY SANDSTONE; light gray to dark gray, fine- to coarse-grained sand and silt, generally massive with laminated shale interbeds, moderately cemented and moderately friable, very widely spaced joints, parts easily along bedding	140
145	R27	11:48	100	100	0	B J	A	TH M	S	P S D	I	F	50 30		SILTSTONE/SANDSTONE; light gray to dark-gray, fine- to medium-grained sand and silt with clay, trace gravel, moderately cemented, moderately friable, very thinly bedded sandstone and laminated shale interbeds, widely spaced joints, parts easily along shale laminae	145
150	R28	12:21 12:35	100	98	0.2	B J S	A	VT MM	S SR	D S	I VI	F	80 50 50		- scattered tightly healed microfaults and joints	150
155	R29	13:03 13:14	100	48	3	B J S	B1	L MM	S SR SK	D P W	I	F	45 80 80		- very thin conglomeratic layer - very thin conglomeratic layer	155 TEST 4
160	R30	13:27 13:40	98	92	0.6	B S J	A	L MM	R SK	P W S	I VI	F	20 60		- very thin conglomeratic layer - very thin conglomeratic layer - scattered clay-lined shears parallel to bedding	160
165	R31	13:51 14:02	98	68	0.2	B J	B	VT T	SR	P	I	F	40 75		- discontinuous shale layers [driller reports borehole takes water then recovers it after a run is completed]	165 TEST 3
170																170

LOG OF BORING SM-11

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4160178/E4178320
Boring No.: SM-11	Page No.: 6 of 9

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R32	14:42	97	97	0.2	J	A	T	S	W	I	F	35		**UPPER TOPANGA FORMATION (Ttu):** SILTY SANDSTONE; very light gray and medium dark gray, fine- to coarse-grained sand and silt, generally massive with infrequent laminated shale interbeds, moderately cemented and moderately friable, very widely spaced joints, scattered fine gravel-sized siltstone intraclasts, parts easily along bedding	
175	R33	15:06 15:21	100	72	0.4	J	A	MM	SR	S	I	F	90 70		some fine gravel - rare white mineral-filled veins - rough joint with steps up to 5 mm high	175
180	R34	15:42 15:56	90	90	0.2	J B S	A	TH T	S SK	D W P	I VIII	F	30 50		- 15 cm wide, extremely closely sheared zone within a 0.5 m thick laminated shale layer	180
185	R35	16:12 16:43	98	98	0	B	A	M	-	-	I	F			- scattered gravel-sized siltstone intraclasts	185
190	R36	16:53 17:07	100	100	0	B	A	M	-	-	I	F	55		- scattered gravel - scattered gravel-sized siltstone intraclasts	190
195	R37	17:18 17:35	100	90	0.4	J B	A	VT MM	S SR	D W P S	I	F	55 30 20		parts easily along bedding - scattered moderate red coarse gravel-sized siltstone intraclasts	195
200	R38	07:46 10/22 08:04	90	90	0.25	J	A	MM T	SR	S	I	F	15 10		scattered tightly healed intraformational microfaults - scattered coal intraclasts [driller reports temporary artesian condition from borehole]	200
	R39	08:27	100	72	0.2	B	B1	L	SR	W	I	F			[driller reports hole taking water]	
205																205

LOG OF BORING SM-11

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4160178/E4178320
Boring No.: SM-11	Page No.: 7 of 9

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		08:45				J S		MM	S SK	P S D	VIII		60 30		**UPPER TOPANGA FORMATION (Ttu):** SHALE/SANDSTONE; very light gray and dark gray, fine- to coarse-grained sand and silt with clay, trace gravel, moderately cemented, moderately friable, very thinly bedded sandstone with laminated shale interbeds, moderately closely spaced rough and up to 7 mm high stepped joints, parts easily along shale laminae, scattered tightly healed intraformational microfaults; [driller reports temporary loss in water during drilling, slight artesian condition at the completion of runs]	
	R40		100	100	0	B	A	L	S	P D	I	F	30			
210	R41	09:12 09:29	100	69	0.4	J S	A	VT MM	SR SK S	P S D	I VIII	F	20 80 35			210
215	R42	09:45 10:06	100	90	0.8	J S B	A	TH MM	SR S SK	D P S	I VI VIII	F	60 10 30		- 5 mm wide clay-lined shear - 5 mm wide rough clay-lined shear stepped up to 3 mm high	215
220	R43	10:52 11:09	100	92	0.8	J S B	A	L T	SR S SK	P S D	I VIII	F	30 60 45		[artesian rate measured at about 1 gpm at about 2 psi] - 3 cm wide clay-lined shear - 5-8 mm wide rough joint with steps up to 3 mm high	220
225	R44	11:18 11:35	100	100	0.2	S	A	MM T	S SK	D P	I VIII	F	30 60		- scattered tightly healed joints - 4 cm thick clay-lined shear zone - scattered coarse gravel-sized siltstone intraclasts	225
230	R45	11:45 12:06	100	98	0.8	J S B	B1	L T	SK S SR	W P S	I VI	F	75 30 50		very widely spaced joints - scattered coarse gravel-sized siltstone intraclasts - 3 mm wide clay-lined shear	230
235	R46	12:28 12:50	100	100	0	B	A	MM T	S	W D	I	F	25		- scattered gravel - parts along shale laminae	235
240																240

LOG OF BORING SM-11

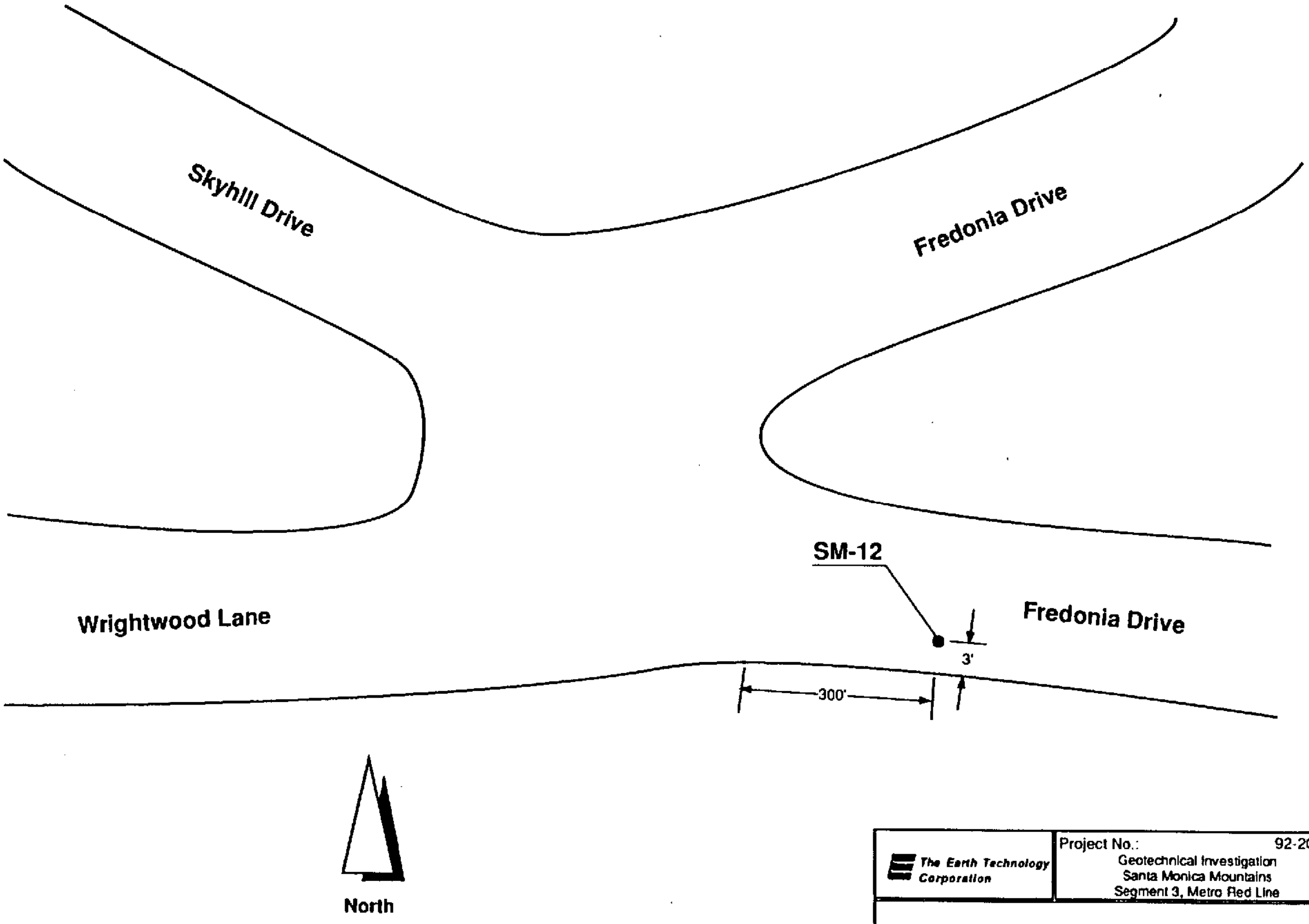
Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4160178/E4178320
Boring No.: SM-11	Page No.: 8 of 9

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R47	13:07 13:27	97	87	0.2	B J S	A	L T	SR S SK	D P S	I VI	F	40 20		**UPPER TOPANGA FORMATION (Ttu):** SILTY SANDSTONE; very light gray and medium dark gray, fine- to coarse-grained sand and silt, generally massive with laminated shale interbeds, moderately cemented and moderately friable, widely spaced joints, scattered moderate red fine gravel-sized siltstone intraclasts, parts easily along bedding; scattered coal-like flecks @ 243'	
245	R48	13:54 14:11	100	98	0.4	S	B	MM	S SK	P S	I VI	F	40 55		- locally scattered gravel	245
250	R49	14:27 14:53	100	100	0	S B	A	MM T	S	P	I	F	60 40		- 0.4 m thick laminated shale layer with silty sandstone interbeds - locally scattered gravel	250 TEST 1-
255	R50	15:27 15:50	99	99	0.6	S J	B1	MM T	SK SR	W S	I VIII	F	40		- 1 cm wide, rough and slickensided shear with steps up to 7 mm high [driller added Alconox to drilling fluid]	255
260	R51	11:04 11:22	99	80	0.6	B J	A	VT MM	SR S	P S	I	F	5 50 40 80		- locally scattered gravel - rough joint with steps up to 7 mm high - small open cavity - rough joint with steps up to 7 mm high	260
265	R52	11:31 10/23 11:47	97	97	0.2	S	A	MM T	SK	W	I II	F	30		- tightly healed joint	265
270	R53	11:59 12:16	100	95	0.4	S B	A	TH MM	SK S	P D S	I VI	F	25		- locally discontinuous bedding and scattered moderate red gravel-sized siltstone intraclasts - rough and slickensided joint with >1 mm high steps	270
275																275

LOG OF BORING SM-11

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4160178/E4178320
Boring No.: SM-11	Page No.: 9 of 9

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R54	12:28 12:48	94	91	0.8	J S B	A	MM	SR SK S	D S P	I VI	F	40 40		**UPPER TOPANGA FORMATION (Ttu):** SILTSTONE/SANDSTONE; very light gray and dark gray, fine- to coarse-grained sand and silt with clay, trace gravel, moderately well cemented, moderately friable, very thinly bedded sandstone and laminated shale interbeds, moderately closely spaced rough and up to 7 mm high stepped joints, parts easily along shale laminae, slickensided; 4 cm wide clay gouge zone @ 279'	
280	R55	13:07 13:26	100	82	1.4	J S B	A	TH MM	SR SK S	D P O W	I VI	F	50 75 50			280 TEST 2
285	R56	13:36 13:54	100	65	3.3	J S B	A	VT MM	SR SK S	W P S O	I VI VIII	F	30 70 30 25		- 0.3 m wide irregular clay-lined shear zone - <1 mm wide slickensided shear - locally open joints - poorly cemented layer	285
290	R57	14:34 14:47	100	88	0.6	J S B	B1	TH MM	SR SK S	D W P S	I VI	F	60 50 60 30		- <1 mm wide slickensided shear	290
295	R58	10:17 10/24 10:33	93	70	0.4	J S B	A	VT MM	S SK	P	I VI	F	50 55 15		- locally tightly healed shears parallel to bedding - 5 cm wide shear zone - <0.5 mm wide slickensided shear	295
300	R59	10:56 11:13	100	83	0.2	J B	A	L MM	S	P	I	F				300
305	R60	11:31 11:37	100	50	0	B	A	L TH	S	P	I	F	50			305
310															Boring terminated at 307 feet on 10/24/92.	310



Not to Scale

The Earth Technology Corporation

Project No.: 92-2050
Geotechnical Investigation
Santa Monica Mountains
Segment 3, Metro Red Line

Location of Boring
SM-12

Figure A-16

The Earth Technology Corporation

LOG OF BORING SM-12

Client: PB/DMJM
Project: Metro Red Line-Segment 3
Project No.: 92-2050
Location: N4160825/E4177823
Surface Elevation (ft): 671
Boring No.: SM-12
Inclination (Deg.): 90
Bearing: NA
Depth (ft): 207.0
Depth to Water Table (ft): 26
Started: 10/26/92
Finished: 10/29/92
Core Dia. (in.): 2.4
No. of Core Boxes: 13
Driller: PC Exploration, Inc.
Drilling Method: Mud rotary
Fluids: Bentonite/Clear mud
Drilling Equipment: Mobile B-53
Logged By: P. Dunster
Checked By: G. Miller
Page No.: 1 of 7

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
0															**ASPHALT**	0
	R1	07:07 10/27			-	-	-	-	-	-	-	-			**ALLUVIUM (Qal):** SILT (ML); mottled light brown, moderate yellowish brown and dark yellowish orange, dry to slightly moist, nonelastic silt with fine-grained sand, massive [Drilled with Punch Core]	
5	R2	07:10 07:15			-	-	-	-	-	-	-	-			CLAYEY SILT (MH); mottled light brown, moderate yellowish brown, dry to slightly moist, elastic silt and plastic clay, some fine-grained sand, massive	5
															[driller indicates harder drilling]	
10	R3	07:20 07:27	0	0	-	-	-	-	-	-	-	-			**UPPER TOPANGA FORMATION (Ttu):** SILTY SANDSTONE; mottled dark yellowish orange and grayish orange, fine-grained sand and silt, very friable, parts along bedding, laminated [change to diamond impregnated core bit]	10
	R4	07:35 07:47	70	0	0	B	A	L VT	S	D P	III II	MW W				
15															light brown and light olive gray siltstone, claystone and shale laminae	15
													50			
	R5	07:54 08:07	19	0		B	A	L VT	S	D P	III II	MW HW				
20																20
	R6	08:11 08:18	30	7		B	A	L TH	S	D P	III II	MW HW				
25													60			25
	R7	08:26 08:34	63	0	0.2	B S J	A	L VT	S SK	D P	III VIII II	MW HW				
													65		- slickensided clay-lined joint	
30																30

LOG OF BORING SM-12

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4160825/E4177823
Boring No.: SM-12	Page No.: 2 of 7

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
30 35	R8	08:42 08:54	57	0	0.2	S J B	A	L	S SR SK	D P S	I III VI	FW F	30 70		**UPPER TOPANGA FORMATION (Ttu):** SANDSTONE; light brown, moderate brown, dark to pale yellowish orange, fine-grained sand with silt, very friable, parts along bedding, laminated with siltstone and claystone interbeds, black discoloration on bedding surfaces, scattered slickensided shears parallel to bedding	30 35
40	R9	09:06 09:32	93	37	1	S J B	B1	L MM	S SK SR	D P S	I VI	F	70 30		very light gray and dark gray - stepped joints	40
	R10	09:39 11:20	94	10	-	S J B	A	L VT TH	S SK SR	D P	I VI VIII	F	60		- 15 cm wide shear zone - coal-like intraclasts - 0.4 m wide very closely fractured zone with polished surfaces	
45	R11	11:26 11:35	94	27	1	J B	A	L TH	S SR	D P	I VI	F	65 30		- randomly spaced discontinuous slightly rough joints	45
50	R12	11:45 11:53	100	71	0.5	B	A	TH	S SR	D P	I VI	F	70 30		SILTSTONE; very light gray and dark gray, highly elastic silt with fine-grained sand, very friable, parts along bedding, laminated with sandstone and claystone interbeds, closely spaced joints and shears	50
55	R13	11:59 12:09	87	10	1	B J S	B1	L TH	S SR SK	D P S	I	F	30 80		- sheared interval, <1 mm thick	55
60	R14	12:21 12:32	100	33	1	B J S	A	VT TH	S SR	D P	VIII V	F	80 70 80 30		- 1.5 cm thick sheared clay seam	60
	R15	12:45 13:21	80	0	0	B	A	TH	S	-	-	F	60		- parts along bedding planes	
65	R16	12:33 13:45	93	0	0	B S	A	L VT	S	P	I VI	F				65

LOG OF BORING SM-12

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4160825/E4177823
Boring No.: SM-12	Page No.: 3 of 7

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		14:07											30 40		**UPPER TOPANGA FORMATION (Ttu):** SILTSTONE; very light gray and dark gray, highly elastic silt, plastic clay with fine-grained sand, very friable, parts along bedding, laminated with sandstone and claystone interbeds, closely spaced joints and shears which are parallel to bedding	
70	R17	14:31 14:40	100	0		B S	A	VT	S SK SR	P D	I VI VIII	F	30 60		- very closely spaced joints, soft and punky	70
75	R18	14:45 15:02	80	0	1	B S	B1	L VT	S SK	D W	I VI VIII	F	30 50 60			75
80	R19	15:11 15:27	95	23	0.4	B J	A	L TH	SR S SK	D W P	I	F	65 60 30		scattered coal fragments	80
	R20	- 15:52	100	50	0.3	B J	A	L MM	S SR	D P S	I	F	65 55 40		- stepped joint	
85	R21		67	42	2	B J	A	L TH	S SR	P	I	F	60		- well cemented sandstone layer with coal fragments	85
90	R22	16:35 16:41	100	88	0	B	A	VT MM	S	D P	I	F	60 55			90
95	R23	16:50 16:57	100	77	0.2	B J	A	VT MM	S	D P	I	F	60 60 50			95
100	R24	17:02	98	62	0	B	A	MM	S	P D	I	F	50 50		SANDSTONE; light gray and dark gray, fine- to coarse-grained sand with silt, parts along bedding, laminated with shale interbeds, moderately closely spaced joints, shears parallel to bedding, scattered coal-like fragments	100

The Earth Technology Corporation

LOG OF BORING SM-12

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4160825/E4177823
Boring No.: SM-12	Page No.: 4 of 7

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
105	R25	17:07 -	100	83	0.6	B J	A	L MM	SK S	D P	I	F	30 50 20		**UPPER TOPANGA FORMATION (Ttu):** SANDSTONE; light gray and dark gray, fine- to coarse-grained sand with silt, parts along bedding, laminated with shale interbeds, moderately closely spaced joints, shears parallel to bedding, scattered coal-like fragments, convoluted bedding and flame structures @ 104'	105
110	R26	17:22 - 10/28	98	88	0.4	B J	A	VT MM	SR S	D P	I	F	45 20 50			110
	R27	07:42 07:53	94	48	0.25	B J	A	VT MM	SR S	D P S	I	F	50 40 50			
115	R28	08:01 08:08	95	70	0.6	B J	A	VT MM	SR S	D P	I	F	60 50 60			115
120	R29	08:17	0	0	-	-	-	-	-	-	-	-			extremely friable sand, very closely fractured	120
	R30	09:01	8	8	-	B	-	-	S	P	I	F	60			
125	R31	09:05 09:14	90	73	0.6	B J	C1	VT MM	SR	P W	I	F	30 50 80		[water flows from boring for brief period of time] massive sandstone, no shale interbeds	125
130 135	R32	09:21 - 09:48	57	38	0.4	J	A	TH MM	SR	P W	I	F	30 80		[water flows from boring for brief period of time]	130 135

LOG OF BORING SM-12

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4160825/E4177823
Boring No.: SM-12	Page No.: 5 of 7

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R33	10:10 10:15	82	30	0	B	A	L TH	S SR	D P	I	F	80 85		**UPPER TOPANGA FORMATION (Ttu):** SANDSTONE; light gray and dark gray, fine- to coarse-grained sand with silt, parts along bedding, moderately closely spaced joints, shears parallel to bedding, scattered coal-like fragments	
140	R34	10:47	100	100	1	J B	A	TH	SR	W	I	F	60		interbedded shale laminae	140
145	R35	10:51 11:02	97	60	1.2	J B	A	VT MM	SR S	D P	I	F	70 75 75		- 5 cm wide extremely closely fractured zone - bedding plane parting	145
150	R36	13:25 13:31	93	77	0	J B	A	VT MM	SR S	D P	I	F	75		fewer shale interbeds	150
155	R37	13:40 13:47	60	53	0	B	A	TH MM	SR	D P	I	F	70 70 70		- bedding plane parting	TEST 1 155
160	R38	13:55 14:04	92	15	0	B	A	L MM	SR S	D P	I	F	75 75 75		- bedding plane parting - bedding plane parting	160
165	R39	07:16 10/29 07:23	100	80	0.6	B J	A	VT MM	S SR	D P	I	F	70 20 75 70		[driller indicates bottom 2 m caved after packer test] - bedding plane partings	165
170	R40	07:29	100	100	0	B	A	VT	-	-	I	F	60		- scattered tightly healed faults	170

LOG OF BORING SM-12

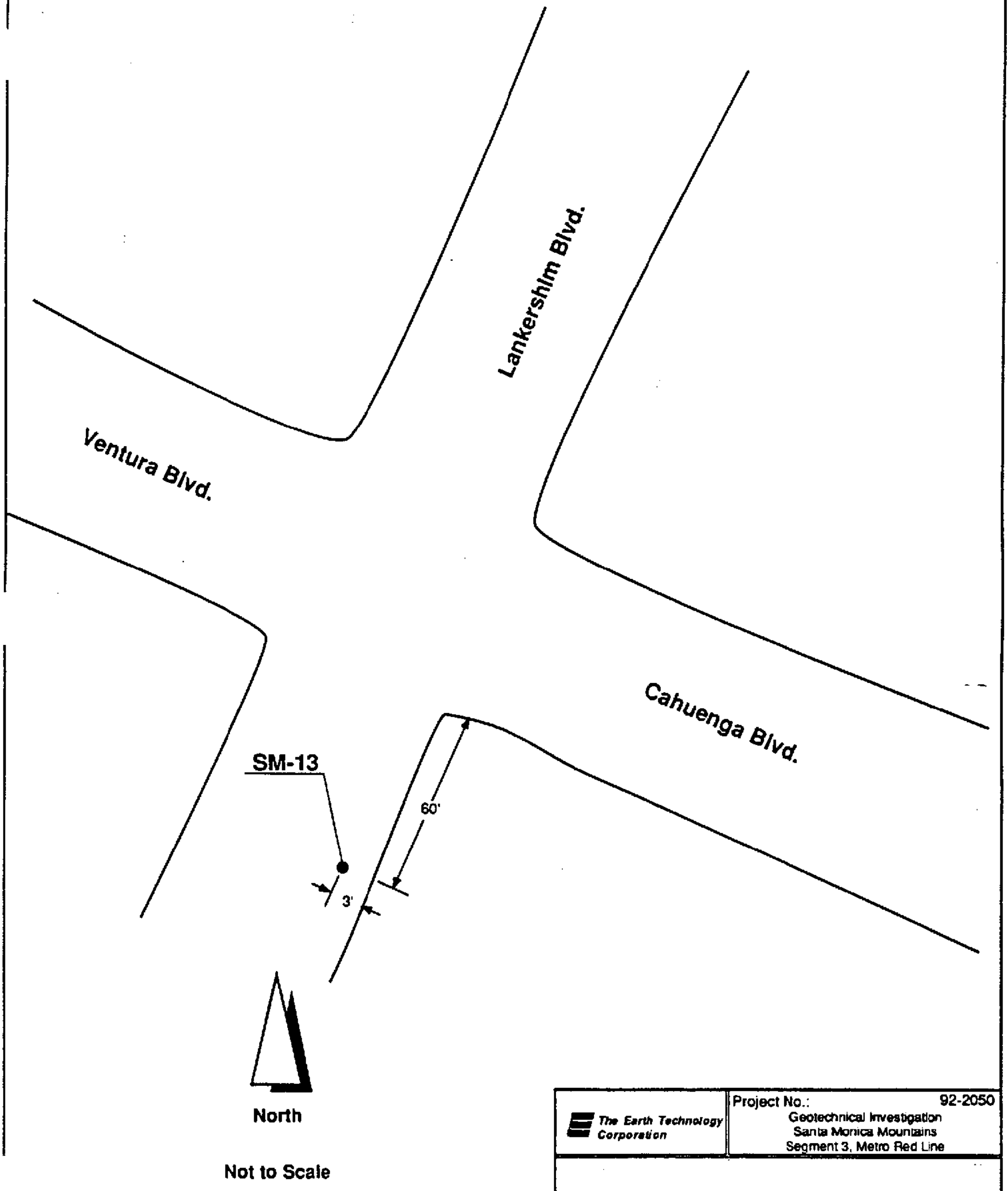
Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4160825/E4177823
Boring No.: SM-12	Page No.: 6 of 7

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
		07:39													**UPPER TOPANGA FORMATION (Ttu):** SANDSTONE; light gray and dark gray, fine- to coarse-grained sand with silt, parts along bedding, laminated with shale interbeds, moderately closely spaced joints, shears parallel to bedding, scattered coal-like fragments	
175	R41	07:49 08:00	100	98	0	B	A	MM	S	D P	-	F	55			175
180	R42	08:08 08:14	98	77	0	B S J	A	TH MM	S SR	D P	I VI	F	50		bedding plane partings common - 5 cm wide extremely closely fractured zone - < 0.5 mm wide clay-lined shears parallel to bedding	180
185	R43	08:23 08:29	100	67	0	B	A	L MM	S SR	D P	-	F	50 50			185
190	R44	08:36 08:48	88	27	0.2	B J	A	L TH	S SR	D W P	I	F	50 40 50			190
195	R45	09:00 09:09	100	63	0.2	B S J	A	L MM	S SR SK	D W P S	I	F	55 70 50		- < 0.5 mm wide slickensided joint/shear across bedding	195
200	R46	09:23 09:33	97	65	0.4	B J	A	VT MM	S SR SK	P S	I	F	50 20 50			200
205	R47	09:46	97	97	0	B	A	TH	S	P W S	-	F	55 50			205

LOG OF BORING SM-12

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4160825/E4177823
Boring No.: SM-12	Page No.: 7 of 7

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
		09:54												▨	**UPPER TOPANGA FORMATION (Ttu): see above**	
															Boring terminated at 206 feet on 10/29/92.	
210																210
215																215
220																220
225																225
230																230
235																235
240																240



The Earth Technology Corporation

Project No.: 92-2050
Geotechnical Investigation
Santa Monica Mountains
Segment 3, Metro Red Line

Location of Boring
SM-13

Figure A-17

The Earth Technology Corporation

LOG OF BORING SM-13

Client: PB/DMJM	Project: Metro Red Line-Segment 3	Project No.: 92-2050
Location: N4162233/E4177843	Surface Elevation (ft): 590	Boring No.: SM-13
Inclination (Deg.): 90	Bearing: NA Depth (ft): 130.5	Depth to Water Table (ft): 12
Started: 11/3/92 Finished: 11/4/92	Core Dia. (in.): 2.4	No. of Core Boxes: 9
Driller: PC Exploration, Inc.	Drilling Method: Mud rotary Fluids: Bentonite/Clear mud	Drilling Equipment: Mobile B-53
Logged By: P. Dunster	Checked By: G. Miller	Page No.: 1 of 4

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
0	R1	11:15 11/3													ASPHALT ALLUVIUM (Qal): SILTY CLAY (CH); dusky yellowish brown to brownish black, plastic clay with silt, some fine-grained sand, friable, massive, slightly porous [punch core to 40']	0
5	R2	11:38													SILT (MH); moderate yellowish brown to moderate brown, elastic silt with clay, some fine-grained sand, moderately friable, massive CLAY (CH); olive gray to pale yellowish brown, plastic clay with silt, moderately friable, massive	5
10		11:50														10
	R3	11:53													SILT (MH/ML); grayish olive, slightly elastic silt with clay and fine-grained sand, moderately friable, massive	
15		11:57														15
	R4	12:00	100	60	0	B	A	L VT	-	W	-	HW CW	50- 70		mottled light olive brown and dusky yellow UPPER TOPANGA FORMATION (Ttu): SILTY SANDSTONE/SANDY SILTSTONE; pale yellowish brown to dark yellowish brown and light gray, interbedded nonelastic silt with clay and fine- to medium-grained sand, weakly cemented, laminated to thinly bedded, black discoloration on bedding planes	
20		12:15														20
	R5		100		-	-	-	-	-	-	-	-				
	R6	13:01	67	41	0	B	A	L VT	SR	W D	V	HW	70		parts along bedding	
25		13:08														25
	R7	13:12	62	38	0	B	A	L VT	SR	W D	V	HW	70		moderate yellow and light gray	
30		13:20														30

LOG OF BORING SM-13

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4162233/E4177843
Boring No.: SM-13	Page No.: 2 of 4

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
30	R8	13:32 13:39	50	0	0.2	B J	A	L VT	S	W D	IV	HW	40 75		UPPER TOPANGA FORMATION (Ttu): SILTY SANDSTONE/SANDY SILTSTONE; yellowish gray to light olive gray and dark yellowish orange, fine- to coarse-grained sand and silt and clay interbeds, moderately cemented, laminated to very thinly bedded, black discoloration on bedding planes, widely spaced joints, parts along bedding	
35	R9	14:27 14:32	0		-	-	-	-	-	-	-	-				
40	R10	14:40 14:50	100	60	1.0	J B	B1	VT MM	S SR	P S	I II	FW SW	30 25 15 75		[no recovery due to use of modified punch core method, switched to diamond impregnated core bit at 40'] - fine-grained sand SILTSTONE; light gray to dark gray and pale yellowish orange to dark yellowish orange, slightly elastic silt with clay, some fine- to medium-grained sand interbeds, moderately cemented, laminated with medium bedded sandstone layers, closely space rough and stepped joints, parts along bedding	
45	R11	15:02 15:11	95	58	2.0	J B	A	VT MM	SR S	P S	I II	SW FW	15 75 20		light gray to dark gray, iron-oxide stains on joints	
50	R12	15:28 15:40	95	15	2.0	J B	B1	VT TH	SR	P S	I II	SW FW	60 65 80		SILTY SANDSTONE/SANDY SILTSTONE; light gray to dark gray, interbedded nonelastic silt with clay and fine- to coarse-grained sand, weakly cemented, laminated to thinly bedded, closely spaced iron oxide stained joints, parts along bedding,	
55	R13	15:59 16:02	60	0		J B	A	L VT	S	P	I	FW	90 30			
60	R14	16:26 16:34	77	48	1.2	J B	B1	L MM	S SR	P S W	I	F	55 85 85		convoluted, nearly vertical bedding	
65																

LOG OF BORING SM-13

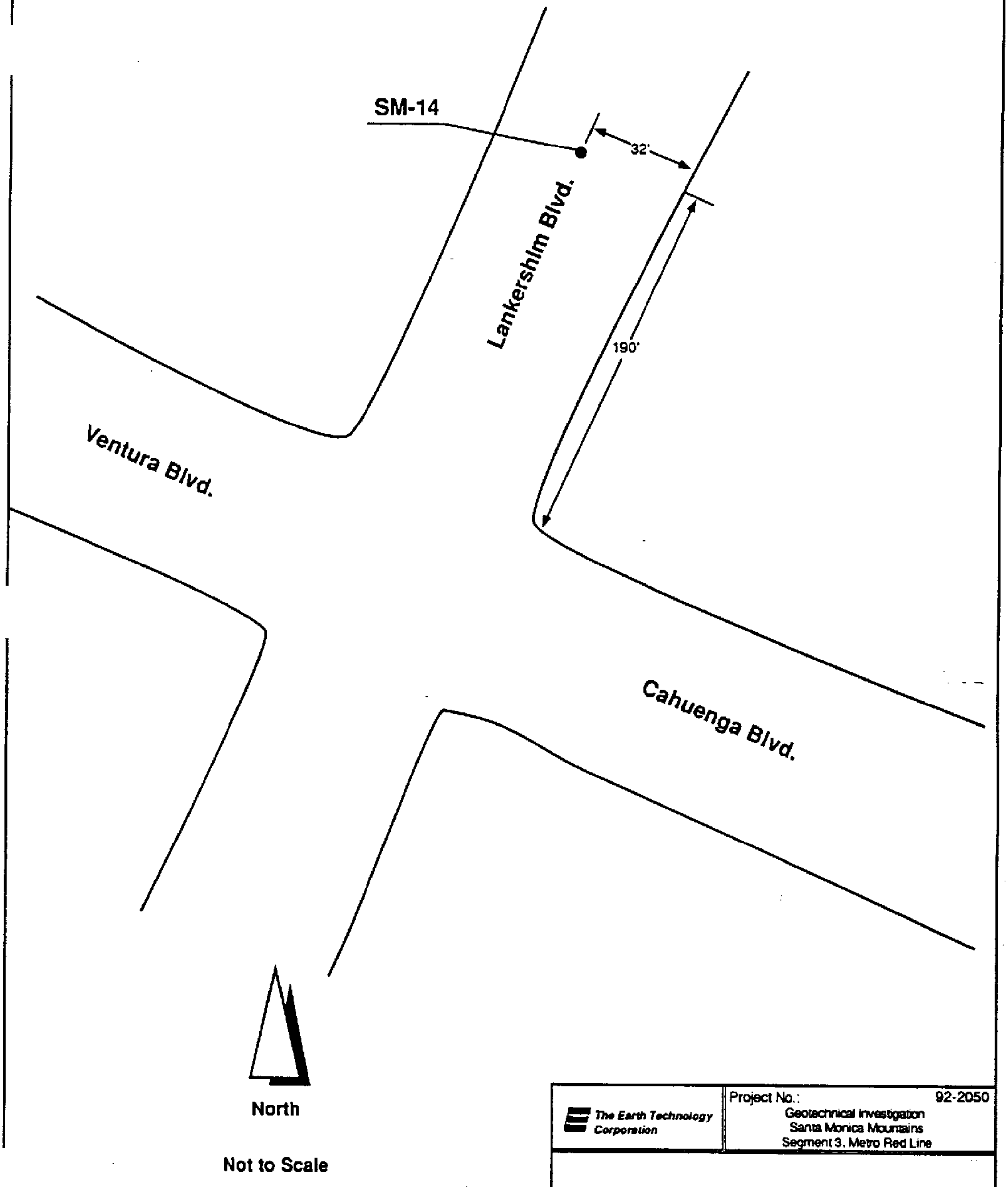
Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4162233/E4177843
Boring No.: SM-13	Page No.: 3 of 4

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description									Lithic Description	Packer Test Interval
						Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch		
	R15	07:28 11/4 07:37	87	65	0.4	B J	A	VT TH	SR	D S	-	F	90- 85 60		**UPPER TOPANGA FORMATION (Ttu):** SILTY SANDSTONE/SANDY SILTSTONE; light gray to dark gray, interbedded nonelastic silt with clay and fine- to coarse-grained sand, weakly cemented, vertically laminated to thin beds, unfractured, locally crossbedded and convoluted, parts along bedding	
70	R16	07:55 08:63	97	68	0	B	A	VT	S SR	P W	-	F	90			70
75	R17	08:50 08:58	100	100	0	B	A	VT	-	-	-	F	90		scattered carbon fragments [driller adds detergent to drilling fluid]	75 T E S T 1
80	R18	09:23 09:32	98	72	0	B	A	L VT	S SR	P W	I	F	85- 90			80
85	R19	09:49 09:54	97	77	1.0	B J	B	L MM	S SR	S P	I	F	15 80 15 80 80		parts readily along bedding, moderately closely spaced fractures - 3 mm high steps along rough joint	85
90	R20	12:16 12:20	72	72	0	-	A	-	-	-	I	F	85 85		no bedding plane partings, unfractured	90
95	R21	12:28 12:33	92	73	0	-	A	-	-	-	I	F	70 70		- healed fractures	95
	R22	12:40	89	63	1.2	J	B1	VT	SR	S	I	F	30			
100																100

LOG OF BORING SM-13

Client: PB/DMJM	Project: Metro Red Line-Segment 3
Project No.: 92-2050	Location: N4162233/E4177843
Boring No.: SM-13	Page No.: 4 of 4

Depth(feet)	Run No.	Begin/End Time(hrs)	Core Recovery(%)	RQD (%)	Discontinuity Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
		12:50				B		MM	S	P			30 60 60		**UPPER TOPANGA FORMATION (Ttu):** SILTY SANDSTONE/SANDY SILTSTONE; light gray to dark gray, interbedded nonelastic silt with clay and fine- to coarse-grained sand, weakly cemented, laminated to thinly bedded, wide to very wide spaced joints	
105	R23	12:55 13:00	100	100	0	B	A	T	S	P	-	F	70		- scattered siltstone intraclasts 1.1 m thick sandstone layer with infrequent siltstone interbeds	105
110	R24	13:08 13:13	98	90	0.2	B J	A	TH T	S SR	P	I	F	30 60		- parts along joint	110
115	R25	13:30 13:36	100	53	0.4	B J	A	L MM	S SR	P D W	I	F	35 50 50		- carbon-rich layers	115
120	R26	13:43 13:47	100	42	0.5	B S	A	VT TH	S SR SK	P	I VIII	F	55 70		parts readily along bedding	120
125	R27	13:54 13:58	98	98	0.0	B S	A	T	-	P W	I VIII	F			15 cm wide clay-lined and polished shear zone, no partings	125
130	R28	14:06 14:09	93	72	0.8	B J S	A	MM	SR	P	I III	F	40 40		- scattered siltstone intraclasts - slickensided, polished and soft shear	130
135															Boring terminated at 130.5 feet on 11/4/92.	135



The Earth Technology Corporation

Project No.: 92-2050

Geotechnical Investigation
Santa Monica Mountains
Segment 3, Metro Red Line

Location of Boring
SM-14

Figure A-18

Project Name:	Metro Rail		
Project Number: 92-2050	Boring Number: SM-14	Sheet 1 of 5	
Boring Location:	N4162525/E4178016	Elevation and Datum(feet):	580.3
Health and Safety: None		Date Started: 6/7/93	Date Finished: 6/8/93
Drilling Equipment: Acker D2		Total Depth (feet): 55.5	Depth to Bedrock(feet): 50.8
Drilling Method: Hollow-Stem Auger		Number of Samples: 10	Depth to Water (feet): 7.3
Boring Diameter: 8"		Completion Information: see log	
Hammer Information: Downhole Hammer:140-lb and 30-inch drop.		Logged By: M. Curtis	Checked By: G. Miller

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples							
					Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
0		Concrete (8-1/4")							NA			NA
		CLAYEY SAND; dark yellowish orange (10YR 6/6), dry, dense, medium-grained sand with fine-grained sand and clay	SC	Qal								
		SANDY CLAY; dark yellowish brown (10YR 4/2), dry, medium stiff, 6" thick	CL									
		SILT; dark yellowish brown (10YR 4/2), moist, medium stiff, medium to high plasticity, trace fine-grained sand, micaceous	MH									
5					1	D	5/6	12/12				
		trace coarse-grained sand										
		wet										
	▼											
		SANDY SILT; dark yellowish brown (10YR 9/2), wet, stiff, low plasticity, some fine-grained sand, trace clay, micaceous	ML									
10												

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Project Name: Metro Rail

Project Number: 92-2050 | Boring Number: SM-14 | Sheet 2 of 5

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Samples Type	Samples Blow Count	Samples Recovery	Samples RQD (%)	Samples Dry Density (pcf)	Samples Moisture Content (%)	Begin/End Time (hr)
10		SANDY SILT; dark yellowish brown (10YR 4/2), wet, stiff, low plasticity, some fine-grained sand, trace clay, micaceous	ML	Qal	2	S	7/28/28	18/18	NA			NA
15		some clay			3	D	28/30	12/12				
20		SILTY CLAY; dark yellowish brown (10YR 4/2), wet, medium stiff to stiff, medium to high plastic clay with silt, trace fine-grained sand	MH/CH	Qal	4	S	10/20/28	18/18				
25												

Project Name:	Metro Rall		
Project Number:	92-2050	Boring Number: SM-14	Sheet 3 of 5

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		(sample muddy and soft, may not be representative) SILTY CLAY; dark yellowish brown (10YR 4/2), wet, medium stiff to stiff, medium to high plastic clay with silt, trace fine-grained sand	MH/CH	Qal	5	D	7/14	10/12	NA			NA
		SANDY SILT; moderate yellowish brown (10YR 5/4), wet, medium stiff, low plastic silt with medium- to fine-grained sand	ML									
30					6	S	42/46/48	18/18				
		SILT; olive gray (5Y 3/2), moist, medium stiff to stiff, trace clay	ML									
		SILTY SAND (SM); moderate yellowish brown (10YR 5/4) to light olive gray, moist, medium dense to dense, very fine-grained sand with silt	SM									
35					7	D	34/42	12/12				
		harder drilling, dense to hard										
		very fine- to fine-grained sand, some silt										
40												

Project Name:		Metro Rail												
Project Number:		92-2050	**Boring Number:**	SM-14					**Sheet** 4 **of** 5					

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		SILTY SAND; as above	SM	Qal	8	S	48/50	12/12	NA			NA
		SILTY GRAVEL; olive gray (5Y 3/2), moist to wet, hard, high plastic silt with gravel up to 3/4" in size, micaceous	GM									
		CLAYEY SILT; light olive brown to olive gray (5Y 5/6-3/2), moist to very moist, stiff, medium plastic silt with clay, trace fine-grained sand	CL/ML									
45					9	D	19/50	11/12				
		SAND; moderate brown (5YR 3/4), moist to wet, very dense, coarse-grained sand, trace silt and medium-grained sand	SP									
50					10	S	38/50	12/12				
		INTERBEDDED SILTY SANDSTONE AND SILTSTONE; banded grayish orange (10YR 7/4) and grayish blue (5PB 5/2), highly weathered, thinly bedded		Tt								
55												

Project Name:	Metro Rail		
Project Number:	92-2050	Boring Number: SM-14	Sheet 5 of 5

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples							
					Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		SANDSTONE; grayish blue (5PB 5/2), fine-grained sand, laminated, moderately weathered, apparent dip 47 degrees		Tt	11	D	50/4"	1/4	NA			NA
		Boring terminated at 55.5 feet by refusal. Groundwater encountered at 6 feet.										
60												
65												
70												

LOGS OF BORINGS R-8 AND R-9 DRILLED IN 1989

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LOG OF CORING R-8

Project Name: Metro Rail Project; Rock Coring - Santa Monica Mountains

Project Number: 89-409

Corehole Number: R-8

Sheet 1 of 6

Corehole Location: Fredonia Avenue

Elevation and Datum(feet): 665

Date Started: 5/16/89

Date Finished: 5/19/89

Drilling Equipment: Failing 750

Total Depth(feet): 200.5

Depth to Bedrock(feet): 20.5

Drilling Method: Rotary Wash
Nx Core

Corehole Diameter: 3-inch

Piezometer Installation: YES

Depth(feet): 80

Hammer Information:
SPT Hammer: 140-lb and 30-inch drop.
DOWNHOLE Hammer: 295-lb and 18-inch drop.

Logged By: Steve Townsend

Checked By: Fred CHEN, GE

Depth (feet)	Elev. (feet)	Total Core Recovery	R.Q.D.	Geologic Unit	Lithic Symbol	Lithic Description	Fracture Log	Structural Description	Remarks
	665				■	ASPHALT			
		N/A	N/A		▩	SILTY SAND; Medium to dark gray. Fill material.			
5	660				⁘	SAND; Firmer.			
					▨	CLAY; Medium dense.			
10	655	N/A	N/A		⁘	SAND; Dark yellow.			
					▨	CLAY; Very dark grey, moist, medium dense, slightly silty, occasional gravel up to 1/12-inch-size.			Set Casing at 12 feet.
15	650	72	N/A						
				Res. Soil					
20	645	N/A	N/A		⁘	SILTY SAND; Grey orange, moist, dense.			OVA Headspace 5.6 ppm
				Ttw	☰	SAND(STONE); Grey orange, fine grained, subangular, weathered, friable, poorly cemented, interbedded with medium dark grey, poorly cemented siltstone and slightly silty, firm claystone.		Dip approximately 50 degrees.	
25	640	N/A	N/A						

LOG OF CORING R-8

The Earth Technology Corporation

Project Name:	Metro Rail Project; Rock Coring - Santa Monica Mountains		
Project Number:	89-409	**Corehole Number:** R-8	**sheet** 2 **of** 6

Depth (feet)	Elev. (feet)	Total Core Recovery	R.Q.D.	Geologic Unit	Lithic Symbol	Lithic Description	Fracture Log	Structural Description	Remarks
	635	71	N/A	Tto		SAND(STONE); Medium dark grey, moderately hard, moderately cemented, fine grained, subangular to subrounded, with 1/12- to 1/5-inch-thick oxidised zones.			OVA Headspace 5.6 ppm 5/15/89-5/16/89
35	630	85	N/A	Ttf		SILTSTONE; Medium dark grey to dark olive grey, very thinly interbedded with claystone.			OVA Headspace 5.6 ppm OVA background 5.6 ppm
40	625	64	N/A			SILTSTONE; Medium grey to medium dark grey, moderately hard, moderately cemented, interbedded with medium dark grey, waxy, firm to stiff claystone.			OVA Headspace 5.6 ppm
45	620	N/A	N/A			SANDSTONE; Medium grey, dense, hard, moderately cemented, very fine grained, subangular to subrounded. Some siltstone. Harder at 48.9 feet.			OVA Headspace 5.6 ppm. Poor recovery due to lack of penetration.
50	615	100	N/A			SANDSTONE; Medium dark grey to dark olive grey, dense, hard, moderately cemented, very fine grained, interbedded with siltstone and medium dark grey to dark olive grey, waxy, stiff claystone.		Up to 3-inch-thick claystone interbeds.	OVA Headspace 5.6 ppm Pitcher 200-250 psi
55	610	86	N/A			SANDSTONE; Medium dark grey, hard to very hard, locally cemented, fine grained to very fine grained. Dark olive grey, waxy, stiff, claystone in fractures.		Claystone-filled fractures.	
60	605	80	0			Harder Drilling at 60 feet. SILTSTONE; Dense, hard, interbedded with grey black to grey green, very fine-grained to fine-grained, subangular to subrounded sandstone and greyish green, firm, waxy claystone. SANDSTONE; Medium light grey, dense, very hard, strongly cemented, fine grained, sucrosic, textured. Trace black minerals. Noncalcareous cementation. Grading to poorly cemented, friable sandstone at 64 feet.		Dip approximately 60 to 70 degrees. Numerous vertical fractures with some minor vertical offset up to 1/2 inch. Convoluted bedding. Partings along claystone interbeds.	
65	600								

LOG OF CORING R-8

The Earth Technology Corporation

Project Name: Metro Rail Project; Rock Coring - Santa Monica Mountains

Project Number: 89-409 **Corehole Number:** R-8 **sheet** 3 **of** 6

Depth (Feet)	Elev. (Feet)	Total Core Recovery	R.Q.D.	Geologic Unit	Lithic Symbol	Lithic Description	Fracture Log	Structural Description	Remarks
70	595	100	82	Ttf		SANDSTONE; Medium dark grey, dense, hard, strongly cemented, fine grained to medium grained, subangular to subrounded, interbedded with dark olive grey, firm, waxy claystone. Trace calcite within partings.		Dip approximately 70 degrees. Thickly bedded sandstone (up to 3 foot thick) with thin (up to 1/4-inch-thick) claystone interbeds. Convoluted bedding. Partings along claystone interbeds; Slickensided partings surfaces. Minor calcite-filled fractures.	
75	590								
80	585	83	37			SANDSTONE; Medium dark grey, dense, moderately hard, moderately cemented, medium grained to fine grained, subangular to subrounded. SILTSTONE; Dark olive grey, firm, moderately cemented, very fine grained, with claystone along bedding planes. SANDSTONE; Medium dark grey, moderately cemented, fine grained to medium grained, laminated with siltstone.		Dip approximately 70 degrees. Convoluted bedding. Partings along claystone interbeds; Slickensided partings surfaces. Disturbed zone (vertical organic zones up to 1/2 inch long).	
85	580								
90	575	87	37			SANDSTONE; Medium dark grey, dense, very hard, fine grained to medium grained, strongly cemented with calcite, interbedded with siltstone. Very thinly bedded, dark olive green, firm, siltstone. SANDSTONE; Medium dark grey, moderately hard, moderately cemented, medium grained to fine grained.		Dip approximately 70 degrees. Convoluted bedding. Partings along siltstone interbeds; Polished partings surfaces.	
95	570					SILTSTONE; Dark olive grey, very thinly bedded. 2- to 3-inch-thick claystone zone at contact. SANDSTONE; Medium dark grey, moderately cemented, friable.			Oil stains in drilling mud at 96 feet.
100	565	75	44			SANDSTONE; Medium dark grey, fine grained, strongly cemented, hard, very thinly interbedded to laminated with medium dark olive siltstone. SILTSTONE; Medium dark grey, hard, moderately cemented, very thinly interbedded with fine grained sandstone.		Dip approximately 70 degrees. Partings along claystone interbeds; Slickensided partings surfaces.	
105	560					SANDSTONE, Medium dark grey, friable, poorly cemented, fine grained. SILTSTONE; Medium dark grey to dark olive grey, moderately cemented.			5/16/89-5/17/89

LOG OF CORING R-8

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Project Name:	Metro Rail Project; Rock Coring - Santa Monica Mountains
Project Number:	89-409
Corehole Number:	R-8
sheet	4 of 6

Depth (feet)	Elev. (feet)	Total Core Recovery	R.Q.D.	Geologic Unit	Lithic Symbol	Lithic Description	Fracture Log	Structural Description	Remarks
	555	90	52	Ttf		SILTSTONE; Dark olive grey to dark grey, moderately weak, moderately cemented, waxy.		Dip approximately 70 degrees. Partings along claystone interbeds; Slickensided partings surfaces. Parallel to subparallel interbeds.	
						SANDSTONE: Medium dark grey to dark grey, fine grained, moderately cemented, weak, friable.			
						SILTSTONE; Dark grey to dark olive grey, moderately cemented, moderately hard, waxy, laminated with sandstone and firm, waxy, claystone.			
115	550								
120	545	88	40			SANDSTONE; Medium dark grey, fine grained, moderately cemented, friable, interbedded with siltstone and dark grey, firm, strongly cemented, waxy, claystone. Trace of organic materials at 122 feet.		Dip approximately 70 degrees. Partings along claystone interbeds; Polished partings surfaces. Parallel to subparallel interbeds.	
125	540	98	41			SILTSTONE; Dark olive grey, weak to firm, locally cemented.		Dip approximately 70 degrees. Irregular, discontinuous, closely spaced, closed, rough fractures in 125-126.5 depth interval. Slickensided partings surfaces.	
						SANDSTONE; Medium dark grey, medium grained to fine grained, moderately cemented, weak, friable, subangular to subrounded.			
130	535	96	94					Dip approximately 70 degrees. Convoluted bedding.	
						Very thinly interbedded, dark grey siltstone and dark olive grey claystone.		Discontinuous, widely spaced, closed fractures.	
						SANDSTONE; alternating moderate and strong cementation. Mostly siliceous cementation except for one calcareous zone.			
135	530	100	74					Dip approximately 70 degrees. Convoluted bedding. Partings along siltstone and claystone interbeds.	
						SILTSTONE; Dark grey to dark olive gray, moderately cemented, weak along bedding planes, very thinly interbedded with sandstone.			
140	525	88	52					Dip approximately 70 degrees.	
						SANDSTONE; Medium dark grey, fine grained, subangular to subrounded, moderately cemented. Calcareous cementation at 142 feet. Medium dark grey to dark grey siltstone interbed at 143 feet . Dark olive grey, waxy, soft to stiff claystone interbed at 143.5 feet. Numerous Dark grey to dark olive grey siltstone interbeds in the 145-150 depth interval.			
145	520	97	37					Dip approximately 70 degrees. Highly sheared, 1/2-inch-wide claystone seam at 146.5 feet. Irregular, discontinuous, closely spaced, narrow to wide calcite-filled fractures in 146.5-147 depth interval.	
		98	72					Dip approximately 70 degrees.	

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LOG OF CORING R-8

Project Name:	Metro Rail Project; Rock Coring - Santa Monica Mountains				
Project Number:	89-409	**Corehole Number:**	R-8	**sheet**	5 of 6

Depth (feet)	Elev. (feet)	Total Core Recovery	R.Q.D.	Geologic Unit	Lithic Symbol	Lithic Description	Fracture Log	Structural Description	Remarks
	515			Ttf		SILTSTONE; Dark grey to dark olive, very fine grained, moderately cemented, friable, weak, very thinly interbedded with sandstone.		Discontinuous, closely spaced, normal to bedding, smooth to rough, slickensided, claystone-lined fractures with some offset.	
		97	60			SANDSTONE; Medium dark grey, hard, medium grained, subangular to subrounded, strongly cemented. Some olive black, soft claystone.		Dip approximately 70 degrees. Discontinuous, closely spaced, irregular, up to 1-inch-thick, claystone-filled fractures. Some shearing observed. Fractures in sandstone are calcite-lined.	5/17/89-5/18/89
155	510					Very thinly interbedded siltstone at 154.5 feet.			
		100	58			Fault gouge at 157.5 feet.		Dip approximately 70 degrees. Irregular, discontinuous, very closely to closely spaced, rough, clay-lined (gouge) fractures in 157.5-159 depth interval.	
160	505					SANDSTONE; Medium dark grey, medium grained to fine grained, subangular to subrounded, strong siliceous cementation, pyrite.			
		88	85			Interbedded siltstone/claystone/sandstone at 163 feet.		Dip approximately 50 degrees. Convoluted bedding. Polished partings surfaces along claystone interbeds.	
165	500					Interbedded siltstone/claystone/sandstone at 166 feet.			
		100	93			Strong cementation at 168 feet.		Dip approximately 50 degrees. Discontinuous, very closely spaced, fractures in the 168-169 depth interval. Some offset. Polished partings surfaces. Convoluted bedding.	
170	495					Strongly cemented, interbedded siltstone at 170 feet.			
		93	55			SANDSTONE; Alternating strong and poor cementation. Strongly cemented, interbedded siltstone/claystone/sandstone at 173.5 feet.		Dip approximately 60 degrees. Widely spaced fractures. Polished partings surfaces. Fractures in sandstone are narrow and normal to bedding.	
175	490					Alternating beds of light grey sandstone and olive black shale at 174.5 feet.			
		85	65					Dip approximately 50 degrees. Discontinuous, normal to bedding, vertical, claystone-lined fractures in the 178-179 depth interval.	
180	485								
								Calcite-filled fracture at 181.5 feet.	
		93	68					Dip approximately 50 degrees. Smooth to slighly rough, slickensided and polished partings surfaces.	
185	480								
		98	48			SANDSTONE; Dark grey, strong siliceous cementation, with occasional thin shale interbeds.		Dip approximately 50 degrees. Widely-spaced joints.	5/18/89-5/19/89

LOG OF CORING R-8

The Earth Technology Corporation

Project Name: Metro Rail Project; Rock Coring - Santa Monica Mountains

Project Number: 89-409 **Corehole Number:** R-8 **sheet** 6 **of** 6

Depth (feet)	Elev. (feet)	Total Core Recovery	R.Q.D.	Geologic Unit	Lithic Symbol	Lithic Description	Fracture Log	Structural Description	Remarks
	475			Ttf					
		96	90			SANDSTONE; Dark grey, poorly cemented, very fine grained. SANDSTONE; Dark grey, very fine grained, massive with occasional thin shale interbeds, strongly cemented.			
195	470								
		100	93			SANDSTONE; Massive, very fine grained, subrounded.		Cemented joints with 1/4-inch to 1-inch displacements at 198 feet.	
200	465					COREHOLE TERMINATED AT 200.5 FEET. PIEZOMETER INSTALLED. NOTE: This Borehole log is based on field classification and visual soil description, and is further modified to include results of laboratory classification tests, where available. 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 passage of time. The data presented is simplification of actual conditions encountered. The stratification lines represent the approximate boundary between subsurface material types and the transition may be gradual.			
205	460								
210	455								
215	450								
220	445								
225	440								

LOG OF CORING R-9

The Earth Technology Corporation

Project Name:	Metro Rail Project; Rock Coring - Santa Monica Mountains		
Project Number:	89-409	Corehole Number: R-9	sheet 1 of 4
Corehole location:	Located at the southwestern corner of the Kentucky/Lankershim intersection.	Elevation and Datum(feet): 605	
		Date Started: 5/12/89	Date Finished: 5/15/89
Drilling Equipment:	Failing 750	Total Depth(feet): 139.2	Depth to Bedrock(feet): 22
Drilling Method:	Rotary Wash	Corehole Diameter: 3-inch	
	Nx Core	Piezometer Installation: YES	Depth(feet): 70
Hammer Information:	SPT Hammer: 140-lb and 30-inch drop. DOWNHOLE Hammer: 295-lb and 18-inch drop.	Logged By: Steve Townsend	Checked By: Fred CHEN, GE

Depth (feet)	Elev. (feet)	Total Core Recovery	R.Q.D.	Geologic Unit	Lithic Symbol	Lithic Description	Fracture Log	Structural Description	Remarks
	605					ASPHALT.			
		N/A	N/A			SANDY CLAY; Dark grey, soft, gas smell, fill materials.			OVA Headspace 7.0 ppm
5	600	N/A	N/A			SILTY SAND; Light grey, firm.			OVA Headspace 6.8 ppm
				Res. Soil		SANDY CLAY; light grey, medium stiff. Nodules in drilling mud.			Set casing at 8 feet.
10	595	100	N/A			SILTY SAND/SANDY CLAY; Brown to greyish brown, dense to very dense.			OVA Headspace 8.0 ppm
				Ttw		SILTY SAND(STONE)/SANDY CLAY(STONE); Brownish orange to tan, weathered, friable, poorly cemented. Poorly graded, fine-grained sand(stone).			
15	590	87	N/A	Tto		SILTY SAND(STONE)/SANDY CLAY(STONE); Mottled brown with grey, very dense/hard.		Laminations. Dip approximately 20 to 30 degrees.	OVA Headspace 6.6 ppm
20	585	100	N/A			SILTY CLAY(STONE); Dark grey, very stiff.			OVA Headspace 6.6 ppm 200-300 psi Pitcher
						SAND(STONE); Greyish orange with thinly interbedded dark grey clay(stone).		Dip approximately 80 degrees.	
25	580	67	N/A			SAND(STONE); Medium grey, moderately cemented with silica, fine grained, well graded, subangular to subrounded, interbedded with medium dark grey claystone.		Dip approximately 70 to 80 degrees. Interbeds up to 1/2 inch thick.	OVA Headspace 10 ppm

LOG OF CORING R-9

Project Name: Metro Rail Project; Rock Coring - Santa Monica Mountains

Project Number: 89-409 **Corehole Number:** R-9 **sheet** 2 of 4

Depth (feet)	Elev. (feet)	Total Core Recovery	R.Q.D.	Geologic Unit	Lithic Symbol	Lithic Description	Fracture Log	Structural Description	Remarks
	575	100	N/A	Tto		SAND(STONE); Greyish orange to medium grey, friable, fine grained, well graded, subangular to subrounded, silica cement, thinly interbedded with medium dark grey siltstone and claystone.		Dip approximately 80 degrees.	OVA Headspace 14 ppm
				Ttf		SANDSTONE; Medium grey, strongly cemented, well graded, subangular.			
35	570	100	50			SANDSTONE; Fine grained, as above. SANDSTONE/SILTSTONE; Medium dark grey, poorly cemented, well graded, laminated with dark grey claystone.	≡	Parting along bedding planes. Nearly vertical fracture healed with silica cement, less than 1/25 inch wide. Laminations approximately 1/10 inch thick. Dip approximately 63 degrees.	100 psi Core
						CLAYSTONE; Poorly cemented, poorly graded, interbedded with siltstone. Dark brown silica with pyrite speckels.		1/16- to 1/5-inch-thick interbeds.	
40	565								
45	560	100	N/A			SANDSTONE; Medium grey, hard, strongly cemented, subangular.			OVA Headspace 6.2 ppm
						SILTSTONE; Medium dark to dark grey, very thinly interbedded with claystone.		Interbeds along bedding planes. Dip approximately 80 degrees	300 psi Pitcher
50	555	58	N/A			SANDSTONE; Medium grey, well graded, subangular.		Dip approximately 80 degrees.	OVA Headspace 14 ppm
55	550	71	N/A			SILTSTONE/CLAYSTONE; Medium grey to dark grey, poorly cemented.	≡	Very thinly bedded, convoluted. Small fault fracture in sample.	OVA Headspace 7.6 ppm
60	545	58	N/A					Laminated. Dip approximately 80 degrees.	OVA Headspace 4.6 ppm 250 psi Pitcher
		96	N/A			Harder.		Dip approximately 80 degrees.	OVA Headspace 4.5 ppm 300 psi Pitcher
		67	N/A			SANDSTONE; Medium grey to dark grey, moderately cemented, very fine grained, well graded, trace calcite. Very thinly interbedded with siltstone and claystone.			OVA Headspace 6.0 ppm
65	540							Dip approximately vertical. Some partings along bedding planes. Smooth to slightly rough, partly polished.	300 psi Pitcher
		50	30			Same as above except silica cement.			
								Dip approximately vertical.	
						SILTSTONE/CLAYSTONE; Medium grey, poorly cemented.		Minor claystone along bedding	

LOG OF CORING R-9

The Earth Technology Corporation

Project Name:	Metro Rail Project; Rock Coring - Santa Monica Mountains
Project Number: 89-409	**Corehole Number:** R-9 · **sheet** 3 **of** 4

Depth (feet)	Elev. (feet)	Total Core Recovery	R.Q.D.	Geologic Unit	Lithic Symbol	Lithic Description	Fracture Log	Structural Description	Remarks
70	535			Ttf		CLAYSTONE; Medium dark grey, soft, slightly sandy.		Dip approximately 80 degrees.	
		88	67			SILTSTONE; Dark grey to medium grey, poorly cemented, slightly sandy, subangular.		Very thinly laminated. Dip approximately 80 degrees. Laminated.	5/12/89-5/13/89
						SANDSTONE; Medium dark grey, poorly to moderately cemented with silica cement , fine grained, well graded, subangular.		Dip approximately vertical. Thinly interbedded.	
75	530					SILTSTONE/SHALE; Dark grey, poorly cemented with calcite, slightly sandy.		Dip approximately vertical. Laminated.	
		60	9			SHALE; Dark grey, soft, smooth, 20 percent clastics.		Dip approximately vertical. Dip approximately vertical.	
80	525					SHALE; Dark grey, smooth, moderately hard, strongly cemented over a 6-inch-long section, laminated with medium grey, hard, fine-grained, subangular, well graded, moderately cemented with slightly calcite, mostly silica cement, sandstone.			
		67	N/A						
						SANDSTONE; Medium dark grey, friable, poorly cemented, very fine grained to fine grained, well graded.		No structures visible.	
85	520	95	N/A			SANDSTONE/SILTSTONE; Moderately hard to hard, differentially cemented.		Laminated.	
90	515	90	N/A			SILTSTONE/CLAYSTONE; Dark grey to medium dark grey.		Laminated.	350 psi Pitcher
95	510	100	N/A			SANDSTONE; Medium grey,poorly cemented with minor siltstone along bedding planes, fine grained, well graded.			350 psi Pitcher
100	505	79	N/A			SANDSTONE; Medium grey to medium dark grey, friable, poorly cemented, fine grained to very fine grained,well graded.		Thin vertical fractures filled with claystone. Some clay balls along fractures.	OVA Headspace 4.8 ppm 300 psi Pitcher
105	500	100	N/A			SANDSTONE; Medium grey to medium dark grey, poorly cemented, fine grained to very fine grained, well graded, laminated with claystone.		1/12-inch-thick laminations.	OVA Headspace 5.4 ppm 350 psi Pitcher 5/13/89-5/14/89

LOG OF CORING R-9

The Earth Technology Corporation

Project Name:	Metro Rail Project; Rock Coring - Santa Monica Mountains
Project Number:	89-409
Corehole Number:	R-9
sheet	4 of 4

Depth (feet)	Elev. (feet)	Total Core Recovery	R.Q.D.	Geologic Unit	Lithic Symbol	Lithic Description	Fracture Log	Structural Description	Remarks
	495	92	N/A	Ttf		SANDSTONE; Medium grey, moderately hard, moderately cemented, fine grained to very fine grained, well graded, subangular, laminated with siltstone.		Minor medium dark grey claystone along lamination.	OVA Headspace 4.8 ppm 300 psi Pitcher
115	490	97	N/A			SANDSTONE/SILTSTONE/CLAYSTONE; Medium grey to medium dark grey, moderately hard, moderately cemented, very fine grained to fine grained, subangular.		Laminated. Numerous claystone-filled, up to 1-inch-wide, small fractures. Offset along fractures.	OVA Headspace 5.0 ppm 380 psi Pitcher
120	485	100	82			SANDSTONE; Medium grey, moderately cemented, fine grained, subangular to subrounded, well graded.		Dip approximately vertical. 2- to 4-inch-spaced fractures healed with silica cement along bedding planes. Convoluted bedding.	
		98	60			SANDSTONE; Light grey, hard, strongly cemented, very fine grained to fine grained, well graded, subangular to subrounded, trace mica, interbedded with dark olive grey claystone.		Nearly vertical, calcite-filled, narrow fracture at 124 feet.	
125	480					SILTSTONE/CLAYSTONE; Dark grey to dark olive grey, well graded.		Very thinly bedded laminations and smooth polished partings along bedding planes. 1/25- to 1/5-inch-thick interbeds.	
						SANDSTONE/SILTSTONE; Dark grey, poorly cemented, very fine grained, poorly graded, subrounded.			
130	475	100	N/A			CLAYSTONE/SHALE; Dark olive grey, fissile.			OVA Headspace 5.1 ppm
135	470	96	N/A			SANDSTONE; Medium dark grey to dark olive grey, fine grained to medium fine grained, interbedded with very thinly bedded claystone.		Numerous claystone-filled fractures.	
		96	N/A			SANDSTONE; Medium dark grey to dark olive grey, poorly cemented, very fine grained to fine grained, interbedded with siltstone and claystone.		Claystone-filled fractures.	
140	465					COREHOLE TERMINATED AT 139.2 FEET. PIEZOMETER INSTALLED. NOTE: This Borehole log is based on field classification and visual soil description, and is further modified to include results of laboratory classification tests, where available. 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 passage of time. The data presented is simplification of actual conditions encountered. The stratification lines represent the approximate boundary between subsurface material types and the transition may be gradual.			
145	460								

APPENDIX B

PACKER TEST RESULTS

APPENDIX B
PACKER TEST RESULTS

B.1 GENERAL

A series of packer tests were performed to estimate the hydraulic conductivity characteristics of the bedrock materials along the tunnel alignment. Both single and double packer test systems were utilized to test selected bedrock zones in the vicinity of the planned tunnel envelope. A total of 22 tests were performed in 10 borings (SM-1A, SM-2 to SM-4, SM-6, SM-8, SM-9 and SM-11 to SM-13). These tests included 16 single packer and 6 double packer tests. The thickness of the test zones ranged from about 8 feet to about 17 feet. Descriptions of test setup, procedures and results are provided in subsequent sections.

B.2 TEST SETUP

The setup for single packer tests is shown in Figure B-1. In general, the system consists of a wireline assembly with inflatable packers, pressure gauges to monitor inflated packer pressure and water pressure, a nitrogen tank and a regulator to supply and monitor packer pressure, a pump assembly, a water tank, a flow meter to measure water flow and all necessary valves, inflatable tubing and flexible water hoses. The wireline packer assembly was designed to be lowered within the drill casing to a predetermined depth. As shown in Figure B-1A, the packers were then inflated with the upper packer sealing the casing and the lower packer sealing the boring. The test section extended from the lower packer-boring seal to the bottom of the boring.

The setup for double packer tests was similar to that for the single packer tests and is shown in Figure B-1B. In this case, a double packer assembly was attached to the end of the drill rod which was then lowered into an uncased boring to the predetermined test depth interval. The packers were then inflated to seal off a boring section for testing. The test zone was between the two inflated packers.

B.3 TEST PROCEDURES

Test procedures for both single and double packer tests were the same. They were conducted in general accordance with those specified in U.S. Department of the Interior, Water and Power Resources Service's Groundwater Manual, 1981. In general, the following test steps were involved.

1. Flush and clean mud and cuttings from the boring prior to conducting the test.

2. Lower the packer assembly to the predetermined depth interval.

3. Inflate packers to seal off the boring section to be tested. Apply pressure equal to about the sum of groundwater hydrostatic pressure and 150 percent of the maximum test (water) pressure to be applied. If leakage occurs relax and reexpand packer; if leakage still occurs, the packers are removed from the boring, the boring is flushed to remove loose cuttings/materials, and repeat steps 2 and 3.

4. Pump water into the test zone under a number of pressure increments. A typical test consist of 2 to 6 test pressure increments increasing from lowest to the predetermined maximum pressure value (ranging from 25 to 190 psi in this investigation) then subsequently decreasing to zero. At each test pressure increment, the water pressure is kept practically consistent for at least 20 minutes and the flow intake rates are recorded at 1, 2, 3, 4 and 5 minutes and thereafter at 5-minute intervals until at least 3 consecutive 5-minute readings are consistent.

5. Move the assembly to next test zone and repeat the above steps 1 through 4.

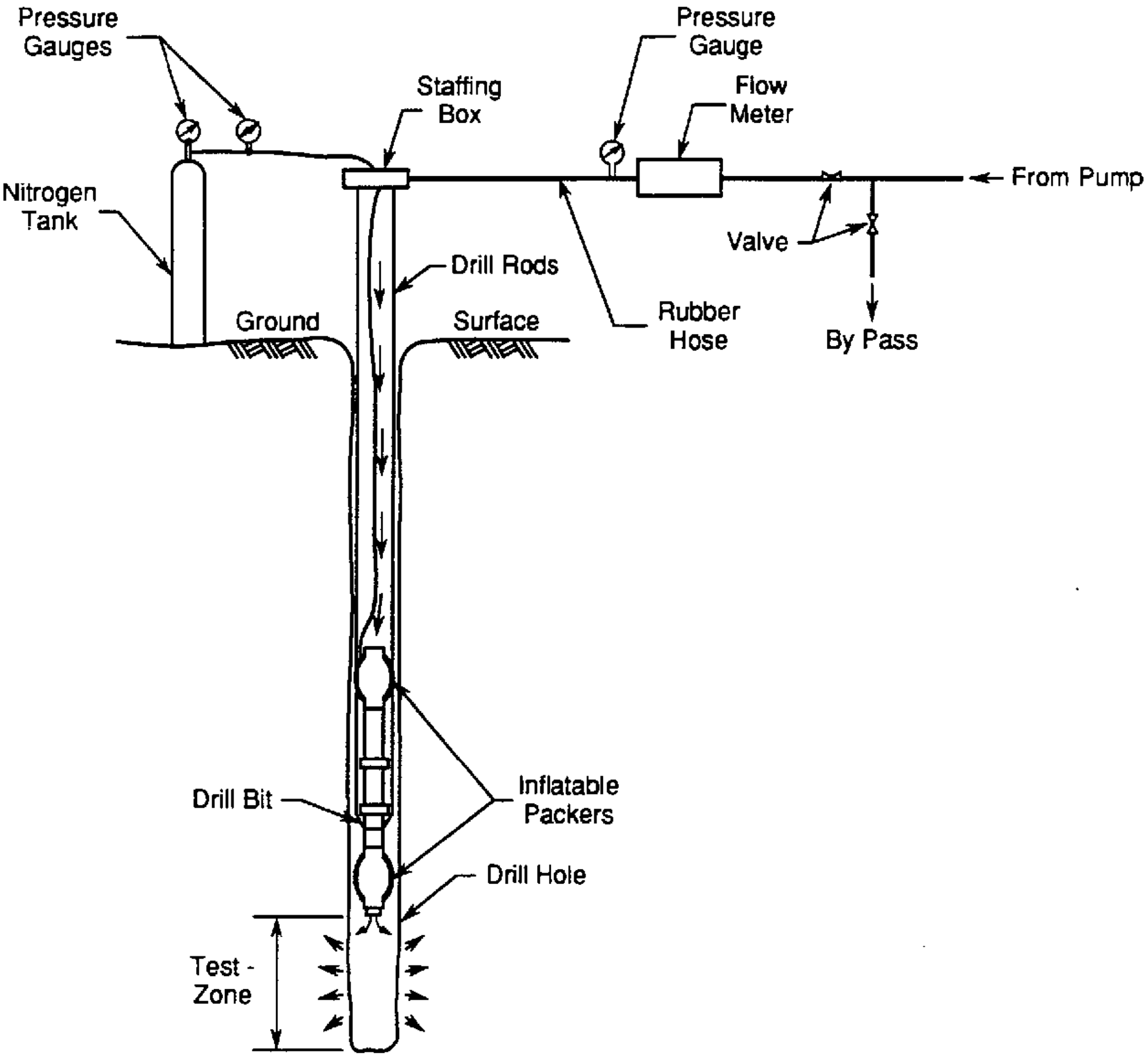
B.4 DATA REDUCTION AND RESULTS

The hydraulic packer test data were analyzed to estimate the range of hydraulic conductivity in accordance with methods detailed in the Groundwater Manual by the U.S. Department of Interior (revised 1981). Relevant formulae and interpretations are provided in Figures B-2 and B-3, respectively. The results of the tests are summarized in Table B-1.

Figures B-4 through B-25 present the detailed analyses of the test results with plots of average rate of flow versus effective head and cumulative intake versus elapsed time for all individuals test zones. These plots are useful in qualitatively assessing the hydraulic flow and fracture characteristics of the test zones (refer to the groundwater manual by the U.S. Department of Interior, 1981).

TABLE B-1. SUMMARY OF PACKER HYDRAULIC CONDUCTIVITY TESTS

Boring No.	Approximate Offset From Center Line of AR Track (feet)	Approximate Elevations			Test No.	Type of Test	Approximate Elevations			Depth Below Ground Surface			Rock Characteristics			Average Hydraulic Conductivity (cm/sec)	Remarks
		Ground surface (feet)	Tunnel Crown (feet)	Tunnel Invert (feet)			Water Table (feet)	Top of Test Interval (feet)	Bottom of Test Interval (feet)	Water Table (feet)	Top of Test Interval (feet)	Bottom of Test Interval (feet)	Type	Recovery (%)	RQD (%)		
SM-1A	320RT.	492	348	328	1	Single	476	335	327	16	157	165	Granodiorite/Gouge	75	72	3.3E-06	
SM-2	130LT.	720	350	330	1	Single	512	340	330	208	380	390	Granodiorite	89	7	9.2E-06	
					2	Single		299	289	208	421	431	Granodiorite	81	5	2.0E-05	
SM-3	60LT.	686	350	330	1	Single	643	342	332	43	344	354	Granodiorite	97	38	4.3E-06	
					2	Single		302	292	43	385	394	Granodiorite	98	12	5.2E-05	
SM-4	70LT.	960	375	355	1	Single	863	344	334	97	616	626	Granodiorite	100	99	4.6E-08	
					2	Double		361	345	97	599	615	Granodiorite	86	63	9.0E-06	
					3	Double		422	406	97	538	554	Granodiorite/Crushed	96	25	1.7E-04	
SM-6	60RT.	1180	408	388	1	Double	1106	485	469	74	695	711	Conglomerate	100	47	2.9E-06	
					2	Double		406	390	74	774	790	Granodiorite	100	99	1.9E-06	
SM-8	0RT.	1175	450	430	1	Single	1008	460	447	167	715	728	Sandstone	100	99	2.3E-07	
					2	Single		444	433	167	731	743	Sandstone/Siltstone	100	93	----	No Measurable Flow
					3	Single		405	388	167	770	788	Sandstone/Siltstone	100	100	4.7E-07	
SM-9	170LT.	1112	479	459	1	Single	1008	488	479	104	624	633	Basalt Breccia	99	94	1.7E-06	
					2	Single		474	465	104	638	648	Basalt Breccia	95	81	8.0E-07	
					3	Single		434	419	104	678	693	Basalt Breccia	99	79	3.2E-05	
SM-11	30LT.	778	528	508	1	Single	781	528	518	-3	250	260	Sandstone/Siltstone	100	100	----	No Measurable Flow
					2	Single		498	483	-3	280	295	Sandstone/Siltstone	100	76	5.2E-08	
					3	Double		613	597	-3	165	181	Sandstone	98	79	4.2E-04	
					4	Double		623	607	-3	155	171	Sandstone/Siltstone	99	69	3.5E-04	
SM-12	230LT.	671	525	505	1	Single	645	524	510	26	147	161	Sandstone/Siltstone	82	48	2.0E-05	
SM-13	10LT.	590	521	501	1	Single	578	515	500	12	75	90	Sandstone/Siltstone	98	83	1.0E-06	



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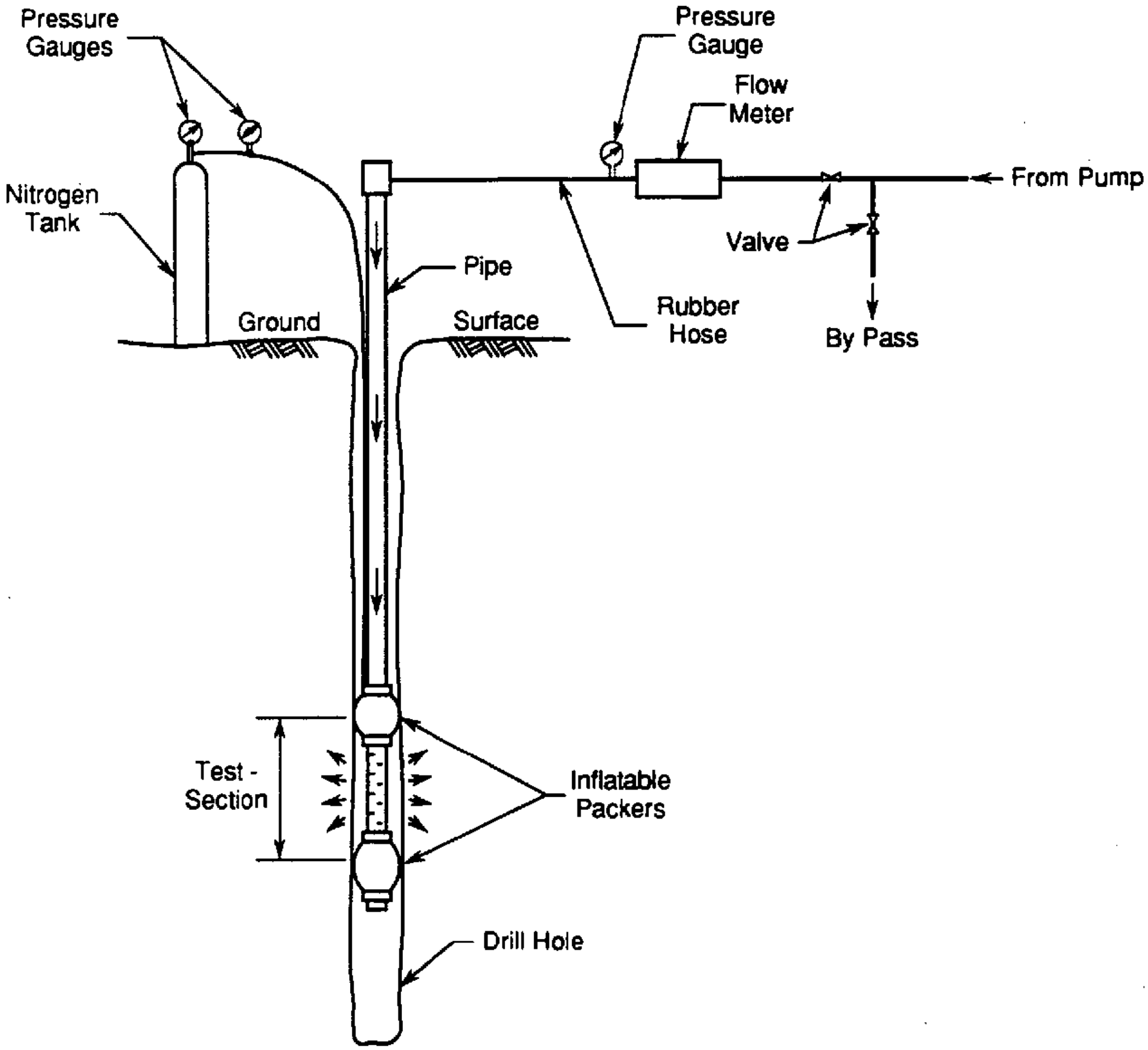
Schematic of a Single Packer Type Pressure Test

Figure B-1A



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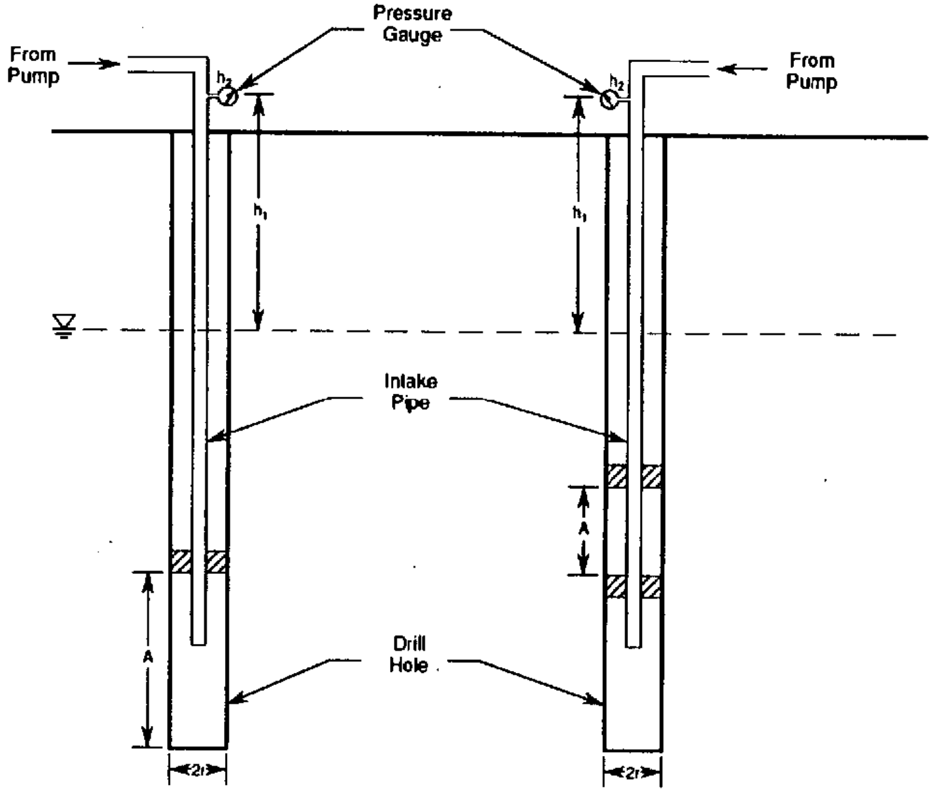
Schematic of a Double Packer Type Pressure Test

Figure B-1B

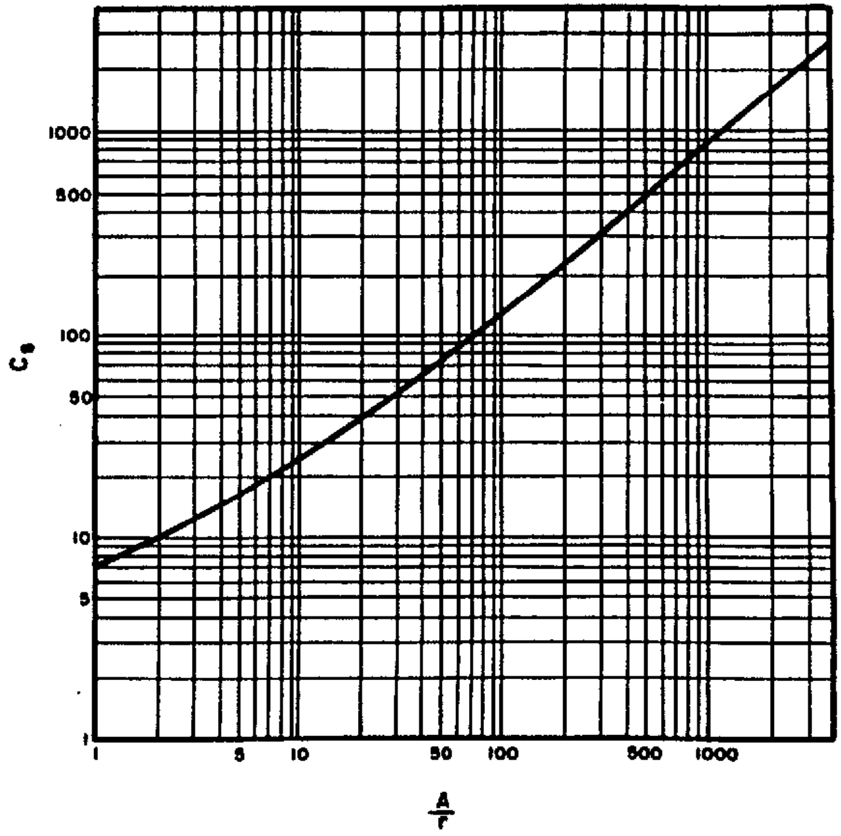


$$K = \frac{Q}{(C_s+4)rH}$$

Single Packer

$$K = \frac{Q}{C_s rH}$$

Double Packer



Notes: (1) K = Coefficient of Permeability

(2) Q = Flow Rate

(3) h_2 = Applied Pressure at Gauge

(4) Effective Head (H) = h1+h2 (Head loss in intake pipe due to friction neglected)

(5) C_s from the plot of C_s vs. A/r

Source: U.S. Dept. of Interior, 1981

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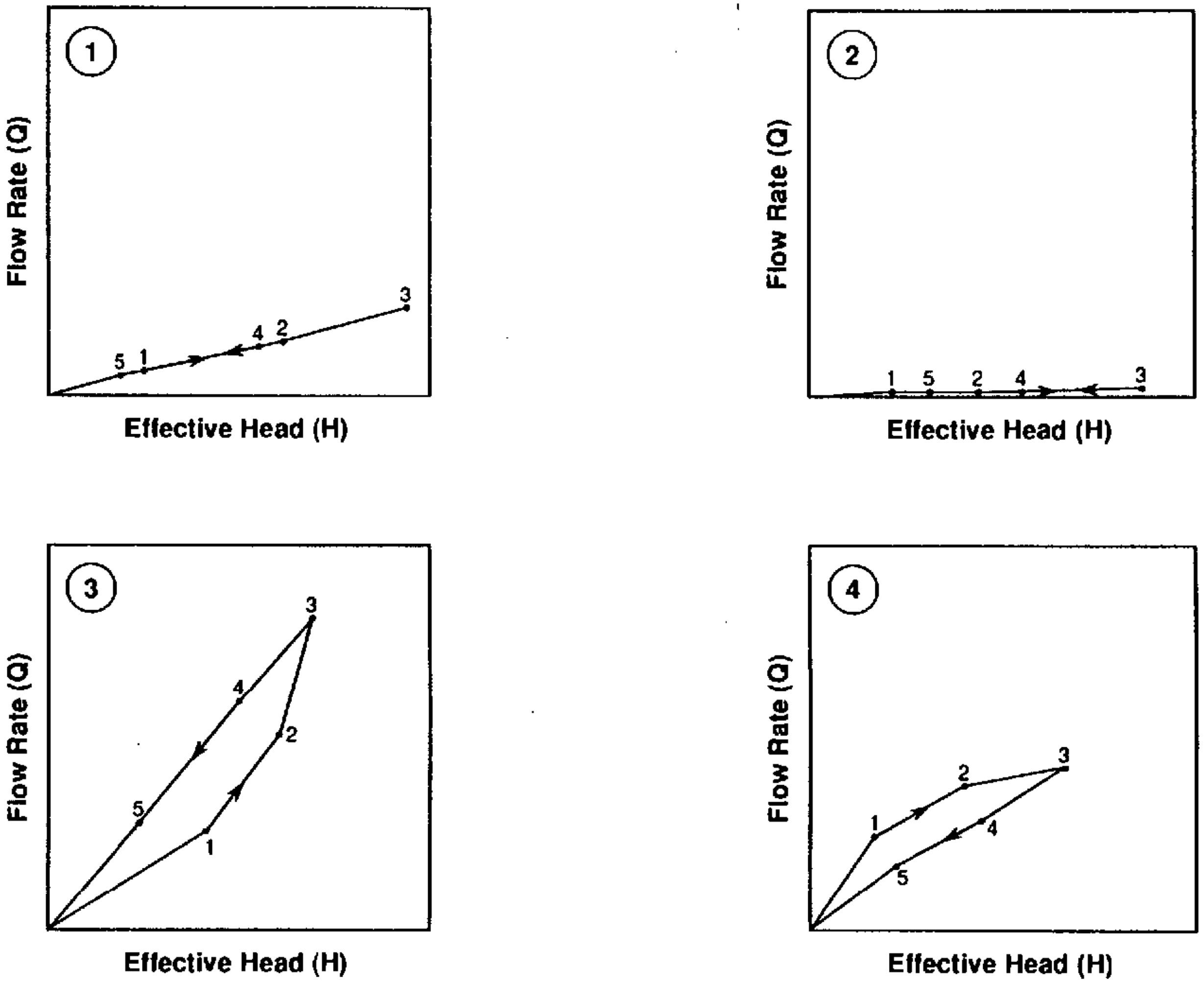
Computation of Permeability from Packer Tests

Figure B-2



Source: U.S. Dept. of Interior, 1981

① Probably very narrow, clean fractures. Flow is laminar with discharge directly proportional to head.

② Firm, practically impermeable material; fractures are tight. Little or no intake regardless of pressure.

③ Fracture filling material which washes out, increasing permeability with time. Fractures probably are relatively large. Flow is turbulent.

④ Fractures are relatively tight and contain filling material which tends to expand on wetting or dislodges and tends to collect in traps that retard flow. Flow is laminar.

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Santa Monica Mountains
Segment 3, Metro Red Line

Interpretation of Multiple Pressure Packer Tests

Figure B-3

PACKER TEST DATA ANALYSES

FIGURE B-4 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT: METRO RED LINE, SEGMENT 3
LOCATION: LA BREA AVENUE/ LA BREA TERRACE
DATE: 11-21-92

BORING SIZE (in.) 2r : 3.65
PACKER CONFIGURATION: Single
PACKER PRESSURE (psi): 300
TEST INTERVAL (ft below GS*) A : 156.5 to 165.0
PRESSURE GAGE HT. (ft above GS*): 3.5

*GS = Ground surface

PROJECT NO.: 92-2050
BORING NO.: SM-1A
TEST NO.: 1
SURFACE ELEVATION (ft): 492
ROCK TYPE: GRANODIORITE/GOUGE
STATIC WATER LEVEL (ft below GS*): 21

COMPUTED HEAD LOSS (ft): 0.00
A/r: 55.9
CONDUCTIVITY COEFFICIENT Cs: 81.8

STAGE 1 : PRESSURE 25 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	25	1842.532	0.000
1.0	25	1842.541	0.067
2.0	25	1842.552	0.150
3.0	25	1842.565	0.247
4.0	25	1842.577	0.337
5.0	25	1842.590	0.434
10.0	25	1842.640	0.808
15.0	25	1842.675	1.070
20.0	25	1842.715	1.369

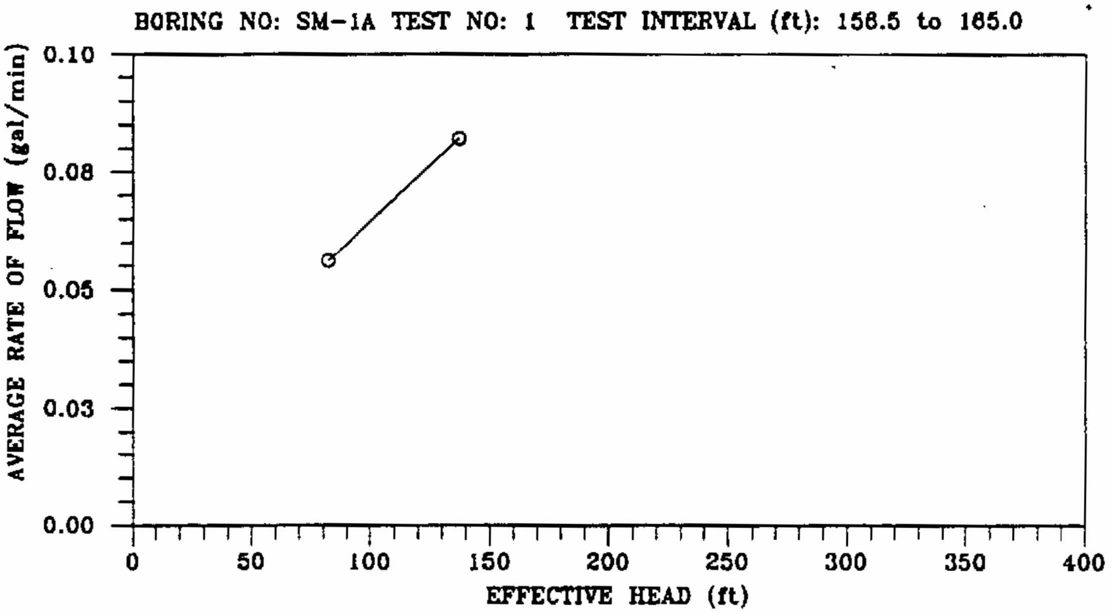
Effective head (ft) H = 82.2
Average rate of flow (gpm) Q = 0.056
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 3.5E-06

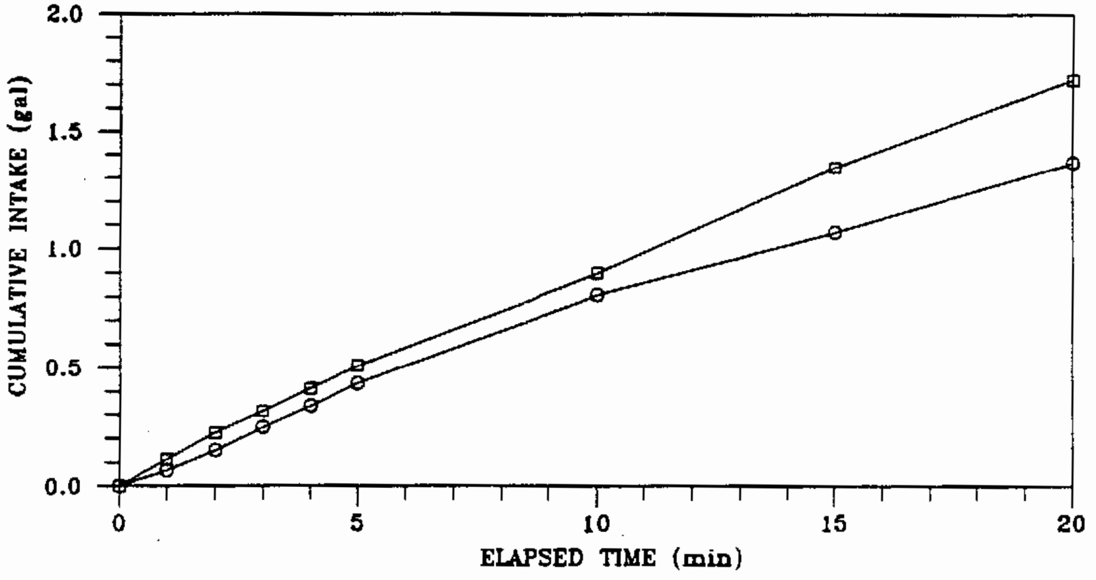
STAGE 2 : PRESSURE 49 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	50	1842.730	0.000
1.0	50	1842.745	0.112
2.0	50	1842.760	0.224
3.0	50	1842.772	0.314
4.0	50	1842.785	0.411
5.0	50	1842.798	0.509
10.0	48	1842.850	0.898
15.0	48	1842.910	1.346
20.0	48	1842.960	1.721

Effective head (ft) H = 137.0
Average rate of flow (gpm) Q = 0.082
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 3.1E-06

FIGURE B-4 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS


BORING NO: SM-1A TEST NO: 1 TEST INTERVAL (ft): 156.5 to 165.0



SUMMARY

SYMBOL	STAGE	AVERAGE GAGE PRESSURE (psi)	HYDRAULIC CONDUCTIVITY (cm/sec)	
○○○○○	1	25	3.5E-06	AVERAGE HYDRAULIC
□□□□□	2	49	3.1E-06	CONDUCTIVITY = 3.3E-06

FIGURE B–5 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT:	METRO RED LINE, SEGMENT 3
LOCATION:	RUNYON CANYON PARK
DATE:	10–12–92
BORING SIZE (in.) 2r :	3.65
PACKER CONFIGURATION:	Single
PACKER PRESSURE (psi):	500
TEST INTERVAL (ft below GS*) A :	380.0 to 390.0
PRESSURE GAGE HT. (ft above GS*):	5.5

PROJECT NO.:	92–2050
BORING NO.:	SM–2
TEST NO.:	1
SURFACE ELEVATION (ft):	723
ROCK TYPE:	GRANODIORITE
STATIC WATER LEVEL (ft below GS*):	208
COMPUTED HEAD LOSS (ft):	0.00
A/r:	65.8
CONDUCTIVITY COEFFICIENT Cs:	93.5

*GS = Ground surface

STAGE 1 : PRESSURE 49 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	50	1722.600	0.000
1.0	50	1722.615	0.112
2.0	50	1722.630	0.224
3.0	50	1722.645	0.337
4.0	50	1722.660	0.449
5.0	50	1722.670	0.524
10.0	48	1722.725	0.935
15.0	48	1722.780	1.346

Effective head (ft) H = 326.0

Average rate of flow (gpm) Q = 0.082

Hydraulic Conductivity (cm/sec)

k=Q/[(Cs+4)rH] = 1.2E–06

STAGE 2 : PRESSURE 98 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	100	1722.910	0.000
1.0	100	1722.990	0.598
2.0	100	1723.085	1.309
3.0	100	1723.180	2.020
4.0	100	1723.270	2.693
5.0	98	1723.360	3.366
10.0	98	1723.810	6.732
15.0	95	1724.265	10.136

Effective head (ft) H = 439.3

Average rate of flow (gpm) Q = 0.677

Hydraulic Conductivity (cm/sec)

k=Q/[(Cs+4)rH] = 7.1E–06

STAGE 3 : PRESSURE 148 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	150	1724.500	0.000
1.0	150	1724.850	2.618
2.0	150	1725.190	5.162
3.0	150	1725.525	7.668
4.0	150	1725.840	10.024
5.0	150	1726.150	12.343
10.0	150	1727.640	23.489
15.0	145	1729.225	35.345
20.0	145	1730.725	46.566

Effective head (ft) H = 555.3

Average rate of flow (gpm) Q = 2.244

Hydraulic Conductivity (cm/sec)

k=Q/[(Cs+4)rH] = 1.9E–05

STAGE 4 : PRESSURE 100 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	100	1730.920	0.000
1.0	100	1731.130	1.571
2.0	100	1731.320	2.992
3.0	100	1731.515	4.451
4.0	100	1731.695	5.797
5.0	100	1731.870	7.106
10.0	100	1732.745	13.652
15.0	100	1733.570	19.823

Effective head (ft) H = 444.3

Average rate of flow (gpm) Q = 1.234

Hydraulic Conductivity (cm/sec)

k=Q/[(Cs+4)rH] = 1.3E–05

FIGURE B-5 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT: METRO RED LINE, SEGMENT 3
LOCATION: RUNYON CANYON PARK
DATE: 10-12-92

BORING SIZE (in.) 2r : 3.65
PACKER CONFIGURATION: Single
PACKER PRESSURE (psi): 500
TEST INTERVAL (ft below GS*) A : 380.0 to 390.0
PRESSURE GAGE HT. (ft above GS*): 5.5

*GS = Ground surface

PROJECT NO.: 92-2050
BORING NO.: SM-2
TEST NO.: 1
SURFACE ELEVATION (ft): 723
ROCK TYPE: GRANODIORITE
STATIC WATER LEVEL (ft below GS*): 208

COMPUTED HEAD LOSS (ft): 0.00
A/r: 65.8
CONDUCTIVITY COEFFICIENT Cs: 93.5

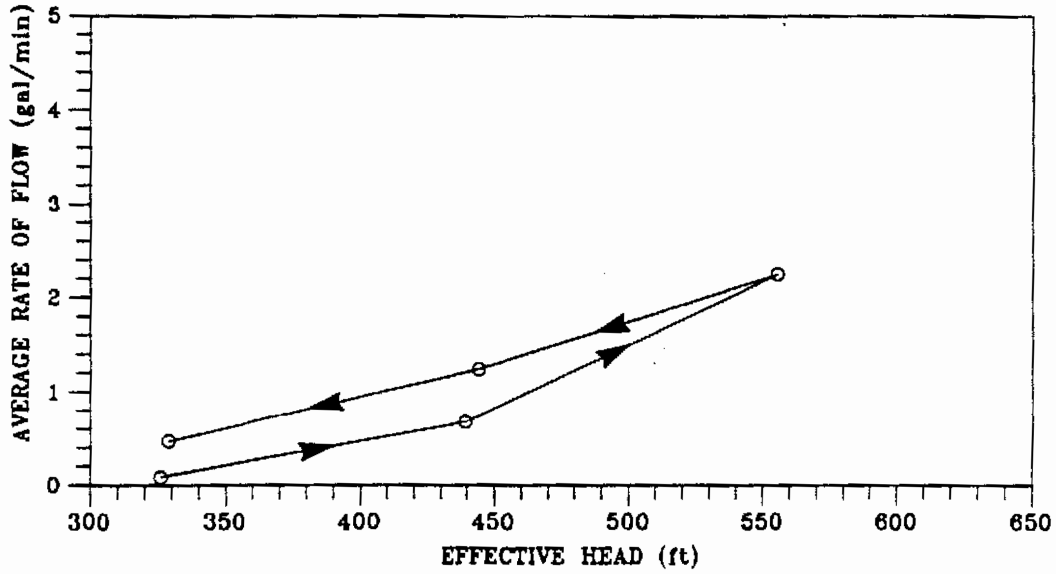
STAGE 5 : PRESSURE 50 psi

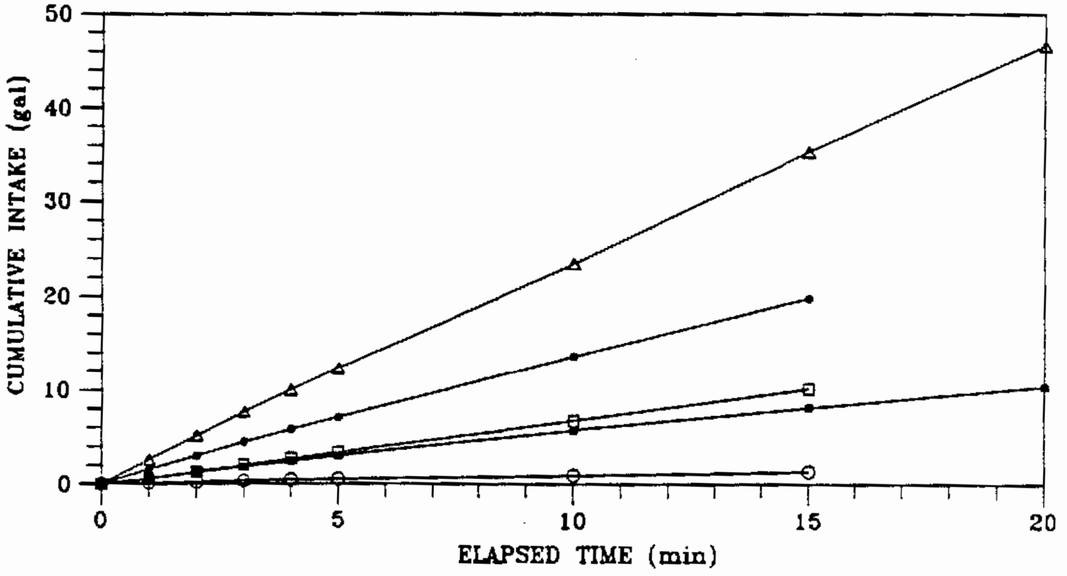
Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	50	1733.730	0.000
1.0	50	1733.810	0.598
2.0	50	1733.895	1.234
3.0	50	1733.975	1.833
4.0	50	1734.055	2.431
5.0	50	1734.130	2.992
10.0	50	1734.500	5.760
15.0	50	1734.820	8.154
20.0	50	1735.125	10.435

Effective head (ft) H = 328.9
Average rate of flow (gpm) Q = 0.468
Hydraulic Conductivity (cm/sec)
$k=Q/[(Cs+4)rH]$ = 6.5E-06

FIGURE B-5 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

BORING NO: SM-2 TEST NO: 1 TEST INTERVAL (ft): 380.0 to 390.0





SUMMARY

SYMBOL	STAGE	AVERAGE GAGE PRESSURE (psi)	HYDRAULIC CONDUCTIVITY (cm/sec)
○○○○○	1	49	1.2E-06
□□□□□	2	98	7.1E-06
△△△△△	3	148	1.9E-05
●●●●●	4	100	1.3E-05
■■■■■	5	50	6.5E-06

AVERAGE HYDRAULIC CONDUCTIVITY = 9.2E-06

FIGURE B-6 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT: METRO RED LINE, SEGMENT 3
LOCATION: RUNYON CANYON PARK
DATE: 10-13-92

BORING SIZE (in.) 2r : 3.65
PACKER CONFIGURATION: Single
PACKER PRESSURE (psi): 520
TEST INTERVAL (ft below GS*) A : 421.0 to 431.0
PRESSURE GAGE HT. (ft above GS*): 3.7

PROJECT NO.: 92-2050
BORING NO.: SM-2
TEST NO.: 2
SURFACE ELEVATION (ft): 723
ROCK TYPE: GRANODIORITE
STATIC WATER LEVEL (ft below GS*): 208

COMPUTED HEAD LOSS (ft): 0.00
A/r: 65.8
CONDUCTIVITY COEFFICIENT Cs: 93.5

*GS = Ground surface

STAGE 1 : PRESSURE 50 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	50	1786.680	0.000
1.0	50	1786.720	0.299
2.0	50	1786.761	0.606
3.0	50	1786.812	0.987
4.0	50	1786.881	1.504
5.0	50	1786.950	2.020
10.0	50	1787.315	4.750
15.0	50	1787.640	7.181
20.0	50	1787.960	9.575

Effective head (ft) H = 327.1
Average rate of flow (gpm) Q = 0.483
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 6.8E-06

STAGE 2 : PRESSURE 100 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	100	1788.300	0.000
1.0	100	1788.625	2.431
2.0	100	1788.961	4.945
3.0	100	1789.430	8.453
4.0	100	1789.697	10.450
5.0	100	1790.072	13.255
10.0	100	1791.832	26.421
15.0	100	1793.530	39.123
20.0	100	1795.068	50.628

Effective head (ft) H = 442.4
Average rate of flow (gpm) Q = 2.421
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 2.5E-05

STAGE 3 : PRESSURE 150 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	150	1795.700	0.000
1.0	150	1796.320	4.638
2.0	150	1796.905	9.014
3.0	150	1797.500	13.465
4.0	150	1798.075	17.766
5.0	150	1798.645	22.030
10.0	150	1801.355	42.302
15.0	150	1803.810	60.667

Effective head (ft) H = 557.8
Average rate of flow (gpm) Q = 3.673
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 3.0E-05

STAGE 4 : PRESSURE 104 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	100	1804.350	0.000
1.0	100	1804.705	2.656
2.0	100	1805.055	5.274
3.0	100	1805.405	7.892
4.0	100	1805.742	10.413
5.0	100	1806.075	12.904
10.0	100	1807.675	24.873
15.0	110	1809.111	35.615
20.0	110	1810.460	45.706

Effective head (ft) H = 451.1
Average rate of flow (gpm) Q = 2.083
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 2.1E-05

FIGURE B-6 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT:	METRO RED LINE, SEGMENT 3
LOCATION:	RUNYON CANYON PARK
DATE:	10-13-92
BORING SIZE (in.) 2r :	3.65
PACKER CONFIGURATION:	Single
PACKER PRESSURE (psi):	520
TEST INTERVAL (ft below GS*) A :	421.0 to 431.0
PRESSURE GAGE HT. (ft above GS*):	3.7

*GS = Ground surface

PROJECT NO.:	92-2050
BORING NO.:	SM-2
TEST NO.:	2
SURFACE ELEVATION (ft):	723
ROCK TYPE:	GRANODIORITE
STATIC WATER LEVEL (ft below GS*):	208
COMPUTED HEAD LOSS (ft):	0.00
A/r:	65.8
CONDUCTIVITY COEFFICIENT Cs:	93.5

STAGE 5 : PRESSURE 50 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	50	1810.720	0.000
1.0	50	1810.899	1.339
2.0	50	1811.075	2.656
3.0	50	1811.250	3.965
4.0	50	1811.418	5.221
5.0	50	1811.580	6.433
10.0	50	1812.409	12.635
15.0	50	1813.210	18.626

Effective head (ft) H = 327.1

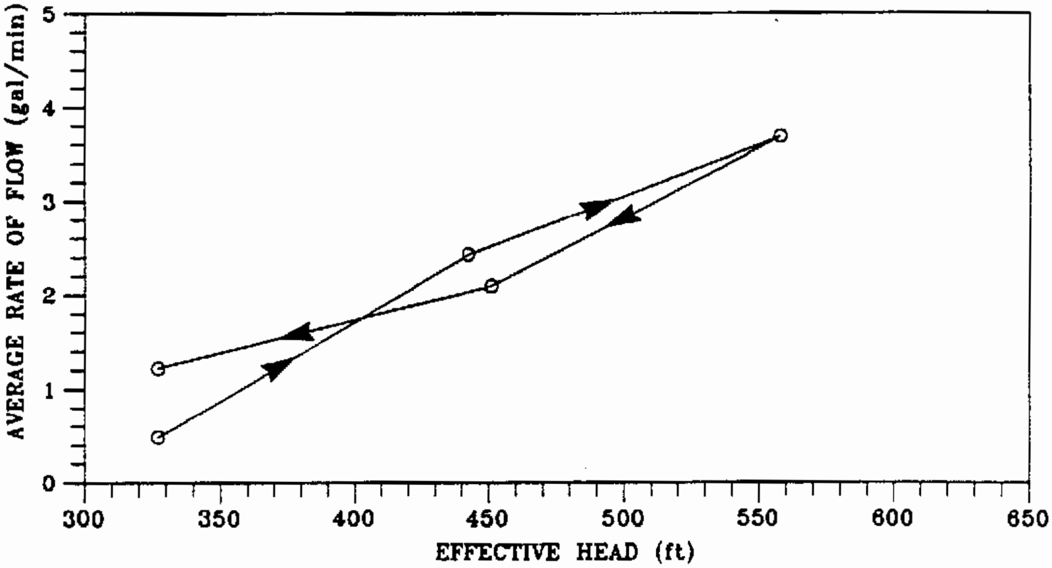
Average rate of flow (gpm) Q = 1.219

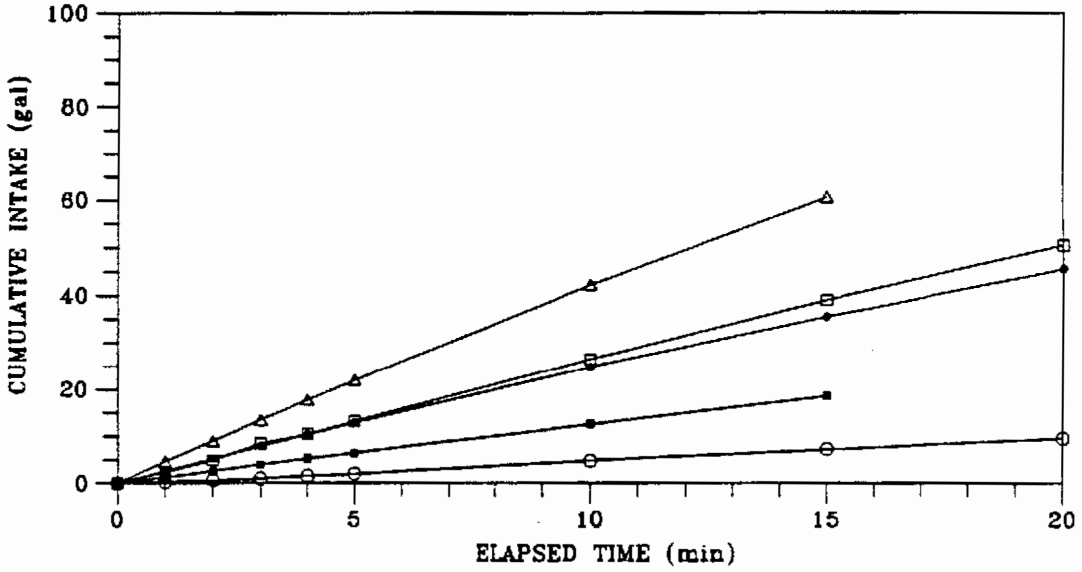
Hydraulic Conductivity (cm/sec)

k=Q/[(Cs+4)rH] = 1.7E-05

FIGURE B-6 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

BORING NO: SM-2 TEST NO: 2 TEST INTERVAL (ft): 421.0 to 431.0





SUMMARY

SYMBOL	STAGE	AVERAGE GAGE PRESSURE (psi)	HYDRAULIC CONDUCTIVITY (cm/sec)
○○○○○	1	50	6.8E-06
□□□□□	2	100	2.5E-05
△△△△△	3	150	3.0E-05
◆◆◆◆◆	4	104	2.1E-05
■■■■■	5	50	1.7E-05

AVERAGE HYDRAULIC CONDUCTIVITY = 2.0E-05

FIGURE B-7 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT: METRO RED LINE, SEGMENT 3
LOCATION: RUNYON CANYON PARK
DATE: 10-11-92

BORING SIZE (in.) 2r : 3.65
PACKER CONFIGURATION: Single
PACKER PRESSURE (psi): 400
TEST INTERVAL (ft below GS*) A : 344.0 to 354.0
PRESSURE GAGE HT. (ft above GS*): 5.9

*GS = Ground surface

PROJECT NO.: 92-2050
BORING NO.: SM-3
TEST NO.: 1
SURFACE ELEVATION (ft): 686
ROCK TYPE: GRANODIORITE
STATIC WATER LEVEL (ft below GS*): 43

COMPUTED HEAD LOSS (ft): 0.00
A/r: 65.8
CONDUCTIVITY COEFFICIENT Cs: 93.5

STAGE 1 : PRESSURE 50 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	50	1712.980	0.000
1.0	50	1712.990	0.075
2.0	50	1713.005	0.187
3.0	50	1713.015	0.262
4.0	50	1713.025	0.337
5.0	50	1713.035	0.411
10.0	50	1713.090	0.823
15.0	50	1713.135	1.159

Effective head (ft) H = 164.3
Average rate of flow (gpm) Q = 0.067
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 1.9E-06

STAGE 2 : PRESSURE 100 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	100	1713.260	0.000
1.0	100	1713.315	0.411
2.0	100	1713.370	0.823
3.0	100	1713.420	1.197
4.0	100	1713.465	1.534
5.0	100	1713.510	1.870
10.0	100	1713.725	3.478
15.0	100	1713.920	4.937

Effective head (ft) H = 279.7
Average rate of flow (gpm) Q = 0.292
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 4.8E-06

STAGE 3 : PRESSURE 160 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	160	1714.020	0.000
1.0	160	1714.140	0.898
2.0	160	1714.250	1.721
3.0	160	1714.355	2.506
4.0	160	1714.455	3.254
5.0	160	1714.530	3.815
10.0	160	1715.015	7.443
15.0	160	1715.470	10.847

Effective head (ft) H = 418.1
Average rate of flow (gpm) Q = 0.703
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 7.7E-06

STAGE 4 : PRESSURE 100 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	100	1715.550	0.000
1.0	100	1715.600	0.374
2.0	100	1715.650	0.748
3.0	100	1715.690	1.047
4.0	100	1715.735	1.384
5.0	100	1715.770	1.646
10.0	100	1715.965	3.104
15.0	100	1716.130	4.339
20.0	100	1716.280	5.461

Effective head (ft) H = 279.7
Average rate of flow (gpm) Q = 0.224
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 3.7E-06

FIGURE B-7 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT: METRO RED LINE, SEGMENT 3
LOCATION: RUNYON CANYON PARK
DATE: 10-11-92

BORING SIZE (in.) 2r : 3.65
PACKER CONFIGURATION: Single
PACKER PRESSURE (psi): 400
TEST INTERVAL (ft below GS*) A : 344.0 to 354.0
PRESSURE GAGE HT. (ft above GS*): 5.9

*GS = Ground surface

PROJECT NO.: 92-2050
BORING NO.: SM-3
TEST NO.: 1
SURFACE ELEVATION (ft): 686
ROCK TYPE: GRANODIORITE
STATIC WATER LEVEL (ft below GS*): 43

COMPUTED HEAD LOSS (ft): 0.00
A/r: 65.8
CONDUCTIVITY COEFFICIENT Cs: 93.5

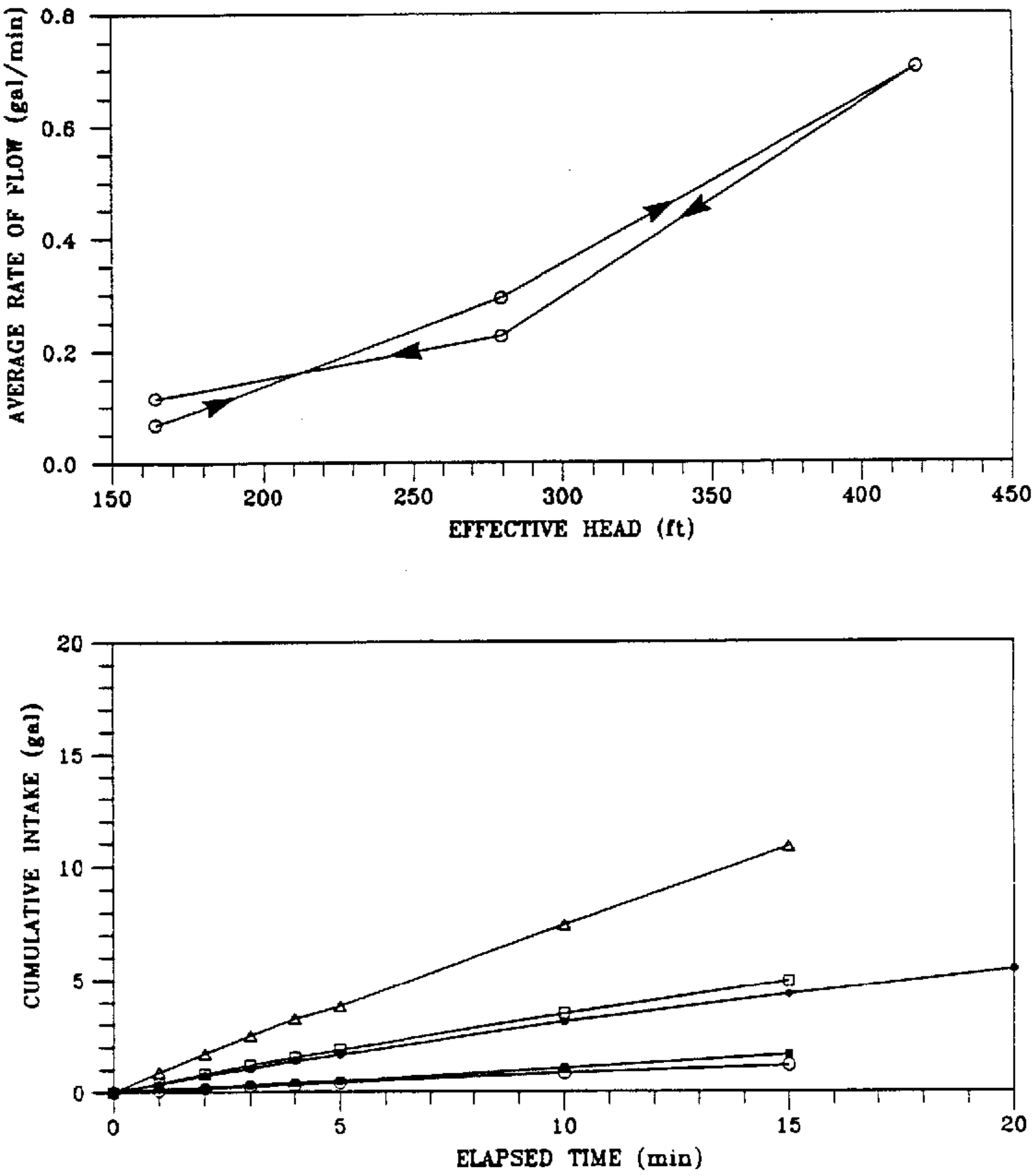
STAGE 5 : PRESSURE 50 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	50	1716.300	0.000
1.0	50	1716.320	0.150
2.0	50	1716.330	0.224
3.0	50	1716.345	0.337
4.0	50	1716.355	0.411
5.0	50	1716.365	0.486
10.0	50	1716.440	1.047
15.0	50	1716.520	1.646

Effective head (ft) H = 164.3
Average rate of flow (gpm) Q = 0.116
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 3.2E-06

FIGURE B-7 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

BORING NO: SM-3 TEST NO: 1 TEST INTERVAL (ft): 344.0 to 354.0



SUMMARY

SYMBOL	STAGE	AVERAGE GAGE PRESSURE (psi)	HYDRAULIC CONDUCTIVITY (cm/sec)	
○○○○○	1	50	1.9E-06	AVERAGE HYDRAULIC
□□□□□	2	100	4.8E-06	CONDUCTIVITY = 4.3E-06
△△△△△	3	160	7.7E-08	
◆◆◆◆◆	4	100	3.7E-06	
■■■■■	5	50	3.2E-06	

FIGURE B-7
(3 OF 3)

FIGURE B–8 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT:	METRO RED LINE, SEGMENT 3	PROJECT NO.:	92–2050
LOCATION:	RUNYON CANYON PARK	BORING NO.:	SM–3
DATE:	10–12–92	TEST NO.:	2
		SURFACE ELEVATION (ft):	686
BORING SIZE (in.) 2r :	3.65	ROCK TYPE:	GRANODIORITE
PACKER CONFIGURATION:	Single	STATIC WATER LEVEL (ft below GS*):	43
PACKER PRESSURE (psi):	500		
TEST INTERVAL (ft below GS*) A :	384.5 to 394.0	COMPUTED HEAD LOSS (ft):	0.00
		A/r:	62.5
PRESSURE GAGE HT. (ft above GS*):	2.8	CONDUCTIVITY COEFFICIENT Cs:	90.0

*GS = Ground surface

STAGE 1 : PRESSURE 53 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	53	1744.000	0.000
1.0	53	1744.235	1.758
2.0	53	1744.450	3.366
3.0	53	1744.660	4.937
4.0	53	1744.860	6.433
5.0	53	1745.070	8.004
10.0	53	1746.040	15.260
15.0	53	1747.060	22.890
20.0	53	1748.070	30.446

Effective head (ft) H = 167.0
Average rate of flow (gpm) Q = 1.519
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 4.3E–05

STAGE 2 : PRESSURE 100 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	100	1749.500	0.000
1.0	100	1749.845	2.581
2.0	100	1750.195	5.199
3.0	100	1750.550	7.855
4.0	100	1750.895	10.435
5.0	100	1751.230	12.941
10.0	100	1752.955	25.845
15.0	100	1754.700	38.899

Effective head (ft) H = 276.6
Average rate of flow (gpm) Q = 2.596
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 4.5E–05

STAGE 3 : PRESSURE 150 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	150	1755.800	0.000
1.0	150	1756.520	5.386
2.0	150	1757.210	10.548
3.0	150	1757.910	15.784
4.0	150	1758.610	21.020
5.0	150	1759.300	26.182
10.0	150	1762.770	52.139
15.0	150	1766.195	77.760

Effective head (ft) H = 392.0
Average rate of flow (gpm) Q = 5.158
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 6.3E–05

STAGE 4 : PRESSURE 103 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	103	1767.000	0.000
1.0	103	1767.550	4.114
2.0	103	1768.075	8.042
3.0	103	1768.580	11.819
4.0	103	1769.080	15.559
5.0	103	1769.575	19.262
10.0	103	1771.930	36.879
15.0	105	1774.180	53.710

Effective head (ft) H = 283.3
Average rate of flow (gpm) Q = 3.366
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 5.6E–05

FIGURE B–8 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT:	METRO RED LINE, SEGMENT 3	PROJECT NO.:	92–2050
LOCATION:	RUNYON CANYON PARK	BORING NO.:	SM–3
DATE:	10–12–92	TEST NO.:	2
		SURFACE ELEVATION (ft):	686
BORING SIZE (in.) 2r :	3.65	ROCK TYPE:	GRANODIORITE
PACKER CONFIGURATION:	Single	STATIC WATER LEVEL (ft below GS*):	43
PACKER PRESSURE (psi):	500		
TEST INTERVAL (ft below GS*) A :	384.5 to 394.0	COMPUTED HEAD LOSS (ft):	0.00
		A/r:	62.5
PRESSURE GAGE HT. (ft above GS*):	2.8	CONDUCTIVITY COEFFICIENT Cs:	90.0

*GS = Ground surface

STAGE 5 : PRESSURE 50 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	50	1774.500	0.000
1.0	50	1774.780	2.095
2.0	50	1775.055	4.152
3.0	50	1775.310	6.059
4.0	50	1775.585	8.116
5.0	50	1775.850	10.099
10.0	50	1777.125	19.636
15.0	50	1778.345	28.763

Effective head (ft) H = 161.2

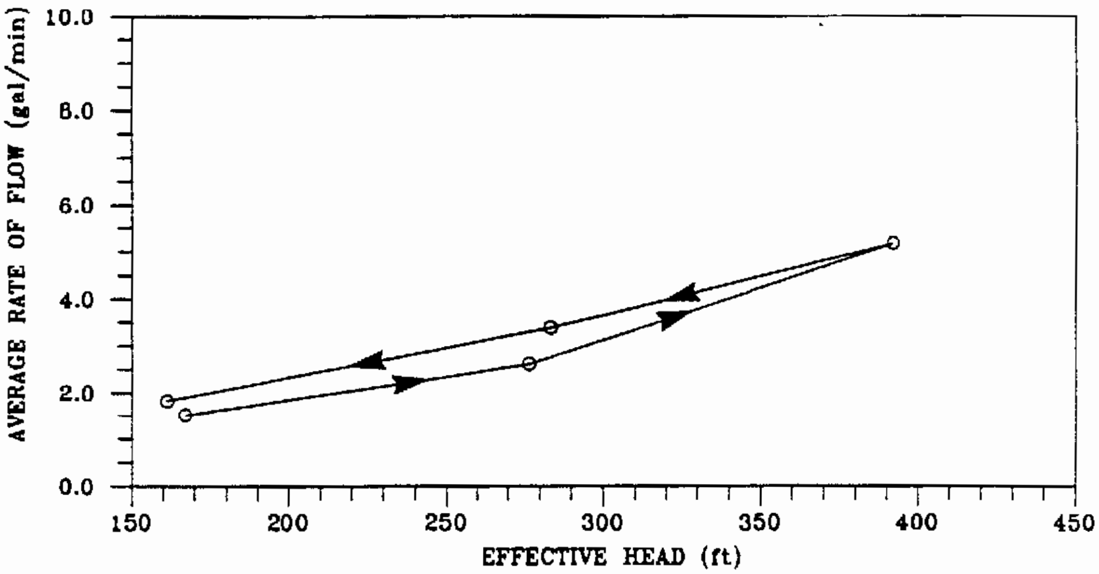
Average rate of flow (gpm) Q = 1.825

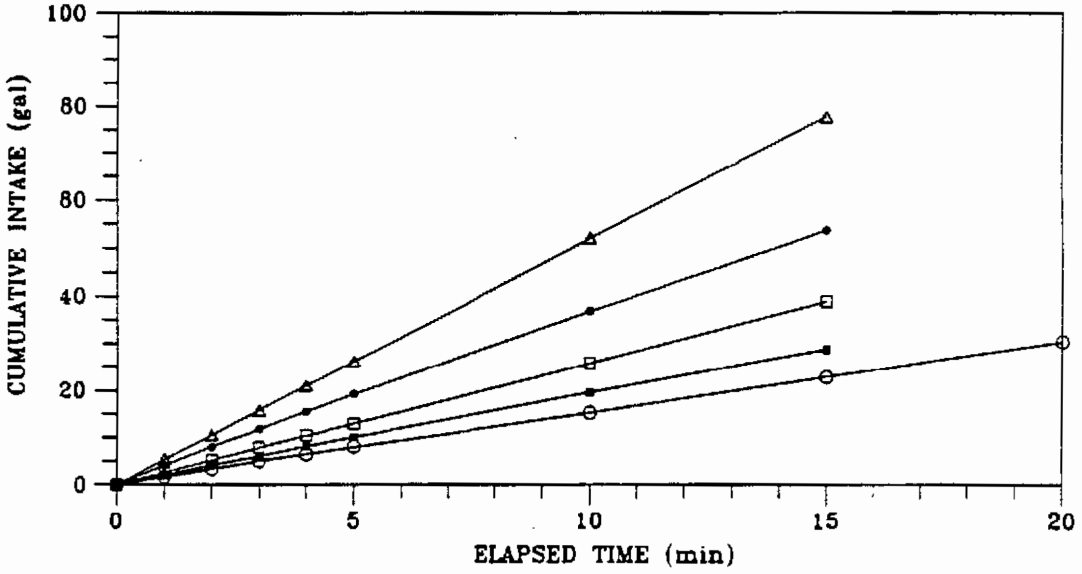
Hydraulic Conductivity (cm/sec)

k=Q/[(Cs+4)rH] = 5.4E–05

FIGURE B-8 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

BORING NO: SM-3 TEST NO: 2 TEST INTERVAL (ft): 384.5 to 394.0





SUMMARY

SYMBOL	STAGE	AVERAGE GAGE PRESSURE (psi)	HYDRAULIC CONDUCTIVITY (cm/sec)
○	1	53	4.3E-05
□	2	100	4.5E-05
△	3	150	6.3E-05
●	4	103	5.6E-05
■	5	50	5.4E-05

AVERAGE HYDRAULIC CONDUCTIVITY = 5.2E-05

FIGURE B–9 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT: METRO RED LINE, SEGMENT 3
LOCATION: RUNYON CANYON PARK
DATE: 10–6–92

BORING SIZE (in.) 2r : 3.75
PACKER CONFIGURATION: Single
PACKER PRESSURE (psi): 650–780
TEST INTERVAL (ft below GS*) A : 615.7 to 626.0
PRESSURE GAGE HT. (ft above GS*): 3.0

*GS = Ground surface

PROJECT NO.: 92–2050
BORING NO.: SM–4
TEST NO.: 1
SURFACE ELEVATION (ft): 960
ROCK TYPE: GRANODIORITE
STATIC WATER LEVEL (ft below GS*): 97

COMPUTED HEAD LOSS (ft): 0.00
A/r: 65.9
CONDUCTIVITY COEFFICIENT Cs: 93.7

STAGE 1 : PRESSURE 50 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	50	1550.030	0.000
1.0	50	1550.030	0.000
2.0	50	1550.030	0.000
3.0	50	1550.030	0.000
4.0	50	1550.030	0.000
5.0	50	1550.030	0.000
10.0	50	1550.030	0.000
15.0	50	1550.030	0.000

Effective head (ft) H = 215.4
Average rate of flow (gpm) Q = 0.000
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 0.0E+00

STAGE 2 : PRESSURE 94 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	95	1499.975	0.000
1.0	95	1499.975	0.000
2.0	95	1499.975	0.000
3.0	95	1499.975	0.000
4.0	95	1499.975	0.000
5.0	95	1499.975	0.000
10.0	95	1499.975	0.000
15.0	90	1499.975	0.000

Effective head (ft) H = 317.3
Average rate of flow (gpm) Q = 0.000
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 0.0E+00

STAGE 3 : PRESSURE 190 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	195	1550.050	0.000
1.0	195	1550.055	0.037
2.0	195	1550.060	0.075
3.0	195	1550.065	0.112
4.0	195	1550.070	0.150
5.0	195	1550.075	0.187
10.0	185	1550.090	0.299
15.0	185	1550.105	0.411

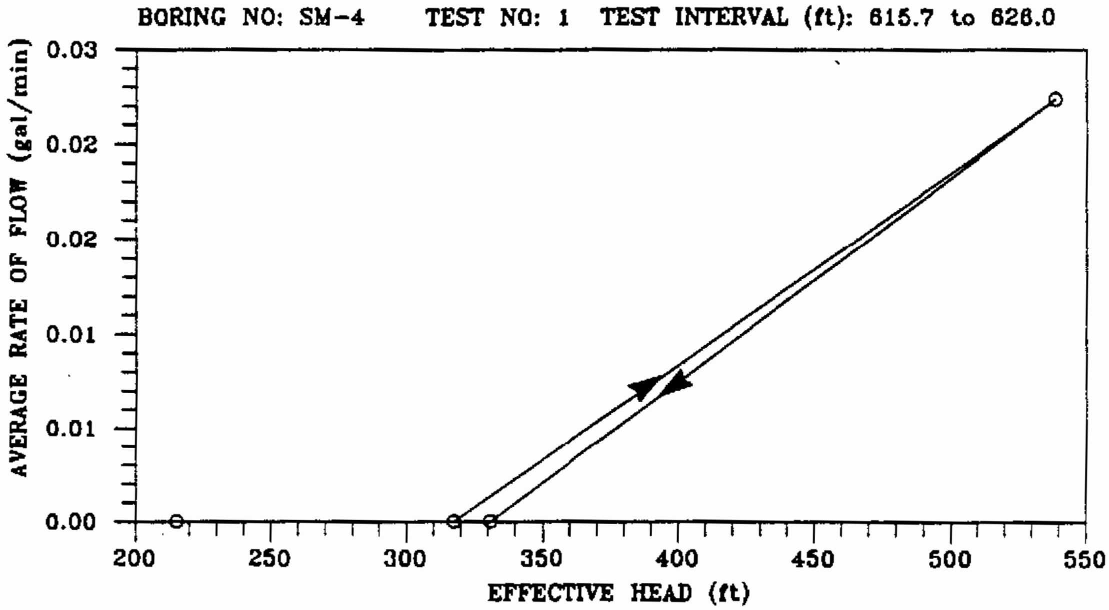
Effective head (ft) H = 538.5
Average rate of flow (gpm) Q = 0.022
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 1.9E–07

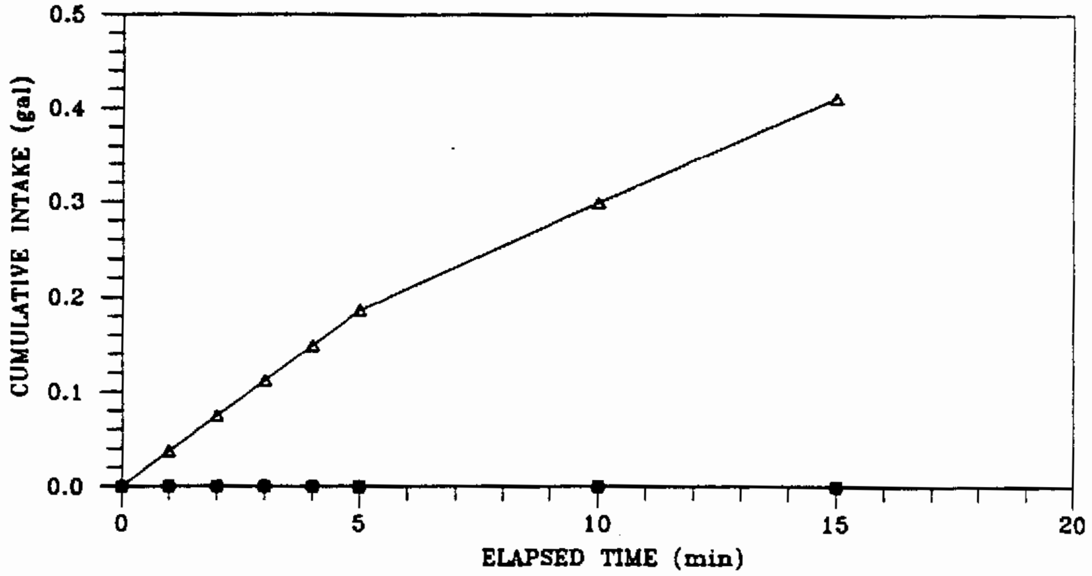
STAGE 4 : PRESSURE 100 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	100	1550.100	0.000
1.0	100	1550.100	0.000
2.0	100	1550.100	0.000
3.0	100	1550.100	0.000
4.0	100	1550.100	0.000
5.0	100	1550.100	0.000
10.0	100	1550.100	0.000

Effective head (ft) H = 330.8
Average rate of flow (gpm) Q = 0.000
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 0.0E+00

FIGURE B-9 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS





SUMMARY

SYMBOL	STAGE	AVERAGE GAGE PRESSURE (psi)	HYDRAULIC CONDUCTIVITY (cm/sec)
○○○○○	1	50	0.0E-00
□□□□□	2	94	0.0E-00
△△△△△	3	190	1.9E-07
●●●●●	4	100	0.0E-00

AVERAGE HYDRAULIC CONDUCTIVITY = 4.6E-08

FIGURE B-9
(2 OF 2)

FIGURE B–10 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT: METRO RED LINE, SEGMENT 3
LOCATION: RUNYON CANYON PARK
DATE: 10–7–92

BORING SIZE (in.) 2r : 3.75
PACKER CONFIGURATION: Double
PACKER PRESSURE (psi): 600–700
TEST INTERVAL (ft below GS*) A : 599.1 to 615.3
PRESSURE GAGE HT. (ft above GS*): 6.7

*GS = Ground surface

PROJECT NO.: 92–2050
BORING NO.: SM–4
TEST NO.: 2
SURFACE ELEVATION (ft): 960
ROCK TYPE: GRANODIORITE
STATIC WATER LEVEL (ft below GS*): 97

COMPUTED HEAD LOSS (ft): 0.00
A/r: 103.7
CONDUCTIVITY COEFFICIENT Cs: 134.4

STAGE 1 : PRESSURE 50 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	50	1588.920	0.000
1.0	50	1589.005	0.636
2.0	50	1589.100	1.346
3.0	50	1589.190	2.020
4.0	50	1589.280	2.693
5.0	50	1589.370	3.366
10.0	50	1589.750	6.209
15.0	50	1590.190	9.500

Effective head (ft) H = 219.1
Average rate of flow (gpm) Q = 0.613
Hydraulic Conductivity (cm/sec)
k=Q/[CsrH] = 9.1E–06

STAGE 2 : PRESSURE 105 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	105	1590.420	0.000
1.0	105	1590.570	1.122
2.0	105	1590.700	2.095
3.0	105	1590.840	3.142
4.0	105	1590.980	4.189
5.0	105	1591.120	5.236
10.0	105	1591.850	10.697
15.0	105	1592.520	15.709

Effective head (ft) H = 346.0
Average rate of flow (gpm) Q = 1.002
Hydraulic Conductivity (cm/sec)
k=Q/[CsrH] = 9.4E–06

STAGE 3 : PRESSURE 145 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	150	1596.870	0.000
1.0	145	1597.065	1.459
2.0	145	1597.250	2.843
3.0	145	1597.440	4.264
4.0	145	1597.620	5.610
5.0	145	1597.790	6.882
10.0	145	1598.670	13.465
15.0	145	1599.470	19.449

Effective head (ft) H = 438.7
Average rate of flow (gpm) Q = 1.197
Hydraulic Conductivity (cm/sec)
k=Q/[CsrH] = 8.8E–06

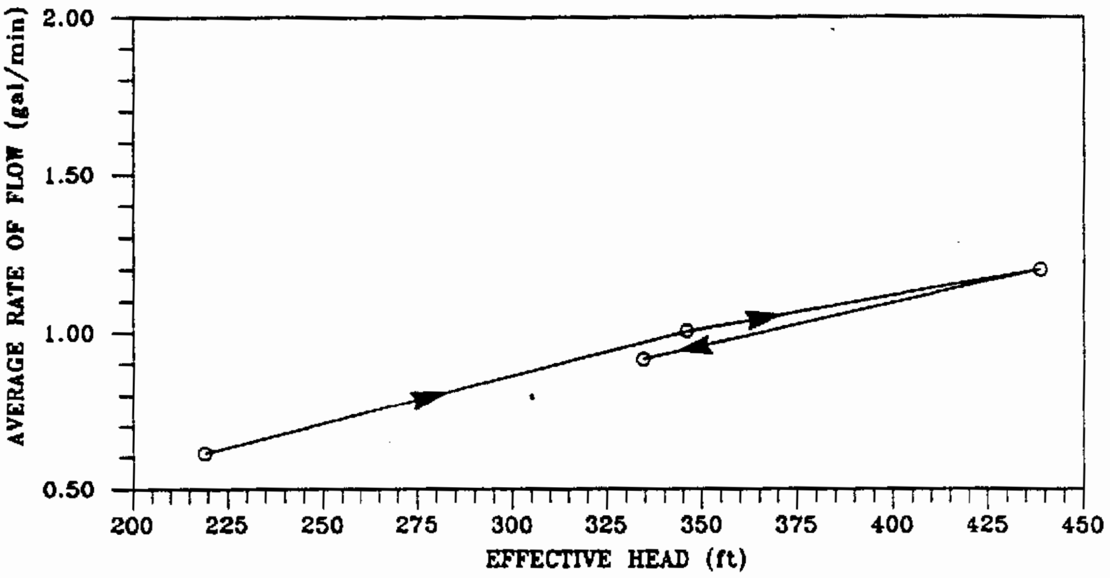
STAGE 4 : PRESSURE 100 psi

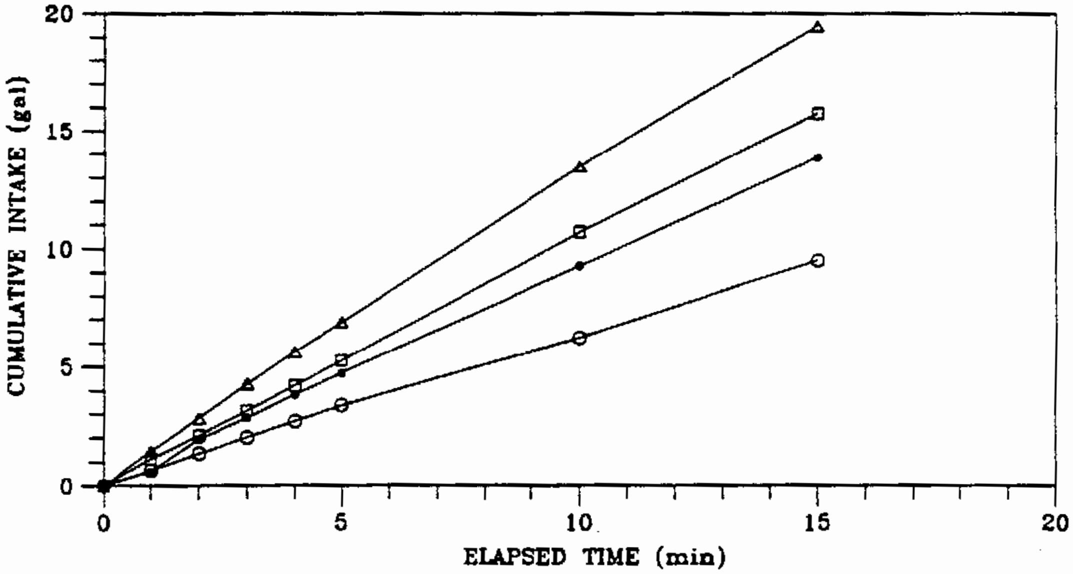
Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	100	1599.640	0.000
1.0	100	1599.720	0.598
2.0	100	1599.900	1.945
3.0	100	1600.020	2.843
4.0	100	1600.150	3.815
5.0	100	1600.270	4.713
10.0	100	1600.880	9.276
15.0	100	1601.490	13.839

Effective head (ft) H = 334.4
Average rate of flow (gpm) Q = 0.913
Hydraulic Conductivity (cm/sec)
k=Q/[CsrH] = 8.8E–06

FIGURE B-10 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

BORING NO: SM-4 TEST NO: 2 TEST INTERVAL (ft): 599.1 to 615.3





SUMMARY

SYMBOL	STAGE	AVERAGE GAGE PRESSURE (psi)	HYDRAULIC CONDUCTIVITY (cm/sec)
○○○○○	1	50	9.1E-06
□□□□□	2	105	9.4E-06
△△△△△	3	145	8.8E-06
●●●●●	4	100	8.8E-06

AVERAGE HYDRAULIC CONDUCTIVITY = 9.0E-06

FIGURE B–11 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT:	METRO RED LINE, SEGMENT 3
LOCATION:	RUNYON CANYON PARK
DATE:	10–7–92
BORING SIZE (in.) 2r :	3.75
PACKER CONFIGURATION:	Double
PACKER PRESSURE (psi):	640–550
TEST INTERVAL (ft below GS*) A :	538.0 to 554.3
PRESSURE GAGE HT. (ft above GS*):	7.8

PROJECT NO.:	92–2050
BORING NO.:	SM–4
TEST NO.:	3
SURFACE ELEVATION (ft):	960
ROCK TYPE:	GRANODIORITE
STATIC WATER LEVEL (ft below GS*):	97
COMPUTED HEAD LOSS (ft):	0.00
A/r:	104.0
CONDUCTIVITY COEFFICIENT Cs:	134.7

*GS = Ground surface

STAGE 1 : PRESSURE 25 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	25	1610.700	0.000
1.0	25	1611.940	9.276
2.0	25	1613.150	18.327
3.0	25	1614.340	27.229
4.0	25	1615.530	36.131
5.0	25	1616.740	45.182
7.0	25	1619.080	62.687
10.0	25	1622.760	90.215
15.0	25	1629.070	137.417

Effective head (ft) H = 162.4
Average rate of flow (gpm) Q = 9.341
Hydraulic Conductivity (cm/sec)
k=Q/[CsrH] = 1.9E–04

STAGE 2 : PRESSURE 50 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	50	1630.500	0.000
1.0	50	1632.050	11.595
2.0	50	1633.600	23.190
3.0	50	1635.120	34.560
4.0	50	1636.630	45.855
5.0	50	1638.160	57.301
7.0	50	1641.230	80.266
10.0	50	1645.830	114.676
15.0	50	1653.420	171.453

Effective head (ft) H = 220.1
Average rate of flow (gpm) Q = 11.355
Hydraulic Conductivity (cm/sec)
k=Q/[CsrH] = 1.7E–04

STAGE 3 : PRESSURE 75 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	75	1655.000	0.000
1.0	75	1656.840	13.764
2.0	75	1658.630	27.154
3.0	75	1660.460	40.844
4.0	75	1662.230	54.084
5.0	75	1664.000	67.325
7.0	75	1667.580	94.105
10.0	75	1673.050	135.023
15.0	75	1682.300	204.218

Effective head (ft) H = 277.8
Average rate of flow (gpm) Q = 13.764
Hydraulic Conductivity (cm/sec)
k=Q/[CsrH] = 1.6E–04

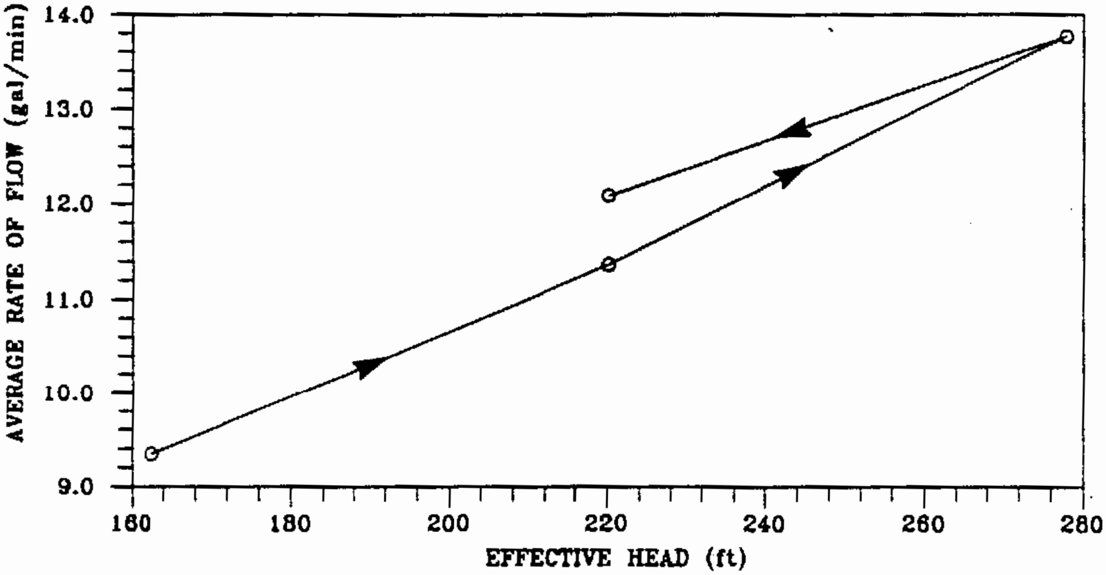
STAGE 4 : PRESSURE 50 psi

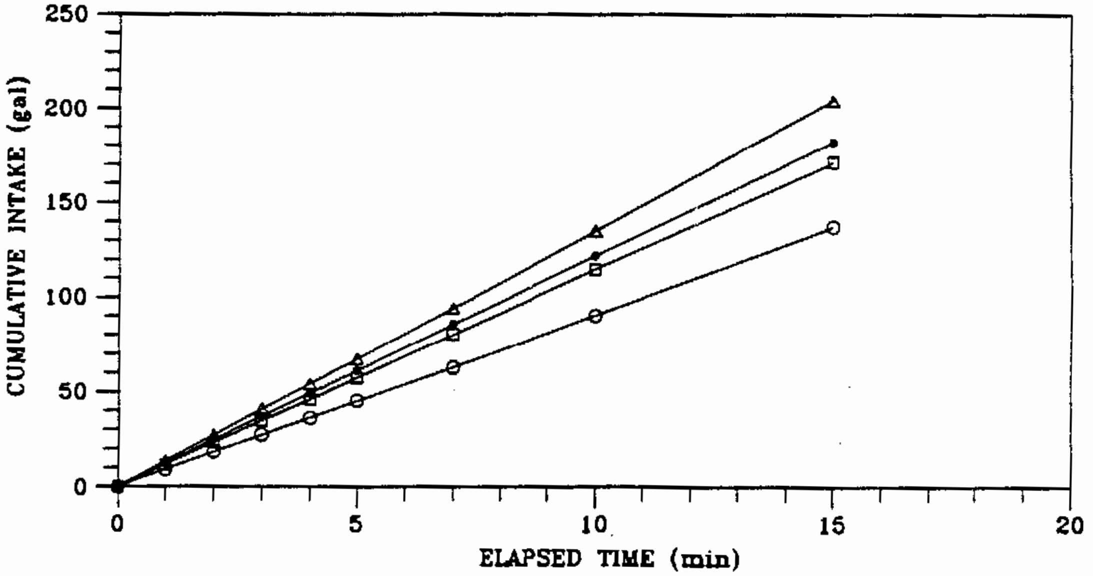
Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	50	1684.000	0.000
1.0	50	1685.660	12.418
2.0	50	1687.300	24.686
3.0	50	1688.950	37.028
4.0	50	1690.550	48.997
5.0	50	1692.180	61.190
7.0	50	1695.450	85.652
10.0	50	1700.300	121.932
15.0	50	1708.370	182.300

Effective head (ft) H = 220.1
Average rate of flow (gpm) Q = 12.081
Hydraulic Conductivity (cm/sec)
k=Q/[CsrH] = 1.8E–04

FIGURE B-11 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

BORING NO: SM-4 TEST NO: 3 TEST INTERVAL (ft): 538.0 to 554.3





SUMMARY

SYMBOL	STAGE	AVERAGE GAGE PRESSURE (psi)	HYDRAULIC CONDUCTIVITY (cm/sec)
○○○○○	1	25	1.9E-04
□□□□□	2	50	1.7E-04
△△△△△	3	75	1.6E-04
●●●●●	4	50	1.8E-04

AVERAGE HYDRAULIC CONDUCTIVITY = 1.7E-04

FIGURE B-12 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT:	METRO RED LINE, SEGMENT 3	PROJECT NO.:	92-2050
LOCATION:	RUNYON CANYON PARK	BORING NO.:	SM-6
DATE:	10-11-92	TEST NO.:	1
		SURFACE ELEVATION (ft):	1180
BORING SIZE (in.) 2r :	3.65	ROCK TYPE:	GRANODIORITE
PACKER CONFIGURATION:	Double	STATIC WATER LEVEL (ft below GS*):	74
PACKER PRESSURE (psi):	600-680		
TEST INTERVAL (ft below GS*) A :	694.8 to 711.0	COMPUTED HEAD LOSS (ft):	0.00
		A/r:	106.5
PRESSURE GAGE HT. (ft above GS*):	10.7	CONDUCTIVITY COEFFICIENT Cs:	137.0

*GS = Ground surface

STAGE 1 : PRESSURE 50 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (gal)	Cumulative Intake (gal)
0.0	50	34480.000	0.000
1.0	50	34480.300	0.300
2.0	50	34480.600	0.600
3.0	50	34480.800	0.800
4.0	50	34481.050	1.050
5.0	50	34481.300	1.300
10.0	50	34482.550	2.550
15.0	50	34483.800	3.800

Effective head (ft) H = 200.1
Average rate of flow (gpm) Q = 0.250
Hydraulic Conductivity (cm/sec)
k=Q/[CsrH] = 4.1E-06

STAGE 2 : PRESSURE 101 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (gal)	Cumulative Intake (gal)
0.0	105	34484.200	0.000
1.0	105	34484.400	0.200
2.0	100	34484.600	0.400
3.0	100	34484.850	0.650
4.0	100	34485.100	0.900
5.0	100	34485.350	1.150
10.0	100	34486.600	2.400
15.0	100	34487.850	3.650

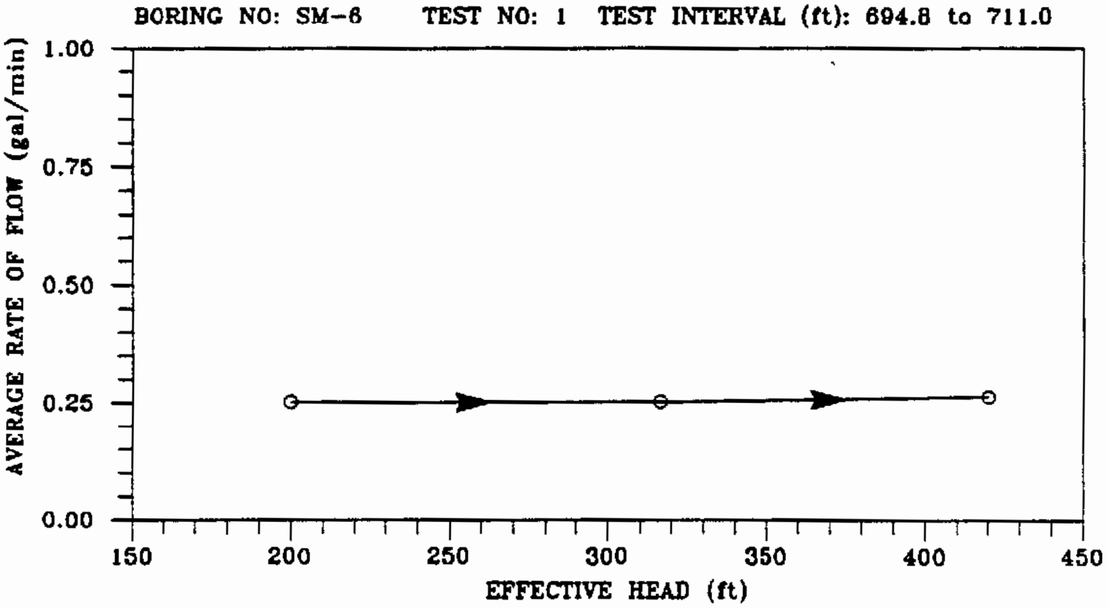
Effective head (ft) H = 316.6
Average rate of flow (gpm) Q = 0.250
Hydraulic Conductivity (cm/sec)
k=Q/[CsrH] = 2.6E-06

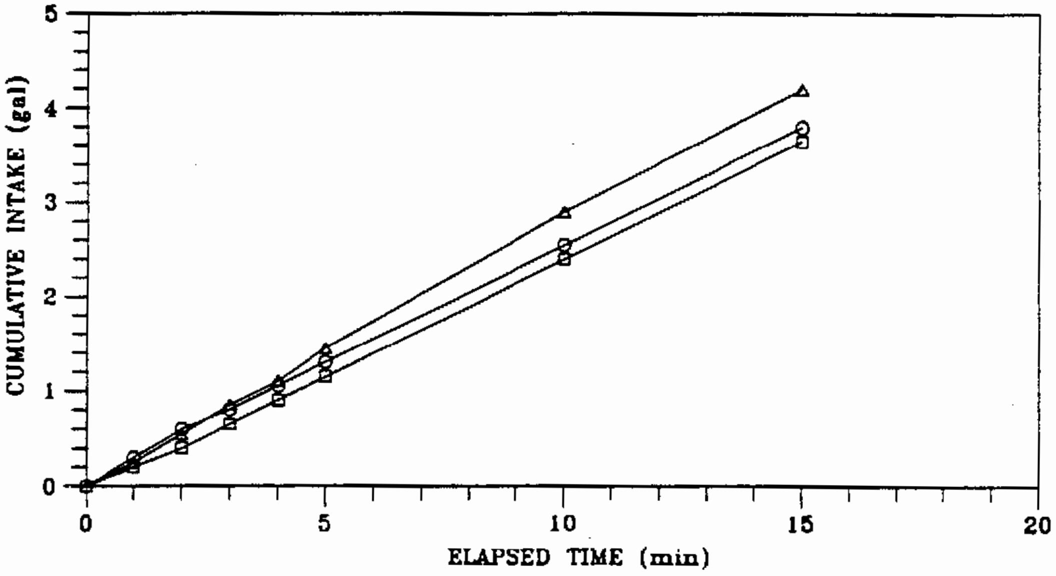
STAGE 3 : PRESSURE 145 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (gal)	Cumulative Intake (gal)
0.0	150	34501.000	0.000
1.0	150	34501.250	0.250
2.0	150	34501.550	0.550
3.0	150	34501.850	0.850
4.0	145	34502.100	1.100
5.0	145	34502.450	1.450
10.0	145	34503.900	2.900
15.0	140	34505.200	4.200

Effective head (ft) H = 420.1
Average rate of flow (gpm) Q = 0.260
Hydraulic Conductivity (cm/sec)
k=Q/[CsrH] = 2.0E-06

FIGURE B-12 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS





SUMMARY

SYMBOL	STAGE	AVERAGE GAGE PRESSURE (psi)	HYDRAULIC CONDUCTIVITY (cm/sec)
○○○○○	1	50	4.1E-06
□□□□□	2	101	2.6E-06
△△△△△	3	145	2.0E-06

AVERAGE HYDRAULIC CONDUCTIVITY = 2.9E-06

FIGURE B-13 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT: METRO RED LINE, SEGMENT 3
LOCATION: RUNYON CANYON PARK
DATE: 10-11-92

BORING SIZE (in.) 2r : 3.65
PACKER CONFIGURATION: Double
PACKER PRESSURE (psi): 600
TEST INTERVAL (ft below GS*) A : 773.8 to 790.0
PRESSURE GAGE HT. (ft above GS*): 13.0

*GS = Ground surface

PROJECT NO.: 92-2050
BORING NO.: SM-6
TEST NO.: 2
SURFACE ELEVATION (ft): 1180
ROCK TYPE: GRANODIORITE
STATIC WATER LEVEL (ft below GS*): 74

COMPUTED HEAD LOSS (ft): 0.00
A/r: 106.5
CONDUCTIVITY COEFFICIENT Cs: 137.0

STAGE 1 : PRESSURE 50 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (gal)	Cumulative Intake (gal)
0.0	50	34400.200	0.000
1.0	50	34400.350	0.150
2.0	50	34400.450	0.250
3.0	50	34400.600	0.400
4.0	50	34400.700	0.500
5.0	50	34400.820	0.620
10.0	50	34401.420	1.220
15.0	50	34402.000	1.800
20.0	50	34402.520	2.320

Effective head (ft) H = 202.4
Average rate of flow (gpm) Q = 0.104
Hydraulic Conductivity (cm/sec)
k=Q/[CsrH] = 1.7E-06

STAGE 2 : PRESSURE 100 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (gal)	Cumulative Intake (gal)
0.0	100	34429.450	0.000
1.0	100	34429.920	0.470
2.0	100	34430.450	1.000
3.0	100	34431.000	1.550
4.0	100	34431.600	2.150
5.0	100	34432.300	2.850
10.0	100	34434.300	4.850
15.0	100	34436.200	6.750
20.0	100	34438.000	8.550

Effective head (ft) H = 317.8
Average rate of flow (gpm) Q = 0.360
Hydraulic Conductivity (cm/sec)
k=Q/[CsrH] = 3.7E-06

STAGE 3 : PRESSURE 150 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (gal)	Cumulative Intake (gal)
0.0	150	34452.050	0.000
1.0	150	34452.320	0.270
2.0	150	34452.550	0.500
3.0	150	34452.800	0.750
4.0	150	34453.000	0.950
5.0	150	34453.220	1.170
10.0	150	34454.420	2.370

Effective head (ft) H = 433.2
Average rate of flow (gpm) Q = 0.237
Hydraulic Conductivity (cm/sec)
k=Q/[CsrH] = 1.8E-06

STAGE 4 : PRESSURE 100 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (gal)	Cumulative Intake (gal)
0.0	100	34466.450	0.000
1.0	100	34466.570	0.120
2.0	100	34466.720	0.270
3.0	100	34466.850	0.400
4.0	100	34466.980	0.530
5.0	100	34467.100	0.650
10.0	100	34467.750	1.300

Effective head (ft) H = 317.8
Average rate of flow (gpm) Q = 0.130
Hydraulic Conductivity (cm/sec)
k=Q/[CsrH] = 1.3E-06

FIGURE B-13 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT:	METRO RED LINE, SEGMENT 3	PROJECT NO.:	92-2050
LOCATION:	RUNYON CANYON PARK	BORING NO.:	SM-6
DATE:	10-11-92	TEST NO.:	2
		SURFACE ELEVATION (ft):	1180
BORING SIZE (in.) 2r :	3.65	ROCK TYPE:	GRANODIORITE
PACKER CONFIGURATION:	Double	STATIC WATER LEVEL (ft below GS*):	74
PACKER PRESSURE (psi):	600		
TEST INTERVAL (ft below GS*) A :	773.8 to 790.0	COMPUTED HEAD LOSS (ft):	0.00
		A/r:	106.5
PRESSURE GAGE HT. (ft above GS*):	13.0	CONDUCTIVITY COEFFICIENT Cs:	137.0

*GS = Ground surface

STAGE 5 : PRESSURE 50 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (gal)	Cumulative Intake (gal)
0.0	50	34467.900	0.000
1.0	50	34467.980	0.080
2.0	50	34468.050	0.150
3.0	50	34468.100	0.200
4.0	50	34468.180	0.280
5.0	50	34468.250	0.350
10.0	50	34468.620	0.720

Effective head (ft) H = 202.4

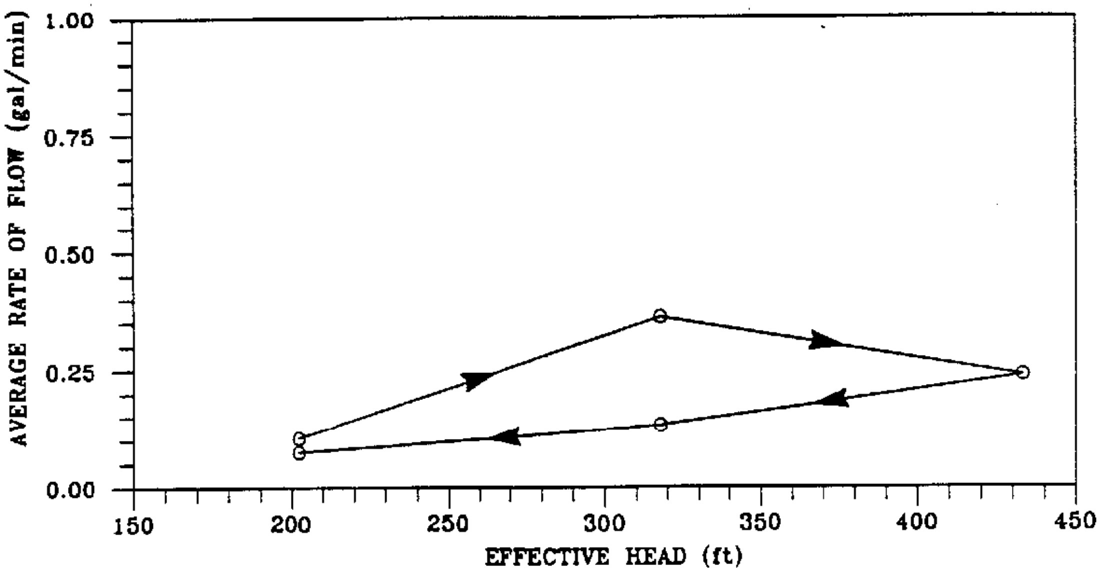
Average rate of flow (gpm) Q = 0.074

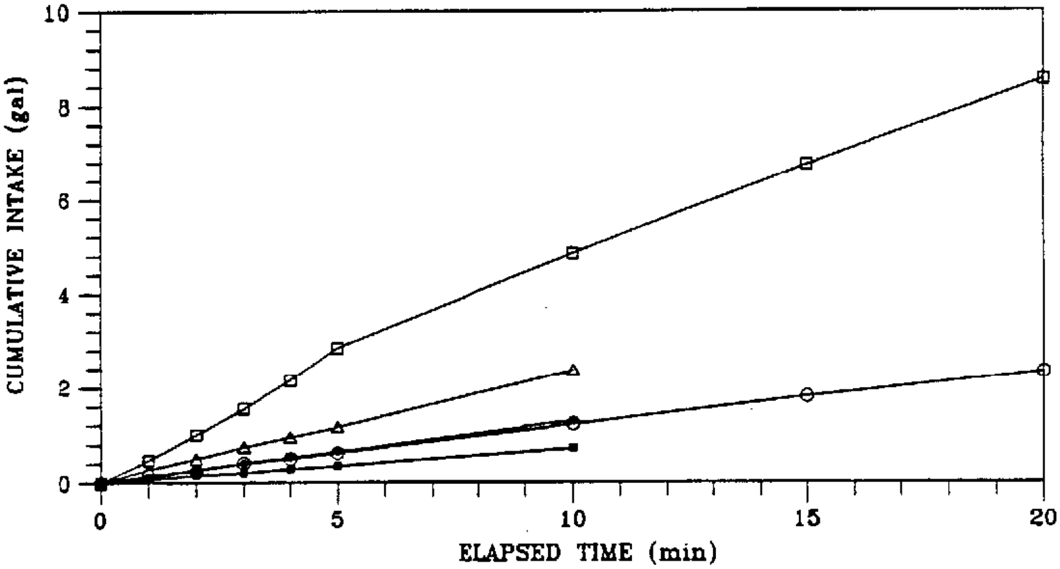
Hydraulic Conductivity (cm/sec)

k=Q/[CsrH] = 1.2E-06

FIGURE B-13 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

BORING NO: SM-6 TEST NO: 2 TEST INTERVAL (ft): 773.8 to 790.0





SUMMARY

SYMBOL	STAGE	AVERAGE GAGE PRESSURE (psi)	HYDRAULIC CONDUCTIVITY (cm/sec)
○○○○○	1	50	1.7E-06
□□□□□	2	100	3.7E-06
△△△△△	3	150	1.8E-06
●●●●●	4	100	1.3E-06
■■■■■	5	50	1.2E-06

AVERAGE HYDRAULIC CONDUCTIVITY = 1.9E-06

FIGURE B-13
(3 OF 3)

FIGURE B−14 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT:	METRO RED LINE, SEGMENT 3
LOCATION:	7404 MULLHOLLAND DRIVE
DATE:	09−01−92
BORING SIZE (in.) 2r :	3.75
PACKER CONFIGURATION:	Single
PACKER PRESSURE (psi):	600−680
TEST INTERVAL (ft below GS*) A :	715.0 to 727.8
PRESSURE GAGE HT. (ft above GS*):	4.5

*GS = Ground surface

PROJECT NO.:	92−2050
BORING NO.:	SM−8
TEST NO.:	1
SURFACE ELEVATION (ft):	1175
ROCK TYPE:	SANDSTONE
STATIC WATER LEVEL (ft below GS*):	167
COMPUTED HEAD LOSS (ft):	0.0
A/r:	81.9
CONDUCTIVITY COEFFICIENT Cs:	115.4

STAGE 1 : PRESSURE 33 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	33	1486.360	0.000
1.0	33	1486.375	0.112
2.0	33	1486.385	0.187
3.0	33	1486.395	0.262
4.0	33	1486.410	0.374
5.0	33	1486.410	0.374
10.0	33	1486.410	0.374
15.0	33	1486.410	0.374

Effective head (ft) H = 247.7
Average rate of flow (gpm) Q = 0.000
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 0.0E+00

STAGE 2 : PRESSURE 70 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	66	1486.490	0.000
1.0	70	1486.530	0.299
2.0	70	1486.550	0.449
3.0	70	1486.565	0.561
4.0	70	1486.575	0.636
5.0	70	1486.580	0.673
10.0	70	1486.620	0.972
15.0	70	1486.640	1.122
20.0	70	1486.660	1.272

Effective head (ft) H = 332.8
Average rate of flow (gpm) Q = 0.030
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 3.3E−07

STAGE 3 : PRESSURE 111 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	105	1486.750	0.000
1.0	107	1486.785	0.262
2.0	110	1486.805	0.411
3.0	110	1486.825	0.561
4.0	110	1486.840	0.673
5.0	110	1486.850	0.748
10.0	112	1486.900	1.122
15.0	112	1486.945	1.459
20.0	112	1486.980	1.721

Effective head (ft) H = 427.6
Average rate of flow (gpm) Q = 0.052
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 4.5E−07

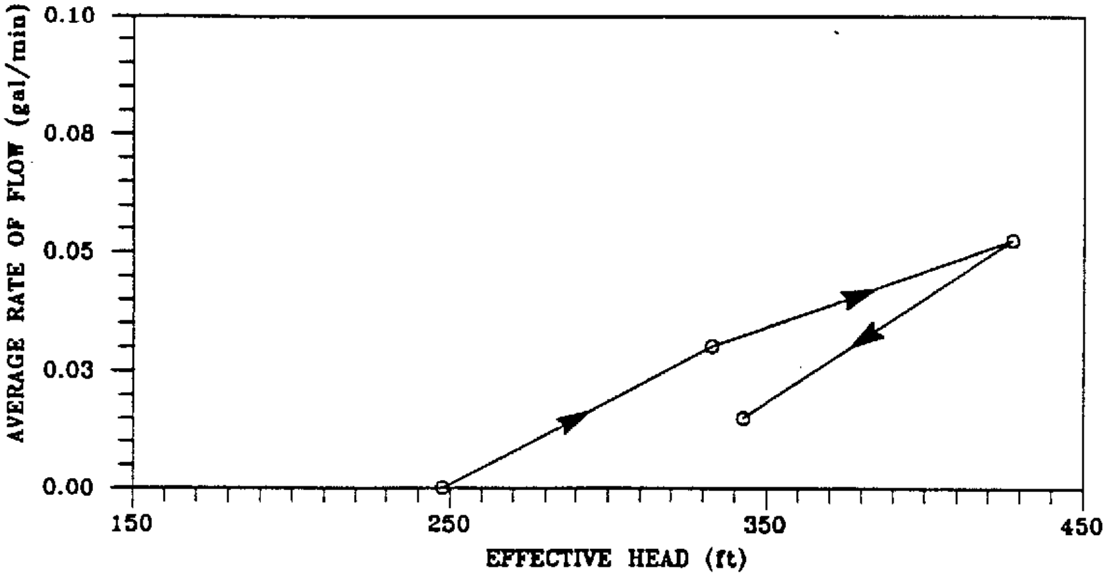
STAGE 4 : PRESSURE 74 psi

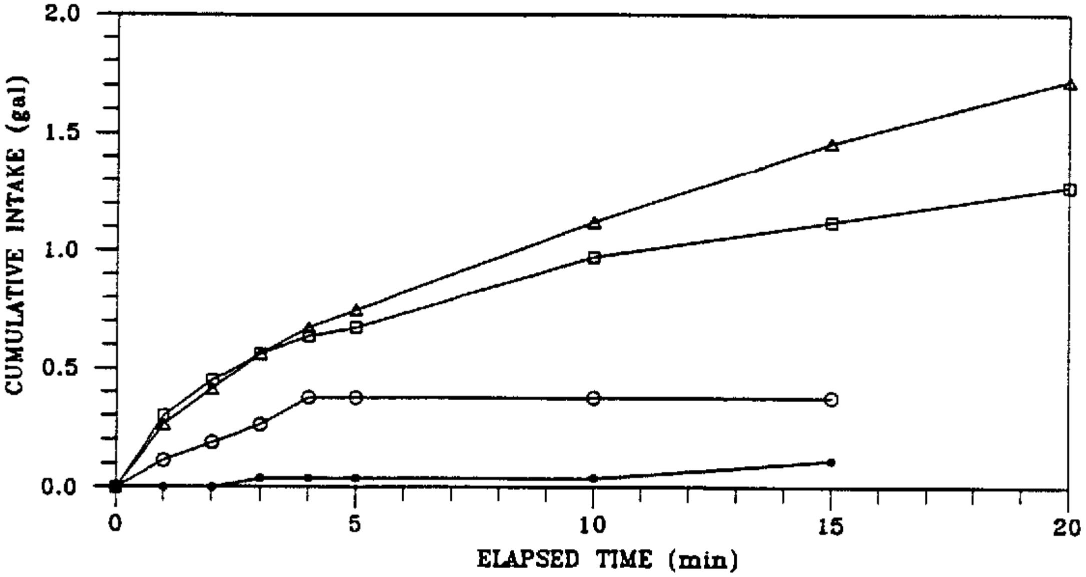
Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	70	1486.890	0.000
1.0	70	1486.890	0.000
2.0	70	1486.890	0.000
3.0	75	1486.895	0.037
4.0	75	1486.895	0.037
5.0	75	1486.895	0.037
10.0	75	1486.895	0.037
15.0	75	1486.905	0.112

Effective head (ft) H = 342.7
Average rate of flow (gpm) Q = 0.015
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 1.6E−07

FIGURE B-14 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

BORING NO: SM-8 TEST NO: 1 TEST INTERVAL (ft): 715.0 to 727.8





SUMMARY

SYMBOL	STAGE	AVERAGE GAGE PRESSURE (psi)	HYDRAULIC CONDUCTIVITY (cm/sec)
○○○○○	1	33	0.0E-00
□□□□□	2	70	3.3E-07
△△△△△	3	111	4.5E-07
●●●●●●	4	74	1.6E-07

AVERAGE HYDRAULIC
CONDUCTIVITY = 2.3E-07

FIGURE B-15 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT: METRO RED LINE, SEGMENT 3
LOCATION: 7404 MULLHOLLAND DRIVE
DATE: 09-01-92

BORING SIZE (in.) 2r : 3.75
PACKER CONFIGURATION: Single
PACKER PRESSURE (psi): 640-680
TEST INTERVAL (ft below GS*) A : 730.7 to 742.6
PRESSURE GAGE HT. (ft above GS*): 8.5

*GS = Ground surface

PROJECT NO.: 92-2050
BORING NO.: SM-8
TEST NO.: 2
SURFACE ELEVATION (ft): 1175
ROCK TYPE: CONGLOMERATIC SANDSTONE
STATIC WATER LEVEL (ft below GS*): 167

COMPUTED HEAD LOSS (ft): 0.0
A/r: 76.2
CONDUCTIVITY COEFFICIENT Cs: 106.2

STAGE 1 : PRESSURE 38 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	38	1542.590	0.000
1.0	38	1542.590	0.000
2.0	38	1542.590	0.000
3.0	38	1542.590	0.000
4.0	39	1542.590	0.000
5.0	39	1542.590	0.000
10.0	37	1542.595	0.037
15.0	37	1542.595	0.037

Effective head (ft) H = 262.7
Average rate of flow (gpm) Q = 0.000
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 0.0E+00

STAGE 2 : PRESSURE 77 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	78	1542.615	0.000
1.0	77	1542.630	0.112
2.0	77	1542.630	0.112
3.0	77	1542.630	0.112
4.0	77	1542.630	0.112
5.0	77	1542.630	0.112
10.0	79	1542.630	0.112
15.0	77	1542.630	0.112

Effective head (ft) H = 354.2
Average rate of flow (gpm) Q = 0.000
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 0.0E+00

STAGE 3 : PRESSURE 120 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	121	1542.630	0.000
1.0	120	1542.630	0.000
2.0	120	1542.630	0.000
3.0	120	1542.630	0.000
4.0	120	1542.630	0.000
5.0	120	1542.630	0.000
10.0	120	1542.630	0.000
15.0	120	1542.630	0.000
20.0	120	1542.630	0.000

Effective head (ft) H = 452.5
Average rate of flow (gpm) Q = 0.000
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 0.0E+00

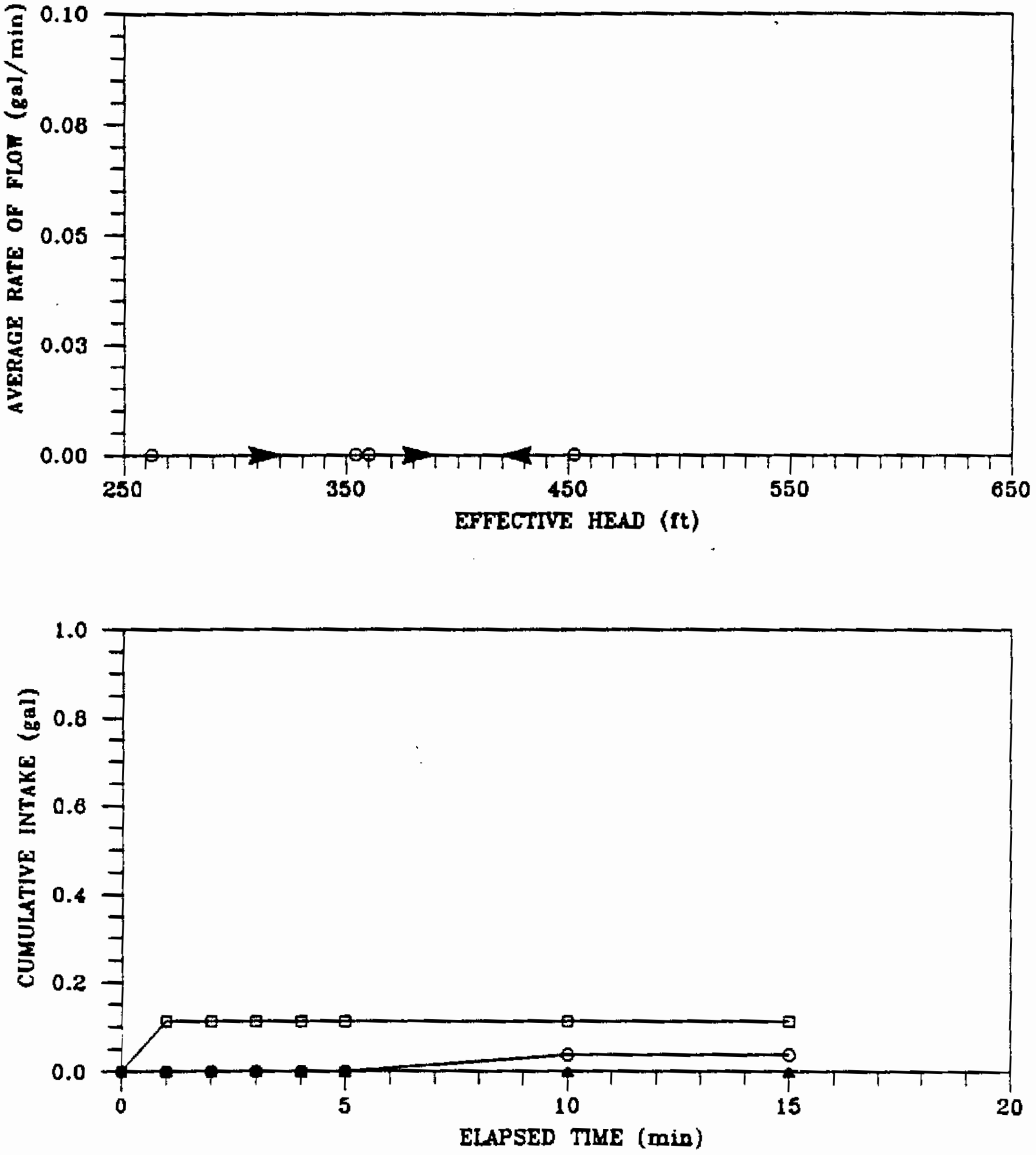
STAGE 4 : PRESSURE 80 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	80	1542.630	0.000
1.0	80	1542.630	0.000
2.0	80	1542.630	0.000
3.0	80	1542.630	0.000
4.0	80	1542.630	0.000
5.0	80	1542.630	0.000
10.0	80	1542.630	0.000
15.0	80	1542.630	0.000

Effective head (ft) H = 360.1
Average rate of flow (gpm) Q = 0.000
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 0.0E+00

FIGURE B-15 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

BORING NO: SM-8 TEST NO: 2 TEST INTERVAL (ft): 730.7 to 742.6



SUMMARY

SYMBOL	STAGE	AVERAGE GAGE PRESSURE (psi)	HYDRAULIC CONDUCTIVITY (cm/sec)
○○○○○	1	38	0.0E-00
□□□□□	2	77	0.0E-00
△△△△△	3	120	0.0E-00
●●●●●	4	80	0.0E-00

AVERAGE HYDRAULIC CONDUCTIVITY = 0.0E-00

FIGURE B-15
(2 OF 2)

FIGURE B–16 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT: METRO RED LINE, SEGMENT 3
LOCATION: 7404 MULLHOLLAND DRIVE
DATE: 09–09–92

BORING SIZE (in.) 2r : 3.75
PACKER CONFIGURATION: Single
PACKER PRESSURE (psi): 680
TEST INTERVAL (ft below GS*) A : 770.2 to 787.5
PRESSURE GAGE HT. (ft above GS*): 4.0

PROJECT NO.: 92–2050
BORING NO.: SM–8
TEST NO.: 3
SURFACE ELEVATION (ft): 1175
ROCK TYPE: SANDSTONE
STATIC WATER LEVEL (ft below GS*): 167

COMPUTED HEAD LOSS (ft): 0.0
A/r: 110.7
CONDUCTIVITY COEFFICIENT Cs: 140.8

*GS = Ground surface

STAGE 1 : PRESSURE 50 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	50	1543.310	0.000
1.0	50	1543.310	0.000
2.0	50	1543.315	0.037
3.0	50	1543.320	0.075
4.0	50	1543.325	0.112
5.0	50	1543.330	0.150
10.0	50	1543.350	0.299
15.0	50	1543.370	0.449

Effective head (ft) H = 286.4
Average rate of flow (gpm) Q = 0.030
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 3.1E–07

STAGE 2 : PRESSURE 97 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	100	1543.380	0.000
1.0	100	1543.390	0.075
2.0	100	1543.410	0.224
3.0	100	1543.415	0.262
4.0	100	1543.420	0.299
5.0	100	1543.425	0.337
10.0	95	1543.465	0.636
15.0	95	1543.495	0.860
20.0	95	1543.525	1.085

Effective head (ft) H = 394.6
Average rate of flow (gpm) Q = 0.045
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 3.4E–07

STAGE 3 : PRESSURE 200 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	200	1543.570	0.000
1.0	200	1543.590	0.150
2.0	200	1543.610	0.299
3.0	200	1543.635	0.486
4.0	200	1543.660	0.673
5.0	200	1543.685	0.860
10.0	200	1543.785	1.608
15.0	200	1543.880	2.319
20.0	200	1543.985	3.104

Effective head (ft) H = 632.5
Average rate of flow (gpm) Q = 0.150
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 7.1E–07

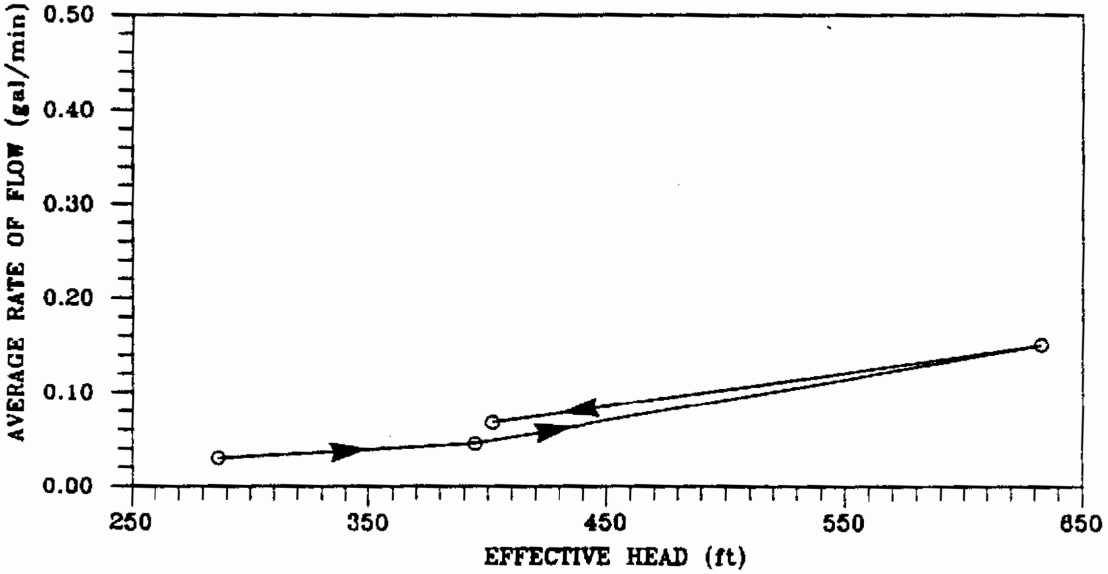
STAGE 4 : PRESSURE 100 psi

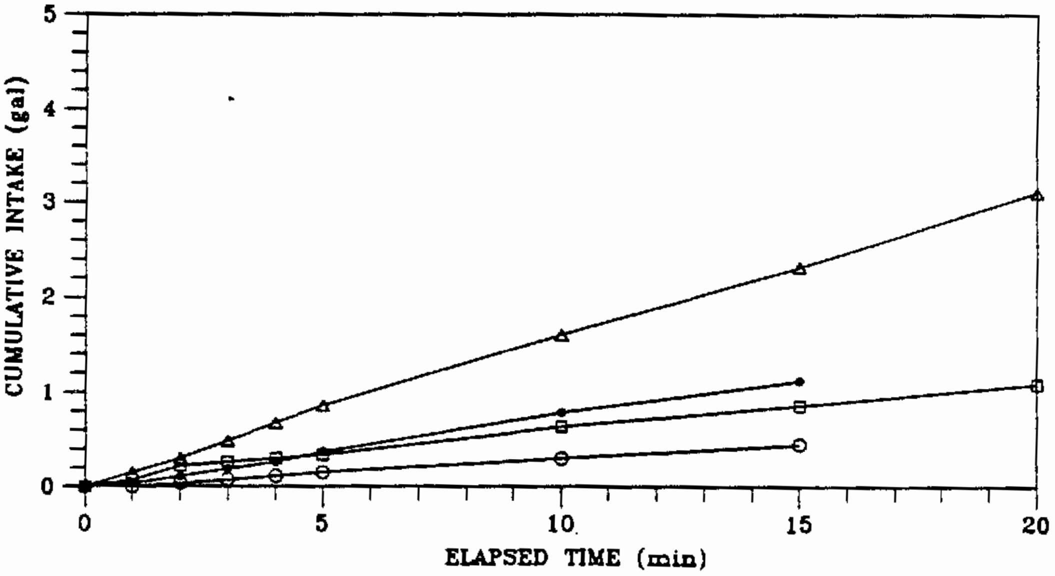
Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	100	1543.990	0.000
1.0	100	1543.995	0.037
2.0	100	1544.005	0.112
3.0	100	1544.015	0.187
4.0	100	1544.025	0.262
5.0	100	1544.040	0.374
10.0	100	1544.095	0.785
15.0	100	1544.140	1.122

Effective head (ft) H = 401.8
Average rate of flow (gpm) Q = 0.067
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 5.0E–07

FIGURE B-16 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

BORING NO: SM-8 TEST NO: 3 TEST INTERVAL (ft): 770.2 to 787.5





SUMMARY

SYMBOL	STAGE	AVERAGE GAGE PRESSURE (psi)	HYDRAULIC CONDUCTIVITY (cm/sec)
○○○○○	1	50	3.1E-07
□□□□□	2	97	3.4E-07
△△△△△	3	200	7.1E-07
●●●●●	4	100	5.0E-07

AVERAGE HYDRAULIC CONDUCTIVITY = 4.7E-07

FIGURE B–17 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT: METRO RED LINE, SEGMENT 3
LOCATION: MULLHOLLAND DRIVE/ WOODROW WILSON DRIVE
DATE: 08–31–92
BORING SIZE (in.) 2r : 3.65
PACKER CONFIGURATION: Single
PACKER PRESSURE (psi): 400
TEST INTERVAL (ft below GS*) A : 624.2 to 633.0
PRESSURE GAGE HT. (ft above GS*): 5.0

PROJECT NO.: 92–2050
BORING NO.: SM–9
TEST NO.: 1
SURFACE ELEVATION (ft): 1112
ROCK TYPE: BASALT BRACCIA
STATIC WATER LEVEL (ft below GS*): 104

COMPUTED HEAD LOSS (ft): 0.00
A/r: 57.9
CONDUCTIVITY COEFFICIENT Cs: 84.3

*GS = Ground surface

STAGE 1 : PRESSURE 30 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	30	1474.020	0.000
1.0	30	1474.020	0.000
2.0	30	1474.021	0.007
3.0	30	1474.050	0.224
4.0	30	1474.080	0.449
5.0	30	1474.150	0.972
10.0	30	1474.165	1.085
15.0	29	1474.255	1.758
20.0	31	1474.265	1.833

Effective head (ft) H = 177.9
Average rate of flow (gpm) Q = 0.057
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 1.6E–06

STAGE 2 : PRESSURE 63 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	60	1474.510	0.000
1.0	62	1474.560	0.374
2.0	63	1474.590	0.598
3.0	63	1474.620	0.823
4.0	63	1474.640	0.972
5.0	63	1474.665	1.159
10.0	63	1474.780	2.020
15.0	63	1474.890	2.843

Effective head (ft) H = 254.0
Average rate of flow (gpm) Q = 0.168
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 3.4E–06

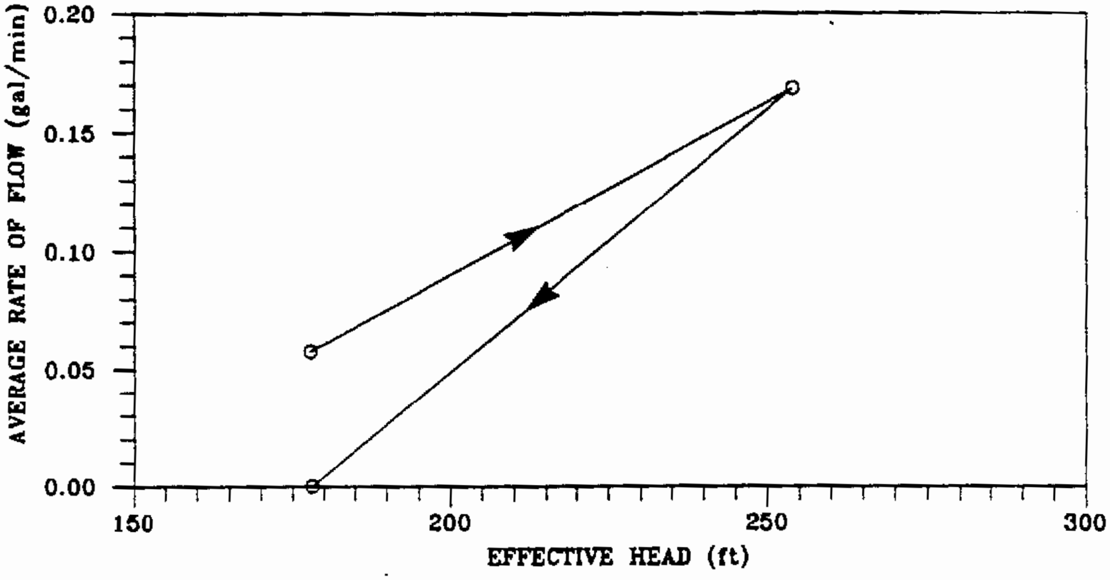
STAGE 3 : PRESSURE 30 psi

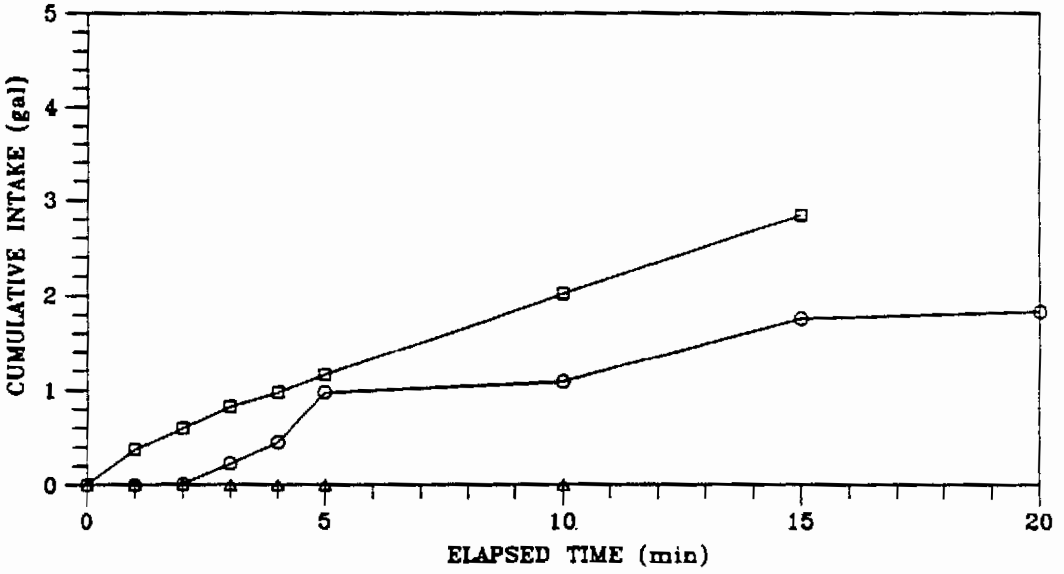
Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	30	1478.490	0.000
1.0	30	1478.490	0.000
2.0	30	1478.490	0.000
3.0	30	1478.490	0.000
4.0	30	1478.490	0.000
5.0	30	1478.490	0.000
10.0	30	1478.490	0.000
15.0	30	1478.490	0.000
20.0	30	1478.490	0.000

Effective head (ft) H = 178.2
Average rate of flow (gpm) Q = 0.000
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 0.0E+00

FIGURE B-17 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

BORING NO: SM-9 TEST NO: 1 TEST INTERVAL (ft): 624.2 to 633.0





SUMMARY

SYMBOL	STAGE	AVERAGE GAGE PRESSURE (psi)	HYDRAULIC CONDUCTIVITY (cm/sec)
○○○○○	1	30	1.6E-06
□□□□□	2	63	3.4E-06
△△△△△	3	30	0.0E-00

AVERAGE HYDRAULIC CONDUCTIVITY = 1.7E-06

FIGURE B-17
(2 OF 2)

FIGURE B–18 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT:	METRO RED LINE, SEGMENT 3	PROJECT NO.:	92–2050
LOCATION:	MULLHOLLAND DRIVE/ WOODROW WILSON DRIVE	BORING NO.:	SM–9
		TEST NO.:	2
		SURFACE ELEVATION (ft):	1112
DATE:	08–31–92	ROCK TYPE:	BASALT BRACCIA
BORING SIZE (in.) 2r :	3.65	STATIC WATER LEVEL (ft below GS*):	104
PACKER CONFIGURATION:	Single		
PACKER PRESSURE (psi):	550		
TEST INTERVAL (ft below GS*) A :	638.2 to 647.5	COMPUTED HEAD LOSS (ft):	0.00
		A/r:	61.2
PRESSURE GAGE HT. (ft above GS*):	6.0	CONDUCTIVITY COEFFICIENT Cs:	88.5

*GS = Ground surface

STAGE 1 : PRESSURE 30 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	30	1479.680	0.000
1.0	30	1479.685	0.037
2.0	30	1479.690	0.075
3.0	30	1479.692	0.090
4.0	30	1479.695	0.112
5.0	30	1479.697	0.127
10.0	30	1479.695	0.112
15.0	30	1479.695	0.112

Effective head (ft) H = 179.2

Average rate of flow (gpm) Q = 0.000

Hydraulic Conductivity (cm/sec)

k=Q/[(Cs+4)rH] = 0.0E+00

STAGE 2 : PRESSURE 60 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	60	1479.710	0.000
1.0	60	1479.710	0.000
2.0	60	1479.715	0.037
3.0	60	1479.715	0.037
4.0	60	1479.710	0.000
5.0	60	1479.710	0.000
10.0	60	1479.719	0.067
15.0	60	1479.740	0.224
20.0	60	1479.765	0.411

Effective head (ft) H = 248.5

Average rate of flow (gpm) Q = 0.034

Hydraulic Conductivity (cm/sec)

k=Q/[(Cs+4)rH] = 6.7E–07

STAGE 3 : PRESSURE 90 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	90	1479.780	0.000
1.0	90	1479.785	0.037
2.0	90	1479.790	0.075
3.0	90	1479.800	0.150
4.0	90	1479.805	0.187
5.0	90	1479.810	0.224
10.0	90	1479.860	0.598
15.0	90	1479.915	1.010
20.0	90	1479.975	1.459

Effective head (ft) H = 317.7

Average rate of flow (gpm) Q = 0.082

Hydraulic Conductivity (cm/sec)

k=Q/[(Cs+4)rH] = 1.3E–06

STAGE 4 : PRESSURE 63 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	63	1479.990	0.000
1.0	63	1479.995	0.037
2.0	63	1480.005	0.112
3.0	63	1480.015	0.187
4.0	63	1480.025	0.262
5.0	63	1480.035	0.337
10.0	63	1480.095	0.785
15.0	63	1480.150	1.197
20.0	63	1480.195	1.534

Effective head (ft) H = 255.4

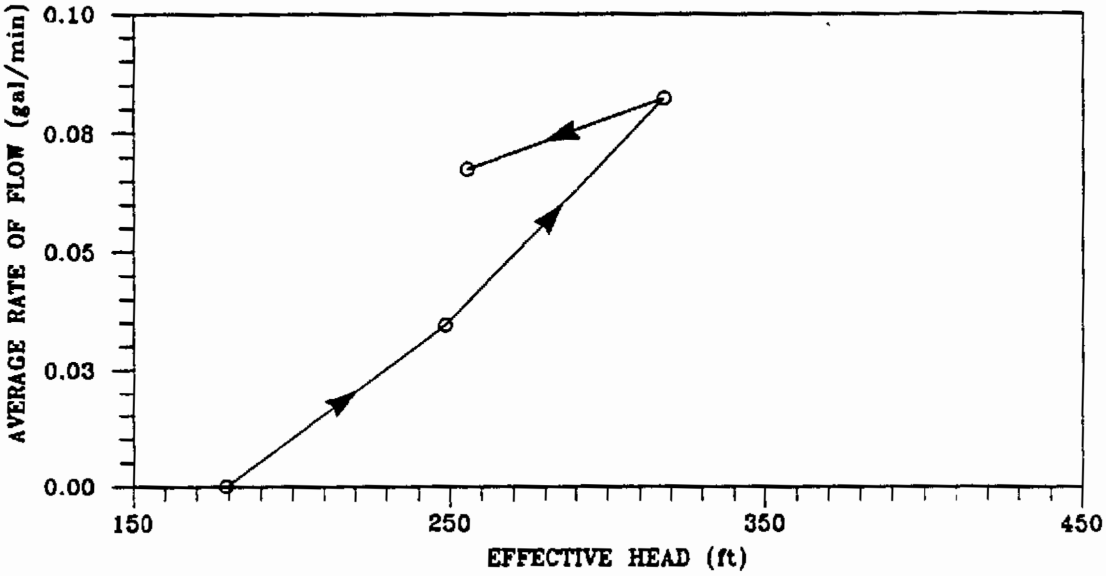
Average rate of flow (gpm) Q = 0.067

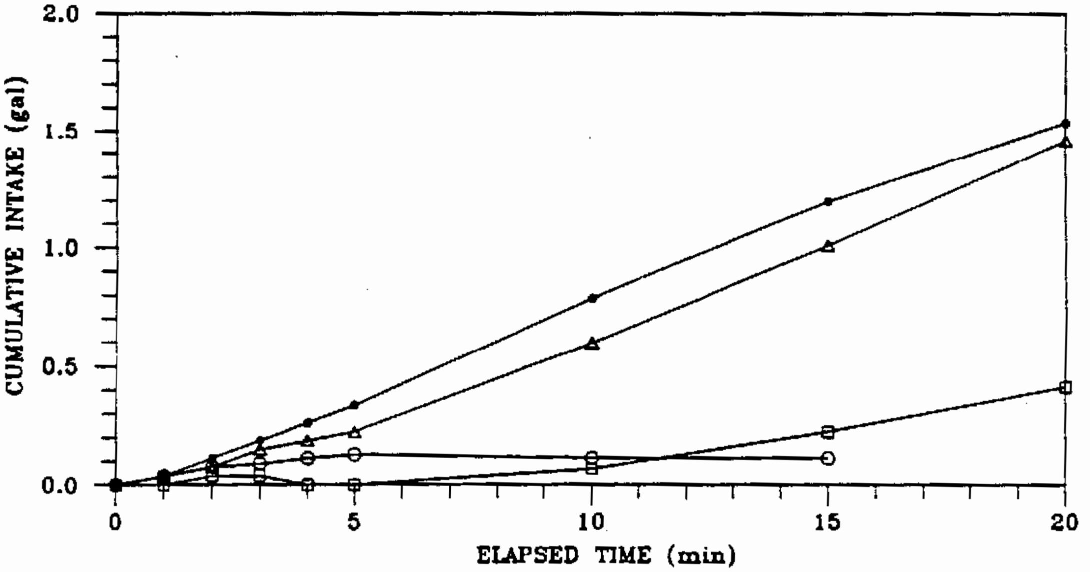
Hydraulic Conductivity (cm/sec)

k=Q/[(Cs+4)rH] = 1.3E–06

FIGURE B-18 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

BORING NO: SM-9 TEST NO: 2 TEST INTERVAL (ft): 638.2 to 647.5





SUMMARY

SYMBOL	STAGE	AVERAGE GAGE PRESSURE (psi)	HYDRAULIC CONDUCTIVITY (cm/sec)
○○○○○	1	30	0.0E-00
□□□□□	2	60	6.7E-07
△△△△△	3	90	1.3E-06
●●●●●	4	63	1.3E-06

AVERAGE HYDRAULIC CONDUCTIVITY = 8.0E-07

FIGURE B-19 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT: METRO RED LINE, SEGMENT 3
LOCATION: MULLHOLLAND DRIVE/ WOODROW WILSON DRIVE
DATE: 09-02-92
BORING SIZE (in.) 2r : 3.65
PACKER CONFIGURATION: Single
PACKER PRESSURE (psi): 650-700
TEST INTERVAL (ft below GS*) A : 678.2 to 693.0
PRESSURE GAGE HT. (ft above GS*): 6.0

*GS = Ground surface

PROJECT NO.: 92-2050
BORING NO.: SM-9
TEST NO.: 3
SURFACE ELEVATION (ft): 1112
ROCK TYPE: BASALT BRECCIA
STATIC WATER LEVEL (ft below GS*): 104

COMPUTED HEAD LOSS (ft): 0.00
A/r: 97.3
CONDUCTIVITY COEFFICIENT Cs: 128.5

STAGE 1 : PRESSURE 53 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	50	1490.400	0.000
1.0	50	1490.680	2.095
2.0	50	1490.930	3.965
3.0	50	1491.200	5.984
4.0	50	1491.460	7.929
5.0	50	1491.700	9.725
10.0	55	1492.980	19.300
15.0	55	1494.190	28.351
20.0	55	1495.350	37.028

Effective head (ft) H = 232.6
Average rate of flow (gpm) Q = 1.773
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 2.6E-05

STAGE 2 : PRESSURE 105 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	100	1495.720	0.000
1.0	100	1496.260	4.039
2.0	100	1496.755	7.742
3.0	100	1497.250	11.445
4.0	100	1497.680	14.662
5.0	107	1498.145	18.140
10.0	107	1500.385	34.897
15.0	107	1502.660	51.915
20.0	107	1504.870	68.447

Effective head (ft) H = 353.3
Average rate of flow (gpm) Q = 3.355
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 3.2E-05

STAGE 3 : PRESSURE 160 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	155	1505.550	0.000
1.0	155	1506.380	6.209
2.0	160	1507.200	12.343
3.0	160	1507.960	18.028
4.0	160	1508.730	23.788
5.0	160	1509.510	29.623
10.0	160	1513.410	58.797
15.0	160	1517.370	88.420

Effective head (ft) H = 478.1
Average rate of flow (gpm) Q = 5.880
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 4.1E-05

STAGE 4 : PRESSURE 215 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	210	1528.750	0.000
1.0	210	1529.620	6.508
2.0	215	1530.420	12.492
3.0	220	1531.240	18.626
4.0	215	1532.065	24.798
5.0	215	1532.850	30.670
10.0	215	1536.880	60.816
15.0	215	1540.880	90.738

Effective head (ft) H = 605.8
Average rate of flow (gpm) Q = 6.007
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 3.3E-05

FIGURE B-19 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT: METRO RED LINE, SEGMENT 3
LOCATION: MULLHOLLAND DRIVE/ WOODROW WILSON DRIVE
DATE: 09-02-92
BORING SIZE (in.) 2r : 3.65
PACKER CONFIGURATION: Single
PACKER PRESSURE (psi): 650-700
TEST INTERVAL (ft below GS*) A : 678.2 to 693.0
PRESSURE GAGE HT. (ft above GS*): 6.0

PROJECT NO.: 92-2050
BORING NO.: SM-9
TEST NO.: 3
SURFACE ELEVATION (ft): 1112
ROCK TYPE: BASALT BRECCIA
STATIC WATER LEVEL (ft below GS*): 104

COMPUTED HEAD LOSS (ft): 0.00
A/r: 97.3
CONDUCTIVITY COEFFICIENT Cs: 128.5

*GS = Ground surface

STAGE 5 : PRESSURE 114 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	105	1520.070	0.000
1.0	107	1520.600	3.965
2.0	115	1521.080	7.555
3.0	115	1521.560	11.146
4.0	115	1522.010	14.512
5.0	115	1522.470	17.953
10.0	115	1524.815	35.495

Effective head (ft) H = 372.4
Average rate of flow (gpm) Q = 3.509
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 3.2E-05

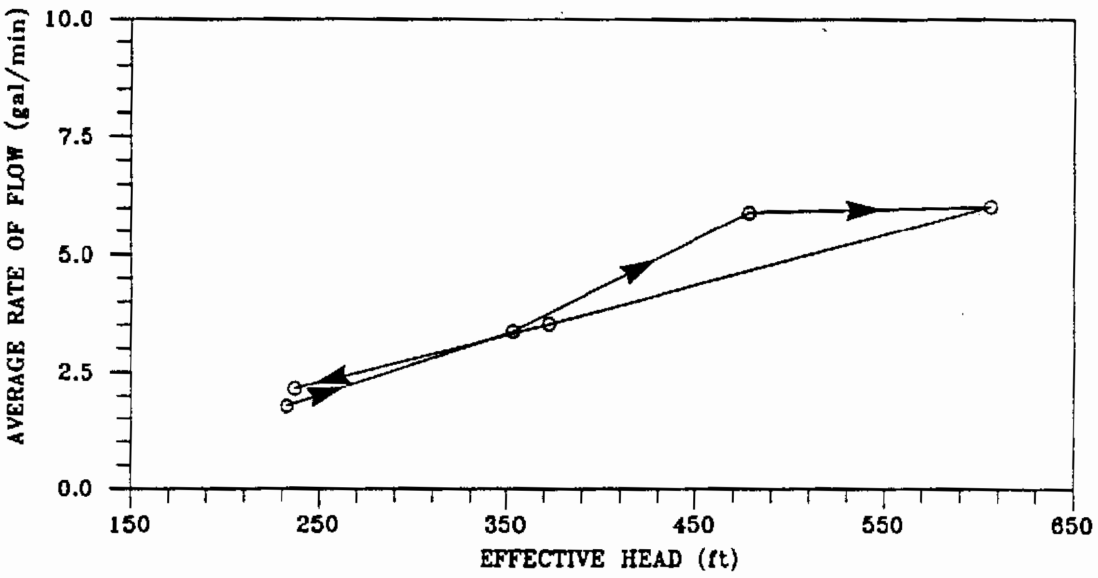
STAGE 6 : PRESSURE 55 psi

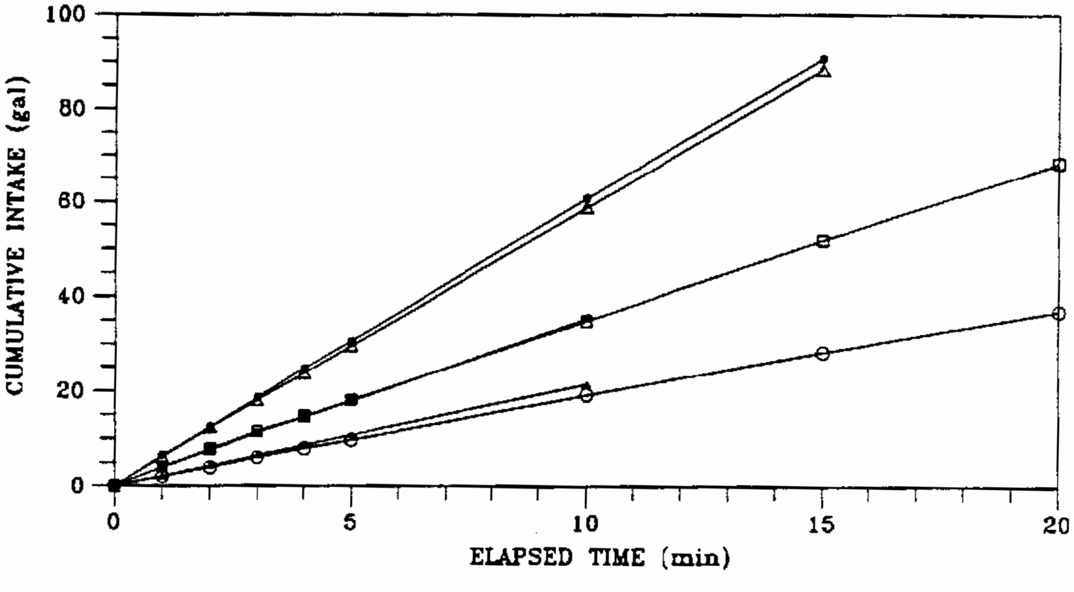
Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	55	1525.095	0.000
1.0	55	1525.370	2.057
2.0	55	1525.670	4.301
3.0	55	1525.960	6.471
4.0	55	1526.255	8.677
5.0	55	1526.545	10.847
10.0	55	1527.970	21.506

Effective head (ft) H = 236.9
Average rate of flow (gpm) Q = 2.138
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 3.0E-05

FIGURE B-19 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

BORING NO: SM-9 TEST NO: 3 TEST INTERVAL (ft): 678.2 to 693.0





SUMMARY

SYMBOL	STAGE	AVERAGE GAGE PRESSURE (psi)	HYDRAULIC CONDUCTIVITY (cm/sec)
○○○○○	1	53	2.6E-05
□□□□□	2	105	3.2E-05
△△△△△	3	160	4.1E-05
●●●●●	4	215	3.3E-05
■■■■■	5	114	3.2E-05
•••••	6	55	3.0E-05

AVERAGE HYDRAULIC CONDUCTIVITY = 3.2E-05

FIGURE B-19
(3 OF 3)

FIGURE B–20 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT: METRO RED LINE, SEGMENT 3
LOCATION: 3600 MULTIVIEW DRIVE
DATE: 10–23–92

BORING SIZE (in.) 2r : 3.785
PACKER CONFIGURATION: Single
PACKER PRESSURE (psi): 420
TEST INTERVAL (ft below GS*) A : 250.0 to 260.0
PRESSURE GAGE HT. (ft above GS*): 9.0

PROJECT NO.: 92–2050
BORING NO.: SM–11
TEST NO.: 1
SURFACE ELEVATION (ft): 778
ROCK TYPE: SANDSTONE
STATIC WATER LEVEL (ft below GS*): –3

COMPUTED HEAD LOSS (ft): 0.00
A/r: 63.4
CONDUCTIVITY COEFFICIENT Cs: 91.0

*GS = Ground surface

STAGE 1 : PRESSURE 50 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	50	1813.515	0.000
1.0	50	1813.520	0.037
2.0	50	1813.520	0.037
3.0	50	1813.520	0.037
4.0	50	1813.520	0.037
5.0	50	1813.520	0.037
10.0	50	1813.520	0.037
15.0	50	1813.520	0.037

Effective head (ft) H = 121.4
Average rate of flow (gpm) Q = 0.000
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 0.0E+00

STAGE 2 : PRESSURE 100 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	100	1813.520	0.000
1.0	100	1813.522	0.015
2.0	100	1813.522	0.015
3.0	100	1813.525	0.037
4.0	100	1813.525	0.037
5.0	100	1813.525	0.037
10.0	100	1813.528	0.060
15.0	100	1813.528	0.060

Effective head (ft) H = 236.8
Average rate of flow (gpm) Q = 0.000
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 0.0E+00

STAGE 3 : PRESSURE 150 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	150	1813.530	0.000
1.0	150	1813.530	0.000
2.0	150	1813.532	0.015
3.0	150	1813.532	0.015
4.0	150	1813.532	0.015

Effective head (ft) H = 352.2
Average rate of flow (gpm) Q = 0.000
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 0.0E+00

STAGE 4 : PRESSURE 125 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	125	1813.522	0.000
1.0	125	1813.522	0.000
2.0	125	1813.522	0.000
3.0	125	1813.522	0.000
4.0	125	1813.522	0.000
5.0	125	1813.522	0.000
10.0	125	1813.522	0.000
15.0	125	1813.522	0.000

Effective head (ft) H = 294.5
Average rate of flow (gpm) Q = 0.000
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 0.0E+00

FIGURE B-20 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT:	METRO RED LINE, SEGMENT 3	PROJECT NO.:	92-2050
LOCATION:	3600 MULTIVIEW DRIVE	BORING NO.:	SM-11
DATE:	10-23-92	TEST NO.:	1
		SURFACE ELEVATION (ft):	778
BORING SIZE (in.) 2r :	3.785	ROCK TYPE:	SANDSTONE
PACKER CONFIGURATION:	Single	STATIC WATER LEVEL (ft below GS*):	-3
PACKER PRESSURE (psi):	420		
TEST INTERVAL (ft below GS*) A :	250.0 to 260.0	COMPUTED HEAD LOSS (ft):	0.00
		A/r:	63.4
PRESSURE GAGE HT. (ft above GS*):	9.0	CONDUCTIVITY COEFFICIENT Cs:	91.0

*GS = Ground surface

STAGE 5 : PRESSURE 100 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	100	1813.522	0.000
1.0	100	1813.522	0.000
2.0	100	1813.522	0.000
3.0	100	1813.522	0.000
4.0	100	1813.522	0.000
5.0	100	1813.522	0.000
10.0	100	1813.522	0.000
15.0	100	1813.522	0.000

Effective head (ft) H = 236.8

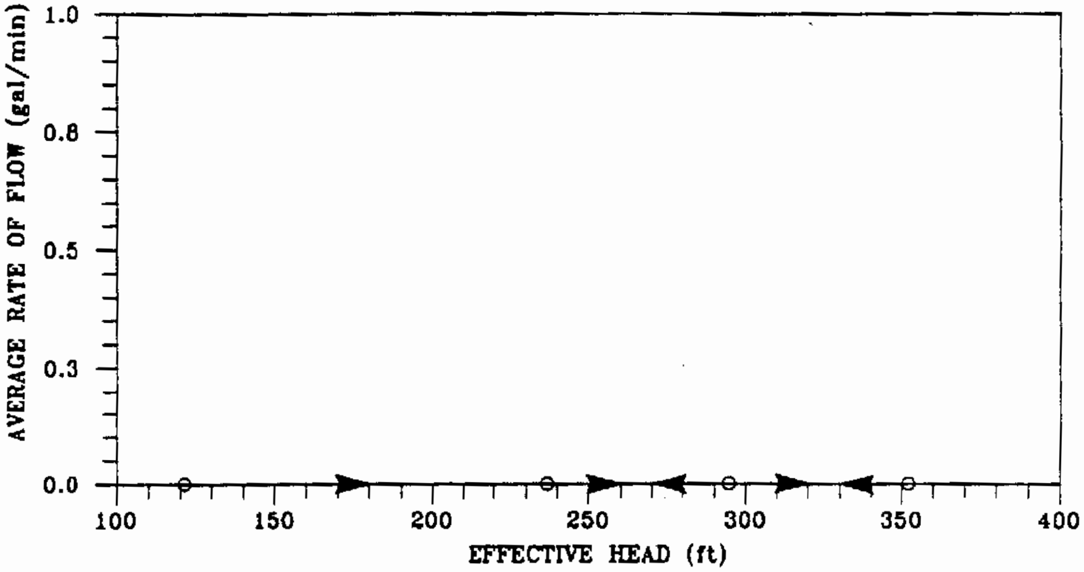
Average rate of flow (gpm) Q = 0.000

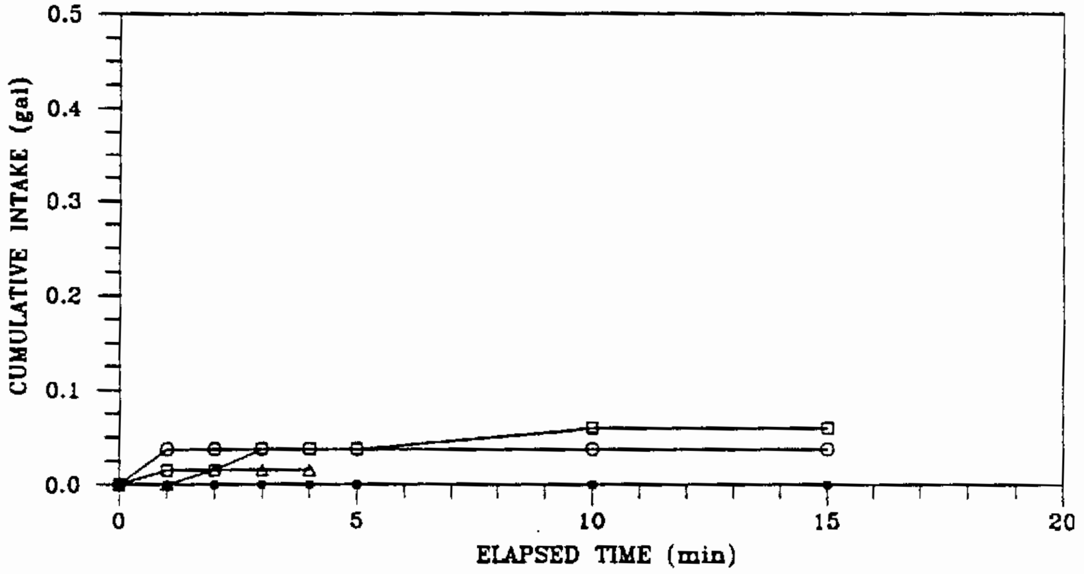
Hydraulic Conductivity (cm/sec)

k=Q/[(Cs+4)rH] = 0.0E+00

FIGURE B-20 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

BORING NO: SM-11 TEST NO: 1 TEST INTERVAL (ft): 250.0 to 260.0





SUMMARY

SYMBOL	STAGE	AVERAGE GAGE PRESSURE (psi)	HYDRAULIC CONDUCTIVITY (cm/sec)
○○○○○	1	50	0.0E-00
□□□□□	2	100	0.0E-00
△△△△△	3	150	0.0E-00
●●●●●	4	125	0.0E-00
■■■■■	5	100	0.0E-00

AVERAGE HYDRAULIC CONDUCTIVITY = 0.0E-00

FIGURE B-20
(3 OF 3)

FIGURE B−21 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT: METRO RED LINE, SEGMENT 3
LOCATION: 3600 MULTIVIEW DRIVE
DATE: 10−23−92

BORING SIZE (in.) 2r : 3.65
PACKER CONFIGURATION: Single
PACKER PRESSURE (psi): 400
TEST INTERVAL (ft below GS*) A : 280.0 to 295.0
PRESSURE GAGE HT. (ft above GS*): 9.0

*GS = Ground surface

PROJECT NO.: 92−2050
BORING NO.: SM−11
TEST NO.: 2
SURFACE ELEVATION (ft): 778
ROCK TYPE: . CONGLOMERATIC SANDSTONE
STATIC WATER LEVEL (ft below GS*): −3

COMPUTED HEAD LOSS (ft): 0.00
A/r: 98.6
CONDUCTIVITY COEFFICIENT Cs: 129.7

STAGE 1 : PRESSURE 50 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	50	1813.639	0.000
1.0	50	1813.639	0.000
2.0	50	1813.639	0.000
3.0	50	1813.639	0.000
4.0	50	1813.639	0.000
5.0	50	1813.639	0.000
10.0	50	1813.640	0.007
15.0	50	1813.640	0.007

Effective head (ft) H = 121.4
Average rate of flow (gpm) Q = 0.000
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 0.0E+00

STAGE 2 : PRESSURE 100 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	100	1813.642	0.000
1.0	100	1813.642	0.000
2.0	100	1813.642	0.000
3.0	100	1813.642	0.000
4.0	100	1813.642	0.000
5.0	100	1813.642	0.000
10.0	100	1813.645	0.022
15.0	100	1813.651	0.067

Effective head (ft) H = 236.8
Average rate of flow (gpm) Q = 0.009
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 1.3E−07

STAGE 3 : PRESSURE 130 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	130	1813.675	0.000
1.0	130	1813.678	0.022
2.0	130	1813.680	0.037
3.0	130	1813.682	0.052
4.0	130	1813.685	0.075
5.0	130	1813.685	0.075
10.0	130	1813.694	0.142
15.0	130	1813.699	0.180

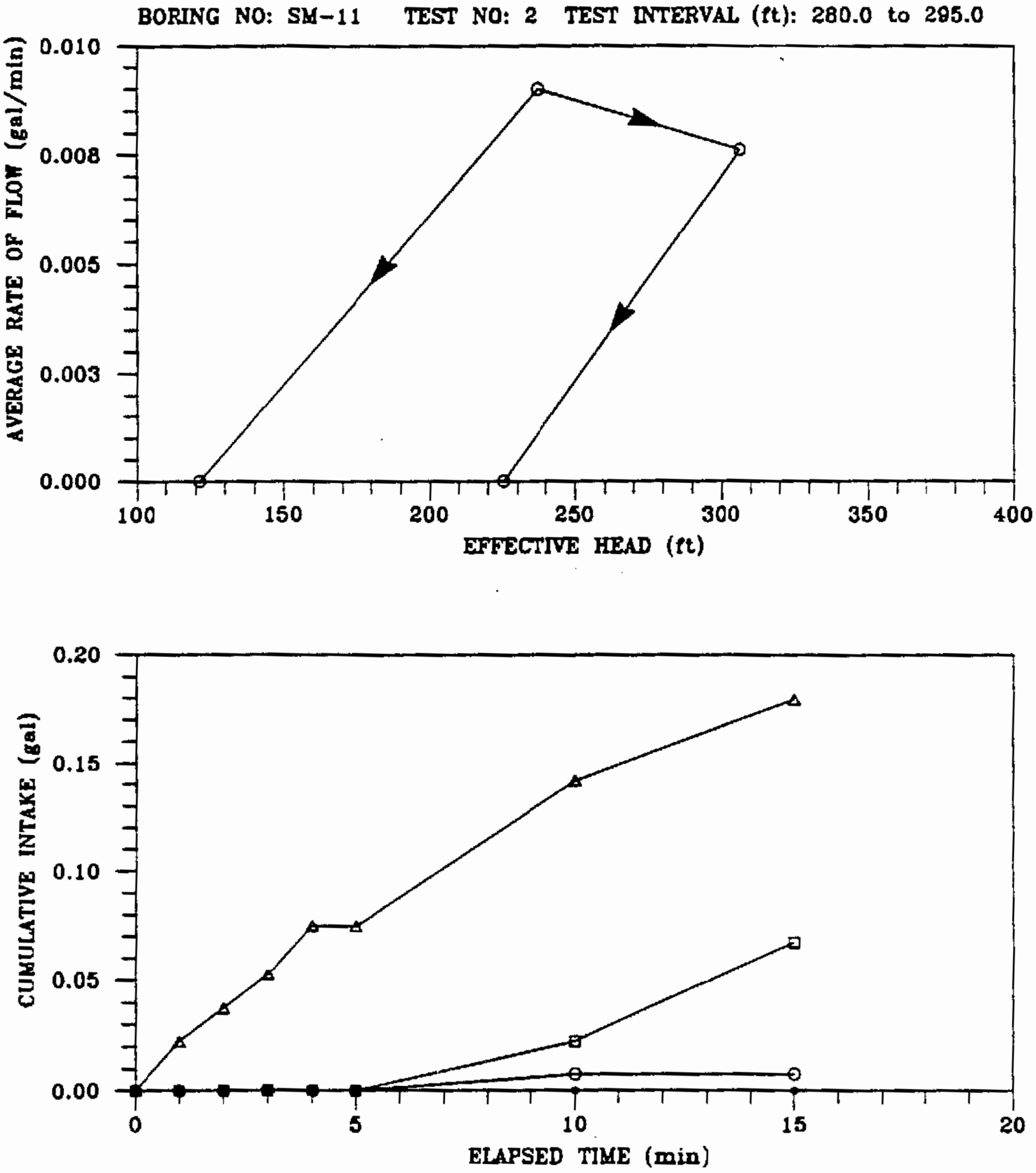
Effective head (ft) H = 306.0
Average rate of flow (gpm) Q = 0.008
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 8.3E−08

STAGE 4 : PRESSURE 95 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	95	1813.700	0.000
1.0	95	1813.700	0.000
2.0	95	1813.700	0.000
3.0	95	1813.700	0.000
4.0	95	1813.700	0.000
5.0	95	1813.700	0.000
10.0	95	1813.700	0.000
15.0	95	1813.700	0.000

Effective head (ft) H = 225.2
Average rate of flow (gpm) Q = 0.000
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 0.0E+00

FIGURE B-21 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS



SUMMARY

SYMBOL	STAGE	AVERAGE GAGE PRESSURE (psi)	HYDRAULIC CONDUCTIVITY (cm/sec)
○○○○○	1	50	0.0E-00
□□□□□	2	100	1.3E-07
△△△△△	3	130	8.3E-08
●●●●●	4	95	0.0E-00

AVERAGE HYDRAULIC CONDUCTIVITY = 5.2E-08

FIGURE B-21
(2 OF 2)

FIGURE B-22 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT: METRO RED LINE, SEGMENT 3
LOCATION: 3600 MULTIVIEW DRIVE
DATE: 10-24-92

BORING SIZE (in.) 2r : 3.65
PACKER CONFIGURATION: Double
PACKER PRESSURE (psi): 350
TEST INTERVAL (ft below GS*) A : 165.0 to 181.2
PRESSURE GAGE HT. (ft above GS*): 10.0

*GS = Ground surface

PROJECT NO.: 92-2050
BORING NO.: SM-11
TEST NO.: 3
SURFACE ELEVATION (ft): 778
ROCK TYPE: SANDSTONE
STATIC WATER LEVEL (ft below GS*): -3

COMPUTED HEAD LOSS (ft): 0.00
A/r: 106.3
CONDUCTIVITY COEFFICIENT Cs: 136.8

STAGE 1 : PRESSURE 27 psi

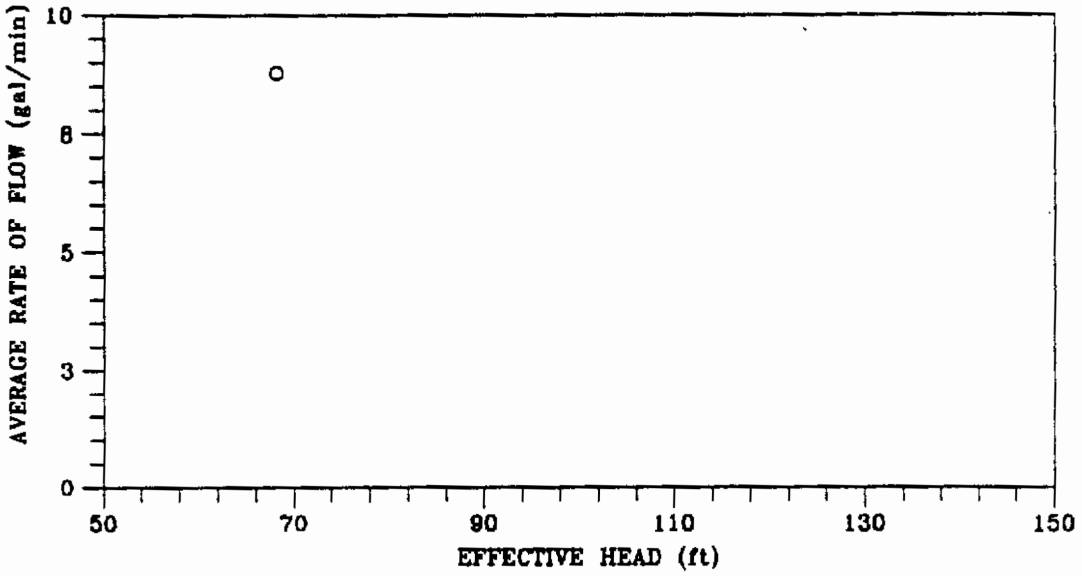
Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	25	1814.600	0.000
1.0	25	1815.750	8.603
2.0	25	1816.930	17.430
3.0	25	1818.100	26.182
4.0	30	1819.250	34.784
5.0	30	1820.450	43.761

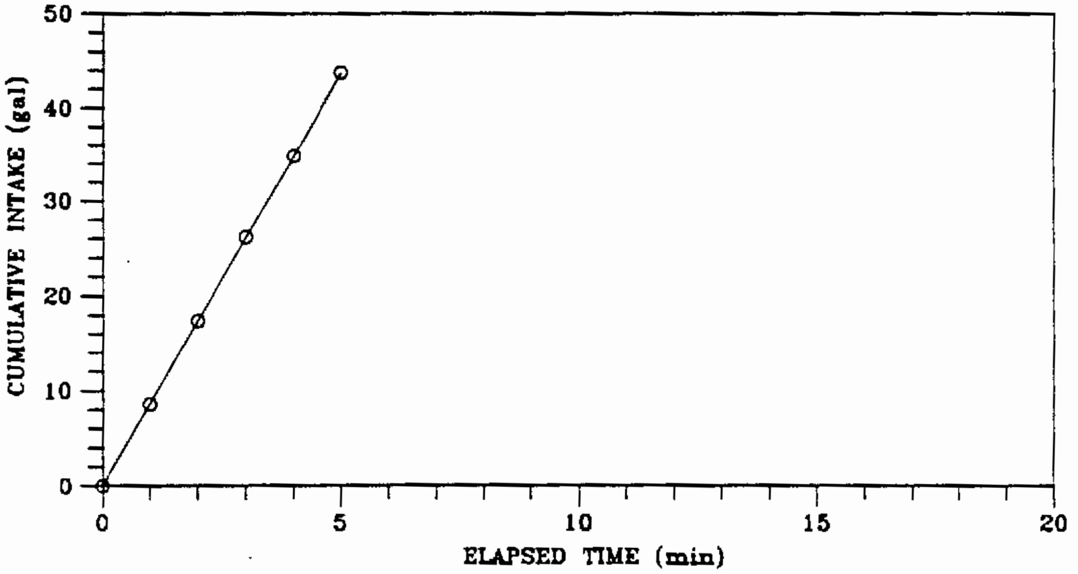
Effective head (ft) H = 68.2
Average rate of flow (gpm) Q = 8.777
Hydraulic Conductivity (cm/sec)
k=Q/[CsrH] = 4.2E-04

Note: Reached pump capacity at 30 psi

FIGURE B-22 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

BORING NO: SM-11 TEST NO: 3 TEST INTERVAL (ft): 165.0 to 181.2





SUMMARY

SYMBOL	STAGE	AVERAGE GAGE PRESSURE (psi)	HYDRAULIC CONDUCTIVITY (cm/sec)
⊖⊖⊖⊖⊖	1	27	4.2E-04

AVERAGE HYDRAULIC CONDUCTIVITY = 4.2E-04

FIGURE B-23 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT: METRO RED LINE, SEGMENT 3
LOCATION: 3600 MULTIVIEW DRIVE
DATE: 10-24-92

BORING SIZE (In.) 2r : 3.65
PACKER CONFIGURATION: Double
PACKER PRESSURE (psi): 375
TEST INTERVAL (ft below GS*) A : 155.0 to 171.2
PRESSURE GAGE HT. (ft above GS*): 10.0

PROJECT NO.: 92-2050
BORING NO.: SM-11
TEST NO.: 4
SURFACE ELEVATION (ft): 778
ROCK TYPE: SANDSTONE
STATIC WATER LEVEL (ft below GS*): -3

COMPUTED HEAD LOSS (ft): 0.00
A/r: 106.3
CONDUCTIVITY COEFFICIENT Cs: 136.8

*GS = Ground surface

STAGE 1 : PRESSURE 28 psi

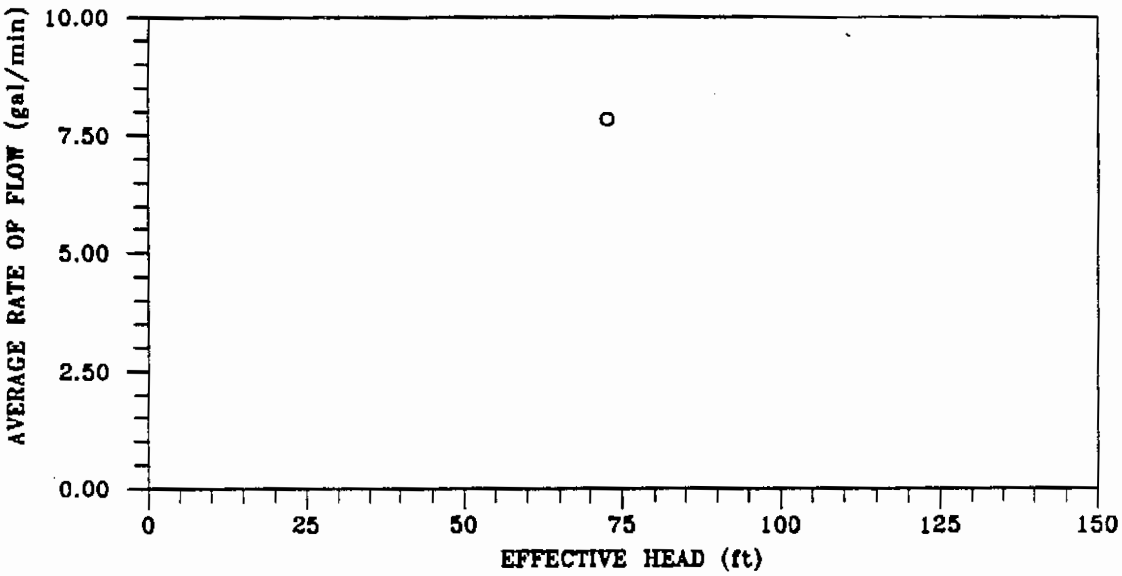
Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	20	1822.200	0.000
1.0	20	1823.200	7.481
2.0	25	1824.370	16.233
3.0	27	1825.410	24.012
4.0	27	1826.480	32.017
5.0	30	1827.530	39.871
6.0	30	1828.600	47.875
7.0	33	1829.630	55.580
8.0	33	1830.680	63.435
9.0	33	1831.700	71.065
10.0	33	1832.760	78.994

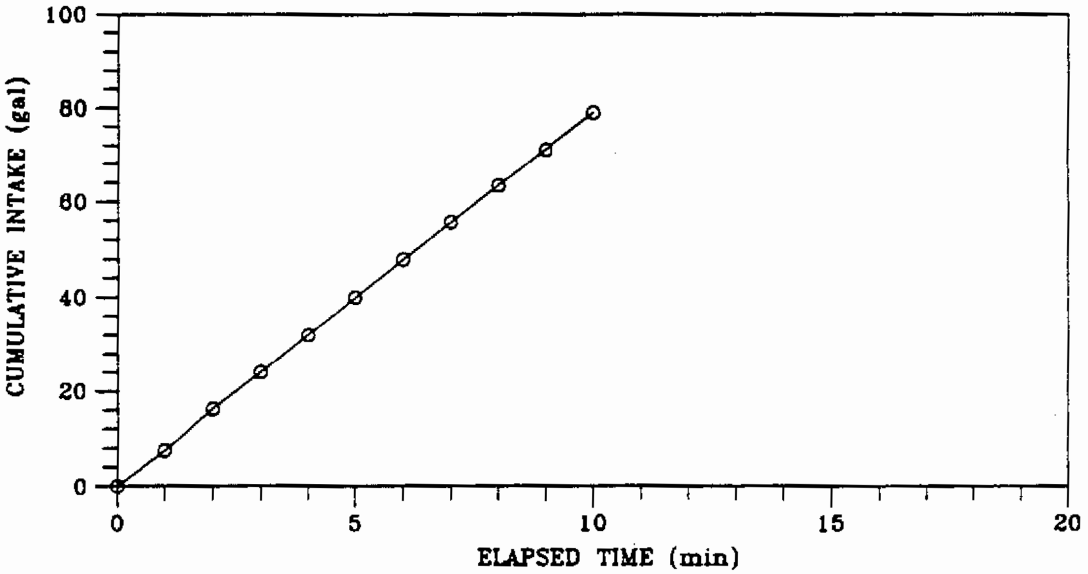
Effective head (ft) H = 72.7
Average rate of flow (gpm) Q = 7.825
Hydraulic Conductivity (cm/sec)
k=Q/[CsrH] = 3.5E-04

Note: Reached pump capacity at 33 psi

FIGURE B-23 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

BORING NO: SM-11 TEST NO: 4 TEST INTERVAL (ft): 155.0 to 171.2





SUMMARY

SYMBOL	STAGE	AVERAGE GAGE PRESSURE (psi)	HYDRAULIC CONDUCTIVITY (cm/sec)
⊖⊖⊖⊖⊖	1	28	3.5E-04

AVERAGE HYDRAULIC CONDUCTIVITY = 3.5E-04

FIGURE B-24 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT:	METRO RED LINE, SEGMENT 3
LOCATION:	3773 FREDONIA DRIVE
DATE:	10-28-92
BORING SIZE (in.) 2r :	4
PACKER CONFIGURATION:	Single
PACKER PRESSURE (psi):	300
TEST INTERVAL (ft below GS*) A :	146.7 to 161.0
PRESSURE GAGE HT. (ft above GS*):	3.2

*GS = Ground surface

PROJECT NO.:	92-2050
BORING NO.:	SM-12
TEST NO.:	1
SURFACE ELEVATION (ft):	671
ROCK TYPE:	SANDSTONE/SILTSTONE
STATIC WATER LEVEL (ft below GS*):	26
COMPUTED HEAD LOSS (ft):	0.00
A/r:	86.0
CONDUCTIVITY COEFFICIENT Cs:	118.8

STAGE 1 : PRESSURE 50 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	50	1829.470	0.000
1.0	50	1829.518	0.355
2.0	50	1829.558	0.655
3.0	50	1829.595	0.935
4.0	50	1829.635	1.234
5.0	50	1829.664	1.451
10.0	50	1829.804	2.498
15.0	50	1829.933	3.463
20.0	50	1830.049	4.331

Effective head (ft) H =	144.6
Average rate of flow (gpm) Q =	0.183
Hydraulic Conductivity (cm/sec)	
k=Q/[(Cs+4)rH] =	4.2E-06

STAGE 2 : PRESSURE 100 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	100	1830.380	0.000
1.0	100	1830.588	1.556
2.0	100	1830.725	2.581
3.0	100	1830.848	3.501
4.0	100	1830.968	4.399
5.0	100	1831.085	5.274
10.0	100	1831.670	9.650
15.0	100	1832.208	13.674
20.0	100	1832.775	17.916

Effective head (ft) H =	259.9
Average rate of flow (gpm) Q =	0.827
Hydraulic Conductivity (cm/sec)	
k=Q/[(Cs+4)rH] =	1.1E-05

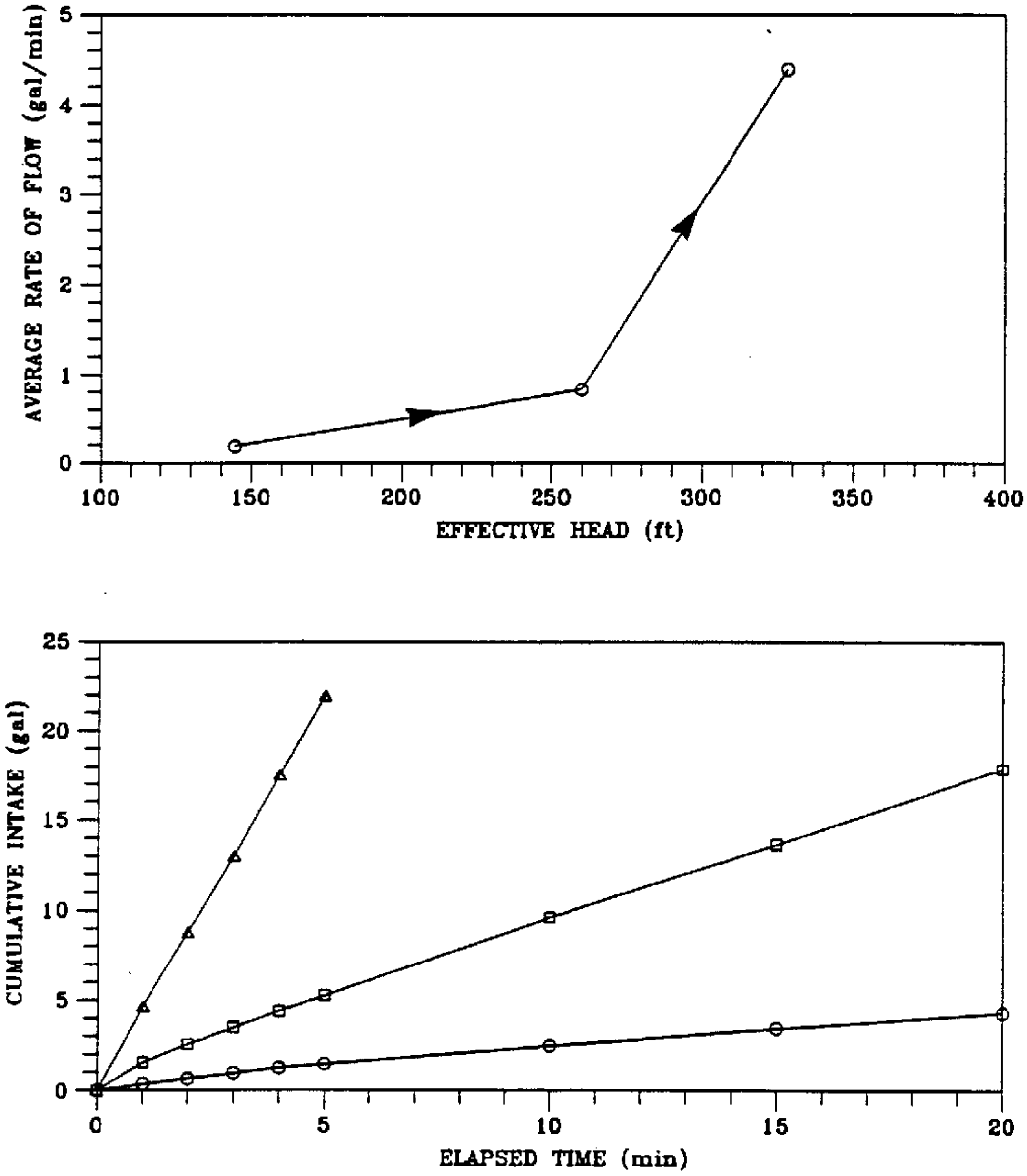
STAGE 3 : PRESSURE 129.5 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	125	1833.150	0.000
1.0	130	1833.775	4.675
2.0	130	1834.328	8.812
3.0	130	1834.890	13.016
4.0	130	1835.492	17.519
5.0	130	1836.090	21.993

Effective head (ft) H =	328.0
Average rate of flow (gpm) Q =	4.394
Hydraulic Conductivity (cm/sec)	
k=Q/[(Cs+4)rH] =	4.4E-05

FIGURE B-24 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

BORING NO: SM-12 TEST NO: 1 TEST INTERVAL (ft): 146.7 to 161.0



SUMMARY

SYMBOL	STAGE	AVERAGE GAGE PRESSURE (psi)	HYDRAULIC CONDUCTIVITY (cm/sec)	
○○○○○	1	50	4.2E-06	AVERAGE HYDRAULIC
□□□□□	2	100	1.1E-05	CONDUCTIVITY = 2.0E-05
△△△△△	3	130	4.4E-05	

FIGURE B-25 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

PROJECT: METRO RED LINE, SEGMENT 3
LOCATION: CAHUENGA BLVD/LANKERSHIM BLVD
DATE: 11-04-92

BORING SIZE (in.) 2r : 3.75
PACKER CONFIGURATION: Single
PACKER PRESSURE (psi): 290
TEST INTERVAL (ft below GS*) A : 75.0 to 90.0
PRESSURE GAGE HT. (ft above GS*): 4.0

PROJECT NO.: 92-2050
BORING NO.: SM-13
TEST NO.: 1
SURFACE ELEVATION (ft): 590
ROCK TYPE: SANDSTONE/SILTSTONE
STATIC WATER LEVEL (ft below GS*): 12

COMPUTED HEAD LOSS (ft): 0.00
A/r: 96.0
CONDUCTIVITY COEFFICIENT Cs: 127.3

*GS = Ground surface

STAGE 1 : PRESSURE 20 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	20	1838.090	0.000
1.0	20	1838.098	0.056
2.0	20	1838.099	0.067
3.0	20	1838.115	0.187
4.0	20	1838.115	0.187
5.0	20	1838.115	0.187
10.0	20	1838.115	0.187
15.0	20	1838.115	0.187

Effective head (ft) H = 62.2
Average rate of flow (gpm) Q = 0.000
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 0.0E+00

STAGE 2 : PRESSURE 40 psi

Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	40	1838.130	0.000
1.0	40	1838.142	0.090
2.0	40	1838.152	0.165
3.0	40	1838.162	0.239
4.0	40	1838.175	0.337
5.0	40	1838.187	0.426
10.0	40	1838.220	0.673
15.0	40	1838.260	0.972
20.0	40	1838.291	1.204

Effective head (ft) H = 108.3
Average rate of flow (gpm) Q = 0.016
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 5.0E-07

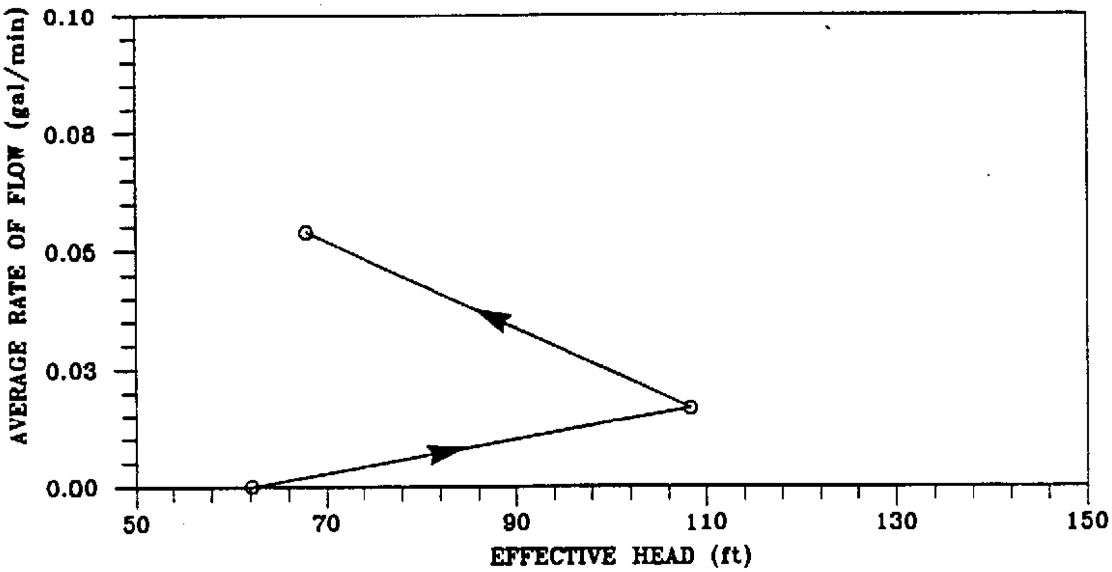
STAGE 3 : PRESSURE 23 psi

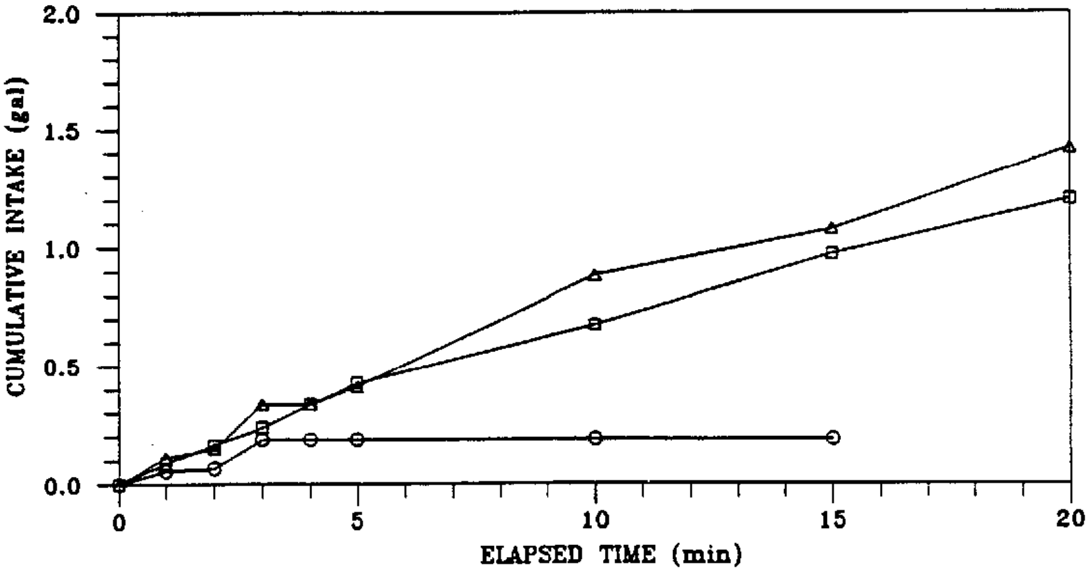
Elapsed Time (min)	Gage Pressure (psi)	Flow Meter Reading (ft3)	Cumulative Intake (gal)
0.0	60	1838.350	0.000
1.0	60	1838.365	0.112
2.0	60	1838.370	0.150
3.0	60	1838.395	0.337
4.0	60	1838.395	0.337
5.0	60	1838.405	0.411
10.0	60	1838.468	0.883
15.0	60	1838.494	1.077
20.0	60	1838.540	1.421

Effective head (ft) H = 67.9
Average rate of flow (gpm) Q = 0.054
Hydraulic Conductivity (cm/sec)
k=Q/[(Cs+4)rH] = 2.6E-06

FIGURE B-25 PACKER HYDRAULIC CONDUCTIVITY TEST DATA ANALYSIS

BORING NO: SM-13 TEST NO: 1 TEST INTERVAL (ft): 75.0 to 90.0





SUMMARY

SYMBOL	STAGE	AVERAGE GAGE PRESSURE (psi)	HYDRAULIC CONDUCTIVITY (cm/sec)
○○○○○	1	20	0.0E-00
□□□□□	2	40	5.0E-07
△△△△△	3	23	2.6E-06

AVERAGE HYDRAULIC CONDUCTIVITY = 1.0E-06

APPENDIX C

GEOPHYSICAL WIRELINE LOGGING RESULTS

APPENDIX C
GEOPHYSICAL WIRELINE LOGGING RESULTS

This appendix describes the instrumentation and procedures used to collect and interpret the wireline data. Sonic and electric logs for each boring are included in the pockets in this appendix.

The wireline survey consisted of lowering an instrumented package (sonic or electric sonde) to the boring bottom and recording data as the package is raised at 10 to 20 feet per minute. Data are digitally recorded at a rate of ten points per vertical foot. Logs were run a second time within the tunnel zone only to provide a check on data quality and repeatability. The sonic sonde consisted of a crystal transmitter (30 KHz) and two receivers spaced one foot apart with the lower one a foot above the transmitter. The sonde continuously recorded the entire sonic waveform arriving at each receiver. The electric sonde consisted of several transmitting and receiving electrodes that recorded the spontaneous potential and electrical resistivity of the boring fluid and the formation. Both sondes were calibrated and functionally checked immediately prior to and after data collection. Logs were digitally recorded, edited, and displayed in standard industry format as depth sections. The logs' depth axis was relative to ground surface at the boring. The wireline survey was conducted by Barbour Corporation, Camarillo, California.

Additional logs were planned to further quantify subsurface conditions. At the first boring, a video log was conducted to measure formation wall conditions. Visible light used by this log is of higher frequency than the sonic tool transmitter and can resolve smaller dimension fractures with its smaller wavelength signals. The video log failed because the boring fluid could not be flushed clear enough of suspended particles to adequately film the formation wall. This log was not conducted at the other borings.

Sonic Log

Sonic data were recorded with a Mt Sophris model CLP-4877 sonde (S/N R001-F) with model CLM-4877 electronic module (S/N 53). Loggin started below the water table where wave attenuation is minimized. The effective formation penetration in the approximate four-inch boring is 0.7-1.0 foot. The sonic log contains two data graphs with depth plotted on the vertical axes. The left graph has the compressional wave transit time between the two receivers plotted on the horizontal axis. Compressional velocities were calculated as receiver separation (one foot) divided by the measured transit time. Velocities were measured only within depth intervals where the transit time was relatively constant and well behaved. This graph shows that formation velocity increases to the left as transit time decreases. Fracture locations were identified as large amplitude positive and negative deviations (Fractures in otherwise competent rock will decrease the wave amplitude arriving at one or both of the receivers causing large amplitude signal deviations known as cycle skips).

The right graph shows dark/light banding representing the entire waveform arriving at the receiver closest to the transmitter. The first arriving compressional wave is not visible because the display gain function is set low enough to minimize its amplitude. The first obvious wave is usually the larger amplitude, formation shear wave. Shear wave velocities were calculated as transmitter-receiver separation (one foot) divided by measured shear wave arrival time. Dynamic elastic moduli (shear, Youngs, and bulk) and Poisson Ratio were calculated using the standard equations (Paillet, 1991) and the measured compressional and shear velocities and densities obtained by laboratory analysis of rock samples. Effective porosity was calculated using the compressional velocities with the Wyllie time average equation (Keys, 1988). An upper estimate of permeability was calculated using the Kozeny-Carmen model (Keys, 1988). Uncertainties of all calculated values are estimated at ±20%.

The next coherent signal is the much slower tube wave which travels along the boring fluid/formation interface. Tube wave velocity is relatively unimportant but its amplitude is especially sensitive to energy loss through fractures in the formation wall. In competent rock the tube amplitude is continuous as shown by parallel banding of equal intensity. The tube wave signal becomes irregular and smaller amplitude when open fractures or increased permeability zones are encountered. Closed fractures (clay and quartz filled) do not distort the tube wave as much as open fractures. Tube waves are insensitive to fracture orientation. Fracture locations interpreted from tube wave irregularities were compared with those identified from compressional wave transit time. Fracture frequency per ten feet intervals were calculated and compared with laboratory analysis of frequency and Rock Quality Designation (RQD) values.

Electric Log

The electric log was recorded with a Mt Sophris model ELP-41277 sonde (S/N B-1-SS) and model ELM-4277 electronics module (S/N 52). The log also started below the water table to provide good formation coupling with the boring fluid. The log consists of four data profiles plotted on three graphs with depth on the vertical axes. On the left graph, spontaneous potential is plotted on the horizontal axis. This log measures electric currents produced by chemical reactions between the drilling fluid and the formation. The log shows changes related to changing clay content and groundwater quality. Open fractures may produce positive or negative peaks in this log by allowing formation waters to interact with boring fluids. Closed fractures generally produce smaller amplitude peaks (and may not be identified) because the clay/quartz filling the fracture minimizes chemical reactions with formation waters. Peaks were identified on the log and compared with fractures interpreted from the sonic log.

The central graph shows electrical resistivity measurements on the horizontal axis. The 16-inch measurements responds mostly to boring fluid and mudcake resistivities. The 64-inch measurements responds to formation changes with a penetration of about two feet. The right graph also shows formation resistivities on the horizontal axis as measured with a 6-foot lateral sonde. This sonde focusses electrical current deeper into the formation and has about four feet of penetration. Resistivity changes in the lateral and 64-inch data not solely caused by boring fluid changes (as shown by the 16-inch data) were interpreted as significant formation changes (degree of fracturing, cementation, clay content). Qualitative rock strength was estimated from the following relations.

Resistivity Range (ohm meters)	Rock Strength
0 - 50	unconsolidated
50 - 300	poorly consolidated
300 - 600	consolidated
>600	competent, few fractures

References

Keys, W., 1988. Borehole Geophysics Applied To Ground-Water Investigations. U.S. Geologic Survey, Open File Report 87-539, Denver, CO.

Paillet, F. and C. Cheng, 1991. Acoustic Waves in Boreholes. CRC Press, Boca Raton, FL.

APPENDIX D

MONITORING WELLS

APPENDIX D
MONITORING WELLS

D.1 MONITORING WELL DIAGRAMS

Five monitoring wells were installed as part of this investigation. Two monitoring wells were installed in the 1989 geotechnical investigation. The diagrams of all the monitoring wells (SM-1A, SM-1, SM-3A, SM-6A, SM-9A, SM-14, R-8 and R-9) are included in this appendix.

D.2 WELL DEVELOPMENT

The purpose of monitoring well development is to remove fine particulate materials, commonly clay and silt, from the geologic formation near the well intake. If particulate matter is not removed, as water moves through the formation into the well, the water sampled may be turbid, and the viability of the water quality analyses may be impaired. A properly developed well, therefore, will provide samples that are truly representative of the quality of water that is moving through the formation.

Four monitoring wells (SM-3A, SM-6A, SM-9A and R-8) were developed between November 16 to November 18, 1992. A combination of three well development methods was used to develop each well. These methods were: 1) bailing, 2) mechanical (surge block) surging, and 3) pumping/overpumping.

A bailer, allowed to fall freely through the well casing until it strikes the surface of the water, produces a strong outward surge of water that is forced from the well casing through the well intake and into the formation. This tends to break up bridging that may have developed within the formation. As the bailer fills and is rapidly withdrawn, the water and particulate material is pulled through the well intake and into the well. Subsequent bailing will remove the particulate material. Similarly, a surge block agitates and loosens particulate material so that it can be removed by bailing or pumping. By using a pump, groundwater flow is induced towards the well along with particulate material which will be pumped out.

Using the above methods, well development was performed until (1) a minimum of five well casing volumes of groundwater were removed from the well (or all standing water in the well casing had been removed), (2) the temperature, pH, and conductivity had stabilized to within 10 percent between consecutive measurements; and (3) if possible, the discharge water was clear (< 10 NTU). As used here, the term "casing volume" refers to the volume of standing water in the monitoring well within the casing. All well activities were recorded on Earth Technology's Well Development/Purge Log and are included in this appendix.

D.3 GROUNDWATER SAMPLE COLLECTION

Groundwater samples were obtained from Monitoring Wells SM-3A, SM-6A, SM-9A and R-8 for chemical analyses. The field procedures used in collecting the groundwater samples were as follows:

D.3.1 Purging Wells

The monitoring wells were purged before obtaining groundwater samples. They were purged until: (1) a minimum of four casing volumes were removed from the wells or all standing water in the well casing had been removed (one casing volume), (2) the field parameters including pH, specific conductivity, and temperature of recovered water were stabilized as per the following criteria: pH - constant within 0.1, specific conductivity - did not vary more than 10 percent from the previous reading, and temperature - constant within 1°C.

Purging of the wells was accomplished by using a submersible pump. During purging the aforementioned field parameters were measured and recorded. Field Organic Vapor Analyzer (OVA) readings at the well heads prior to and during purging were obtained and recorded. The groundwater monitoring well sample logs are included in this appendix.

D.3.2 Water Sampling

After the aforementioned field parameters had stabilized, groundwater samples were collected from each well using a Teflon bailer. The samples were transferred from the bailer into appropriate containers and were labeled with the following information: date and time of sampling, sample identification, location, preservation methods, sample collector, owner (client), and chemical testing methods. Labeled and sealed samples were placed in ice chests and were maintained in a chilled condition in the field and through shipment to the analytical laboratory.

The submersible pump and discharge hose were flushed with a dilute solution of Alconox to remove contaminants that may have adhered to the pump and hose during purging. The pump was then run for a period of approximately five minutes, after which the pump and hose were placed in a container of fresh water. The pump was then operated for an additional five minutes.

D.3.3 Transport of Water Samples

The groundwater samples contained in sealed ice chests were transported to Pace Incorporated Analytical Laboratories, Huntington Beach, California with properly filled out chain-of-custody records which are presented in this appendix.

D.3.4 Transport and Disposal of Purged Water

Fluids produced from well purging and equipment decontamination activities were placed in separate DOT-approved 55-gallon steel drums. The drums were properly packed and were labeled with the following information: location, well number, content and date, generator's name, address, and telephone number. The drums were then transported to a temporary storage yard located at 4435, Fountain Avenue, Los Angeles. The drums were placed on the ground in the storage yard with two layers of 4-mil thick polyethylene sheets between the soil and the drums.

Following the testing, the purged water was transported to Southwest Processors, Inc. a Treatment, Storage and Disposal Facility (TSDF) in Los Angeles under a Uniform Non-hazardous Waste Manifest. The water was disposed of properly in accordance with regulatory requirements by the TSDF. Copy of the non-hazardous waste manifest is included in this appendix.

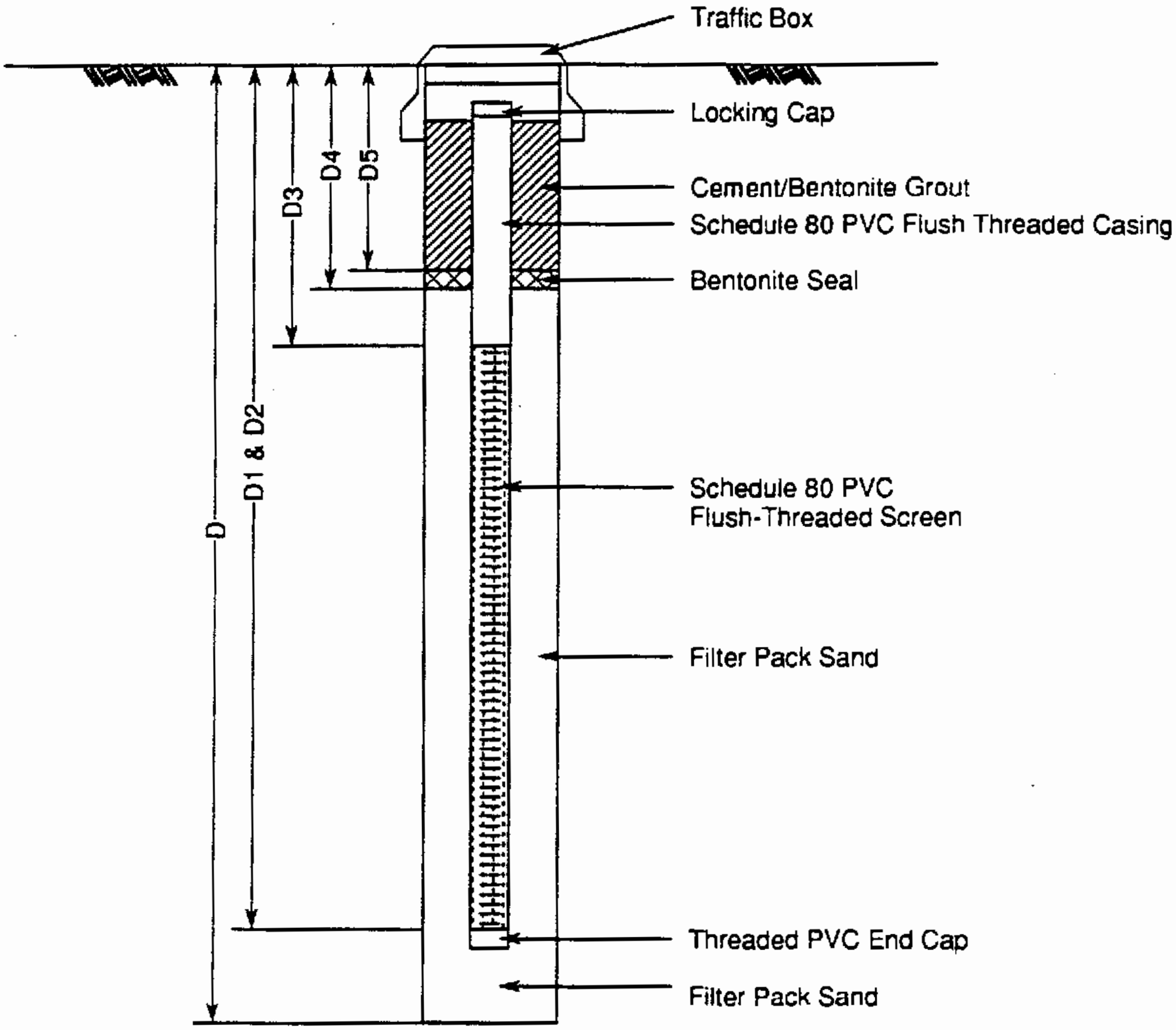
D.3.5 Health and Safety

A Health and Safety manual for this investigation was prepared in accordance with the provisions of 29CFR 1910.120. All the field personnel were briefed about the Health and Safety manual and it was implemented in the field by a Site Safety Officer.

All on-site personnel had participated in an OSHA, 40-hour hazardous waste training course. In addition, supervisors had completed the 8-hour Hazardous Waste Supervisor's training course. The 40-hour course was supplemented with a 3-day on-the-job training course and was updated annually with an 8-hour refresher course.

During purging and groundwater sampling activities, traffic cones were placed around the well locations. All on-site personnel wore orange traffic vests. The work area was cordoned off with cones and caution tape to prevent unauthorized personnel from entering the work area.

MONITORING WELL DIAGRAMS



Total Depth (D)	= 199 Feet
Total Depth of Casing (D1)	= 195 Feet
Depth to Bottom of Well Screen (D2)	= 195 Feet
Depth to Top of Well Screen (D3)	= 125 Feet
Depth to Bottom of Top Seal (D4)	= 112 Feet
Depth to Top of Top Seal (D5)	= 103.3 Feet
Well Casing Diameter	= 2 Inch
Well Screen Slot Size	= 0.01 Inch
Filter Pack Sand Type	= 2/12 Monterey
Bentonite Seal Type	= 1/4 Inch Pellets and Chips

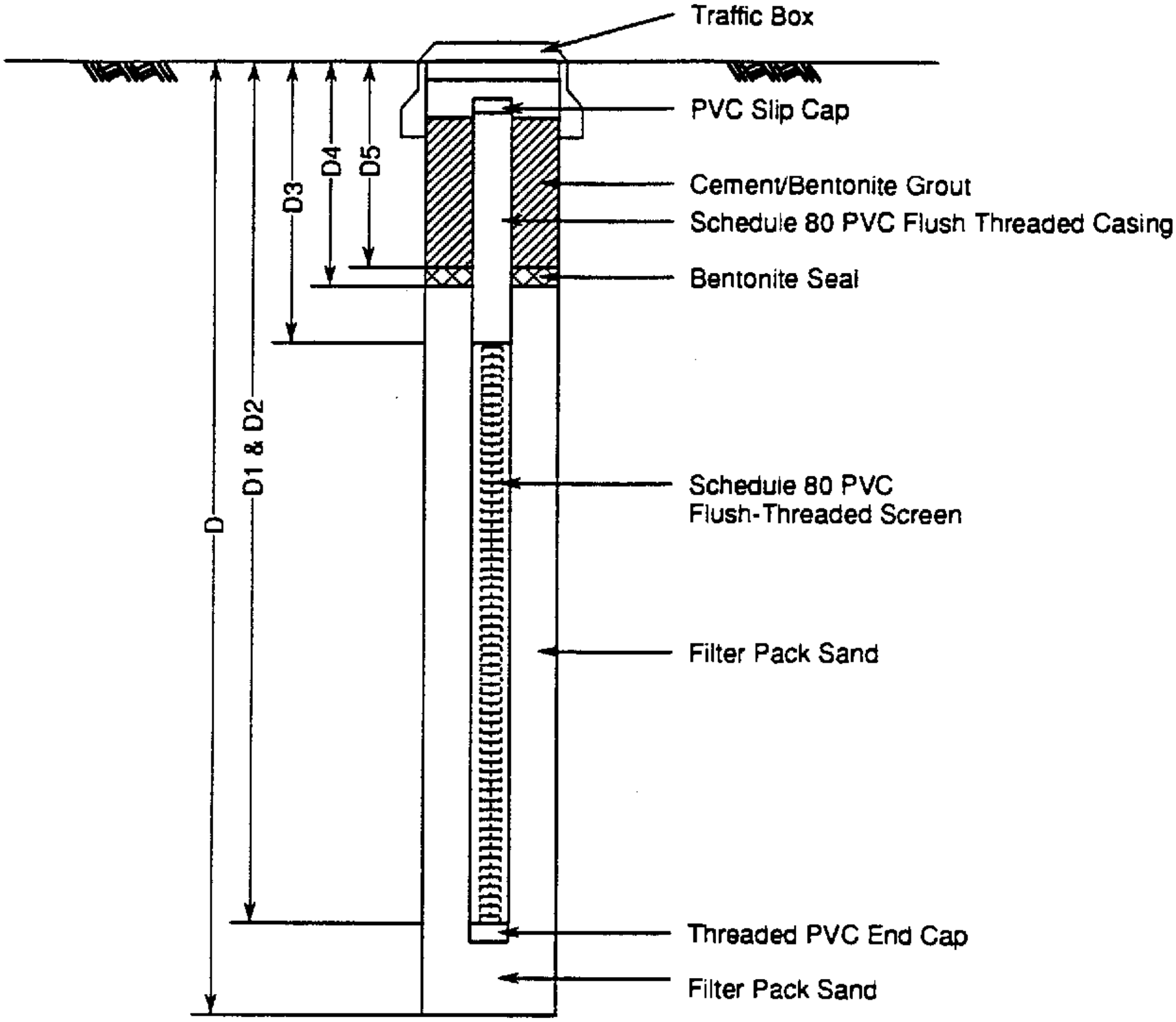
The Earth Technology Corporation

Project No. 92-2050
Geotechnical Investigation
Santa Monica Mountains
Segment 3, Metro Red Line

Well Number SM-1

1-93

Figure D-1



Total Depth (D)	= 180 Feet (Sloughed to 150 feet)
Total Depth of Casing (D1)	= 150 Feet
Depth to Bottom of Well Screen (D2)	= 150 Feet
Depth to Top of Well Screen (D3)	= 10 Feet
Depth to Bottom of Top Seal (D4)	= 9 Feet
Depth to Top of Top Seal (D5)	= 3 Feet
Well Casing Diameter	= 1 Inch
Well Screen Slot Size	= 0.01 Inch
Filter Pack Sand Type	= 2/12 Monterey
Bentonite Seal Type	= 1/4 Inch Pellets

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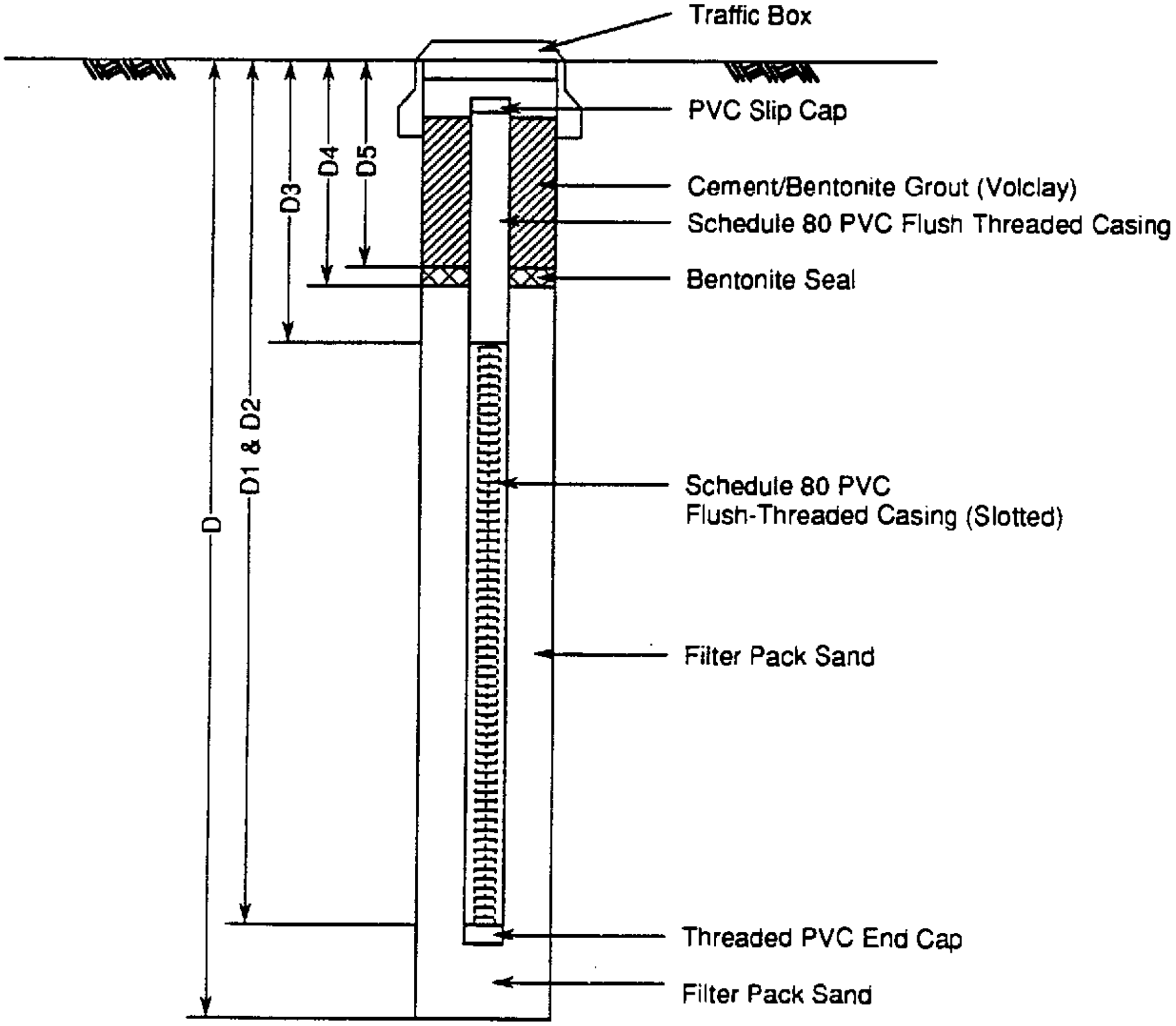
Geotechnical Investigation
Santa Monica Mountains
Segment 3, Metro Red Line

Well Number SM-1A

1-93

Figure D-2



Total Depth (D)	= 95 Feet (2' Slough)
Total Depth of Casing (D1)	= 92 Feet
Depth to Bottom of Well Screen (D2)	= 92 Feet
Depth to Top of Well Screen (D3)	= 32 Feet
Depth to Bottom of Top Seal (D4)	= 27 Feet
Depth to Top of Top Seal (D5)	= 16 Feet
Well Casing Diameter	= 2 Inch
Well Screen Slot Size	= 0.01 Inch
Filter Pack Sand Type	= 2/12 Monterey
Bentonite Seal Type	= 1/4 Inch Pellets and Chips

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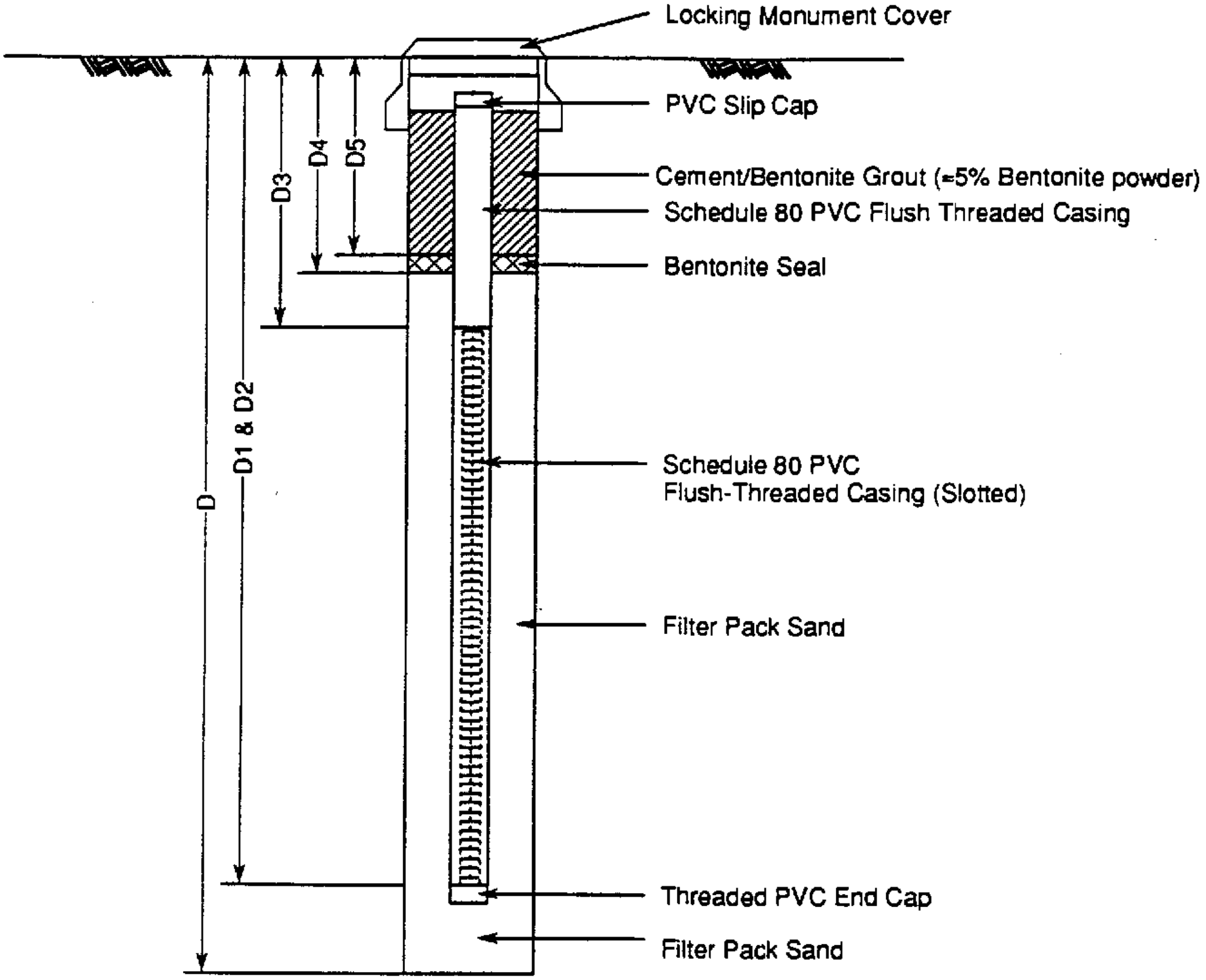
Project No. 92-2050
Geotechnical Investigation
Santa Monica Mountains
Segment 3, Metro Red Line

Well Number SM-3A

1-93

Figure D-3



Total Depth (D)	= 127 Feet
Total Depth of Casing (D1)	= 125 Feet
Depth to Bottom of Well Screen (D2)	= 125 Feet
Depth to Top of Well Screen (D3)	= 65 Feet
Depth to Bottom of Top Seal (D4)	= 60 Feet
Depth to Top of Top Seal (D5)	= 48.5 Feet
Well Casing Diameter	= 2 Inch
Well Screen Slot Size	= 0.01 Inch
Filter Pack Sand Type	= 2/12 Monterey
Bentonite Seal Type	= 1/4 Inch Pellets and Chips

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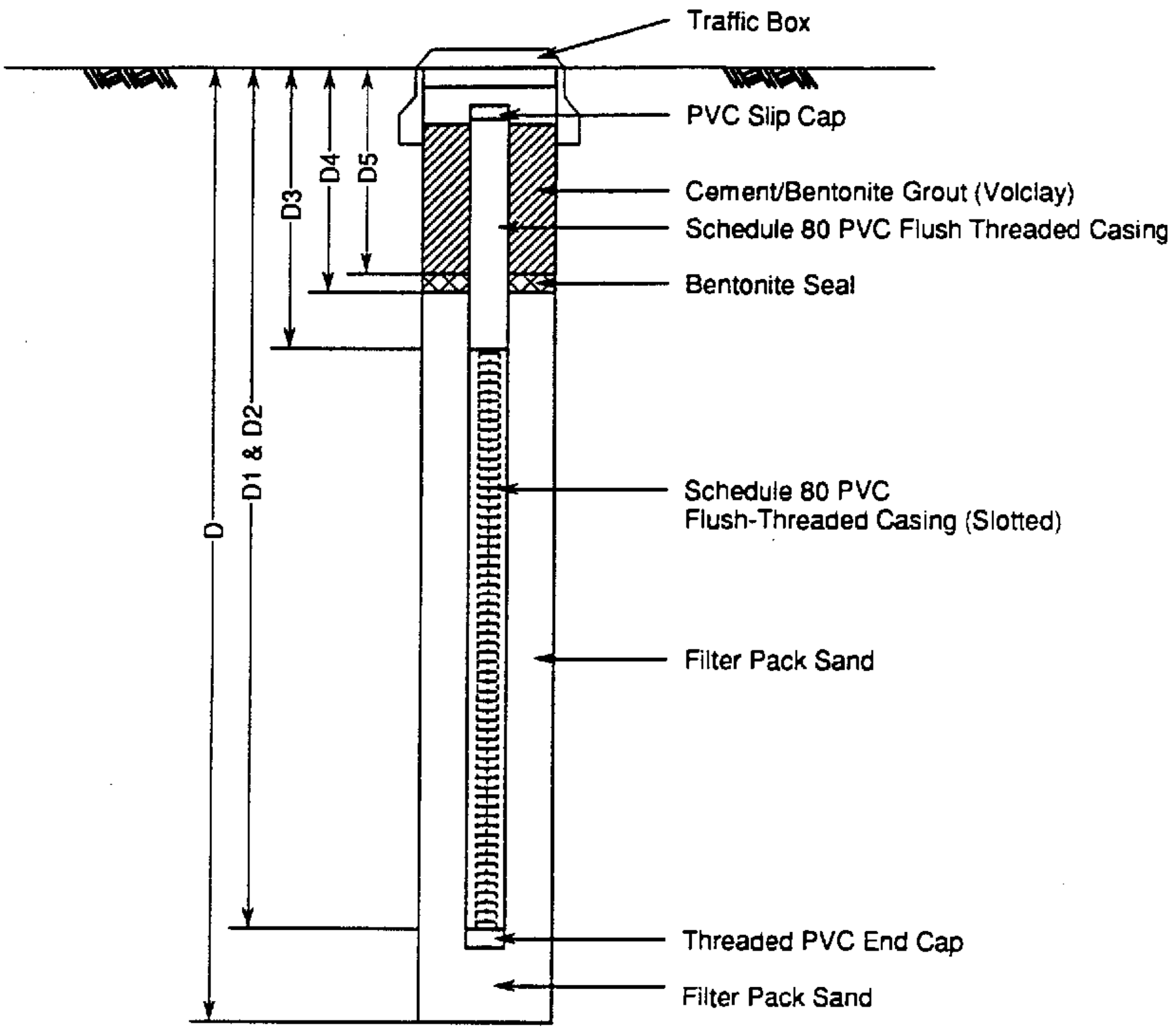
Project No. 92-2050
Geotechnical Investigation
Santa Monica Mountains
Segment 3, Metro Red Line

Well Number SM-6A

1-93

Figure D-4



Total Depth (D)	= 155.0 Feet (3.4' Slough)
Total Depth of Casing (D1)	= 150.6 Feet
Depth to Bottom of Well Screen (D2)	= 150.6 Feet
Depth to Top of Well Screen (D3)	= 90.6 Feet
Depth to Bottom of Top Seal (D4)	= 85.2 Feet
Depth to Top of Top Seal (D5)	= 73.6 Feet
Well Casing Diameter	= 2 Inch
Well Screen Slot Size	= 0.01 Inch
Filter Pack Sand Type	= 2/12 Monterey
Bentonite Seal Type	= 1/4 Inch Pellets and Chips

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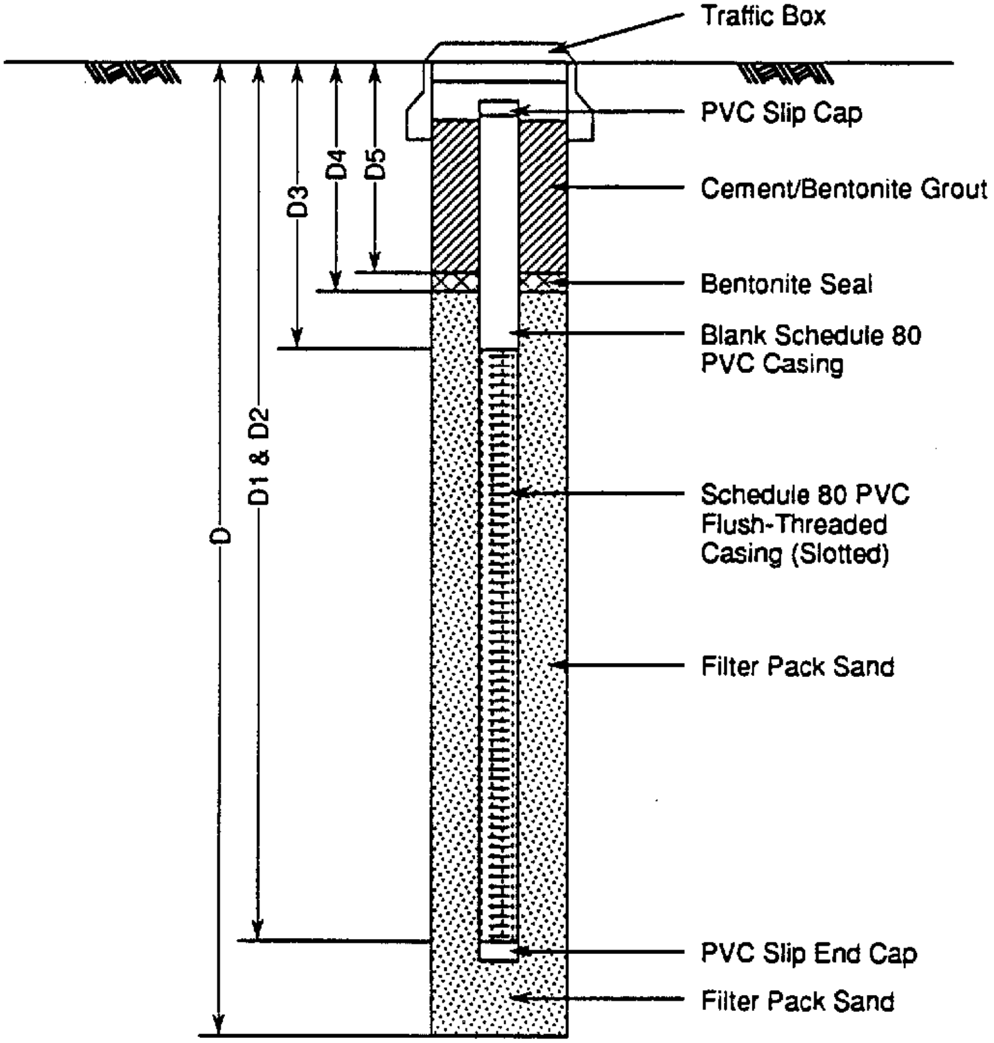
Project No. 92-2050
Geotechnical Investigation
Santa Monica Mountains
Segment 3, Metro Red Line

Well Number SM-9A

1-93

Figure D-5



Total Depth (D)	=	55.5	Feet
Total Depth of Casing (D1)	=	53.5	Feet
Depth to Bottom of Well Screen (D2)	=	53.5	Feet
Depth to Top of Well Screen (D3)	=	3.5	Feet
Depth to Bottom of Top Seal (D4)	=	3.0	Feet
Depth to Top of Top Seal (D5)	=	0.5	Feet
Well Casing Diameter	=	2	Inch
Well Screen Slot Size	=	0.02	Inch
Filter Pack Sand Type	=	2/12	Monterey
Bentonite Seal Type	=	Bentonite	Chips

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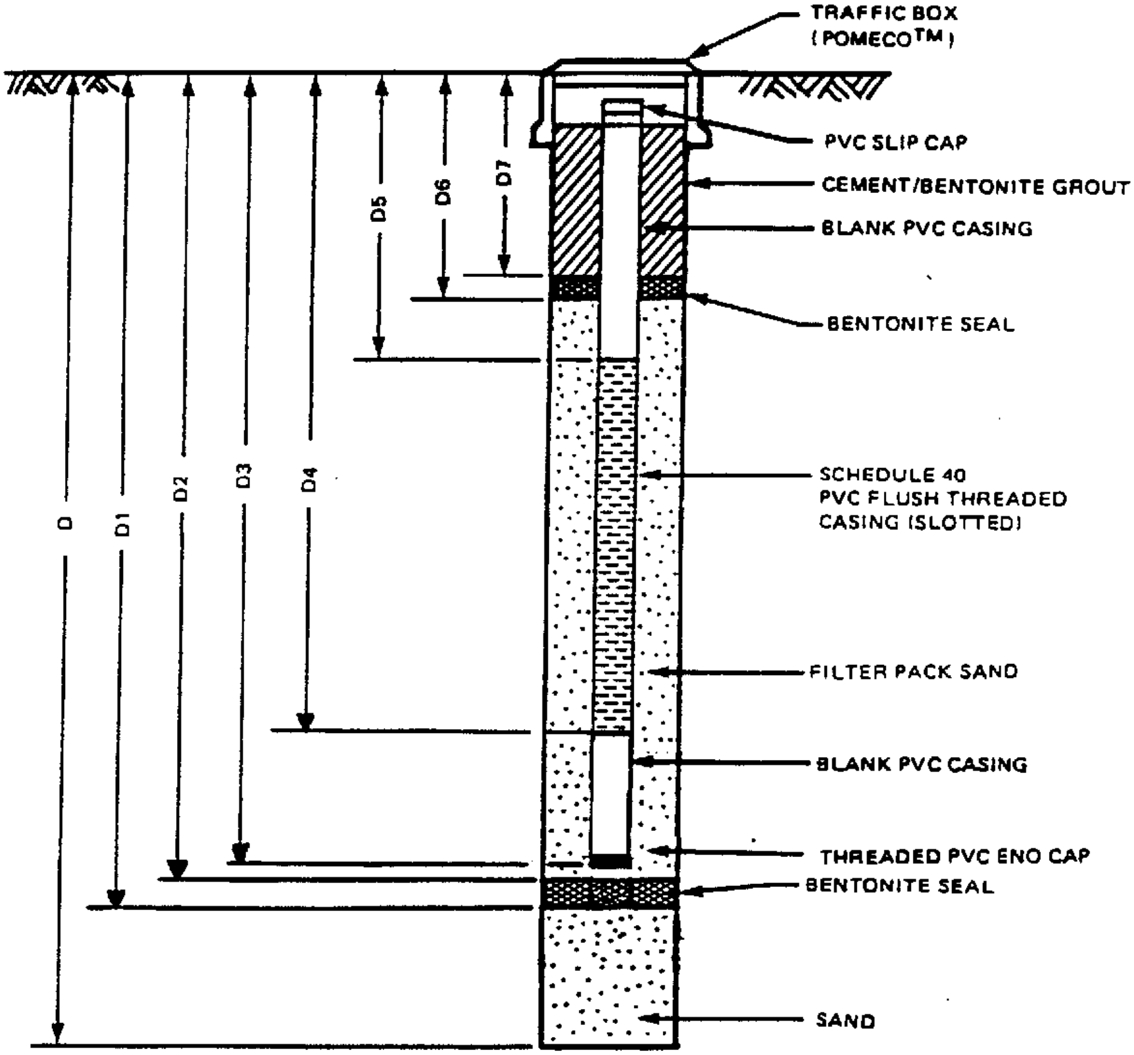
Project No. 92-2050
Geotechnical Investigation
Santa Monica Mountains
Segment 3, Metro Red Line

Well Number SM-14

6-93

Figure D-6



TOTAL DEPTH (D)	=	200.5	FEET
DEPTH TO BOTTOM OF BOTTOM SEAL (D1)	=	83.0	FEET
DEPTH TO TOP OF BOTTOM SEAL (D2)	=	80.0	FEET
TOTAL DEPTH OF CASING (D3)	=	80.0	FEET
DEPTH TO BOTTOM OF WELL SCREEN (D4)	=	50.0	FEET
DEPTH TO TOP OF WELL SCREEN (D5)	=	10.0	FEET
DEPTH TO BOTTOM OF TOP SEAL (D6)	=	8.0	FEET
DEPTH TO TOP OF TOP SEAL (D7)	=	3.0	FEET
WELL CASING DIAMETER	=	2	INCH
WELL SCREEN SLOT SIZE	=	0.02	INCH
FILTERPACK SAND TYPE	=	# 30	MONTEREY
BENTONITE SEAL TYPE	=		HOLE PLUG

The Earth Technology Corporation

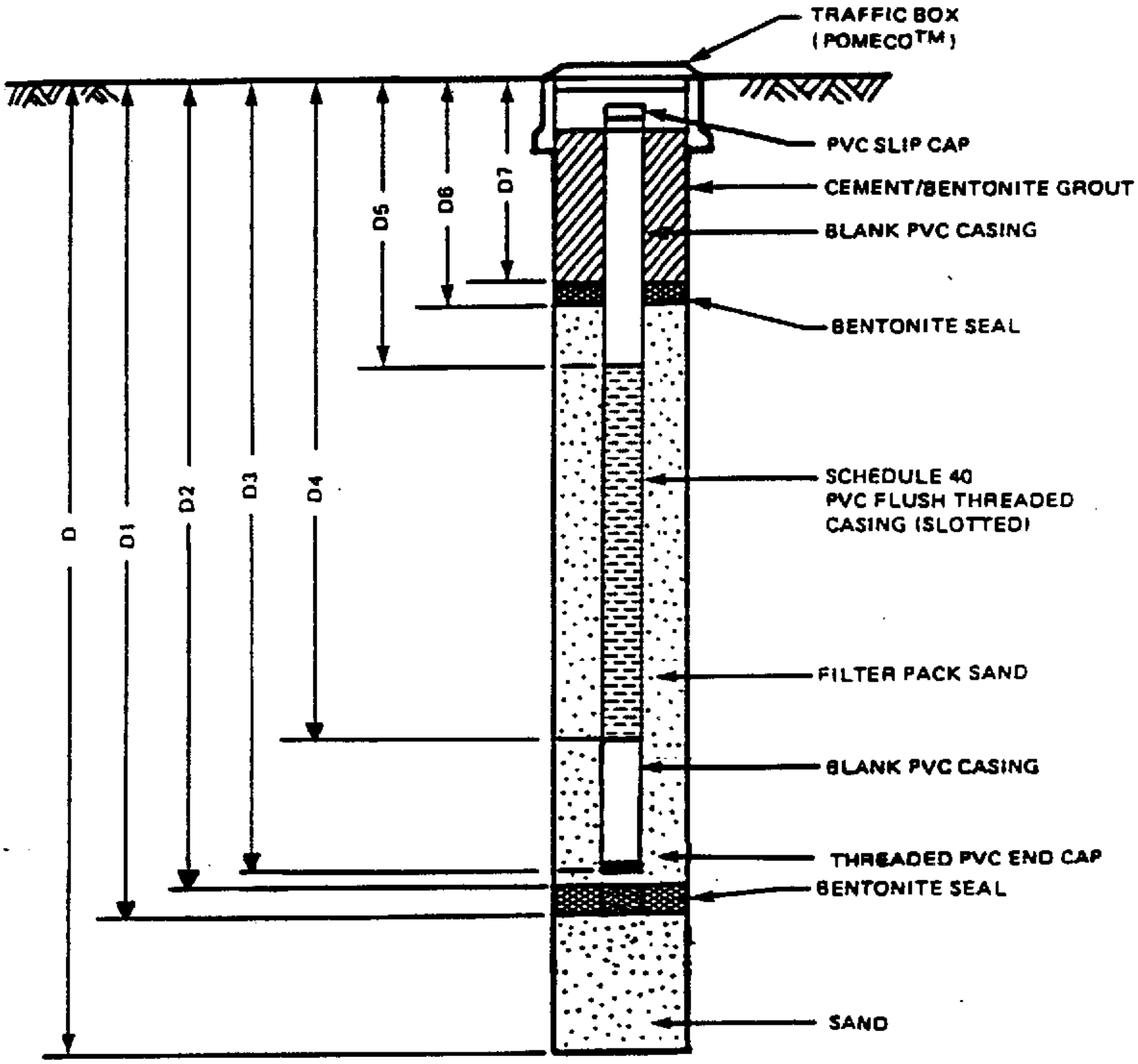
Project No. 89-409

Metro Rail

Well Number R-8

4-90

Figure D-7



TOTAL DEPTH (D)	=	139.2	FEET
DEPTH TO BOTTOM OF BOTTOM SEAL (D1)	=	73.0	FEET
DEPTH TO TOP OF BOTTOM SEAL (D2)	=	70.0	FEET
TOTAL DEPTH OF CASING (D3)	=	70.0	FEET
DEPTH TO BOTTOM OF WELL SCREEN (D4)	=	35.0	FEET
DEPTH TO TOP OF WELL SCREEN (D5)	=	5.0	FEET
DEPTH TO BOTTOM OF TOP SEAL (D6)	=	4.0	FEET
DEPTH TO TOP OF TOP SEAL (D7)	=	1.0	FEET
WELL CASING DIAMETER	=	2	INCH
WELL SCREEN SLOT SIZE	=	0.02	INCH
FILTERPACK SAND TYPE	=	# 30	MONTEREY
BENTONITE SEAL TYPE	=		HOLE PLUG

The Earth Technology Corporation

Project No. 89-409

Metro Rail

Well Number R-9

4-90

Figure D-8

NON-HAZARDOUS WASTE MANIFEST

Nº 93-002

NON-HAZARDOUS WASTE DATA FORM

TO BE COMPLETED BY GENERATOR

NAME LACTC / RCC

ADDRESS 818 W. 7TH STREET, 10TH FLOOR

EPA I.D. NO. CAD983615165

CITY, STATE, ZIP LOS ANGELES CA 90017

PHONE NO (213) 244-6233

CONTAINERS: No. 1 VOLUME 500 WEIGHT

TYPE ☒ TANK TRUCK ☐ DUMP TRUCK ☐ DRUMS ☐ CARTONS ☐ OTHER

WASTE DESCRIPTION Well Groundwater Water GENERATING PROCESS Monitoring Wells

COMPONENTS OF WASTE	PPM	%	COMPONENTS OF WASTE	PPM	%
1. Chloroform	25 ppb		5. Barium	≤ 0.051 ppm	
2. [illegible]	22 ppb		6. Beryllium	≤ 0.003 ppm	
3. [illegible]	≤ 0.06 ppm		7. Selenium	≤ 0.003 ppm	
4. Arsenic	≤ 0.011 ppm		8. OTHERS (Please see the attached Results)		

PROPERTIES: pH 6 ☐ SOLID ☒ LIQUID ☐ SLUDGE ☐ SLURRY ☐ OTHER

HANDLING INSTUCTIONS:

THE GENERATOR CERTIFIES THAT THE WASTE AS DESCRIBED IS 100% NON-HAZARDOUS.

[illegible] HAZEN [illegible] 1/19/93

TYPED OR PRINTED FULL NAME & SIGNATURE DATE

TRANSPORTER

NAME RIOS CHEMICAL DISPOSAL INC.

EPA I.D. NO. CAD 001 628 024

ADDRESS 11849 SUSAN AVE.

SERVICE ORDER NO.

CITY, STATE, ZIP DOWNEY, CA 90241

PICK UP DATE 1-27-93

PHONE NO. (213) 928-4979

TRUCK UNIT. I.D. NO. 2

Andrew R 1-27-93

TYPED OR PRINTED FULL NAME & SIGNATURE DATE

TSD FACILITY

NAME SOUTHWEST PROCESSORS, INC.

EPA I.D. NO.

DISPOSAL METHOD

ADDRESS 4120 BANDINI BOULEVARD ☐ LANDFILL ☐ OTHER

CITY, STATE, ZIP LOS ANGELES CA 90023

PHONE NO. (213) 269-9576

1-27-93

TYPED OR PRINTED FULL NAME & SIGNATURE DATE

GEN	OLD/NEW	L	A	TONS	
TRANS		S	B		
C/O		RT/CD		HWDF NONE	DISCREPANCY

BKK FORM #6062 (6/83)

WELL DEVELOPMENT/PURGE LOGS

The Earth Technology Corporation

Well Development/Purge Log

Page 1 of 1

Project Name Metro Rail

Location Ruyon Park

Project Number 92-2050-02

Well No. SM-3A

Date 11-17-92

Recorded By Bob B.

Time (24 hr.)	Flow Rate (gpm)	Water Temp. In C°	pH	Cond. µmhos/cm	Turbidity NTU	Settleable Solids (ml)	Gallons Dev./Purge Before Meas.	Water Level (feet)	Remarks (e.g. water clarity)
0725								42.46	
0810	.16	66 9	6.52	8.50	2007	26.0	6		silty
08 33		66.5	767	5.77		39	10		
09 33	.30	67.9	7.33	5.77		40	15		
09 40							17		silty
10 05									pumping began
10 17	1	69.7	7.26	5.49			20	43.0	silty
10 23		70.1	7.34	5 71			25	42.7	clear
10 47	1	69.4	7.25	5.73	15	0	35	43.48	
10 52		70 2	7.23	8.82	7		40	43.96	
10 54		70.6	7.29	5.53	5		45		
10 56	2 5	70.7	7.31	8 55	5		50		
10 58		70.7	7.33	5 56	5		55	43.57	

Notes: 1 ft length of 4" = 0.087 ft^3 or 0.65 gal

1 ft length of 2" = 0.022 ft^3 or 0.16 gal

1 casing volume = 779 gallons

5 casing volumes = 38.95 gallons

OVA = 1/1 ppm (sample/bkgrd)

Form F-1003A
9/1/91

The Earth Technology Corporation

Well Development/Purge Log

Page 1 of 1

Project Name Metro Rail
Location Runyan Park
Project Number 92-2050-02
Well No. SM 6A
Date 11-18-92
Recorded By Mark S / Jim V

Time (24 hr.)	Flow Rate (gpm)	Water Temp. °F In ~~C~~	pH	Cond. µmhos/cm	Turbidity NTU	Settleable Solids (ml)	Gallons Dev./Purge Before Meas.	Water Level (feet)	Remarks (e.g. water clarity)
09 25		64.2	6.2	14.4				76.42	
09 25		64.2	6 2	14.4			5		
10 25	.25	66.0	6.18	14.6			10		
11 05	1	67.0	6 66	13.5			20	79.05	
11 10	3	67.0	7.05	13.4			25		
11 13	2.5	66.8	7.10	13 5			35	79.50	
11 15	1+	66.4	7.32	13 3			40		clear
11 26	3	65.1	7.44	13.0		0.5	55	79.62	
11 35	2 5	65.7	7.20	13.0			85	114.0	
1145		65.9	7.37	12.71	>10		110	77.2	

Notes: 1 ft length of 4" = 0.087 ft^3 or 0.65 gal
1 ft length of 2" = 0.022 ft^3 or 0.16 gal

1 casing volume = 5.03 gallons
5 casing volumes = 40 15 gallons

OVA 1/1 ppm
(sample / bkgnd)

Form F-1003A
9/1/91

The Earth Technology Corporation

Well Development/Purge Log

Page 1 of 1

Project Name Metro Rail
Location Woodrow Wilson / Mulholland
Project Number 92-2050
Well No. SM-9A
Date 11-17-92 - 11-18 92
Recorded By Mark S / Bob B.

Time (24 hr.)	Flow Rate (gpm)	Water Temp. In C°	pH	Cond. µmhos/cm	Turbidity NTU	Settleable Solids (ml)	Gallons Dev./Purge Before Meas.	Water Level (feet)	Remarks (e.g. water clarity)
13.07								106.4	started bailing
13 31		74.3	8.44	17.83	200 7	32	3		gray / silty
13 35							4		began surging casing
13 50									stopped surging casing
13 56		72.6	9.74	17.66	200 7	35	6		start pumping
14 30		72.9	9.59	> 20 K	200 7	2	10		
14 38		72.5	9.60	> 20 K	200 >		15		
14 39									stop pumping
13 20		76.5	8.45	19.74	200 7		20	106.4	start pumping
13 35		72.4	8.55	19.07					stop pumping / dry
13 36									start pumping
14 10		70.6	9.32	18.88	2007		40		
14 15							45		stop pumping
14 42		71.0	9.37	12.25			45		start pumping
14 55		71.1	9.45	16.29	2007		50		
15 04									stop pumping

OVA = 1/1 ppm
(sample / bkgrd)

1 casing volume = 7.06 gallons
5 casing volumes = 35.3 gallons

Notes: 1 ft length of 4" = 0.087 ft^3 or 0.65 gal
1 ft length of 2" = 0.022 ft^3 or 0.16 gal

Form F-1003A
9/1/91

The Earth Technology Corporation

Well Development/Purge Log

Page 1 of 1

Project Name Metro Rail
Location Fredonia
Project Number 92-2050
Well No. R-8
Date 11/16/92
Recorded By Tom S/Bob B.

Time (24 hr.)	Flow Rate (gpm)	Water Temp. In ~~C~~ F°	pH	Cond. µmhos/cm	Turbidity NTU	Settleable Solids (ml)	Gallons Dev./Purge Before Meas.	Water Level (feet)	Remarks (e.g. water clarity)
0805	~0.2	63.9	5 11	2.48	200>		5		gray w/sand
0815					|	730	7		
0831		64.5	7.48	2.14	|		10		
0835					|	565			
0845		65 3	7 14	2.09	|		15		
1215	0.8	77.5	7.85	2.11	200>		20		gray/silty
1218		75.0	7.69	2.02	|		25		gray/silty
1223	1.0	74.1	7.68	2.14	|	250	30		
1228					|		35		pumping stopped/dry
1240					|				pump on
1253					|		38		pumping stopped/dry
1328		76.1	7.74	2.23	|	255	40		pump on/gray/silty
1358					|		42		pumping stopped/dry

OVA = 1/1 ppm
(sample/bkgrd)

Notes: 1 ft length of 4" = 0.087 ft^3 or 0.65 gal
1 ft length of 2" = 0.022 ft^3 or 0.16 gal

Form F-1003A
9/1/91

GROUNDWATER MONITORING WELL SAMPLE LOGS

Groundwater Monitoring Well Sample Log

Project Name: Metro Rail　　Project No.: 92-2050-02

Location: Runyon Park　　Date: 11/19/92

Logged By: JRV

Well Identification: SM-3A　　Casing Diameter: 2"　　Sch. 80　　PVC/S.S.

Total Well Depth: 91.52 Feet　　Reference Point: ______

Depth to Water: 42.84 Feet　　Product Detected: NONE

Water Column: 48.68 Feet x (0.16 gal/ft) = 7.79 gallons (1 Well Volume)

4"=0.65 gal/ft
2"=0.16 gal/ft

Purge Volume = 46.7 gallons (6 Well Volumes)

Time	Gallons	Temp. °F(~~°C~~)	pH	EC/µmhos	Water Quality Comments Turbidity-Odor-Color	NTU or Imhoff Cone
12^{00}	0					
12^{05}	10	80.1	7.13	8.56		>200
12^{23}	30	76.6	7.19	7.96		3
12^{25}	35	73.3	7.05	7.75		3
12^{30}	40	72.3	7.09	7.71		
12^{35}	45	72.0	7.21	7.74		.25
12^{40}	50	72.0	7.24	7.70		.25
12^{41}						

Total Gallons Extracted: 50 (6.4 Well Volumes)

Start Time: 12 NOON　　Finish Time: 12^{41}　　Water Level: 42.85' Feet

No. of Drums and Location: 1 drum @ storage area

Sample No.: SM-3A　　Sample Time and Date: 11/19/92 1^{30} - 2^{00}

Analyses Sampled for: ______

Comments: OVA readings 0/0 ppm
s/Readings

The Earth Technology Corporation

Page _____ of _____

Groundwater Monitoring Well Sample Log

Project Name: Metro Rail
Project No.: 92-2050
Location: Runyon Canyon
Date: 11-20-92
Logged By: JRU
Well Identification: SM-6A
Casing Diameter: 2"
Sch. 80 PVC/S.S.
Total Well Depth: 126.02 Feet
Reference Point:
Depth to Water: 76.42 Feet
Product Detected:
Water Column: 50.20 Feet x (0.16 gal/ft) = 8.03 gallons (1 Well Volume)
4"=0.65 gal/ft
2"=0.16 gal/ft

Purge Volume = 48.2 gallons (6 Well Volumes)

Time	Gallons	Temp. °F ~~(°C)~~	pH	EC/µmhos	Water Quality Comments Turbidity-Odor-Color	NTU or Imhoff Cone
10:10	0	63.9	7.65	13.54	cloudy	200 >
10:14	15	62.9	6.35	13.15		
10:16	20	64.0	6.65	13.39		60 >
10:18	25	65.2	6.77	13.45	clear	35 >
10:20	30	65.2	6.89	13.40		
10:22	35	65.4	6.90	13.49		21 >
10:23	40	65.0	6.90	13.50		
10:25	45	65.4	6.92	13.45		15 >
10:27	50	65.0	6.94	13.38		
10:30	52	64.9	6.97	13.37		9.5 >

Total Gallons Extracted: 52 (6.5 Well Volumes)
Start Time: 10:10
Finish Time: 10:30
Water Level: 76.42' Feet
No. of Drums and Location: 1 drum @ storage area.
Sample No.: SM6A
Sample Time and Date: 11⁰⁰ am to 12 noon
Analyses Sampled for:

Comments: OVA readings 0/0 ppm
sample/readings

The Earth Technology Corporation

Page 1 of 1

Groundwater Monitoring Well Sample Log

Project Name: Metro Rail
Project No.: 92-2050-02
Location: Hull - Woodrow
Date: 11-20-92
Logged By: JRV
Well Identification: SM-9A
Casing Diameter: 2"
Sch. 50 PVC/S.S.
Total Well Depth: 150.58 Feet
Reference Point:
Depth to Water: 106.40 Feet
Product Detected: NONE
Water Column: 44.11 Feet x (0.16 gal/ft) = 7.06 gallons (1 Well Volume)
4"=0.65 gal/ft
2"=0.16 gal/ft

Purge Volume = 42.3 gallons (6 Well Volumes)

Time	Gallons	Temp. F ~~(ºC)~~	pH	EC/µmhos	Water Quality Comments Turbidity-Odor-Color	NTU or Imhoff Cone
08:55	0	63.6	9.14	14.27	cloudy	200 >
09:00	5	65.1	9.17	16.09	↓	
09:05	10	67.6	9.31	16.29		
09:10	15	66.01	9.44	15.59		
09:21	20	66.6	9.74	13.19		
03:50		73.0*	9.75	16.11		
					purging stopped - well dry	

Total Gallons Extracted: 20 (~3 Well Volumes)
Start Time: 08:55 Finish Time: 09:21 Water Level: 106.40 Feet
No. of Drums and Location: one drum / at storage area
Sample No.: SM-9A Sample Time and Date: 12^{30} - 1^{30} on 11/20/92
Analyses Sampled for:

Comments: OVA readings 0/0 ppm
sample / reading

The Earth Technology
Corporation

Page ____ of ____

Groundwater Monitoring Well Sample Log

Project Name: Metro Rail
Project No.: 92-2050
Location: Fredonia + Skyhill Dr.
Date: 11-19-92 - 11-20-92
Logged By: JRJ
Well Identification: R-8
Casing Diameter: 2"
Sch. 80 PVC/S.S.
Total Well Depth: 80.04 Feet
Reference Point:
Depth to Water: 18.14 Feet
Product Detected:
Water Column: 61.86 Feet x (0.16 gal/ft) = 9.90 gallons (1 Well Volume)
4"=0.65 gal/ft
2"=0.16 gal/ft

Purge Volume = 59.4 gallons (6 Well Volumes)

Time	Gallons	Temp. °F ~~(°C)~~	pH	EC/µmhos	Water Quality Comments Turbidity-Odor-Color	NTU or Imhoff Cone
09:49	0	61.3	6.60	2.11	clear	>200
09:55	5	69.4	6.30	2.08	cloudy	
10:14	10	73.8	6.76	2.11		
10:35	17	74.6	7.30	2.18		
10:50	25	77.1	7.46	2.19	↓	
10:55	30				stop purging / well dry	↓
06:15					dtw @ 20.40' / start sampling	

Total Gallons Extracted: 30 (~3 Well Volumes)
Start Time: 11/19/92 9^{49}AM Finish Time: 11/20/92 8^{00}AM Water Level: 18.14 Feet
No. of Drums and Location: 1 drum @ storage area
Sample No.: R-8 Sample Time and Date: 11/20/92 7am to 8AM
Analyses Sampled for:

Comments: OVA reading: 0/0 ppm
sample / reading

CHAIN-OF-CUSTODY RECORDS

pace INCORPORATED
THE ASSURANCE OF QUALITY

110406

CHAIN-OF-CUSTODY RECORD
Analytical Request

Client Earth Technology Corp.
Address Irvine CA

Phone (714) 458-7414

Report To: Dr. Ram
Bill To: TETC
P.O. # / Billing Reference 92-2050-02
Project Name / No. Metro Rail

Pace Client No.
Pace Project Manager
Pace Project No.
*Requested Due Date:

Sampled By (PRINT): Tom Seckington
Tom Seckington 11/19/92
Sampler Signature Date Sampled

ITEM NO.	SAMPLE DESCRIPTION	TIME	MATRIX	PACE NO.	NO. OF CONTAINERS	PRESERVATIVES: UNPRESERVED	H_2SO_4	HNO_3	VOA	2N ACETATE	HCl	ANALYSES REQUEST: Set Solids	Sulfide	418.1	Aquatic Toxicity	Chrome VI	TTLC	Chloride	COD	REMARKS
1	SM3A - Amber liter	1330	H_2O		1	X						X								
2	SM3A - Amber liter	13 30	H_2O		1					X			X							
3	SM3A - Amber liter	13 25			1						X			X						
4	SM3A - 1 GALLON - PLASTIC	13 40			5	X									X					
5	SM3A - Amber liter	13 50			1	X										X				filtered
6	SM3A - liter plastic	13 53			1			X									X			filtered
7	SM3A - 500 ml plastic	13 55			1	X												X		
8	SM3A - 500ml plastic	13 45			1		X												X	

COOLER NOS.	BAILERS	SHIPMENT METHOD OUT / DATE	RETURNED / DATE

Additional Comments

ITEM NUMBER	RELINQUISHED BY / AFFILIATION	ACCEPTED BY / AFFILIATION	DATE	TIME
	Tom Seckington / TETC	J. Drome / Pace	11-19	17:00

SEE REVERSE SIDE FOR INSTRUCTIONS

pace INCORPORATED
THE ASSURANCE OF QUALITY

110401

CHAIN-OF-CUSTODY RECORD
Analytical Request

Client: Earth Technology Corp.
Address: Irvine, CA
Phone: (714) 455-7414

Report To: Dr. Ram
Bill To: TETC
P.O. # / Billing Reference: 92-2050-02
Project Name / No.: Metro Rail

Pace Client No.:
Pace Project Manager:
Pace Project No.:
*Requested Due Date:

Sampled By (PRINT): Tom Sackington
Sampler Signature: Tom Sackington
Date Sampled: 11/19/92

ITEM NO.	SAMPLE DESCRIPTION	TIME	MATRIX	PACE NO.	NO. OF CONTAINERS	UNPRESERVED	H_2SO_4	HNO_3	VOA	HCL		8015-GAS	624	8015-Diesel	625	B.O.D	OIL & GREASE	TSS/TDS/SULFATE	TURBIDITY/E Cond/pH	REMARKS
1	SM3A -VOA	13^{15}	H_2O		2	X				X		X								
2	SM3A -VOA	13^{15}	H_2O		2	X				X			X							
3	SM3A - AMBER LITER	13:20	H_2O		1	X								X						
4	SM3A - 2 AMBER LITERS	13:20	H_2O		2	X									X					
5	SM3A - AMBER LITER	13^{25}			1	X										X				
6	SM3A - AMBER LITER	13^{30}			1	X											X			
7	SM3A - AMBER LITER	13^{25}			1	X												X		
8	SM3A - AMBER LITER	13^{25}			1	X													X	

PRESERVATIVES / ANALYSES REQUEST

COOLER NOS.	BAILERS	SHIPMENT METHOD OUT / DATE	SHIPMENT METHOD RETURNED / DATE

ITEM NUMBER	RELINQUISHED BY / AFFILIATION	ACCEPTED BY / AFFILIATION	DATE	TIME
	Tom Sackington / TETC	/ Pace	11/19	17:00

Additional Comments

SEE REVERSE SIDE FOR INSTRUCTIONS

2

pace INCORPORATED
THE ASSURANCE OF QUALITY

11)5 .

CHAIN-OF-CUSTODY RECORD
Analytical Request

Client: Earth Technology
Address: Irvine, CA
Phone: (714)455-7414

Report To: Dr. Ram
Bill To: TETC
P.O. # / Billing Reference: 92-2050-02
Project Name / No.: Metro Rail

Pace Client No.:
Pace Project Manager:
Pace Project No.:
*Requested Due Date:

Sampled By (PRINT): Tom Sackington
Sampler Signature: Tom Sackington
Date Sampled: 11/19/9—

ITEM NO.	SAMPLE DESCRIPTION	TIME	MATRIX	PACE NO.	NO. OF CONTAINERS	UNPRESERVED	H_2SO_4	HNO_3	VOA			ANALYSES REQUEST: Nitrate/Nitrite	REMARKS
1	5M3A - 500ml plast. c	13^{37}	H_2O		1		X					X	
2													
3													
4													
5													
6													
7													
8													

COOLER NOS.	BAILERS	SHIPMENT METHOD OUT / DATE	SHIPMENT METHOD RETURNED / DATE

Additional Comments

ITEM NUMBER	RELINQUISHED BY / AFFILIATION	ACCEPTED BY / AFFILIATION	DATE	TIME
	Tom Sackington / TETC	/ Pace	11-19	12:00

SEE REVERSE SIDE FOR INSTRUCTIONS

pace INCORPORATED
THE ASSURANCE OF QUALITY

110301

CHAIN-OF-CUSTODY RECORD
Analytical Request

Client: Earth Technology
Address: 13900 Alton Pkwy, Suite 120
Irvine, CA 92718
Phone: (714) 455-7414

Report To: Earth Technology / D. Ram
Bill To: 92-2050-02 / TETC
P.O. # / Billing Reference: 92-2050-02
Project Name / No.: Metro Rail

Pace Client No.:
Pace Project Manager:
Pace Project No.:
*Requested Due Date:

Sampled By (PRINT): Thomas M. Seckington
Sampler Signature: Th. M.
Date Sampled: 11/20/92

ITEM NO.	SAMPLE DESCRIPTION	TIME	MATRIX	PACE NO.	NO. OF CONTAINERS	UNPRESERVED	H_2SO_4	HNO_3	VOA	HCl	H_2SO_4	VOC/624	Semi VOC/625	TPH/418.1	Oil/413.1/413.2	8015/GAS	8015/Diesel	Title 22 Metal	Chromium VI	REMARKS
1	SM-6A / VOA	11^{03}	H_2O		2					X		X								2 VOA VIALS
2	SM-6A / Amber liter	11^{45}			2	X							X							2 amber liter
3	SM-6A / Amber liter	11^{07}			1					X				X						1 amber liter
4	SM-6A / Amber liter	11^{17}			1						X				X					1 amber liter
5	SM-6A / VOA	11^{03}			2					X						X				2 VOA VIAL
6	SM-6A / Amber liter	11^{10}			1	X											X			1 amber liter
7	SM-6A / Plastic liter	11^{55}			1			X										X		1 plastic liter/filtered
8	SM-6A / Amber liter	11^{50}			1	X													X	1 amber ~~plastic~~ liter/filtered

COOLER NOS.	BAILERS	SHIPMENT METHOD OUT / DATE	SHIPMENT METHOD RETURNED / DATE

ITEM NUMBER	RELINQUISHED BY / AFFILIATION	ACCEPTED BY / AFFILIATION	DATE	TIME
	Thomas M. Seckington / TETC	S. Thomas / Pace	11-20	6:20

Additional Comments

SEE REVERSE SIDE FOR INSTRUCTIONS

2

pace INCORPORATED
THE ASSURANCE OF QUALITY

11[illegible]02

CHAIN-OF-CUSTODY RECORD
Analytical Request

Client: Earth Technology
Address: 13900 Alton Pkwy, Suite 120
Irvine, CA 92718
Phone: (714) 458-7414

Report To: Earth Technology/De Ram
Bill To: Earth Technology
P.O. # / Billing Reference: 92-2050-02
Project Name / No.: Metro Rail

Pace Client No.:
Pace Project Manager:
Pace Project No.:
*Requested Due Date:

Sampled By (PRINT): Thomas M. Seckington
Sampler Signature: Thomas M. Seckington
Date Sampled: 11/20/92

ITEM NO.	SAMPLE DESCRIPTION	TIME	MATRIX	PACE NO.	NO. OF CONTAINERS	PRESERVATIVES: UNPRESERVED	H_2SO_4	HNO_3	VOA			ANALYSES REQUEST: Aquatic tox	B.O.D./405.1	C.O.D./H.K.	TSS/160.2	TDS/160.1	Sulfate/375.3	Set. Solid/160.5			REMARKS
1	SM-6A / Plastic gallon	11^{50}	H_2O		5	X						X									5 plastic gallon
2	SM-6A / Amber liter	11^{12}			1	X							X								1 amber liter
3	SM-6A / Plastic 500ml	11^{12}			1		X							X							1 500ml plastic
4	SM-6A / Amber liter	11^{07}			1	X									X	X	X				1 amber liter
5	SM-6A / Amber liter	11^{20}			1	X												X			1 amber liter
6																					
7																					
8																					

COOLER NOS.	BAILERS	SHIPMENT METHOD OUT / DATE	SHIPMENT METHOD RETURNED / DATE

ITEM NUMBER	RELINQUISHED BY / AFFILIATION	ACCEPTED BY / AFFILIATION	DATE	TIME
	Thomas M. Seckington/TETC	/Pace	11-20	16:00

Additional Comments

SEE REVERSE SIDE FOR INSTRUCTIONS

pace INCORPORATED
THE ASSURANCE OF QUALITY

117303

CHAIN-OF-CUSTODY RECORD
Analytical Request

Client: Earth Technology
Address: 13900 Alton Parkway, Suite 120
Irvine, CA 92718
Phone: (714) 458-7414

Report To: Earth Technology / D. Rum
Bill To: Earth Technology
P.O. # / Billing Reference: 92-2050-02
Project Name / No.: Metro Rail

Pace Client No.:
Pace Project Manager:
Pace Project No.:
*Requested Due Date:

Sampled By (PRINT): Thomas M. Schiff
Sampler Signature: Thomas M. Schiff
Date Sampled: 11/20/92

ITEM NO.	SAMPLE DESCRIPTION	TIME	MATRIX	PACE NO.	NO. OF CONTAINERS	PRESERVATIVES					ANALYSES REQUEST									REMARKS
						UNPRESERVED	H_2SO_4	HNO_3	VOA	ZN Acetate	Turbidity/180.1	S. Cond/120.1	pH/150.1	chloride	sulfide	nitrate/300	nitrite/300			
1	SM-6A / Amber liter	11^{15}	H_2O		1	X					X	X	X							1 amber liter
2	SM-6A / Plastic 500ml	11^{10}			1	X								X						1 plastic 500 ml
3	SM-6A / Amber liter	11^{23}			1					X					X					1 amber liter
4	SM-6A / Plastic 500ml	11^{12}			1	X										X	X			1 plastic 500ml
5																				
6																				
7																				
8																				

COOLER NOS.	BAILERS	SHIPMENT METHOD OUT / DATE	RETURNED / DATE	ITEM NUMBER	RELINQUISHED BY / AFFILIATION	ACCEPTED BY / AFFILIATION	DATE	TIME
					Thomas M. Schiff 11/20/92	D. Romo / Pace	11-20	1600

Additional Comments

2

SEE REVERSE SIDE FOR INSTRUCTIONS

PACE INCORPORATED
THE ASSURANCE OF QUALITY

11[illegible]304

CHAIN-OF-CUSTODY RECORD
Analytical Request

Client: Earth Technology
Address: 13900 Alton Pkwy, Suite 120
Irvine, CA 92718
Phone: (714) 455-7414

Report To: Earth Technology / Dr Ram
Bill To: 92-2050-02 / TETC
P.O. # / Billing Reference: 92-2050-02
Project Name / No.: Metro Rail

Pace Client No.:
Pace Project Manager:
Pace Project No.:
*Requested Due Date:

Sampled By (PRINT): Thomas M. Seckington
Sampler Signature: Thomas M. Seckington
Date Sampled: 11/20/92

ITEM NO.	SAMPLE DESCRIPTION	TIME	MATRIX	PACE NO.	NO. OF CONTAINERS	UNPRESERVED	H_2SO_4	HNO_3	VOA	HCL	H_2SO_4	VOC/624	Semi-VOC/625	TPH/418.1	O&G/413.1 & 413.2	6015/6AS	6015/Diesel	Title 22 Metal	Chromium VI	REMARKS
1	SM-9A / VOA	12^{30}	H_2O		2					X		X								2 VOA VIALS
2	SM-9A / Amber liter	12^{50}			1	X							X							1 amber liter
3	SM-9A / Amber liter	12^{40}			1					X				X						1 amber liter
4	SM-9A / Amber liter	12^{45}			1						X				X					1 amber liter
5	SM-9A / VOA	12^{30}			2					X						X				2 VOA vials
6	SM-9A / Amber liter	12^{40}			1	X											X			1 amber liter
7	SM-9A / Plastic liter	1^{50}			1			X										X		1 plastic liter/filtered
8	SM-9A / Amber liter	1^{53}			1	X													X	1 amber ~~plastic~~ liter/filtered

COOLER NOS.	BAILERS	SHIPMENT METHOD OUT / DATE	SHIPMENT METHOD RETURNED / DATE

ITEM NUMBER	RELINQUISHED BY / AFFILIATION	ACCEPTED BY / AFFILIATION	DATE	TIME
	Thomas M. Seckington / TETC	[illegible] / Pace	11-20	1600

Additional Comments

2

SEE REVERSE SIDE FOR INSTRUCTIONS

pace INCORPORATED
THE ASSURANCE OF QUALITY

11 1306

CHAIN-OF-CUSTODY RECORD
Analytical Request

Client: Earth Technology
Address: 13900 Alton Parkway, Suite 120
Irvine, CA. 92718
Phone: (714) 458-7414

Report To: Earth Technology / De Rum
Bill To: Earth Technology
P.O. # / Billing Reference: 92-2050-02
Project Name / No.: Metro Rail

Pace Client No.:
Pace Project Manager:
Pace Project No.:
*Requested Due Date:

Sampled By (PRINT): Thomas M. Seckington
Sampler Signature: Thomas M. Seckington
Date Sampled: 11/20/92

ITEM NO.	SAMPLE DESCRIPTION	TIME	MATRIX	PACE NO.	NO. OF CONTAINERS	PRESERVATIVES: UNPRESERVED	H_2SO_4	HNO_3	VOA	Zn Acetate		ANALYSES REQUEST: Turbidity/180.1	Sp Cond/120.1	pH/150.1	chloride	sulfide	nitrate/300	nitrite/300			REMARKS
1.	SM-9A / Amber liter	12^{40}	H_2O		1	X						X	X	X							1 amber liter
2	SM-9A / Plastic 500ml	13^{00}			1	X				X					X						1 plastic 500ml
3	SM-9A / Amber liter	12^{45}			1					X						X					1 amber liter
4	SM-9A / Plastic 500ml	13^{00}			1	X											X	X			1 plastic 500ml
5																					
6																					
7																					
8																					

COOLER NOS.	BAILERS	SHIPMENT METHOD OUT / DATE	RETURNED / DATE

Additional Comments

ITEM NUMBER	RELINQUISHED BY / AFFILIATION	ACCEPTED BY / AFFILIATION	DATE	TIME
	Thomas M. Seckington / TETC	S. Thomas / Pace	11-20	16:00

SEE REVERSE SIDE FOR INSTRUCTIONS

2

PACE INCORPORATED
THE ASSURANCE OF QUALITY

11 05

CHAIN-OF-CUSTODY RECORD
Analytical Request

Client: Earth Technology
Address: 13900 Alton Pkwy, Suite 120
Irvine, CA 92718
Phone: (714) 458-7414

Report To: Earth Technology / Dr. Ram
Bill To: Earth Technology
P.O. # / Billing Reference: 92-2050-02
Project Name / No.: Metro Rail

Pace Client No.:
Pace Project Manager:
Pace Project No.:
*Requested Due Date:

Sampled By (PRINT): Thomas M. Seckington
Sampler Signature: Thomas M. Seckington
Date Sampled: 11/20/92

ITEM NO.	SAMPLE DESCRIPTION	TIME	MATRIX	PACE NO.	NO. OF CONTAINERS	PRESERVATIVES UNPRESERVED	H_2SO_4	HNO_3	VOA			ANALYSES REQUEST Aquatic Tox	BOD/405.1	COD/H.K	TSS/160.2	TDS/160.1	Sulfate/375.3	Set. Solids/160.5			REMARKS
1	SM-9A / Plastic gallon	1^{30}	H_2O		5	X						X									5 plastic gallon
2	SM-9A / Amber liter	12^{55}			1	X							X								1 amber liter
3	SM-9A / Plastic 500ml	13^{00}			1		X							X							1 500ml plastic
4	SM-9A / Amber liter	12^{45}			1	X									X	X	X				1 amber liter
5	SM-9A / Amber liter	12^{55}			1	X												X			1 amber liter
6																					
7																					
8																					

COOLER NOS.	BAILERS	SHIPMENT METHOD OUT / DATE	RETURNED / DATE

ITEM NUMBER	RELINQUISHED BY / AFFILIATION	ACCEPTED BY / AFFILIATION	DATE	TIME
	Thomas M. Seckington / TETC	Thom / Pace	11-20	6:00

Additional Comments

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pace INCORPORATED
THE ASSURANCE OF QUALITY

110402

CHAIN-OF-CUSTODY RECORD
Analytical Request

Client: Earth Technology
Address: 13900 Alton Pkwy, Suite 120
Irvine, CA 92718
Phone: (714) 458-7414

Report To: Earth Technology /Dr. Ram
Bill To: 92-2050-02 /TETC
P.O. # / Billing Reference: 92-2050-02
Project Name / No.: Metro Rail

Pace Client No.
Pace Project Manager
Pace Project No.
*Requested Due Date:

Sampled By (PRINT): Thomas M. Seckington
Sampler Signature
Date Sampled: 11/20/92

ITEM NO.	SAMPLE DESCRIPTION	TIME	MATRIX	PACE NO.	NO. OF CONTAINERS	UNPRESERVED	H_2SO_4	HNO_3	VOA	HCL	H_2SO_4	VOC/624	Semi VOC/625	TPH/418.1	O&G/413.1 & 413.2	8015/GAS	8015/Diesel	Title 22 Metals	Chromium VI		REMARKS
1	R-8 / VOA	7^{10}	H_2O		2					X		X									2 VOA VIALS
2	R-8 /Amber liter	7^{15}			2	X							X								2 amber liters
3	R-8 /Amber liter	7^{25}			1					X				X							1 amber liter
4	R-8 /Amber liter	7^{25}			1						X				X						1 amber liter
5	R-8 /VOA	7^{10}			2					X						X					2 VOA VIALS
6	R-8 / Amber liter	7^{15}			1	X											X				1 amber liter
7	R-8 / Plastic liter	7^{35}			1			X										X			1 plastic liter/filter
8	R-8 / Amber liter	7^{30}			1	X													X		1 amber liter/filter

COOLER NOS.	BAILERS	SHIPMENT METHOD OUT / DATE	SHIPMENT METHOD RETURNED / DATE

ITEM NUMBER	RELINQUISHED BY / AFFILIATION	ACCEPTED BY / AFFILIATION	DATE	TIME
	/TETC	/Pace	11-20	16:00

Additional Comments

SEE REVERSE SIDE FOR INSTRUCTIONS

pace INCORPORATED
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11 13

CHAIN-OF-CUSTODY RECORD
Analytical Request

Client: Earth Technology
Address: 13900 Alton Pkwy, Suite 120
Irvine, CA 92718
Phone: (714) 458-7414

Report To: Earth Technology / Dr Ram
Bill To: Earth Technology
P.O. # / Billing Reference: 92-2050-02
Project Name / No.: Metro Rail

Pace Client No.
Pace Project Manager
Pace Project No.
*Requested Due Date:

Sampled By (PRINT): Thomas M. Seckington
Sampler Signature: Thomas M. Seckington
Date Sampled: 11/20/92

ITEM NO.	SAMPLE DESCRIPTION	TIME	MATRIX	PACE NO.	NO. OF CONTAINERS	PRESERVATIVES: UNPRESERVED	H_2SO_4	HNO_3	VOA			ANALYSES REQUEST: Aquatic Toxicity	B.O.D/405.1	C.O.D/Hach Kit	TSS/160.2	TDS/160.1	Sulfate/375.3	Set Solids/160.5			REMARKS
1	R-8 / Plastic gallon	7^{50}	H_2O		5	X						X									5 plastic gallon
2	R-8 / Amber liter	7^{22}			1	X							X								1 amber liter
3	R-8 / Plastic 500ml	7^{20}			1		X							X							1 500 ml/plastic
4	R-8 / Amber liter	7^{10}			1	X									X	X	X				1 amber liter
5	R-8 / Amber liter	7^{10}			1	X												X			1 amber liter
6																					
7																					
8																					

COOLER NOS.	BAILERS	SHIPMENT METHOD OUT / DATE	RETURNED / DATE

ITEM NUMBER	RELINQUISHED BY / AFFILIATION	ACCEPTED BY / AFFILIATION	DATE	TIME
	Thomas M. Seckington/ETC	[illegible]/Pace	11-20	16:00

Additional Comments

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pace INCORPORATED
THE ASSURANCE OF QUALITY

11 404

CHAIN-OF-CUSTODY RECORD
Analytical Request

Client: Earth Technology
Address: 13900 Alton Parkway, Suite 120
Irvine, CA 92718
Phone: (714) 458-7414

Report To: Earth Technology / Dr Ram
Bill To: Earth Technology
P.O. # / Billing Reference: 92-2050-02
Project Name / No.: Metro Rail

Pace Client No.:
Pace Project Manager:
Pace Project No.:
*Requested Due Date:

Sampled By (PRINT): Thomas M. Seckington
Sampler Signature: Tho. M. Seck
Date Sampled: 11/20/92

ITEM NO.	SAMPLE DESCRIPTION	TIME	MATRIX	PACE NO.	NO. OF CONTAINERS	PRESERVATIVES: UNPRESERVED	H_2SO_4	HNO_3	VOA	ZN Acetate	ANALYSES REQUEST: Turbidity/180.1	Sp. Cond/120.1	pH/150.1	chloride	sulfide	nitrate/300	nitrite/300			REMARKS
1	R-8 / Amber liter	7^{00}	H_2O		1	X					X	X	X							1 amber liter
2	R-8 / Plastic 500ml	7^{45}	|		1	X								X						1 plastic 500ml
3	R-8 / Amber liter	7^{10}	|		1					X					X					1 amber liter
4	R-8 / Plastic 500ml	7^{20}	|		1		X									X	X			1 plastic 500ml
5			|																	
6			|																	
7			|																	
8			|																	

COOLER NOS.	BAILERS	SHIPMENT METHOD OUT / DATE	RETURNED / DATE

ITEM NUMBER	RELINQUISHED BY / AFFILIATION	ACCEPTED BY / AFFILIATION	DATE	TIME
	Thom. M. Seckingt / TETC	/ Pace	11/20	6:00

Additional Comments

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11 07

CHAIN-OF-CUSTODY RECORD
Analytical Request

Client: Earth Technology

Address: 13900 Alton Pkwy, Suite 120
Irvine, CA 92718

Phone: (714) 458-7014

Report To: Earth Technology / Dr. Ram

Bill To: Earth Technology

P.O. # / Billing Reference: 92-2050-02

Project Name / No.: Metro Rail

Pace Client No.

Pace Project Manager

Pace Project No.

*Requested Due Date:

Sampled By (PRINT): Thomas M. Seckington

Sampler Signature: Thomas M.

Date Sampled: 11/20/92

ITEM NO.	SAMPLE DESCRIPTION	TIME	MATRIX	PACE NO.	NO. OF CONTAINERS	PRESERVATIVES						ANALYSES REQUEST								REMARKS
						UNPRESERVED	H_2SO_4	HNO_3	VOA	HCl	H_2SO_4	VOC/624	Semi-VOC/625	TPH/418.1	O&G/413.1	8015/Gas	8015/Diesel	Title 22 Metals	Chromium VI	
1	EB / VOA	10^{45}	H_2O		2					X		X								2 VOA Vials
2	EB / Amber liter	10^{45}			1	X							X							1 amber liter
3	EB / Amber liter	10^{45}			1					X				X						1 amber liter
4	EB / Amber liter	10^{45}			1						X				X					1 amber liter
5	EB / VOA	10^{40}			2					X						X				2 VOA vials
6	EB / Amber liter	10^{45}			1	X											X			1 amber liter
7	EB / Plastic liter	10^{30}			1		X											X		1 plastic liter/filtered
8	EB / Amber liter	10^{45}			1	X													X	1 amber ~~plastic~~ liter/filtered

COOLER NOS.	BAILERS	SHIPMENT METHOD OUT / DATE	SHIPMENT METHOD RETURNED / DATE

ITEM NUMBER	RELINQUISHED BY / AFFILIATION	ACCEPTED BY / AFFILIATION	DATE	TIME
	Thomas M. / TETC	J. Deason / Pace	11-20	16:00

Additional Comments

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pace
INCORPORATED
THE ASSURANCE OF QUALITY

110413

CHAIN-OF-CUSTODY RECORD
Analytical Request

Client: Earth Technology
Address: 13900 Alton Parkway, Suite 120
Irvine CA 92718
Phone: (714) 458-7414

Report To: Earth Technology / Dr Ram
Bill To: Earth Technology
P.O. # / Billing Reference: 92-2050-02
Project Name / No.: Metro Rail

Pace Client No.:
Pace Project Manager:
Pace Project No.:
*Requested Due Date:

Sampled By (PRINT): Thomas M. Sackington
Sampler Signature: Thomas M. Sackington
Date Sampled: 11/20/92

ITEM NO.	SAMPLE DESCRIPTION	TIME	MATRIX	PACE NO.	NO. OF CONTAINERS	PRESERVATIVES					ANALYSES REQUEST									REMARKS
						UNPRESERVED	H_2SO_4	HNO_3	VOA	ZN ACETATE	Turbidity / 180.1	Sp. Cond / 120.1	pH / 150.1	chloride	sulfide	nitrate / 300	nitrite / 300			
1	EB / Amber liter	10^{45}	H_2O		1	X					X	X	X							1 amber liter
2	EB / Plastic 500ml	10^{50}	|		1	X								X						1 plastic 500ml
3	EB / Amber liter	10^{45}			1					X					X					1 amber lite
4	EB / Plastic 500ml	10^{50}			1	X										X	X			1 plastic 500ml
5																				
6																				
7																				
8																				

COOLER NOS.	BAILERS	SHIPMENT METHOD OUT / DATE	SHIPMENT METHOD RETURNED / DATE

ITEM NUMBER	RELINQUISHED BY / AFFILIATION	ACCEPTED BY / AFFILIATION	DATE	TIME
	Thomas M. Sackington TETC	J. Brossman / Pace	11-20	16:00

Additional Comments

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PACE INCORPORATED
THE ASSURANCE OF QUALITY

11. 12

CHAIN-OF-CUSTODY RECORD
Analytical Request

Client: Earth Technology
Address: 13900 Alton Parkway, Suite 120
Irvine, CA 92718
Phone: (714) 458-7414

Report To: Earth Technology / DeRam
Bill To: Earth Technology
P.O. # / Billing Reference: 92-2055-02
Project Name / No.: Metro Rail

Pace Client No.:
Pace Project Manager:
Pace Project No.:
*Requested Due Date:

Sampled By (PRINT): Thomas M. Seckington
Sampler Signature:
Date Sampled: 11/20/92

ITEM NO.	SAMPLE DESCRIPTION	TIME	MATRIX	PACE NO.	NO. OF CONTAINERS	PRESERVATIVES: UNPRESERVED	H₂SO₄	HNO₃	VOA			ANALYSES REQUEST: Aquatic Tox	BOD/405.1	COD/H.K	TSS/160.2	TDS/160.1	Sulfate 375.3	Set. Solids 160.5			REMARKS
1	EB/ Plastic gallon	10^{55}	H_2O		5	X						X									5 plastic gallon
2	EB/ Amber liter	10^{45}	|		1	X							X								1 amber liter
3	EB / Plastic 500ml	10^{50}	|		1		X							X							1 500ml plastic
4	EB / Amber liter	10^{45}	|		1	X									X	X	X				1 amber liter
5	EB / Amber liter	10^{45}	|		1	X												X			1 amber liter
6																					
7																					
8																					

COOLER NOS.	BAILERS	SHIPMENT METHOD OUT / DATE	RETURNED / DATE

Additional Comments

ITEM NUMBER	RELINQUISHED BY / AFFILIATION	ACCEPTED BY / AFFILIATION	DATE	TIME
	Thomas M. Seckington /ETC	S. [illegible] /Pace	11-20	6:00

SEE REVERSE SIDE FOR INSTRUCTIONS

pace INCORPORATED
THE ASSURANCE OF QUALITY

11,197

CHAIN-OF-CUSTODY RECORD
Analytical Request

Client Earth Technology

Address

Phone (714)458-7414

Report To: Dr Ram

Bill To: TETC

P.O. # / Billing Reference 92-2050-02

Project Name / No. Metro Rail

Pace Client No.

Pace Project Manager

Pace Project No.

*Requested Due Date:

Sampled By (PRINT): Thomas M. Sakryn

Sampler Signature Thomas M. Sakryn

Date Sampled 11/20/92

ITEM NO.	SAMPLE DESCRIPTION	TIME	MATRIX	PACE NO.	NO. OF CONTAINERS	PRESERVATIVES: UNPRESERVED	H_2SO_4	HNO_3	VOA	HCL		ANALYSES REQUEST: 602	8015-GAS								REMARKS
1	TRIP BLANK		H_2O		4					1		X									
2	TRIP BLANK		|		4					|			X								
3																					
4																					
5																					
6																					
7																					
8																					

COOLER NOS.	BAILERS	SHIPMENT METHOD OUT / DATE	SHIPMENT METHOD RETURNED / DATE

ITEM NUMBER	RELINQUISHED BY / AFFILIATION	ACCEPTED BY / AFFILIATION	DATE	TIME
	Thomas M. Sakryn / TETC	[illegible] / Pace	11-20	16:00

Additional Comments

SEE REVERSE SIDE FOR INSTRUCTIONS

2

APPENDIX E

GEOMECHANICAL LABORATORY TEST PROCEDURES AND RESULTS

APPENDIX E
GEOMECHANICAL LABORATORY TEST PROCEDURES AND RESULTS

E.1 SOIL TESTING

E.1.1 Test Procedures

As summarized in the main text, 15 grain size analyses and 21 sets of Atterberg limits tests were performed on selected soil samples. The test procedures utilized in the soil testing are described in the following paragraphs.

GRAIN SIZE ANALYSIS

The distribution of particle sizes of selected soil samples was determined quantitatively by sieving for particle sizes larger than 75 μm (retained on the No. 200 sieve) through a set of standardized sieves. The gradation analysis was performed in accordance with ASTM D422-63.

ATTERBERG LIMITS

This test type includes the determination of liquid limit, plastic limit and plasticity index of selected soil samples. The liquid limit is the water content at which a pat of soil placed in a standard cup and cut by a groove of standard dimensions will flow together at the base of the groove for a distance of ½ inch when subjected to 25 shocks from the cup being dropped 10 mm in a standard liquid limit apparatus operated at a rate of 2 shocks per second. The plastic limit is the water content at which the soil begins to crumble when rolled into threads of ⅛-inch diameter in size. The amount of water which must be added to change a soil from its plastic limit to its liquid limit is an indication of the plasticity of the soil. The plasticity of a soil is measured by the "plasticity index" which is equal to the liquid limit minus the plastic limit.

The liquid limits were determined in general accordance with ASTM D4318-84. Prior to the test, each material obtained from crushed soil sample was allowed to hydrate overnight. Multipoint liquid limit procedures in accordance with ASTM D4318-84 were performed in this study.

Similarly, each sample for plastic limit determination was mixed with water and allowed to hydrate overnight at a water content lower than the liquid limit. The material was then rolled on a glass plate until it broke at a diameter of ⅛ inch, in accordance with ASTM D4318-84. The corresponding water content was measured and reported as the plastic limit.

E.1.2 Results of Soil Testing

The results of soil test program are summarized in Table E-1. The grain size distribution curves are presented in Figures E-1 through E-16.

E.2 ROCK TESTING

E.2.1 Test Procedures

As described in Section 4.0 in the main text, the rock test program included specific gravity, bulk density and moisture content determination, uniaxial compression tests with or without stress-strain monitoring (i.e., with or without Young's Modulus and Poisson's ratio determination), slake durability tests, swell pressure determination, and Modified Taber Abrasion hardness tests. All rock testing except Modified Taber Abrasion hardness tests were performed by Science Applications International Corporation (SA1C) at their rock mechanics laboratory in Las Vegas, Nevada. The Modified Taber Abrasion hardness tests were performed by Haley and Aldrich, Inc. in Cambridge, Massachusetts. A brief description of the test procedures utilized in the rock testing is provided in the following paragraphs.

BULK SPECIFIC GRAVITY

Specific gravity is the ratio of the mass of a unit volume of a material in air to the mass of the same volume of gas-free distilled water. The specific gravity was determined in general accordance with ASTM C97-90. The sample was air dried for about 48 hours or more in a ventilated oven at a temperature of 60 ±2°C until there are three successive hourly readings with the same weight. The dry weight of the sample was measured after allowing the sample to cool for more than 30 minutes. Sample was then immersed in distilled water at 20 ±5°C for least for 1 hour. Weight of the sample was obtained after removing them from the water bath and drying the surface with a damp cloth. Weight of soaked specimen in water was determined before the sample has stood in water more than 5 minutes.

Bulk specific gravity was calculated by finding the ratio of weight of dried sample to the difference in weights between the soaked (surface dried) sample in air and soaked specimen in water.

MOISTURE CONTENT

Moisture content was determined in general accordance with ASTM D2216-80 by drying a limited amount of material to a constant mass in a drying oven controlled at 110 ±5° until a constant mass is reached. The lost mass of material was used as the mass of water in the material or test specimen. The mass of material remaining after oven-drying is the mass of the solid particles. The moisture content of a material is then calculated as the ratio, expressed as a percentage, of the mass of water in a given mass of material to the mass of the solid material particles.

DRY BULK DENSITY

Dry Bulk Density was determined by measuring the dry weight and the volume of a right cylindrical sample by calipers to estimate the volume of the sample in general accordance with ISRM suggested methods of determining water content, porosity density, absorption and related properties and swelling and slake durability index properties, Part 3, #2. Dry bulk density is then calculated by dividing the measured dried weight by the measured volume.

UNIAXIAL COMPRESSION TESTS

A series of uniaxial compression tests were performed. Some of these tests were performed to determine both the ultimate compressive strength and the elastic deformation characteristics (Young's modulus and Poisson's ratio) moduli. Other tests were performed to determine the ultimate compressive strength only. All tests were conducted in a 200,000 LB stiff loading frame. Axial stress was controlled using an electro-hydraulic servo-system. Two LVDTs attached to the loading platens, recorded the axial displacement while two clip gauges (strain gauge mounted aluminum half circular bands), mounted at the center of the sample 90° opposing, recorded the radial displacements. Axial load was measured with a load cell.

The tests were performed in general accordance with the ISRM suggested methods for determining the strength of rock in triaxial compression. Test procedures required obtaining the weight and physical dimensions of the specimen. After being photographed, the specimen was placed between two hardened endcaps. If applicable, the strain sensors were attached and the specimen placed in the loading frame. Some specimens were loosely wrapped with rubber tape to contain "explosive failure". The test proceeded by applying an axial load at an axial strain rate of $\leq 1 \times 10^{-5}$ in/in/sec. Data were recorded at nominal 10 second intervals. All tests were conducted at ambient temperatures. Axial loading continued until a discernable drop in load was observed. The specimen was again photographed, marked, and wrapped for storage.

The total axial stress was determined by dividing the measured load by the initial cross-sectional area of the specimen (Jaeger and Cooke, 1976):

$$\sigma_z = P/A$$

where:

σ_z = Engineering Stress (psi)
P = Axial Load (lbf)
A = Initial Cross Sectional Area (in^2)

Strain was determined by dividing the change in specimen dimension (length or radius) by the initial specimen dimension:

$$\epsilon = (l_o - l_i) l_o$$

where:
ϵ = Engineering Strain (in/in)
l_o = Specimen Initial Dimension (in)
l_i = Current Specimen Dimension (in)

The ultimate uniaxial compressive strength was chosen as the maximum total axial stress achieved during testing.

Young's modulus was determined at the linear least squares slope of the differential axial stress versus the axial strain data. Poisson's ratio was determined by the linear least square slope of the radial strain versus the axial strain data. Best fit slopes were calculated over the portion of the axial strain curve providing the best r^2 value results (generally, the r^2 value for Young's Modulus $\geq$.97).

POINT LOAD TEST

Point load tests were performed on 55 samples. These tests were intended for obtaining an indication of rock strength and estimating uniaxial compressive strengths to supplement the data from uniaxial compressive tests performed in this investigation. All tests were performed using a point load strength tester Model PLT-10 manufactured by Structural Behavior Engineering Laboratory, Inc.

The tests were performed in general accordance with the ISRM suggested method for determining point load strength. The test procedure essentially consisted of placing a rock specimen between a pair of spherically truncated conical-platens and applying a steadily-increased compression point load until failure occurred within 10 to 60 seconds. Specimens in the forms of intact core (diametral and axial tests) and irregular lumps (irregular lump test) were tested to obtain point load strengths of intact cores (including matrix and clast) and clasts, respectively. Up to 8 point load test readings were conducted per sample. When breaks along discontinuities caused early failure, the readings were not used to compute the load. An average of all accepted readings is reported for each sample. Prior to testing, selected rock specimens were water-saturated for at least 24 hours. One sample from boring SM-8 disintegrated due to slaking and could not be tested.

The uncorrected point load strength I is calculated as:

$$I = P/D_e^2$$

where: P = failure point load
D_e = equivalent core diameter

The equivalent diameter, De, is determined as follows:

$$2\ \sqrt{A/\pi} \quad \textit{for lump tests or}$$
$$= \textit{core diameter for diametral test}$$

where: A = minimum cross-sectional area of a plane through the platen contact points

Size correction to a standard 50mm (Nx) core strength, I_{50}, was obtained by the following correlation:

$$I_{50} = I\ (De/50)\ 0.45$$

where: De = equivalent core diameter in mm

Correlation of I_{50} to uniaxial compressive strength is only approximate. On average, uniaxial compressive strength is about 20 to 25 times the standard point load strength. However, in tests on many different rock types, the ratio can vary between 15 and 50, especially for anisotropic rock. For this investigation program, a ratio of 22 was adopted.

SLAKE DURABILITY

Slake durability is an index test which assess the resistance offered by rock samples to weakening and disintegration when subjected to two cycles of drying and wetting with abrasion. The second cycle slake-durability index is calculated as the ratio, expressed in percentage, of final to initial dry sample masses retained on a No. 10 (2mm) sieve.

The slake durability was done in general accordance with ASTM D4644-87 method. Each sample consisted of ten intact, roughly equidimensional fragments weighing 40 to 60 g each. The sample was placed in a standard slake durability test drum and dried in the oven for 16 hours or to a constant mass. The drum was weighed often cooling for 20 minutes in room temperature. The drum containing cooled sample was then mounted in a trough and coupled to a motor. The trough was filled with distilled water. The level of the water was kept to about 20 mm below the drum axis. The drum was then rotated at 20 rpm for a period of 10 minutes. The drum was then removed with the retained portion of the sample and was dried in an oven for 16 hours or to a constant mass. The whole cycle was repeated for the second time. The initial and final dry sample masses were measured appropriately on cooled sample before and after every cycle. The second cycle slake durability index as defined above was then calculated.

SWELL PRESSURE

Swell pressure is the pressure necessary to constrain an undisturbed rock specimen at constant volume when it is immersed in water.

The swell pressure was determined in general accordance with the ISRM suggested methods for determining water content, porosity, density, absorption, and related properties and swelling and slake durability index properties. Part 2, #1. Standard soil consolidation testing apparatus was used for this test. The sample was inserted into consolidation ring and trimmed to the required size. The apparatus was assembled and a small axial force of about 10 kPa was applied to the specimens. The cell was then flooded with water to cover the top porous plate, and the swelling force was recorded as a function of time elapsed. The applied force was regularly adjusted to maintain the thickness of the specimen within 0.01 mm. The test was continued until the swelling force reached a constant level or passed a peak.

The swelling pressure index was calculated by dividing the maximum axial swelling force recorded during the test by the cross sectional area of the specimen.

MODIFIED TABER ABRASION HARDNESS

The Modified Taber Abrasion Hardness (H_A) is an index which is determined by taking two ¼-inch (6 mm) thick disks of NX core and abrading each side for 400 revolutions on a Modified Taber Abraser. The inverse of the average weight loss of the two disks is the Abrasion Hardness (H_A).

Sample preparation included cutting the two disks from a selected rock core and drilling a 5/16-inch hole in the center of each disk. After removing surface grit, specimens were dried in an oven for 4 to 8 hours or to a constant mass and allowed to cool before testing. It was ensured that all test specimens had smooth and flat surfaces under the area covered by the abraser disk and were free of cracks and discontinuities.

The first disk with known weight was mounted on the Modified Taber Abraser and abraded for 400 revolutions on one side. Using another fresh abraser wheel the other side of the disk was also abraded for the same number of revolutions. The weights before and after abrasion were used to calculate the weight loss. Following the same procedure, weight loss for the second disk was calculated.

Abrasion hardness (H_A) was determined by calculating the reciprocal of the average weight loss in grams for both disks.

E.1.2 Results of Rock Testing

The results of the rock testing programs are tabulated in Table E-2. Individual stress-strain plots are presented in Figures E-17 through E-59.

TABLE E-1. SUMMARY OF LABORATORY TEST RESULTS FOR SOILS

Boring No.	Approximate Offset From Center Line of AR Track (feet)	Approximate Elevations			Sample Interval				USCS Classification	Grain Size Distribution			Atterberg Limits		Swell Pressure (psi)
		Ground surface (feet)	Tunnel Crown (feet)	Tunnel Invert (feet)	Depth		Elevation			Gravel (%)	Sand (%)	Fines (%)	LL (%)	PI (%)	
					From (feet)	To (feet)	From (feet)	To (feet)							
SM-1	335RT.	485	347	327	6.0	10.0	479.0	475.0	CL	0	39	61	41	22	
					95.0	100.0	390.0	385.0	CH	0	5	95	65	41	
					128.0	130.0	357.0	355.0	SC-SM	1	71	28	26	6	
					136.0		349.0		SC	0	54	46	37	20	
					155.0	160.0	330.0	325.0	CL	0	43	57	46	25	
SM-1A	320RT.	492	348	328	139.0	143.0	353.0	349.0	CL				28	13	
					155.5	156.5	336.5	335.5	SC	7	46	47	34	20	
					156.5	160.0	335.5	332.0	CL				37	24	
					162.0	165.0	330.0	327.0	CL				40	25	
					173.0	175.5	319.0	316.5	SC	5	54	41	23	8	
SM-1B	340RT.	487	348	328	144.0	145.0	343.0	342.0	SP	1	98	1	36	12	
					169.0	169.8	318.0	317.2	SP	4	95	1	33	12	
SM-4	70LT.	960	375	355	0.0	7.0	960.0	953.0	CL	0	25	75	39	24	
					10.0	11.0	950.0	949.0	SM	0	85	15			
SM-5	130LT.	1226	396	376	451.0	451.5	775.0	774.5	SP	8	91	1	37	17	4.9
SM-11	30LT.	778	528	508	8.5	10.0	769.5	768.0	SC	0	70	30	39	19	
SM-12	230LT.	671	525	505	3.8	4.4	667.2	666.6	CL	0	46	54	37	20	
					6.9	7.4	664.1	663.6	CL	0	45	55	35	19	
SM-13	10LT.	590	521	501	4.1	4.6	585.9	585.4	CL				40	25	
					7.3	7.8	582.7	582.2	ML				27	4	
					9.0	9.5	581.0	580.5	CL				38	20	
					14.1	14.6	575.9	575.4	CL				40	24	
					15.0	20.0	575.0	570.0	SC	0	54	46	30	8	

TABLE E-2. SUMMARY OF LABORATORY TEST RESULTS FOR ROCKS

Boring No.	Approximate Offset From Center Line of AR Track (feet)	Approximate Elevations			Sample Interval				Rock Type (Formation)	Bulk Specific Gravity	Bulk Density (pcf)	Moisture Content (%)	Uniaxial Compression				Point Load		Slake Durability (%)	Swell Pressure (psi)	Modified Taber Abrasion(6) (Ha)
		Ground Surface (feet)	Tunnel Crown (feet)	Tunnel Invert (feet)	Depth		Elevation						Failure Mode (1) (Discontinuity)	Failure Stress (psi)	Young's Modulus (psi)	Poisson's Ratio	Strength Index (2) (psi)	Estimated Uniaxial Compressive(5) Strength (psi)			
					From (feet)	To (feet)	From (feet)	To (feet)													
SM-1A	320RT.	492	348	328	124.0	124.5	368.0	367.5	Granodiorite/Gouge	2.66											
					162.0	165.0	330.0	327.0	Granodiorite/Gouge	2.70									24.5		
SM-2	130LT.	720	350	330	242.3	242.8	477.7	477.2	Granodiorite				Axial Splitting	13900	7.0E+06	0.19					
					251.7	252.7	468.3	467.3	Granodiorite	2.75	171	0.2	Shear Plane	10700	6.7E+06	0.21					
					367.0	367.5	353.0	352.5	Granodiorite	2.68	166	0.8	Conical Failure (Joints)	1730	1.1E+06	0.02					
					368.5	368.8	351.5	351.2	Granodiorite		162	0.5									
					376.7	377.0	343.3	343.0	Granodiorite/Crushed												9.3
					382.0	382.3	338.0	337.7	Granodiorite	2.73	170	0.3									
					394.0	394.3	326.0	325.7	Granodiorite		171	0.2									
					403.8	404.2	316.2	315.8	Granodiorite												9.9
					408.1	408.7	311.9	311.3	Granodiorite				Axial Splitting	15900	6.7E+06	0.25					
SM-3	60LT.	686	350	330	154.5	155.6	531.5	530.4	Granodiorite		178	0.4	Axial Splitting (Joint)	13100							
					223.7	224.8	462.3	461.2	Granodiorite	2.83	175	0.2	Axial Splitting	11200	5.7E+06	0.40					
					265.1	266.3	420.9	419.7	Granodiorite		170	0.2	Axial Splitting	14300							
					295.0	295.5	391.0	390.5	Granodiorite				Shear Plane (Joint, calcite healed)	3060							
					303.7	305.3	382.3	380.7	Granodiorite		172	0.2	Axial Splitting	10600							
					324.4	324.9	361.6	361.1	Granodiorite	2.79	175	0.1	Shear Plane(Joints)	12200							
					335.3	335.9	350.7	350.1	Granodiorite	2.70	173	0.1	Shear Plane(Joint)	10000	4.4E+06	0.10					
					338.0	339.0	348.0	347.0	Granodiorite		171	0.1	Axial Splitting	21200	6.4E+06	0.13					
					341.0	341.4	345.0	344.6	Granodiorite		172	0.1	Axial Splitting	17200							
					344.7	345.5	341.3	340.5	Granodiorite	2.73	170	0.3	Conical Failure	14800	1.2E+07	0.13					11.0
					358.5	359.2	327.5	326.8	Granodiorite	2.71	169	0.7	Axial Splitting (Joints, calcite healed)	8600							10.2
SM-4	70LT.	960	375	355	77.6	78.3	882.4	881.7	Granodiorite		167	1.3	Shear Plane (Joint, calcite healed)	3890							

TABLE E-2. SUMMARY OF LABORATORY TEST RESULTS FOR ROCKS

Boring No	Approximate Offset From Center Line of AR Track	Approximate Elevations			Sample Interval				Rock Type (Formation)	Bulk Specific Gravity	Bulk Density	Moisture Content	Uniaxial Compression				Point Load		Slake Durability	Swell Pressure	Modified Taber Abrasion(6)
		Ground Surface	Tunnel Crown	Tunnel Invert	Depth		Elevation						Failure Mode (1)	Failure Stress	Young's Modulus	Poisson's Ratio	Strength Index (2)	Estimated Uniaxial Compressive(5) Strength			
					From	To	From	To													
	(feet)	(feet)	(feet)	(feet)	(feet)	(feet)	(feet)	(feet)			(pcf)	(%)	(Discontinuity)	(psi)	(psi)		(psi)	(psi)	(%)	(psi)	(Ha)
SM-5	130LT.	1226	396	376	109.0	109.5	851.0	850.5	Granodiorite				Shear Plane	15600							
					396.0	396.7	564.0	563.3	Granodiorite				Axial Splitting	16400							
					467.8	469.0	492.2	491.0	Granod./Aphanitic dike(7)	2.68	166	0.4	Axial Splitting	6670	5.4E+06	0.27					
					573.3	575.0	386.7	385.0	Granodiorite								1440	31680			
					578.0	579.1	382.0	380.9	Granodiorite	2.72	169	>0.1	Axial Splitting	22600	9.5E+06	0.15					
					580.4	581.7	379.6	378.3	Granodiorite	2.65	169	0.1	Conical	22900	1.0E+07	0.15					
					583.0	583.3	377.0	376.7	Granodiorite												9.7
					583.4	585.0	376.6	375.0	Granodiorite	2.72	169	0.1	Axial Splitting	20700							
					586.6	589.6	371.4	370.4	Granodiorite		168	0.1	Conical	17400							
					590.0	590.9	370.0	369.1	Granodiorite		167	0.2	Shear Plane	20500							
					592.5	592.8	367.5	367.2	Granodiorite												10.0
					596.6	597.6	363.4	362.4	Granodiorite	2.72	169	0.2	Conical	14000	8.4E+06	0.26					
					599.2	599.7	360.8	360.3	Granodiorite												11.8
					608.5	609.6	351.5	350.4	Granodiorite	2.69	167	0.2	Axial Splitting	15400	9.1E+06	0.23					
					609.7	610.2	350.3	349.8	Granodiorite												8.8
					623.0	624.5	337.0	335.5	Granodiorite								1070	23540			
					148.0	149.5	1078.0	1076.5	Sandstone (Chico)								365	8030			
					167.8	168.4	1058.2	1057.6	Conglo. Sandstone (Chico)				Axial Splitting (Clast Boundary)	3320							
					180.3	180.8	1045.7	1045.2	Sandstone (Chico)								368	8096			
					294.8	295.6	931.2	930.4	Conglo. Sandstone (Chico)	2.55	161	0.4	Conical (Clast Boundaries)	5050							
					305.3	306.0	920.7	920.0	Granitic Clast (Chico)								648(3)	14256			
					315.2	315.9	910.8	910.1	Sandstone (Chico)								309	6798			
					330.2	332.0	895.8	894.0	Sandstone (Chico)								235	5170			
					364.5	366.0	861.5	860.0	Conglomerate (Chico)								160	3520			

TABLE E-2. SUMMARY OF LABORATORY TEST RESULTS FOR ROCKS

Boring No	Approximate Offset From Center Line of AR Track	Approximate Elevations			Sample Interval				Rock Type (Formation)	Bulk Specific Gravity	Bulk Density	Moisture Content	Uniaxial Compression				Point Load		Slake Durability	Swell Pressure	Modified Taber Abrasion(6)
		Ground Surface	Tunnel Crown	Tunnel Invert	Depth From	Depth To	Elevation From	Elevation To					Failure Mode (1) (Discontinuity)	Failure Stress	Young's Modulus	Poisson's Ratio	Strength Index (2)	Estimated Uniaxial Compressive(5) Strength			
	(feet)	(feet)	(feet)	(feet)	(feet)	(feet)	(feet)	(feet)			(pcf)	(%)		(psi)	(psi)		(psi)	(psi)	(%)	(psi)	(Ha)
					398.1	398.6	829.9	829.4	Sandstone Clast (Chico)								120(3)	2640			
					400.0	401.7	826.0	824.3	Sandstone (Chico)		159	0.3	Shear Plane	8700							
					539.9	541.0	686.1	685.0	Conglomerate (Chico)								4	88			
					551.5	552.0	674.5	674.0	Conglo. Clay Gouge (Chico)				Shear Plane (Clay Shear)	500							
					553.2	553.9	672.8	672.1	Conglo. Clay Gouge (Chico)											8.2	
					564.4	565.0	661.6	661.0	Granod./Chlorite alteration				Shear Plane (Joints)	1840	4.9E+05	0.45					
					697.9	698.7	528.1	527.3	Granodiorite/Jointed								148	3256			
					722.8	723.4	503.2	502.6	Granodiorite				Conical (Joints, chlorite lined)	1620							
					726.3	727.2	499.7	498.8	Granodiorite/Weathered								57	1254			
					760.2	770.0	465.8	456.0	Granodiorite								573	12606			
					826.9	827.4	399.1	398.6	Granodiorite				Conical (Joint)	5030	2.8E+06	0.10					
					836.3	837.0	389.7	389.0	Granodiorite		163	1.1									
					838.7	839.6	387.3	386.4	Granodiorite	2.63	166	1.2	Shear Plane	10100	4.7E+06	0.25					
					841.9	842.5	384.1	383.5	Granodiorite												6.9
					853.5	854.4	372.5	371.6	Granodiorite	2.67	169	1.4	No Discernible Plane	10300							
					859.0	859.3	367.0	366.7	Granodiorite												7.1
					860.4	861.0	365.6	365.0	Granodiorite				Shear Plane (Joints, chlorite lined)	3320							
					861.4	861.9	364.6	364.1	Granodiorite		162	1.0									
					869.3	870.1	356.7	355.9	Granodiorite/Jointed								387	8514			
					886.5	887.3	339.5	338.7	Granodiorite								1142	25124			
SM-6	60RT.	1180	408	388	51.5	52.6	1128.5	1127.4	Conglomerate (Chico)	2.65	150	0.7	Conical (Clast Boundaries)	970	1.4E+05	0.44					
					121.3	121.7	1058.7	1058.3	Conglomerate (Chico)				Conical	6050							

TABLE E-2. SUMMARY OF LABORATORY TEST RESULTS FOR ROCKS

Boring No	Approximate Offset From Center Line of AR Track (feet)	Approximate Elevations			Sample Interval				Rock Type (Formation)	Bulk Specific Gravity	Bulk Density (pcf)	Moisture Content (%)	Uniaxial Compression				Point Load		Slake Durability (%)	Swell Pressure (psi)	Modified Taber Abrasion(6) (Ha)
		Ground Surface (feet)	Tunnel Crown (feet)	Tunnel Invert (feet)	Depth		Elevation						Failure Mode (1) (Discontinuity)	Failure Stress (psi)	Young's Modulus (psi)	Poisson's Ratio	Strength Index (2) (psi)	Estimated Uniaxial Compressive(5) Strength (psi)			
					From (feet)	To (feet)	From (feet)	To (feet)													
					158.3	159.0	1021.7	1021.0	Sandstone Clast (Chico)								19(3)	416			
					233.1	234.1	946.9	945.9	Granitic Clast (Chico)								492(3)	10824			
					282.6	283.8	897.4	896.2	Conglomerate (Chico)										97.4		
					375.9	376.9	804.1	803.1	Conglomerate (Chico)	2.49	156	0.3	Conical	3002	1.6E+06	0.37					
													(Clast Boundaries)								
					439.1	440.9	740.9	739.1	Conglo. Sandstone (Chico)								336(4)	7392			
									Quartzite Clast (Chico)								500(3)	11000			
					492.5	493.0	687.5	687.0	Sandstone (Chico)				Axial Splitting	6060							
					571.2	572.0	608.8	608.0	Sandstone (Chico)								405(4)	8910			
									Quartzite Clast (Chico)								731(3)	16082			
					591.4	592.1	588.6	587.9	Con·, Sandstone (Chico)								583	12826			
					687.0	687.6	493.0	492.4	Conglomerate (Chico)				Shear Plane	7170							
													(Clast Boundary)								
					738.0	739.0	442.0	441.0	Granodiorite/Weathered								107	2354			
					754.2	755.0	425.8	425.0	Granodiorite/Weathered								197	4334			
					773.5	774.1	406.5	405.9	Granodiorite	2.64	164	2.6	Shear Plane (Joint ?)	3330	1.1E+06	0.04					
					777.8	778.6	402.2	401.4	Granodiorite	2.57	162	1.0	Axial Splitting	2930	4.0E+05	0.35					
					782.5	783.8	397.5	396.2	Granodiorite		162	0.6	Conical	4400	4.6E+06	0.36					5.3
					789.3	790.0	390.7	390.0	Granodiorite	2.63	164	0.9	Conical	3210							
					800.6	801.0	379.4	379.0	Granodiorite												4.9
					807.9	808.9	372.1	371.1	Granodiorite/Weathered								61	1342			
SM-7	225LT.	1100	428	408	73.0	74.3	1027.0	1025.7	Sandstone (Simi)		155	0.50	Conical (Joint)	1270							
					111.5	112.7	988.5	987.3	Sandstone (Simi)		159	0.60	Shear Plane	4560							
					181.7	182.1	918.3	917.9	Quartzite Clast (Chico)								606(3)	13332			
					186.0	186.8	914.0	913.2	Sandstone (Chico)								6	132			
					192.4	193.3	907.6	906.7	Sandstone (Chico)		152	1.00	Shear Plane	5870							
					289.0	290.0	811.0	810.0	Sandstone (Chico)	2.50	152	0.3	Shear Plane	4980	1.4E+06	0.35					

TABLE E-2. SUMMARY OF LABORATORY TEST RESULTS FOR ROCKS

Boring No	Approximate Offset From Center Line of AR Track	Approximate Elevations			Sample Interval				Rock Type (Formation)	Bulk Specific Gravity	Bulk Density	Moisture Content	Uniaxial Compression				Point Load		Slake Durability	Swell Pressure	Modified Taber Abrasion (6)
		Ground Surface	Tunnel Crown	Tunnel Invert	Depth		Elevation						Failure Mode (1)	Failure Stress	Young's Modulus	Poisson's Ratio	Strength Index (2)	Estimated Uniaxial Compressive(5) Strength			
					From	To	From	To													
	(feet)	(feet)	(feet)	(feet)	(feet)	(feet)	(feet)	(feet)			(pcf)	(%)	(Discontinuity)	(psi)	(psi)		(psi)	(psi)	(%)	(psi)	(Ha)
SM-8	ORT.	1175	450	430	303.3	304.0	796.7	796.0	Sandstone (Chico)								96	2112			
					432.7	433.6	667.3	666.4	Sandstone (Chico)		164	0.2	Conical	18106							
					565.7	566.6	534.3	533.4	Conglomerate (Chico)		160	0.8	Conical (Clast Boundaries)	5190							
					590.3	591.4	509.7	508.6	Conglomerate (Chico)								34	748			
					662.0	662.4	438.0	437.6	Conglomerate (Chico)												4.3
					672.6	673.3	427.4	426.7	Conglomerate (Chico)	2.55	157	0.6	No Discernible Plane (Clast Boundaries)	1800	9.7E+05	0.50					
					681.5	682.0	418.5	418.0	Sandstone (Chico)												3.1
					685.3	685.8	414.7	414.2	Conglomerate (Chico)		140	0.5	Shear Pl.(Shear, calcite h	1190	4.0E+05	0.38					
					699.5	700.6	400.5	399.4	Conglomerate (Chico)	2.50	157	0.6	Shear Plane (Sheared Surface)	3890							
					701.5	702.0	398.5	398.0	Conglomerate (Chico)												3.8
					703.0	703.7	397.0	396.3	Conglomerate (Chico)		152	0.6	Shear Plane (Shears)	2430	1.6E+06	0.10					
					704.0	704.6	396.0	395.4	Conglomerate (Chico)								25	50			
					704.7	705.7	395.3	394.3	Conglomerate (Chico)										95.3		
					706.0	706.8	394.0	393.2	Conglomerate (Chico)	2.43	152	0.8	Shear Plane (Clay Coated Shears)	280							
					706.8	707.8	393.2	392.2	Conglomerate (Chico)		154	0.4	Axial Splitting (Shears)	3340	1.8E+06	0.31					
					730.3	731.2	369.7	368.8	Conglomerate (Chico)								639	14058			
					77.6	79.4	1097.4	1095.6	Basalt (M Topanga)		151	5.1	Conical (Joint)	4310					96.7		
					210.6	211.7	964.4	963.3	Basalt (M Topanga)								32	704			
					217.7	218.3	957.3	956.7	Basalt (M Topanga)				Axial Splitting	4200							
					271.0	272.4	904.0	902.6	Basalt (M Topanga)								20	440			
					323.8	324.8	851.2	850.2	Basalt (M Topanga)	2.38	150	3.7									
					325.5	326.3	849.5	848.7	Basalt (M Topanga)								248	5456			
					397.5	398.8	777.5	776.2	Basalt (M Topanga)								32	704			
					453.5	454.5	721.5	720.5	Basalt (M Topanga)		128	10.0	Shear Plane	2400							

TABLE E-2. SUMMARY OF LABORATORY TEST RESULTS FOR ROCKS

Boring No.	Approximate Offset From Center Line of AR Track	Approximate Elevations			Sample Interval				Rock Type (Formation)	Bulk Specific Gravity	Bulk Density	Moisture Content	Uniaxial Compression				Point Load		Slake Durability	Swell Pressure	Modified Taber Abrasion(6)
		Ground Surface	Tunnel Crown	Tunnel Invert	Depth		Elevation						Failure Mode (1) (Discontinuity)	Failure Stress	Young's Modulus	Poisson's Ratio	Strength Index (2)	Estimated Uniaxial Compressive(5) Strength			
					From	To	From	To													
	(feet)	(feet)	(feet)	(feet)	(feet)	(feet)	(feet)	(feet)			(pcf)	(%)		(psi)	(psi)		(psi)	(psi)	(%)	(psi)	(Ha)
					491.0	492.5	684.0	682.5	Basalt (M Topanga)								173	3806			
					536.3	540.1	636.7	634.9	Basalt Breccia (M Top.)	2.57	137	7.7							59.0		
					654.4	655.6	520.6	519.4	Sandstone (L Topanga)								36	792			
					712.4	713.4	462.6	461.6	Sandstone (L Topanga)												0.8
					721.4	722.2	453.6	452.8	Sandstone (L Topanga)	2.42	149	0.6	Conical	4620	1.2E+06	0.39					
					731.3	732.0	443.7	443.0	Conglomeratic Sandstone (L Topanga)	2.45	154	0.6	Axial Splitting	3230	2.5E+06	0.26					
					737.1	737.5	437.9	437.5	Sandstone (L Topanga)												0.5
					741.5	742.6	433.5	432.4	Sandstone (L Topanga)	2.41	152	1.6	Axial Splitting	1500	4.3E+05	0.43					
					745.0	745.3	430.0	429.7	Conglo. Sandstone (L Top.)												2.0
					752.5	753.6	422.5	421.4	Sandstone (L Topanga)		152	1.0	Shear Plane*/Axial Splitti	3320							
					762.7	763.5	412.3	411.5	Sandstone (L Topanga)	2.39	154	2.5	Shear Plane (Joints)	970	3.4E+05	0.11			93.8		
					786.5	787.5	388.5	387.5	Sandstone (L Topanga)								261	6182			
SM-9	170LT.	1112	479	459	33.5	34.3	1078.5	1077.7	Basalt Breccia (M Topanga)								27	594			
					62.5	63.5	1049.5	1048.5	Basalt Breccia (M Topanga)		134	5.6	Shear Plane	3650							
					117.0	117.8	995.0	994.2	Basalt (M Topanga)		154	4.7									
					151.9	152.7	960.1	959.3	Basalt Breccia (M Topanga)								39	858			
					196.9	197.9	915.1	914.1	Basalt Breccia (M Topanga)		142	5.8	Shear Plane (Shears, zeolite healed)	930							
					286.5	288.2	825.5	823.8	Basalt Breccia (M Topanga)								38	836			
					315.1	317.0	796.9	795.0	Basalt Breccia (M Topanga)		136	4.7	Axial Splitting (Shears, dacite-chlorite healed)	1050					60.6		
					437.7	439.0	674.3	673.0	Basalt Breccia (M Topanga)		148	3.5									
					567.7	568.3	544.3	543.7	Basalt Breccia (M Topanga)								259	5698			
					575.5	577.0	536.5	535.0	Basalt Breccia (M Topanga)		134	6.8	Conical (Shear, chlorite healed)	1670							

TABLE E-2. SUMMARY OF LABORATORY TEST RESULTS FOR ROCKS

Boring No.	Approximate Offset From Center Line of AR Track (feet)	Approximate Elevations			Sample Interval				Rock Type (Formation)	Bulk Specific Gravity	Bulk Density (pcf)	Moisture Content (%)	Uniaxial Compression				Point Load		Slake Durability (%)	Swell Pressure (psi)	Modified Taber Abrasion (6) (Ha)
		Ground Surface (feet)	Tunnel Crown (feet)	Tunnel Invert (feet)	Depth From (feet)	Depth To (feet)	Elevation From (feet)	Elevation To (feet)					Failure Mode (1) (Discontinuity)	Failure Stress (psi)	Young's Modulus (psi)	Poisson's Ratio	Strength Index (2) (psi)	Estimated Uniaxial Compressive(5) Strength (psi)			
					623.0	624.6	489.0	487.4	Basalt Breccia (M Topanga)	2.25	148	9.6	Axial Splitting (Shear,	950							
													clacite-chlorite healed)								
					626.0	626.6	486.0	485.4	Basalt Breccia (M Topanga)										83.8		
					627.5	628.0	484.5	484.0	Basalt Breccia (M Topanga)												1.4
					635.7	636.3	476.3	475.7	Basalt Breccia (M Topanga)		144	7.0	Conical	40							
													(Clast Boundaries)								
					644.2	645.2	467.8	466.8	Basalt Breccia (M Topanga)										75.0		
					645.8	646.9	466.2	465.1	Basalt Breccia (M Topanga)	2.27	147	5.8	Conical (Shear,	430	3.8E+05	0.45					
													chlorite-zeolite healed)								
					663.8	664.9	448.2	447.1	Basalt Breccia (M Topanga)		142	7.2	Conical	1510							
													(Clast Boundaries)								
					672.4	673.0	439.6	439.0	Basalt Breccia (M Topanga)	2.31	135	7.6	Shear Plane	1040	5.2E+05	0.22					
SM-10	190LT.	1147	505	485	46.0	48.0	1101.0	1099.0	Sandstone (U Topanga)		136	2.6									
					89.0	90.0	1058.0	1057.0	Conglo. Sandstone (U Top.)		131	4.0									
					173.9	175.0	973.1	972.0	Cong. Sandstone (U Top.)								433	9526			
					186.7	187.5	960.3	959.5	Sandstone (U Topanga)				Axial Splitting	3750							
					290.0	291.3	857.0	855.7	Sandstone (U Topar ga)		139	2.5									
					349.0	350.0	798.0	797.0	Sandstone (U Top.)								140	3080			
					366.2	367.2	780.8	779.8	Sandstone (U Top.)								217	4774			
					435.0	437.0	712.0	710.0	Conglo. Sandstone (U Top.)	2.22	143	2.2	Shear Plane	2670	7.8E+05	0.35					
					542.6	543.7	604.4	603.3	Conglo. Sandstone (U Top.)		142	2.0									
					600.0	601.5	547.0	545.5	Granitic Clast (U Top.)								522(3)	11484			
									Cong. Sandstone (U Top.)								90(4)	1980			
					611.5	613.9	535.5	533.1	Sandstone (U Topanga)		143	1.0	Axial Splitting	5170							
					630.0	631.1	517.0	515.9	Sandstone (U Topanga)	2.22	138	1.1	Conical	2830							
					635.0	635.4	512.0	511.6	Sandstone (U Topanga)										77.4		8.1
					640.0	641.0	507.0	506.0	Conglo. Sandstone (U Top.)		144	3.4	Shear Plane	5320	2.5E+06	0.32					
					641.5	641.9	505.5	505.1	Conglo. Sandstone (U Top.)												15.1
					643.9	645.0	503.1	502.0	Conglo. Sandstone (U Top.)		143	2.1	Axial Splitting	4810							
					645.0	646.0	502.0	501.0	Sandstone (U Topanga)	2.24	139	0.7	Shear Plane	3540	1.9E+06	0.39					
					655.0	656.1	492.0	490.9	Sandstone (U Topanga)		142	1.7	Axial Splitting	3640							

TABLE E-2. SUMMARY OF LABORATORY TEST RESULTS FOR ROCKS

Boring No.	Approximate Offset From Center Line of AR Track (feet)	Approximate Elevations			Sample Interval				Rock Type (Formation)	Bulk Specific Gravity	Bulk Density (pcf)	Moisture Content (%)	Uniaxial Compression				Point Load		Slake Durability (%)	Swell Pressure (psi)	Modified Taber Abrasion(6) (Ha)
		Ground Surface (feet)	Tunnel Crown (feet)	Tunnel Invert (feet)	Depth		Elevation						Failure Mode (1) (Discontinuity)	Failure Stress (psi)	Young's Modulus (psi)	Poisson's Ratio	Strength Index (2) (psi)	Estimated Uniaxial Compressive(5) Strength (psi)			
					From (feet)	To (feet)	From (feet)	To (feet)													
SM-11	30LT.	776	526	506	659.1	659.5	487.8	487.5	Sandstone (U Topanga)												4.0
					668.8	670.0	478.2	477.0	Sandstone (U Topanga)	2.60	163	0.3	Conical	13500	5.4E+06	0.35					
					670.0	670.7	477.0	476.3	Granitic Clast (U Top.)								366(3)	8052			
					676.6	677.6	470.4	469.4	Granitic Clast (U Top.)								803(3)	17668			
					678.4	680.0	468.6	467.0	Sandstone (U Top.)								181	3982			
					63.7	64.8	714.3	713.2	Sandstone/Siltstone (U Top.)		128	5.2									
					111.2	112.5	666.8	665.5	Sandstone (U Topanga)	2.64	124	7.8	Shear Plane	1110							
					115.0	116.7	663.0	661.3	Sandstone (U Topanga)								61	1342			
					160.2	162.3	617.8	615.7	Cong. Sandstone (U Top.)		141	1.0							95.7		
					190.0	192.0	588.0	586.0	Sandstone (U Topanga)								153	3366			
					212.9	214.6	565.1	563.4	Shale/Sandstone (U Top.)								22	484			
					217.5	218.7	560.5	559.3	Sandstone (U Topanga)		149	2.4	Shear Plane (Bedding)	1020							
					236.9	237.9	541.1	540.1	Sandstone (U Topanga)	2.02	130	7.8	Axial Splitting	2260	5.2E+05	0.28					
					239.0	239.7	539.0	538.3	Sandstone (U Topanga)												0.7
					242.5	244.5	535.5	533.5	Sandstone (U Topanga)		131	5.7	Shear Plane	4480	1.1E+06	0.33					
					245.0	246.0	533.0	532.0	Sandstone (U Topanga)		127	4.6	Conical	3170							
					253.6	254.8	524.2	523.2	Cong. Sandstone (U Top.)	2.34	145	2.1	Shear Plane	4790	1.5E+06	0.24					
					260.0	261.1	518.0	516.9	Sandstone (U Topanga)		138	2.1	Axial Splitting	3070							
					275.0	276.0	503.0	502.0	Sandstone/Siltstone (U Top.)	2.77	135	7.9	Conical (Bedding Plane)	140	1.4E+05				50.1		
					300.5	301.0	477.5	477.0	Sandstone/Siltstone (U Top.)								57	1254			
SM-12	230LT.	671	525	505	36.8	37.3	634.2	633.7	Sandstone/Siltstone (U Topanga)				Shear Plane (Bedding)	60							
					89.6	90.1	581.4	580.9	Sandstone (U Topanga)				Shear Plane	270							
					95.0	96.0	576.0	575.0	Siltstone (U Topanga)								76	1672			
					103.4	104.1	567.6	566.9	Sandstone/Siltstone (U Topanga)				Shear Plane (Bedding)	50	9.3E+03	0.27					

TABLE E-2. SUMMARY OF LABORATORY TEST RESULTS FOR ROCKS

Boring No	Approximate Offset From Center Line of AR Track (feet)	Approximate Elevations			Sample Interval				Rock Type (Formation)	Bulk Specific Gravity	Bulk Density (pcf)	Moisture Content (%)	Uniaxial Compression				Point Load		Slake Durability (%)	Swell Pressure (psi)	Modified Taber Abrasion(6) (Ha)
		Ground Surface (feet)	Tunnel Crown (feet)	Tunnel Invert (feet)	Depth		Elevation						Failure Mode (1) (Discontinuity)	Failure Stress (psi)	Young's Modulus (psi)	Poisson's Ratio	Strength Index (2) (psi)	Estimated Uniaxial Compressive(5) Strength (psi)			
					From (feet)	To (feet)	From (feet)	To (feet)													
SM-13	10LT.	590	521	501	142.6	143.6	528.4	527.4	Sandstone/Siltstone (U Topanga)		124	12.5	Conical (across bedding)	230							
					151.7	152.9	519.3	518.1	Sandstone (U Topanga)	2.26	141	6.9	Axial Splitting	1760	5.5E+05	0.44					
					162.1	162.9	508.9	508.1	Sandstone/Siltstone (U Topanga)	2.70	127	10.1	Shear Plane (Bedding)	140	3.2E+04	0.37					
					165.2	166.0	505.8	505.0	Sandstone/Siltstone(U Top.)		128	5.0	Shear Plane (Bedding)	100					11.3		
					167.0	168.0	504.0	503.0	Sandstone/Siltstone(U Top.)		126	8.8	Shear Plane (Bedding)	100							
					174.8	175.8	496.2	495.2	Sandstone/Siltstone(U Top.)	2.72	131	5.6	Shear Plane (Bedding)	20							
					191.5	192.0	479.5	479.0	Sandstone (U Topanga)								36	792			
					46.9	48.0	543.1	542.0	Sandstone/Siltstone (U Top.)										1.1		
					60.3	62.2	529.7	527.8	Sandstone/Siltstone (U Top.)	2.64	123	7.6	Shear Plane (Bedding)	280	5.6E+04	0.43					
					65.1	66.4	524.9	523.6	Sandstone/Siltstone (U Top.)			13.5	Shear Plane (Bedding)	230							
					71.1	72.9	518.9	517.1	Sandstone/Siltstone (U Top.)	2.61	119	6.0	Shear Plane (Bedding)	40							
					79.0	79.9	511.0	510.1	Sandstone/Siltstone (U Top.)		122	12.6	Shear Plane (Bedding)	120							
					92.5	93.7	497.5	496.3	Sandstone/Siltstone (U Top.)		124	11.0	Shear Plane (Bedding)	60							
					96.7	98.7	493.3	491.3	Sandstone/Siltstone (U Top.)	2.70	124	3.5	Shear Plane (Bedding)	170					1.3		

Notes: (1) Three failure modes were observed. These included:

(i) Axial Splitting mode where failure planes were near vertical and splitted the samples into two pieces.

(ii) Shear plane mode where well-defined inclined failure (shear) planes (i.e. at an angle to vertical) were observed.

(iii) Conical failure mode where cone-shaped failure planes were observed.

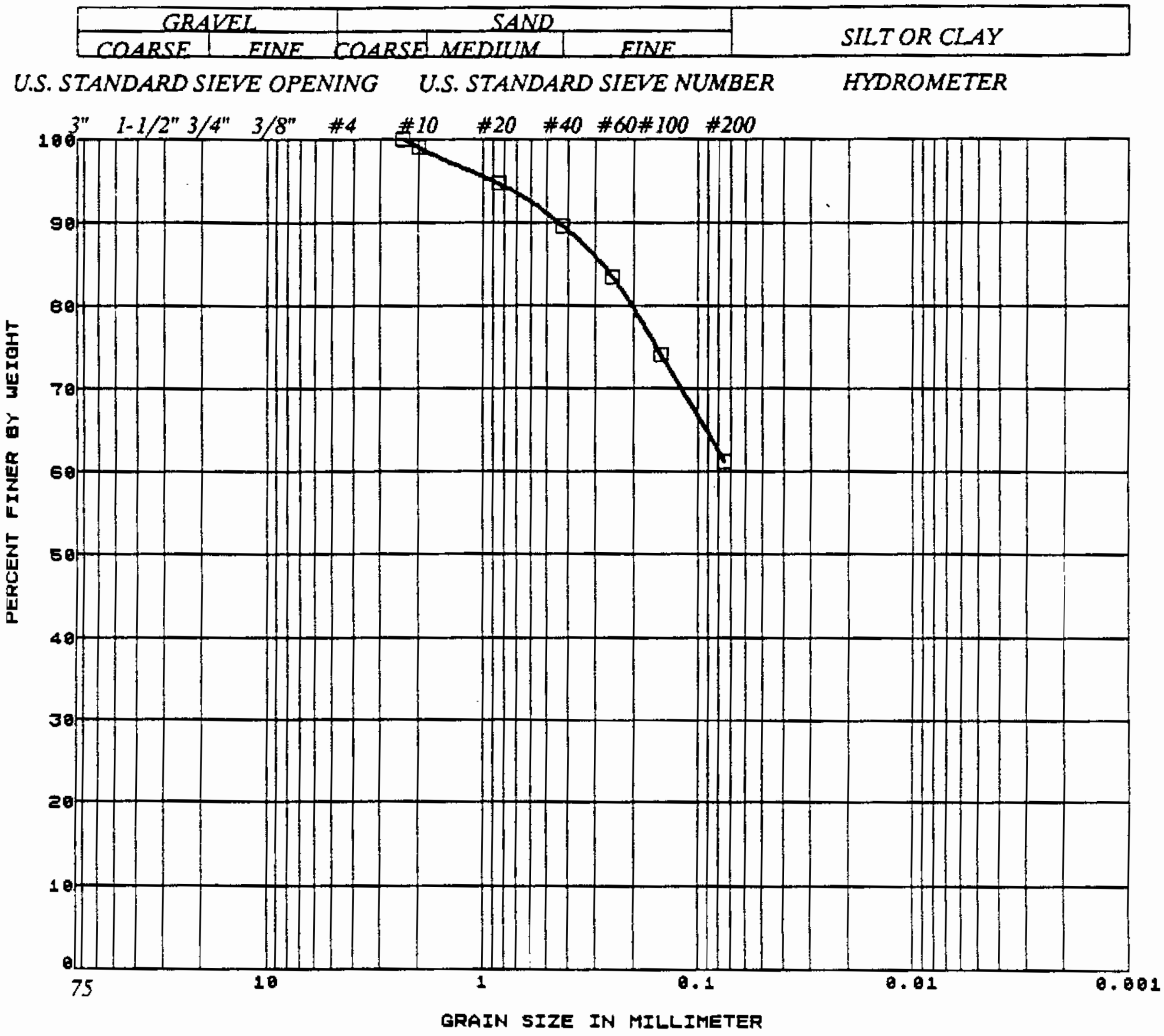
(2) The point load strength has been corrected for size effects as per ISRM Standards.

(3) Point load strength index for the sample clast.

(4) Point load strength index for the sample matrix.

(5) Estimated uniaxial compressive strength calculated by multiplying Point Load Strength Index by a factor of 22.

GRAIN SIZE DISTRIBUTION CURVES



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTICITY INDEX
☐	*SM-1*	*T2*	*6.0 - 10.0*		*CL*	*41*	*22*

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PROJECT NAME:
METRO RED LINE
SEGMENT 3

GRAIN SIZE
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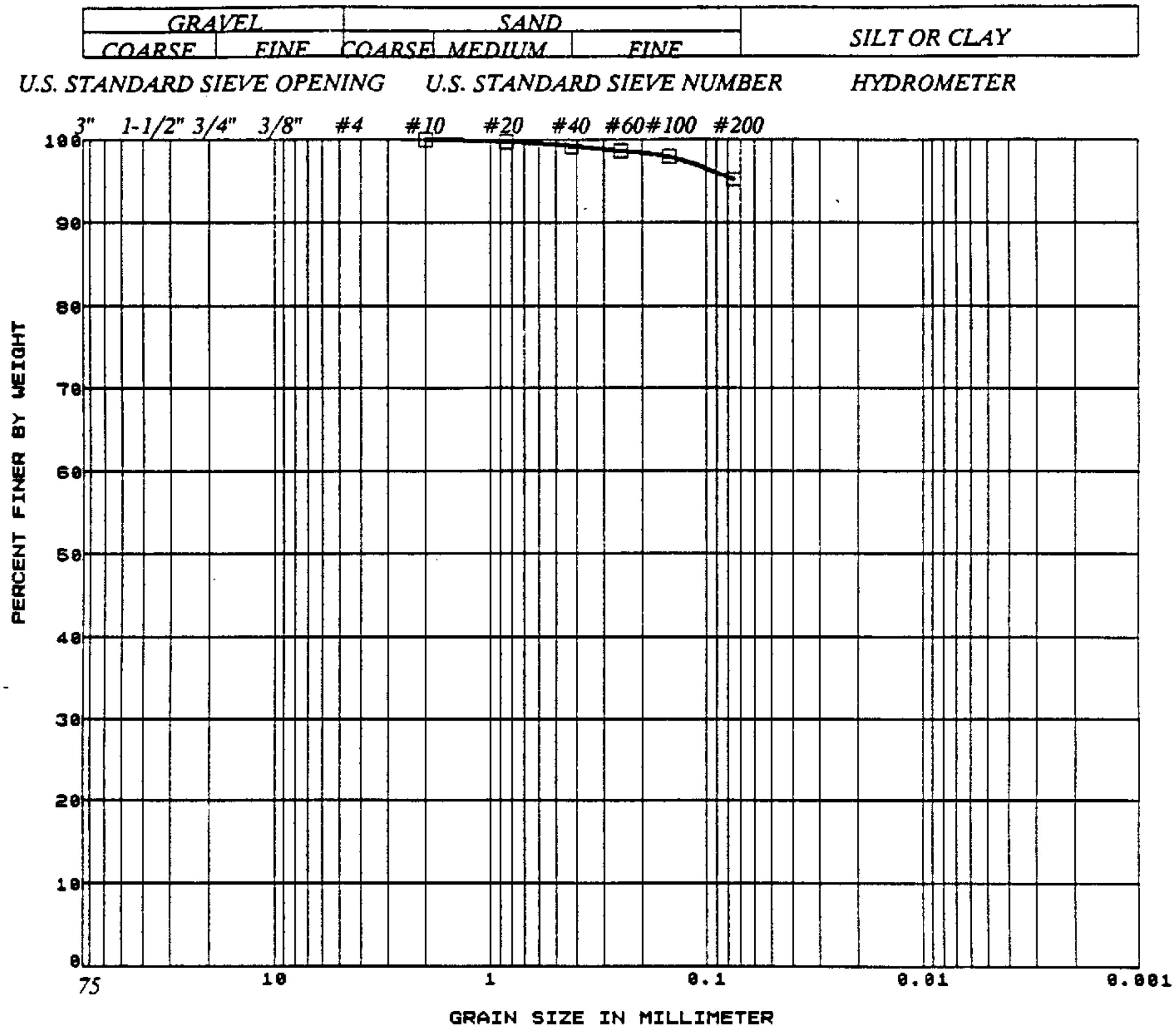
FIGURE E-1



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTICITY INDEX
☐	*SM-1*	*T3*	*95.0-100.0*		*CH*	*65*	*41*

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GRAIN SIZE
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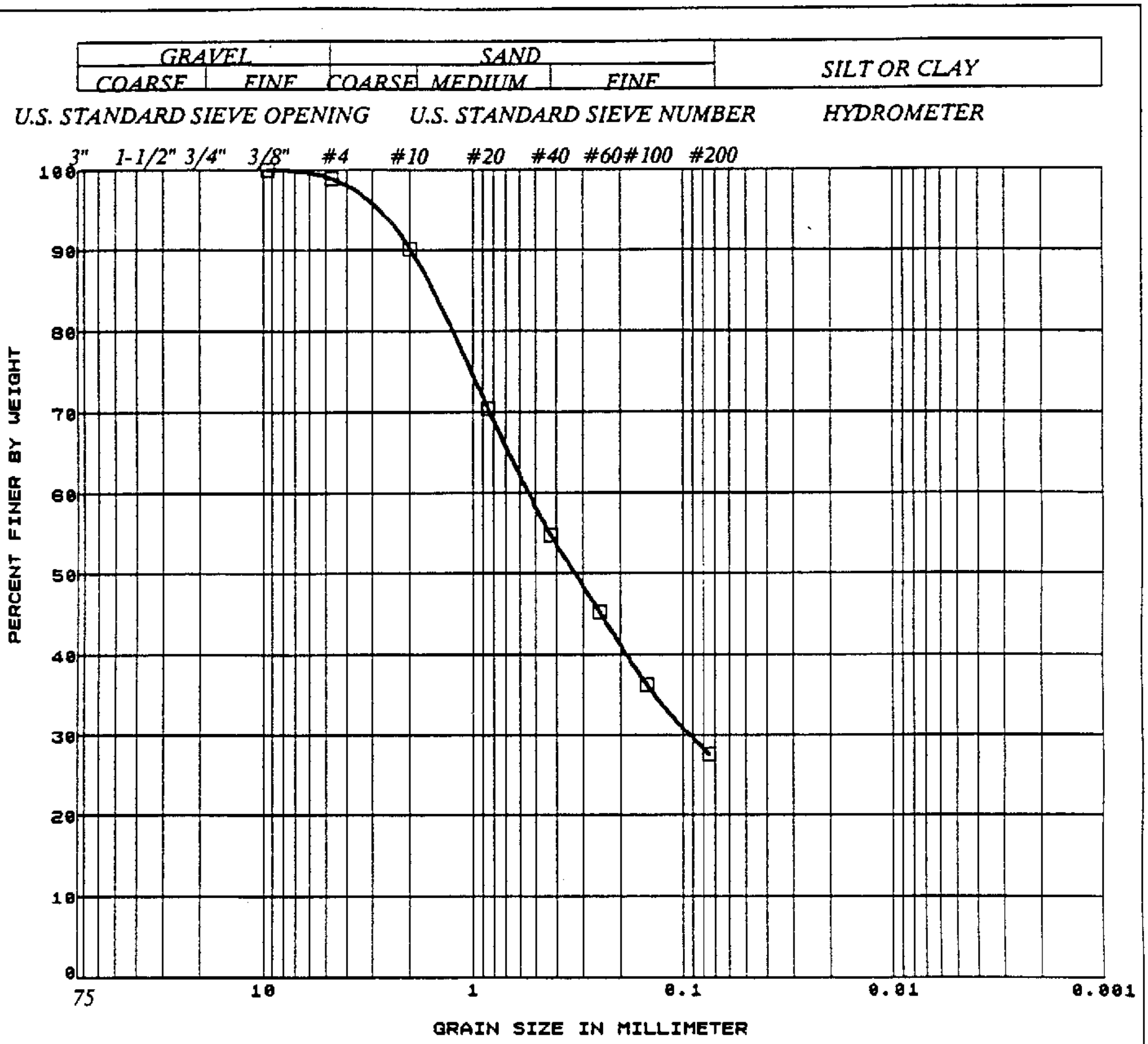
FIGURE E-2



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
□	*SM-1*	*T4*	*128.0-130.0*		*SC-SM*	*26*	*6*

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GRAIN SIZE
DISTRIBUTION CURVE

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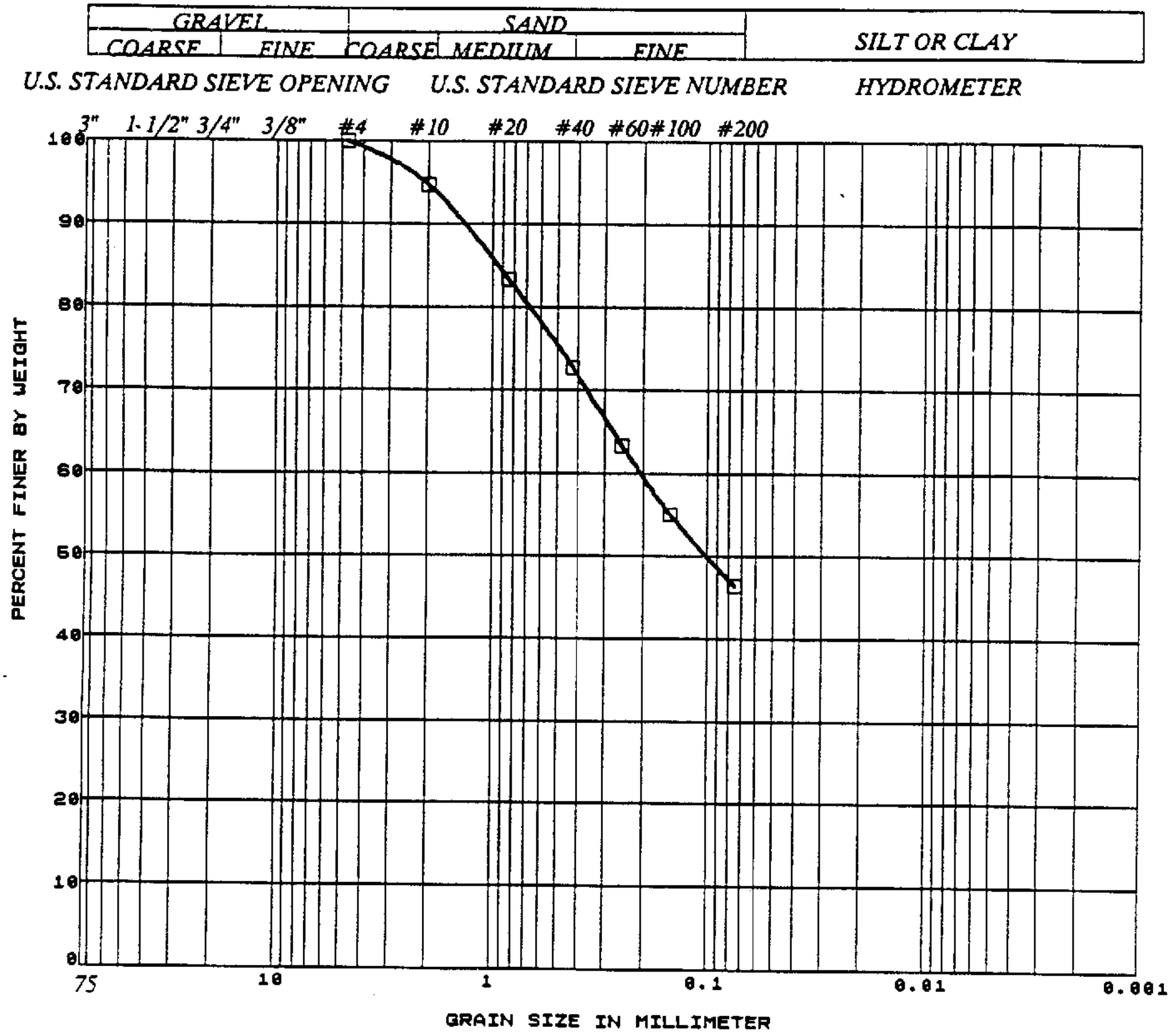
FIGURE E-3



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
□	*SM-1*	*T6*	*136.0*		*SC*	*37*	*20*

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SEGMENT 3

GRAIN SIZE
DISTRIBUTION CURVE

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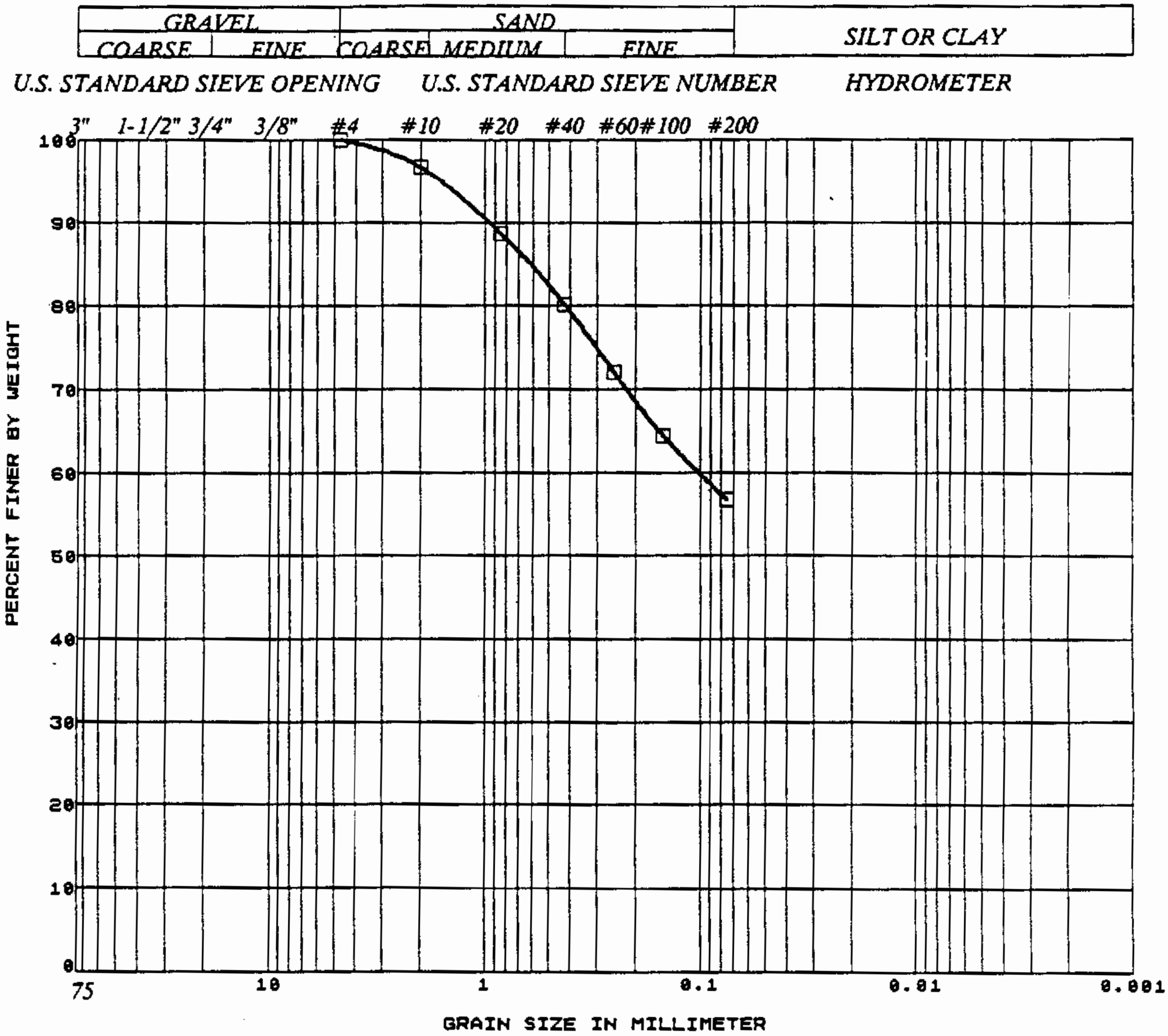
FIGURE E-4



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTICITY INDEX
□	*SM-1*	*T9*	*155.0-160.0*		*CL*	*46*	*25*

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SEGMENT 3

GRAIN SIZE
DISTRIBUTION CURVE

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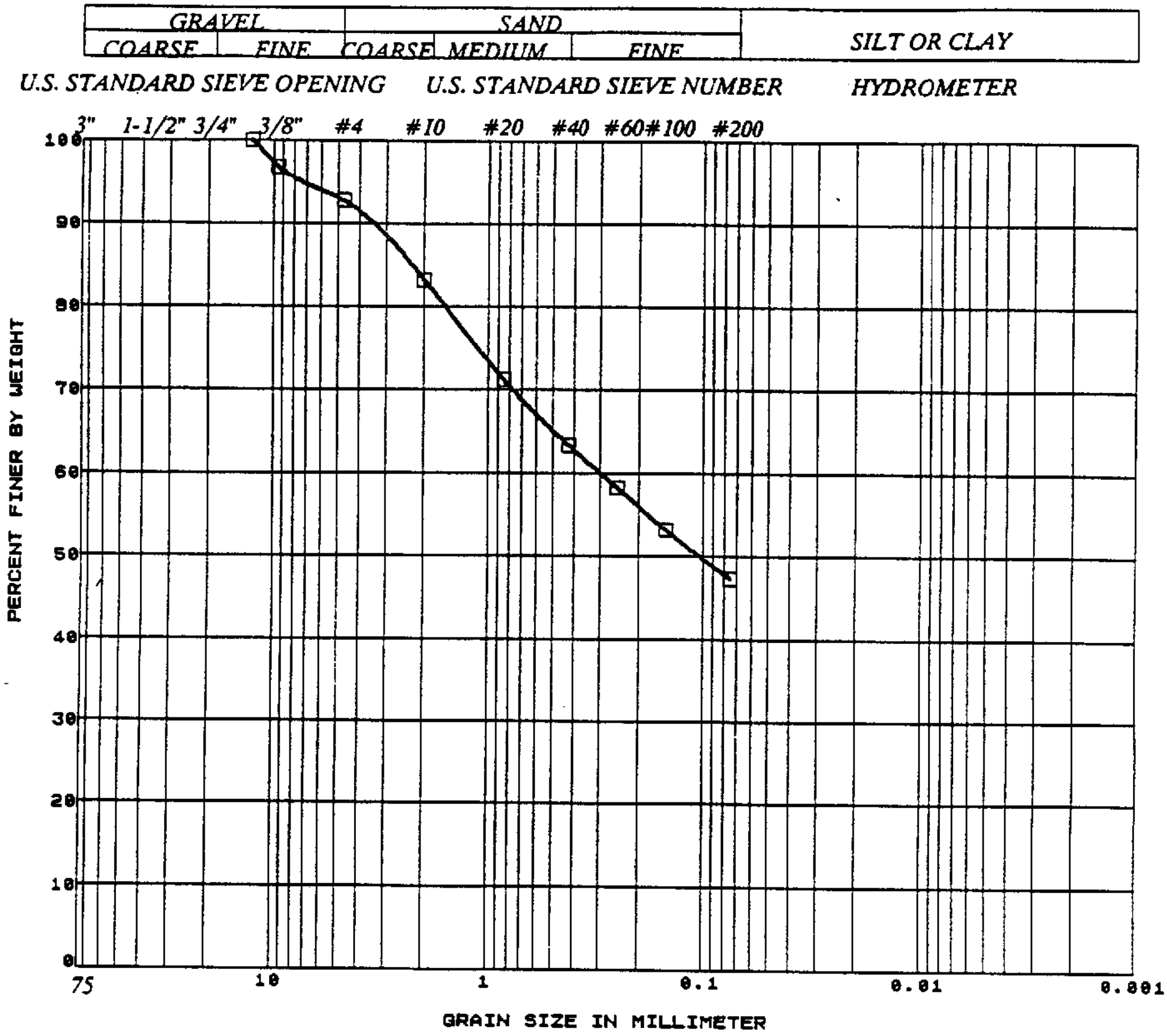
FIGURE E-5



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
☐	SM-1A	T2	155.5-156.5		SC	34	20

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GRAIN SIZE
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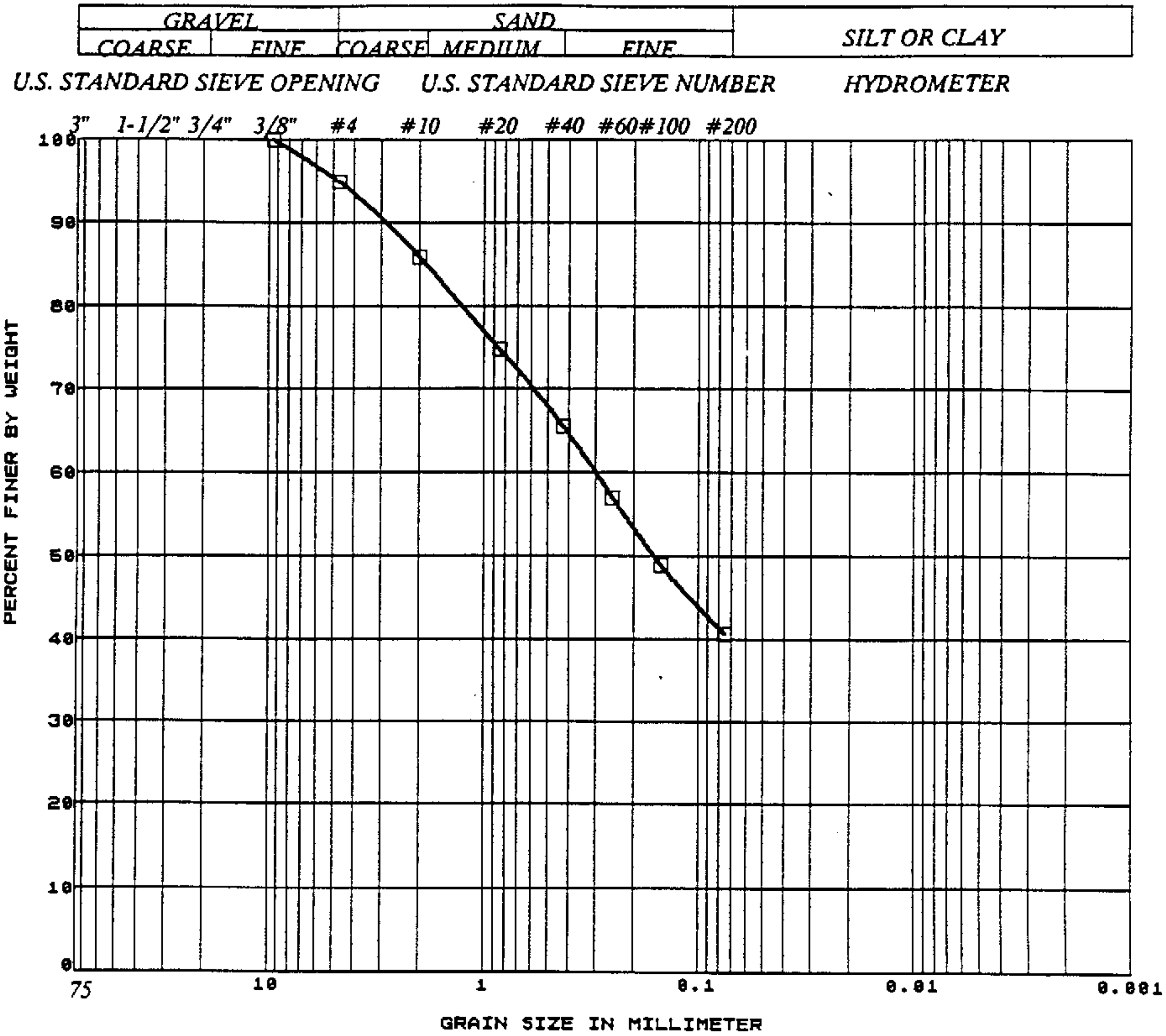
FIGURE E-6



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
☐	*SM-1A*	*T5*	*173.0-175.5*		*SC*	*23*	*8*

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GRAIN SIZE DISTRIBUTION CURVE

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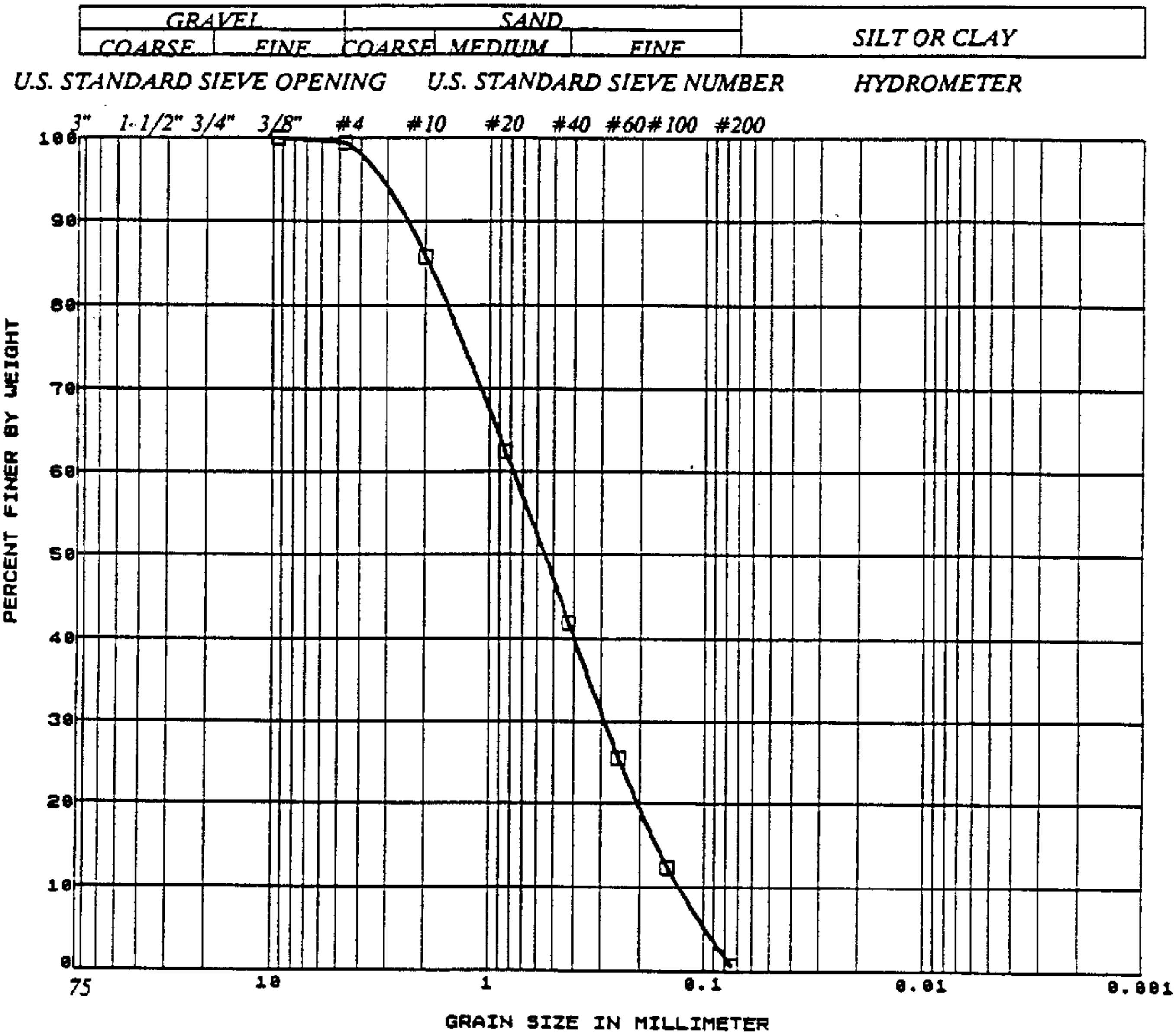
FIGURE E-7



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
☐	*SM-1B*	*R46*	*144.0-145.0*		*SP*	*36*	*12*

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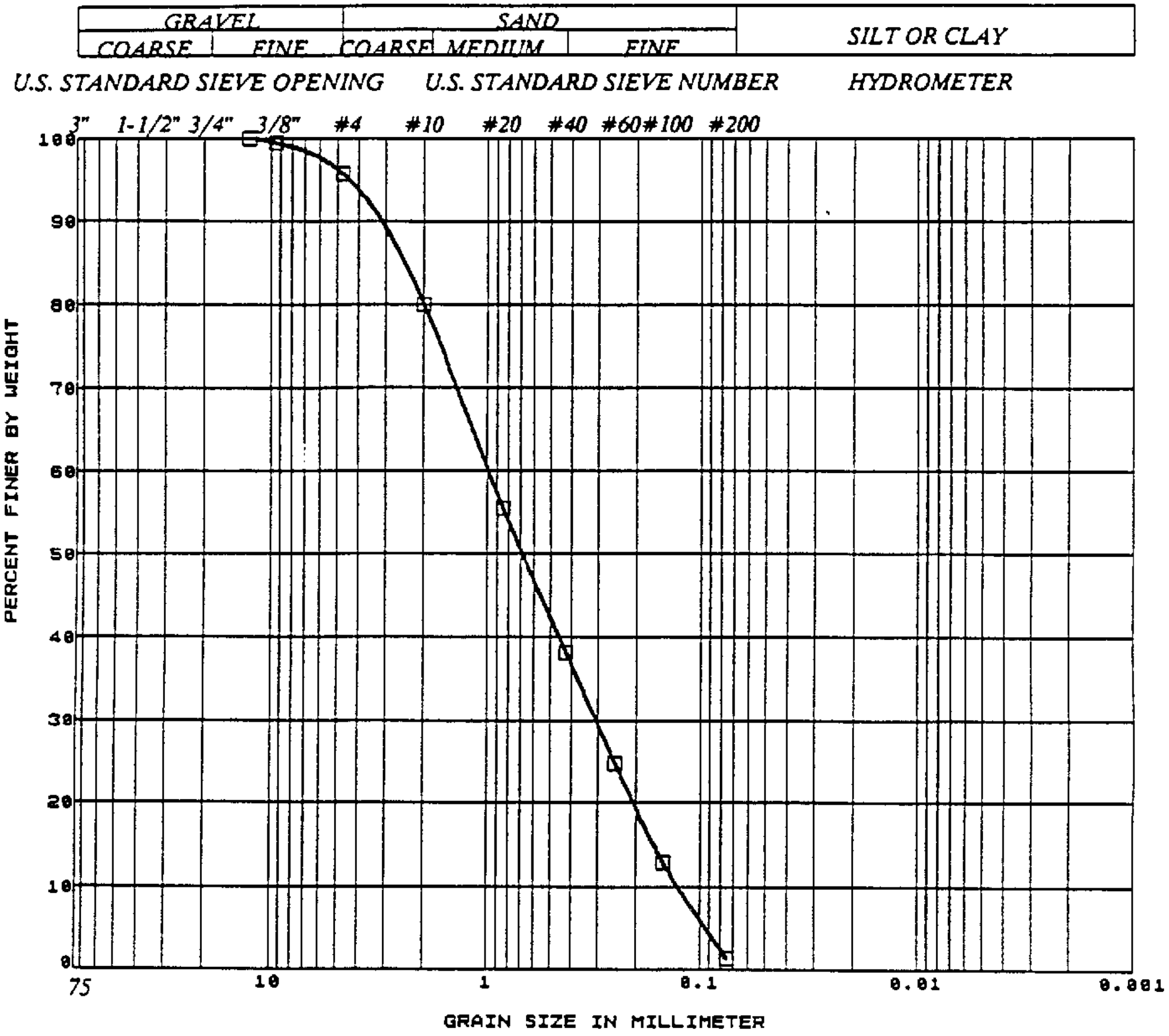
METRO RED LINE
SEGMENT 3

GRAIN SIZE
DISTRIBUTION CURVE

12/92

FIGURE E-8



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTICITY INDEX
□	*SM-1B*	*R51*	*169.0-169.8*		*SP*	*33*	*12*

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GRAIN SIZE
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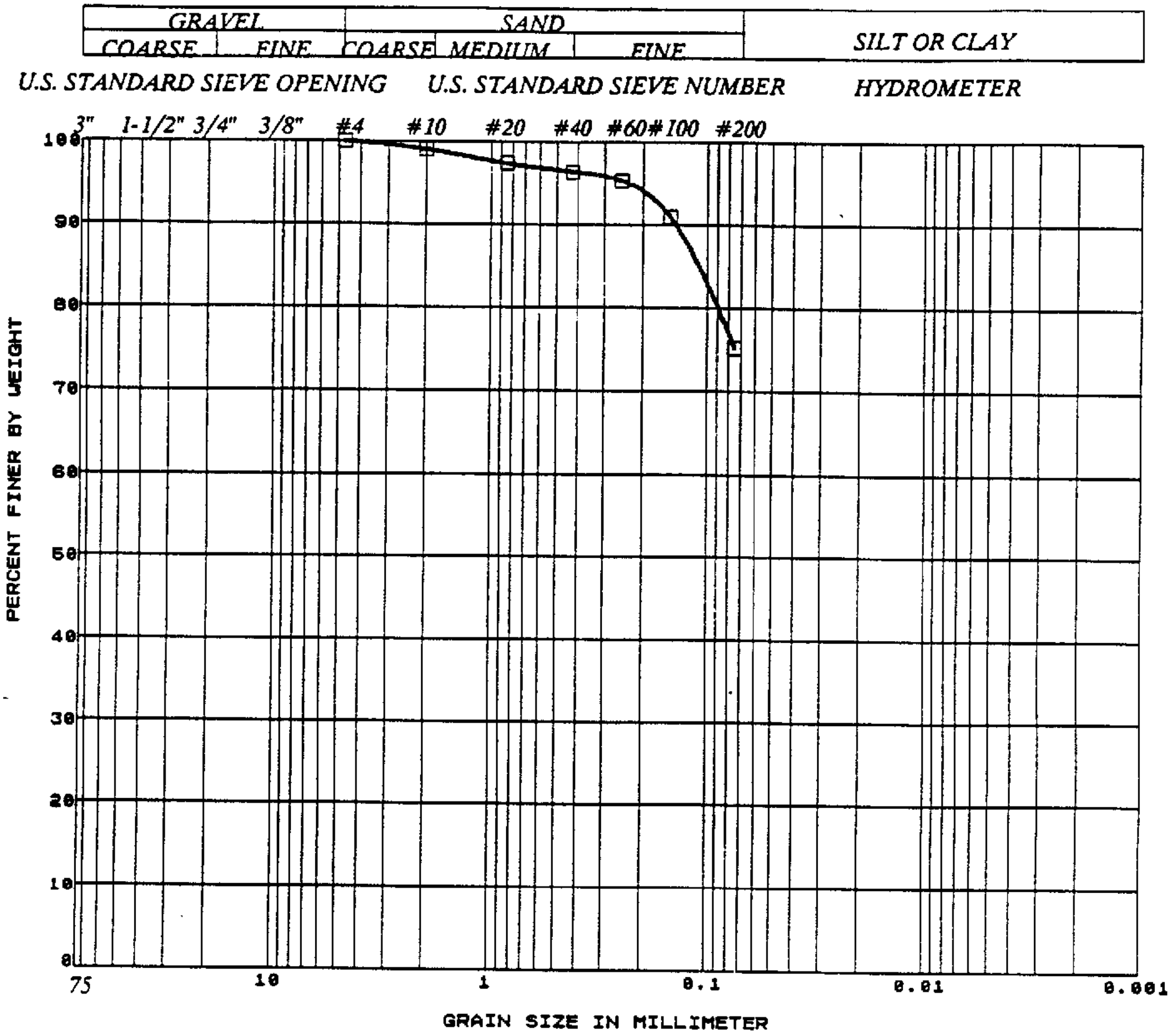
FIGURE E-9



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTICITY INDEX
☐	SM-4	R1	0.0 - 7.0		CL	39	24

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GRAIN SIZE
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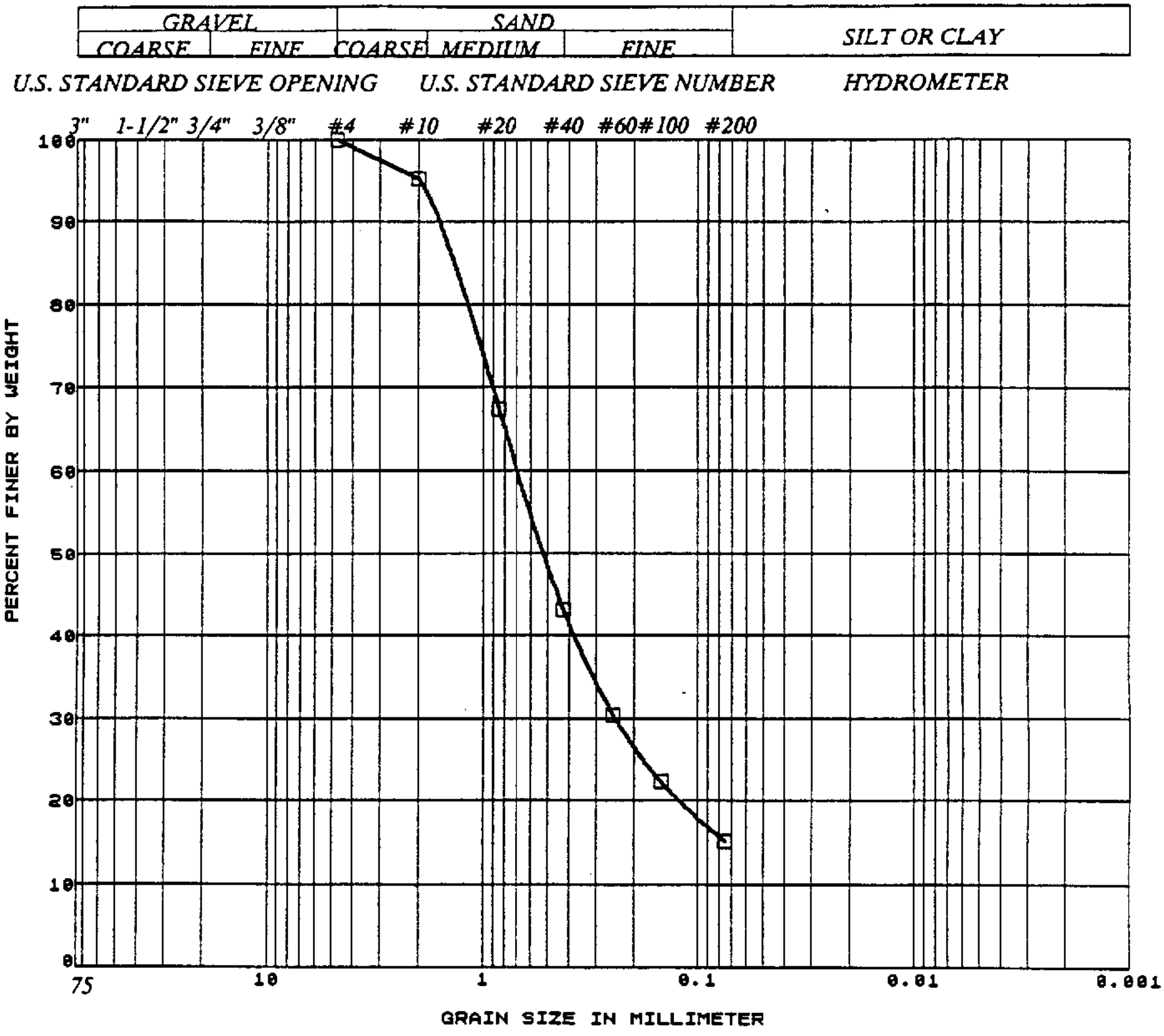
FIGURE E-10



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
□	SM-4	R2	10.0 - 11.0				

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GRAIN SIZE
DISTRIBUTION CURVE

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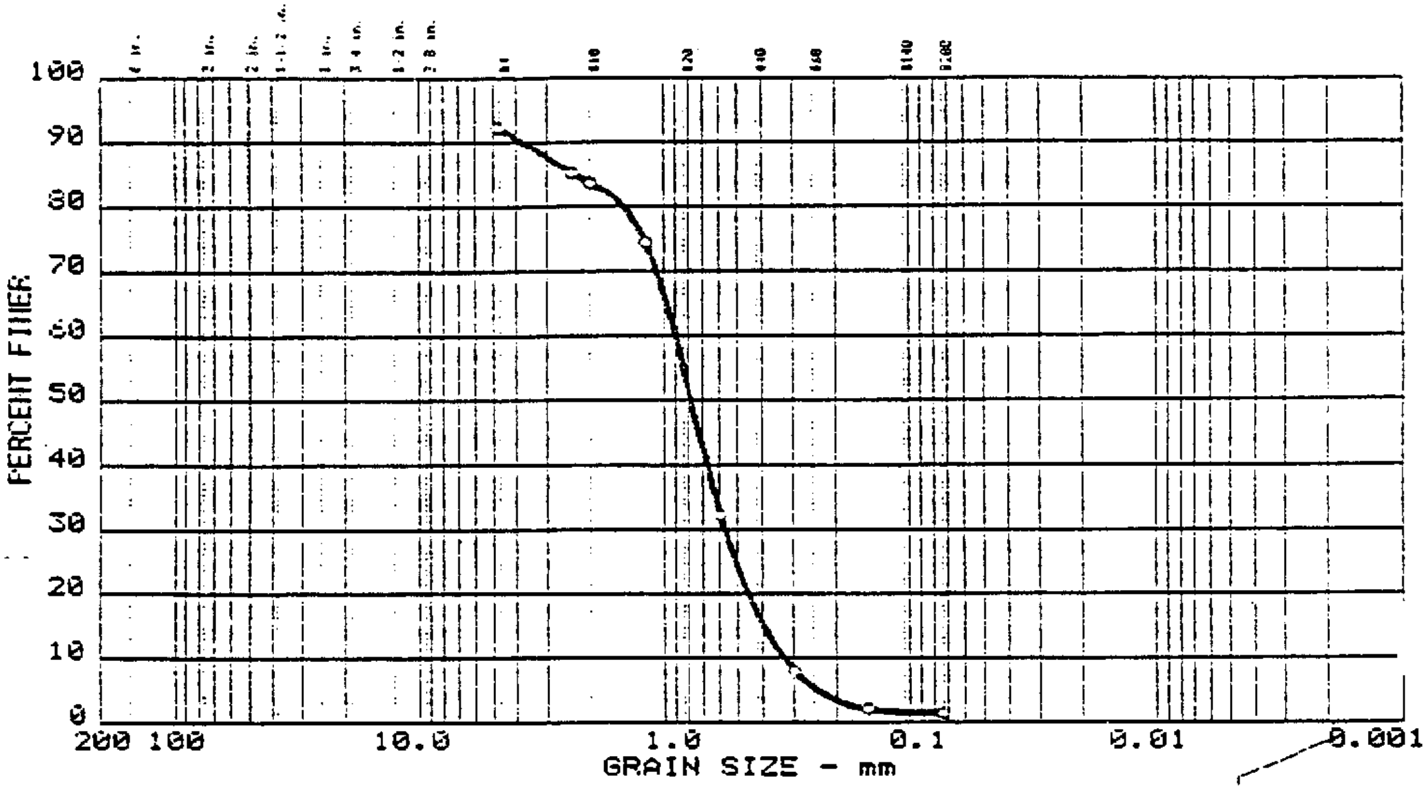
FIGURE E-11

GRAIN SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	7.7	90.9	1.4	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	37	17	2.32	0.90	0.78	0.565	0.3954	0.3251	1.09	2.8

MATERIAL DESCRIPTION	USCS	AASHTO
○	PROBABLE SP	

Project No.: 01-0192-05-1677-000
Project: EARTH TECHNOLOGY CORP.
○ Location: SM-5 92 451.5 FEET / SANTA MONICA MTN

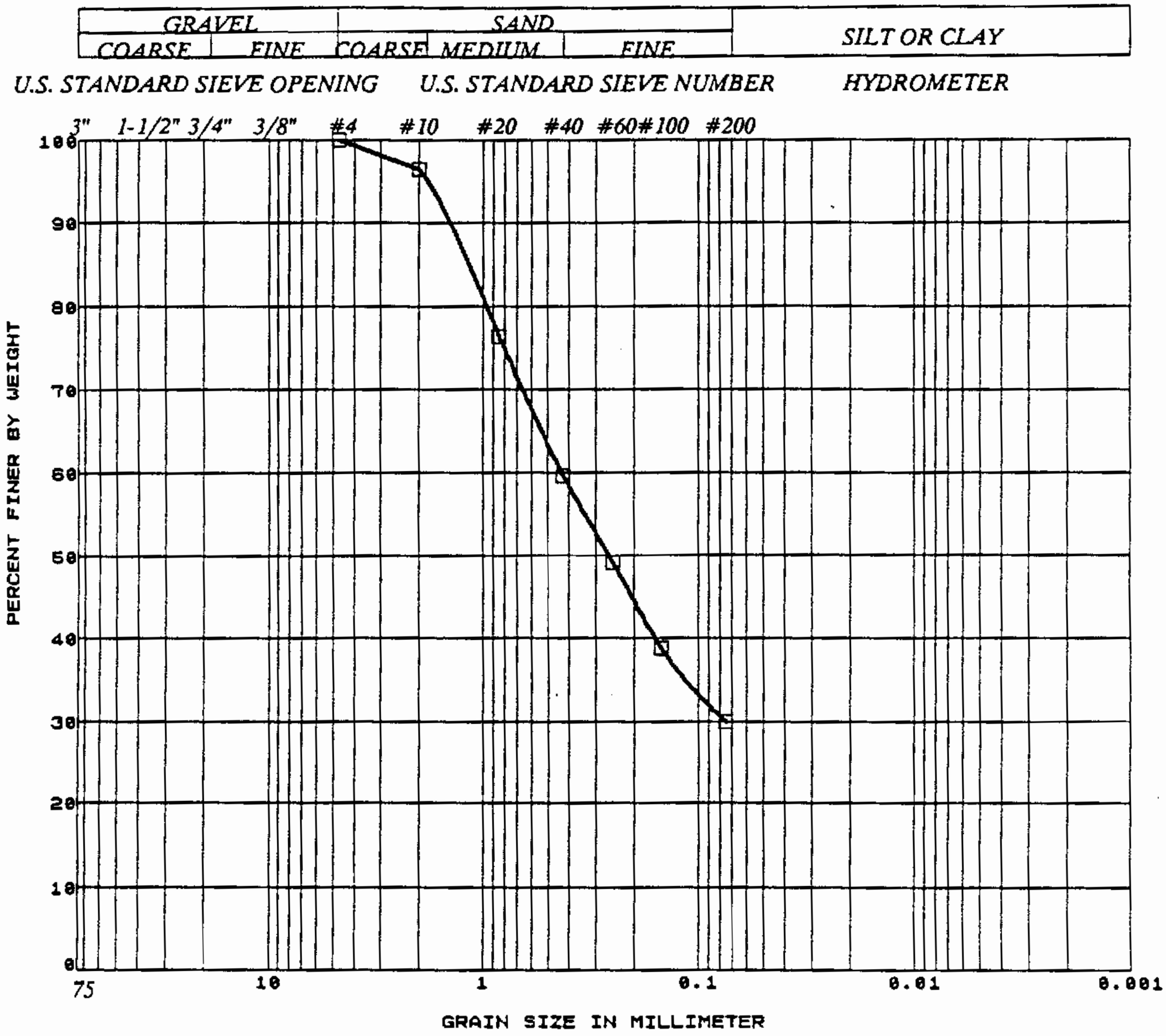
Date: JANUARY 4, 1993

Remarks:

SM-5 92 451.5 FEET

GRAIN SIZE DISTRIBUTION TEST REPORT
SCIENCE APPLICATIONS INT'L CORP.

FIGURE E-12



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
□	*SM-11*	*S2*	*8.5 - 10.0*		*SC*	*39*	*19*

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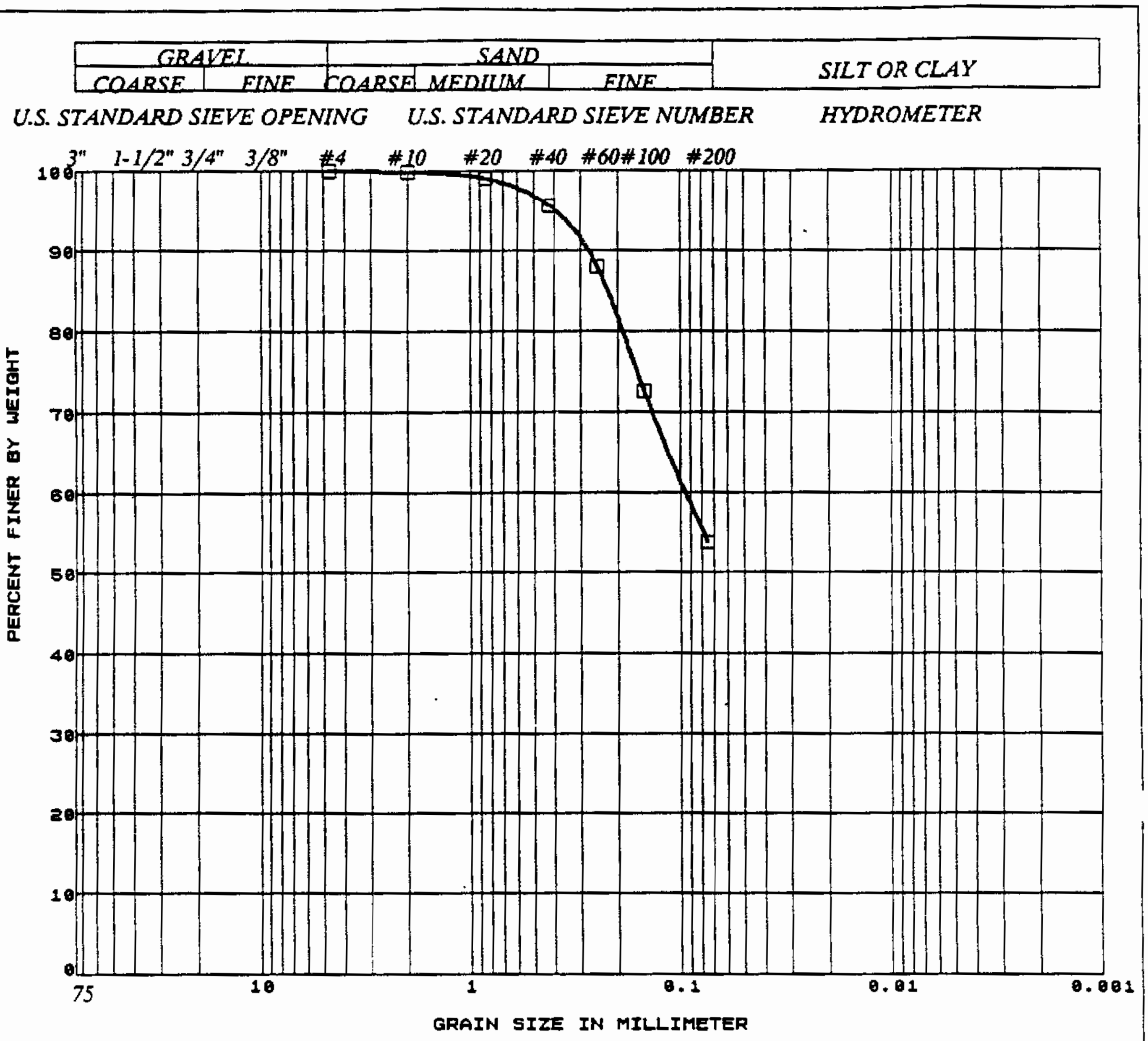
FIGURE E-13



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
☐	*SM-12*	*R1*	*3.8 - 4.4*		*CL*	*37*	*20*

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GRAIN SIZE
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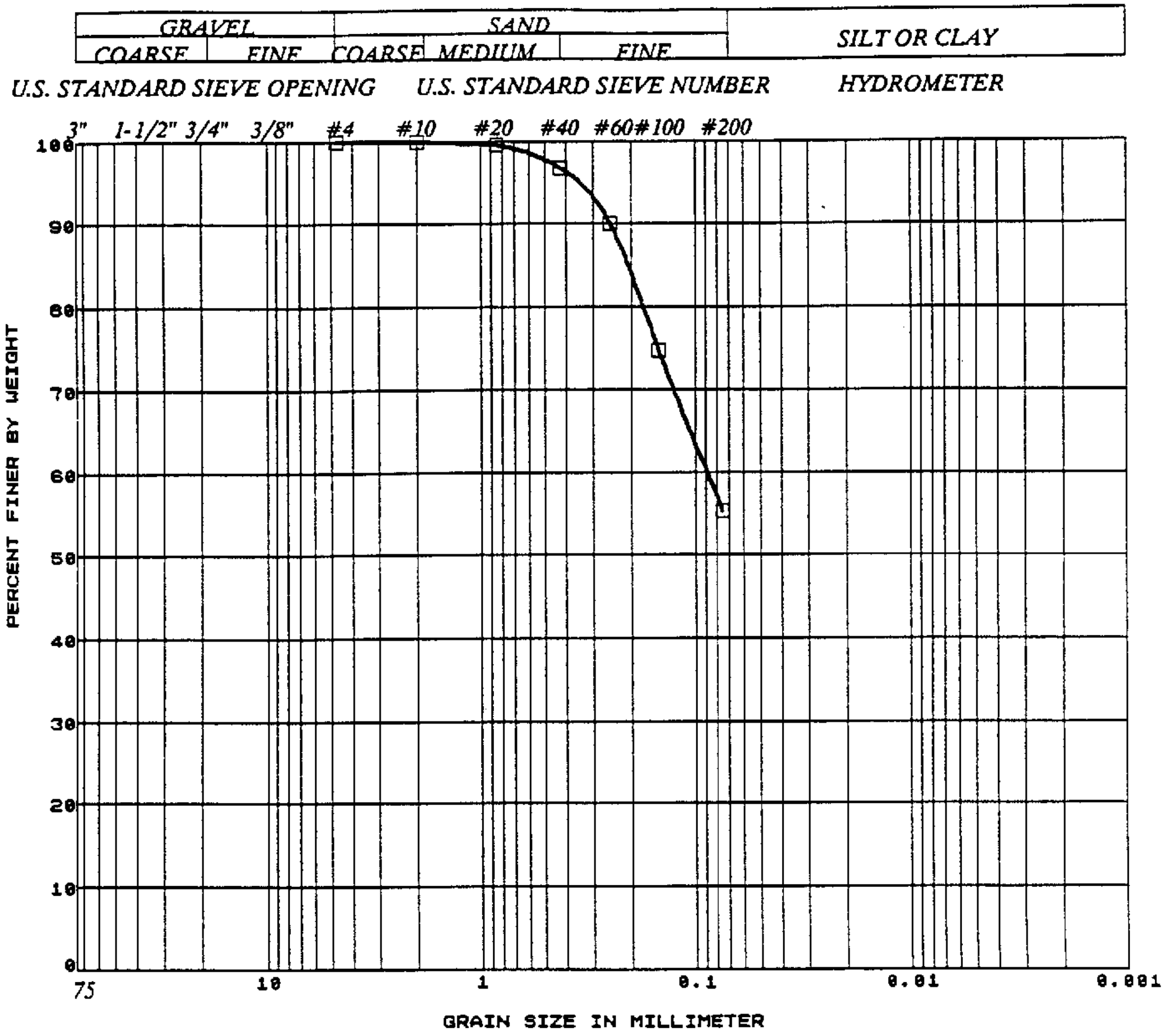
FIGURE E-14



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTI-CITY INDEX
□	SM-12	R2	6.9 - 7.4		CL	35	19

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GRAIN SIZE
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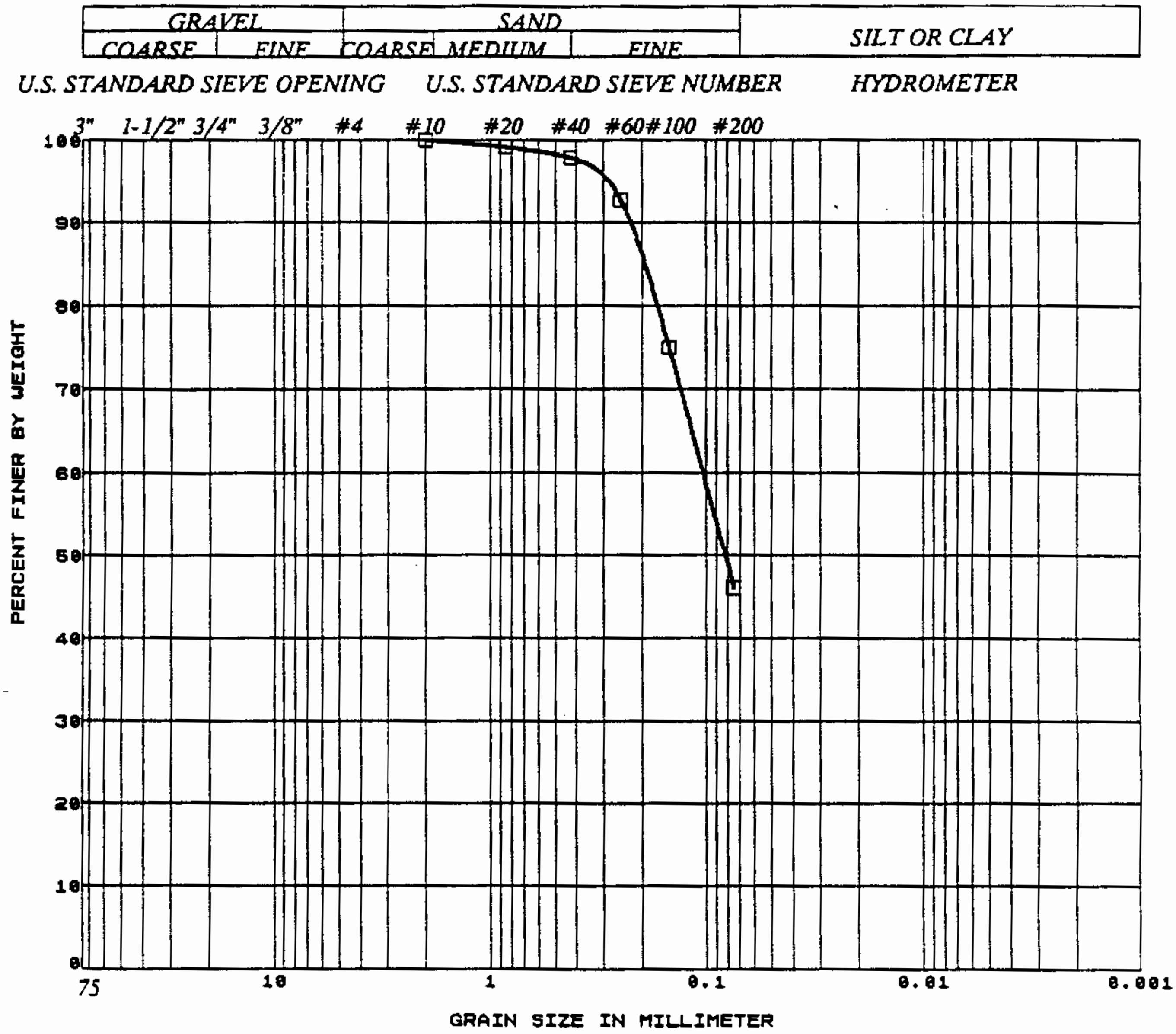
FIGURE E-15



SYMBOL	BORING NO.	SAMPLE NO.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTICITY INDEX
☐	*SM-13*	*T5*	*15.0 - 20.0*		*SC*	*30*	*8*

The Earth Technology Corporation	PROJECT NAME: METRO RED LINE SEGMENT 3

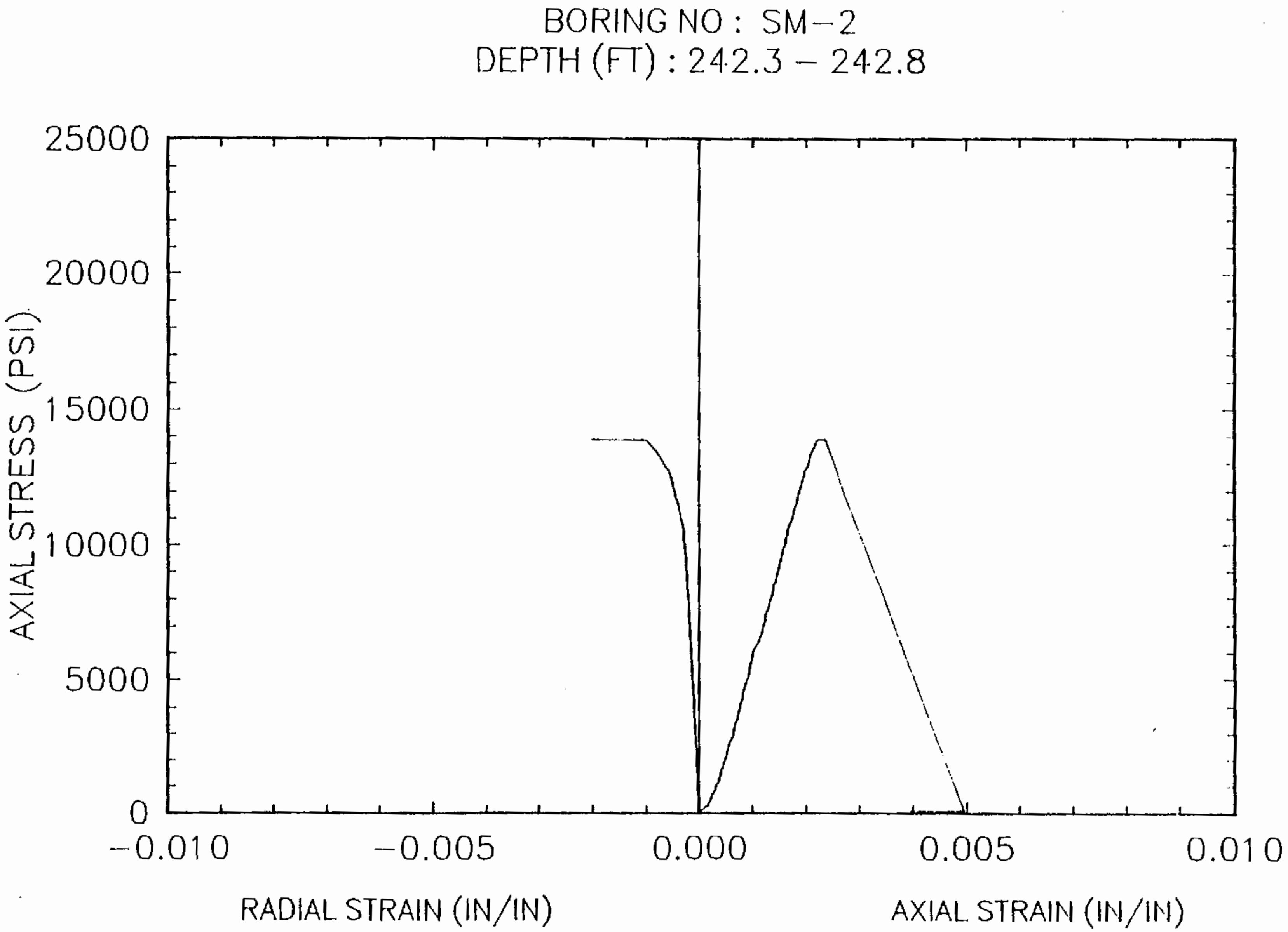
GRAIN SIZE

DISTRIBUTION CURVE

12/92

FIGURE E-16

STRESS-STRAIN PLOTS


BORING NO : SM-2
DEPTH (FT) : 242.3 - 242.8
AXIAL STRESS (PSI)
25000
20000
15000
10000
5000
0
-0.010
-0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

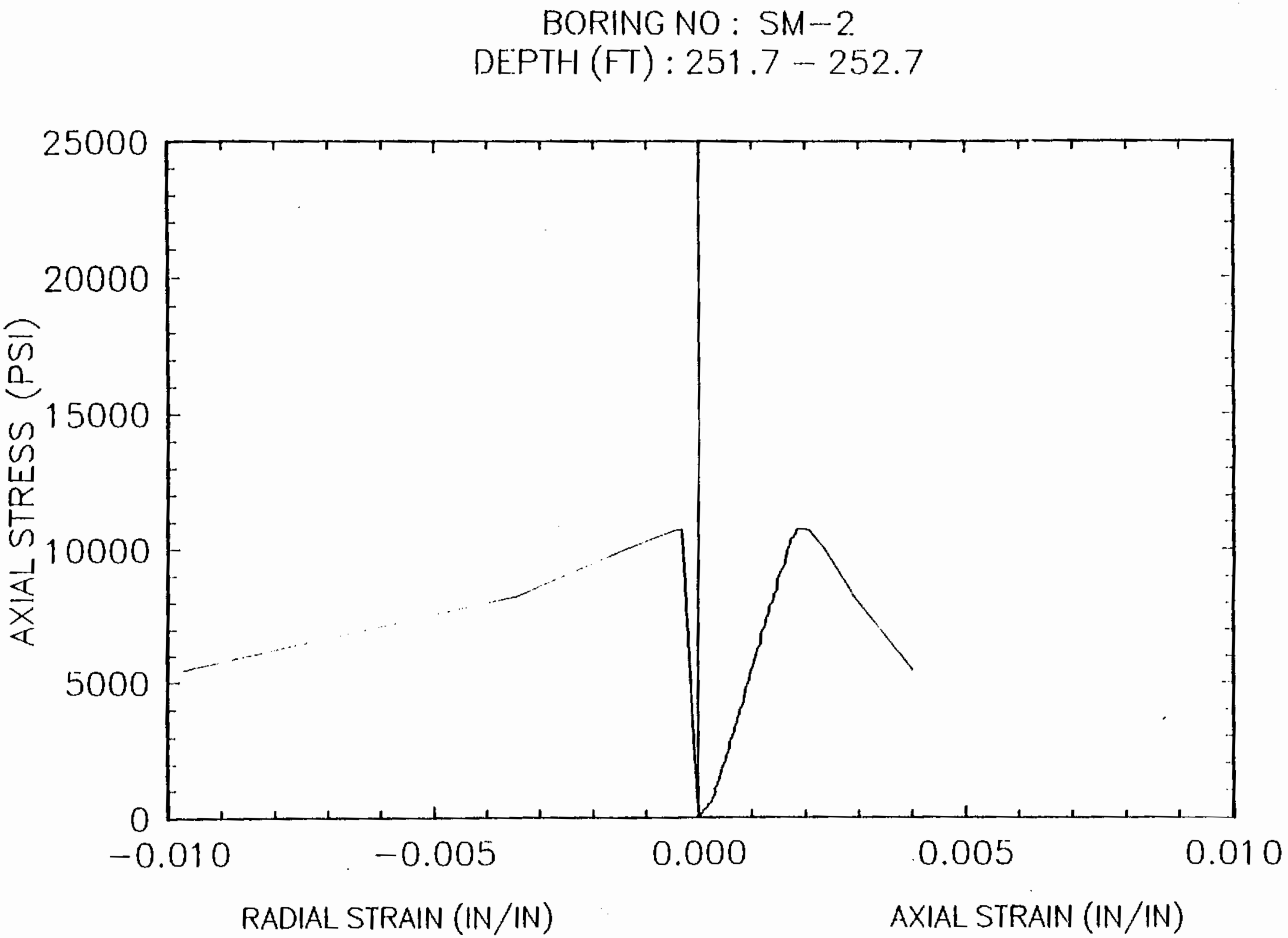

BORING NO : SM-2
DEPTH (FT) : 251.7 - 252.7
AXIAL STRESS (PSI)
25000
20000
15000
10000
5000
0
-0.010
-0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

FIGURE E-18

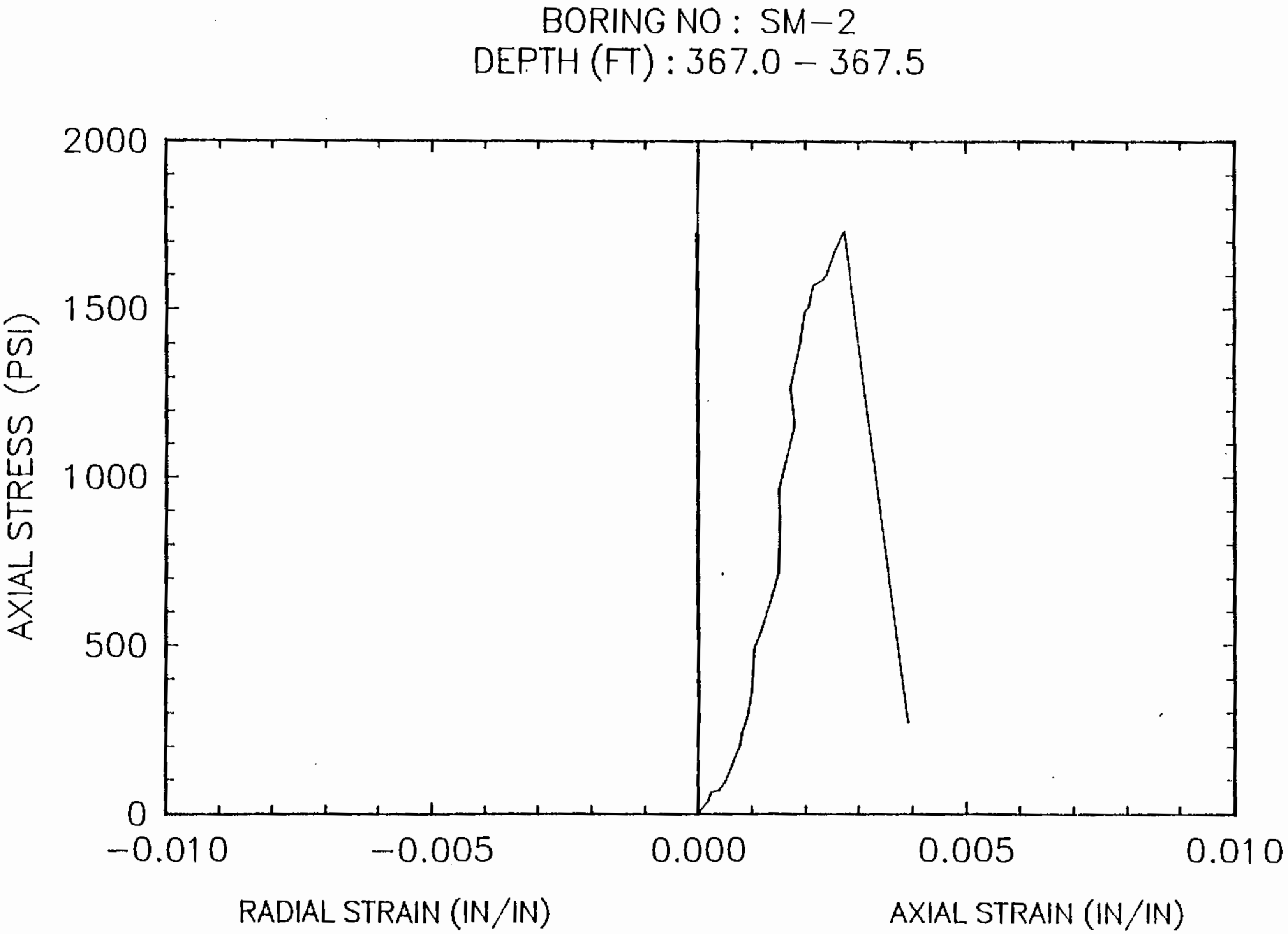

BORING NO : SM−2
DEPTH (FT) : 367.0 − 367.5
2000
1500
1000
500
0
AXIAL STRESS (PSI)
−0.010
−0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

FIGURE E-19

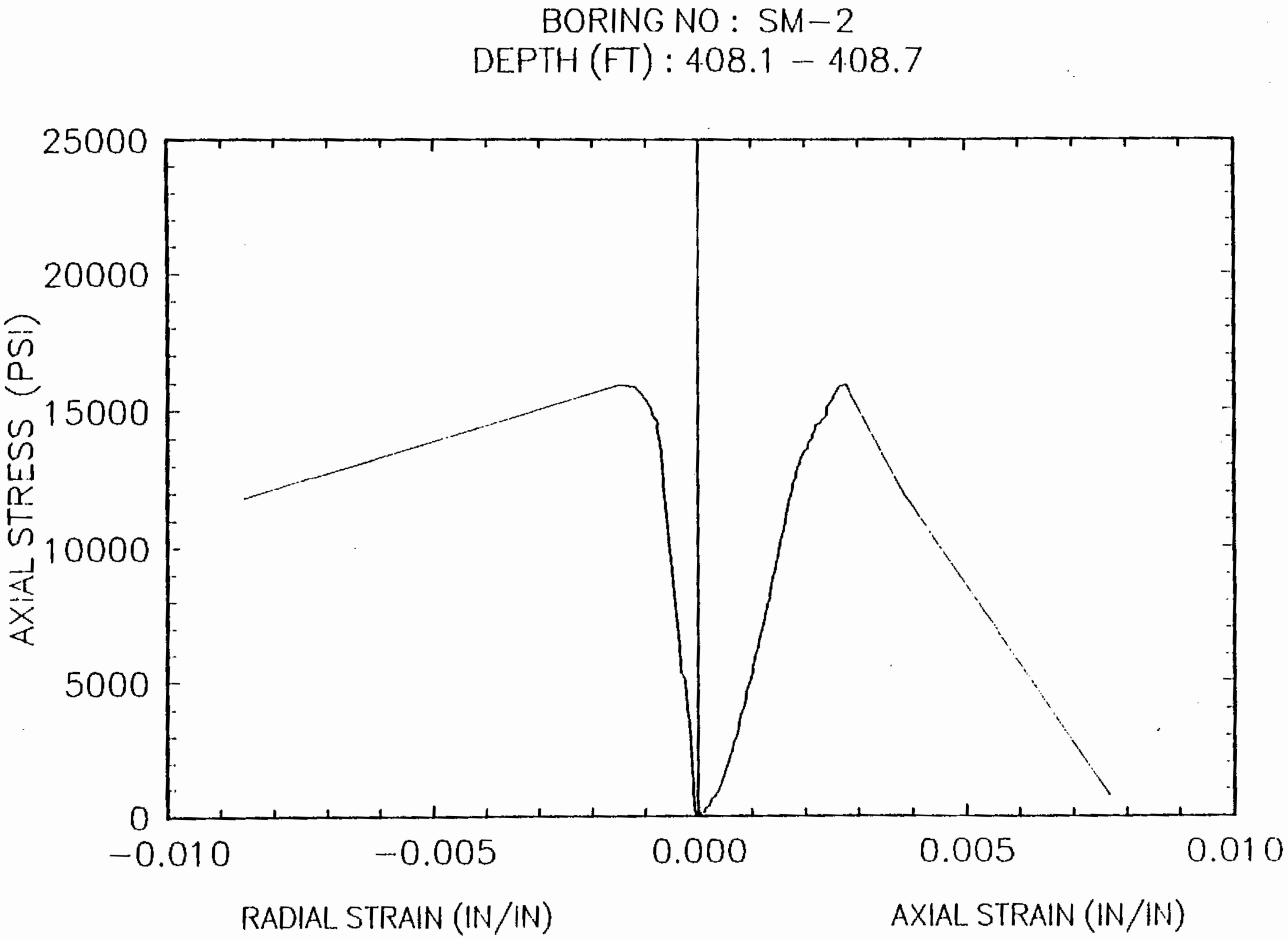
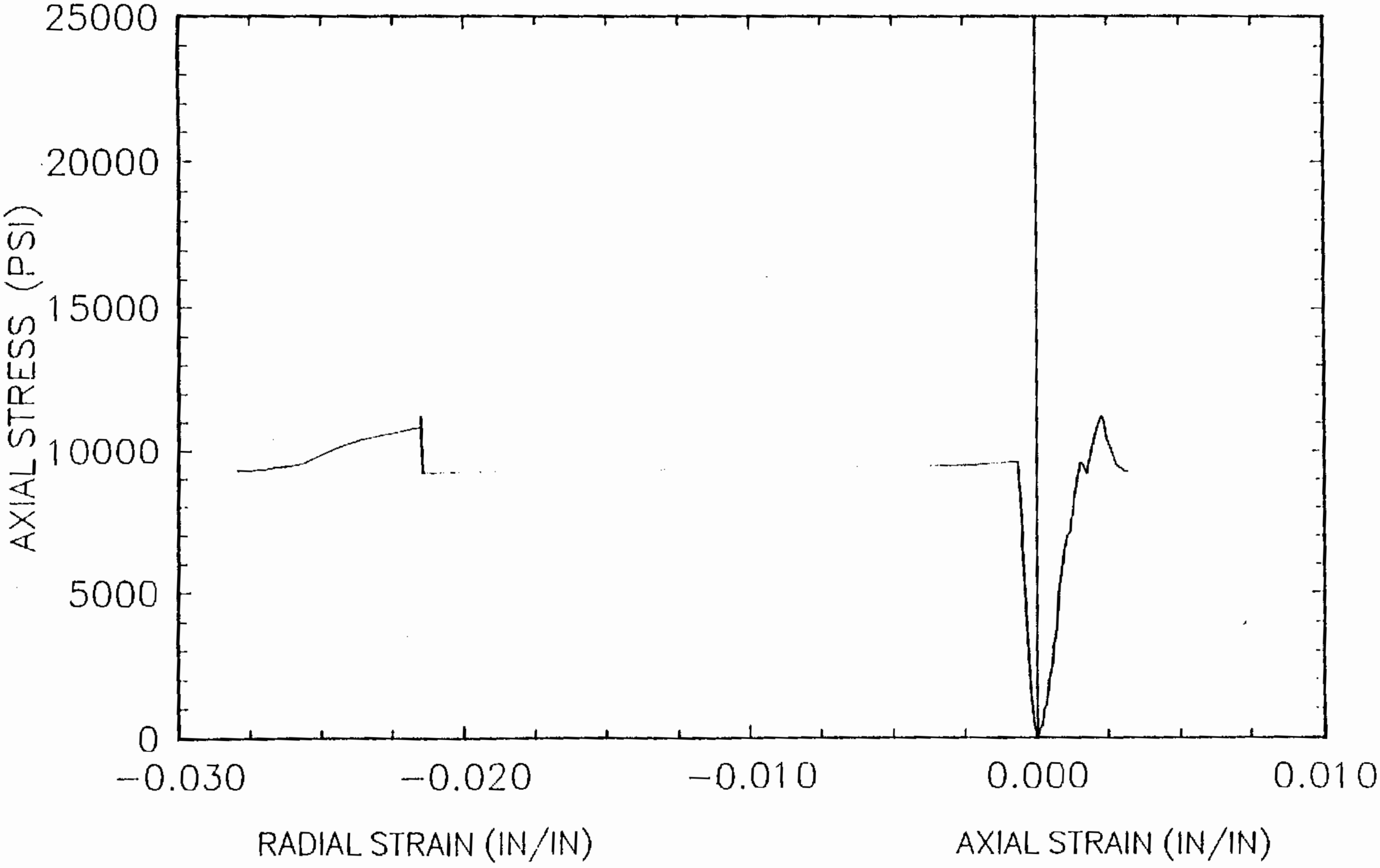

BORING NO : SM−2
DEPTH (FT) : 408.1 − 408.7
AXIAL STRESS (PSI)
25000
20000
15000
10000
5000
0
−0.010
−0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

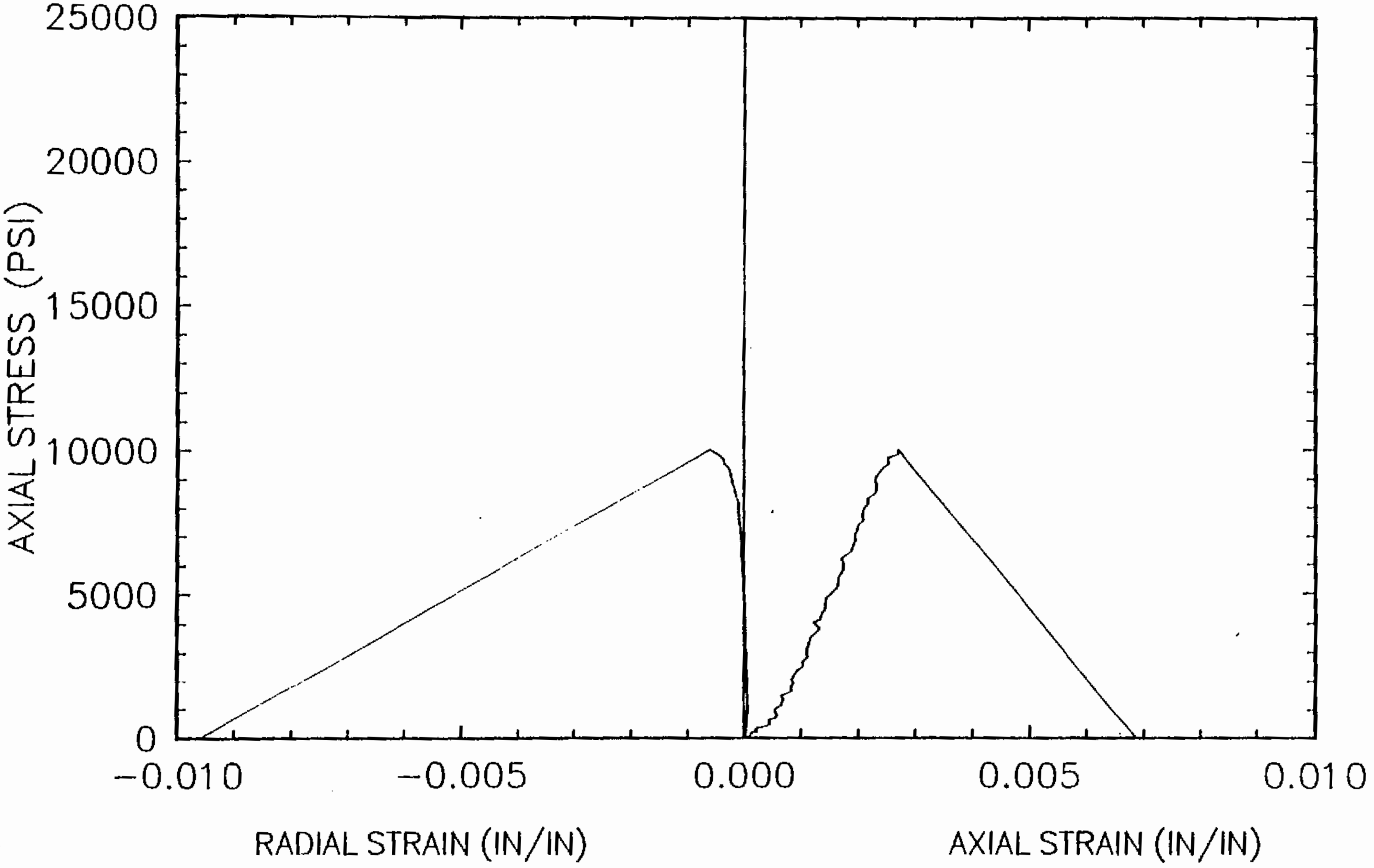
FIGURE E-20



BORING NO : SM−3
DEPTH (FT) : 223.7 − 224.8

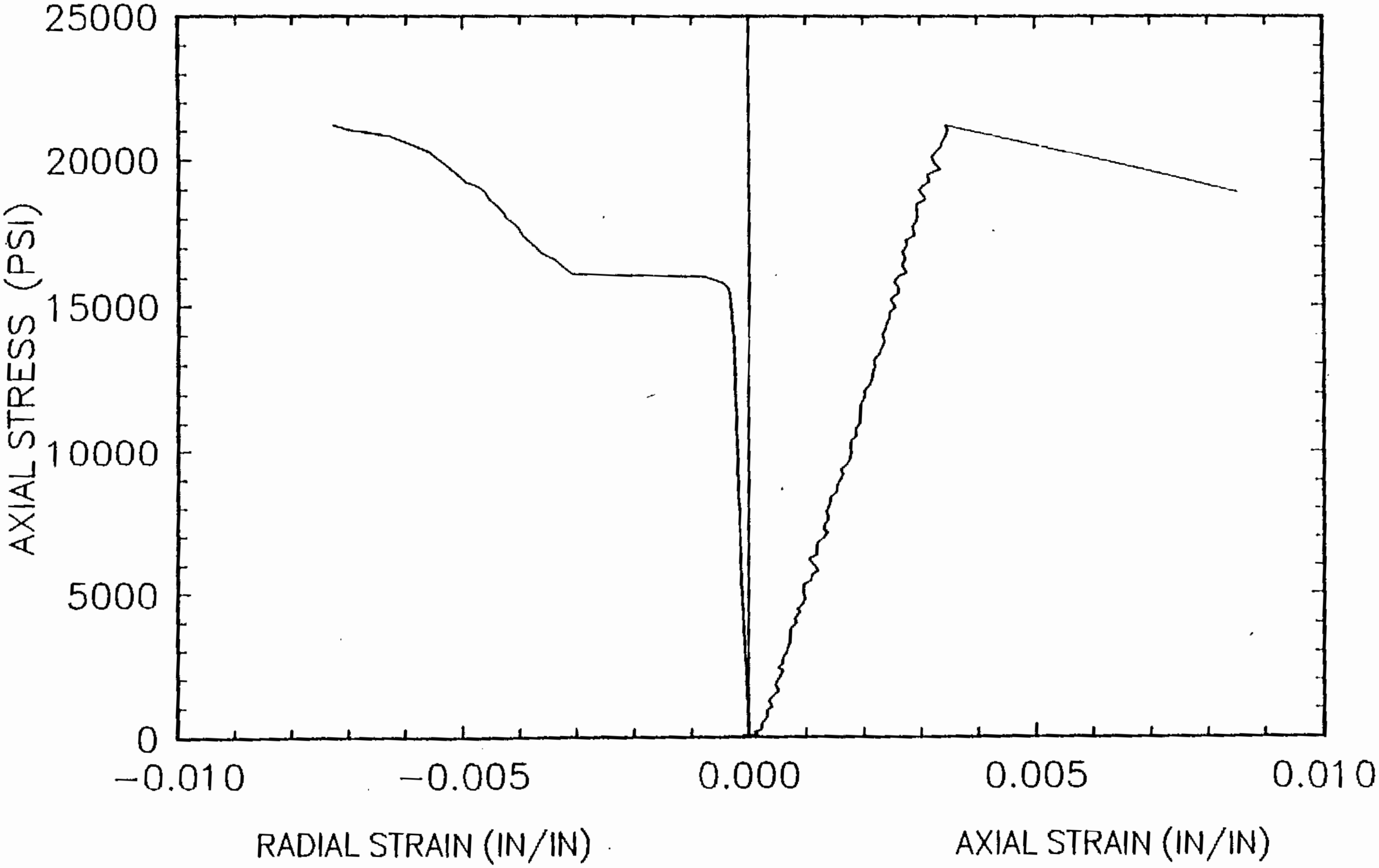
FIGURE F-21

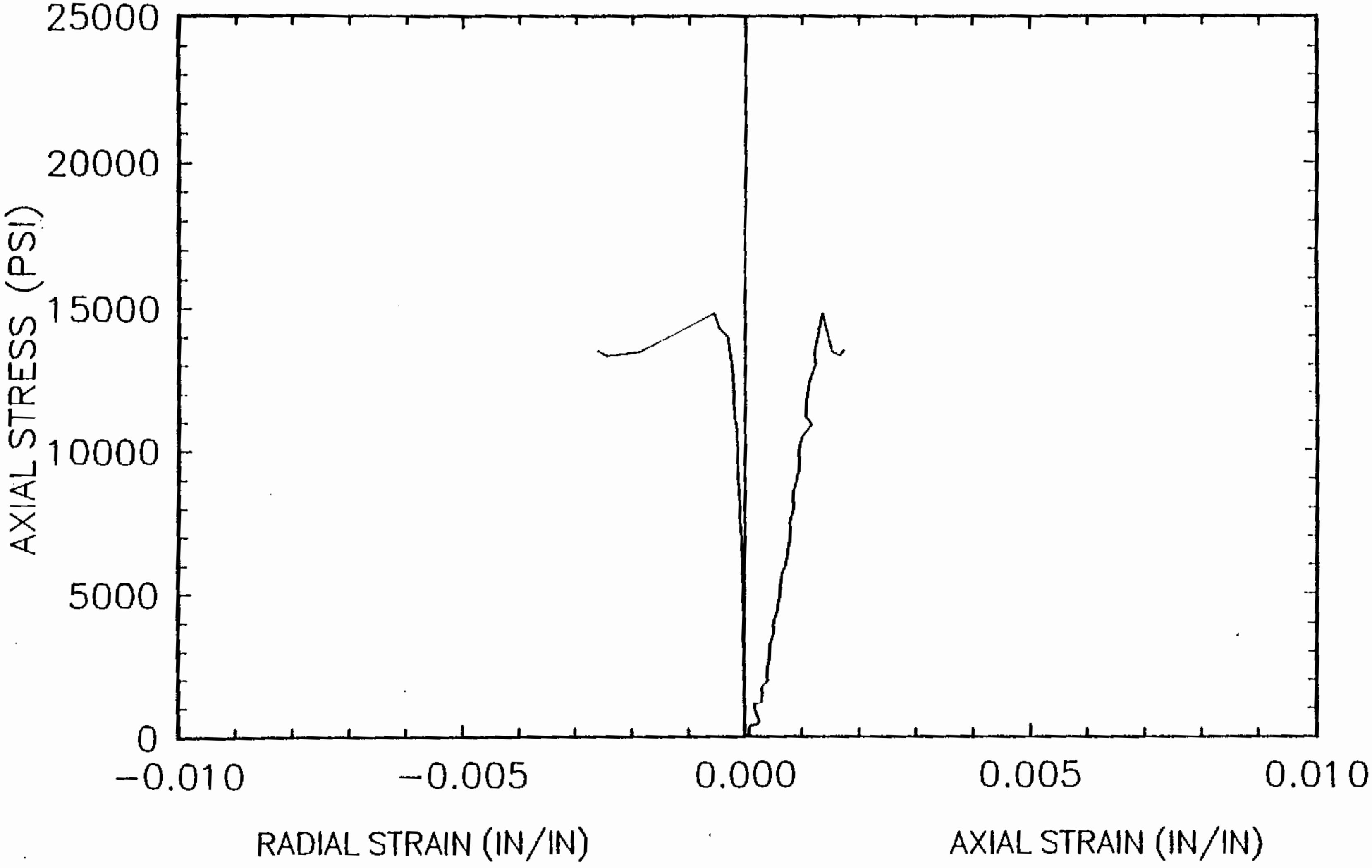
BORING NO : SM–3
DEPTH (FT) : 335.3 – 335.9



URE E-22

BORING NO : SM−3
DEPTH (FT) : 338.0 − 339.0





BORING NO : SM−3
DEPTH (FT) : 345.0 − 345.5

URE E-24

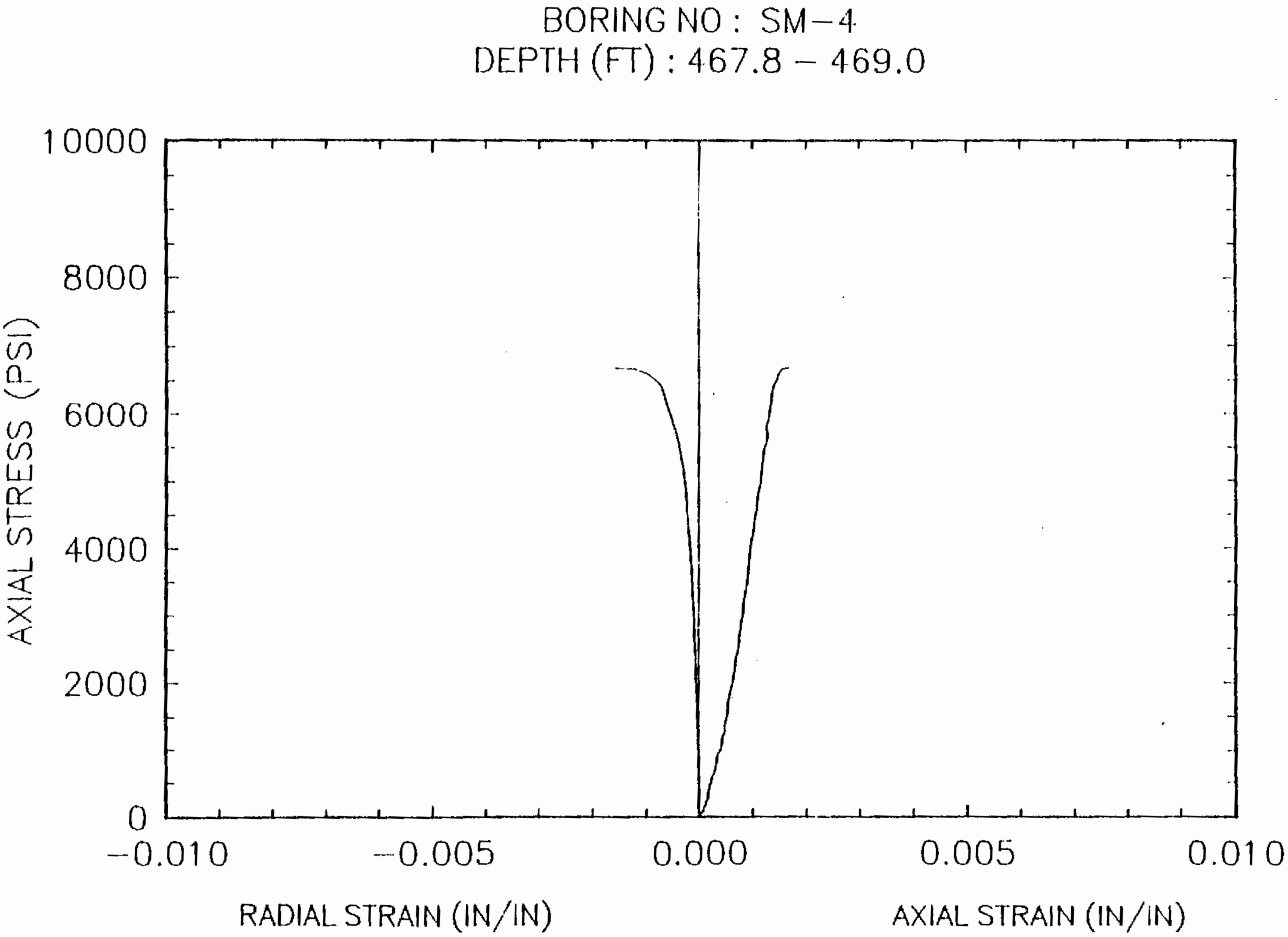
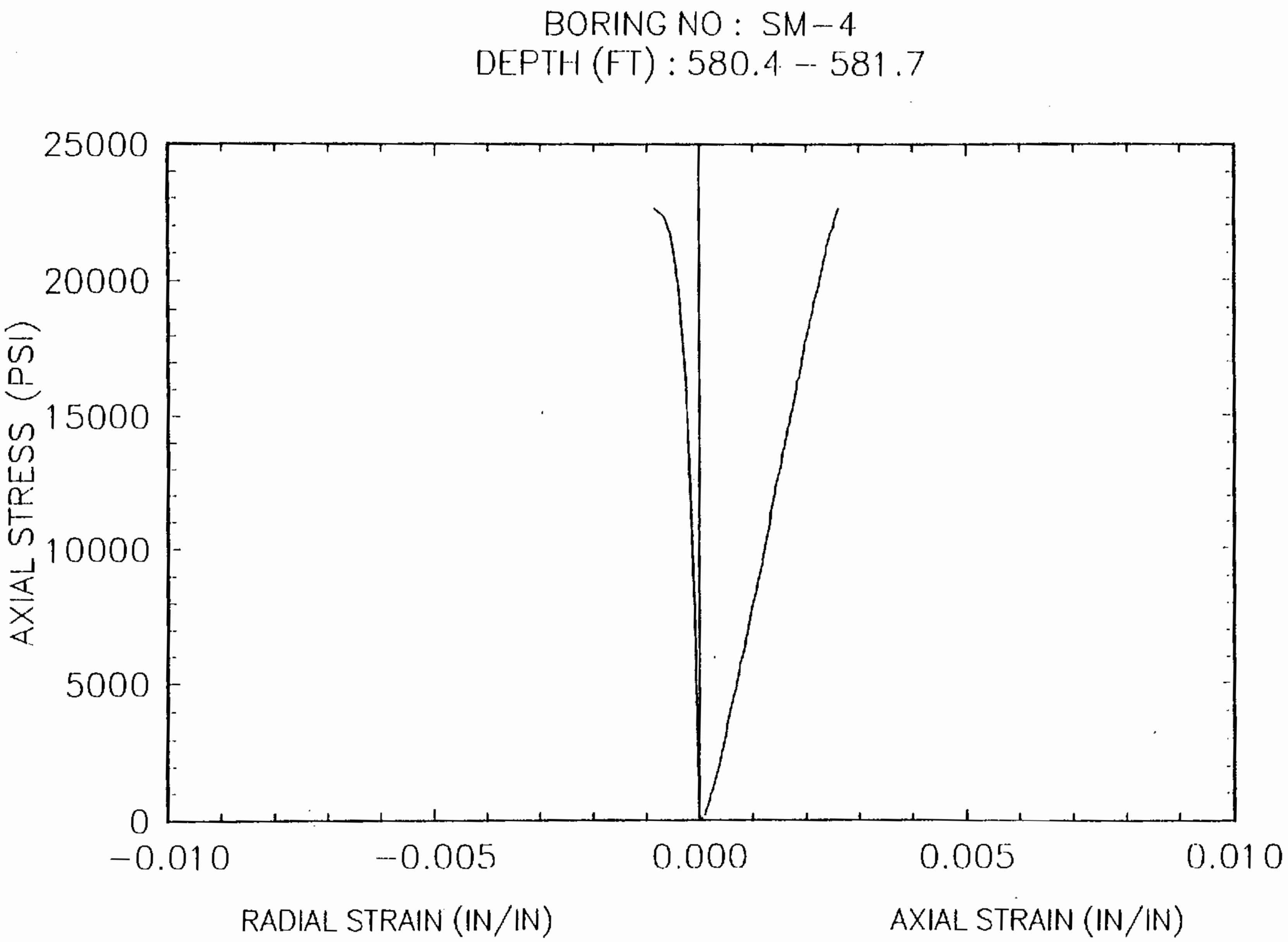

BORING NO : SM−4
DEPTH (FT) : 467.8 − 469.0
AXIAL STRESS (PSI)
10000
8000
6000
4000
2000
0
−0.010
−0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

FIGURE E-25


BORING NO : SM–4
DEPTH (FT) : 580.4 – 581.7
25000
20000
15000
10000
5000
0
AXIAL STRESS (PSI)
–0.010
–0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

ꟷURE E-26

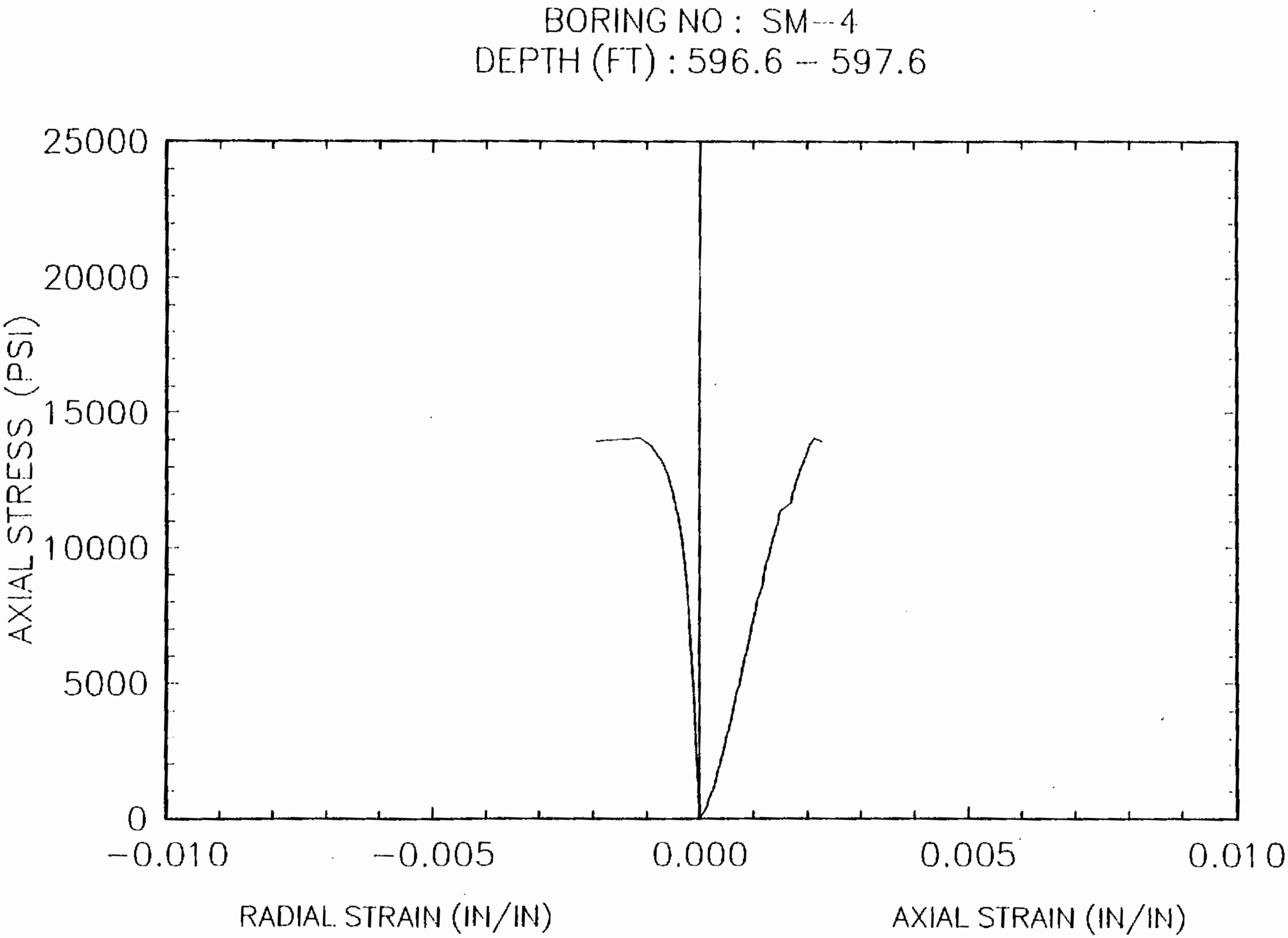
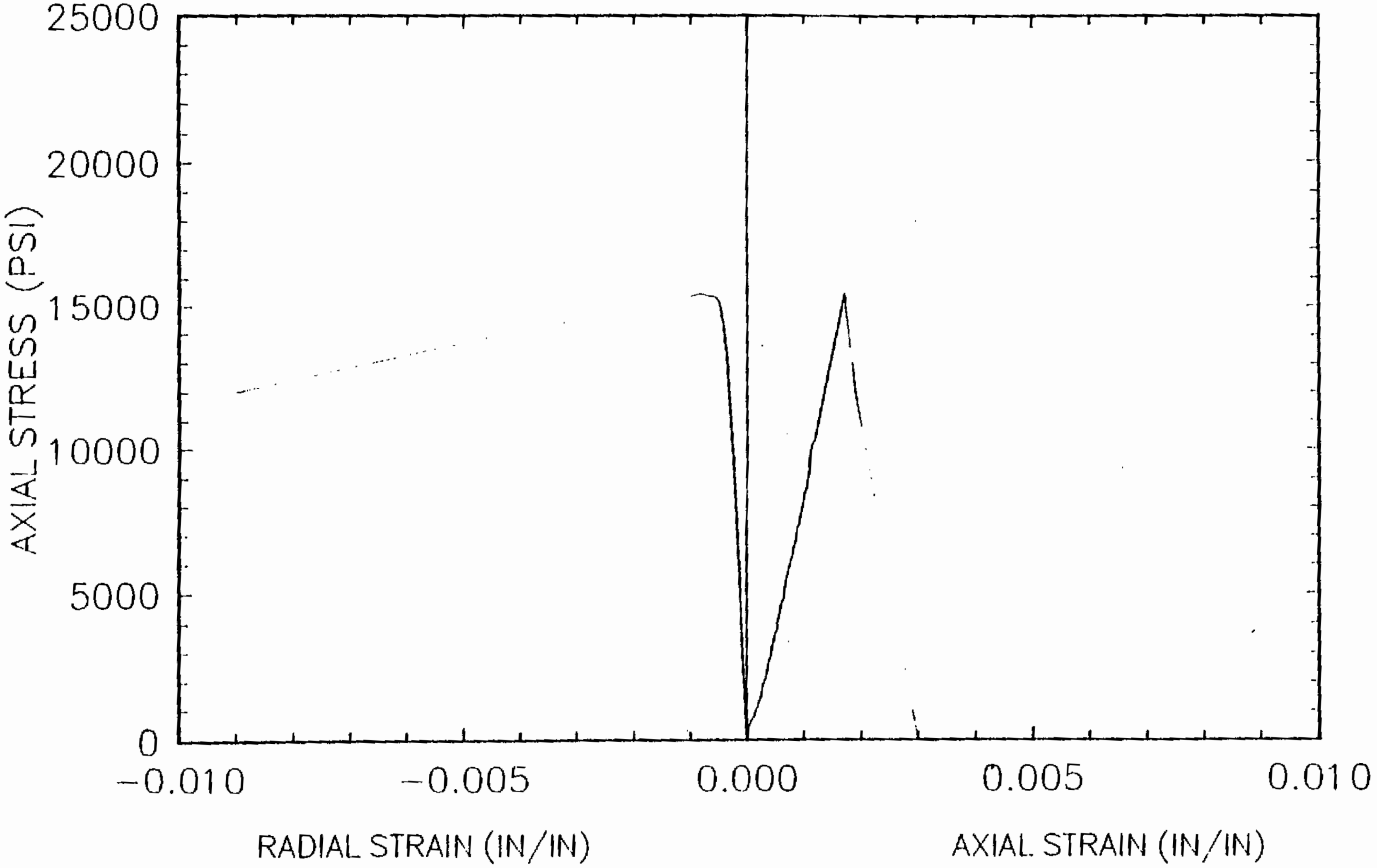

BORING NO : SM-4
DEPTH (FT) : 596.6 – 597.6
AXIAL STRESS (PSI)
25000
20000
15000
10000
5000
0
−0.010
−0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

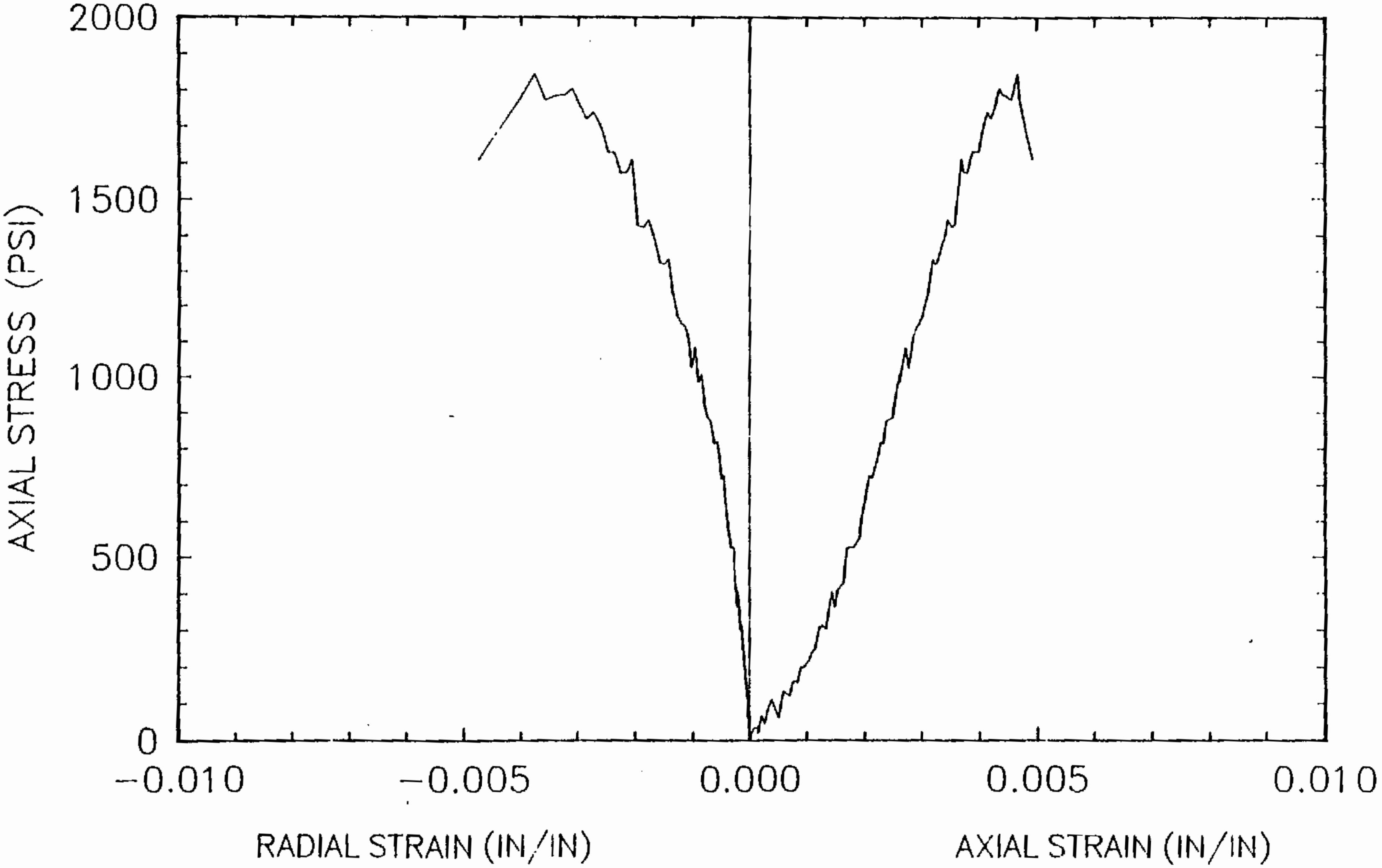
FIGURE E-27

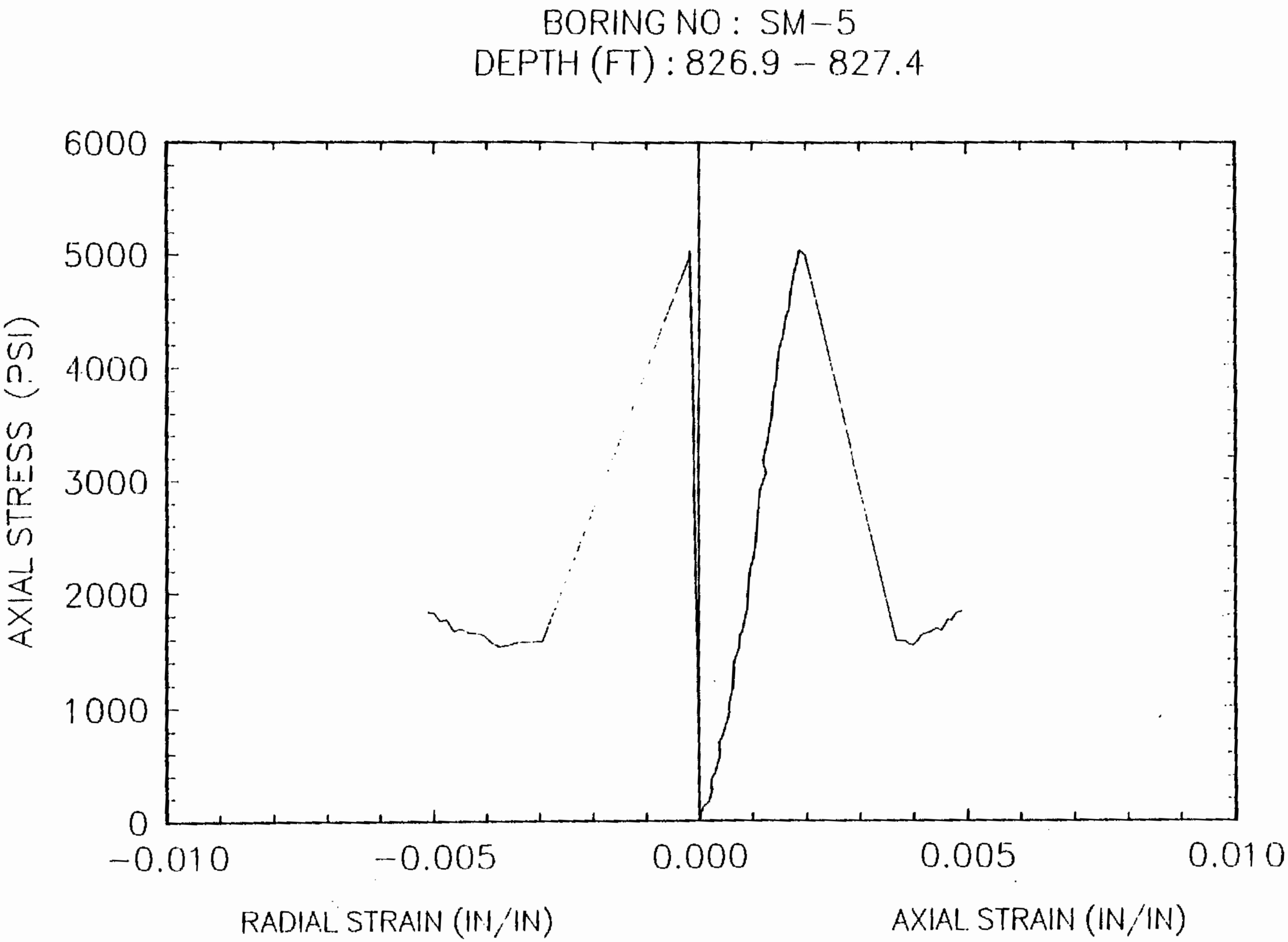
BORING NO : SM-4
DEPTH (FT) : 608.5 - 609.6



GURE E-28

BORING NO : SM–5
DEPTH (FT) : 564.4 – 565.0





BORING NO : SM–5
DEPTH (FT) : 826.9 – 827.4

URE E-30

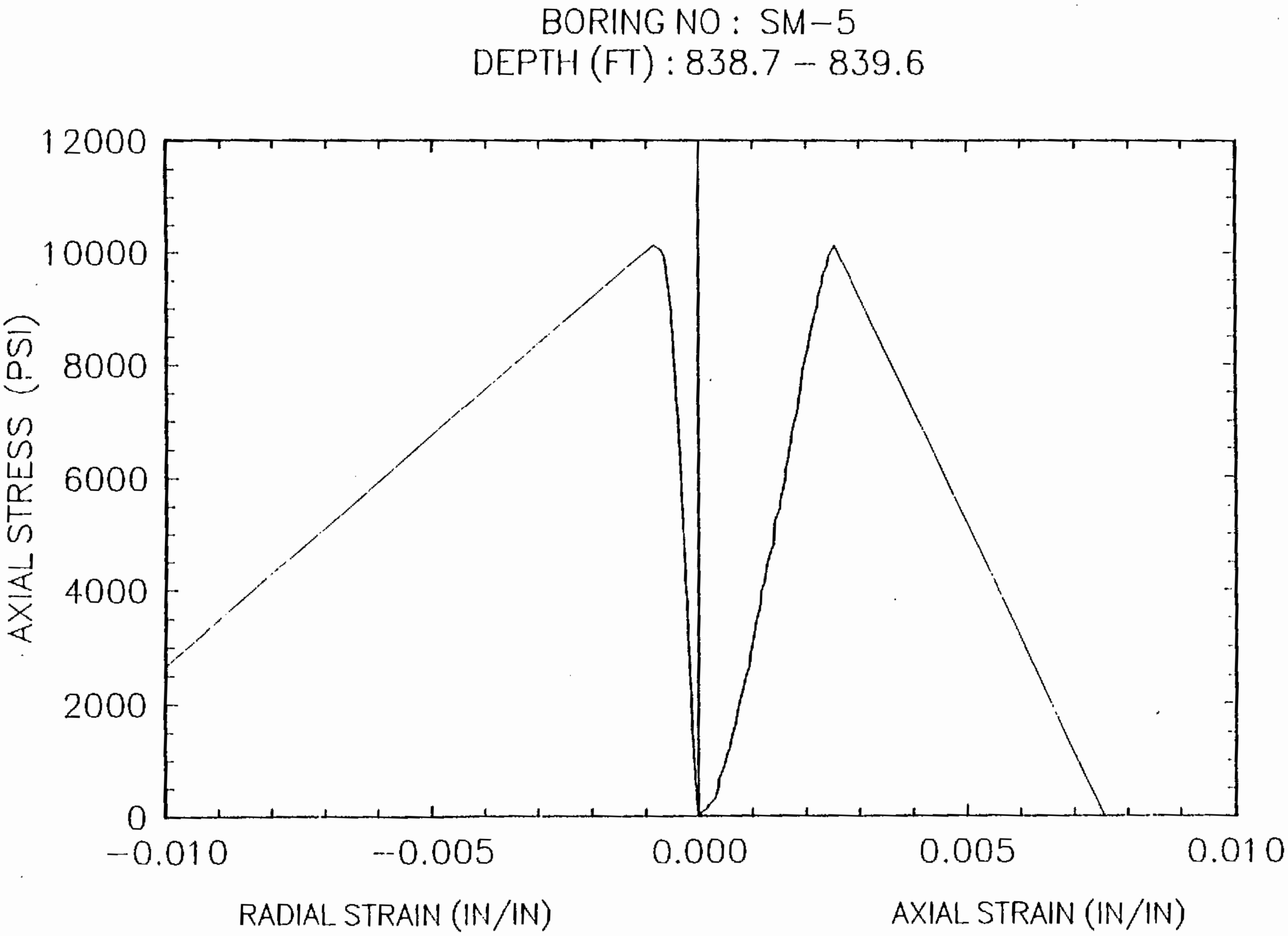

BORING NO : SM–5
DEPTH (FT) : 838.7 – 839.6
12000
10000
8000
6000
4000
2000
0
AXIAL STRESS (PSI)
–0.010
–0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

FIGURE 5.31

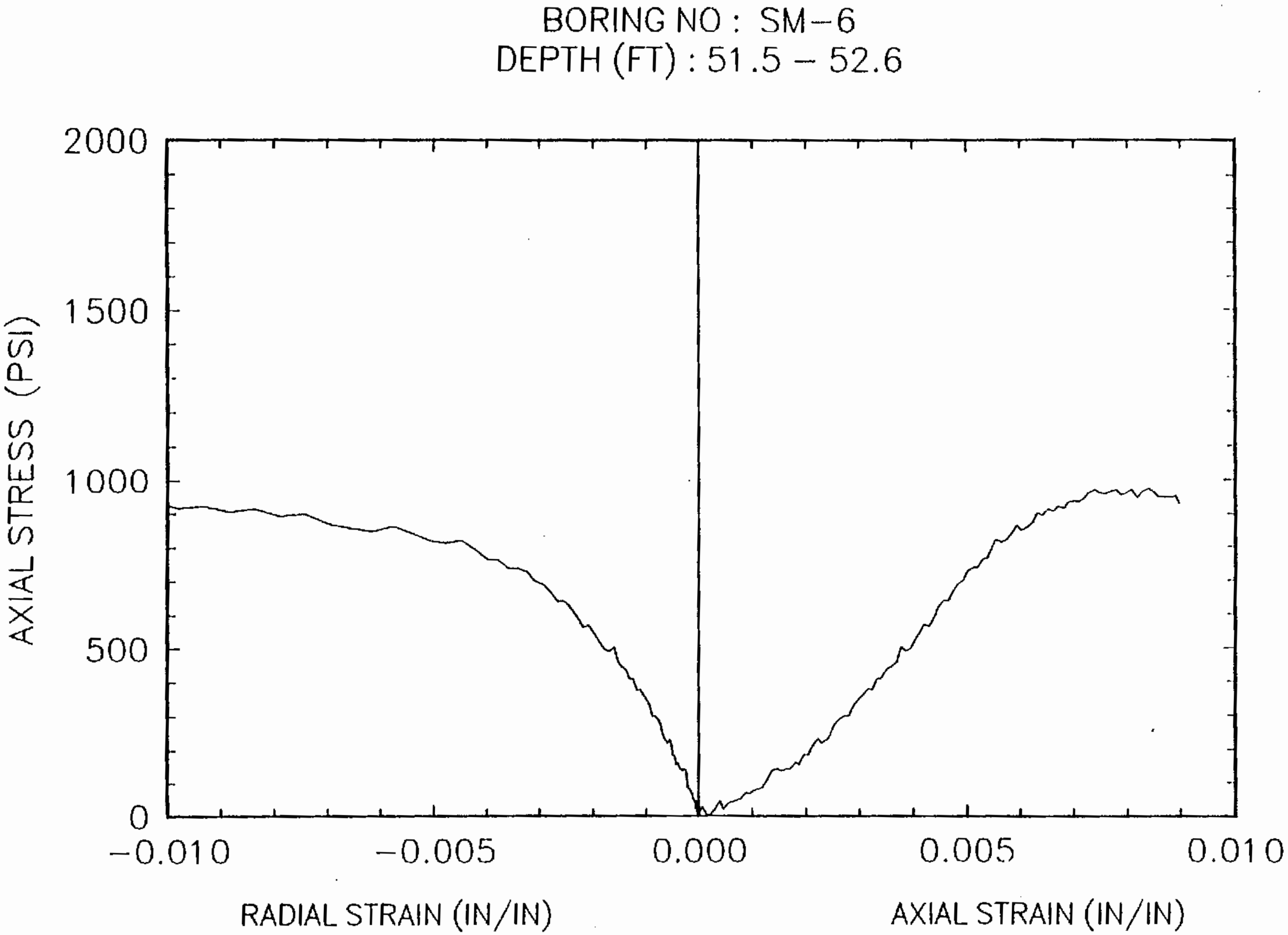
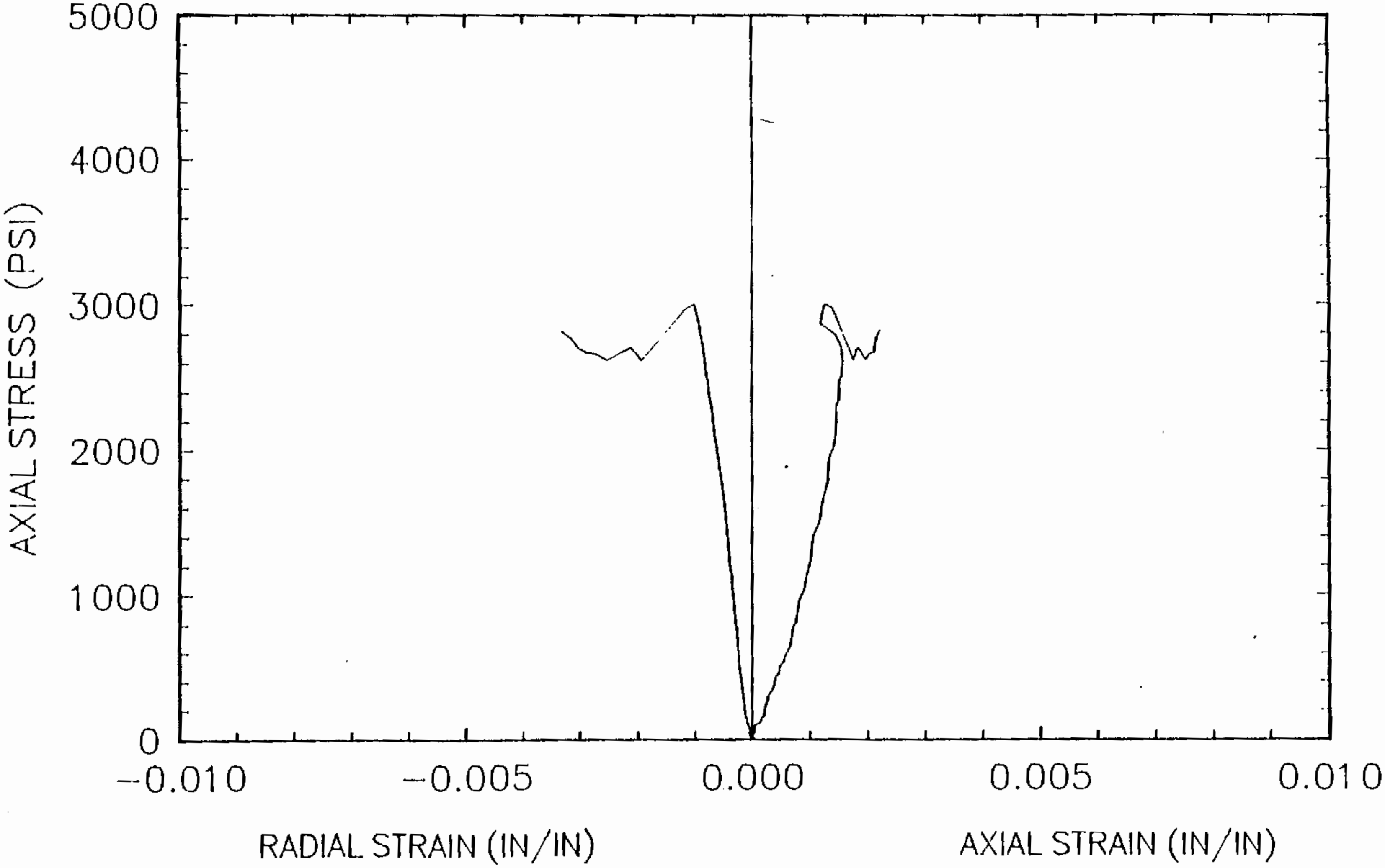
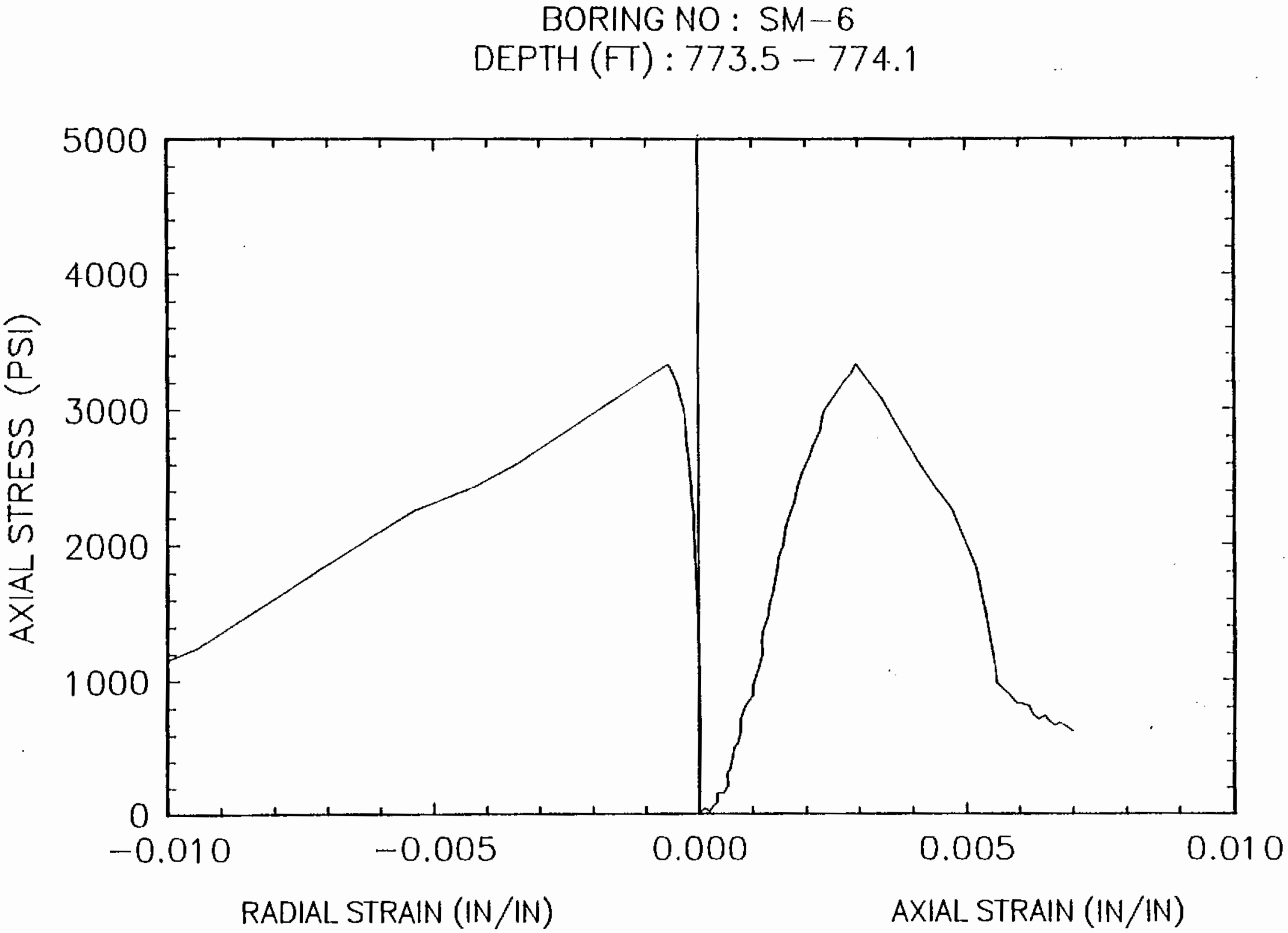

BORING NO : SM-6
DEPTH (FT) : 51.5 - 52.6
2000
1500
1000
500
0
AXIAL STRESS (PSI)
-0.010
-0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

FIGURE E-32

BORING NO : SM-6
DEPTH (FT) : 375.9 - 376.9



FIGURE


BORING NO : SM-6
DEPTH (FT) : 773.5 - 774.1
AXIAL STRESS (PSI)
5000
4000
3000
2000
1000
0
-0.010
-0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

URE E-34

BORING NO : SM−6
DEPTH (FT) : 777.8 − 778.6

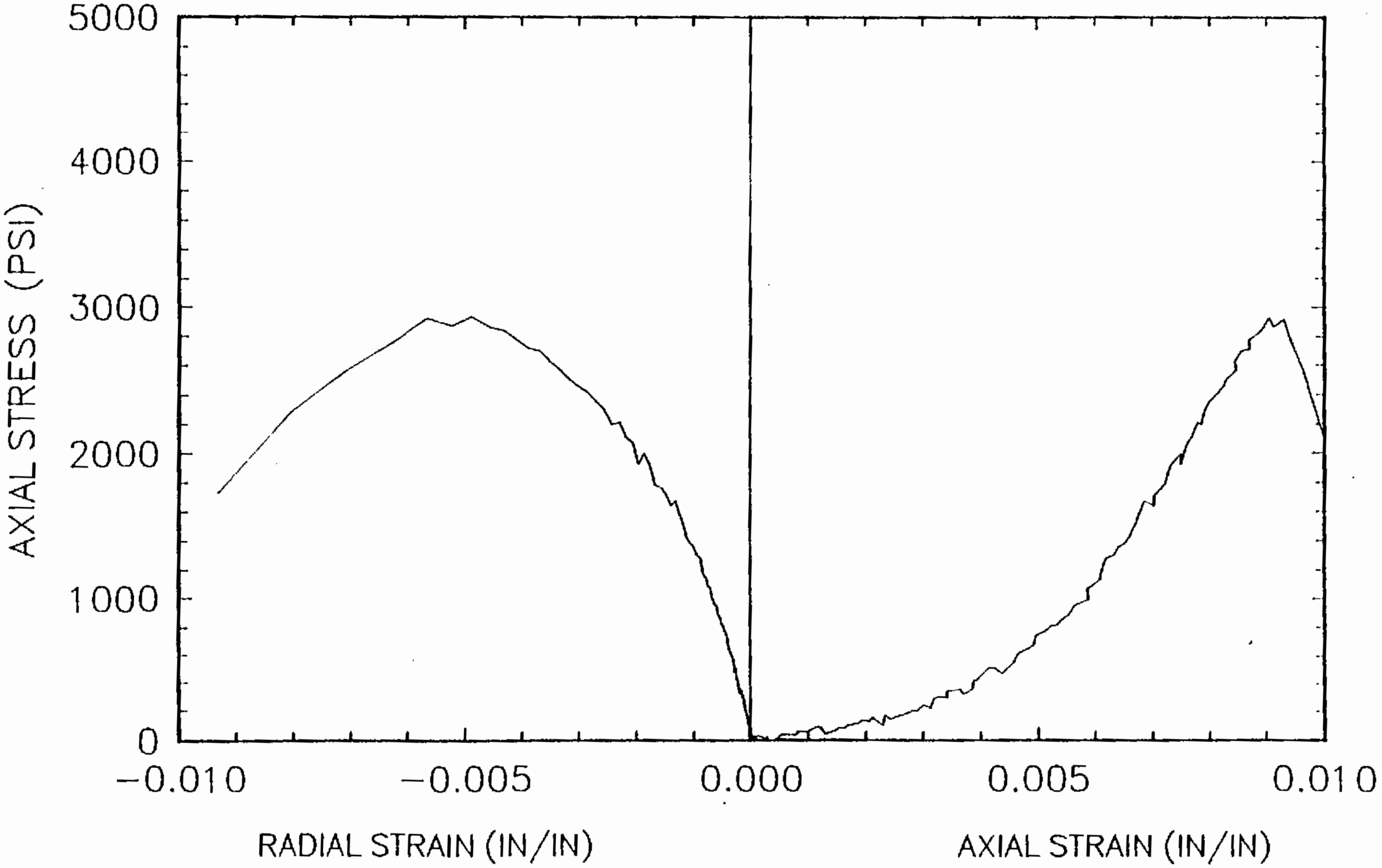
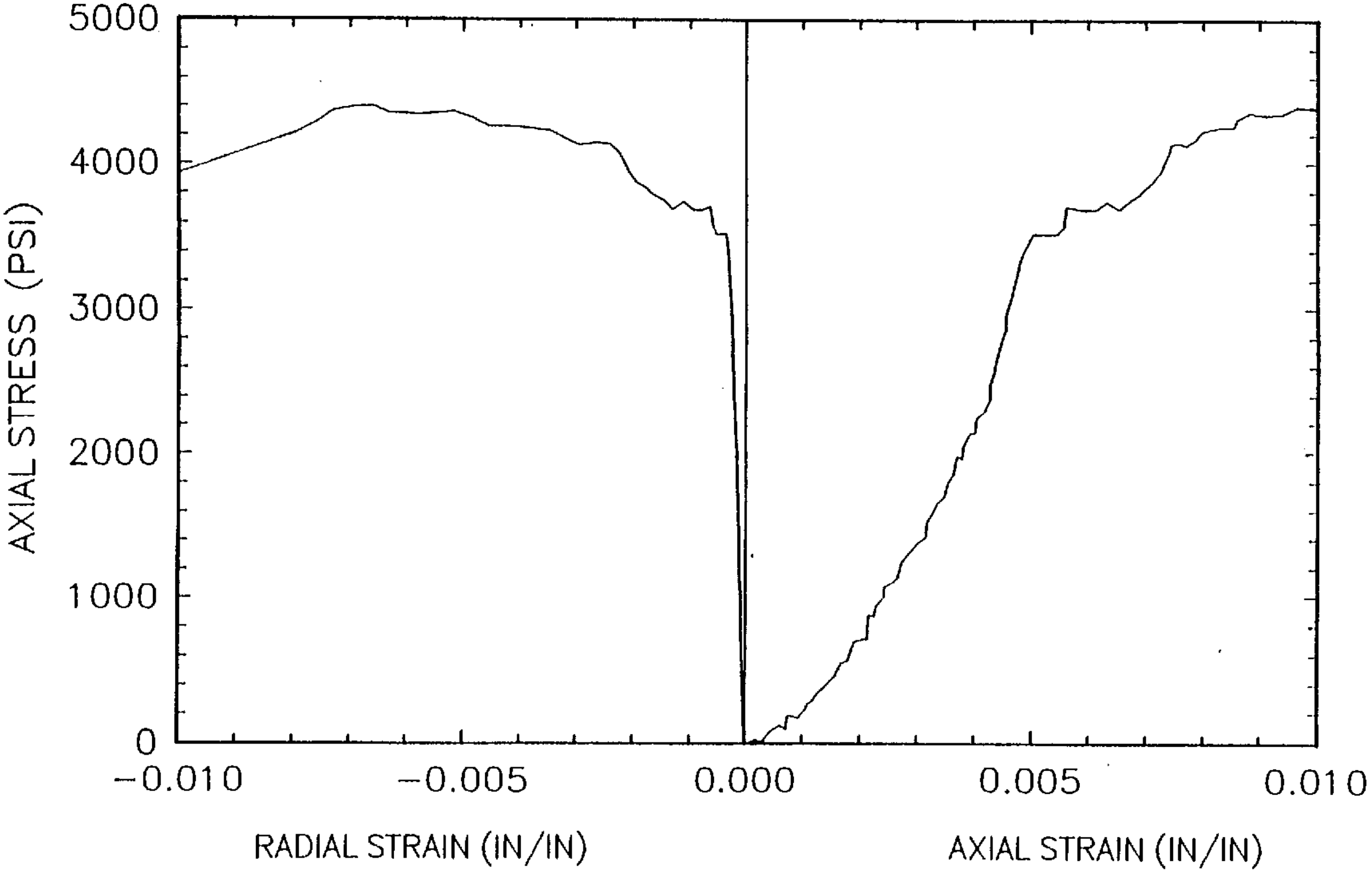
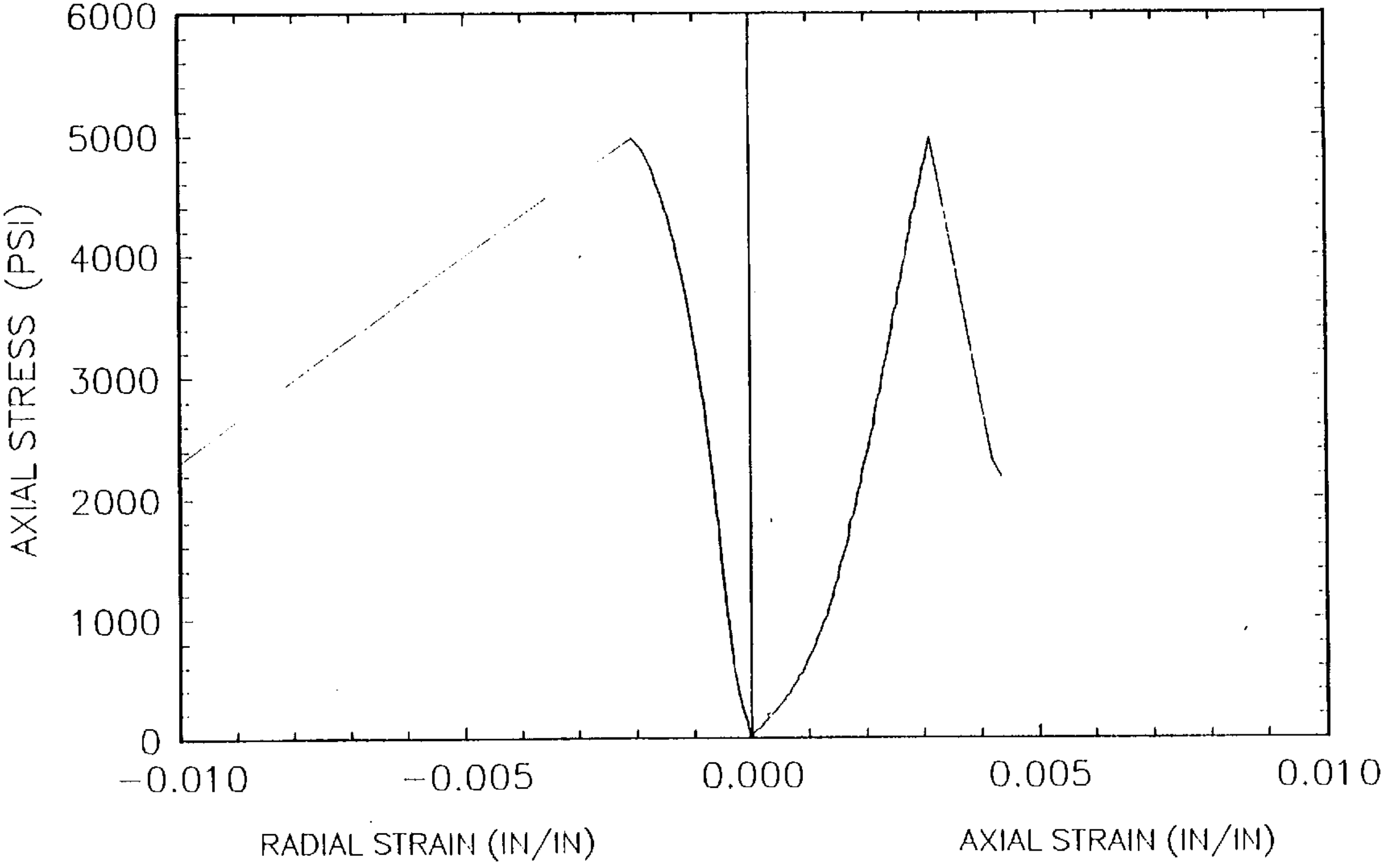


FIGURE F-35



BORING NO : SM-6
DEPTH (FT) : 782.5 - 783.1

GURE E-36



BORING NO : SM–7
DEPTH (FT) : 289.0 – 290.0

FIGURE E-37

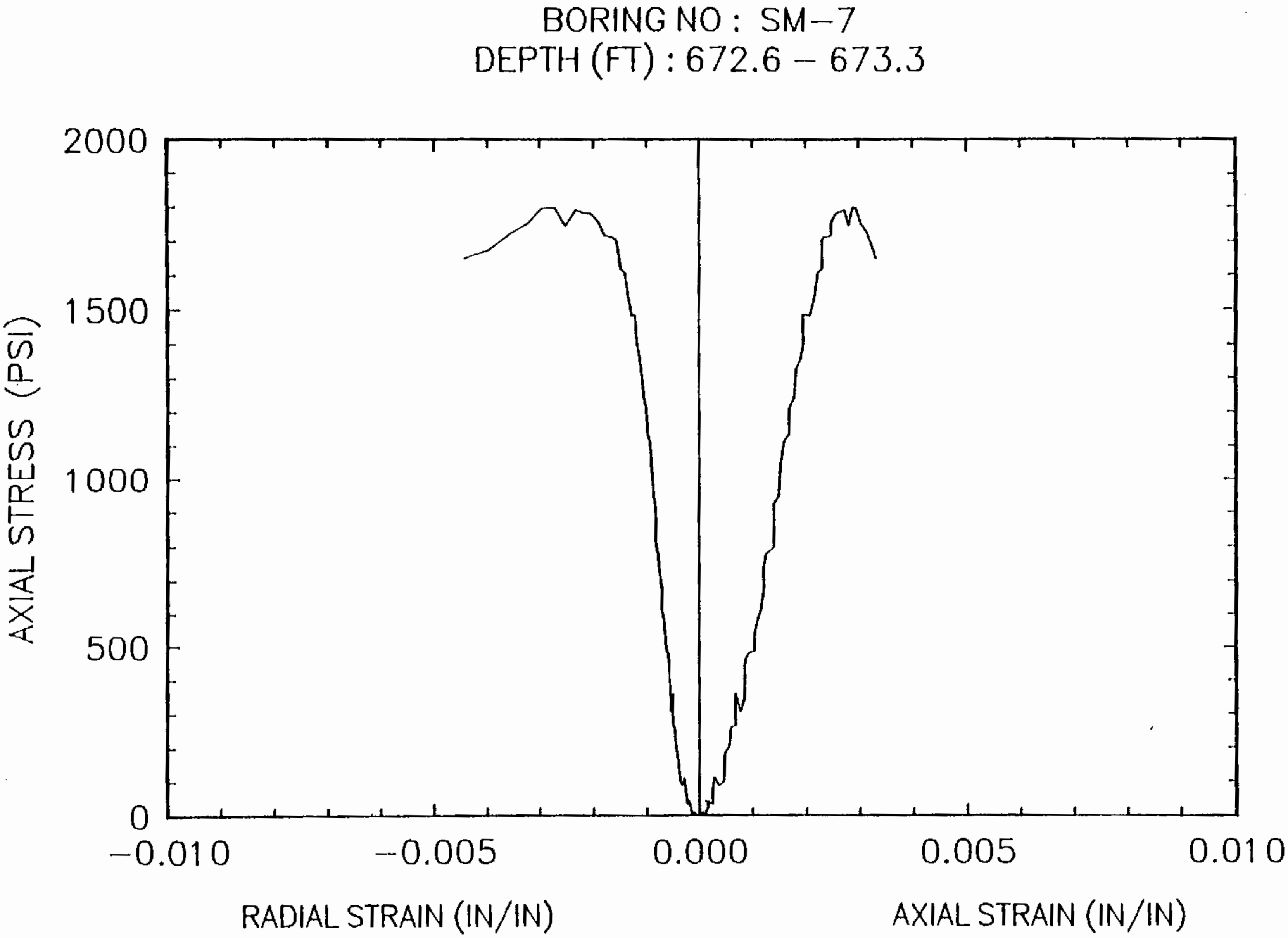

BORING NO : SM–7
DEPTH (FT) : 672.6 – 673.3
2000
1500
1000
500
0
AXIAL STRESS (PSI)
–0.010
–0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

FIGURE E-38

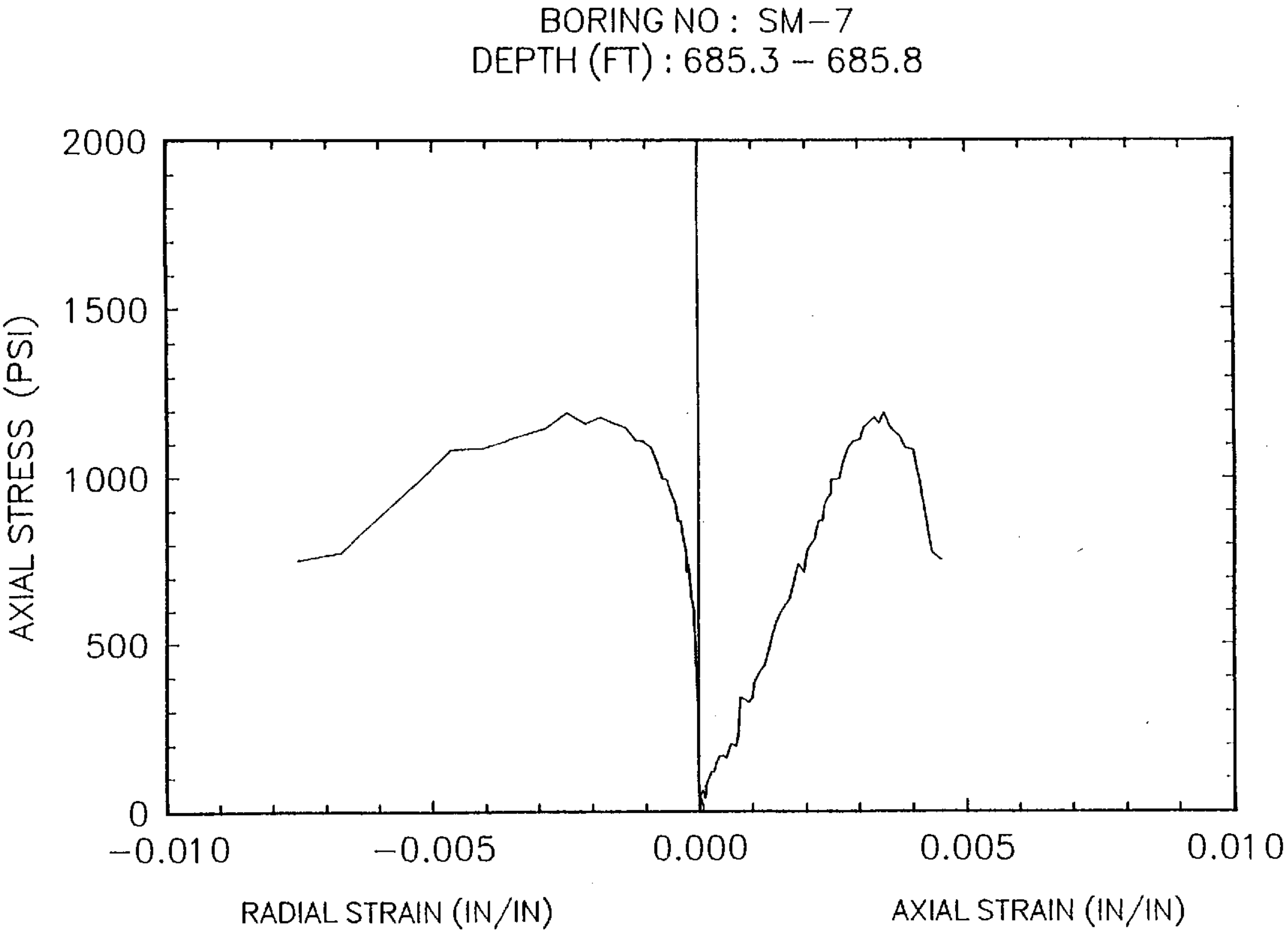
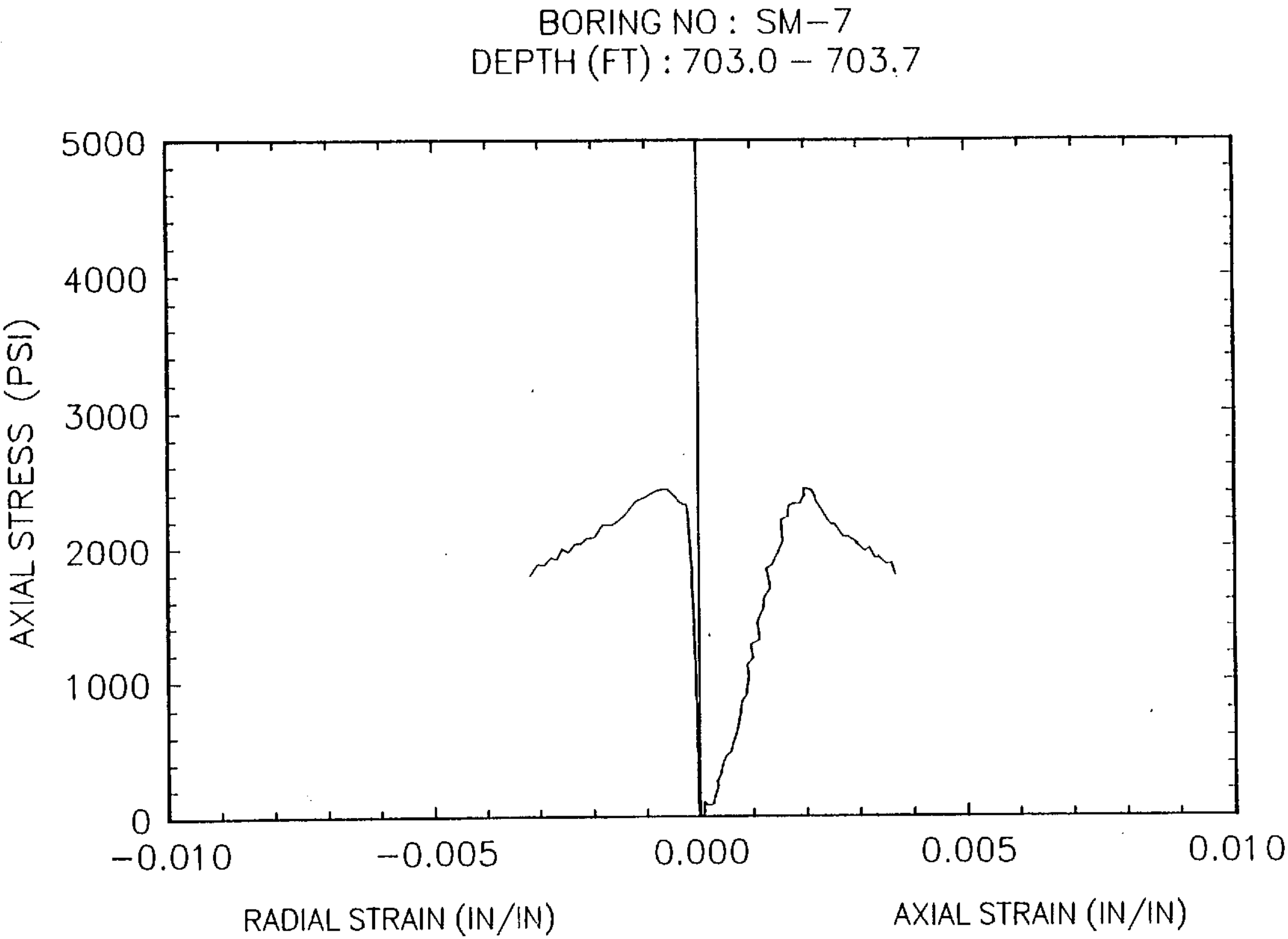

BORING NO : SM−7
DEPTH (FT) : 685.3 − 685.8
AXIAL STRESS (PSI)
2000
1500
1000
500
0
−0.010
−0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

FIGURE E-39


BORING NO : SM−7
DEPTH (FT) : 703.0 − 703.7
AXIAL STRESS (PSI)
5000
4000
3000
2000
1000
0
−0.010
−0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

URE E-40

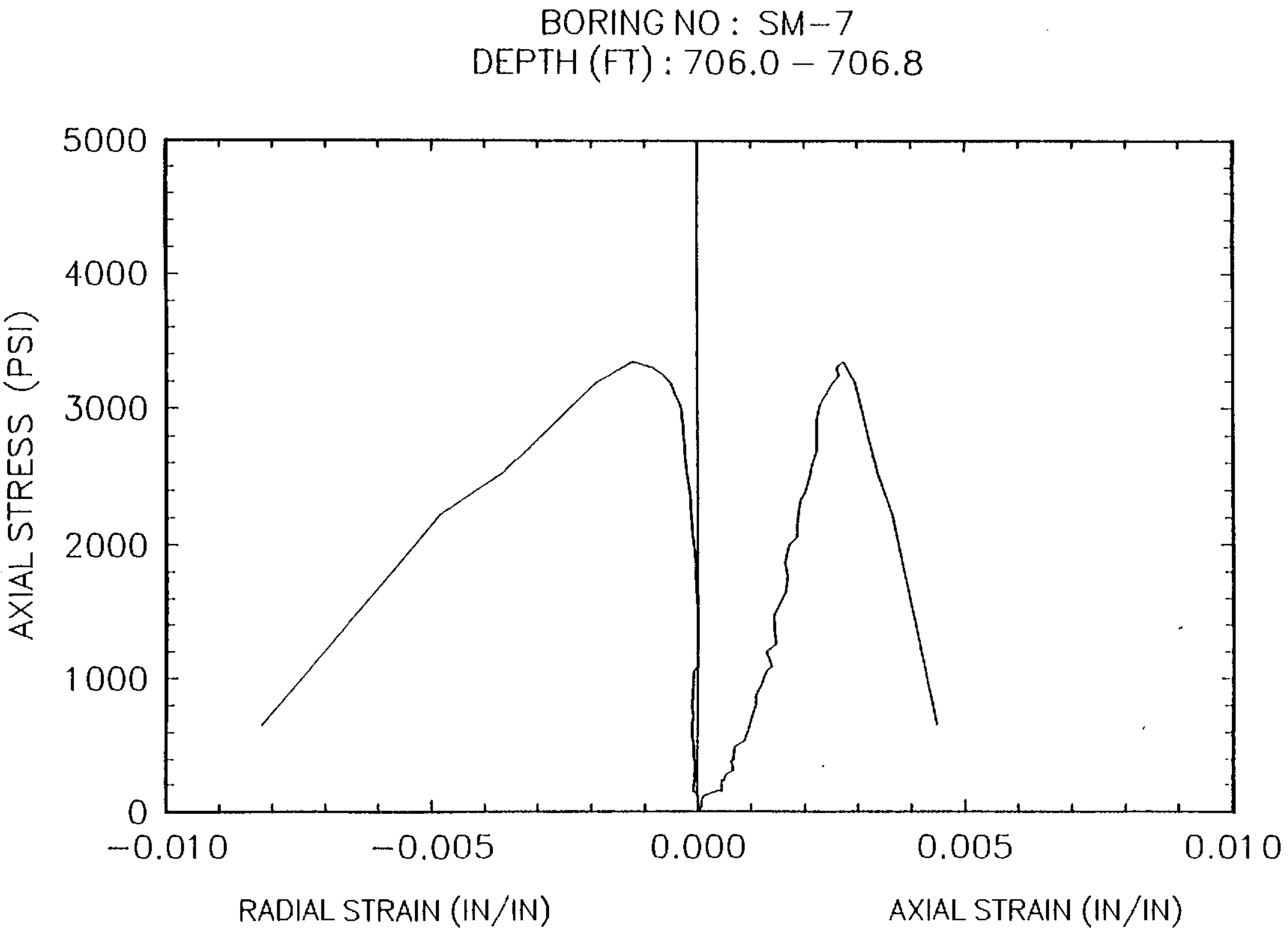
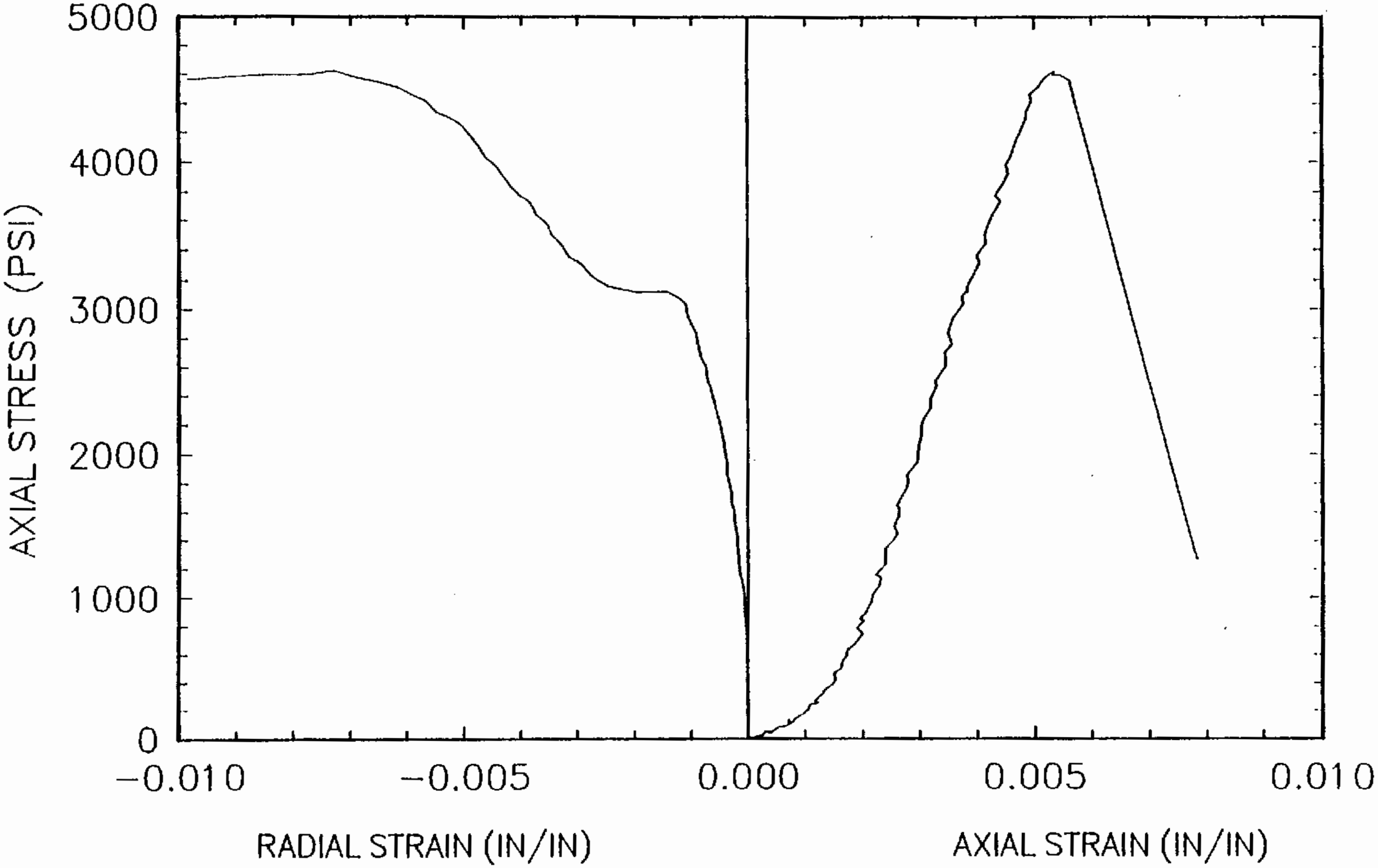

BORING NO : SM-7
DEPTH (FT) : 706.0 - 706.8
AXIAL STRESS (PSI)
5000
4000
3000
2000
1000
0
-0.010
-0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

FIGURE E-41

BORING NO : SM–8
DEPTH (FT) : 721.4 – 722.2



IGURE E-42

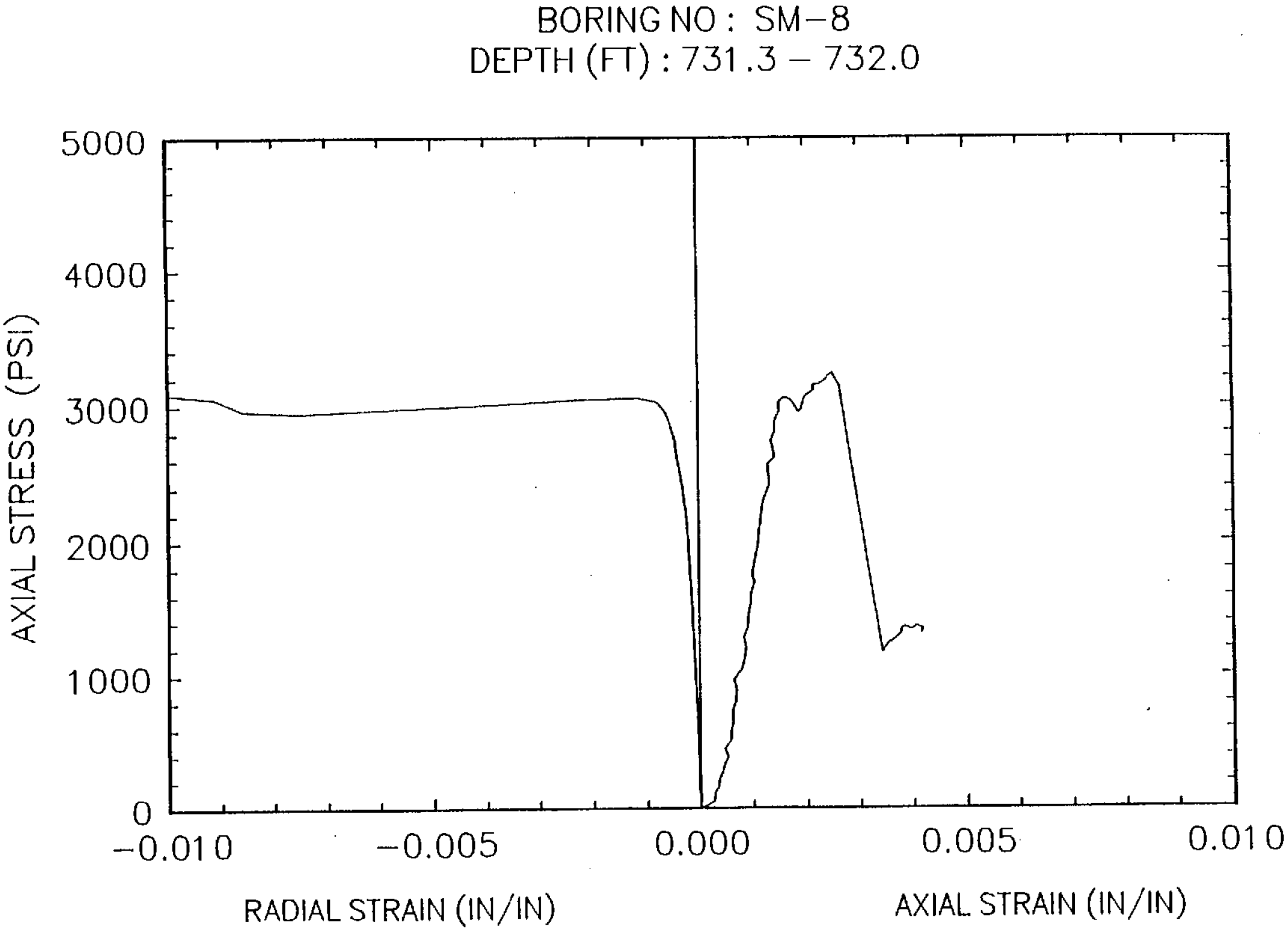
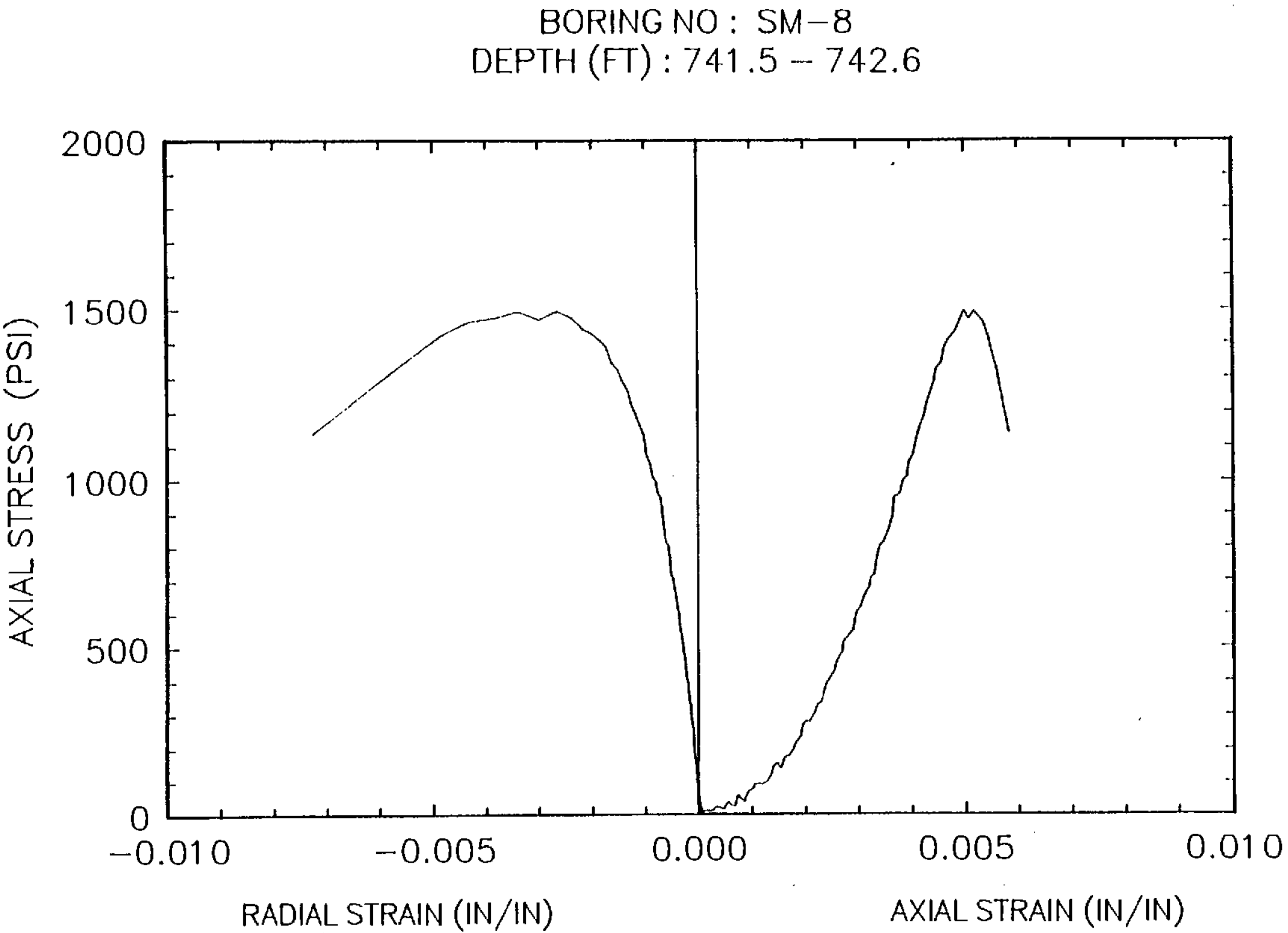

BORING NO : SM-8
DEPTH (FT) : 731.3 – 732.0
AXIAL STRESS (PSI)
5000
4000
3000
2000
1000
0
-0.010
-0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

FIGURE E-43


BORING NO : SM−8
DEPTH (FT) : 741.5 – 742.6
AXIAL STRESS (PSI)
2000
1500
1000
500
0
−0.010
−0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

GURE E-44

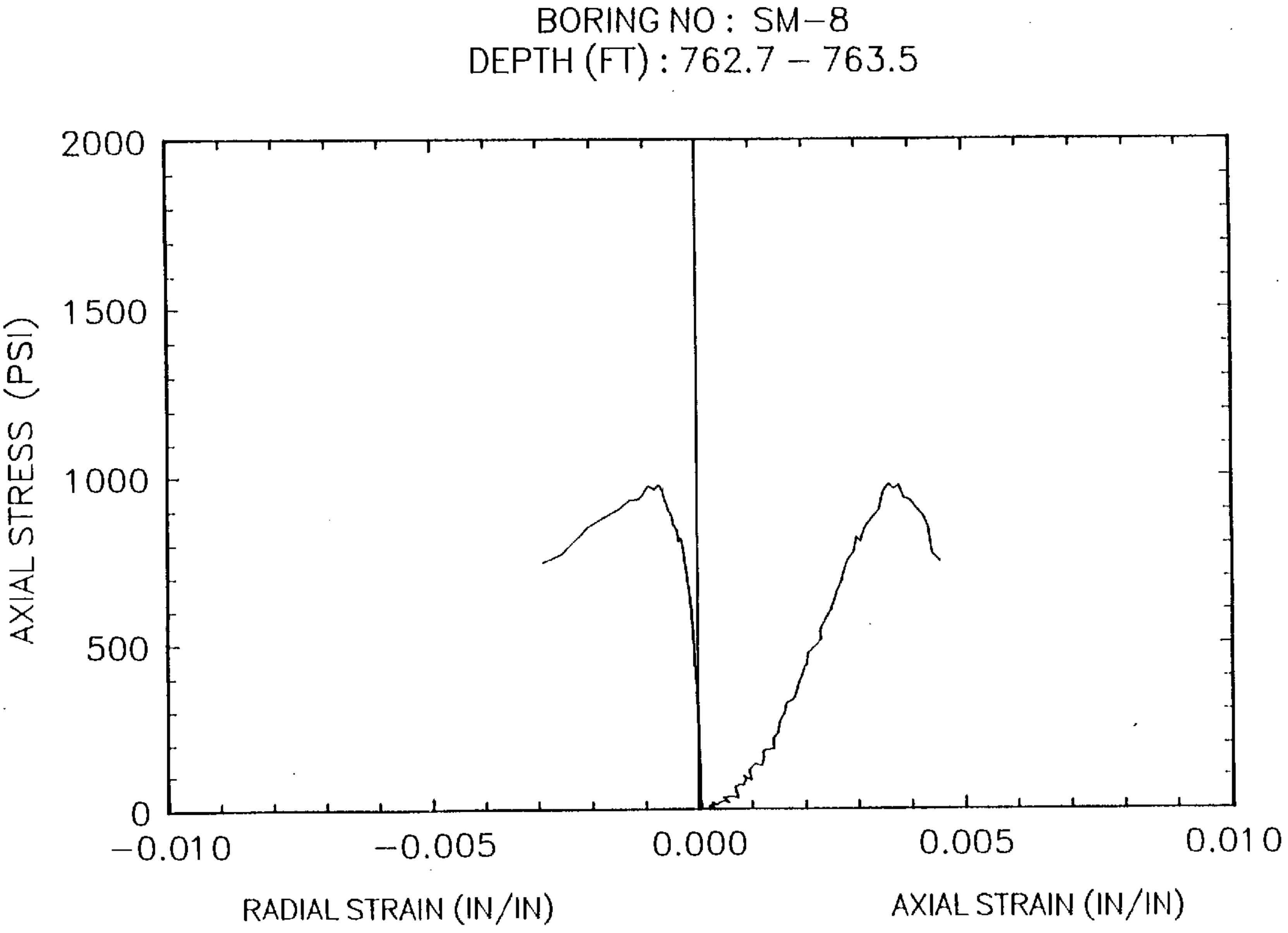
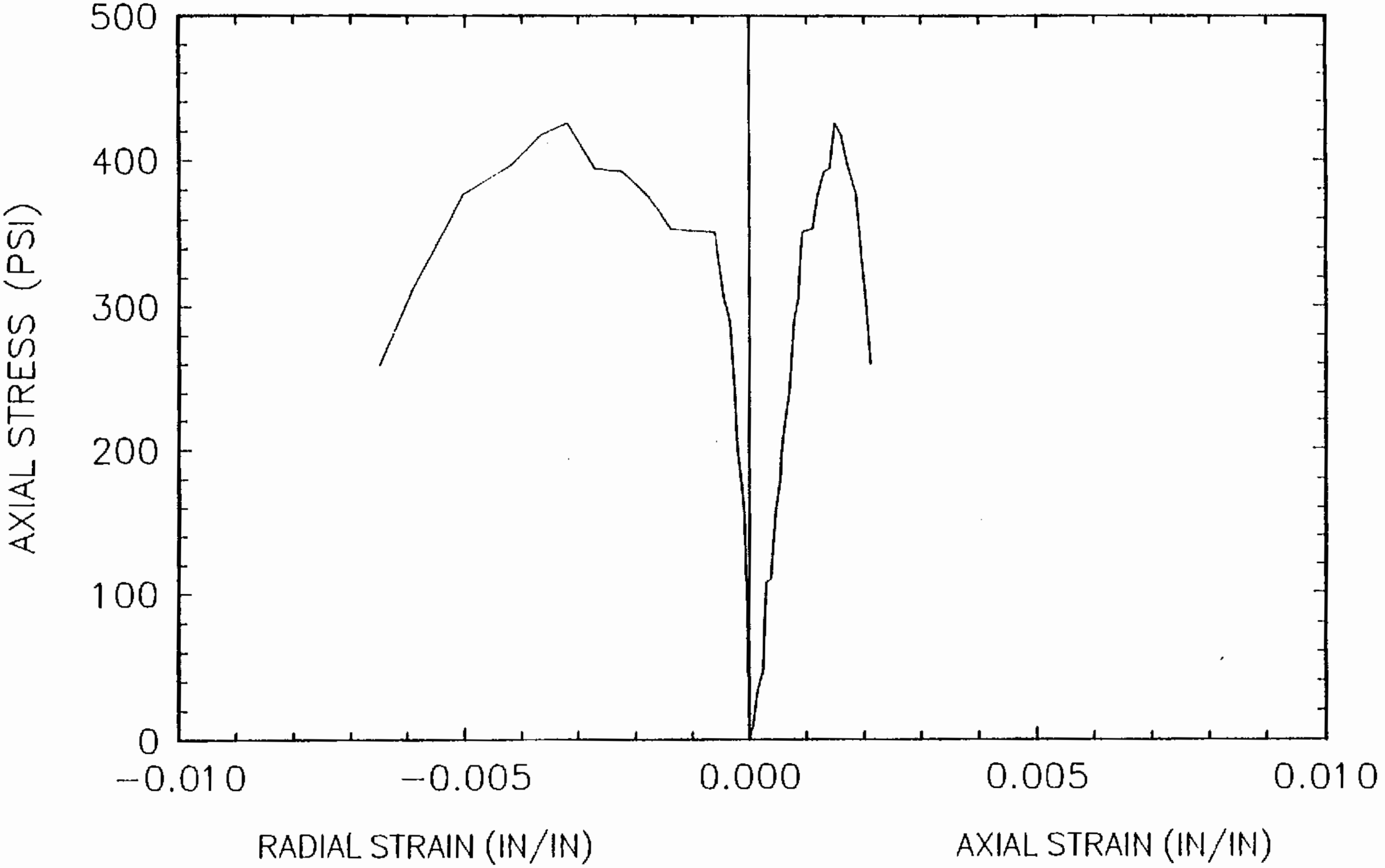

BORING NO : SM-8
DEPTH (FT) : 762.7 - 763.5
AXIAL STRESS (PSI)
2000
1500
1000
500
0
-0.010
-0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

FIGURE E-45



BORING NO : SM–9
DEPTH (FT) : 645.8 – 646.9

URE E-46

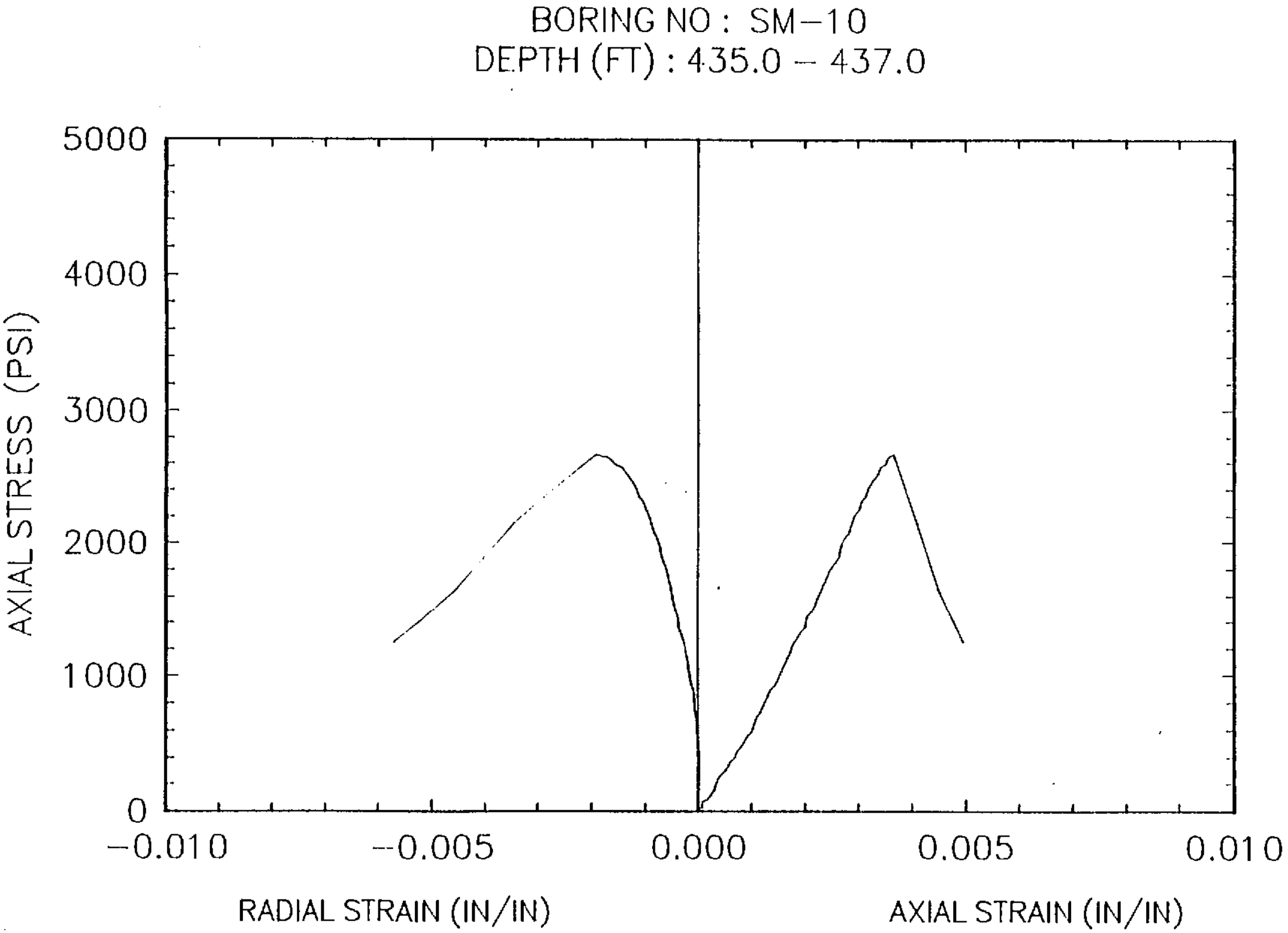
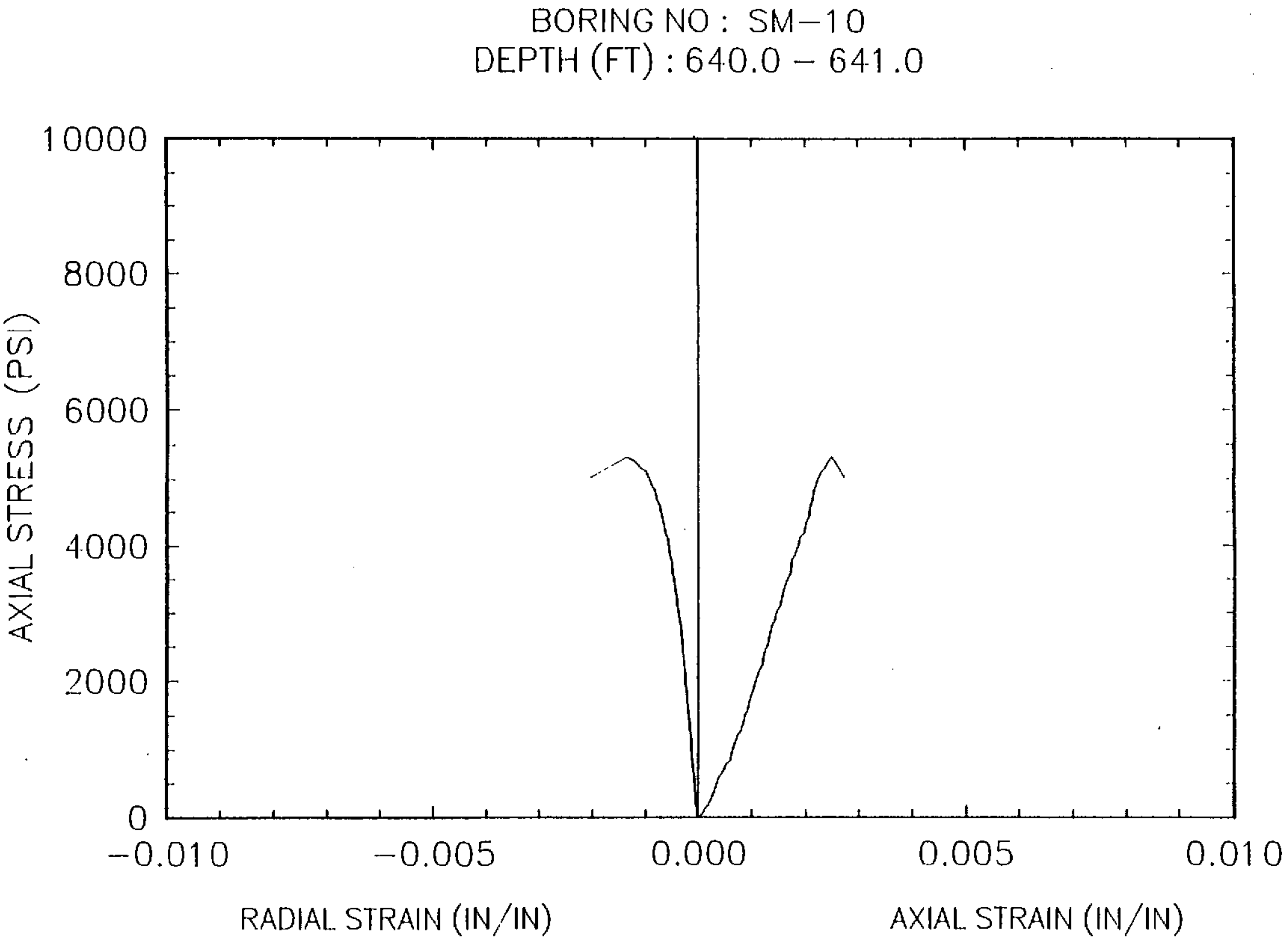

BORING NO : SM−10
DEPTH (FT) : 435.0 – 437.0
AXIAL STRESS (PSI)
5000
4000
3000
2000
1000
0
−0.010
−0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

FIGURE E-47


BORING NO : SM-10
DEPTH (FT) : 640.0 - 641.0
AXIAL STRESS (PSI)
10000
8000
6000
4000
2000
0
-0.010
-0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

URE E-48

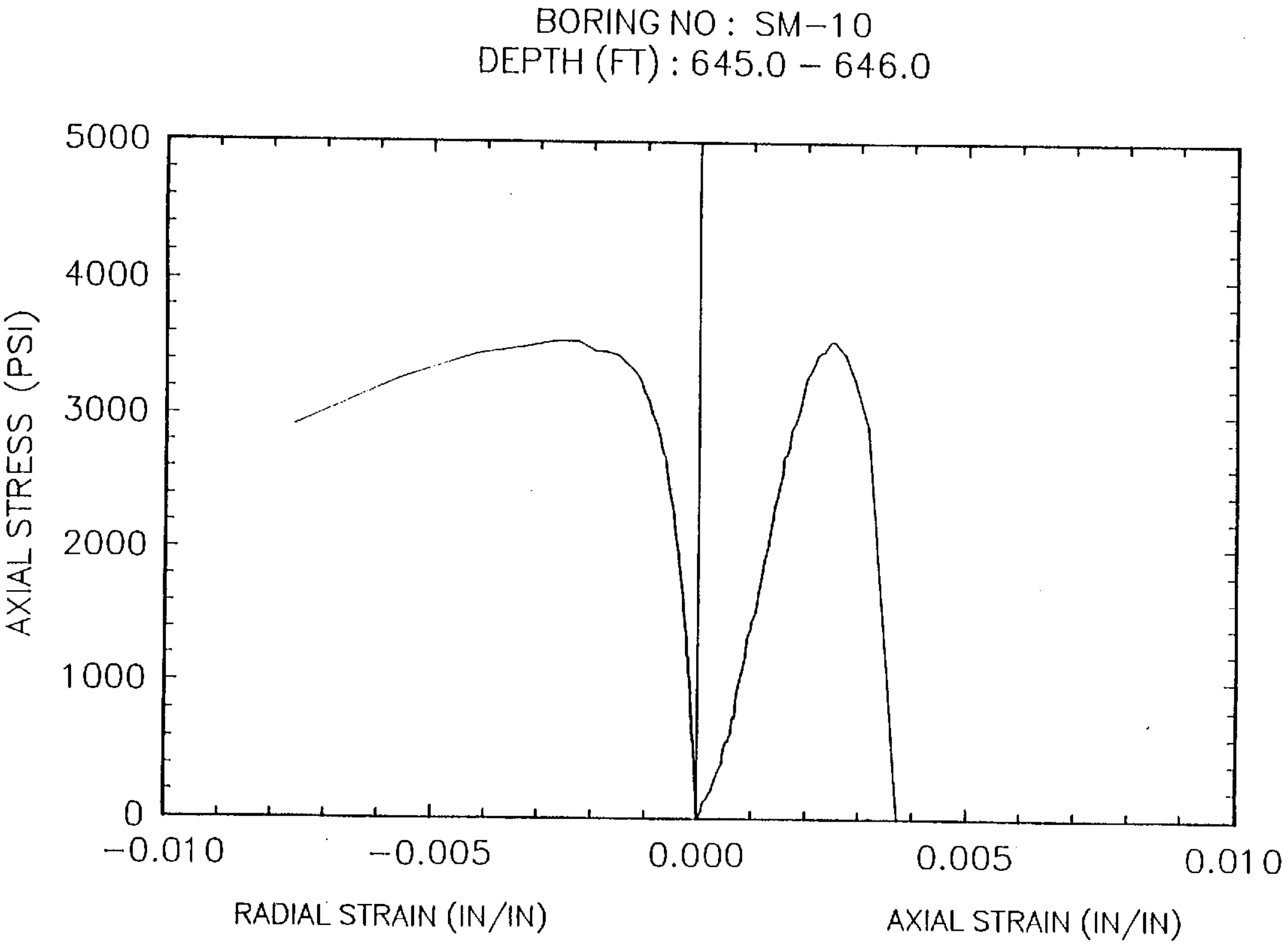
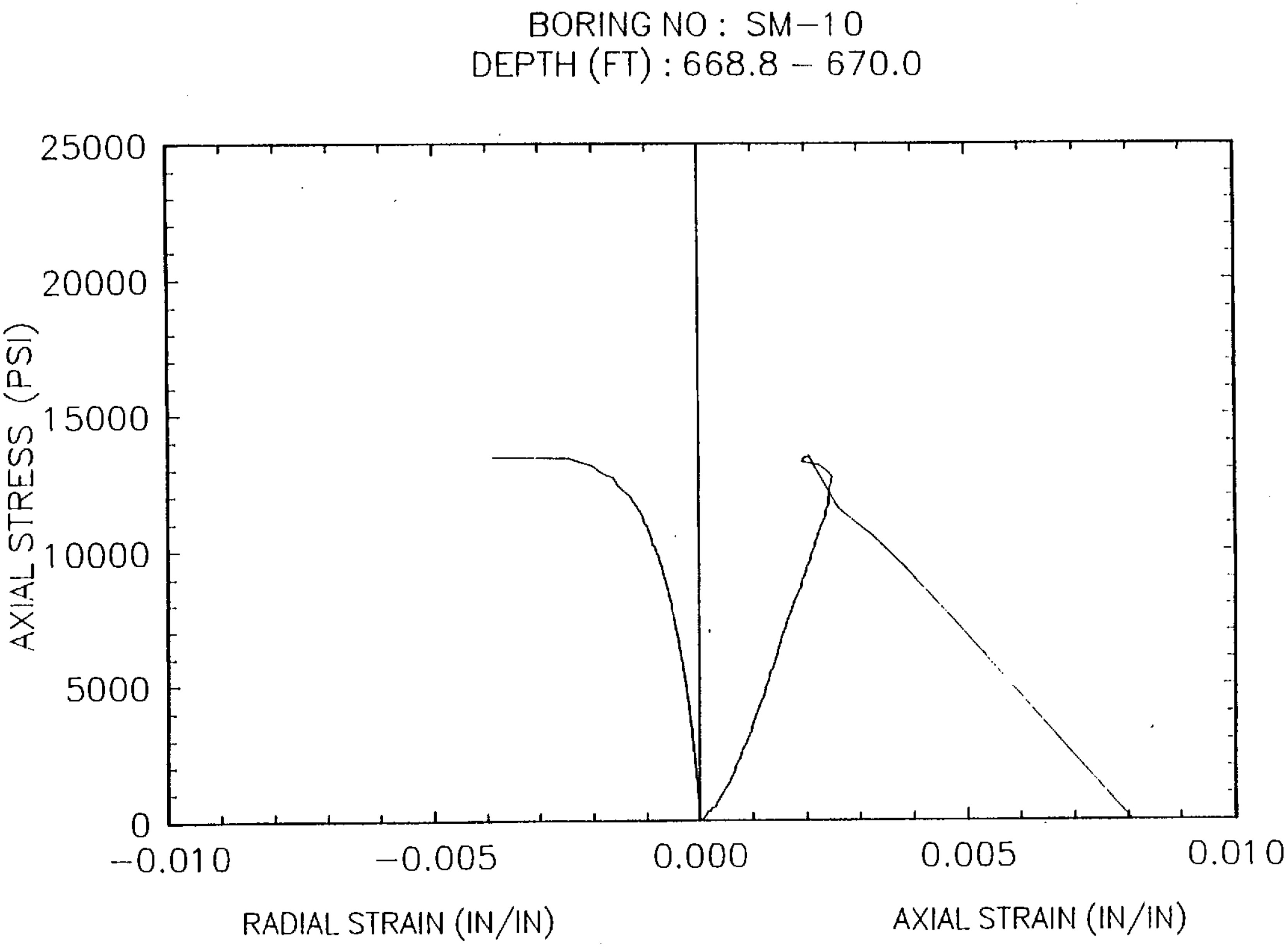

BORING NO : SM-10
DEPTH (FT) : 645.0 - 646.0
5000
4000
3000
2000
1000
0
AXIAL STRESS (PSI)
-0.010
-0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

FIGURE E-49


BORING NO : SM-10
DEPTH (FT) : 668.8 - 670.0
AXIAL STRESS (PSI)
25000
20000
15000
10000
5000
0
-0.010
-0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

URE E-50

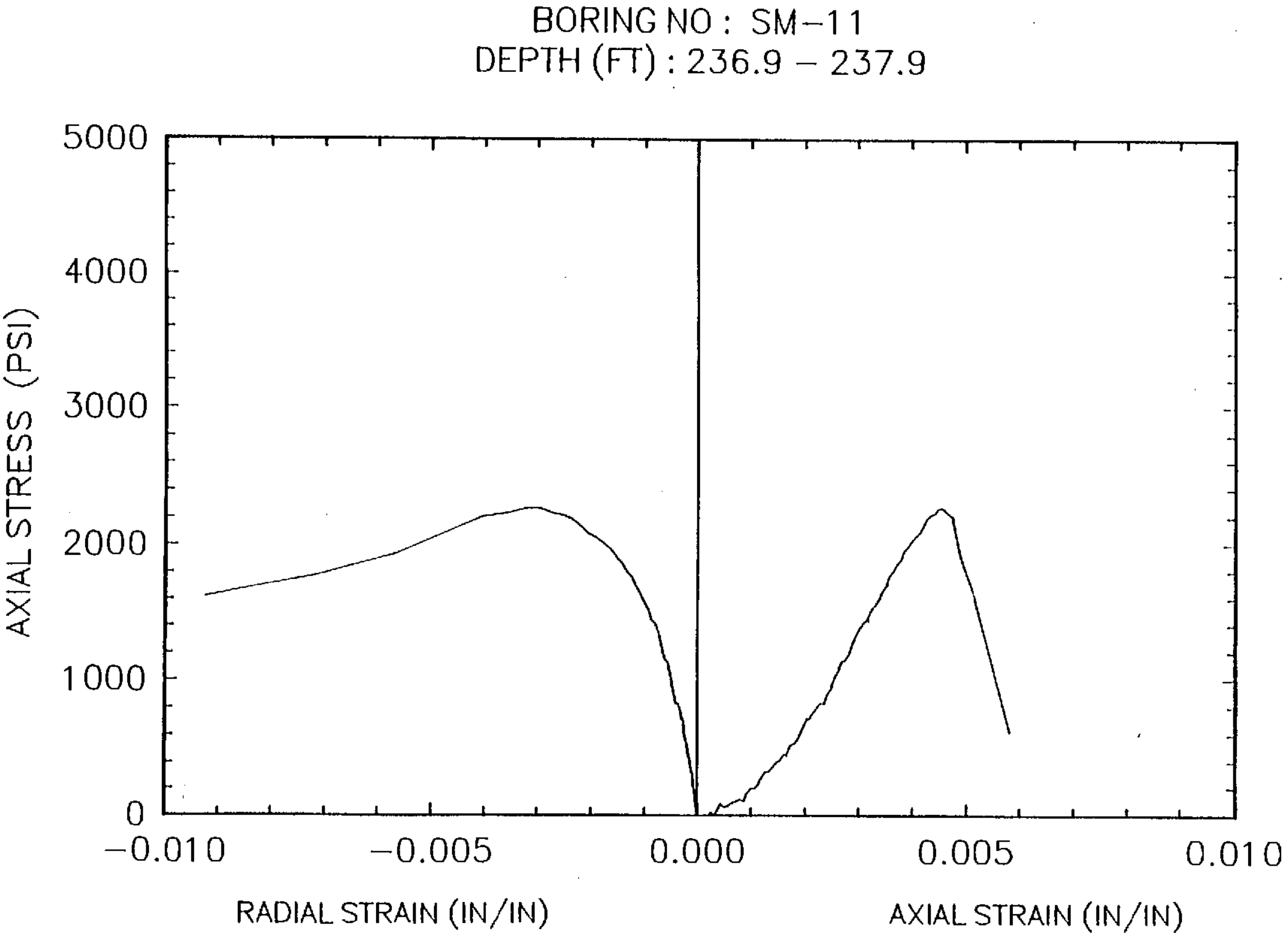
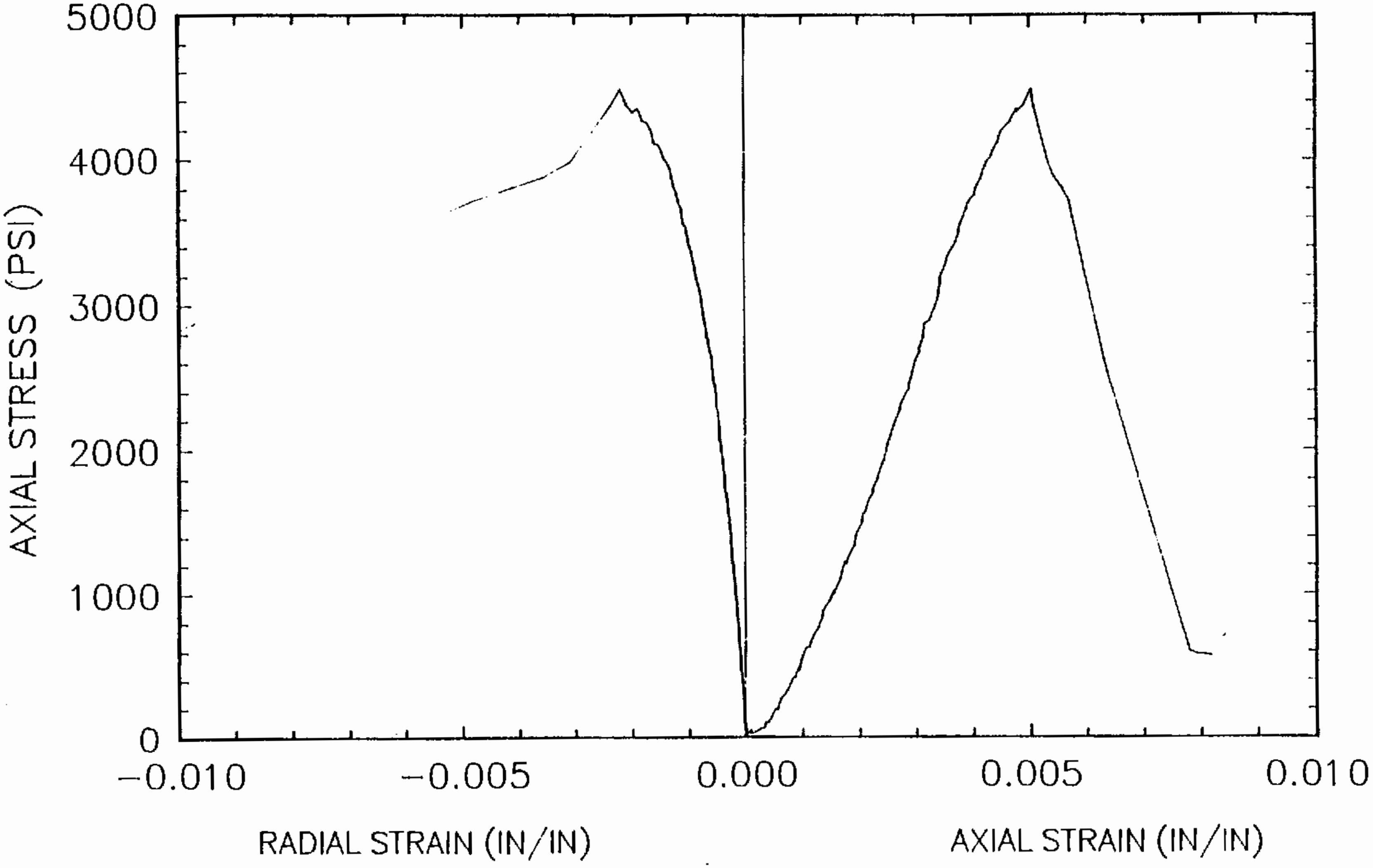

BORING NO : SM-11
DEPTH (FT) : 236.9 - 237.9
AXIAL STRESS (PSI)
5000
4000
3000
2000
1000
0
-0.010
-0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

FIGURE E-51

BORING NO : SM−11
DEPTH (FT) : 242.5 − 244.5



GURE E-52

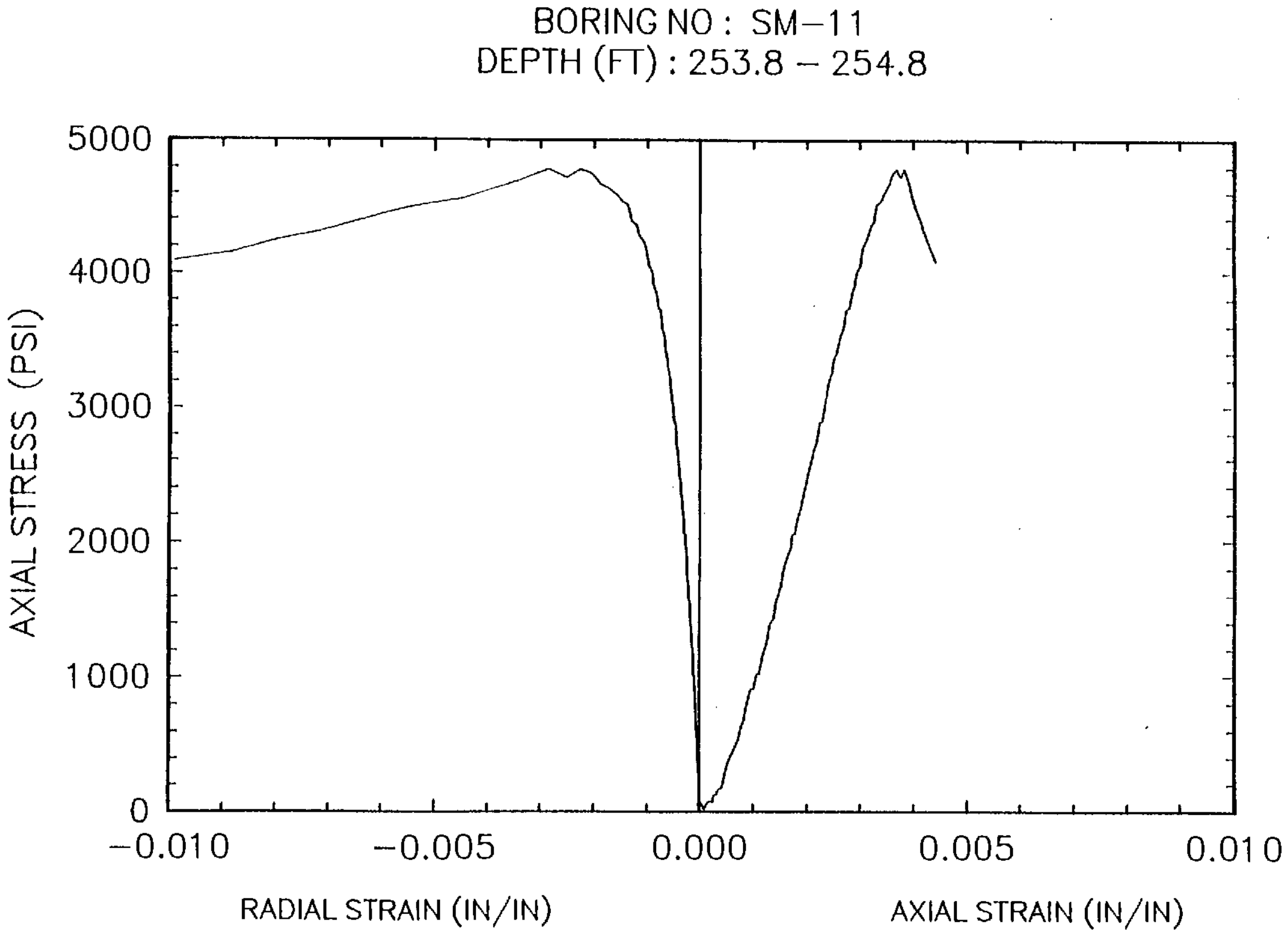
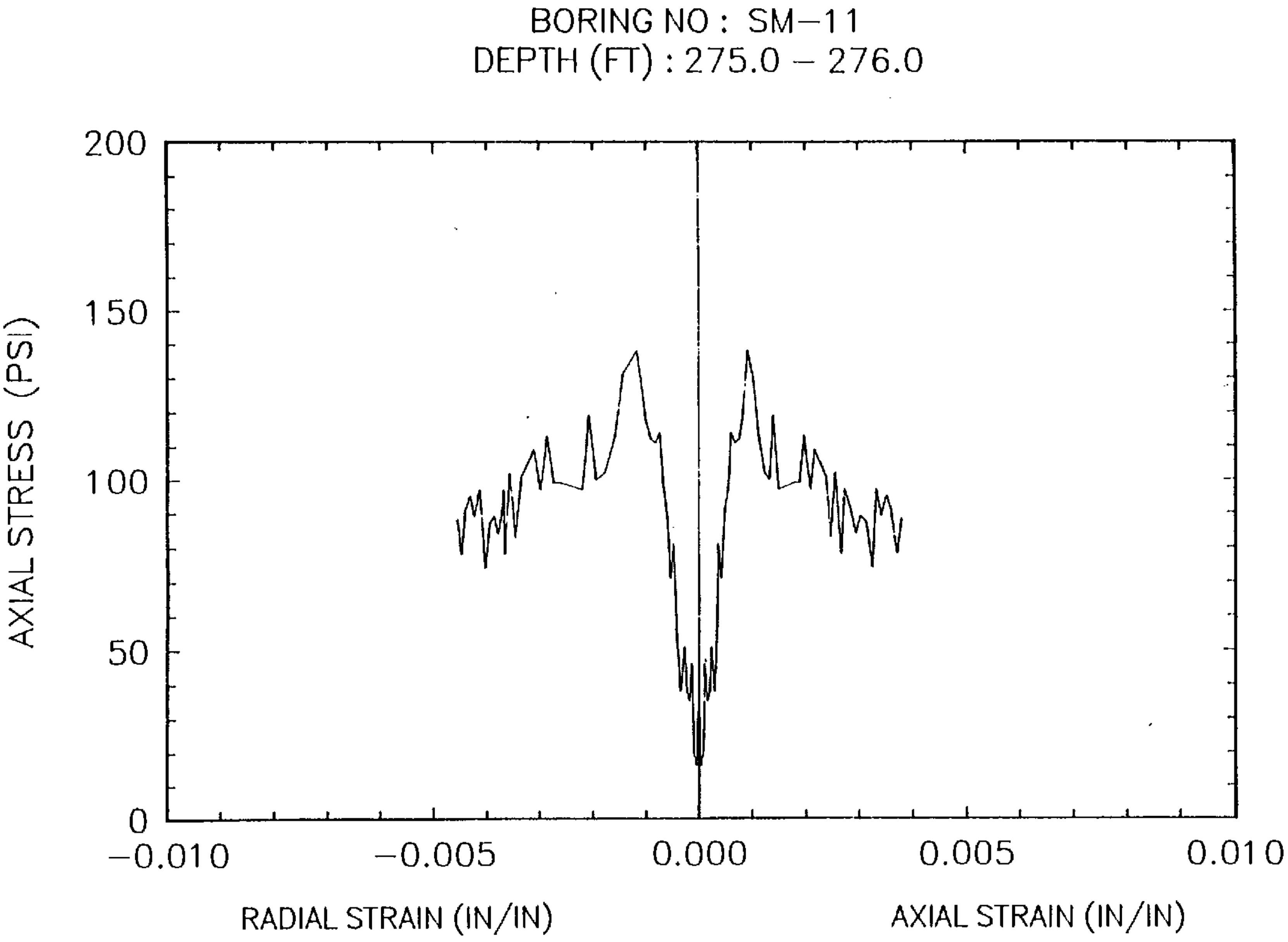

BORING NO : SM-11
DEPTH (FT) : 253.8 - 254.8
AXIAL STRESS (PSI)
5000
4000
3000
2000
1000
0
-0.010
-0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

FIGURE E-53


BORING NO : SM–11
DEPTH (FT) : 275.0 – 276.0
AXIAL STRESS (PSI)
200
150
100
50
0
–0.010
–0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

URE E-54

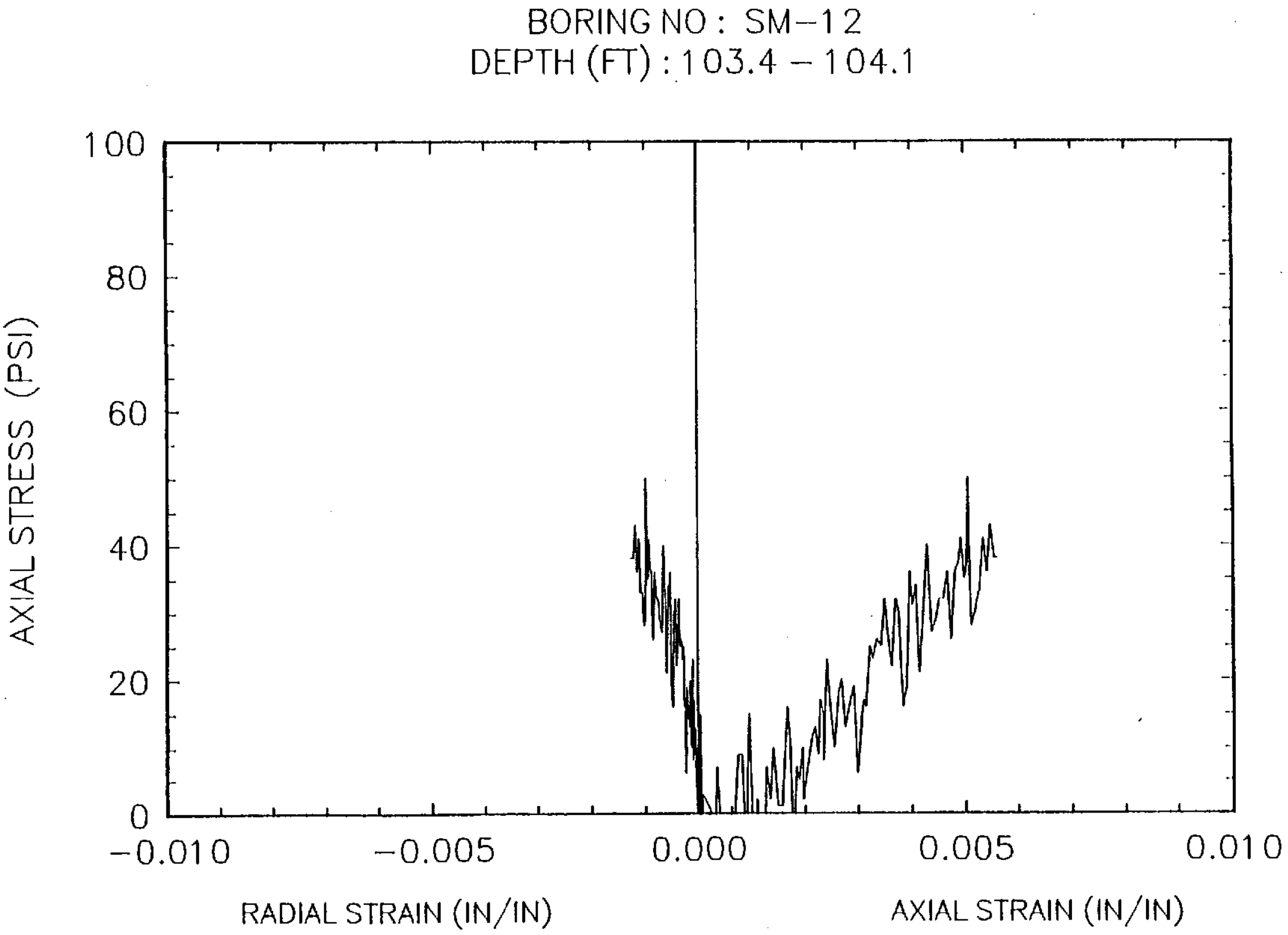
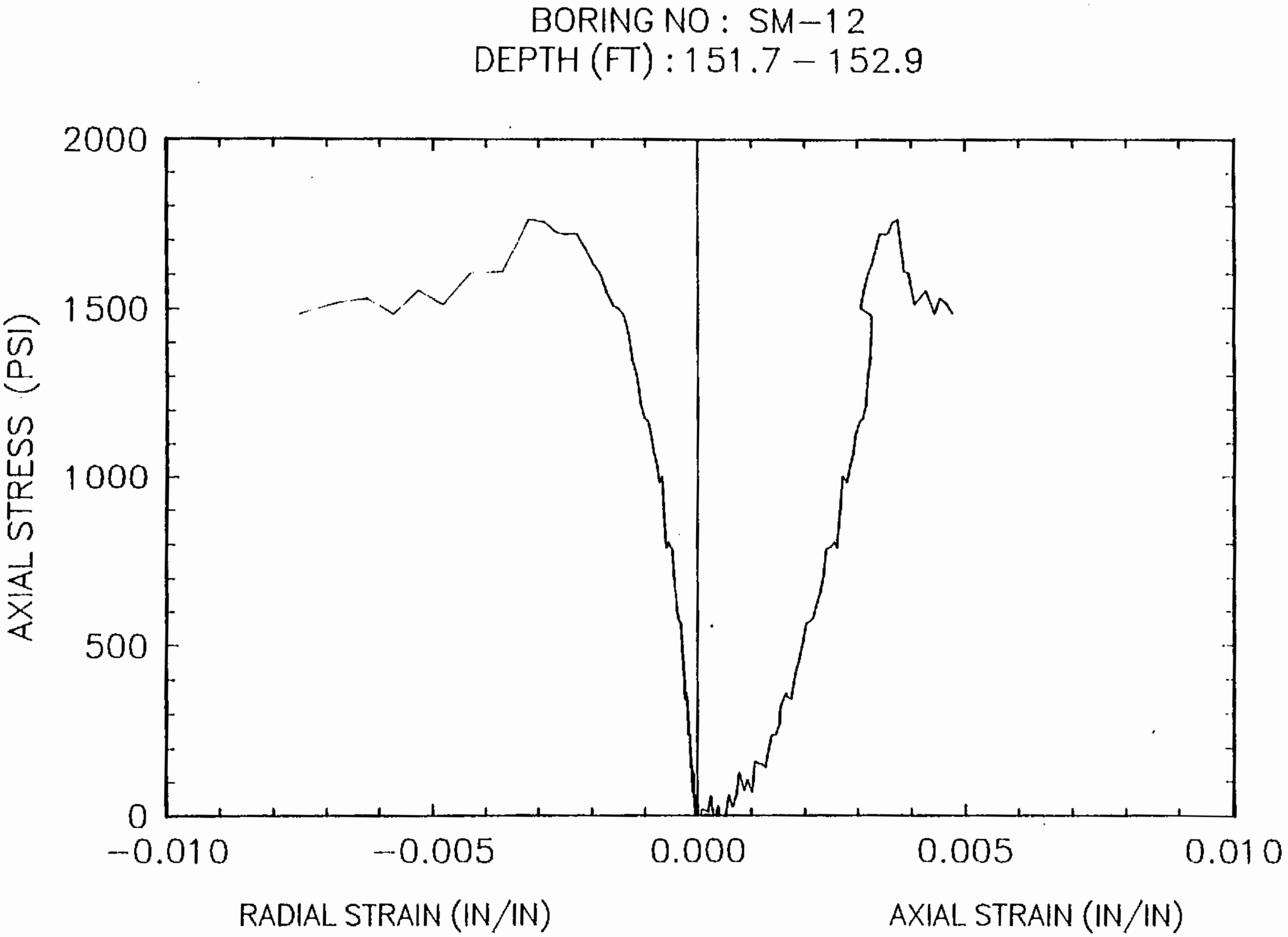
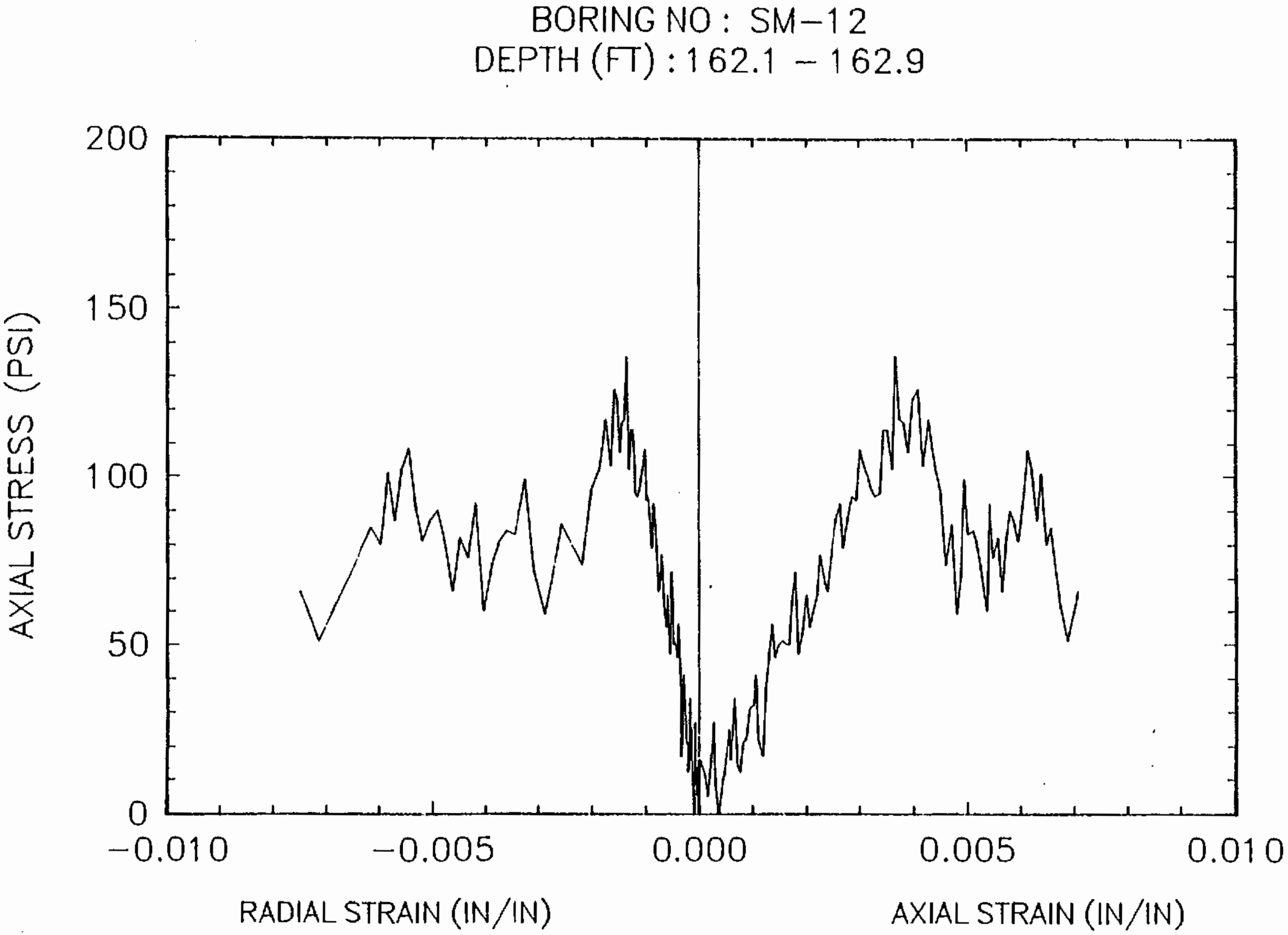

BORING NO : SM−12
DEPTH (FT) : 103.4 − 104.1
100
80
60
40
20
0
AXIAL STRESS (PSI)
−0.010
−0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

FIGURE E-55

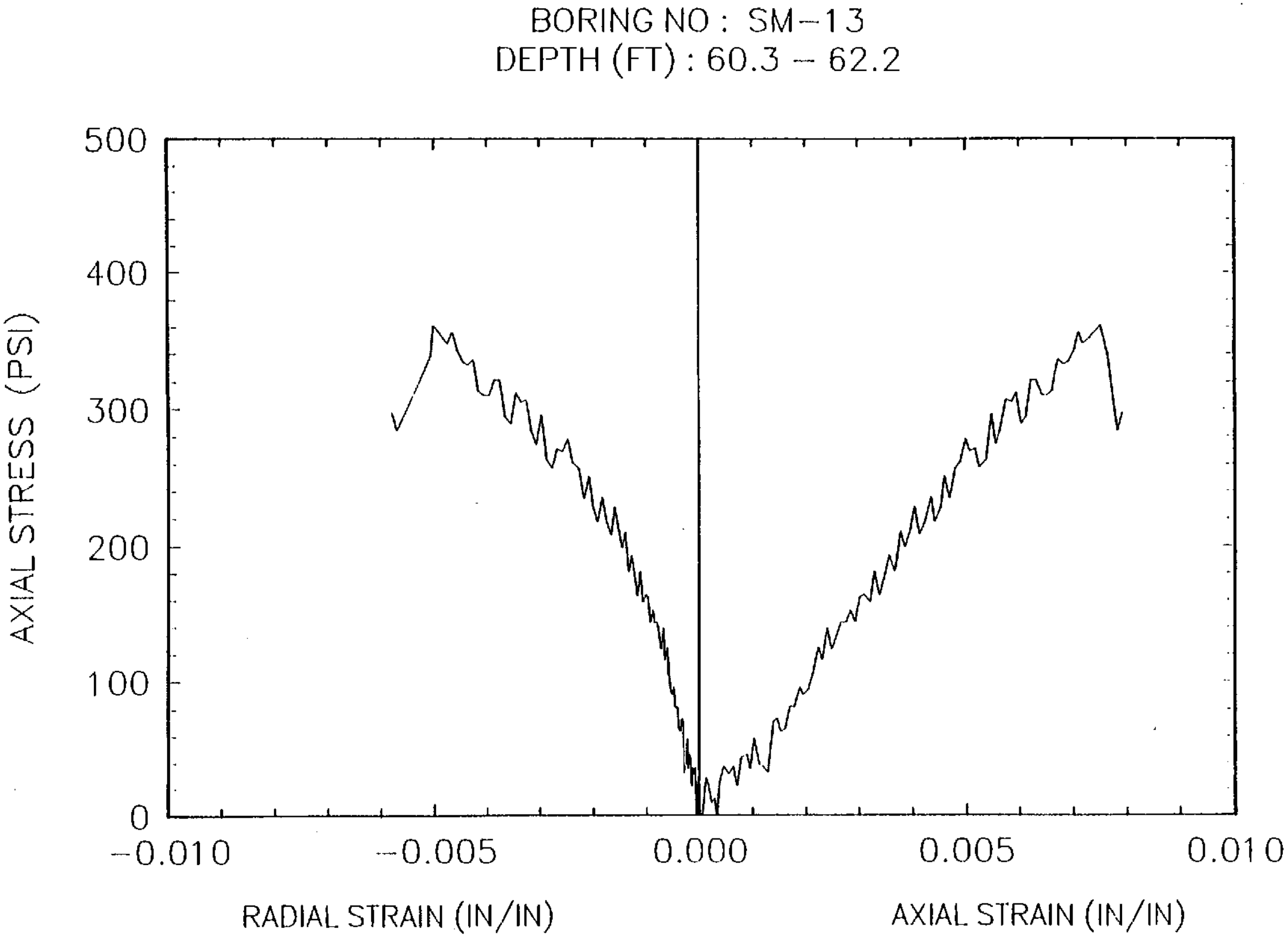

BORING NO : SM-12
DEPTH (FT) : 151.7 - 152.9
2000
1500
1000
500
0
AXIAL STRESS (PSI)
-0.010
-0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

GURE E-56



BORING NO : SM-12
DEPTH (FT) : 162.1 - 162.9
AXIAL STRESS (PSI)
200
150
100
50
0
-0.010
-0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

FIGURE E-57


BORING NO : SM-13
DEPTH (FT) : 60.3 - 62.2
AXIAL STRESS (PSI)
500
400
300
200
100
0
-0.010
-0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

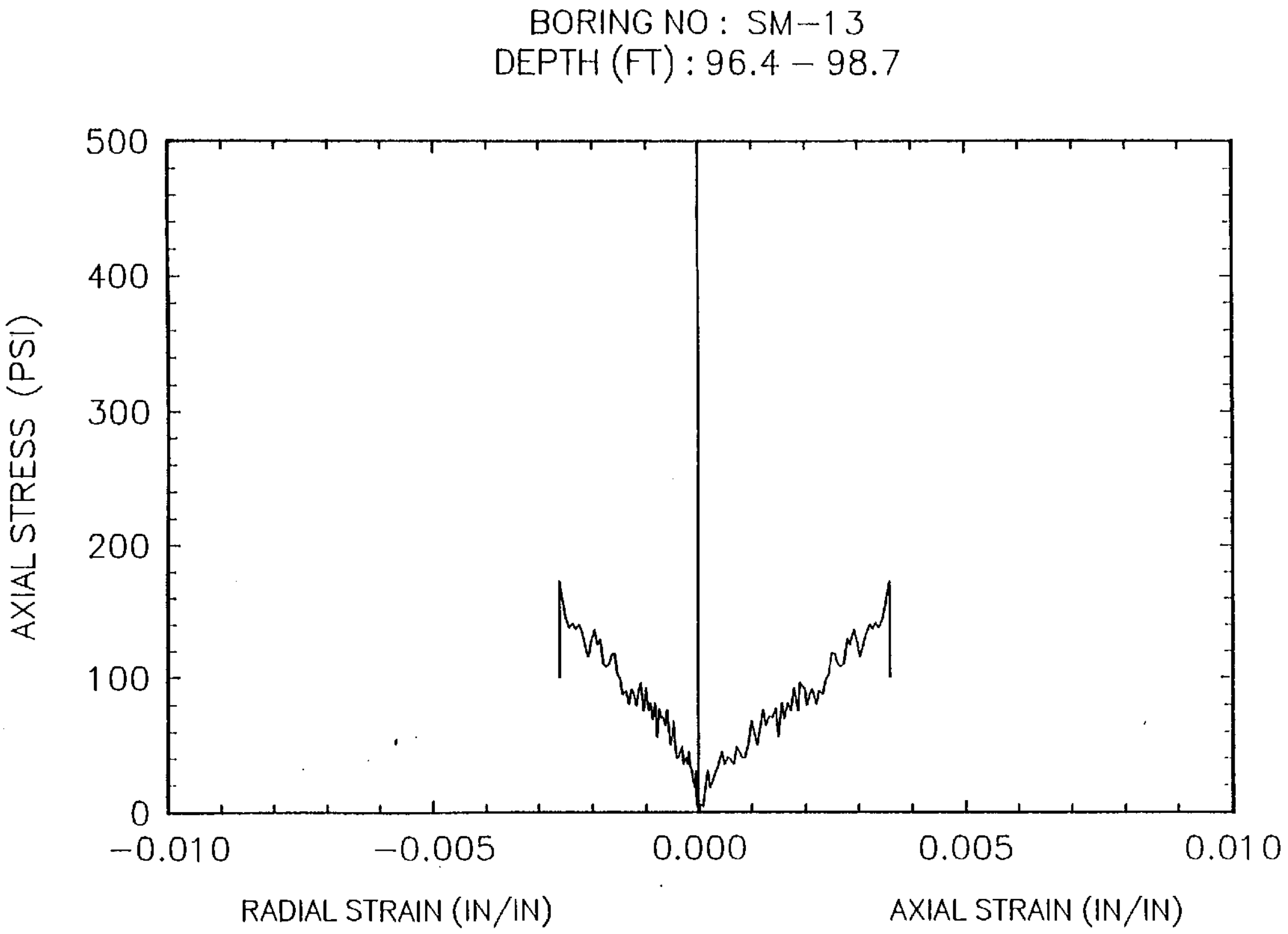

BORING NO : SM-13
DEPTH (FT) : 96.4 - 98.7
AXIAL STRESS (PSI)
500
400
300
200
100
0
-0.010
-0.005
0.000
0.005
0.010
RADIAL STRAIN (IN/IN)
AXIAL STRAIN (IN/IN)

FIGURE E-59

APPENDIX F

CHEMICAL LABORATORY TEST RESULTS

APPENDIX F
CHEMICAL LABORATORY TEST RESULTS

F.1 LABORATORY ANALYSES

The chemical analyses of the groundwater samples were done at Pace Incorporated, a California-certified hazardous waste testing laboratory. Formal QA/QC protocol performed at Pace included: sample receipt standards, chain-of-custody procedural review, calibration practices, preventative maintenance, analysis of quality control samples (e.g. method blanks, duplicates, calibration check standards, surrogate piles, spiked blanks, matrix spikes, and/or reference standards), nonconformance corrective actions and control audits.

Groundwater samples from Monitoring Wells SM-3A, SM-6A, SM-9A and R-8 were tested for the analytes listed in Table F-1 to provide the data necessary to apply for Natural Pollution Discharge Elimination System (NPDES) permit.

For QA/QC purposes, an equipment blank was also tested for the analytes listed in Table F-1. A trip blank was analyzed for volatile organics using EPA Method No. 624 and for gasoline using EPA Method No. 8015. Laboratory test results are summarized in Table 5-7 of Volume I as well as in Table F-2 in this appendix. The detailed chemical analyses test results along with quality control data sheets are included in this appendix.

F.2 BORING SM-11

During drilling of Boring SM-11, an artesian condition was observed, i.e. water was flowing out of the well even after the drilling was stopped. A groundwater sample of the water coming out of the boring was filled directly into sample containers. The groundwater sample was analyzed for volatile organic compounds using EPA Method No. 624, semi-volatile organic compounds using EPA Method No. 625, selected metals, total dissolved solids, sulfide, specific conductance and pH. The results of the laboratory analyses are summarized in Table F-3. The detailed test results are also included in this appendix.

TABLE F-1. LIST OF CHEMICAL ANALYSES FOR GROUNDWATER SAMPLES (Page 1 of 2)

Analyte Number	Analyte	EPA Test Method	Requested Detection Limit (ppb)	Preservatives	Field Filter	Container	Storage
1	Purgeable Volatile Organic Compounds	624	5 to 20	Cool 4°C 0.008% $Na_2S0_20_3$ (1)	No (4)	Two - 40 ml glass	7 days (2)
2	Semivolatile Organic Compounds	625	5 to 50	Cool 4°C	No	Two - 1 liter glass	7 days
3	Total Petroleum Hydrocarbons	418.1	500	H_2S0_4 to pH <2 Cool 4°C	No (5)	One - 1 liter glass	28 days
4	Oil & Grease	413.1 or 413.2	500	H_2S0_4 to pH <2 Cool 4°C	No	One - 1 liter glass	28 days
5	Total Fuel Hydrocarbons, Gasoline and Diesel	8015 LUFT	Gasoline 20 Diesel 200	Cool 4°C	No (3)	Two - 40 ml glass	14 days
6	CCR Title 22 Metals	SW-846 or ICP-MS	1/2 the MCL	HNO_3 to pH <2	Yes (3)	One - 1 liter plastic	6 months
7	Chromium VI	7196	10	Cool 4°C	Yes (3)	One - 500 ml liter plastic	24 hours
8	Aquatic Toxicity	NA	N/A	Cool 4°C	No	One - 5 gallon plastic	24 hours
9	Biological Oxygen Demand (BOD)	405.1	5,000	Cool 4°C	No (6)	One - 500 ml glass	48 hours
10	Chemical Oxygen Demand (COD)	Hach Kit	20,000	Cool 4°C	No	One - 400 ml glass	28 days
11	Nonfilterable Residues Total Suspended Solids (TSS)	160.2	1,000 to 5,000	Cool 4°C	No	One - 1 liter plastic or glass	7 days
12	Settleable Solids (SS)	160.5	1,000 to 5,000	Cool 4°C	No	One - 1 liter plastic or glass	2 days
13	Turbidity	180.1	1,000 to 5,000	Cool 4°C	No	One - 100 ml plastic	48 hours
14	Filterable Residues - Total Dissolved Solids (TDS)	160.1	10,000	Cool 4°C	No	One - 1 liter plastic or glass	7 days

TABLE F-1. LIST OF CHEMICAL ANALYSES OF GROUNDWATER SAMPLES (Page 2 of 2)

Analyte Number	Analyte	EPA Test Method	Requested Detection Limit (ppb)	Preservatives	Field Filter	Container	Storage
15	Chloride	325.3	10,000	None	No	One - 100 ml plastic	28 days
16	Sulfide	376.2	100	$ZnC0_2CH_3$ & NaOH to pH > 9 - Cool 4°C	No	One - 500 ml plastic	7 days
17	Sulfate	375.3	10,000	Cool 4°C	No	One - 500 ml plastic	28 days
18	Nitrite	300	100	Cool 4°C H_2S0_4 to pH <2	No	One - 100 ml plastic	28 days
19	Nitrate	300	100	H_2S0_4 to pH <2 Cool 4°C	No	One - 100 ml plastic	28 days
20	Specific Conductance	120.1	N/A	Cool 4°C	No	One - 500 ml plastic	28 days
21	pH	150.1	N/A	None	No	One - 100 ml glass	Immediately

Notes:

(1)	Should only be used in presence of residual chlorine
(2)	CRWQCB recommends 7 day storage time for EPA 624
(3)	Field filter with 0.45 micron filter
(4)	24 hour gravity settle of solids in the laboratory prior to analysis
(5)	Filter sample in laboratory prior to analysis using centrifugation
(6)	Laboratory filtration prior to analysis

TABLE F–2. SUMMARY OF CHEMICAL TEST RESULTS OF GROUNDWATER SAMPLES (1 OF 6)

ANALYTE	WELL NO. SM–3A	WELL NO. SM–6A	WELL NO. SM–9A	WELL NO. R–8	WELL NO. EQUIP. BLANK	WELL NO. TRIP BLANK
1. PURGEABLE VOLATILE ORGANIC COMPOUNDS **Parameter (Units: ug/L)**						
1,1,2–Trichor–1,2,3–trifluoroethane	ND	ND	ND	ND	ND	ND
Chloromethane	ND	ND	ND	ND	ND	ND
Vinyl Chloride	ND	ND	ND	ND	ND	ND
Bromomethane	ND	ND	ND	ND	ND	ND
Chloroethane	ND	ND	ND	ND	ND	ND
Trichlorofluoromethane	ND	ND	ND	ND	ND	ND
1,1–Dichloroethene	ND	ND	ND	ND	ND	ND
Acetone	ND	ND	ND	ND	ND	ND
Carbon Disulfide	ND	ND	ND	ND	ND	ND
Methylene Chloride	ND	ND	ND	ND	ND	ND
Trans–1,2–Dichloroethene	ND	ND	ND	ND	ND	ND
1,1–Dichloroethane	ND	ND	ND	ND	ND	ND
2–Butanone	ND	ND	ND	ND	ND	ND
cis–1,2–Dichloroethene	ND	ND	ND	ND	ND	ND
Chloroform	ND	ND	28	ND	ND	ND
1,2–Dichloroethane	ND	ND	ND	ND	ND	ND
1,1,1–Trichloroethane	ND	ND	ND	ND	ND	ND
Carbon Tetrachloride	ND	ND	ND	ND	ND	ND
Benzene	ND	ND	ND	ND	ND	ND
Trichloroethene	ND	ND	ND	ND	ND	ND
1,2–Dichloropropane	ND	ND	ND	ND	ND	ND
Bromodichloromethane	ND	ND	ND	ND	ND	ND
cis–1,3–Dichloropropene	ND	ND	ND	ND	ND	ND
trans–1,3–Dichloropropene	ND	ND	ND	ND	ND	ND
1,1,2–Trichloroethane	ND	ND	ND	ND	ND	ND
Dibromochloromethane	ND	ND	ND	ND	ND	ND
Bromoform	ND	ND	ND	ND	ND	ND
4–Methyl–2–Pentanone	ND	ND	ND	ND	ND	ND
Toluene	ND	ND	ND	ND	ND	ND

TABLE F-2. SUMMARY OF CHEMICAL TEST RESULTS OF GROUNDWATER SAMPLES (2 OF 6)

ANALYTE	WELL NO. SM-3A	WELL NO. SM-6A	WELL NO. SM-9A	WELL NO. R-8	WELL NO. EQUIP. BLANK	WELL NO. TRIP BLANK
1. PURGEABLE VOLATILE ORGANIC COMPOUNDS **Parameter (Units: ug/L)**						
2-Hexanone	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND
Tetrachloroethene	ND	ND	ND	ND	ND	ND
Chlorobenzene	ND	ND	ND	ND	ND	ND
Ethylbenzene	ND	ND	ND	ND	ND	ND
Styrene	ND	ND	ND	ND	ND	ND
Xylenes (total)	ND	ND	ND	ND	ND	ND
2. SEMI-VOLATILE ORGANIC COMPOUNDS **Parameter (Units: ug/L)**						
N-Nitrosodimethylamine	ND	ND	ND	ND	ND	NA
Phenol	ND	ND	ND	ND	ND	NA
Aniline	ND	ND	ND	ND	ND	NA
bis(2-chloroethyl) ether	ND	ND	ND	ND	ND	NA
2-Chlorophenol	ND	ND	ND	ND	ND	NA
1,3-Dichlorobenzene	ND	ND	ND	ND	ND	NA
1,4-Dichlorobenzene	ND	ND	ND	ND	ND	NA
Benzyl alcohol	ND	ND	ND	ND	ND	NA
1,2-Dichlorobenzene	ND	ND	ND	ND	ND	NA
2-Methylphenol	ND	ND	ND	ND	ND	NA
bis(2-Chloroisopropyl) ether	ND	ND	ND	ND	ND	NA
4-Methylphenol	ND	ND	ND	ND	ND	NA
N-Nitroso-di-n-propylamine	ND	ND	ND	ND	ND	NA
Hexachloroethane	ND	ND	ND	ND	ND	NA
Nitrobenzene	ND	ND	ND	ND	ND	NA
Isophorone	ND	ND	ND	ND	ND	NA
2-Nitrophenol	ND	ND	ND	ND	ND	NA
2,4-Dimethylphenol	ND	ND	ND	ND	ND	NA
Benzoic Acid	ND	ND	ND	ND	ND	NA

TABLE F-2. SUMMARY OF CHEMICAL TEST RESULTS OF GROUNDWATER SAMPLES (3 OF 6)

ANALYTE	WELL NO. SM-3A	WELL NO. SM-6A	WELL NO. SM-9A	WELL NO. R-8	WELL NO. EQUIP. BLANK	WELL NO. TRIP BLANK
2. SEMI-VOLATILE ORGANIC COMPOUNDS (CONT'D)						
Parameter (Units: ug/L)						
bis (2-Chloroethoxy) methane	ND	ND	ND	ND	ND	NA
2,4-Dichlorophenol	ND	ND	ND	ND	ND	NA
1,2,4-Trichlorobenzene	ND	ND	ND	ND	ND	NA
Naphthalene	ND	ND	ND	ND	ND	NA
4-Chloroaniline	ND	ND	ND	ND	ND	NA
Hexachlorobutadiene	ND	ND	ND	ND	ND	NA
4-Chloro-3-methylphenol	ND	ND	ND	ND	ND	NA
2-Methylnaphthalene	ND	ND	ND	ND	ND	NA
Hexachlorocyclopentadiene	ND	ND	ND	ND	ND	NA
2,4,6-Trichlorophenol	ND	ND	ND	ND	ND	NA
2,4,5-Trichlorophenol	ND	ND	ND	ND	ND	NA
2-Chloronaphthalene	ND	ND	ND	ND	ND	NA
2-Nitroaniline	ND	ND	ND	ND	ND	NA
Dimethylphthalate	ND	ND	ND	ND	ND	NA
Acenaphthylene	ND	ND	ND	ND	ND	NA
2,6-Dinitrotoluene	ND	ND	ND	ND	ND	NA
3-Nitroaniline	ND	ND	ND	ND	ND	NA
Acenaphthene	ND	ND	ND	ND	ND	NA
2,4-Dinitrophenol	ND	ND	ND	ND	ND	NA
4-Nitrophenol	ND	ND	ND	ND	ND	NA
Dibenzofuran	ND	ND	ND	ND	ND	NA
2,4-Dinitrotoluene	ND	ND	ND	ND	ND	NA
Diethylphthalate	ND	ND	ND	ND	ND	NA
4-Chlorophenyl-phenylether	ND	ND	ND	ND	ND	NA
Fluorene	ND	ND	ND	ND	ND	NA
4-Nitroaniline	ND	ND	ND	ND	ND	NA

TABLE F–2. SUMMARY OF CHEMICAL TEST RESULTS OF GROUNDWATER SAMPLES (4 OF 6)

ANALYTE	WELL NO. SM–3A	WELL NO. SM–6A	WELL NO. SM–9A	WELL NO. R–8	WELL NO. EQUIP. BLANK	WELL NO. TRIP BLANK
2. SEMI–VOLATILE ORGANIC COMPOUNDS (CONT'D) **Parameter (Units: ug/L)**						
4,6–Dinitro–2–methylphenol	ND	ND	ND	ND	ND	NA
N–Nitrosodiphenylamine	ND	ND	ND	ND	ND	NA
4–Bromophenyl–phenylether	ND	ND	ND	ND	ND	NA
Hexachlorobenzene	ND	ND	ND	ND	ND	NA
Pentachloropenol	ND	ND	ND	ND	ND	NA
Phenanthrene	ND	ND	ND	ND	ND	NA
Anthracene	ND	ND	ND	ND	ND	NA
Di–n–butylphthalate	ND	ND	ND	ND	ND	NA
Fluoranthene	ND	ND	ND	ND	ND	NA
Benzidine	ND	ND	ND	ND	ND	NA
Pyrene	ND	ND	ND	ND	ND	NA
Butylbenzylphthalate	ND	ND	ND	ND	ND	NA
Benzo(a)anthracene	ND	ND	ND	ND	ND	NA
Chrysene	ND	ND	ND	ND	ND	NA
bis(2–Ethylhexyl)phthalate	ND	15	28	ND	ND	NA
Di–n–octyl phthalate	ND	ND	ND	ND	ND	NA
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	NA
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	NA
Benzo(a)pyrene	ND	ND	ND	ND	ND	NA
Dibenz(a,j)acridine	ND	ND	ND	ND	ND	NA
Indeno(1,2,3–cd)pyrene	ND	ND	ND	ND	ND	NA
Dibenzo(a,h)anthracene	ND	ND	ND	ND	ND	NA
Benzo(g,h,i)perylene	ND	ND	ND	ND	ND	NA
3. TOTAL RECOVERABLE PETROLEUM HYDROCARBONS (mg/l)	ND	ND	ND	ND	ND	NA

TABLE F-2. SUMMARY OF CHEMICAL TEST RESULTS OF GROUNDWATER SAMPLES (5 OF 6)

ANALYTE	WELL NO. SM-3A	WELL NO. SM-6A	WELL NO. SM-9A	WELL NO. R-8	WELL NO. EQUIP. BLANK	WELL NO. TRIP BLANK
4. OIL AND GREASE (mg/L)	0.06	ND	ND	0.07	ND	NA
5. TOTAL FUEL HYDROCARBONS (mg/L)						
Gasoline	ND	ND	ND	ND	ND	ND
Diesel	ND	ND	ND	ND	ND	NA
6. CCR TITLE 22 METALS **Parameter (Units:mg/L)**						
Antimony, Sb	ND	ND	ND	ND	ND	NA
Arsenic, As	ND	ND	0.016	ND	ND	NA
Barium, Ba	0.05	0.013	ND	0.02	ND	NA
Beryllium, Be	ND	ND	0.003	ND	ND	NA
Cadmium, Cd	ND	ND	ND	ND	ND	NA
Chromium, Cr	ND	ND	ND	ND	ND	NA
Cobalt, Co	ND	ND	ND	ND	ND	NA
Copper, Cu	ND	ND	ND	ND	ND	NA
Lead, Pb	ND	ND	ND	ND	ND	NA
Mercury, Hg	ND	ND	ND	ND	ND	NA
Molybdenum, Mo	ND	ND	0.008	0.011	ND	NA
Nickel, Ni	ND	ND	ND	ND	ND	NA
Selenium, Se	ND	0.01	0.019	0.02	ND	NA
Silver, Ag	ND	ND	ND	ND	ND	NA
Thallium, Tl	ND	ND	ND	ND	ND	NA
Vanadium, V	ND	ND	0.031	ND	ND	NA
Zinc, Zn	0.025	0.04	0.03	0.06	0.012	NA
7. CHROMIUM VI (mg/L)	ND	ND	ND	ND	ND	NA
8. ACUTE AQUATIC TOXICITY (Toxicity Units)	<0.588	<0.588	0.588	<0.588	0.588	NA
9. BIOLOGICAL CHEMICAL OXYGEN DEMAND (mg	2.2	4.2	7.6	7	2.6	NA

TABLE F–2. SUMMARY OF CHEMICAL TEST RESULTS OF GROUNDWATER SAMPLES (6 OF 6)

ANALYTE	WELL NO. SM–3A	WELL NO. SM–6A	WELL NO. SM–9A	WELL NO. R–8	WELL NO. EQUIP. BLANK	WELL NO. TRIP BLANK
10. CHEMICAL OXYGEN DEMAND (mg/L)	ND	ND	ND	ND	ND	NA
11. TOTAL SUSPENDED SOLIDS (mg/L)	500	870	1810	80	ND	NA
12. SETTLABLE MATTER (ml/L)	0.6	1.5	0.1	2.2	ND	NA
13. TURBIDITY (NTU)	190	320	560	4.5	ND	NA
14. TOTAL DISSOLVED SOLIDS (mg/L)	590	1020	620	1500	ND	NA
15. CHLORIDE (mg/L)	32	46	75	43	ND	NA
16. SULFIDE (mg/L)	ND	ND	ND	ND	ND	NA
17. SULFATE (mg/L)	78	470	330	750	ND	NA
18. NITRITE (mg/L)	ND	ND	ND	ND	ND	NA
19. NITRATE (mg/L)	62	ND	3	3	2	NA
20. SPECIFIC CONDUCTANCE (umho/cm)	860	1220	1020	1820	ND	NA
21. pH (pH units)	7.9	7.0	9.5	7.5	6.2	NA

NOTES: Units–
ug/L = micrograms per liter
mg/L = milligrams per liter
NTU = National turbidity units
umho/cm = micro mhos per centimeter
ND = Not Detected
B = Indictes the analyte was observed in associated blank as well as the sample
CCR Title 22 = California Code of Regulations, Title 22, Division 4, Chapter 30, Article 11
NA = not analyzed

TABLE F–3. SUMMARY OF CHEMICAL TEST RESULTS OF GROUNDWATER SAMPLE FROM BORING SM–11 (1 of 4)

ANALYTE	WELL NO. SM–11
1. PURGEABLE VOLATILE ORGANIC COMPOUNDS **Parameter (Units: ug/L)**	
1,1,2–Trichor–1,2,3–trifluoroethane	ND
Chloromethane	ND
Vinyl Chloride	ND
Bromomethane	ND
Chloroethane	ND
Trichlorofluoromethane	ND
1,1–Dichloroethene	ND
Acetone	ND
Carbon Disulfide	ND
Methylene Chloride	ND
Trans–1,2–Dichloroethene	ND
1,1–Dichloroethane	ND
2–Butanone	ND
cis–1,2–Dichloroethene	ND
Chloroform	ND
1,2–Dichloroethane	ND
1,1,1–Trichloroethane	ND
Carbon Tetrachloride	ND
Benzene	ND
Trichloroethene	ND
1,2–Dichloropropane	ND
Bromodichloromethane	ND
cis–1,3–Dichloropropene	ND
trans–1,3–Dichloropropene	ND
1,1,2–Trichloroethane	ND
Dibromochloromethane	ND
Bromoform	ND
4–Methyl–2–Pentanone	ND
Toluene	ND
2–Hexanone	ND
1,1,2,2–Tetrachloroethane	ND
Tetrachloroethene	ND
Chlorobenzene	ND
Ethylbenzene	ND
Styrene	ND
Xylenes (total)	13
2. SEMI–VOLATILE ORGANIC COMPOUNDS **Parameter (Units: ug/L)**	
N–Nitrosodimethylamine	ND
Phenol	ND
Aniline	ND
bis(2–chloroethyl) ether	ND
2–Chlorophenol	ND

TABLE F-3. SUMMARY OF CHEMICAL TEST RESULTS OF GROUNDWATER SAMPLE FROM BORING SM-11 (2 of 4)

ANALYTE	WELL NO. SM-11
2. SEMI-VOLATILE ORGANIC COMPOUNDS (CONT'D) **Parameter (Units: ug/L)**	
1,3-Dichlorobenzene	ND
1,4-Dichlorobenzene	ND
Benzyl alcohol	ND
1,2-Dichlorobenzene	ND
2-Methylphenol	ND
bis(2-Chloroisopropyl) ether	ND
4-Methylphenol	ND
N-Nitroso-di-n-propylamine	ND
Hexachloroethane	ND
Nitrobenzene	ND
Isophorone	ND
2-Nitrophenol	ND
2,4-Dimethylphenol	ND
Benzoic Acid	ND
bis (2-Chloroethoxy) methane	ND
2,4-Dichlorophenol	ND
1,2,4-Trichlorobenzene	ND
Naphthalene	ND
4-Chloroaniline	ND
Hexachlorobutadiene	ND
4-Chloro-3-methylphenol	ND
2-Methylnaphthalene	ND
Hexachlorocyclopentadiene	ND
2,4,6-Trichlorophenol	ND
2,4,5-Trichlorophenol	ND
2-Chloronaphthalene	ND
2-Nitroaniline	ND
Dimethylphthalate	ND
Acenaphthylene	ND
2,6-Dinitrotoluene	ND
3-Nitroaniline	ND
Acenaphthene	ND
2,4-Dinitrophenol	ND
4-Nitrophenol	ND
Dibenzofuran	ND
2,4-Dinitrotoluene	ND
Diethylphthalate	ND
4-Chlorophenyl-phenylether	ND
Fluorene	ND
4-Nitroaniline	ND
4,6-Dinitro-2-methylphenol	ND

TABLE F-3. SUMMARY OF CHEMICAL TEST RESULTS OF GROUNDWATER SAMPLE FROM BORING SM-11 (3 of 4)

ANALYTE	WELL NO. SM-11
2. SEMI-VOLATILE ORGANIC COMPOUNDS (CONT'D) **Parameter (Units: ug/L)**	
N-Nitrosodiphenylamine	ND
4-Bromophenyl-phenylether	ND
Hexachlorobenzene	ND
Pentachloropenol	ND
Phenanthrene	ND
Anthracene	ND
Di-n-butylphthalate	ND
Fluoranthene	ND
Benzidine	ND
Pyrene	ND
Butylbenzylphthalate	ND
Benzo(a)anthracene	ND
Chrysene	ND
bis(2-Ethylhexyl)phthalate	ND
Di-n-octyl phthalate	ND
Benzo(b)fluoranthene	ND
Benzo(k)fluoranthene	ND
Benzo(a)pyrene	ND
Dibenz(a,j)acridine	NA
Indeno(1,2,3-cd)pyrene	ND
Dibenzo(a,h)anthracene	ND
Benzo(g,h,i)perylene	ND
3. CCR TITLE 22 METALS **Parameter (Units:mg/L)**	
Antimony, Sb	ND
Arsenic, As	0.007
Barium, Ba	NA
Beryllium, Be	ND
Cadmium, Cd	NA
Chromium, Cr	0.036
Cobalt, Co	NA
Copper, Cu	0.031
Lead, Pb	ND
Mercury, Hg	ND
Molybdenum, Mo	NA
Nickel, Ni	0.04
Selenium, Se	ND
Silver, Ag	ND
Thallium, Tl	ND
Vanadium, V	NA
Zinc, Zn	0.12

TABLE F-3. SUMMARY OF CHEMICAL TEST RESULTS OF GROUNDWATER SAMPLE FROM BORING SM-11 (4 of 4)

ANALYTE	WELL NO. SM-11
4. TOTAL DISSOLVED SOLIDS (mg/L)	1250
5. SULFIDE (mg/L)	ND
6. SPECIFIC CONDUCTANCE (umho/cm)	1650
7. pH (pH units)	7.4

NOTES: Units-
ug/L = micrograms per liter
mg/L = milligrams per liter
NTU = National turbidity units
umho/cm = micro mhos per centimeter
ND = Not Detected
B = Indictes the analyte was observed in associated blank as well as the sample
CCR Title 22 = California Code of Regulations, Title 22, Division 4, Chapter 30, Article 11
NA = not analyzed

REPORTS OF LABORATORY ANALYSES
MONITORING WELL SM-3A

pace
INCORPORATED
THE ASSURANCE OF QUALITY

REPORT OF LABORATORY ANALYSIS

December 11, 1992

Dr. Ram
Earth Technology Corporation
13900 Alton Parkway
Suite 120
Irvine, CA 92718

RE: PACE Project No. 721129.508
Client Reference: Metro Rail/92-2050-02

Dear Dr. Ram:

Enclosed is the report of laboratory analyses for samples received November 19, 1992. Samples were received by the laboratory in good condition with proper preservatives per the requested analytical work.

Footnotes are given at the end of the report.

If you have any questions concerning this report, please feel free to contact us.

Sincerely,

Eric S Howarth

Eric S. Howarth
Project Manager

Enclosures

5702 Bolsa Avenue
Huntington Beach, CA 92649
TEL: 714-892-2565
FAX: 714-890-4032

An Equal Opportunity Employer

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721129.508

CLIENT PROJECT NAME: Metro Rail/92-2050-02

CLIENT SAMPLE DESCRIPTION: SM3A

SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
1,1,2-Trichlor-1,2,2-trifluoroethane	10	ug/L	ND	624	11/30/92
Chloromethane	10	ug/L	ND	624	11/30/92
Vinyl chloride	10	ug/L	ND	624	11/30/92
Bromomethane	10	ug/L	ND	624	11/30/92
Chloroethane	10	ug/L	ND	624	11/30/92
Trichlorofluoromethane	10	ug/L	ND	624	11/30/92
1,1-Dichloroethene	5	ug/L	ND	624	11/30/92
Acetone	50	ug/L	ND	624	11/30/92
Carbon disulfide	5	ug/L	ND	624	11/30/92
Methylene chloride	5	ug/L	ND	624	11/30/92
trans-1,2-Dichloroethene	5	ug/L	ND	624	11/30/92
1,1-Dichloroethane	5	ug/L	ND	624	11/30/92
2-Butanone	50	ug/L	ND	624	11/30/92
cis-1,2-Dichloroethene	5	ug/L	ND	624	11/30/92
Chloroform	5	ug/L	ND	624	11/30/92
1,2-Dichloroethane	5	ug/L	ND	624	11/30/92
1,1,1-Trichloroethane	5	ug/L	ND	624	11/30/92
Carbon tetrachloride	5	ug/L	ND	624	11/30/92
Benzene	5	ug/L	ND	624	11/30/92
Trichloroethene	5	ug/L	ND	624	11/30/92
1,2-Dichloropropane	5	ug/L	ND	624	11/30/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721129.508
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: SM3A
SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Bromodichloromethane	5	ug/L	ND	624	11/30/92
cis-1,3-Dichloropropene	5	ug/L	ND	624	11/30/92
trans-1,3-Dichloropropene	5	ug/L	ND	624	11/30/92
1,1,2-Trichloroethane	5	ug/L	ND	624	11/30/92
Dibromochloromethane	5	ug/L	ND	624	11/30/92
Bromoform	5	ug/L	ND	624	11/30/92
4-Methyl-2-pentanone	50	ug/L	ND	624	11/30/92
Toluene	5	ug/L	ND	624	11/30/92
2-Hexanone	50	ug/L	ND	624	11/30/92
1,1,2,2-Tetrachloroethane	5	ug/L	ND	624	11/30/92
Tetrachloroethene	5	ug/L	ND	624	11/30/92
Chlorobenzene	5	ug/L	ND	624	11/30/92
Ethylbenzene	5	ug/L	ND	624	11/30/92
Styrene	5	ug/L	ND	624	11/30/92
Xylenes (Total)	5	ug/L	ND	624	11/30/92
1,3-Dichlorobenzene	5	ug/L	ND	624	11/30/92
1,4-Dichlorobenzene	5	ug/L	ND	624	11/30/92
1,2-Dichlorobenzene	5	ug/L	ND	624	11/30/92
1,2-Dichloroethane-d4 (Surrog. Recovery)		%	123	624	11/30/92
Toluene-d8 (Surrog. Recovery)		%	101	624	11/30/92
4-Bromofluorobenzene (Surrog. Recovery)		%	97.1	624	11/30/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721129.508
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: SM3A
SAMPLE MATRIX: WATER

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
8270 Date Extracted			-	3520	11/20/92
n-Nitrosodimethylamine	10	ug/L	ND	625	11/27/92
Phenol	10	ug/L	ND	625	11/27/92
Aniline	10	ug/L	ND	625	11/27/92
bis(2-Chloroethyl)ether	10	ug/L	ND	625	11/27/92
2-Chlorophenol	10	ug/L	ND	625	11/27/92
1,3-Dichlorobenzene	10	ug/L	ND	625	11/27/92
1,4-Dichlorobenzene	10	ug/L	ND	625	11/27/92
Benzyl alcohol	10	ug/L	ND	625	11/27/92
1,2-Dichlorobenzene	10	ug/L	ND	625	11/27/92
2-Methylphenol	10	ug/L	ND	625	11/27/92
bis(2-Chloroisopropyl)ether	10	ug/L	ND	625	11/27/92
4-Methylphenol	10	ug/L	ND	625	11/27/92
n-Nitroso-di-n-propylamine	10	ug/L	ND	625	11/27/92
Hexachloroethane	10	ug/L	ND	625	11/27/92
Nitrobenzene	10	ug/L	ND	625	11/27/92
Isophorone	10	ug/L	ND	625	11/27/92
2-Nitrophenol	10	ug/L	ND	625	11/27/92
2,4-Dimethylphenol	10	ug/L	ND	625	11/27/92
Benzoic acid	50	ug/L	ND	625	11/27/92
bis(2-Chloroethoxy)methane	10	ug/L	ND	625	11/27/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721129.508
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: SM3A
SAMPLE MATRIX: WATER

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
2,4-Dichlorophenol	10	ug/L	ND	625	11/27/92
1,2,4-Trichlorobenzene	10	ug/L	ND	625	11/27/92
Naphthalene	10	ug/L	ND	625	11/27/92
4-Chloroaniline	20	ug/L	ND	625	11/27/92
Hexachlorobutadiene	10	ug/L	ND	625	11/27/92
4-Chloro-3-methylphenol	10	ug/L	ND	625	11/27/92
2-Methylnaphthalene	10	ug/L	ND	625	11/27/92
Hexachlorocyclopentadiene	10	ug/L	ND	625	11/27/92
2,4,6-Trichlorophenol	10	ug/L	ND	625	11/27/92
2,4,5-Trichlorophenol	10	ug/L	ND	625	11/27/92
2-Chloronaphthalene	50	ug/L	ND	625	11/27/92
2-Nitroaniline	50	ug/L	ND	625	11/27/92
Dimethylphthalate	10	ug/L	ND	625	11/27/92
Acenaphthylene	10	ug/L	ND	625	11/27/92
2,6-Dinitrotoluene	10	ug/L	ND	625	11/27/92
3-Nitroaniline	50	ug/L	ND	625	11/27/92
Acenaphthene	10	ug/L	ND	625	11/27/92
2,4-Dinitrophenol	50	ug/L	ND	625	11/27/92
4-Nitrophenol	50	ug/L	ND	625	11/27/92
Dibenzofuran	10	ug/L	ND	625	11/27/92
2,4-Dinitrotoluene	10	ug/L	ND	625	11/27/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721129.508
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: SM3A
SAMPLE MATRIX: WATER

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Diethylphthalate	10	ug/L	ND	625	11/27/92
4-Chlorophenyl-phenylether	10	ug/L	ND	625	11/27/92
Fluorene	10	ug/L	ND	625	11/27/92
4-Nitroaniline	50	ug/L	ND	625	11/27/92
4,6-Dinitro-2-methylphenol	50	ug/L	ND	625	11/27/92
n-Nitrosodiphenylamine	10	ug/L	ND	625	11/27/92
4-Bromophenyl-phenylether	10	ug/L	ND	625	11/27/92
Hexachlorobenzene	10	ug/L	ND	625	11/27/92
Pentachlorophenol	10	ug/L	ND	625	11/27/92
Phenanthrene	10	ug/L	ND	625	11/27/92
Anthracene	10	ug/L	ND	625	11/27/92
Di-n-butylphthalate	10	ug/L	ND	625	11/27/92
Fluoranthene	10	ug/L	ND	625	11/27/92
Benzidine	50	ug/L	ND	625	11/27/92
Pyrene	10	ug/L	ND	625	11/27/92
Butylbenzylphthalate	10	ug/L	ND	625	11/27/92
Benzo(a)anthracene	10	ug/L	ND	625	11/27/92
Chrysene	10	ug/L	ND	625	11/27/92
bis(2-Ethylhexyl)phthalate	10	ug/L	ND	625	11/27/92
Di-n-octylphthalate	10	ug/L	ND	625	11/27/92
Benzo(b)fluoranthene	10	ug/L	ND	625	11/27/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721129.508
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: SM3A
SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Benzo(k)fluoranthene	10	ug/L	ND	625	11/27/92
Benzo(a)pyrene	10	ug/L	ND	625	11/27/92
Indeno(1,2,3-cd)pyrene	10	ug/L	ND	625	11/27/92
Dibenzo(a,h)anthracene	10	ug/L	ND	625	11/27/92
Benzo(g,h,i)perylene	10	ug/L	ND	625	11/27/92
2-Fluorophenol (Surrog. Recovery)		%	56.4	625	11/27/92
Phenol-d5 (Surrog. Recovery)		%	59.2	625	11/27/92
Nitrobenzene-d5 (Surrog. Recovery)		%	59.3	625	11/27/92
2-Fluorobiphenyl (Surrog. Recovery)		%	63.0	625	11/27/92
2,4,6-Tribromophenol (Surrog. Recovery)		%	79.4	625	11/27/92
Terphenyl-d14 (Surrog. Recovery)		%	93.2	625	11/27/92
Date Extracted			-	418.1	11/24/92
Total Petroleum Hydrocarbons	0.05	mg/L	ND	418.1	11/24/92
Date Extracted			-	413.2	12/01/92
Oil & Grease	0.05	mg/L	0.06	413.2	12/01/92
TPH Quantified as Gasoline	20	ug/L	ND	8015 LUFT	11/23/92
Date Extracted			-	8015 LUFT	11/23/92
TPH Quantified as Diesel	500	ug/L	ND	8015 LUFT	11/24/92
TTLC, CV Date Digested			-	7470	12/02/92
TTLC, CV Mercury	0.0003	mg/L	ND	7470	12/02/92
Antimony (Sb)	0.003	mg/L	ND	6020	12/01/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721129.508 December 11, 1992
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: SM3A
SAMPLE MATRIX: WATER

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Arsenic (As)	0.005	mg/L	ND	6020	12/01/92
Berium (Ba)	0.004	mg/L	0.050	6020	12/01/92
Beryllium (Be)	0.002	mg/L	ND	6020	12/01/92
Cadmium (Cd)	0.0025	mg/L	ND	6020	12/01/92
Chromium (Cr)	0.004	mg/L	ND	6020	12/01/92
Cobalt (Co)	0.004	mg/L	ND	6020	12/01/92
Copper (Cu)	0.005	mg/L	ND	6020	12/01/92
Lead (Pb)	0.005	mg/L	ND	6020	12/01/92
Molybdenum (Mo)	0.005	mg/L	ND	6020	12/01/92
Nickel (Ni)	0.005	mg/L	ND	6020	12/01/92
Selenium (Se)	0.005	mg/L	ND	270.2	12/01/92
Silver (Ag)	0.005	mg/L	ND	6020	12/01/92
Thallium (Tl)	0.005	mg/L	ND	6020	12/01/92
Vanadium (V)	0.005	mg/L	ND	6020	12/01/92
Zinc (Zn)	0.007	mg/L	0.025	6020	12/01/92
Date Extracted			-	7196	11/19/92
Chromium, Hexavalent	0.01	mg/L	ND	7196	11/19/92
Acute Aquatic Toxicity (Bioassay)		% Survival	100		11/20/92
Date Incubated			-	405.1	11/20/92
Biological Oxygen Demand	0.2	mg/L	2.2	405.1	11/25/92
Spectrophotometric-Chem Oxygen Demand	5.0	mg/L	ND	Hach Kit	12/08/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721129.508
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: SM3A
SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Gravimetric-Total Suspended Solids	4.0	mg/L	500	160.2	11/23/92
Settleable Matter	0.1	ml/L	0.6	160.5	11/19/92
Turbidity	2.0	NTU	190	180.1	11/19/92
Gravimetric-Total Dissolved Solids	10	mg/L	590	160.1	11/23/92
Titrimetric-Chloride	0.5	mg/L	32	325.3	11/30/92
Spectrophotometric-Total Sulfide	0.05	mg/L	ND	376.2	11/24/92
Gravimetric-Sulfate	1.0	mg/L	78	375.3	11/30/92
Nitrite	1.0	mg/L	ND	300	12/04/92
Nitrate	1	mg/L	62	300	12/04/92
Specific Conductance	10	umhos/cm	860	120.1	12/01/92
pH	2.0	Units	7.9	150.1	11/19/92

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December 11, 1992
PACE Project Number: 721129508

Client Reference: Metro Rail/92-2050-02

All QA reports and data have been reviewed and are within acceptable limits.

Kenneth D. Faust,
Southern California Regional Director

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FOOTNOTES
for pages 1 through 6

December 11, 1992
PACE Project Number: 72112950

Client Reference: Metro Rail/92-2050-02

<	Less than reported value.
MDL	Method Detection Limit
ND	Not detected at or above the MDL.

REPORT OF LABORATORY ANALYSIS

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721129508

Client Reference: Metro Rail/92-2050-02

Biological Oxygen Demand
Batch: 75 04303
Samples: 75 0158949

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750158949 Water SM3A	Duplicate of 75 0158949	RPD
Biological Oxygen Demand	mg/L	0.2	ND	2.2	2.2	0%

Dr. Ram QUALITY CONTROL DATA December 11, 1992
Page 12 PACE Project Number: 72112950

Client Reference: Metro Rail/92-2050-02

Gravimetric-Sulfate
Batch: 75 04297
Samples: 75 0158949

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159392	Duplicate of 75 0159392	RPD
Gravimetric-Sulfate	mg/L	1.0	ND	750	750	0%

SPIKE:

Parameter	Units	MDL	750159392	Spike	Spike Recv
Gravimetric-Sulfate	mg/L	1.0	750	338	98%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
Gravimetric-Sulfate	mg/L	1.0	338	95%

r. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721129508

Client Reference: Metro Rail/92-2050-02

Gravimetric-Total Dissolved Solids
Batch: 75 04192
Samples: 75 0158949

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422	Duplicate of 75 0159422	RPD
Gravimetric-Total Dissolved Solids	mg/L	10	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159422	Spike	Spike Recv
Gravimetric-Total Dissolved Solids	mg/L	10	ND	1000	101%

LABORATORY CONTROL SAMPLE:

'arameter	Units	MDL	Reference Value	Recv
;ravimetric-Total Dissolved Solids	mg/L	10	1000	99%

REPORT OF LABORATORY ANALYSIS

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 72112950

Client Reference: Metro Rail/92-2050-02

Gravimetric-Total Suspended Solids
Batch: 75 04300
Samples: 75 0158949

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422	Duplicate of 75 0159422	RPD
Gravimetric-Total Suspended Solids	mg/L	4.0	ND	ND	ND	NC

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721129508

Client Reference: Metro Rail/92-2050-02

Specific Conductance
Batch: 75 04288
Samples: 75 0158949

SAMPLE DUPLICATE:

Parameter	Units	MDL	750158949 Water SM3A	Duplicate of 75 0158949	RPD
Specific Conductance	umhos/cm	10	860	870	1%

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721129508

Client Reference: Metro Rail/92-2050-02

Spectrophotometric-Chem Oxygen Demand
Batch: 75 04425
Samples: 75 0158949

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422	Duplicate of 75 0159422	RPD
Spectrophotometric-Chem Oxygen Demand	mg/L	5.0	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159422	Spike	Spike Recv
Spectrophotometric-Chem Oxygen Demand	mg/L	5.0	ND	50	124%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
Spectrophotometric-Chem Oxygen Demand	mg/L	5.0	50	126%

r. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721129508

Client Reference: Metro Rail/92-2050-02

Spectrophotometric-Total Sulfide
Batch: 75 04311
Samples: 75 0158949

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422	Duplicate of 75 0159422	RPD
Spectrophotometric-Total Sulfide	mg/L	0.05	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159422	Spike	Spike Recv
Spectrophotometric-Total Sulfide	mg/L	0.05	ND	0.21	100%

LABORATORY CONTROL SAMPLE:

arameter	Units	MDL	Reference Value	Recv
pectrophotometric-Total Sulfide	mg/L	0.05	0.21	90%

REPORT OF LABORATORY ANALYSIS

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721129508

Client Reference: Metro Rail/92-2050-02

Titrimetric-Chloride
Batch: 75 04298
Samples: 75 0158949

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422	Duplicate of 75 0159422	RPD
Titrimetric-Chloride	mg/L	0.5	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159422	Spike	Spike Recv
Titrimetric-Chloride	mg/L	0.5	ND	88.65	98%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
Titrimetric-Chloride	mg/L	0.5	88.65	97%

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721129508

Client Reference: Metro Rail/92-2050-02

Turbidity
Batch: 75 04289
Samples: 75 0158949

SAMPLE DUPLICATE:

Parameter	Units	MDL	750158949 Water SM3A	Duplicate of 75 0158949	RPD
Turbidity	NTU	2.0	190		
Turbidity	NTU	0.2		190	0%

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721129506

Client Reference: Metro Rail/92-2050-02

pH
Batch: 75 04194
Samples: 75 0158949

SAMPLE DUPLICATE:

Parameter	Units	MDL	750158949 Water SM3A	Duplicate of 75 0158949	RPD
pH	Units	2.0	7.9	7.9	0%

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721129508

Client Reference: Metro Rail/92-2050-02

SPECTROPHOTOMETRIC, IR-OIL & GREASE
Batch: 75 04310
Samples: 75 0158949

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Date Extracted			-
Oil & Grease	mg/L	0.05	ND

LABORATORY CONTROL SAMPLE AND CONTROL SAMPLE DUPLICATE:

Parameter	Units	MDL	Reference Value	Recv	Dupl Recv	RPD
Oil & Grease	mg/L	0.05	4.62	89%	89%	0%

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721129506

Client Reference: Metro Rail/92-2050-02

SPECTROPHOTOMETRIC, IR-TPH
Batch: 75 04309
Samples: 75 0158949

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Date Extracted			-
Total Petroleum Hydrocarbons	mg/L	0.05	ND

LABORATORY CONTROL SAMPLE AND CONTROL SAMPLE DUPLICATE:

Parameter	Units	MDL	Reference Value	Recv	Dupl Recv	RPD
Total Petroleum Hydrocarbons	mg/L	0.05	4.89	84%	85%	1%

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721129508

Client Reference: Metro Rail/92-2050-02

SPECTROPHOTOMETRIC-CHROMIUM, HEXAVALENT
Batch: 75 04293
Samples: 75 0158949

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750158949 Water SM3A	Duplicate of 75 0158949	RPD
Date Extracted			-	-	-	NC
Chromium, Hexavalent	mg/L	0.01	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750158949 Water SM3A	Spike	Spike Recv
Chromium, Hexavalent	mg/L	0.01	ND	0.53	98%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
Chromium, Hexavalent	mg/L	0.01	0.53	100%

REPORT OF LABORATORY ANALYSIS

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 72112950

Client Reference: Metro Rail/92-2050-02

TITLE 22 TTLC MERCURY BY CV
Batch: 75 04384
Samples: 75 0158949

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422	Duplicate of 75 0159422	RPD
TTLC, CV Mercury	mg/L	0.0003	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159422	Spike	Spike Recv
TTLC, CV Mercury	mg/L	0.0003	ND	0.005	108%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
TTLC, CV Mercury	mg/L	0.0003	0.005	98%

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721129508

Client Reference: Metro Rail/92-2050-02

BTEX & TPH QUANTIFIED AS GASOLINE
Batch: 75 04233
Samples: 75 0158949

METHOD BLANK:

Parameter	Units	MDL	Method Blank
TPH Quantified as Gasoline	ug/L	50	ND
Benzene	ug/L	0.3	ND
Toluene	ug/L	0.3	ND
Ethylbenzene	ug/L	0.3	ND
Xylenes	ug/L	0.6	ND
% FB Surrogate Spike Recovery			90%

SPIKE AND SPIKE DUPLICATE:

Parameter	Units	MDL	750158949 Water SM3A	Spike	Spike Recv	Spike Dupl Recv	RPD
TPH Quantified as Gasoline	ug/L	20	ND				
TPH Quantified as Gasoline	ug/L	50		400	90%	91%	1%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
TPH Quantified as Gasoline	ug/L	50	400	97%
Benzene	ug/L	0.3	20	98%
Toluene	ug/L	0.3	20	95%
Ethylbenzene	ug/L	0.3	20	97%
Xylenes	ug/L	0.6	60	93%

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721129506

Client Reference: Metro Rail/92-2050-02

EXTRACTABLE TPH QUANTIFIED AS DIESEL
Batch: 75 04296
Samples: 75 0158949

METHOD BLANK:

Parameter	Units	MDL	Method Blank
TPH Quantified as Diesel	ug/L	500	ND

LABORATORY CONTROL SAMPLE AND CONTROL SAMPLE DUPLICATE:

Parameter	Units	MDL	Reference Value	Recv	Dupl Recv	RPD
TPH Quantified as Diesel	ug/L	500	2500	112%	116%	3%

REPORT OF LABORATORY ANALYSIS

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721129508

Client Reference: Metro Rail/92-2050-02

SEMI-VOLATILES
Batch: 75 04241
Samples: 75 0158949

METHOD BLANK:

Parameter	Units	MDL	Method Blank
n-Nitrosodimethylamine	ug/L	10	ND
Phenol	ug/L	10	ND
Aniline	ug/L	10	ND
bis(2-Chloroethyl)ether	ug/L	10	ND
2-Chlorophenol	ug/L	10	ND
1,3-Dichlorobenzene	ug/L	10	ND
1,4-Dichlorobenzene	ug/L	10	ND
Benzyl alcohol	ug/L	10	ND
1,2-Dichlorobenzene	ug/L	10	ND
2-Methylphenol	ug/L	10	ND
bis(2-Chloroisopropyl)ether	ug/L	10	ND
4-Methylphenol	ug/L	10	ND
n-Nitroso-di-n-propylamine	ug/L	10	ND
Hexachloroethane	ug/L	10	ND
Nitrobenzene	ug/L	10	ND
Isophorone	ug/L	10	ND
2-Nitrophenol	ug/L	10	ND
2,4-Dimethylphenol	ug/L	10	ND
Benzoic acid	ug/L	50	ND
bis(2-Chloroethoxy)methane	ug/L	10	ND
2,4-Dichlorophenol	ug/L	10	ND
1,2,4-Trichlorobenzene	ug/L	10	ND
Naphthalene	ug/L	10	ND
4-Chloroaniline	ug/L	20	ND
Hexachlorobutadiene	ug/L	10	ND
4-Chloro-3-methylphenol	ug/L	10	ND
2-Methylnaphthalene	ug/L	10	ND
Hexachlorocyclopentadiene	ug/L	10	ND
2,4,6-Trichlorophenol	ug/L	10	ND
2,4,5-Trichlorophenol	ug/L	10	ND
2-Chloronaphthalene	ug/L	50	ND
2-Nitroaniline	ug/L	50	ND

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721129506

Client Reference: Metro Rail/92-2050-02

SEMI-VOLATILES
Batch: 75 04241
Samples: 75 0158949

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Dimethylphthalate	ug/L	10	ND
Acenaphthylene	ug/L	10	ND
2,6-Dinitrotoluene	ug/L	10	ND
3-Nitroaniline	ug/L	50	ND
Acenaphthene	ug/L	10	ND
2,4-Dinitrophenol	ug/L	50	ND
4-Nitrophenol	ug/L	50	ND
Dibenzofuran	ug/L	10	ND
2,4-Dinitrotoluene	ug/L	10	ND
Diethylphthalate	ug/L	10	ND
4-Chlorophenyl-phenylether	ug/L	10	ND
Fluorene	ug/L	10	ND
4-Nitroaniline	ug/L	50	ND
4,6-Dinitro-2-methylphenol	ug/L	50	ND
n-Nitrosodiphenylamine	ug/L	10	ND
4-Bromophenyl-phenylether	ug/L	10	ND
Hexachlorobenzene	ug/L	10	ND
Pentachlorophenol	ug/L	10	ND
Phenanthrene	ug/L	10	ND
Anthracene	ug/L	10	ND
Di-n-butylphthalate	ug/L	10	ND
Fluoranthene	ug/L	10	ND
Benzidine	ug/L	50	ND
Pyrene	ug/L	10	ND
Butylbenzylphthalate	ug/L	10	ND
Benzo(a)anthracene	ug/L	10	ND
Chrysene	ug/L	10	ND
bis(2-Ethylhexyl)phthalate	ug/L	10	ND
Di-n-octylphthalate	ug/L	10	ND
Benzo(b)fluoranthene	ug/L	10	ND
Benzo(k)fluoranthene	ug/L	10	ND
Benzo(a)pyrene	ug/L	10	ND

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721129508

Client Reference: Metro Rail/92-2050-02

SEMI-VOLATILES
Batch: 75 04241
Samples: 75 0158949

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Indeno(1,2,3-cd)pyrene	ug/L	10	ND
Dibenzo(a,h)anthracene	ug/L	10	ND
Benzo(g,h,i)perylene	ug/L	10	ND
2-Fluorophenol	(Surrog. Recovery %		68.4
Phenol-d5	(Surrog. Recovery %		70.5
Nitrobenzene-d5	(Surrog. Recovery %		71.2
2-Fluorobiphenyl	(Surrog. Recovery %		72.8
2,4,6-Tribromophenol	(Surrog. Recovery %		78.7
Terphenyl-d14	(Surrog. Recovery %		116

LABORATORY CONTROL SAMPLE AND CONTROL SAMPLE DUPLICATE:

			Reference		Dupl	
Parameter	Units	MDL	Value	Recv	Recv	RPD
Phenol	ug/L	10	100.00	61%	75%	20%
2-Chlorophenol	ug/L	10	100.0	62%	70%	12%
1,4-Dichlorobenzene	ug/L	10	50.0	65%	79%	19%
n-Nitroso-di-n-propylamine	ug/L	10	50.0	62%	75%	18%
1,2,4-Trichlorobenzene	ug/L	10	50.0	62%	74%	17%
4-Chloro-3-methylphenol	ug/L	10	100.0	70%	78%	10%
Acenaphthene	ug/L	10	50.0	70%	80%	13%
4-Nitrophenol	ug/L	50	100.0	110%	105%	4%
2,4-Dinitrotoluene	ug/L	10	50.0	74%	76%	2%
Pentachlorophenol	ug/L	10	100.0	77%	78%	1%
Pyrene	ug/L	10	50.0	138%	134%	2%

There was not enough sample for an MS/MSD. The LCS/LCSD results are reported instead.

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721129506

Client Reference: Metro Rail/92-2050-02

VOLATILE ORGANICS
Batch: 75 04260
Samples: 75 0158949

METHOD BLANK:

Parameter	Units	MDL	Method Blank
1,1,2-Trichlor-1,2,2-trifluoroethane	ug/L	10	ND
Chloromethane	ug/L	10	ND
Vinyl chloride	ug/L	10	ND
Bromomethane	ug/L	10	ND
Chloroethane	ug/L	10	ND
Trichlorofluoromethane	ug/L	10	ND
1,1-Dichloroethene	ug/L	5	ND
Acetone	ug/L	50	ND
Carbon disulfide	ug/L	5	ND
Methylene chloride	ug/L	5	ND
trans-1,2-Dichloroethene	ug/L	5	ND
1,1-Dichloroethane	ug/L	5	ND
2-Butanone	ug/L	50	ND
cis-1,2-Dichloroethene	ug/L	5	ND
Chloroform	ug/L	5	ND
1,2-Dichloroethane	ug/L	5	ND
1,1,1-Trichloroethane	ug/L	5	ND
Carbon tetrachloride	ug/L	5	ND
Benzene	ug/L	5	ND
Trichloroethene	ug/L	5	ND
1,2-Dichloropropane	ug/L	5	ND
Bromodichloromethane	ug/L	5	ND
cis-1,3-Dichloropropene	ug/L	5	ND
trans-1,3-Dichloropropene	ug/L	5	ND
1,1,2-Trichloroethane	ug/L	5	ND
Dibromochloromethane	ug/L	5	ND
Bromoform	ug/L	5	ND
4-Methyl-2-pentanone	ug/L	50	ND
Toluene	ug/L	5	ND
2-Hexanone	ug/L	50	ND
1,1,2,2-Tetrachloroethane	ug/L	5	ND
Tetrachloroethene	ug/L	5	ND

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721129508

Client Reference: Metro Rail/92-2050-02

VOLATILE ORGANICS
Batch: 75 04260
Samples: 75 0158949

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Chlorobenzene	ug/L	5	ND
Ethylbenzene	ug/L	5	ND
Styrene	ug/L	5	ND
Xylenes (Total)	ug/L	5	ND
1,3-Dichlorobenzene	ug/L	5	ND
1,4-Dichlorobenzene	ug/L	5	ND
1,2-Dichlorobenzene	ug/L	5	ND
1,2-Dichloroethane-d4 (Surrog. Recovery	%		119
Toluene-d8 (Surrog. Recovery	%		100
4-Bromofluorobenzene (Surrog. Recovery	%		96.9

SPIKE AND SPIKE DUPLICATE:

Parameter	Units	MDL	750158949 Water SM3A	Spike	Spike Recv	Spike Dupl Recv	RPD
1,1-Dichloroethene	ug/L	5	ND	50	82%	85%	3%
Benzene	ug/L	5	ND	50	92%	95%	3%
Trichloroethene	ug/L	5	ND	50	101%	105%	3%
Toluene	ug/L	5	ND	50	96%	96%	0%
Chlorobenzene	ug/L	5	ND	50	97%	97%	0%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
1,1-Dichloroethene	ug/L	5	50	82%
Benzene	ug/L	5	50	90%
Trichloroethene	ug/L	5	50	92%
Toluene	ug/L	5	50	93%
Chlorobenzene	ug/L	5	50	94%

Dr. Ram	FOOTNOTES	December 11, 1992
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Client Reference: Metro Rail/92-2050-02

MDL	Method Detection Limit
NC	No calculation due to value below detection limit.
ND	Not detected at or above the MDL.
RPD	Relative Percent Difference

REPORTS OF LABORATORY ANALYSES
MONITORING WELL SM-6A

pace
INCORPORATED
THE ASSURANCE OF QUALITY

REPORT OF LABORATORY ANALYSIS

December 11, 1992

Dr. Ram
Earth Technology Corporation
13900 Alton Parkway
Suite 120
Irvine, CA 92718

RE: PACE Project No. 721120.508
Client Reference: Metro Rail/92-2050-02

Dear Dr. :

Enclosed is the report of laboratory analyses for samples received November 20, 1992. Samples were received by the laboratory in good condition with the proper preservatives per the requested analytical work.

Footnotes are given at the end of the report.

If you have any questions concerning this report, please feel free to contact us.

Sincerely,

Eric S. Howarth
Project Manager

Enclosures

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.508
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: SM-6A
SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
1,1,2-Trichlor-1,2,2-trifluoroethane	10	ug/L	ND	624	12/01/92
Chloromethane	10	ug/L	ND	624	12/01/92
Vinyl chloride	10	ug/L	ND	624	12/01/92
Bromomethane	10	ug/L	ND	624	12/01/92
Chloroethane	10	ug/L	ND	624	12/01/92
Trichlorofluoromethane	10	ug/L	ND	624	12/01/92
1,1-Dichloroethene	5	ug/L	ND	624	12/01/92
Acetone	50	ug/L	ND	624	12/01/92
Carbon disulfide	5	ug/L	ND	624	12/01/92
Methylene chloride	5	ug/L	ND	624	12/01/92
trans-1,2-Dichloroethene	5	ug/L	ND	624	12/01/92
1,1-Dichloroethane	5	ug/L	ND	624	12/01/92
2-Butanone	50	ug/L	ND	624	12/01/92
cis-1,2-Dichloroethene	5	ug/L	ND	624	12/01/92
Chloroform	5	ug/L	ND	624	12/01/92
1,2-Dichloroethane	5	ug/L	ND	624	12/01/92
1,1,1-Trichloroethane	5	ug/L	ND	624	12/01/92
Carbon tetrachloride	5	ug/L	ND	624	12/01/92
Benzene	5	ug/L	ND	624	12/01/92
Trichloroethene	5	ug/L	ND	624	12/01/92
1,2-Dichloropropane	5	ug/L	ND	624	12/01/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.508
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: SM-6A
SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Bromodichloromethane	5	ug/L	ND	624	12/01/92
cis-1,3-Dichloropropene	5	ug/L	ND	624	12/01/92
trans-1,3-Dichloropropene	5	ug/L	ND	624	12/01/92
1,1,2-Trichloroethane	5	ug/L	ND	624	12/01/92
Dibromochloromethane	5	ug/L	ND	624	12/01/92
Bromoform	5	ug/L	ND	624	12/01/92
4-Methyl-2-pentanone	50	ug/L	ND	624	12/01/92
Toluene	5	ug/L	ND	624	12/01/92
2-Hexanone	50	ug/L	ND	624	12/01/92
1,1,2,2-Tetrachloroethane	5	ug/L	ND	624	12/01/92
Tetrachloroethene	5	ug/L	ND	624	12/01/92
Chlorobenzene	5	ug/L	ND	624	12/01/92
Ethylbenzene	5	ug/L	ND	624	12/01/92
Styrene	5	ug/L	ND	624	12/01/92
Xylenes (Total)	5	ug/L	ND	624	12/01/92
1,3-Dichlorobenzene	5	ug/L	ND	624	12/01/92
1,4-Dichlorobenzene	5	ug/L	ND	624	12/01/92
1,2-Dichlorobenzene	5	ug/L	ND	624	12/01/92
1,2-Dichloroethane-d4 (Surrog. Recovery)		%	129	624	12/01/92
Toluene-d8 (Surrog. Recovery)		%	100	624	12/01/92
4-Bromofluorobenzene (Surrog. Recovery)		%	97.0	624	12/01/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.508

CLIENT PROJECT NAME: Metro Rail/92-2050-02

CLIENT SAMPLE DESCRIPTION: SM-6A

SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
8270 Date Extracted			-	3520	11/20/92
n-Nitrosodimethylamine	10	ug/L	ND	625	11/27/92
Phenol	10	ug/L	ND	625	11/27/92
Aniline	10	ug/L	ND	625	11/27/92
bis(2-Chloroethyl)ether	10	ug/L	ND	625	11/27/92
2-Chlorophenol	10	ug/L	ND	625	11/27/92
1,3-Dichlorobenzene	10	ug/L	ND	625	11/27/92
1,4-Dichlorobenzene	10	ug/L	ND	625	11/27/92
Benzyl alcohol	10	ug/L	ND	625	11/27/92
1,2-Dichlorobenzene	10	ug/L	ND	625	11/27/92
2-Methylphenol	10	ug/L	ND	625	11/27/92
bis(2-Chloroisopropyl)ether	10	ug/L	ND	625	11/27/92
4-Methylphenol	10	ug/L	ND	625	11/27/92
n-Nitroso-di-n-propylamine	10	ug/L	ND	625	11/27/92
Hexachloroethane	10	ug/L	ND	625	11/27/92
Nitrobenzene	10	ug/L	ND	625	11/27/92
Isophorone	10	ug/L	ND	625	11/27/92
2-Nitrophenol	10	ug/L	ND	625	11/27/92
2,4-Dimethylphenol	10	ug/L	ND	625	11/27/92
Benzoic acid	50	ug/L	ND	625	11/27/92
bis(2-Chloroethoxy)methane	10	ug/L	ND	625	11/27/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.508

CLIENT PROJECT NAME: Metro Rail/92-2050-02

CLIENT SAMPLE DESCRIPTION: SM-6A

SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
2,4-Dichlorophenol	10	ug/L	ND	625	11/27/92
1,2,4-Trichlorobenzene	10	ug/L	ND	625	11/27/92
Naphthalene	10	ug/L	ND	625	11/27/92
4-Chloroaniline	20	ug/L	ND	625	11/27/92
Hexachlorobutadiene	10	ug/L	ND	625	11/27/92
4-Chloro-3-methylphenol	10	ug/L	ND	625	11/27/92
2-Methylnaphthalene	10	ug/L	ND	625	11/27/92
Hexachlorocyclopentadiene	10	ug/L	ND	625	11/27/92
2,4,6-Trichlorophenol	10	ug/L	ND	625	11/27/92
2,4,5-Trichlorophenol	10	ug/L	ND	625	11/27/92
2-Chloronaphthalene	50	ug/L	ND	625	11/27/92
2-Nitroaniline	50	ug/L	ND	625	11/27/92
Dimethylphthalate	10	ug/L	ND	625	11/27/92
Acenaphthylene	10	ug/L	ND	625	11/27/92
2,6-Dinitrotoluene	10	ug/L	ND	625	11/27/92
3-Nitroaniline	50	ug/L	ND	625	11/27/92
Acenaphthene	10	ug/L	ND	625	11/27/92
2,4-Dinitrophenol	50	ug/L	ND	625	11/27/92
4-Nitrophenol	50	ug/L	ND	625	11/27/92
Dibenzofuran	10	ug/L	ND	625	11/27/92
2,4-Dinitrotoluene	10	ug/L	ND	625	11/27/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.508

CLIENT PROJECT NAME: Metro Rail/92-2050-02

CLIENT SAMPLE DESCRIPTION: SM-6A

SAMPLE MATRIX: WATER

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Diethylphthalate	10	ug/L	ND	625	11/27/92
4-Chlorophenyl-phenylether	10	ug/L	ND	625	11/27/92
Fluorene	10	ug/L	ND	625	11/27/92
4-Nitroaniline	50	ug/L	ND	625	11/27/92
4,6-Dinitro-2-methylphenol	50	ug/L	ND	625	11/27/92
n-Nitrosodiphenylamine	10	ug/L	ND	625	11/27/92
4-Bromophenyl-phenylether	10	ug/L	ND	625	11/27/92
Hexachlorobenzene	10	ug/L	ND	625	11/27/92
Pentachlorophenol	10	ug/L	ND	625	11/27/92
Phenanthrene	10	ug/L	ND	625	11/27/92
Anthracene	10	ug/L	ND	625	11/27/92
Di-n-butylphthalate	10	ug/L	ND	625	11/27/92
Fluoranthene	10	ug/L	ND	625	11/27/92
Benzidine	50	ug/L	ND	625	11/27/92
Pyrene	10	ug/L	ND	625	11/27/92
Butylbenzylphthalate	10	ug/L	ND	625	11/27/92
Benzo(a)anthracene	10	ug/L	ND	625	11/27/92
Chrysene	10	ug/L	ND	625	11/27/92
bis(2-Ethylhexyl)phthalate	10	ug/L	15	625	11/27/92
Di-n-octylphthalate	10	ug/L	ND	625	11/27/92
Benzo(b)fluoranthene	10	ug/L	ND	625	11/27/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.508
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: SM-6A
SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Benzo(k)fluoranthene	10	ug/L	ND	625	11/27/92
Benzo(a)pyrene	10	ug/L	ND	625	11/27/92
Indeno(1,2,3-cd)pyrene	10	ug/L	ND	625	11/27/92
Dibenzo(a,h)anthracene	10	ug/L	ND	625	11/27/92
Benzo(g,h,i)perylene	10	ug/L	ND	625	11/27/92
2-Fluorophenol (Surrog. Recovery)		%	63.2	625	11/27/92
Phenol-d5 (Surrog. Recovery)		%	73.1	625	11/27/92
Nitrobenzene-d5 (Surrog. Recovery)		%	71.2	625	11/27/92
2-Fluorobiphenyl (Surrog. Recovery)		%	81.6	625	11/27/92
2,4,6-Tribromophenol (Surrog. Recovery)		%	97.3	625	11/27/92
Terphenyl-d14 (Surrog. Recovery)		%	50.7	625	11/27/92
Date Extracted			-	418.1	11/24/92
Total Petroleum Hydrocarbons	0.05	mg/L	ND	418.1	11/24/92
Date Extracted			-	413.2	12/01/92
Oil & Grease	0.05	mg/L	ND	413.2	12/01/92
TPH Quantified as Gasoline	20	ug/L	ND	8015 LUFT	11/23/92
Date Extracted			-	8015 LUFT	11/23/92
TPH Quantified as Diesel	500	ug/L	ND	8015 LUFT	11/24/92
TTLC, CV Date Digested			-	7470	12/02/92
TTLC, CV Mercury	0.0003	mg/L	ND	7470	12/02/92
Antimony (Sb)	0.003	mg/L	ND	6020	12/01/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.508
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: SM-6A
SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Arsenic (As)	0.005	mg/L	ND	6020	12/01/92
Berium (Ba)	0.004	mg/L	0.013	6020	12/01/92
Beryllium (Be)	0.002	mg/L	ND	6020	12/01/92
Cadmium (Cd)	0.0025	mg/L	ND	6020	12/01/92
Chromium (Cr)	0.004	mg/L	ND	6020	12/01/92
Cobalt (Co)	0.004	mg/L	ND	6020	12/01/92
Copper (Cu)	0.005	mg/L	ND	6020	12/01/92
Lead (Pb)	0.005	mg/L	ND	6020	12/01/92
Molybdenum (Mo)	0.005	mg/L	ND	6020	12/01/92
Nickel (Ni)	0.005	mg/L	ND	6020	12/01/92
Selenium (Se)	0.005	mg/L	0.010	270.2	12/01/92
Silver (Ag)	0.005	mg/L	ND	6020	12/01/92
Thallium (Tl)	0.005	mg/L	ND	6020	12/01/92
Vanadium (V)	0.005	mg/L	ND	6020	12/01/92
Zinc (Zn)	0.007	mg/L	0.040	6020	12/01/92
Date Extracted			-	7196	11/20/92
Chromium, Hexavalent	0.01	mg/L	ND	7196	11/20/92
Acute Aquatic Toxicity (Bioassay)		% Survival	100		11/20/92
Date Incubated			-	405.1	11/20/92
Biological Oxygen Demand	0.2	mg/L	4.2	405.1	11/25/92
Spectrophotometric-Chem Oxygen Demand	5.0	mg/L	ND	Hach Kit	12/08/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.508
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: SM-6A
SAMPLE MATRIX: WATER

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Gravimetric-Total Suspended Solids	4.0	mg/L	870	160.2	11/23/92
Settleable Matter	0.1	ml/L	1.5	160.5	11/20/92
Turbidity	2.0	NTU	320	180.1	11/20/92
Gravimetric-Total Dissolved Solids	10	mg/L	1020	160.1	11/23/92
Titrimetric-Chloride	0.5	mg/L	46	325.3	11/30/92
Spectrophotometric-Total Sulfide	0.05	mg/L	ND	376.2	11/24/92
Gravimetric-Sulfate	1.0	mg/L	470	375.3	11/30/92
Nitrite	1.0	mg/L	ND	300	12/04/92
Nitrate	1	mg/L	ND	300	12/04/92
Specific Conductance	10	umhos/cm	1220	120.1	12/01/92
pH	2.0	Units	7.0	150.1	11/20/92

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December 11, 1992
PACE Project Number: 721120508

Client Reference: Metro Rail/92-2050-02

All QA reports and data have been reviewed and are within acceptable limits.

Kenneth D. Faust,
Southern California Regional Director

Dr. Ram	FOOTNOTES	December 11, 1992
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Client Reference: Metro Rail/92-2050-02

<	Less than reported value.
MDL	Method Detection Limit
ND	Not detected at or above the MDL.

r. Ram
age 11

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120508

Client Reference: Metro Rail/92-2050-02

Biological Oxygen Demand
Batch: 75 04303
Samples: 75 0159406

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750158949	Duplicate of 75 0158949	RPD
Biological Oxygen Demand	mg/L	0.2	ND	2.2	2.2	0%

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 72112050t

Client Reference: Metro Rail/92-2050-02

Gravimetric-Sulfate
Batch: 75 04297
Samples: 75 0159406

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159392	Duplicate of 75 0159392	RPD
Gravimetric-Sulfate	mg/L	1.0	ND	750	750	0%

SPIKE:

Parameter	Units	MDL	750159392	Spike	Spike Recv
Gravimetric-Sulfate	mg/L	1.0	750	338	98%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
Gravimetric-Sulfate	mg/L	1.0	338	95%

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120508

Client Reference: Metro Rail/92-2050-02

Gravimetric-Total Dissolved Solids
Batch: 75 04192
Samples: 75 0159406

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422	Duplicate of 75 0159422	RPD
Gravimetric-Total Dissolved Solids	mg/L	10	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159422	Spike	Spike Recv
Gravimetric-Total Dissolved Solids	mg/L	10	ND	1000	101%

LABORATORY CONTROL SAMPLE:

arameter	Units	MDL	Reference Value	Recv
ravimetric-Total Dissolved Solids	mg/L	10	1000	99%

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120508

Client Reference: Metro Rail/92-2050-02

Gravimetric-Total Suspended Solids
Batch: 75 04300
Samples: 75 0159406

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422	Duplicate of 75 0159422	RPD
Gravimetric-Total Suspended Solids	mg/L	4.0	ND	ND	ND	NC

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120508

Client Reference: Metro Rail/92-2050-02

Settleable Matter
Batch: 75 04292
Samples: 75 0159406

SAMPLE DUPLICATE:

Parameter	Units	MDL	750159422	Duplicate of 75 0159422	RPD
Settleable Matter	ml/L	0.1	ND	ND	NC

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120508

Client Reference: Metro Rail/92-2050-02

Specific Conductance
Batch: 75 04288
Samples: 75 0159406

SAMPLE DUPLICATE:

Parameter	Units	MDL	750158949	Duplicate of 75 0158949	RPD
Specific Conductance	umhos/cm	10	860	870	1%

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120508

Client Reference: Metro Rail/92-2050-02

Spectrophotometric-Chem Oxygen Demand
Batch: 75 04425
Samples: 75 0159406

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422	Duplicate of 75 0159422	RPD
Spectrophotometric-Chem Oxygen Demand	mg/L	5.0	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159422	Spike	Spike Recv
Spectrophotometric-Chem Oxygen Demand	mg/L	5.0	ND	50	124%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
Spectrophotometric-Chem Oxygen Demand	mg/L	5.0	50	126%

REPORT OF LABORATORY ANALYSIS

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 72112050

Client Reference: Metro Rail/92-2050-02

Spectrophotometric-Total Sulfide
Batch: 75 04311
Samples: 75 0159406

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422	Duplicate of 75 0159422	RPD
Spectrophotometric-Total Sulfide	mg/L	0.05	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159422	Spike	Spike Recv
Spectrophotometric-Total Sulfide	mg/L	0.05	ND	0.21	100%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
Spectrophotometric-Total Sulfide	mg/L	0.05	0.21	90%

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120508

Client Reference: Metro Rail/92-2050-02

Titrimetric-Chloride
Batch: 75 04298
Samples: 75 0159406

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422	Duplicate of 75 0159422	RPD
Titrimetric-Chloride	mg/L	0.5	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159422	Spike	Spike Recv
Titrimetric-Chloride	mg/L	0.5	ND	88.65	98%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
Titrimetric-Chloride	mg/L	0.5	88.65	97%

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120506

Client Reference: Metro Rail/92-2050-02

Turbidity
Batch: 75 04290
Samples: 75 0159406

SAMPLE DUPLICATE:

Parameter	Units	MDL	750159422	Duplicate of 75 0159422	RPD
Turbidity	NTU	0.2	ND	ND	NC

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120508

Client Reference: Metro Rail/92-2050-02

pH
Batch: 75 04195
Samples: 75 0159406

SAMPLE DUPLICATE:

Parameter	Units	MDL	750159422	Duplicate of 75 0159422	RPD
pH	Units	2.0	6.2	6.2	0%

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120506

Client Reference: Metro Rail/92-2050-02

SPECTROPHOTOMETRIC, IR-OIL & GREASE
Batch: 75 04310
Samples: 75 0159406

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Date Extracted			-
Oil & Grease	mg/L	0.05	ND

LABORATORY CONTROL SAMPLE AND CONTROL SAMPLE DUPLICATE:

Parameter	Units	MDL	Reference Value	Recv	Dupl Recv	RPD
Oil & Grease	mg/L	0.05	4.62	89%	89%	0%

r. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120508

Client Reference: Metro Rail/92-2050-02

SPECTROPHOTOMETRIC, IR-TPH
Batch: 75 04309
Samples: 75 0159406

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Date Extracted			-
Total Petroleum Hydrocarbons	mg/L	0.05	ND

LABORATORY CONTROL SAMPLE AND CONTROL SAMPLE DUPLICATE:

Parameter	Units	MDL	Reference Value	Recv	Dupl Recv	RPD
Total Petroleum Hydrocarbons	mg/L	0.05	4.89	84%	85%	1%

REPORT OF LABORATORY ANALYSIS

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120506

Client Reference: Metro Rail/92-2050-02

SPECTROPHOTOMETRIC-CHROMIUM, HEXAVALENT
Batch: 75 04193
Samples: 75 0159406

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159414	Duplicate of 75 0159414	RPD
Date Extracted			-	-	-	NC
Chromium, Hexavalent	mg/L	0.01	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159414	Spike	Spike Recv
Chromium, Hexavalent	mg/L	0.01	ND	0.53	100%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
Chromium, Hexavalent	mg/L	0.01	0.53	100%

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120508

Client Reference: Metro Rail/92-2050-02

TITLE 22 TTLC MERCURY BY CV
Batch: 75 04384
Samples: 75 0159406

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422	Duplicate of 75 0159422	RPD
TTLC, CV Mercury	mg/L	0.0003	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159422	Spike	Spike Recv
TTLC, CV Mercury	mg/L	0.0003	ND	0.005	108%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
TTLC, CV Mercury	mg/L	0.0003	0.005	98%

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120508

Client Reference: Metro Rail/92-2050-02

BTEX & TPH QUANTIFIED AS GASOLINE
Batch: 75 04233
Samples: 75 0159406

METHOD BLANK:

Parameter	Units	MDL	Method Blank
TPH Quantified as Gasoline	ug/L	50	ND
Benzene	ug/L	0.3	ND
Toluene	ug/L	0.3	ND
Ethylbenzene	ug/L	0.3	ND
Xylenes	ug/L	0.6	ND
% FB Surrogate Spike Recovery			90%

SPIKE AND SPIKE DUPLICATE:

Parameter	Units	MDL	750158949	Spike	Spike Recv	Spike Dupl Recv	RPD
TPH Quantified as Gasoline	ug/L	20	ND				
TPH Quantified as Gasoline	ug/L	50		400	90%	91%	1%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
TPH Quantified as Gasoline	ug/L	50	400	97%
Benzene	ug/L	0.3	20	98%
Toluene	ug/L	0.3	20	95%
Ethylbenzene	ug/L	0.3	20	97%
Xylenes	ug/L	0.6	60	93%

r. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120508

Client Reference: Metro Rail/92-2050-02

EXTRACTABLE TPH QUANTIFIED AS DIESEL
Batch: 75 04296
Samples: 75 0159406

METHOD BLANK:

Parameter	Units	MDL	Method Blank
TPH Quantified as Diesel	ug/L	500	ND

LABORATORY CONTROL SAMPLE AND CONTROL SAMPLE DUPLICATE:

Parameter	Units	MDL	Reference Value	Recv	Dupl Recv	RPD
TPH Quantified as Diesel	ug/L	500	2500	112%	116%	3%

REPORT OF LABORATORY ANALYSIS

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120506

Client Reference: Metro Rail/92-2050-02

SEMI-VOLATILES
Batch: 75 04241
Samples: 75 0159406

METHOD BLANK:

Parameter	Units	MDL	Method Blank
n-Nitrosodimethylamine	ug/L	10	ND
Phenol	ug/L	10	ND
Aniline	ug/L	10	ND
bis(2-Chloroethyl)ether	ug/L	10	ND
2-Chlorophenol	ug/L	10	ND
1,3-Dichlorobenzene	ug/L	10	ND
1,4-Dichlorobenzene	ug/L	10	ND
Benzyl alcohol	ug/L	10	ND
1,2-Dichlorobenzene	ug/L	10	ND
2-Methylphenol	ug/L	10	ND
bis(2-Chloroisopropyl)ether	ug/L	10	ND
4-Methylphenol	ug/L	10	ND
n-Nitroso-di-n-propylamine	ug/L	10	ND
Hexachloroethane	ug/L	10	ND
Nitrobenzene	ug/L	10	ND
Isophorone	ug/L	10	ND
2-Nitrophenol	ug/L	10	ND
2,4-Dimethylphenol	ug/L	10	ND
Benzoic acid	ug/L	50	ND
bis(2-Chloroethoxy)methane	ug/L	10	ND
2,4-Dichlorophenol	ug/L	10	ND
1,2,4-Trichlorobenzene	ug/L	10	ND
Naphthalene	ug/L	10	ND
4-Chloroaniline	ug/L	20	ND
Hexachlorobutadiene	ug/L	10	ND
4-Chloro-3-methylphenol	ug/L	10	ND
2-Methylnaphthalene	ug/L	10	ND
Hexachlorocyclopentadiene	ug/L	10	ND
2,4,6-Trichlorophenol	ug/L	10	ND
2,4,5-Trichlorophenol	ug/L	10	ND
2-Chloronaphthalene	ug/L	50	ND
2-Nitroaniline	ug/L	50	ND

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120508

Client Reference: Metro Rail/92-2050-02

SEMI-VOLATILES
Batch: 75 04241
Samples: 75 0159406

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Dimethylphthalate	ug/L	10	ND
Acenaphthylene	ug/L	10	ND
2,6-Dinitrotoluene	ug/L	10	ND
3-Nitroaniline	ug/L	50	ND
Acenaphthene	ug/L	10	ND
2,4-Dinitrophenol	ug/L	50	ND
4-Nitrophenol	ug/L	50	ND
Dibenzofuran	ug/L	10	ND
2,4-Dinitrotoluene	ug/L	10	ND
Diethylphthalate	ug/L	10	ND
4-Chlorophenyl-phenylether	ug/L	10	ND
Fluorene	ug/L	10	ND
4-Nitroaniline	ug/L	50	ND
4,6-Dinitro-2-methylphenol	ug/L	50	ND
n-Nitrosodiphenylamine	ug/L	10	ND
4-Bromophenyl-phenylether	ug/L	10	ND
Hexachlorobenzene	ug/L	10	ND
Pentachlorophenol	ug/L	10	ND
Phenanthrene	ug/L	10	ND
Anthracene	ug/L	10	ND
Di-n-butylphthalate	ug/L	10	ND
Fluoranthene	ug/L	10	ND
Benzidine	ug/L	50	ND
Pyrene	ug/L	10	ND
Butylbenzylphthalate	ug/L	10	ND
Benzo(a)anthracene	ug/L	10	ND
Chrysene	ug/L	10	ND
bis(2-Ethylhexyl)phthalate	ug/L	10	ND
Di-n-octylphthalate	ug/L	10	ND
Benzo(b)fluoranthene	ug/L	10	ND
Benzo(k)fluoranthene	ug/L	10	ND
Benzo(a)pyrene	ug/L	10	ND

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120506

Client Reference: Metro Rail/92-2050-02

SEMI-VOLATILES
Batch: 75 04241
Samples: 75 0159406

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Indeno(1,2,3-cd)pyrene	ug/L	10	ND
Dibenzo(a,h)anthracene	ug/L	10	ND
Benzo(g,h,i)perylene	ug/L	10	ND
2-Fluorophenol	(Surrog. Recovery %		68.4
Phenol-d5	(Surrog. Recovery %		70.5
Nitrobenzene-d5	(Surrog. Recovery %		71.2
2-Fluorobiphenyl	(Surrog. Recovery %		72.8
2,4,6-Tribromophenol	(Surrog. Recovery %		78.7
Terphenyl-d14	(Surrog. Recovery %		116

LABORATORY CONTROL SAMPLE AND CONTROL SAMPLE DUPLICATE:

Parameter	Units	MDL	Reference Value	Recv	Dupl Recv	RPD
Phenol	ug/L	10	100.00	61%	75%	20%
2-Chlorophenol	ug/L	10	100.0	62%	70%	12%
1,4-Dichlorobenzene	ug/L	10	50.0	65%	79%	19%
n-Nitroso-di-n-propylamine	ug/L	10	50.0	62%	75%	18%
1,2,4-Trichlorobenzene	ug/L	10	50.0	62%	74%	17%
4-Chloro-3-methylphenol	ug/L	10	100.0	70%	78%	10%
Acenaphthene	ug/L	10	50.0	70%	80%	13%
4-Nitrophenol	ug/L	50	100.0	110%	105%	4%
2,4-Dinitrotoluene	ug/L	10	50.0	74%	76%	2%
Pentachlorophenol	ug/L	10	100.0	77%	78%	1%
Pyrene	ug/L	10	50.0	138%	134%	2%

There was not enough sample for an MS/MSD. The LCS/LCSD results are reported instead.

Client Reference: Metro Rail/92-2050-02

VOLATILE ORGANICS
Batch: 75 04284
Samples: 75 0159406

METHOD BLANK:

Parameter	Units	MDL	Method Blank
1,1,2-Trichlor-1,2,2-trifluoroethane	ug/L	10	ND
Chloromethane	ug/L	10	ND
Vinyl chloride	ug/L	10	ND
Bromomethane	ug/L	10	ND
Chloroethane	ug/L	10	ND
Trichlorofluoromethane	ug/L	10	ND
1,1-Dichloroethene	ug/L	5	ND
Acetone	ug/L	50	ND
Carbon disulfide	ug/L	5	ND
Methylene chloride	ug/L	5	ND
trans-1,2-Dichloroethene	ug/L	5	ND
1,1-Dichloroethane	ug/L	5	ND
2-Butanone	ug/L	50	ND
cis-1,2-Dichloroethene	ug/L	5	ND
Chloroform	ug/L	5	ND
1,2-Dichloroethane	ug/L	5	ND
1,1,1-Trichloroethane	ug/L	5	ND
Carbon tetrachloride	ug/L	5	ND
Benzene	ug/L	5	ND
Trichloroethene	ug/L	5	ND
1,2-Dichloropropane	ug/L	5	ND
Bromodichloromethane	ug/L	5	ND
cis-1,3-Dichloropropene	ug/L	5	ND
trans-1,3-Dichloropropene	ug/L	5	ND
1,1,2-Trichloroethane	ug/L	5	ND
Dibromochloromethane	ug/L	5	ND
Bromoform	ug/L	5	ND
4-Methyl-2-pentanone	ug/L	50	ND
Toluene	ug/L	5	ND
2-Hexanone	ug/L	50	ND
1,1,2,2-Tetrachloroethane	ug/L	5	ND
Tetrachloroethene	ug/L	5	ND

QUALITY CONTROL DATA

Client Reference: Metro Rail/92-2050-02

VOLATILE ORGANICS
Batch: 75 04284
Samples: 75 0159406

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Chlorobenzene	ug/L	5	ND
Ethylbenzene	ug/L	5	ND
Styrene	ug/L	5	ND
Xylenes (Total)	ug/L	5	ND
1,3-Dichlorobenzene	ug/L	5	ND
1,4-Dichlorobenzene	ug/L	5	ND
1,2-Dichlorobenzene	ug/L	5	ND
1,2-Dichloroethane-d4 (Surrog. Recovery	%		124
Toluene-d8 (Surrog. Recovery	%		98.6
4-Bromofluorobenzene (Surrog. Recovery	%		96.8

SPIKE AND SPIKE DUPLICATE:

Parameter	Units	MDL	750159406 Water SM-6A	Spike	Spike Recv	Spike Dupl Recv	RPD
1,1-Dichloroethene	ug/L	5	ND	50	84%	86%	2%
Benzene	ug/L	5	ND	50	89%	91%	2%
Trichloroethene	ug/L	5	ND	50	93%	98%	5%
Toluene	ug/L	5	ND	50	92%	96%	4%
Chlorobenzene	ug/L	5	ND	50	94%	97%	3%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
1,1-Dichloroethene	ug/L	5	50	93%
Benzene	ug/L	5	50	92%
Trichloroethene	ug/L	5	50	101%
Toluene	ug/L	5	50	93%
Chlorobenzene	ug/L	5	50	95%

FOOTNOTES
for pages 8 through 29

Client Reference: Metro Rail/92-2050-02

MDL	Method Detection Limit
NC	No calculation due to value below detection limit.
ND	Not detected at or above the MDL.
RPD	Relative Percent Difference

REPORTS OF LABORATORY ANALYSES
MONITORING WELL SM-9A

PACE INCORPORATED
THE ASSURANCE OF QUALITY

REPORT OF LABORATORY ANALYSIS

December 11, 1992

Dr. Ram
Earth Technology Corporation
13900 Alton Parkway
Suite 120
Irvine, CA 92718

RE: PACE Project No. 721120.509
Client Reference: Metro Rail/92-2050-02

Dear Dr. Ram:

Enclosed is the report of laboratory analyses for samples received November 20, 1992. Samples were received by the laboratory in good condition with proper preservatives per the requested analytical work.

Footnotes are given at the end of the report.

If you have any questions concerning this report, please feel free to contact us.

Sincerely,

Eric S Howarth

Eric S. Howarth
Project Manager

Enclosures

5702 Bolsa Avenue
Huntington Beach, CA 92649
TEL: 714-892-2565
FAX: 714-890-4032

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REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.509
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: SM-9A
SAMPLE MATRIX: WATER

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
1,1,2-Trichlor-1,2,2-trifluoroethane	10	ug/L	ND	624	11/30/92
Chloromethane	10	ug/L	ND	624	11/30/92
Vinyl chloride	10	ug/L	ND	624	11/30/92
Bromomethane	10	ug/L	ND	624	11/30/92
Chloroethane	10	ug/L	ND	624	11/30/92
Trichlorofluoromethane	10	ug/L	ND	624	11/30/92
1,1-Dichloroethene	5	ug/L	ND	624	11/30/92
Acetone	50	ug/L	ND	624	11/30/92
Carbon disulfide	5	ug/L	ND	624	11/30/92
Methylene chloride	5	ug/L	ND	624	11/30/92
trans-1,2-Dichloroethene	5	ug/L	ND	624	11/30/92
1,1-Dichloroethane	5	ug/L	ND	624	11/30/92
2-Butanone	50	ug/L	ND	624	11/30/92
cis-1,2-Dichloroethene	5	ug/L	ND	624	11/30/92
Chloroform	5	ug/L	28	624	11/30/92
1,2-Dichloroethane	5	ug/L	ND	624	11/30/92
1,1,1-Trichloroethane	5	ug/L	ND	624	11/30/92
Carbon tetrachloride	5	ug/L	ND	624	11/30/92
Benzene	5	ug/L	ND	624	11/30/92
Trichloroethene	5	ug/L	ND	624	11/30/92
1,2-Dichloropropane	5	ug/L	ND	624	11/30/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.509
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: SM-9A
SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Bromodichloromethane	5	ug/L	ND	624	11/30/92
cis-1,3-Dichloropropene	5	ug/L	ND	624	11/30/92
trans-1,3-Dichloropropene	5	ug/L	ND	624	11/30/92
1,1,2-Trichloroethane	5	ug/L	ND	624	11/30/92
Dibromochloromethane	5	ug/L	ND	624	11/30/92
Bromoform	5	ug/L	ND	624	11/30/92
4-Methyl-2-pentanone	50	ug/L	ND	624	11/30/92
Toluene	5	ug/L	ND	624	11/30/92
2-Hexanone	50	ug/L	ND	624	11/30/92
1,1,2,2-Tetrachloroethane	5	ug/L	ND	624	11/30/92
Tetrachloroethene	5	ug/L	ND	624	11/30/92
Chlorobenzene	5	ug/L	ND	624	11/30/92
Ethylbenzene	5	ug/L	ND	624	11/30/92
Styrene	5	ug/L	ND	624	11/30/92
Xylenes (Total)	5	ug/L	ND	624	11/30/92
1,3-Dichlorobenzene	5	ug/L	ND	624	11/30/92
1,4-Dichlorobenzene	5	ug/L	ND	624	11/30/92
1,2-Dichlorobenzene	5	ug/L	ND	624	11/30/92
1,2-Dichloroethane-d4 (Surrog. Recovery)		%	120	624	11/30/92
Toluene-d8 (Surrog. Recovery)		%	102	624	11/30/92
4-Bromofluorobenzene (Surrog. Recovery)		%	98.5	624	11/30/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.509
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: SM-9A
SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
8270 Date Extracted			-	3520	11/20/92
n-Nitrosodimethylamine	10	ug/L	ND	625	11/28/92
Phenol	10	ug/L	ND	625	11/28/92
Aniline	10	ug/L	ND	625	11/28/92
bis(2-Chloroethyl)ether	10	ug/L	ND	625	11/28/92
2-Chlorophenol	10	ug/L	ND	625	11/28/92
1,3-Dichlorobenzene	10	ug/L	ND	625	11/28/92
1,4-Dichlorobenzene	10	ug/L	ND	625	11/28/92
Benzyl alcohol	10	ug/L	ND	625	11/28/92
1,2-Dichlorobenzene	10	ug/L	ND	625	11/28/92
2-Methylphenol	10	ug/L	ND	625	11/28/92
bis(2-Chloroisopropyl)ether	10	ug/L	ND	625	11/28/92
4-Methylphenol	10	ug/L	ND	625	11/28/92
n-Nitroso-di-n-propylamine	10	ug/L	ND	625	11/28/92
Hexachloroethane	10	ug/L	ND	625	11/28/92
Nitrobenzene	10	ug/L	ND	625	11/28/92
Isophorone	10	ug/L	ND	625	11/28/92
2-Nitrophenol	10	ug/L	ND	625	11/28/92
2,4-Dimethylphenol	10	ug/L	ND	625	11/28/92
Benzoic acid	50	ug/L	ND	625	11/28/92
bis(2-Chloroethoxy)methane	10	ug/L	ND	625	11/28/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.509
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: SM-9A
SAMPLE MATRIX: WATER

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
2,4-Dichlorophenol	10	ug/L	ND	625	11/28/92
1,2,4-Trichlorobenzene	10	ug/L	ND	625	11/28/92
Naphthalene	10	ug/L	ND	625	11/28/92
4-Chloroaniline	20	ug/L	ND	625	11/28/92
Hexachlorobutadiene	10	ug/L	ND	625	11/28/92
4-Chloro-3-methylphenol	10	ug/L	ND	625	11/28/92
2-Methylnaphthalene	10	ug/L	ND	625	11/28/92
Hexachlorocyclopentadiene	10	ug/L	ND	625	11/28/92
2,4,6-Trichlorophenol	10	ug/L	ND	625	11/28/92
2,4,5-Trichlorophenol	10	ug/L	ND	625	11/28/92
2-Chloronaphthalene	50	ug/L	ND	625	11/28/92
2-Nitroaniline	50	ug/L	ND	625	11/28/92
Dimethylphthalate	10	ug/L	ND	625	11/28/92
Acenaphthylene	10	ug/L	ND	625	11/28/92
2,6-Dinitrotoluene	10	ug/L	ND	625	11/28/92
3-Nitroaniline	50	ug/L	ND	625	11/28/92
Acenaphthene	10	ug/L	ND	625	11/28/92
2,4-Dinitrophenol	50	ug/L	ND	625	11/28/92
4-Nitrophenol	50	ug/L	ND	625	11/28/92
Dibenzofuran	10	ug/L	ND	625	11/28/92
2,4-Dinitrotoluene	10	ug/L	ND	625	11/28/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.509
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: SM-9A
SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Diethylphthalate	10	ug/L	ND	625	11/28/92
4-Chlorophenyl-phenylether	10	ug/L	ND	625	11/28/92
Fluorene	10	ug/L	ND	625	11/28/92
4-Nitroaniline	50	ug/L	ND	625	11/28/92
4,6-Dinitro-2-methylphenol	50	ug/L	ND	625	11/28/92
n-Nitrosodiphenylamine	10	ug/L	ND	625	11/28/92
4-Bromophenyl-phenylether	10	ug/L	ND	625	11/28/92
Hexachlorobenzene	10	ug/L	ND	625	11/28/92
Pentachlorophenol	10	ug/L	ND	625	11/28/92
Phenanthrene	10	ug/L	ND	625	11/28/92
Anthracene	10	ug/L	ND	625	11/28/92
Di-n-butylphthalate	10	ug/L	ND	625	11/28/92
Fluoranthene	10	ug/L	ND	625	11/28/92
Benzidine	50	ug/L	ND	625	11/28/92
Pyrene	10	ug/L	ND	625	11/28/92
Butylbenzylphthalate	10	ug/L	ND	625	11/28/92
Benzo(a)anthracene	10	ug/L	ND	625	11/28/92
Chrysene	10	ug/L	ND	625	11/28/92
bis(2-Ethylhexyl)phthalate	10	ug/L	28	625	11/28/92
Di-n-octylphthalate	10	ug/L	ND	625	11/28/92
Benzo(b)fluoranthene	10	ug/L	ND	625	11/28/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.509
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: SM-9A
SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Benzo(k)fluoranthene	10	ug/L	ND	625	11/28/92
Benzo(a)pyrene	10	ug/L	ND	625	11/28/92
Indeno(1,2,3-cd)pyrene	10	ug/L	ND	625	11/28/92
Dibenzo(a,h)anthracene	10	ug/L	ND	625	11/28/92
Benzo(g,h,i)perylene	10	ug/L	ND	625	11/28/92
2-Fluorophenol (Surrog. Recovery)		%	62.7	625	11/28/92
Phenol-d5 (Surrog. Recovery)		%	65.8	625	11/28/92
Nitrobenzene-d5 (Surrog. Recovery)		%	64.2	625	11/28/92
2-Fluorobiphenyl (Surrog. Recovery)		%	70.9	625	11/28/92
2,4,6-Tribromophenol (Surrog. Recovery)		%	90.7	625	11/28/92
Terphenyl-d14 (Surrog. Recovery)		%	72.0	625	11/28/92
Date Extracted			-	418.1	11/24/92
Total Petroleum Hydrocarbons	0.05	mg/L	ND	418.1	11/24/92
Date Extracted			-	413.2	12/01/92
Oil & Grease	0.05	mg/L	ND	413.2	12/01/92
TPH Quantified as Gasoline	20	ug/L	ND	8015 LUFT	11/23/92
Date Extracted			-	8015 LUFT	11/23/92
TPH Quantified as Diesel	500	ug/L	ND	8015 LUFT	11/24/92
TTLC, CV Date Digested			-	7470	12/02/92
TTLC, CV Mercury	0.0003	mg/L	ND	7470	12/02/92
Antimony (Sb)	0.003	mg/L	ND	6020	12/01/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.509
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: SM-9A
SAMPLE MATRIX: WATER

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Arsenic (As)	0.005	mg/L	0.016	6020	12/01/92
Berium (Ba)	0.004	mg/L	ND	6020	12/01/92
Beryllium (Be)	0.002	mg/L	0.003	6020	12/01/92
Cadmium (Cd)	0.0025	mg/L	ND	6020	12/01/92
Chromium (Cr)	0.004	mg/L	ND	6020	12/01/92
Cobalt (Co)	0.004	mg/L	ND	6020	12/01/92
Copper (Cu)	0.005	mg/L	ND	6020	12/01/92
Lead (Pb)	0.005	mg/L	ND	6020	12/01/92
Molybdenum (Mo)	0.005	mg/L	0.008	6020	12/01/92
Nickel (Ni)	0.005	mg/L	ND	6020	12/01/92
Selenium (Se)	0.005	mg/L	0.019	270.2	12/01/92
Silver (Ag)	0.005	mg/L	ND	6020	12/01/92
Thallium (Tl)	0.005	mg/L	ND	6020	12/01/92
Vanadium (V)	0.005	mg/L	0.031	6020	12/01/92
Zinc (Zn)	0.007	mg/L	0.030	6020	12/01/92
Date Extracted			-	7196	11/20/92
Chromium, Hexavalent	0.01	mg/L	ND	7196	11/20/92
Acute Aquatic Toxicity (Bioassay)		% Survival	90		11/20/92
Date Incubated			-	405.1	11/20/92
Biological Oxygen Demand	0.2	mg/L	7.6	405.1	11/25/92
Spectrophotometric-Chem Oxygen Demand	5.0	mg/L	ND	Hach Kit	12/08/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.509
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: SM-9A
SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Gravimetric-Total Suspended Solids	8.0	mg/L	1810	160.2	11/23/92
Settleable Matter	0.1	ml/L	0.1	160.5	11/20/92
Turbidity	5.0	NTU	560	180.1	11/20/92
Gravimetric-Total Dissolved Solids	10	mg/L	620	160.1	11/23/92
Titrimetric-Chloride	0.5	mg/L	75	325.3	11/30/92
Spectrophotometric-Total Sulfide	0.05	mg/L	ND	376.2	11/24/92
Gravimetric-Sulfate	1.0	mg/L	330	375.3	11/30/92
Nitrite	1.0	mg/L	ND	300	12/04/92
Nitrate	1	mg/L	3	300	12/04/92
Specific Conductance	10	umhos/cm	1020	120.1	12/01/92
pH	2.0	Units	9.5	150.1	11/20/92

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December 11, 1992
PACE Project Number: 721120509

Client Reference: Metro Rail/92-2050-02

All QA reports and data have been reviewed and are within acceptable limits.

Kenneth D. Faust,
Southern California Regional Director

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FOOTNOTES
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December 11, 1992
PACE Project Number: 721120509

Client Reference: Metro Rail/92-2050-02

MDL	Method Detection Limit
ND	Not detected at or above the MDL.

REPORT OF LABORATORY ANALYSIS

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120509

Client Reference: Metro Rail/92-2050-02

Biological Oxygen Demand
Batch: 75 04303
Samples: 75 0159414

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750158949	Duplicate of 75 0158949	RPD
Biological Oxygen Demand	mg/L	0.2	ND	2.2	2.2	0%

REPORT OF LABORATORY ANALYSIS

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120509

Client Reference: Metro Rail/92-2050-02

Gravimetric-Sulfate
Batch: 75 04297
Samples: 75 0159414

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159392	Duplicate of 75 0159392	RPD
Gravimetric-Sulfate	mg/L	1.0	ND	750	750	0%

SPIKE:

Parameter	Units	MDL	750159392	Spike	Spike Recv
Gravimetric-Sulfate	mg/L	1.0	750	338	98%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
Gravimetric-Sulfate	mg/L	1.0	338	95%

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120509

Client Reference: Metro Rail/92-2050-02

Gravimetric-Total Dissolved Solids
Batch: 75 04192
Samples: 75 0159414

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422	Duplicate of 75 0159422	RPD
Gravimetric-Total Dissolved Solids	mg/L	10	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159422	Spike	Spike Recv
Gravimetric-Total Dissolved Solids	mg/L	10	ND	1000	101%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
ravimetric-Total Dissolved Solids	mg/L	10	1000	99%

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120509

Client Reference: Metro Rail/92-2050-02

Gravimetric-Total Suspended Solids
Batch: 75 04300
Samples: 75 0159414

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422	Duplicate of 75 0159422	RPD
Gravimetric-Total Suspended Solids	mg/L	4.0	ND	ND	ND	NC

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120509

Client Reference: Metro Rail/92-2050-02

Settleable Matter
Batch: 75 04292
Samples: 75 0159414

SAMPLE DUPLICATE:

Parameter	Units	MDL	750159422	Duplicate of 75 0159422	RPD
Settleable Matter	ml/L	0.1	ND	ND	NC

REPORT OF LABORATORY ANALYSIS

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120509

Client Reference: Metro Rail/92-2050-02

Specific Conductance
Batch: 75 04288
Samples: 75 0159414

SAMPLE DUPLICATE:

Parameter	Units	MDL	750158949	Duplicate of 75 0158949	RPD
Specific Conductance	umhos/cm	10	860	870	1%

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120509

Client Reference: Metro Rail/92-2050-02

Spectrophotometric-Chem Oxygen Demand
Batch: 75 04425
Samples: 75 0159414

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422	Duplicate of 75 0159422	RPD
Spectrophotometric-Chem Oxygen Demand	mg/L	5.0	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159422	Spike	Spike Recv
Spectrophotometric-Chem Oxygen Demand	mg/L	5.0	ND	50	124%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
pectrophotometric-Chem Oxygen Demand	mg/L	5.0	50	126%

REPORT OF LABORATORY ANALYSIS

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120509

Client Reference: Metro Rail/92-2050-02

Spectrophotometric-Total Sulfide
Batch: 75 04311
Samples: 75 0159414

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422	Duplicate of 75 0159422	RPD
Spectrophotometric-Total Sulfide	mg/L	0.05	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159422	Spike	Spike Recv
Spectrophotometric-Total Sulfide	mg/L	0.05	ND	0.21	100%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
Spectrophotometric-Total Sulfide	mg/L	0.05	0.21	90%

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120509

Client Reference: Metro Rail/92-2050-02

Titrimetric-Chloride
Batch: 75 04298
Samples: 75 0159414

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422	Duplicate of 75 0159422	RPD
Titrimetric-Chloride	mg/L	0.5	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159422	Spike	Spike Recv
Titrimetric-Chloride	mg/L	0.5	ND	88.65	98%

LABORATORY CONTROL SAMPLE:

arameter	Units	MDL	Reference Value	Recv
itrimetric-Chloride	mg/L	0.5	88.65	97%

REPORT OF LABORATORY ANALYSIS

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120505

Client Reference: Metro Rail/92-2050-02

Turbidity
Batch: 75 04290
Samples: 75 0159414

SAMPLE DUPLICATE:

Parameter	Units	MDL	750159422	Duplicate of 75 0159422	RPD
Turbidity	NTU	0.2	ND	ND	NC

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120509

Client Reference: Metro Rail/92-2050-02

pH
Batch: 75 04195
Samples: 75 0159414

SAMPLE DUPLICATE:

Parameter	Units	MDL	750159422	Duplicate of 75 0159422	RPD
pH	Units	2.0	6.2	6.2	0%

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120509

Client Reference: Metro Rail/92-2050-02

SPECTROPHOTOMETRIC, IR-OIL & GREASE
Batch: 75 04310
Samples: 75 0159414

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Date Extracted			-
Oil & Grease	mg/L	0.05	ND

LABORATORY CONTROL SAMPLE AND CONTROL SAMPLE DUPLICATE:

Parameter	Units	MDL	Reference Value	Recv	Dupl Recv	RPD
Oil & Grease	mg/L	0.05	4.62	89%	89%	0%

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120509

Client Reference: Metro Rail/92-2050-02

SPECTROPHOTOMETRIC, IR-TPH
Batch: 75 04309
Samples: 75 0159414

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Date Extracted			-
Total Petroleum Hydrocarbons	mg/L	0.05	ND

LABORATORY CONTROL SAMPLE AND CONTROL SAMPLE DUPLICATE:

Parameter	Units	MDL	Reference Value	Recv	Dupl Recv	RPD
Total Petroleum Hydrocarbons	mg/L	0.05	4.89	84%	85%	1%

REPORT OF LABORATORY ANALYSIS

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120509

Client Reference: Metro Rail/92-2050-02

SPECTROPHOTOMETRIC-CHROMIUM, HEXAVALENT
Batch: 75 04193
Samples: 75 0159414

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159414 Water SM-9A	Duplicate of 75 0159414	RPD
Date Extracted			-	-	-	NC
Chromium, Hexavalent	mg/L	0.01	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159414 Water SM-9A	Spike	Spike Recv
Chromium, Hexavalent	mg/L	0.01	ND	0.53	100%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
Chromium, Hexavalent	mg/L	0.01	0.53	100%

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120509

Client Reference: Metro Rail/92-2050-02

TITLE 22 TTLC MERCURY BY CV
Batch: 75 04384
Samples: 75 0159414

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422	Duplicate of 75 0159422	RPD
TTLC, CV Mercury	mg/L	0.0003	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159422	Spike	Spike Recv
TTLC, CV Mercury	mg/L	0.0003	ND	0.005	108%

LABORATORY CONTROL SAMPLE:

'arameter	Units	MDL	Reference Value	Recv
LC, CV Mercury	mg/L	0.0003	0.005	98%

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120509

Client Reference: Metro Rail/92-2050-02

BTEX & TPH QUANTIFIED AS GASOLINE
Batch: 75 04233
Samples: 75 0159414

METHOD BLANK:

Parameter	Units	MDL	Method Blank
TPH Quantified as Gasoline	ug/L	50	ND
Benzene	ug/L	0.3	ND
Toluene	ug/L	0.3	ND
Ethylbenzene	ug/L	0.3	ND
Xylenes	ug/L	0.6	ND
% FB Surrogate Spike Recovery			90%

SPIKE AND SPIKE DUPLICATE:

Parameter	Units	MDL	750158949	Spike	Spike Recv	Spike Dupl Recv	RPD
TPH Quantified as Gasoline	ug/L	20	ND				
TPH Quantified as Gasoline	ug/L	50		400	90%	91%	1

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
TPH Quantified as Gasoline	ug/L	50	400	97%
Benzene	ug/L	0.3	20	98%
Toluene	ug/L	0.3	20	95%
Ethylbenzene	ug/L	0.3	20	97%
Xylenes	ug/L	0.6	60	93%

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120509

Client Reference: Metro Rail/92-2050-02

EXTRACTABLE TPH QUANTIFIED AS DIESEL
Batch: 75 04296
Samples: 75 0159414

METHOD BLANK:

Parameter	Units	MDL	Method Blank
TPH Quantified as Diesel	ug/L	500	ND

LABORATORY CONTROL SAMPLE AND CONTROL SAMPLE DUPLICATE:

Parameter	Units	MDL	Reference Value	Recv	Dupl Recv	RPD
TPH Quantified as Diesel	ug/L	500	2500	112%	116%	3%

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120509

Client Reference: Metro Rail/92-2050-02

SEMI-VOLATILES
Batch: 75 04241
Samples: 75 0159414

METHOD BLANK:

Parameter	Units	MDL	Method Blank
n-Nitrosodimethylamine	ug/L	10	ND
Phenol	ug/L	10	ND
Aniline	ug/L	10	ND
bis(2-Chloroethyl)ether	ug/L	10	ND
2-Chlorophenol	ug/L	10	ND
1,3-Dichlorobenzene	ug/L	10	ND
1,4-Dichlorobenzene	ug/L	10	ND
Benzyl alcohol	ug/L	10	ND
1,2-Dichlorobenzene	ug/L	10	ND
2-Methylphenol	ug/L	10	ND
bis(2-Chloroisopropyl)ether	ug/L	10	ND
4-Methylphenol	ug/L	10	ND
n-Nitroso-di-n-propylamine	ug/L	10	ND
Hexachloroethane	ug/L	10	ND
Nitrobenzene	ug/L	10	ND
Isophorone	ug/L	10	ND
2-Nitrophenol	ug/L	10	ND
2,4-Dimethylphenol	ug/L	10	ND
Benzoic acid	ug/L	50	ND
bis(2-Chloroethoxy)methane	ug/L	10	ND
2,4-Dichlorophenol	ug/L	10	ND
1,2,4-Trichlorobenzene	ug/L	10	ND
Naphthalene	ug/L	10	ND
4-Chloroaniline	ug/L	20	ND
Hexachlorobutadiene	ug/L	10	ND
4-Chloro-3-methylphenol	ug/L	10	ND
2-Methylnaphthalene	ug/L	10	ND
Hexachlorocyclopentadiene	ug/L	10	ND
2,4,6-Trichlorophenol	ug/L	10	ND
2,4,5-Trichlorophenol	ug/L	10	ND
2-Chloronaphthalene	ug/L	50	ND
2-Nitroaniline	ug/L	50	ND

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120509

Client Reference: Metro Rail/92-2050-02

SEMI-VOLATILES
Batch: 75 04241
Samples: 75 0159414

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Dimethylphthalate	ug/L	10	ND
Acenaphthylene	ug/L	10	ND
2,6-Dinitrotoluene	ug/L	10	ND
3-Nitroaniline	ug/L	50	ND
Acenaphthene	ug/L	10	ND
2,4-Dinitrophenol	ug/L	50	ND
4-Nitrophenol	ug/L	50	ND
Dibenzofuran	ug/L	10	ND
2,4-Dinitrotoluene	ug/L	10	ND
Diethylphthalate	ug/L	10	ND
4-Chlorophenyl-phenylether	ug/L	10	ND
luorene	ug/L	10	ND
4-Nitroaniline	ug/L	50	ND
4,6-Dinitro-2-methylphenol	ug/L	50	ND
n-Nitrosodiphenylamine	ug/L	10	ND
4-Bromophenyl-phenylether	ug/L	10	ND
Hexachlorobenzene	ug/L	10	ND
Pentachlorophenol	ug/L	10	ND
Phenanthrene	ug/L	10	ND
Anthracene	ug/L	10	ND
Di-n-butylphthalate	ug/L	10	ND
Fluoranthene	ug/L	10	ND
Benzidine	ug/L	50	ND
Pyrene	ug/L	10	ND
Butylbenzylphthalate	ug/L	10	ND
Benzo(a)anthracene	ug/L	10	ND
Chrysene	ug/L	10	ND
bis(2-Ethylhexyl)phthalate	ug/L	10	ND
Di-n-octylphthalate	ug/L	10	ND
Benzo(b)fluoranthene	ug/L	10	ND
Benzo(k)fluoranthene	ug/L	10	ND
Benzo(a)pyrene	ug/L	10	ND

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120509

Client Reference: Metro Rail/92-2050-02

SEMI-VOLATILES
Batch: 75 04241
Samples: 75 0159414

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Indeno(1,2,3-cd)pyrene	ug/L	10	ND
Dibenzo(a,h)anthracene	ug/L	10	ND
Benzo(g,h,i)perylene	ug/L	10	ND
2-Fluorophenol	(Surrog. Recovery %		68.4
Phenol-d5	(Surrog. Recovery %		70.5
Nitrobenzene-d5	(Surrog. Recovery %		71.2
2-Fluorobiphenyl	(Surrog. Recovery %		72.8
2,4,6-Tribromophenol	(Surrog. Recovery %		78.7
Terphenyl-d14	(Surrog. Recovery %		116

LABORATORY CONTROL SAMPLE AND CONTROL SAMPLE DUPLICATE:

Parameter	Units	MDL	Reference Value	Recv	Dupl Recv	RPD
Phenol	ug/L	10	100.00	61%	75%	20%
2-Chlorophenol	ug/L	10	100.0	62%	70%	12%
1,4-Dichlorobenzene	ug/L	10	50.0	65%	79%	19%
n-Nitroso-di-n-propylamine	ug/L	10	50.0	62%	75%	18%
1,2,4-Trichlorobenzene	ug/L	10	50.0	62%	74%	17%
4-Chloro-3-methylphenol	ug/L	10	100.0	70%	78%	10%
Acenaphthene	ug/L	10	50.0	70%	80%	13%
4-Nitrophenol	ug/L	50	100.0	110%	105%	4%
2,4-Dinitrotoluene	ug/L	10	50.0	74%	76%	2%
Pentachlorophenol	ug/L	10	100.0	77%	78%	1%
Pyrene	ug/L	10	50.0	138%	134%	2%

There was not enough sample for an MS/MSD. The LCS/LCSD results are reported instead.

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120509

Client Reference: Metro Rail/92-2050-02

VOLATILE ORGANICS
Batch: 75 04260
Samples: 75 0159414

METHOD BLANK:

Parameter	Units	MDL	Method Blank
1,1,2-Trichlor-1,2,2-trifluoroethane	ug/L	10	ND
Chloromethane	ug/L	10	ND
Vinyl chloride	ug/L	10	ND
Bromomethane	ug/L	10	ND
Chloroethane	ug/L	10	ND
Trichlorofluoromethane	ug/L	10	ND
1,1-Dichloroethene	ug/L	5	ND
Acetone	ug/L	50	ND
Carbon disulfide	ug/L	5	ND
Methylene chloride	ug/L	5	ND
trans-1,2-Dichloroethene	ug/L	5	ND
1-Dichloroethane	ug/L	5	ND
2-Butanone	ug/L	50	ND
cis-1,2-Dichloroethene	ug/L	5	ND
Chloroform	ug/L	5	ND
1,2-Dichloroethane	ug/L	5	ND
1,1,1-Trichloroethane	ug/L	5	ND
Carbon tetrachloride	ug/L	5	ND
Benzene	ug/L	5	ND
Trichloroethene	ug/L	5	ND
1,2-Dichloropropane	ug/L	5	ND
Bromodichloromethane	ug/L	5	ND
cis-1,3-Dichloropropene	ug/L	5	ND
trans-1,3-Dichloropropene	ug/L	5	ND
1,1,2-Trichloroethane	ug/L	5	ND
Dibromochloromethane	ug/L	5	ND
Bromoform	ug/L	5	ND
4-Methyl-2-pentanone	ug/L	50	ND
Toluene	ug/L	5	ND
2-Hexanone	ug/L	50	ND
1,1,2,2-Tetrachloroethane	ug/L	5	ND
Tetrachloroethene	ug/L	5	ND

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120509

Client Reference: Metro Rail/92-2050-02

VOLATILE ORGANICS
Batch: 75 04260
Samples: 75 0159414

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Chlorobenzene	ug/L	5	ND
Ethylbenzene	ug/L	5	ND
Styrene	ug/L	5	ND
Xylenes (Total)	ug/L	5	ND
1,3-Dichlorobenzene	ug/L	5	ND
1,4-Dichlorobenzene	ug/L	5	ND
1,2-Dichlorobenzene	ug/L	5	ND
1,2-Dichloroethane-d4 (Surrog. Recovery	%		119
Toluene-d8 (Surrog. Recovery	%		100
4-Bromofluorobenzene (Surrog. Recovery	%		96.9

SPIKE AND SPIKE DUPLICATE:

Parameter	Units	MDL	750158949	Spike	Spike Recv	Spike Dupl Recv	RPD
1,1-Dichloroethene	ug/L	5	ND	50	82%	85%	3%
Benzene	ug/L	5	ND	50	92%	95%	3%
Trichloroethene	ug/L	5	ND	50	101%	105%	3%
Toluene	ug/L	5	ND	50	96%	96%	0%
Chlorobenzene	ug/L	5	ND	50	97%	97%	0%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
1,1-Dichloroethene	ug/L	5	50	82%
Benzene	ug/L	5	50	90%
Trichloroethene	ug/L	5	50	92%
Toluene	ug/L	5	50	93%
Chlorobenzene	ug/L	5	50	94%

:. Ram	FOOTNOTES	December 11, 1992
age 33	for pages 8 through 29	PACE Project Number: 721120509

Client Reference: Metro Rail/92-2050-02

MDL	Method Detection Limit
NC	No calculation due to value below detection limit.
ND	Not detected at or above the MDL.
RPD	Relative Percent Difference

REPORTS OF LABORATORY ANALYSES
MONITORING WELL R-8

pace
INCORPORATED
THE ASSURANCE OF QUALITY

REPORT OF LABORATORY ANALYSIS

December 11, 1992

Dr. Ram
Earth Technology Corporation
13900 Alton Parkway
Suite 120
Irvine, CA 92718

RE: PACE Project No. 721120.507
Client Reference: Metro Rail/92-2050-02

Dear Dr. Ram:

Enclosed is the report of laboratory analyses for samples received November 20, 1992. Samples were received by the laboratory in good condition with the proper preservatives per the requested analytical work.

Footnotes are given at the end of the report.

If you have any questions concerning this report, please feel free to contact us.

Sincerely,

Eric S. Howarth

Eric S. Howarth
Project Manager

Enclosures

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.507
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: R-8
SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
1,1,2-Trichlor-1,2,2-trifluoroethane	10	ug/L	ND	624	11/30/92
Chloromethane	10	ug/L	ND	624	11/30/92
Vinyl chloride	10	ug/L	ND	624	11/30/92
Bromomethane	10	ug/L	ND	624	11/30/92
Chloroethane	10	ug/L	ND	624	11/30/92
Trichlorofluoromethane	10	ug/L	ND	624	11/30/92
1,1-Dichloroethene	5	ug/L	ND	624	11/30/92
Acetone	50	ug/L	ND	624	11/30/92
Carbon disulfide	5	ug/L	ND	624	11/30/92
Methylene chloride	5	ug/L	ND	624	11/30/92
trans-1,2-Dichloroethene	5	ug/L	ND	624	11/30/92
1,1-Dichloroethane	5	ug/L	ND	624	11/30/92
2-Butanone	50	ug/L	ND	624	11/30/92
cis-1,2-Dichloroethene	5	ug/L	ND	624	11/30/92
Chloroform	5	ug/L	ND	624	11/30/92
1,2-Dichloroethane	5	ug/L	ND	624	11/30/92
1,1,1-Trichloroethane	5	ug/L	ND	624	11/30/92
Carbon tetrachloride	5	ug/L	ND	624	11/30/92
Benzene	5	ug/L	ND	624	11/30/92
Trichloroethene	5	ug/L	ND	624	11/30/92
1,2-Dichloropropane	5	ug/L	ND	624	11/30/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.507
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: R-8
SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Bromodichloromethane	5	ug/L	ND	624	11/30/92
cis-1,3-Dichloropropene	5	ug/L	ND	624	11/30/92
trans-1,3-Dichloropropene	5	ug/L	ND	624	11/30/92
1,1,2-Trichloroethane	5	ug/L	ND	624	11/30/92
Dibromochloromethane	5	ug/L	ND	624	11/30/92
Bromoform	5	ug/L	ND	624	11/30/92
4-Methyl-2-pentanone	50	ug/L	ND	624	11/30/92
Toluene	5	ug/L	ND	624	11/30/92
2-Hexanone	50	ug/L	ND	624	11/30/92
1,1,2,2-Tetrachloroethane	5	ug/L	ND	624	11/30/92
Tetrachloroethene	5	ug/L	ND	624	11/30/92
Chlorobenzene	5	ug/L	ND	624	11/30/92
Ethylbenzene	5	ug/L	ND	624	11/30/92
Styrene	5	ug/L	ND	624	11/30/92
Xylenes (Total)	5	ug/L	ND	624	11/30/92
1,3-Dichlorobenzene	5	ug/L	ND	624	11/30/92
1,4-Dichlorobenzene	5	ug/L	ND	624	11/30/92
1,2-Dichlorobenzene	5	ug/L	ND	624	11/30/92
1,2-Dichloroethane-d4 (Surrog. Recovery)		%	122	624	11/30/92
Toluene-d8 (Surrog. Recovery)		%	101	624	11/30/92
4-Bromofluorobenzene (Surrog. Recovery)		%	98.1	624	11/30/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.507
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: R-8
SAMPLE MATRIX: WATER

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
8270 Date Extracted			-	3520	11/20/92
n-Nitrosodimethylamine	10	ug/L	ND	625	11/27/92
Phenol	10	ug/L	ND	625	11/27/92
Aniline	10	ug/L	ND	625	11/27/92
bis(2-Chloroethyl)ether	10	ug/L	ND	625	11/27/92
2-Chlorophenol	10	ug/L	ND	625	11/27/92
1,3-Dichlorobenzene	10	ug/L	ND	625	11/27/92
1,4-Dichlorobenzene	10	ug/L	ND	625	11/27/92
Benzyl alcohol	10	ug/L	ND	625	11/27/92
1,2-Dichlorobenzene	10	ug/L	ND	625	11/27/92
2-Methylphenol	10	ug/L	ND	625	11/27/92
bis(2-Chloroisopropyl)ether	10	ug/L	ND	625	11/27/92
4-Methylphenol	10	ug/L	ND	625	11/27/92
n-Nitroso-di-n-propylamine	10	ug/L	ND	625	11/27/92
Hexachloroethane	10	ug/L	ND	625	11/27/92
Nitrobenzene	10	ug/L	ND	625	11/27/92
Isophorone	10	ug/L	ND	625	11/27/92
2-Nitrophenol	10	ug/L	ND	625	11/27/92
2,4-Dimethylphenol	10	ug/L	ND	625	11/27/92
Benzoic acid	50	ug/L	ND	625	11/27/92
bis(2-Chloroethoxy)methane	10	ug/L	ND	625	11/27/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.507
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: R-8
SAMPLE MATRIX: WATER

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
2,4-Dichlorophenol	10	ug/L	ND	625	11/27/92
1,2,4-Trichlorobenzene	10	ug/L	ND	625	11/27/92
Naphthalene	10	ug/L	ND	625	11/27/92
4-Chloroaniline	20	ug/L	ND	625	11/27/92
Hexachlorobutadiene	10	ug/L	ND	625	11/27/92
4-Chloro-3-methylphenol	10	ug/L	ND	625	11/27/92
2-Methylnaphthalene	10	ug/L	ND	625	11/27/92
Hexachlorocyclopentadiene	10	ug/L	ND	625	11/27/92
2,4,6-Trichlorophenol	10	ug/L	ND	625	11/27/92
2,4,5-Trichlorophenol	10	ug/L	ND	625	11/27/92
2-Chloronaphthalene	50	ug/L	ND	625	11/27/92
2-Nitroaniline	50	ug/L	ND	625	11/27/92
Dimethylphthalate	10	ug/L	ND	625	11/27/92
Acenaphthylene	10	ug/L	ND	625	11/27/92
2,6-Dinitrotoluene	10	ug/L	ND	625	11/27/92
3-Nitroaniline	50	ug/L	ND	625	11/27/92
Acenaphthene	10	ug/L	ND	625	11/27/92
2,4-Dinitrophenol	50	ug/L	ND	625	11/27/92
4-Nitrophenol	50	ug/L	ND	625	11/27/92
Dibenzofuran	10	ug/L	ND	625	11/27/92
2,4-Dinitrotoluene	10	ug/L	ND	625	11/27/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.507
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: R-8
SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Diethylphthalate	10	ug/L	ND	625	11/27/92
4-Chlorophenyl-phenylether	10	ug/L	ND	625	11/27/92
Fluorene	10	ug/L	ND	625	11/27/92
4-Nitroaniline	50	ug/L	ND	625	11/27/92
4,6-Dinitro-2-methylphenol	50	ug/L	ND	625	11/27/92
n-Nitrosodiphenylamine	10	ug/L	ND	625	11/27/92
4-Bromophenyl-phenylether	10	ug/L	ND	625	11/27/92
Hexachlorobenzene	10	ug/L	ND	625	11/27/92
Pentachlorophenol	10	ug/L	ND	625	11/27/92
Phenanthrene	10	ug/L	ND	625	11/27/92
Anthracene	10	ug/L	ND	625	11/27/92
Di-n-butylphthalate	10	ug/L	ND	625	11/27/92
Fluoranthene	10	ug/L	ND	625	11/27/92
Benzidine	50	ug/L	ND	625	11/27/92
Pyrene	10	ug/L	ND	625	11/27/92
Butylbenzylphthalate	10	ug/L	ND	625	11/27/92
Benzo(a)anthracene	10	ug/L	ND	625	11/27/92
Chrysene	10	ug/L	ND	625	11/27/92
bis(2-Ethylhexyl)phthalate	10	ug/L	ND	625	11/27/92
Di-n-octylphthalate	10	ug/L	ND	625	11/27/92
Benzo(b)fluoranthene	10	ug/L	ND	625	11/27/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.507
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: R-8
SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Benzo(k)fluoranthene	10	ug/L	ND	625	11/27/92
Benzo(a)pyrene	10	ug/L	ND	625	11/27/92
Indeno(1,2,3-cd)pyrene	10	ug/L	ND	625	11/27/92
Dibenzo(a,h)anthracene	10	ug/L	ND	625	11/27/92
Benzo(g,h,i)perylene	10	ug/L	ND	625	11/27/92
2-Fluorophenol (Surrog. Recovery)		%	54.9	625	11/27/92
Phenol-d5 (Surrog. Recovery)		%	62.0	625	11/27/92
Nitrobenzene-d5 (Surrog. Recovery)		%	61.1	625	11/27/92
2-Fluorobiphenyl (Surrog. Recovery)		%	65.6	625	11/27/92
2,4,6-Tribromophenol (Surrog. Recovery)		%	73.4	625	11/27/92
Terphenyl-d14 (Surrog. Recovery)		%	63.6	625	11/27/92
Date Extracted			-	418.1	11/24/92
Total Petroleum Hydrocarbons	0.05	mg/L	ND	418.1	11/24/92
Date Extracted			-	413.2	12/01/92
Oil & Grease	0.05	mg/L	0.07	413.2	12/01/92
TPH Quantified as Gasoline	20	ug/L	ND	8015 LUFT	11/23/92
Date Extracted			-	8015 LUFT	11/23/92
TPH Quantified as Diesel	500	ug/L	ND	8015 LUFT	11/24/92
TTLC, CV Date Digested			-	7470	12/02/92
TTLC, CV Mercury	0.0003	mg/L	ND	7470	12/02/92
Antimony (Sb)	0.003	mg/L	ND	6020	12/01/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.507
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: R-8
SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Arsenic (As)	0.005	mg/L	ND	6020	12/01/92
Berium (Ba)	0.004	mg/L	0.020	6020	12/01/92
Beryllium (Be)	0.002	mg/L	ND	6020	12/01/92
Cadmium (Cd)	0.0025	mg/L	ND	6020	12/01/92
Chromium (Cr)	0.004	mg/L	ND	6020	12/01/92
Cobalt (Co)	0.004	mg/L	ND	6020	12/01/92
Copper (Cu)	0.005	mg/L	ND	6020	12/01/92
Lead (Pb)	0.005	mg/L	ND	6020	12/01/92
Molybdenum (Mo)	0.005	mg/L	0.011	6020	12/01/92
Nickel (Ni)	0.005	mg/L	ND	6020	12/01/92
Selenium (Se)	0.005	mg/L	0.020	270.2	12/01/92
Silver (Ag)	0.005	mg/L	ND	6020	12/01/92
Thallium (Tl)	0.005	mg/L	ND	6020	12/01/92
Vanadium (V)	0.005	mg/L	ND	6020	12/01/92
Zinc (Zn)	0.007	mg/L	0.060	6020	12/01/92
Date Extracted			-	7196	11/20/92
Chromium, Hexavalent	0.01	mg/L	ND	7196	11/20/92
Acute Aquatic Toxicity (Bioassay)		% Survival	100		11/20/92
Date Incubated			-	405.1	11/20/92
Biological Oxygen Demand	0.2	mg/L	7.0	405.1	11/25/92
Spectrophotometric-Chem Oxygen Demand	5.0	mg/L	ND	Hach Kit	12/08/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.507
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: R-8
SAMPLE MATRIX: WATER

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Gravimetric-Total Suspended Solids	4.0	mg/L	80	160.2	11/23/92
Settleable Matter	0.1	ml/L	2.2	160.5	11/20/92
Turbidity	0.2	NTU	4.5	180.1	11/20/92
Gravimetric-Total Dissolved Solids	10	mg/L	1500	160.1	11/23/92
Titrimetric-Chloride	0.5	mg/L	43	325.3	11/30/92
Spectrophotometric-Total Sulfide	0.05	mg/L	ND	376.2	11/24/92
Gravimetric-Sulfate	1.0	mg/L	750	375.3	11/30/92
Nitrite	1.0	mg/L	ND	300	12/04/92
Nitrate	1	mg/L	3	300	12/04/92
Specific Conductance	10	umhos/cm	1820	120.1	12/01/92
pH	2.0	Units	7.5	150.1	11/20/92

December 11, 1992
PACE Project Number: 721120507

Client Reference: Metro Rail/92-2050-02

All QA reports and data have been reviewed and are within acceptable limits.

Kenneth D. Faust,
Southern California Regional Director

REPORT OF LABORATORY ANALYSIS

Dr. Ram
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FOOTNOTES
for pages 1 through 6

December 11, 1992
PACE Project Number: 721120507

Client Reference: Metro Rail/92-2050-02

<	Less than reported value.
MDL	Method Detection Limit
ND	Not detected at or above the MDL.

REPORT OF LABORATORY ANALYSIS

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120507

Client Reference: Metro Rail/92-2050-02

Biological Oxygen Demand
Batch: 75 04303
Samples: 75 0159392

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750158949	Duplicate of 75 0158949	RPD
Biological Oxygen Demand	mg/L	0.2	ND	2.2	2.2	0%

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120507

Client Reference: Metro Rail/92-2050-02

Gravimetric-Sulfate
Batch: 75 04297
Samples: 75 0159392

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159392 Water R-8	Duplicate of 75 0159392	RPD
Gravimetric-Sulfate	mg/L	1.0	ND	750	750	0%

SPIKE:

Parameter	Units	MDL	750159392 Water R-8	Spike	Spike Recv
Gravimetric-Sulfate	mg/L	1.0	750	338	98%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
Gravimetric-Sulfate	mg/L	1.0	338	95%

r. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120507

Client Reference: Metro Rail/92-2050-02

Gravimetric-Total Dissolved Solids
Batch: 75 04192
Samples: 75 0159392

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422	Duplicate of 75 0159422	RPD
Gravimetric-Total Dissolved Solids	mg/L	10	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159422	Spike	Spike Recv
Gravimetric-Total Dissolved Solids	mg/L	10	ND	1000	101%

LABORATORY CONTROL SAMPLE:

arameter	Units	MDL	Reference Value	Recv
ravimetric-Total Dissolved Solids	mg/L	10	1000	99%

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120507

Client Reference: Metro Rail/92-2050-02

Gravimetric-Total Suspended Solids
Batch: 75 04300
Samples: 75 0159392

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422	Duplicate of 75 0159422	RPD
Gravimetric-Total Suspended Solids	mg/L	4.0	ND	ND	ND	NC

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120507

Client Reference: Metro Rail/92-2050-02

Settleable Matter
Batch: 75 04292
Samples: 75 0159392

SAMPLE DUPLICATE:

Parameter	Units	MDL	750159422	Duplicate of 75 0159422	RPD
Settleable Matter	ml/L	0.1	ND	ND	NC

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120507

Client Reference: Metro Rail/92-2050-02

Specific Conductance
Batch: 75 04288
Samples: 75 0159392

SAMPLE DUPLICATE:

Parameter	Units	MDL	750158949	Duplicate of 75 0158949	RPD
Specific Conductance	umhos/cm	10	860	870	1%

. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120507

Client Reference: Metro Rail/92-2050-02

Spectrophotometric-Chem Oxygen Demand
Batch: 75 04425
Samples: 75 0159392

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422	Duplicate of 75 0159422	RPD
Spectrophotometric-Chem Oxygen Demand	mg/L	5.0	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159422	Spike	Spike Recv
Spectrophotometric-Chem Oxygen Demand	mg/L	5.0	ND	50	124%

LABORATORY CONTROL SAMPLE:

:ameter	Units	MDL	Reference Value	Recv
ectrophotometric-Chem Oxygen Demand	mg/L	5.0	50	126%

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 72112050

Client Reference: Metro Rail/92-2050-02

Spectrophotometric-Total Sulfide
Batch: 75 04311
Samples: 75 0159392

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422	Duplicate of 75 0159422	RPD
Spectrophotometric-Total Sulfide	mg/L	0.05	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159422	Spike	Spike Recv
Spectrophotometric-Total Sulfide	mg/L	0.05	ND	0.21	100%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
Spectrophotometric-Total Sulfide	mg/L	0.05	0.21	90%

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120507

Client Reference: Metro Rail/92-2050-02

Titrimetric-Chloride
Batch: 75 04298
Samples: 75 0159392

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422	Duplicate of 75 0159422	RPD
Titrimetric-Chloride	mg/L	0.5	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159422	Spike	Spike Recv
Titrimetric-Chloride	mg/L	0.5	ND	88.65	98%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
itrimetric-Chloride	mg/L	0.5	88.65	97%

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120507

Client Reference: Metro Rail/92-2050-02

Turbidity
Batch: 75 04290
Samples: 75 0159392

SAMPLE DUPLICATE:

Parameter	Units	MDL	750159422	Duplicate of 75 0159422	RPD
Turbidity	NTU	0.2	ND	ND	NC

r. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120507

Client Reference: Metro Rail/92-2050-02

pH
Batch: 75 04195
Samples: 75 0159392

SAMPLE DUPLICATE:

Parameter	Units	MDL	750159422	Duplicate of 75 0159422	RPD
pH	Units	2.0	6.2	6.2	0%

REPORT OF LABORATORY ANALYSIS

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120507

Client Reference: Metro Rail/92-2050-02

SPECTROPHOTOMETRIC, IR-OIL & GREASE
Batch: 75 04310
Samples: 75 0159392

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Date Extracted			-
Oil & Grease	mg/L	0.05	ND

LABORATORY CONTROL SAMPLE AND CONTROL SAMPLE DUPLICATE:

Parameter	Units	MDL	Reference Value	Recv	Dupl Recv	RPD
Oil & Grease	mg/L	0.05	4.62	89%	89%	0%

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120507

Client Reference: Metro Rail/92-2050-02

SPECTROPHOTOMETRIC, IR-TPH
Batch: 75 04309
Samples: 75 0159392

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Date Extracted			-
Total Petroleum Hydrocarbons	mg/L	0.05	ND

LABORATORY CONTROL SAMPLE AND CONTROL SAMPLE DUPLICATE:

Parameter	Units	MDL	Reference Value	Recv	Dupl Recv	RPD
Total Petroleum Hydrocarbons	mg/L	0.05	4.89	84%	85%	1%

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120507

Client Reference: Metro Rail/92-2050-02

SPECTROPHOTOMETRIC-CHROMIUM, HEXAVALENT
Batch: 75 04193
Samples: 75 0159392

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159414	Duplicate of 75 0159414	RPD
Date Extracted			-	-	-	NC
Chromium, Hexavalent	mg/L	0.01	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159414	Spike	Spike Recv
Chromium, Hexavalent	mg/L	0.01	ND	0.53	100%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
Chromium, Hexavalent	mg/L	0.01	0.53	100%

REPORT OF LABORATORY ANALYSIS

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120507

Client Reference: Metro Rail/92-2050-02

TITLE 22 TTLC MERCURY BY CV
Batch: 75 04384
Samples: 75 0159392

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422	Duplicate of 75 0159422	RPD
TTLC, CV Mercury	mg/L	0.0003	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159422	Spike	Spike Recv
TTLC, CV Mercury	mg/L	0.0003	ND	0.005	108%

LABORATORY CONTROL SAMPLE:

ameter	Units	MDL	Reference Value	Recv
C, CV Mercury	mg/L	0.0003	0.005	98%

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120507

Client Reference: Metro Rail/92-2050-02

BTEX & TPH QUANTIFIED AS GASOLINE
Batch: 75 04233
Samples: 75 0159392

METHOD BLANK:

Parameter	Units	MDL	Method Blank
TPH Quantified as Gasoline	ug/L	50	ND
Benzene	ug/L	0.3	ND
Toluene	ug/L	0.3	ND
Ethylbenzene	ug/L	0.3	ND
Xylenes	ug/L	0.6	ND
% FB Surrogate Spike Recovery			90%

SPIKE AND SPIKE DUPLICATE:

Parameter	Units	MDL	750158949	Spike	Spike Recv	Spike Dupl Recv	RPD
TPH Quantified as Gasoline	ug/L	20	ND				
TPH Quantified as Gasoline	ug/L	50		400	90%	91%	1%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
TPH Quantified as Gasoline	ug/L	50	400	97%
Benzene	ug/L	0.3	20	98%
Toluene	ug/L	0.3	20	95%
Ethylbenzene	ug/L	0.3	20	97%
Xylenes	ug/L	0.6	60	93%

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120507

Client Reference: Metro Rail/92-2050-02

EXTRACTABLE TPH QUANTIFIED AS DIESEL
Batch: 75 04296
Samples: 75 0159392

METHOD BLANK:

Parameter	Units	MDL	Method Blank
TPH Quantified as Diesel	ug/L	500	ND

LABORATORY CONTROL SAMPLE AND CONTROL SAMPLE DUPLICATE:

Parameter	Units	MDL	Reference Value	Recv	Dupl Recv	RPD
TPH Quantified as Diesel	ug/L	500	2500	112%	116%	3%

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120507

Client Reference: Metro Rail/92-2050-02

SEMI-VOLATILES
Batch: 75 04241
Samples: 75 0159392

METHOD BLANK:

Parameter	Units	MDL	Method Blank
n-Nitrosodimethylamine	ug/L	10	ND
Phenol	ug/L	10	ND
Aniline	ug/L	10	ND
bis(2-Chloroethyl)ether	ug/L	10	ND
2-Chlorophenol	ug/L	10	ND
1,3-Dichlorobenzene	ug/L	10	ND
1,4-Dichlorobenzene	ug/L	10	ND
Benzyl alcohol	ug/L	10	ND
1,2-Dichlorobenzene	ug/L	10	ND
2-Methylphenol	ug/L	10	ND
bis(2-Chloroisopropyl)ether	ug/L	10	ND
4-Methylphenol	ug/L	10	ND
n-Nitroso-di-n-propylamine	ug/L	10	ND
Hexachloroethane	ug/L	10	ND
Nitrobenzene	ug/L	10	ND
Isophorone	ug/L	10	ND
2-Nitrophenol	ug/L	10	ND
2,4-Dimethylphenol	ug/L	10	ND
Benzoic acid	ug/L	50	ND
bis(2-Chloroethoxy)methane	ug/L	10	ND
2,4-Dichlorophenol	ug/L	10	ND
1,2,4-Trichlorobenzene	ug/L	10	ND
Naphthalene	ug/L	10	ND
4-Chloroaniline	ug/L	20	ND
Hexachlorobutadiene	ug/L	10	ND
4-Chloro-3-methylphenol	ug/L	10	ND
2-Methylnaphthalene	ug/L	10	ND
Hexachlorocyclopentadiene	ug/L	10	ND
2,4,6-Trichlorophenol	ug/L	10	ND
2,4,5-Trichlorophenol	ug/L	10	ND
2-Chloronaphthalene	ug/L	50	ND
2-Nitroaniline	ug/L	50	ND

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120507

Client Reference: Metro Rail/92-2050-02

SEMI-VOLATILES
Batch: 75 04241
Samples: 75 0159392

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Dimethylphthalate	ug/L	10	ND
Acenaphthylene	ug/L	10	ND
2,6-Dinitrotoluene	ug/L	10	ND
3-Nitroaniline	ug/L	50	ND
Acenaphthene	ug/L	10	ND
2,4-Dinitrophenol	ug/L	50	ND
4-Nitrophenol	ug/L	50	ND
Dibenzofuran	ug/L	10	ND
2,4-Dinitrotoluene	ug/L	10	ND
Diethylphthalate	ug/L	10	ND
4-Chlorophenyl-phenylether	ug/L	10	ND
uorene	ug/L	10	ND
4-Nitroaniline	ug/L	50	ND
4,6-Dinitro-2-methylphenol	ug/L	50	ND
n-Nitrosodiphenylamine	ug/L	10	ND
4-Bromophenyl-phenylether	ug/L	10	ND
Hexachlorobenzene	ug/L	10	ND
Pentachlorophenol	ug/L	10	ND
Phenanthrene	ug/L	10	ND
Anthracene	ug/L	10	ND
Di-n-butylphthalate	ug/L	10	ND
Fluoranthene	ug/L	10	ND
Benzidine	ug/L	50	ND
Pyrene	ug/L	10	ND
Butylbenzylphthalate	ug/L	10	ND
Benzo(a)anthracene	ug/L	10	ND
Chrysene	ug/L	10	ND
bis(2-Ethylhexyl)phthalate	ug/L	10	ND
Di-n-octylphthalate	ug/L	10	ND
Benzo(b)fluoranthene	ug/L	10	ND
Benzo(k)fluoranthene	ug/L	10	ND
Benzo(a)pyrene	ug/L	10	ND

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120507

Client Reference: Metro Rail/92-2050-02

SEMI-VOLATILES
Batch: 75 04241
Samples: 75 0159392

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Indeno(1,2,3-cd)pyrene	ug/L	10	ND
Dibenzo(a,h)anthracene	ug/L	10	ND
Benzo(g,h,i)perylene	ug/L	10	ND
2-Fluorophenol	(Surrog. Recovery %		68.4
Phenol-d5	(Surrog. Recovery %		70.5
Nitrobenzene-d5	(Surrog. Recovery %		71.2
2-Fluorobiphenyl	(Surrog. Recovery %		72.8
2,4,6-Tribromophenol	(Surrog. Recovery %		78.7
Terphenyl-d14	(Surrog. Recovery %		116

LABORATORY CONTROL SAMPLE AND CONTROL SAMPLE DUPLICATE:

Parameter	Units	MDL	Reference Value	Recv	Dupl Recv	RPD
Phenol	ug/L	10	100.00	61%	75%	20%
2-Chlorophenol	ug/L	10	100.0	62%	70%	12%
1,4-Dichlorobenzene	ug/L	10	50.0	65%	79%	19%
n-Nitroso-di-n-propylamine	ug/L	10	50.0	62%	75%	18%
1,2,4-Trichlorobenzene	ug/L	10	50.0	62%	74%	17%
4-Chloro-3-methylphenol	ug/L	10	100.0	70%	78%	10%
Acenaphthene	ug/L	10	50.0	70%	80%	13%
4-Nitrophenol	ug/L	50	100.0	110%	105%	4%
2,4-Dinitrotoluene	ug/L	10	50.0	74%	76%	2%
Pentachlorophenol	ug/L	10	100.0	77%	78%	1%
Pyrene	ug/L	10	50.0	138%	134%	2%

There was not enough sample for an MS/MSD. The LCS/LCSD results are reported instead.

r. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120507

Client Reference: Metro Rail/92-2050-02

VOLATILE ORGANICS
Batch: 75 04260
Samples: 75 0159392

METHOD BLANK:

Parameter	Units	MDL	Method Blank
1,1,2-Trichlor-1,2,2-trifluoroethane	ug/L	10	ND
Chloromethane	ug/L	10	ND
Vinyl chloride	ug/L	10	ND
Bromomethane	ug/L	10	ND
Chloroethane	ug/L	10	ND
Trichlorofluoromethane	ug/L	10	ND
1,1-Dichloroethene	ug/L	5	ND
Acetone	ug/L	50	ND
Carbon disulfide	ug/L	5	ND
Methylene chloride	ug/L	5	ND
trans-1,2-Dichloroethene	ug/L	5	ND
1-Dichloroethane	ug/L	5	ND
2-Butanone	ug/L	50	ND
cis-1,2-Dichloroethene	ug/L	5	ND
Chloroform	ug/L	5	ND
1,2-Dichloroethane	ug/L	5	ND
1,1,1-Trichloroethane	ug/L	5	ND
Carbon tetrachloride	ug/L	5	ND
Benzene	ug/L	5	ND
Trichloroethene	ug/L	5	ND
1,2-Dichloropropane	ug/L	5	ND
Bromodichloromethane	ug/L	5	ND
cis-1,3-Dichloropropene	ug/L	5	ND
trans-1,3-Dichloropropene	ug/L	5	ND
1,1,2-Trichloroethane	ug/L	5	ND
Dibromochloromethane	ug/L	5	ND
Bromoform	ug/L	5	ND
4-Methyl-2-pentanone	ug/L	50	ND
Toluene	ug/L	5	ND
2-Hexanone	ug/L	50	ND
1,1,2,2-Tetrachloroethane	ug/L	5	ND
Tetrachloroethene	ug/L	5	ND

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120507

Client Reference: Metro Rail/92-2050-02

VOLATILE ORGANICS
Batch: 75 04260
Samples: 75 0159392

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Chlorobenzene	ug/L	5	ND
Ethylbenzene	ug/L	5	ND
Styrene	ug/L	5	ND
Xylenes (Total)	ug/L	5	ND
1,3-Dichlorobenzene	ug/L	5	ND
1,4-Dichlorobenzene	ug/L	5	ND
1,2-Dichlorobenzene	ug/L	5	ND
1,2-Dichloroethane-d4 (Surrog. Recovery	%		119
Toluene-d8 (Surrog. Recovery	%		100
4-Bromofluorobenzene (Surrog. Recovery	%		96.9

SPIKE AND SPIKE DUPLICATE:

Parameter	Units	MDL	750158949	Spike	Spike Recv	Spike Dupl Recv	RPD
1,1-Dichloroethene	ug/L	5	ND	50	82%	85%	3%
Benzene	ug/L	5	ND	50	92%	95%	3%
Trichloroethene	ug/L	5	ND	50	101%	105%	3%
Toluene	ug/L	5	ND	50	96%	96%	0%
Chlorobenzene	ug/L	5	ND	50	97%	97%	0%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
1,1-Dichloroethene	ug/L	5	50	82%
Benzene	ug/L	5	50	90%
Trichloroethene	ug/L	5	50	92%
Toluene	ug/L	5	50	93%
Chlorobenzene	ug/L	5	50	94%

r. Ram
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FOOTNOTES
for pages 8 through 29

December 11, 1992
PACE Project Number: 721120507

Client Reference: Metro Rail/92-2050-02

MDL	Method Detection Limit
NC	No calculation due to value below detection limit.
ND	Not detected at or above the MDL.
RPD	Relative Percent Difference

RESULTS OF LABORATORY ANALYSES
EQUIPMENT BLANK

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INCORPORATED
THE ASSURANCE OF QUALITY

REPORT OF LABORATORY ANALYSIS

December 11, 1992

Dr. Ram
Earth Technology Corporation
13900 Alton Parkway
Suite 120
Irvine, CA 92718

RE: PACE Project No. 721120.510
Client Reference: Metro Rail/92-2050-02

Dear Dr. Ram:

Enclosed is the report of laboratory analyses for samples received November 20, 1992. Samples were received by the laboratory in good condition with the proper preservatives per the requested analytical work.

Footnotes are given at the end of the report.

If you have any questions concerning this report, please feel free to contact us.

Sincerely,

Eric S. Howarth
Project Manager

Enclosures

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.510
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: Equipment Blank
SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
1,1,2-Trichlor-1,2,2-trifluoroethane	10	ug/L	ND	624	12/01/92
Chloromethane	10	ug/L	ND	624	12/01/92
Vinyl chloride	10	ug/L	ND	624	12/01/92
Bromomethane	10	ug/L	ND	624	12/01/92
Chloroethane	10	ug/L	ND	624	12/01/92
Trichlorofluoromethane	10	ug/L	ND	624	12/01/92
1,1-Dichloroethene	5	ug/L	ND	624	12/01/92
Acetone	50	ug/L	ND	624	12/01/92
Carbon disulfide	5	ug/L	ND	624	12/01/92
Methylene chloride	5	ug/L	ND	624	12/01/92
trans-1,2-Dichloroethene	5	ug/L	ND	624	12/01/92
1,1-Dichloroethane	5	ug/L	ND	624	12/01/92
2-Butanone	50	ug/L	ND	624	12/01/92
cis-1,2-Dichloroethene	5	ug/L	ND	624	12/01/92
Chloroform	5	ug/L	ND	624	12/01/92
1,2-Dichloroethane	5	ug/L	ND	624	12/01/92
1,1,1-Trichloroethane	5	ug/L	ND	624	12/01/92
Carbon tetrachloride	5	ug/L	ND	624	12/01/92
Benzene	5	ug/L	ND	624	12/01/92
Trichloroethene	5	ug/L	ND	624	12/01/92
1,2-Dichloropropane	5	ug/L	ND	624	12/01/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.510
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: Equipment Blank
SAMPLE MATRIX: WATER

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Bromodichloromethane	5	ug/L	ND	624	12/01/92
cis-1,3-Dichloropropene	5	ug/L	ND	624	12/01/92
trans-1,3-Dichloropropene	5	ug/L	ND	624	12/01/92
1,1,2-Trichloroethane	5	ug/L	ND	624	12/01/92
Dibromochloromethane	5	ug/L	ND	624	12/01/92
Bromoform	5	ug/L	ND	624	12/01/92
4-Methyl-2-pentanone	50	ug/L	ND	624	12/01/92
Toluene	5	ug/L	ND	624	12/01/92
2-Hexanone	50	ug/L	ND	624	12/01/92
1,1,2,2-Tetrachloroethane	5	ug/L	ND	624	12/01/92
Tetrachloroethene	5	ug/L	ND	624	12/01/92
Chlorobenzene	5	ug/L	ND	624	12/01/92
Ethylbenzene	5	ug/L	ND	624	12/01/92
Styrene	5	ug/L	ND	624	12/01/92
Xylenes (Total)	5	ug/L	ND	624	12/01/92
1,3-Dichlorobenzene	5	ug/L	ND	624	12/01/92
1,4-Dichlorobenzene	5	ug/L	ND	624	12/01/92
1,2-Dichlorobenzene	5	ug/L	ND	624	12/01/92
1,2-Dichloroethane-d4 (Surrog. Recovery)		%	129	624	12/01/92
Toluene-d8 (Surrog. Recovery)		%	101	624	12/01/92
4-Bromofluorobenzene (Surrog. Recovery)		%	98.7	624	12/01/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.510
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: Equipment Blank
SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
8270 Date Extracted			-	3520	11/20/92
n-Nitrosodimethylamine	10	ug/L	ND	625	11/27/92
Phenol	10	ug/L	ND	625	11/27/92
Aniline	10	ug/L	ND	625	11/27/92
bis(2-Chloroethyl)ether	10	ug/L	ND	625	11/27/92
2-Chlorophenol	10	ug/L	ND	625	11/27/92
1,3-Dichlorobenzene	10	ug/L	ND	625	11/27/92
1,4-Dichlorobenzene	10	ug/L	ND	625	11/27/92
Benzyl alcohol	10	ug/L	ND	625	11/27/92
1,2-Dichlorobenzene	10	ug/L	ND	625	11/27/92
2-Methylphenol	10	ug/L	ND	625	11/27/92
bis(2-Chloroisopropyl)ether	10	ug/L	ND	625	11/27/92
4-Methylphenol	10	ug/L	ND	625	11/27/92
n-Nitroso-di-n-propylamine	10	ug/L	ND	625	11/27/92
Hexachloroethane	10	ug/L	ND	625	11/27/92
Nitrobenzene	10	ug/L	ND	625	11/27/92
Isophorone	10	ug/L	ND	625	11/27/92
2-Nitrophenol	10	ug/L	ND	625	11/27/92
2,4-Dimethylphenol	10	ug/L	ND	625	11/27/92
Benzoic acid	50	ug/L	ND	625	11/27/92
bis(2-Chloroethoxy)methane	10	ug/L	ND	625	11/27/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.510
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: Equipment Blank
SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
2,4-Dichlorophenol	10	ug/L	ND	625	11/27/92
1,2,4-Trichlorobenzene	10	ug/L	ND	625	11/27/92
Naphthalene	10	ug/L	ND	625	11/27/92
4-Chloroaniline	20	ug/L	ND	625	11/27/92
Hexachlorobutadiene	10	ug/L	ND	625	11/27/92
4-Chloro-3-methylphenol	10	ug/L	ND	625	11/27/92
2-Methylnaphthalene	10	ug/L	ND	625	11/27/92
Hexachlorocyclopentadiene	10	ug/L	ND	625	11/27/92
2,4,6-Trichlorophenol	10	ug/L	ND	625	11/27/92
2,4,5-Trichlorophenol	10	ug/L	ND	625	11/27/92
2-Chloronaphthalene	50	ug/L	ND	625	11/27/92
2-Nitroaniline	50	ug/L	ND	625	11/27/92
Dimethylphthalate	10	ug/L	ND	625	11/27/92
Acenaphthylene	10	ug/L	ND	625	11/27/92
2,6-Dinitrotoluene	10	ug/L	ND	625	11/27/92
3-Nitroaniline	50	ug/L	ND	625	11/27/92
Acenaphthene	10	ug/L	ND	625	11/27/92
2,4-Dinitrophenol	50	ug/L	ND	625	11/27/92
4-Nitrophenol	50	ug/L	ND	625	11/27/92
Dibenzofuran	10	ug/L	ND	625	11/27/92
2,4-Dinitrotoluene	10	ug/L	ND	625	11/27/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.510

CLIENT PROJECT NAME: Metro Rail/92-2050-02

CLIENT SAMPLE DESCRIPTION: Equipment Blank

SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Diethylphthalate	10	ug/L	ND	625	11/27/92
4-Chlorophenyl-phenylether	10	ug/L	ND	625	11/27/92
Fluorene	10	ug/L	ND	625	11/27/92
4-Nitroaniline	50	ug/L	ND	625	11/27/92
4,6-Dinitro-2-methylphenol	50	ug/L	ND	625	11/27/92
n-Nitrosodiphenylamine	10	ug/L	ND	625	11/27/92
4-Bromophenyl-phenylether	10	ug/L	ND	625	11/27/92
Hexachlorobenzene	10	ug/L	ND	625	11/27/92
Pentachlorophenol	10	ug/L	ND	625	11/27/92
Phenanthrene	10	ug/L	ND	625	11/27/92
Anthracene	10	ug/L	ND	625	11/27/92
Di-n-butylphthalate	10	ug/L	ND	625	11/27/92
Fluoranthene	10	ug/L	ND	625	11/27/92
Benzidine	50	ug/L	ND	625	11/27/92
Pyrene	10	ug/L	ND	625	11/27/92
Butylbenzylphthalate	10	ug/L	ND	625	11/27/92
Benzo(a)anthracene	10	ug/L	ND	625	11/27/92
Chrysene	10	ug/L	ND	625	11/27/92
bis(2-Ethylhexyl)phthalate	10	ug/L	ND	625	11/27/92
Di-n-octylphthalate	10	ug/L	ND	625	11/27/92
Benzo(b)fluoranthene	10	ug/L	ND	625	11/27/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.510
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: Equipment Blank
SAMPLE MATRIX: WATER

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Benzo(k)fluoranthene	10	ug/L	ND	625	11/27/92
Benzo(a)pyrene	10	ug/L	ND	625	11/27/92
Indeno(1,2,3-cd)pyrene	10	ug/L	ND	625	11/27/92
Dibenzo(a,h)anthracene	10	ug/L	ND	625	11/27/92
Benzo(g,h,i)perylene	10	ug/L	ND	625	11/27/92
2-Fluorophenol (Surrog. Recovery)		%	64.7	625	11/27/92
Phenol-d5 (Surrog. Recovery)		%	70.0	625	11/27/92
Nitrobenzene-d5 (Surrog. Recovery)		%	59.9	625	11/27/92
2-Fluorobiphenyl (Surrog. Recovery)		%	69.0	625	11/27/92
2,4,6-Tribromophenol (Surrog. Recovery)		%	75.3	625	11/27/92
Terphenyl-d14 (Surrog. Recovery)		%	131	625	11/27/92
Date Extracted			-	418.1	11/24/92
Total Petroleum Hydrocarbons	0.05	mg/L	ND	418.1	11/24/92
Date Extracted			-	413.2	12/01/92
Oil & Grease	0.05	mg/L	ND	413.2	12/01/92
TPH Quantified as Gasoline	20	ug/L	ND	8015 LUFT	11/23/92
Date Extracted			-	8015 LUFT	11/23/92
TPH Quantified as Diesel	500	ug/L	ND	8015 LUFT	11/24/92
TTLC, CV Date Digested			-	7470	12/02/92
TTLC, CV Mercury	0.0003	mg/L	ND	7470	12/02/92
Antimony (Sb)	0.003	mg/L	ND	6020	12/01/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.510
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: Equipment Blank
SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Arsenic (As)	0.005	mg/L	ND	6020	12/01/92
Berium (Ba)	0.004	mg/L	ND	6020	12/01/92
Beryllium (Be)	0.002	mg/L	ND	6020	12/01/92
Cadmium (Cd)	0.0025	mg/L	ND	6020	12/01/92
Chromium (Cr)	0.004	mg/L	ND	6020	12/01/92
Cobalt (Co)	0.004	mg/L	ND	6020	12/01/92
Copper (Cu)	0.005	mg/L	ND	6020	12/01/92
Lead (Pb)	0.005	mg/L	ND	6020	12/01/92
Molybdenum (Mo)	0.005	mg/L	ND	6020	12/01/92
Nickel (Ni)	0.005	mg/L	ND	6020	12/01/92
Selenium (Se)	0.005	mg/L	ND	270.2	12/01/92
Silver (Ag)	0.005	mg/L	ND	6020	12/01/92
Thallium (Tl)	0.005	mg/L	ND	6020	12/01/92
Vanadium (V)	0.005	mg/L	ND	6020	12/01/92
Zinc (Zn)	0.007	mg/L	0.012	6020	12/01/92
Date Extracted			-	7196	11/20/92
Chromium, Hexavalent	0.01	mg/L	ND	7196	11/20/92
Acute Aquatic Toxicity (Bioassay)		% Survival	90		11/20/92
Date Incubated			-	405.1	11/20/92
Biological Oxygen Demand	0.2	mg/L	2.6	405.1	11/25/92
Spectrophotometric-Chem Oxygen Demand	5.0	mg/L	ND	Hach Kit	12/08/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.510
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: Equipment Blank
SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Gravimetric-Total Suspended Solids	4.0	mg/L	ND	160.2	11/23/92
Settleable Matter	0.1	ml/L	ND	160.5	11/20/92
Turbidity	0.2	NTU	ND	180.1	11/20/92
Gravimetric-Total Dissolved Solids	10	mg/L	ND	160.1	11/23/92
Titrimetric-Chloride	0.5	mg/L	ND	325.3	11/30/92
Spectrophotometric-Total Sulfide	0.05	mg/L	ND	376.2	11/24/92
Gravimetric-Sulfate	1.0	mg/L	ND	375.3	11/30/92
Nitrite	1.0	mg/L	ND	300	12/04/92
Nitrate	1.0	mg/L	2	300	12/04/92
Specific Conductance	10	umhos/cm	ND	120.1	12/01/92
pH	2.0	Units	6.2	150.1	11/20/92

Client Reference: Metro Rail/92-2050-02

All QA reports and data have been reviewed and are within acceptable limits.

Kenneth D. Faust,
Southern California Regional Director

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FOOTNOTES
for pages 1 through 6

December 11, 1992
PACE Project Number: 721120510

Client Reference: Metro Rail/92-2050-02

MDL	Method Detection Limit
ND	Not detected at or above the MDL.

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120510

Client Reference: Metro Rail/92-2050-02

Biological Oxygen Demand
Batch: 75 04303
Samples: 75 0159422

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750158949	Duplicate of 75 0158949	RPD
Biological Oxygen Demand	mg/L	0.2	ND	2.2	2.2	0%

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 72112051

Client Reference: Metro Rail/92-2050-02

Gravimetric-Sulfate
Batch: 75 04297
Samples: 75 0159422

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159392	Duplicate of 75 0159392	RPD
Gravimetric-Sulfate	mg/L	1.0	ND	750	750	0%

SPIKE:

Parameter	Units	MDL	750159392	Spike	Spike Recv
Gravimetric-Sulfate	mg/L	1.0	750	338	98%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
Gravimetric-Sulfate	mg/L	1.0	338	95%

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120510

Client Reference: Metro Rail/92-2050-02

Gravimetric-Total Dissolved Solids
Batch: 75 04192
Samples: 75 0159422

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422 Water Equip. Blank	Duplicate of 75 0159422	RPD
Gravimetric-Total Dissolved Solids	mg/L	10	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159422 Water Equip. Blank	Spike	Spike Recv
Gravimetric-Total Dissolved Solids	mg/L	10	ND	1000	101%

BORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
Gravimetric-Total Dissolved Solids	mg/L	10	1000	99%

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 72112051

Client Reference: Metro Rail/92-2050-02

Gravimetric-Total Suspended Solids
Batch: 75 04300
Samples: 75 0159422

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422 Water Equip. Blank	Duplicate of 75 0159422	RPD
Gravimetric-Total Suspended Solids	mg/L	4.0	ND	ND	ND	NC

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120510

Client Reference: Metro Rail/92-2050-02

Settleable Matter
Batch: 75 04292
Samples: 75 0159422

SAMPLE DUPLICATE:

Parameter	Units	MDL	750159422 Water Equip. Blank	Duplicate of 75 0159422	RPD
Settleable Matter	ml/L	0.1	ND	ND	NC

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120510

Client Reference: Metro Rail/92-2050-02

Specific Conductance
Batch: 75 04288
Samples: 75 0159422

SAMPLE DUPLICATE:

Parameter	Units	MDL	750158949	Duplicate of 75 0158949	RPD
Specific Conductance	umhos/cm	10	860	870	1%

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120510

Client Reference: Metro Rail/92-2050-02

Spectrophotometric-Chem Oxygen Demand
Batch: 75 04425
Samples: 75 0159422

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422 Water Equip. Blank	Duplicate of 75 0159422	RPD
Spectrophotometric-Chem Oxygen Demand	mg/L	5.0	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159422 Water Equip. Blank	Spike	Spike Recv
Spectrophotometric-Chem Oxygen Demand	mg/L	5.0	ND	50	124%

BORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
Spectrophotometric-Chem Oxygen Demand	mg/L	5.0	50	126%

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 72112051

Client Reference: Metro Rail/92-2050-02

Spectrophotometric-Total Sulfide
Batch: 75 04311
Samples: 75 0159422

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422 Water Equip. Blank	Duplicate of 75 0159422	RPD
Spectrophotometric-Total Sulfide	mg/L	0.05	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159422 Water Equip. Blank	Spike	Spike Recv
Spectrophotometric-Total Sulfide	mg/L	0.05	ND	0.21	100%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
Spectrophotometric-Total Sulfide	mg/L	0.05	0.21	90%

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120510

Client Reference: Metro Rail/92-2050-02

Titrimetric-Chloride
Batch: 75 04298
Samples: 75 0159422

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422 Water Equip. Blank	Duplicate of 75 0159422	RPD
Titrimetric-Chloride	mg/L	0.5	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159422 Water Equip. Blank	Spike	Spike Recv
Titrimetric-Chloride	mg/L	0.5	ND	88.65	98%

BORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
Titrimetric-Chloride	mg/L	0.5	88.65	97%

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120510

Client Reference: Metro Rail/92-2050-02

Turbidity
Batch: 75 04290
Samples: 75 0159422

SAMPLE DUPLICATE:

Parameter	Units	MDL	750159422 Water Equip. Blank	Duplicate of 75 0159422	RPD
Turbidity	NTU	0.2	ND	ND	NC

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120510

Client Reference: Metro Rail/92-2050-02

pH
Batch: 75 04195
Samples: 75 0159422

SAMPLE DUPLICATE:

Parameter	Units	MDL	750159422 Water Equip. Blank	Duplicate of 75 0159422	RPD
pH	Units	2.0	6.2	6.2	0%

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 72112051

Client Reference: Metro Rail/92-2050-02

SPECTROPHOTOMETRIC, IR-OIL & GREASE
Batch: 75 04310
Samples: 75 0159422

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Date Extracted			-
Oil & Grease	mg/L	0.05	ND

LABORATORY CONTROL SAMPLE AND CONTROL SAMPLE DUPLICATE:

Parameter	Units	MDL	Reference Value	Recv	Dupl Recv	RPD
Oil & Grease	mg/L	0.05	4.62	89%	89%	0%

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120510

Client Reference: Metro Rail/92-2050-02

SPECTROPHOTOMETRIC, IR-TPH
Batch: 75 04309
Samples: 75 0159422

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Date Extracted			-
Total Petroleum Hydrocarbons	mg/L	0.05	ND

LABORATORY CONTROL SAMPLE AND CONTROL SAMPLE DUPLICATE:

Parameter	Units	MDL	Reference Value	Recv	Dupl Recv	RPD
Total Petroleum Hydrocarbons	mg/L	0.05	4.89	84%	85%	1%

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 72112051

Client Reference: Metro Rail/92-2050-02

SPECTROPHOTOMETRIC-CHROMIUM, HEXAVALENT
Batch: 75 04193
Samples: 75 0159422

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159414	Duplicate of 75 0159414	RPD
Date Extracted			-	-	-	NC
Chromium, Hexavalent	mg/L	0.01	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159414	Spike	Spike Recv
Chromium, Hexavalent	mg/L	0.01	ND	0.53	100%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
Chromium, Hexavalent	mg/L	0.01	0.53	100%

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120510

Client Reference: Metro Rail/92-2050-02

TITLE 22 TTLC MERCURY BY CV
Batch: 75 04384
Samples: 75 0159422

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750159422 Water Equip. Blank	Duplicate of 75 0159422	RPD
TTLC, CV Mercury	mg/L	0.0003	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750159422 Water Equip. Blank	Spike	Spike Recv
TTLC, CV Mercury	mg/L	0.0003	ND	0.005	108%

BORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
TTLC, CV Mercury	mg/L	0.0003	0.005	98%

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 72112051

Client Reference: Metro Rail/92-2050-02

BTEX & TPH QUANTIFIED AS GASOLINE
Batch: 75 04233
Samples: 75 0159422

METHOD BLANK:

Parameter	Units	MDL	Method Blank
TPH Quantified as Gasoline	ug/L	50	ND
Benzene	ug/L	0.3	ND
Toluene	ug/L	0.3	ND
Ethylbenzene	ug/L	0.3	ND
Xylenes	ug/L	0.6	ND
% FB Surrogate Spike Recovery			90%

SPIKE AND SPIKE DUPLICATE:

Parameter	Units	MDL	750158949	Spike	Spike Recv	Spike Dupl Recv	RP
TPH Quantified as Gasoline	ug/L	20	ND				
TPH Quantified as Gasoline	ug/L	50		400	90%	91%	1

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
TPH Quantified as Gasoline	ug/L	50	400	97%
Benzene	ug/L	0.3	20	98%
Toluene	ug/L	0.3	20	95%
Ethylbenzene	ug/L	0.3	20	97%
Xylenes	ug/L	0.6	60	93%

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120510

Client Reference: Metro Rail/92-2050-02

EXTRACTABLE TPH QUANTIFIED AS DIESEL
Batch: 75 04296
Samples: 75 0159422

METHOD BLANK:

Parameter	Units	MDL	Method Blank
TPH Quantified as Diesel	ug/L	500	ND

LABORATORY CONTROL SAMPLE AND CONTROL SAMPLE DUPLICATE:

Parameter	Units	MDL	Reference Value	Recv	Dupl Recv	RPD
TPH Quantified as Diesel	ug/L	500	2500	112%	116%	3%

REPORT OF LABORATORY ANALYSIS

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 72112051

Client Reference: Metro Rail/92-2050-02

SEMI-VOLATILES
Batch: 75 04241
Samples: 75 0159422

METHOD BLANK:

Parameter	Units	MDL	Method Blank
n-Nitrosodimethylamine	ug/L	10	ND
Phenol	ug/L	10	ND
Aniline	ug/L	10	ND
bis(2-Chloroethyl)ether	ug/L	10	ND
2-Chlorophenol	ug/L	10	ND
1,3-Dichlorobenzene	ug/L	10	ND
1,4-Dichlorobenzene	ug/L	10	ND
Benzyl alcohol	ug/L	10	ND
1,2-Dichlorobenzene	ug/L	10	ND
2-Methylphenol	ug/L	10	ND
bis(2-Chloroisopropyl)ether	ug/L	10	ND
4-Methylphenol	ug/L	10	ND
n-Nitroso-di-n-propylamine	ug/L	10	ND
Hexachloroethane	ug/L	10	ND
Nitrobenzene	ug/L	10	ND
Isophorone	ug/L	10	ND
2-Nitrophenol	ug/L	10	ND
2,4-Dimethylphenol	ug/L	10	ND
Benzoic acid	ug/L	50	ND
bis(2-Chloroethoxy)methane	ug/L	10	ND
2,4-Dichlorophenol	ug/L	10	ND
1,2,4-Trichlorobenzene	ug/L	10	ND
Naphthalene	ug/L	10	ND
4-Chloroaniline	ug/L	20	ND
Hexachlorobutadiene	ug/L	10	ND
4-Chloro-3-methylphenol	ug/L	10	ND
2-Methylnaphthalene	ug/L	10	ND
Hexachlorocyclopentadiene	ug/L	10	ND
2,4,6-Trichlorophenol	ug/L	10	ND
2,4,5-Trichlorophenol	ug/L	10	ND
2-Chloronaphthalene	ug/L	50	ND
2-Nitroaniline	ug/L	50	ND

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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120510

Client Reference: Metro Rail/92-2050-02

SEMI-VOLATILES
Batch: 75 04241
Samples: 75 0159422

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Dimethylphthalate	ug/L	10	ND
Acenaphthylene	ug/L	10	ND
2,6-Dinitrotoluene	ug/L	10	ND
3-Nitroaniline	ug/L	50	ND
Acenaphthene	ug/L	10	ND
2,4-Dinitrophenol	ug/L	50	ND
4-Nitrophenol	ug/L	50	ND
Dibenzofuran	ug/L	10	ND
2,4-Dinitrotoluene	ug/L	10	ND
Diethylphthalate	ug/L	10	ND
4-Chlorophenyl-phenylether	ug/L	10	ND
Fluorene	ug/L	10	ND
4-Nitroaniline	ug/L	50	ND
4,6-Dinitro-2-methylphenol	ug/L	50	ND
n-Nitrosodiphenylamine	ug/L	10	ND
4-Bromophenyl-phenylether	ug/L	10	ND
Hexachlorobenzene	ug/L	10	ND
Pentachlorophenol	ug/L	10	ND
Phenanthrene	ug/L	10	ND
Anthracene	ug/L	10	ND
Di-n-butylphthalate	ug/L	10	ND
Fluoranthene	ug/L	10	ND
Benzidine	ug/L	50	ND
Pyrene	ug/L	10	ND
Butylbenzylphthalate	ug/L	10	ND
Benzo(a)anthracene	ug/L	10	ND
Chrysene	ug/L	10	ND
bis(2-Ethylhexyl)phthalate	ug/L	10	ND
Di-n-octylphthalate	ug/L	10	ND
Benzo(b)fluoranthene	ug/L	10	ND
Benzo(k)fluoranthene	ug/L	10	ND
Benzo(a)pyrene	ug/L	10	ND

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 72112051

Client Reference: Metro Rail/92-2050-02

SEMI-VOLATILES
Batch: 75 04241
Samples: 75 0159422

METHOD BLANK:

Parameter		Units	MDL	Method Blank
Indeno(1,2,3-cd)pyrene		ug/L	10	ND
Dibenzo(a,h)anthracene		ug/L	10	ND
Benzo(g,h,i)perylene		ug/L	10	ND
2-Fluorophenol	(Surrog. Recovery	%		68.4
Phenol-d5	(Surrog. Recovery	%		70.5
Nitrobenzene-d5	(Surrog. Recovery	%		71.2
2-Fluorobiphenyl	(Surrog. Recovery	%		72.8
2,4,6-Tribromophenol	(Surrog. Recovery	%		78.7
Terphenyl-d14	(Surrog. Recovery	%		116.

LABORATORY CONTROL SAMPLE AND CONTROL SAMPLE DUPLICATE:

Parameter	Units	MDL	Reference Value	Recv	Dupl Recv	RPD
Phenol	ug/L	10	100.00	61%	75%	20%
2-Chlorophenol	ug/L	10	100.0	62%	70%	12%
1,4-Dichlorobenzene	ug/L	10	50.0	65%	79%	19%
n-Nitroso-di-n-propylamine	ug/L	10	50.0	62%	75%	18%
1,2,4-Trichlorobenzene	ug/L	10	50.0	62%	74%	17%
4-Chloro-3-methylphenol	ug/L	10	100.0	70%	78%	10%
Acenaphthene	ug/L	10	50.0	70%	80%	13%
4-Nitrophenol	ug/L	50	100.0	110%	105%	4%
2,4-Dinitrotoluene	ug/L	10	50.0	74%	76%	2%
Pentachlorophenol	ug/L	10	100.0	77%	78%	1%
Pyrene	ug/L	10	50.0	138%	134%	2%

There was not enough sample for an MS/MSD. The LCS/LCSD results are reported instead.

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120510

Client Reference: Metro Rail/92-2050-02

VOLATILE ORGANICS
Batch: 75 04260
Samples: 75 0159422

METHOD BLANK:

Parameter	Units	MDL	Method Blank
1,1,2-Trichlor-1,2,2-trifluoroethane	ug/L	10	ND
Chloromethane	ug/L	10	ND
Vinyl chloride	ug/L	10	ND
Bromomethane	ug/L	10	ND
Chloroethane	ug/L	10	ND
Trichlorofluoromethane	ug/L	10	ND
1,1-Dichloroethene	ug/L	5	ND
Acetone	ug/L	50	ND
Carbon disulfide	ug/L	5	ND
Methylene chloride	ug/L	5	ND
trans-1,2-Dichloroethene	ug/L	5	ND
,1-Dichloroethane	ug/L	5	ND
2-Butanone	ug/L	50	ND
cis-1,2-Dichloroethene	ug/L	5	ND
Chloroform	ug/L	5	ND
1,2-Dichloroethane	ug/L	5	ND
1,1,1-Trichloroethane	ug/L	5	ND
Carbon tetrachloride	ug/L	5	ND
Benzene	ug/L	5	ND
Trichloroethene	ug/L	5	ND
1,2-Dichloropropane	ug/L	5	ND
Bromodichloromethane	ug/L	5	ND
cis-1,3-Dichloropropene	ug/L	5	ND
trans-1,3-Dichloropropene	ug/L	5	ND
1,1,2-Trichloroethane	ug/L	5	ND
Dibromochloromethane	ug/L	5	ND
Bromoform	ug/L	5	ND
4-Methyl-2-pentanone	ug/L	50	ND
Toluene	ug/L	5	ND
2-Hexanone	ug/L	50	ND
1,1,2,2-Tetrachloroethane	ug/L	5	ND
Tetrachloroethene	ug/L	5	ND

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 72112051

Client Reference: Metro Rail/92-2050-02

VOLATILE ORGANICS
Batch: 75 04260
Samples: 75 0159422

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Chlorobenzene	ug/L	5	ND
Ethylbenzene	ug/L	5	ND
Styrene	ug/L	5	ND
Xylenes (Total)	ug/L	5	ND
1,3-Dichlorobenzene	ug/L	5	ND
1,4-Dichlorobenzene	ug/L	5	ND
1,2-Dichlorobenzene	ug/L	5	ND
1,2-Dichloroethane-d4 (Surrog. Recovery	%		119
Toluene-d8 (Surrog. Recovery	%		100
4-Bromofluorobenzene (Surrog. Recovery	%		96.9

SPIKE AND SPIKE DUPLICATE:

Parameter	Units	MDL	750158949	Spike	Spike Recv	Spike Dupl Recv	RPD
1,1-Dichloroethene	ug/L	5	ND	50	82%	85%	3%
Benzene	ug/L	5	ND	50	92%	95%	3%
Trichloroethene	ug/L	5	ND	50	101%	105%	3%
Toluene	ug/L	5	ND	50	96%	96%	0%
Chlorobenzene	ug/L	5	ND	50	97%	97%	0%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
1,1-Dichloroethene	ug/L	5	50	82%
Benzene	ug/L	5	50	90%
Trichloroethene	ug/L	5	50	92%
Toluene	ug/L	5	50	93%
Chlorobenzene	ug/L	5	50	94%

Dr. Ram
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FOOTNOTES
for pages 8 through 29

December 11, 1992
PACE Project Number: 721120510

Client Reference: Metro Rail/92-2050-02

MDL	Method Detection Limit
NC	No calculation due to value below detection limit.
ND	Not detected at or above the MDL.
RPD	Relative Percent Difference

RESULTS OF LABORATORY ANALYSES
TRIP BLANK

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REPORT OF LABORATORY ANALYSIS

December 11, 1992

Dr. Ram
Earth Technology Corporation
13900 Alton Parkway
Suite 120
Irvine, CA 92718

RE: PACE Project No. 721120.511
Client Reference: Metro Rail/92-2050-02

Dear Dr. Ram:

Enclosed is the report of laboratory analyses for samples received November 20, 1992. Samples were received by the laboratory in good condition with proper preservatives per the requested analytical work.

Footnotes are given at the end of the report.

If you have any questions concerning this report, please feel free to contact us.

Sincerely,

Eric S Howarth

Eric S. Howarth
Project Manager

Enclosures

5702 Bolsa Avenue
Huntington Beach, CA 92649
TEL: 714-892-2565
FAX: 714-890-4032

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.511
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: Trip Blank
SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
1,1,2-Trichlor-1,2,2-trifluoroethane	10	ug/L	ND	624	11/30/92
Chloromethane	10	ug/L	ND	624	11/30/92
Vinyl chloride	10	ug/L	ND	624	11/30/92
Bromomethane	10	ug/L	ND	624	11/30/92
Chloroethane	10	ug/L	ND	624	11/30/92
Trichlorofluoromethane	10	ug/L	ND	624	11/30/92
1,1-Dichloroethene	5	ug/L	ND	624	11/30/92
Acetone	50	ug/L	ND	624	11/30/92
Carbon disulfide	5	ug/L	ND	624	11/30/92
Methylene chloride	5	ug/L	ND	624	11/30/92
trans-1,2-Dichloroethene	5	ug/L	ND	624	11/30/92
1,1-Dichloroethane	5	ug/L	ND	624	11/30/92
2-Butanone	50	ug/L	ND	624	11/30/92
cis-1,2-Dichloroethene	5	ug/L	ND	624	11/30/92
Chloroform	5	ug/L	ND	624	11/30/92
1,2-Dichloroethane	5	ug/L	ND	624	11/30/92
1,1,1-Trichloroethane	5	ug/L	ND	624	11/30/92
Carbon tetrachloride	5	ug/L	ND	624	11/30/92
Benzene	5	ug/L	ND	624	11/30/92
Trichloroethene	5	ug/L	ND	624	11/30/92
1,2-Dichloropropane	5	ug/L	ND	624	11/30/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.511
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: Trip Blank
SAMPLE MATRIX: WATER

December 11, 1992
Page 2

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
Bromodichloromethane	5	ug/L	ND	624	11/30/92
cis-1,3-Dichloropropene	5	ug/L	ND	624	11/30/92
trans-1,3-Dichloropropene	5	ug/L	ND	624	11/30/92
1,1,2-Trichloroethane	5	ug/L	ND	624	11/30/92
Dibromochloromethane	5	ug/L	ND	624	11/30/92
Bromoform	5	ug/L	ND	624	11/30/92
4-Methyl-2-pentanone	50	ug/L	ND	624	11/30/92
Toluene	5	ug/L	ND	624	11/30/92
2-Hexanone	50	ug/L	ND	624	11/30/92
1,1,2,2-Tetrachloroethane	5	ug/L	ND	624	11/30/92
Tetrachloroethene	5	ug/L	ND	624	11/30/92
Chlorobenzene	5	ug/L	ND	624	11/30/92
Ethylbenzene	5	ug/L	ND	624	11/30/92
Styrene	5	ug/L	ND	624	11/30/92
Xylenes (Total)	5	ug/L	ND	624	11/30/92
1,3-Dichlorobenzene	5	ug/L	ND	624	11/30/92
1,4-Dichlorobenzene	5	ug/L	ND	624	11/30/92
1,2-Dichlorobenzene	5	ug/L	ND	624	11/30/92
1,2-Dichloroethane-d4 (Surrog. Recovery)		%	122	624	11/30/92
Toluene-d8 (Surrog. Recovery)		%	100	624	11/30/92
4-Bromofluorobenzene (Surrog. Recovery)		%	97.0	624	11/30/92

REPORT OF LABORATORY ANALYSIS

PACE PROJECT NUMBER: 721120.511
CLIENT PROJECT NAME: Metro Rail/92-2050-02
CLIENT SAMPLE DESCRIPTION: Trip Blank
SAMPLE MATRIX: WATER

December 11, 1992

PARAMETER	MDL	UNITS	RESULTS	METHOD	DATE ANALYZED
TPH Quantified as Gasoline	20	ug/L	ND	8015 LUFT	11/23/92

Dr. Ram
Page 4

December 11, 1992
PACE Project Number: 72112051

Client Reference: Metro Rail/92-2050-02

All QA reports and data have been reviewed and are within acceptable limits.

Kenneth D. Faust,
Southern California Regional Director

r. Ram
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FOOTNOTES
for pages 1 through 2

December 11, 1992
PACE Project Number: 721120511

Client Reference: Metro Rail/92-2050-02

MDL	Method Detection Limit
ND	Not detected at or above the MDL.

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120511

Client Reference: Metro Rail/92-2050-02

BTEX & TPH QUANTIFIED AS GASOLINE
Batch: 75 04233
Samples: 75 0159538

METHOD BLANK:

Parameter	Units	MDL	Method Blank
TPH Quantified as Gasoline	ug/L	50	ND
Benzene	ug/L	0.3	ND
Toluene	ug/L	0.3	ND
Ethylbenzene	ug/L	0.3	ND
Xylenes	ug/L	0.6	ND
% FB Surrogate Spike Recovery			90%

SPIKE AND SPIKE DUPLICATE:

Parameter	Units	MDL	750158949	Spike	Spike Recv	Spike Dupl Recv	RPD
TPH Quantified as Gasoline	ug/L	20	ND				
TPH Quantified as Gasoline	ug/L	50		400	90%	91%	1

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
TPH Quantified as Gasoline	ug/L	50	400	97%
Benzene	ug/L	0.3	20	98%
Toluene	ug/L	0.3	20	95%
Ethylbenzene	ug/L	0.3	20	97%
Xylenes	ug/L	0.6	60	93%

Dr. Ram

QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 721120511

Client Reference: Metro Rail/92-2050-02

VOLATILE ORGANICS
Batch: 75 04260
Samples: 75 0159538

METHOD BLANK:

Parameter	Units	MDL	Method Blank
1,1,2-Trichlor-1,2,2-trifluoroethane	ug/L	10	ND
Chloromethane	ug/L	10	ND
Vinyl chloride	ug/L	10	ND
Bromomethane	ug/L	10	ND
Chloroethane	ug/L	10	ND
Trichlorofluoromethane	ug/L	10	ND
1,1-Dichloroethene	ug/L	5	ND
Acetone	ug/L	50	ND
Carbon disulfide	ug/L	5	ND
Methylene chloride	ug/L	5	ND
trans-1,2-Dichloroethene	ug/L	5	ND
1,1-Dichloroethane	ug/L	5	ND
2-Butanone	ug/L	50	ND
cis-1,2-Dichloroethene	ug/L	5	ND
Chloroform	ug/L	5	ND
1,2-Dichloroethane	ug/L	5	ND
1,1,1-Trichloroethane	ug/L	5	ND
Carbon tetrachloride	ug/L	5	ND
Benzene	ug/L	5	ND
Trichloroethene	ug/L	5	ND
1,2-Dichloropropane	ug/L	5	ND
Bromodichloromethane	ug/L	5	ND
cis-1,3-Dichloropropene	ug/L	5	ND
trans-1,3-Dichloropropene	ug/L	5	ND
1,1,2-Trichloroethane	ug/L	5	ND
Dibromochloromethane	ug/L	5	ND
Bromoform	ug/L	5	ND
4-Methyl-2-pentanone	ug/L	50	ND
Toluene	ug/L	5	ND
2-Hexanone	ug/L	50	ND
1,1,2,2-Tetrachloroethane	ug/L	5	ND
Tetrachloroethene	ug/L	5	ND

Dr. Ram
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QUALITY CONTROL DATA

December 11, 1992
PACE Project Number: 72112051.

Client Reference: Metro Rail/92-2050-02

VOLATILE ORGANICS
Batch: 75 04260
Samples: 75 0159538

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Chlorobenzene	ug/L	5	ND
Ethylbenzene	ug/L	5	ND
Styrene	ug/L	5	ND
Xylenes (Total)	ug/L	5	ND
1,3-Dichlorobenzene	ug/L	5	ND
1,4-Dichlorobenzene	ug/L	5	ND
1,2-Dichlorobenzene	ug/L	5	ND
1,2-Dichloroethane-d4 (Surrog. Recovery	%		119
Toluene-d8 (Surrog. Recovery	%		100
4-Bromofluorobenzene (Surrog. Recovery	%		96.9

SPIKE AND SPIKE DUPLICATE:

Parameter	Units	MDL	750158949	Spike	Spike Recv	Spike Dupl Recv	RPD
1,1-Dichloroethene	ug/L	5	ND	50	82%	85%	3%
Benzene	ug/L	5	ND	50	92%	95%	3%
Trichloroethene	ug/L	5	ND	50	101%	105%	3%
Toluene	ug/L	5	ND	50	96%	96%	0%
Chlorobenzene	ug/L	5	ND	50	97%	97%	0%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
1,1-Dichloroethene	ug/L	5	50	82%
Benzene	ug/L	5	50	90%
Trichloroethene	ug/L	5	50	92%
Toluene	ug/L	5	50	93%
Chlorobenzene	ug/L	5	50	94%

Dr. Ram
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FOOTNOTES
for pages 4 through 6

December 11, 1992
PACE Project Number: 721120511

Client Reference: Metro Rail/92-2050-02

MDL	Method Detection Limit
ND	Not detected at or above the MDL.
RPD	Relative Percent Difference

REPORTS OF LABORATORY ANALYSES
MONITORING WELL SM-11

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REPORT OF LABORATORY ANALYSIS

November 15, 1992

Dr. Ram
Earth Technology Corporation
13900 Alton Parkway
Suite 120
Irvine, CA 92718

RE: PACE Project No. 721026.509
Client Reference: 92-2050-02

Dear Dr. :

Enclosed is the report of laboratory analyses for samples received October 26, 1992.

Footnotes are given at the end of the report.

If you have any questions concerning this report, please feel free to contact us.

Sincerely,

Eric S. Howarth
Eric S. Howarth
Project Manager

Enclosures

5702 Bolsa Avenue
Huntington Beach, CA 92649
TEL: 714-892-2565
FAX: 714-890-4032

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REPORT OF LABORATORY ANALYSIS

Earth Technology Corporation
13900 Alton Parkway
Suite 120
Irvine, CA 92718

November 15, 1992
PACE Project Number: 721026509

Attn: Dr. Ram

Client Reference: 92-2050-02

PACE Sample Number: 75 0149397
Date Collected: 10/26/92
Date Received: 10/26/92

Parameter	Units	MDL	SM-11	METHOD	DATE ANALYZED
INORGANIC ANALYSIS					
INDIVIDUAL PARAMETERS					
GFAA, Arsenic	mg/L	0.0025	0.007	7060	11/05/92
GFAA, Date Digested			-	3005	11/04/92
GFAA, Selenium	mg/L	0.0025	ND	7740	11/04/92
GFAA, Thallium	mg/L	0.0025	ND	7841	11/05/92
Gravimetric-Total Dissolved Solids	mg/L	10	1250	160.1	10/28/92
ICP Antimony	mg/L	0.2	ND	6010	11/05/92
ICP Beryllium	mg/L	0.002	ND	6010	11/05/92
ICP Cadmium	mg/L	0.006	ND	6010	11/05/92
ICP Chromium	mg/L	0.004	0.036	6010	11/05/92
ICP Copper	mg/L	0.005	0.031	6010	11/05/92
ICP Date Digested			-	3005	11/04/92
ICP Lead	mg/L	0.05	ND	6010	11/05/92
ICP Nickel	mg/L	0.02	0.04	6010	11/05/92
ICP Silver	mg/L	0.02	ND	6010	11/05/92
ICP Zinc	mg/L	0.007	0.12	6010	11/05/92
Specific Conductance	umhos/cm	10	1650	120.1	10/28/92
Titrimetric-Total Sulfide	mg/L	0.5	ND	376.1	10/29/92
pH	Units	2.0	7.4	150.1	10/27/92
TITLE 22 TTLC MERCURY BY CV				7470	
TTLC, CV Date Digested			-		11/04/92
TTLC, CV Mercury	mg/L	0.0003	ND		11/04/92
ORGANIC ANALYSIS					
VOLATILE ORGANICS				624	
1,1,2-Trichlor-1,2,2-trifluoroethane	ug/L	10	ND		11/03/92
Chloromethane	ug/L	10	ND		11/03/92
Vinyl chloride	ug/L	10	ND		11/03/92
Bromomethane	ug/L	10	ND		11/03/92

REPORT OF LABORATORY ANALYSIS

Dr. Ram
Page 2

November 15, 1992
PACE Project Number: 721026509

Client Reference: 92-2050-02

PACE Sample Number: 75 0149397
Date Collected: 10/26/92
Date Received: 10/26/92
Client Sample ID: SM-11

Parameter	Units	MDL		METHOD	DATE ANALYZED
ORGANIC ANALYSIS					
VOLATILE ORGANICS				624	
Chloroethane	ug/L	10	ND		11/03/92
Trichlorofluoromethane	ug/L	10	ND		11/03/92
1,1-Dichloroethene	ug/L	5	ND		11/03/92
Acetone	ug/L	50	ND		11/03/92
Carbon disulfide	ug/L	5	ND		11/03/92
Methylene chloride	ug/L	5	ND		11/03/92
trans-1,2-Dichloroethene	ug/L	5	ND		11/03/92
1,1-Dichloroethane	ug/L	5	ND		11/03/92
2-Butanone	ug/L	50	ND		11/03/92
cis-1,2-Dichloroethene	ug/L	5	ND		11/03/9
Chloroform	ug/L	5	ND		11/03/92
1,2-Dichloroethane	ug/L	5	ND		11/03/92
1,1,1-Trichloroethane	ug/L	5	ND		11/03/92
Carbon tetrachloride	ug/L	5	ND		11/03/92
Benzene	ug/L	5	ND		11/03/92
Trichloroethene	ug/L	5	ND		11/03/92
1,2-Dichloropropane	ug/L	5	ND		11/03/92
Bromodichloromethane	ug/L	5	ND		11/03/92
cis-1,3-Dichloropropene	ug/L	5	ND		11/03/92
trans-1,3-Dichloropropene	ug/L	5	ND		11/03/92
1,1,2-Trichloroethane	ug/L	5	ND		11/03/92
Dibromochloromethane	ug/L	5	ND		11/03/92
Bromoform	ug/L	5	ND		11/03/92
4-Methyl-2-pentanone	ug/L	50	ND		11/03/92
Toluene	ug/L	5	ND		11/03/92
2-Hexanone	ug/L	50	ND		11/03/92
1,1,2,2-Tetrachloroethane	ug/L	5	ND		11/03/92
Tetrachloroethene	ug/L	5	ND		11/03/92
Chlorobenzene	ug/L	5	ND		11/03/92
Ethylbenzene	ug/L	5	ND		11/03/92
Styrene	ug/L	5	ND		11/03/9

Dr. Ram
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November 15, 1992
PACE Project Number: 721026509

Client Reference: 92-2050-02

PACE Sample Number: 75 0149397
Date Collected: 10/26/92
Date Received: 10/26/92
Client Sample ID: SM-11

Parameter	Units	MDL		METHOD	DATE ANALYZED
ORGANIC ANALYSIS					
VOLATILE ORGANICS				624	
Xylenes (Total)	ug/L	5	13		11/03/92
1,3-Dichlorobenzene	ug/L	5	ND		11/03/92
1,4-Dichlorobenzene	ug/L	5	ND		11/03/92
1,2-Dichlorobenzene	ug/L	5	ND		11/03/92
1,2-Dichloroethane-d4 (Surrog. Recovery)	%		95.1		11/03/92
Toluene-d8 (Surrog. Recovery)	%		93.7		11/03/92
4-Bromofluorobenzene (Surrog. Recovery)	%		92.7		11/03/92
SEMI-VOLATILES				625	
8270 Date Extracted			-		11/01/92
n-Nitrosodimethylamine	ug/L	10	ND		11/05/92
Phenol	ug/L	10	ND		11/05/92
Aniline	ug/L	10	ND		11/05/92
bis(2-Chloroethyl)ether	ug/L	10	ND		11/05/92
2-Chlorophenol	ug/L	10	ND		11/05/92
1,3-Dichlorobenzene	ug/L	10	ND		11/05/92
1,4-Dichlorobenzene	ug/L	10	ND		11/05/92
Benzyl alcohol	ug/L	10	ND		11/05/92
1,2-Dichlorobenzene	ug/L	10	ND		11/05/92
2-Methylphenol	ug/L	10	ND		11/05/92
bis(2-Chloroisopropyl)ether	ug/L	10	ND		11/05/92
4-Methylphenol	ug/L	10	ND		11/05/92
n-Nitroso-di-n-propylamine	ug/L	10	ND		11/05/92
Hexachloroethane	ug/L	10	ND		11/05/92
Nitrobenzene	ug/L	10	ND		11/05/92
Isophorone	ug/L	10	ND		11/05/92
2-Nitrophenol	ug/L	10	ND		11/05/92
2,4-Dimethylphenol	ug/L	10	ND		11/05/92
Benzoic acid	ug/L	50	ND		11/05/92
bis(2-Chloroethoxy)methane	ug/L	10	ND		11/05/92
2,4-Dichlorophenol	ug/L	10	ND		11/05/92
1,2,4-Trichlorobenzene	ug/L	10	ND		11/05/92

Dr. Ram
Page 4

November 15, 1992
PACE Project Number: 721026509

Client Reference: 92-2050-02

PACE Sample Number: 75 0149397
Date Collected: 10/26/92
Date Received: 10/26/92
Client Sample ID: SM-11

Parameter	Units	MDL		METHOD	DATE ANALYZED
ORGANIC ANALYSIS					
SEMI-VOLATILES				625	
Naphthalene	ug/L	10	ND		11/05/92
4-Chloroaniline	ug/L	20	ND		11/05/92
Hexachlorobutadiene	ug/L	10	ND		11/05/92
4-Chloro-3-methylphenol	ug/L	10	ND		11/05/92
2-Methylnaphthalene	ug/L	10	ND		11/05/92
Hexachlorocyclopentadiene	ug/L	10	ND		11/05/92
2,4,6-Trichlorophenol	ug/L	10	ND		11/05/92
2,4,5-Trichlorophenol	ug/L	10	ND		11/05/92
2-Chloronaphthalene	ug/L	50	ND		11/05/92
2-Nitroaniline	ug/L	50	ND		11/05/9
Dimethylphthalate	ug/L	10	ND		11/05/92
Acenaphthylene	ug/L	10	ND		11/05/92
2,6-Dinitrotoluene	ug/L	10	ND		11/05/92
3-Nitroaniline	ug/L	50	ND		11/05/92
Acenaphthene	ug/L	10	ND		11/05/92
2,4-Dinitrophenol	ug/L	50	ND		11/05/92
4-Nitrophenol	ug/L	50	ND		11/05/92
Dibenzofuran	ug/L	10	ND		11/05/92
2,4-Dinitrotoluene	ug/L	10	ND		11/05/92
Diethylphthalate	ug/L	10	ND		11/05/92
4-Chlorophenyl-phenylether	ug/L	10	ND		11/05/92
Fluorene	ug/L	10	ND		11/05/92
4-Nitroaniline	ug/L	50	ND		11/05/92
4,6-Dinitro-2-methylphenol	ug/L	50	ND		11/05/92
n-Nitrosodiphenylamine	ug/L	10	ND		11/05/92
4-Bromophenyl-phenylether	ug/L	10	ND		11/05/92
Hexachlorobenzene	ug/L	10	ND		11/05/92
Pentachlorophenol	ug/L	10	ND		11/05/92
Phenanthrene	ug/L	10	ND		11/05/92
Anthracene	ug/L	10	ND		11/05/92
Di-n-butylphthalate	ug/L	10	ND		11/05/

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November 15, 1992
PACE Project Number: 721026509

Client Reference: 92-2050-02

PACE Sample Number: 75 0149397
Date Collected: 10/26/92
Date Received: 10/26/92
Client Sample ID: SM-11

Parameter	Units	MDL		METHOD	DATE ANALYZED
ORGANIC ANALYSIS					
SEMI-VOLATILES				625	
Fluoranthene	ug/L	10	ND		11/05/92
Benzidine	ug/L	50	ND		11/05/92
Pyrene	ug/L	10	ND		11/05/92
Butylbenzylphthalate	ug/L	10	ND		11/05/92
Benzo(a)anthracene	ug/L	10	ND		11/05/92
Chrysene	ug/L	10	ND		11/05/92
bis(2-Ethylhexyl)phthalate	ug/L	10	ND		11/05/92
Di-n-octylphthalate	ug/L	10	ND		11/05/92
Benzo(b)fluoranthene	ug/L	10	ND		11/05/92
Benzo(k)fluoranthene	ug/L	10	ND		11/05/92
Benzo(a)pyrene	ug/L	10	ND		11/05/92
Indeno(1,2,3-cd)pyrene	ug/L	10	ND		11/05/92
Dibenzo(a,h)anthracene	ug/L	10	ND		11/05/92
Benzo(g,h,i)perylene	ug/L	10	ND		11/05/92
2-Fluorophenol (Surrog. Recovery)	%		62.6		11/05/92
Phenol-d5 (Surrog. Recovery)	%		49.9		11/05/92
Nitrobenzene-d5 (Surrog. Recovery)	%		60.6		11/05/92
2-Fluorobiphenyl (Surrog. Recovery)	%		91.7		11/05/92
2,4,6-Tribromophenol (Surrog. Recovery)	%		73.4		11/05/92
Terphenyl-d14 (Surrog. Recovery)	%		82.7		11/05/92

These data have been reviewed and are approved for release.

Kenneth D. Faust,
Southern California Regional Director

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Client Reference: 92-2050-02

MDL	Method Detection Limit
ND	Not detected at or above the MDL.

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QUALITY CONTROL DATA

November 15, 1992
PACE Project Number: 721026509

Client Reference: 92-2050-02

Gravimetric-Total Dissolved Solids
Batch: 75 03787
Samples: 75 0149397

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750149397 SM-11	Duplicate of 75 0149397	RPD
Gravimetric-Total Dissolved Solids	mg/L	10	ND	1250	1230	2%

SPIKE:

Parameter	Units	MDL	750149397 SM-11	Spike	Spike Recv
Gravimetric-Total Dissolved Solids	mg/L	10	1250	1000	95%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
Gravimetric-Total Dissolved Solids	mg/L	10	1000	97%

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QUALITY CONTROL DATA

November 15, 1992
PACE Project Number: 721026509

Client Reference: 92-2050-02

ICP Copper
Batch: 75 03918
Samples: 75 0149397

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750149397 SM-11	Duplicate of 75 0149397	RPD
ICP Antimony	mg/L	0.2	ND	ND	ND	NC
ICP Beryllium	mg/L	0.002	ND	ND	ND	NC
ICP Cadmium	mg/L	0.006	ND	ND	ND	NC
ICP Chromium	mg/L	0.004	ND	0.036	0.038	5%
ICP Copper	mg/L	0.005	ND	0.031	0.041	28%
ICP Lead	mg/L	0.05	ND	ND	ND	NC
ICP Nickel	mg/L	0.02	ND	0.04	0.03	29%
ICP Silver	mg/L	0.02	ND	ND	0.02	NC
ICP Zinc	mg/L	0.007	ND	0.12	0.12	[illegible]

SPIKE:

Parameter	Units	MDL	750149397 SM-11	Spike	Spike Recv
ICP Antimony	mg/L	0.2	ND	0.5	102%
ICP Beryllium	mg/L	0.002	ND	0.5	98%
ICP Cadmium	mg/L	0.006	ND	0.5	96%
ICP Chromium	mg/L	0.004	0.036	0.5	95%
ICP Copper	mg/L	0.005	0.031	0.5	94%
ICP Lead	mg/L	0.05	ND	0.5	102%
ICP Nickel	mg/L	0.02	0.04	0.5	92%
ICP Silver	mg/L	0.02	ND	0.5	90%
ICP Zinc	mg/L	0.007	0.12	0.5	94%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
ICP Antimony	mg/L	0.2	0.5	96%
ICP Beryllium	mg/L	0.002	0.5	98%
ICP Cadmium	mg/L	0.006	0.5	94%
ICP Chromium	mg/L	0.004	0.5	96%
ICP Copper	mg/L	0.005	0.5	96%
ICP Lead	mg/L	0.05	0.5	100%

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QUALITY CONTROL DATA

November 15, 1992
PACE Project Number: 721026509

Client Reference: 92-2050-02

ICP Copper
Batch: 75 03918
Samples: 75 0149397

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
ICP Nickel	mg/L	0.02	0.5	96%
ICP Silver	mg/L	0.02	0.5	90%
ICP Zinc	mg/L	0.007	0.5	86%

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QUALITY CONTROL DATA

November 15, 1992
PACE Project Number: 721026509

Client Reference: 92-2050-02

Specific Conductance
Batch: 75 03783
Samples: 75 0149397

SAMPLE DUPLICATE:

Parameter	Units	MDL	750149397 SM-11	Duplicate of 75 0149397	RPD
Specific Conductance	umhos/cm	10	1650	1630	1%

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QUALITY CONTROL DATA

November 15, 1992
PACE Project Number: 721026509

Client Reference: 92-2050-02

TTLC, GFAA Arsenic
Batch: 75 03906
Samples: 75 0149397

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750151936	Duplicate of 75 0151936	RPD
TTLC, GFAA Arsenic	mg/L	0.0025	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750151936	Spike	Spike Recv
TTLC, GFAA Arsenic	mg/L	0.0025	ND	0.03	87%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
TTLC, GFAA Arsenic	mg/L	0.0025	0.03	97%

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QUALITY CONTROL DATA

November 15, 1992
PACE Project Number: 721026509

Client Reference: 92-2050-02

TTLC, GFAA Selenium
Batch: 75 03907
Samples: 75 0149397

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750151936	Duplicate of 75 0151936	RPD
TTLC, GFAA Selenium	mg/L	0.0025	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750151936	Spike	Spike Recv
TTLC, GFAA Selenium	mg/L	0.0025	ND	0.03	93%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
TTLC, GFAA Selenium	mg/L	0.0025	0.03	83%

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QUALITY CONTROL DATA

November 15, 1992
PACE Project Number: 721026509

Client Reference: 92-2050-02

TTLC, GFAA Thallium
Batch: 75 03908
Samples: 75 0149397

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750151936	Duplicate of 75 0151936	RPD
TTLC, GFAA Thallium	mg/L	0.0025	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750151936	Spike	Spike Recv
TTLC, GFAA Thallium	mg/L	0.0025	ND	0.03	93%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
TTLC, GFAA Thallium	mg/L	0.0025	0.03	97%

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QUALITY CONTROL DATA

November 15, 1992
PACE Project Number: 721026509

Client Reference: 92-2050-02

Titrimetric-Total Sulfide
Batch: 75 03794
Samples: 75 0149397

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750149397 SM-11	Duplicate of 75 0149397	RPD
Titrimetric-Total Sulfide	mg/L	0.5	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750149397 SM-11	Spike	Spike Recv
Titrimetric-Total Sulfide	mg/L	0.5	ND	11.25	107%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
Titrimetric-Total Sulfide	mg/L	0.5	11.25	107%

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QUALITY CONTROL DATA

November 15, 1992
PACE Project Number: 721026509

Client Reference: 92-2050-02

pH
Batch: 75 03784
Samples: 75 0149397

SAMPLE DUPLICATE:

Parameter	Units	MDL	750149397 SM-11	Duplicate of 75 0149397	RPD
pH	Units	2.0	7.4	7.4	0%

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QUALITY CONTROL DATA

November 15, 1992
PACE Project Number: 721026509

Client Reference: 92-2050-02

TITLE 22 TTLC MERCURY BY CV
Batch: 75 03886
Samples: 75 0149397

METHOD BLANK AND SAMPLE DUPLICATE:

Parameter	Units	MDL	Method Blank	750149397 SM-11	Duplicate of 75 0149397	RPD
TTLC, CV Mercury	mg/L	0.0003	ND	ND	ND	NC

SPIKE:

Parameter	Units	MDL	750149397 SM-11	Spike	Spike Recv
TTLC, CV Mercury	mg/L	0.0003	ND	0.005	100%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
TTLC, CV Mercury	mg/L	0.0003	0.005	100%

Dr. Ram

QUALITY CONTROL DATA

November 15, 1992
PACE Project Number: 721026509

Client Reference: 92-2050-02

SEMI-VOLATILES
Batch: 75 03939
Samples: 75 0149397

METHOD BLANK:

Parameter	Units	MDL	Method Blank
n-Nitrosodimethylamine	ug/L	10	ND
Phenol	ug/L	10	ND
Aniline	ug/L	10	ND
bis(2-Chloroethyl)ether	ug/L	10	ND
2-Chlorophenol	ug/L	10	ND
1,3-Dichlorobenzene	ug/L	10	ND
1,4-Dichlorobenzene	ug/L	10	ND
Benzyl alcohol	ug/L	10	ND
1,2-Dichlorobenzene	ug/L	10	ND
2-Methylphenol	ug/L	10	ND
bis(2-Chloroisopropyl)ether	ug/L	10	ND
4-Methylphenol	ug/L	10	ND
n-Nitroso-di-n-propylamine	ug/L	10	ND
Hexachloroethane	ug/L	10	ND
Nitrobenzene	ug/L	10	ND
Isophorone	ug/L	10	ND
2-Nitrophenol	ug/L	10	ND
2,4-Dimethylphenol	ug/L	10	ND
Benzoic acid	ug/L	50	ND
bis(2-Chloroethoxy)methane	ug/L	10	ND
2,4-Dichlorophenol	ug/L	10	ND
1,2,4-Trichlorobenzene	ug/L	10	ND
Naphthalene	ug/L	10	ND
4-Chloroaniline	ug/L	20	ND
Hexachlorobutadiene	ug/L	10	ND
4-Chloro-3-methylphenol	ug/L	10	ND
2-Methylnaphthalene	ug/L	10	ND
Hexachlorocyclopentadiene	ug/L	10	ND
2,4,6-Trichlorophenol	ug/L	10	ND
2,4,5-Trichlorophenol	ug/L	10	ND
2-Chloronaphthalene	ug/L	50	ND
2-Nitroaniline	ug/L	50	ND

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QUALITY CONTROL DATA

November 15, 1992
PACE Project Number: 721026509

Client Reference: 92-2050-02

SEMI-VOLATILES
Batch: 75 03939
Samples: 75 0149397

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Dimethylphthalate	ug/L	10	ND
Acenaphthylene	ug/L	10	ND
2,6-Dinitrotoluene	ug/L	10	ND
3-Nitroaniline	ug/L	50	ND
Acenaphthene	ug/L	10	ND
2,4-Dinitrophenol	ug/L	50	ND
4-Nitrophenol	ug/L	50	ND
Dibenzofuran	ug/L	10	ND
2,4-Dinitrotoluene	ug/L	10	ND
Diethylphthalate	ug/L	10	ND
4-Chlorophenyl-phenylether	ug/L	10	ND
Fluorene	ug/L	10	ND
4-Nitroaniline	ug/L	50	ND
4,6-Dinitro-2-methylphenol	ug/L	50	ND
n-Nitrosodiphenylamine	ug/L	10	ND
4-Bromophenyl-phenylether	ug/L	10	ND
Hexachlorobenzene	ug/L	10	ND
Pentachlorophenol	ug/L	10	ND
Phenanthrene	ug/L	10	ND
Anthracene	ug/L	10	ND
Di-n-butylphthalate	ug/L	10	ND
Fluoranthene	ug/L	10	ND
Benzidine	ug/L	50	ND
Pyrene	ug/L	10	ND
Butylbenzylphthalate	ug/L	10	ND
Benzo(a)anthracene	ug/L	10	ND
Chrysene	ug/L	10	ND
bis(2-Ethylhexyl)phthalate	ug/L	10	ND
Di-n-octylphthalate	ug/L	10	ND
Benzo(b)fluoranthene	ug/L	10	ND
Benzo(k)fluoranthene	ug/L	10	ND
Benzo(a)pyrene	ug/L	10	ND

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QUALITY CONTROL DATA

November 15, 1992
PACE Project Number: 721026509

Client Reference: 92-2050-02

SEMI-VOLATILES
Batch: 75 03939
Samples: 75 0149397

METHOD BLANK:

Parameter		Units	MDL	Method Blank
Indeno(1,2,3-cd)pyrene		ug/L	10	ND
Dibenzo(a,h)anthracene		ug/L	10	ND
Benzo(g,h,i)perylene		ug/L	10	ND
2-Fluorophenol	(Surrog. Recovery	%		71.0
Phenol-d5	(Surrog. Recovery	%		58.1
Nitrobenzene-d5	(Surrog. Recovery	%		66.6
2-Fluorobiphenyl	(Surrog. Recovery	%		89.0
2,4,6-Tribromophenol	(Surrog. Recovery	%		59.7
Terphenyl-d14	(Surrog. Recovery	%		117

LABORATORY CONTROL SAMPLE AND CONTROL SAMPLE DUPLICATE:

Parameter	Units	MDL	Reference Value	Recv	Dupl Recv	RPD
Phenol	ug/L	10	100.00	59%	60%	1%
2-Chlorophenol	ug/L	10	100.0	63%	66%	4%
1,4-Dichlorobenzene	ug/L	10	50.0	72%	74%	2%
n-Nitroso-di-n-propylamine	ug/L	10	50.0	47%	49%	4%
1,2,4-Trichlorobenzene	ug/L	10	50.0	69%	72%	4%
4-Chloro-3-methylphenol	ug/L	10	100.0	58%	63%	8%
Acenaphthene	ug/L	10	50.0	77%	82%	6%
4-Nitrophenol	ug/L	50	100.0	32%	28%	13%
2,4-Dinitrotoluene	ug/L	10	50.0	64%	56%	13%
Pentachlorophenol	ug/L	10	100.0	75%	73%	2%
Pyrene	ug/L	10	50.0	113%	115%	1%

Not enough sample received for matrix spike and matrix spike duplicate.

REPORT OF LABORATORY ANALYSIS

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QUALITY CONTROL DATA

November 15, 1992
PACE Project Number: 721026509

Client Reference: 92-2050-02

VOLATILE ORGANICS
Batch: 75 03898
Samples: 75 0149397

METHOD BLANK:

Parameter	Units	MDL	Method Blank
1,1,2-Trichlor-1,2,2-trifluoroethane	ug/L	10	ND
Chloromethane	ug/L	10	ND
Vinyl chloride	ug/L	10	ND
Bromomethane	ug/L	10	ND
Chloroethane	ug/L	10	ND
Trichlorofluoromethane	ug/L	10	ND
1,1-Dichloroethene	ug/L	5	ND
Acetone	ug/L	50	ND
Carbon disulfide	ug/L	5	ND
Methylene chloride	ug/L	5	ND
trans-1,2-Dichloroethene	ug/L	5	ND
1,1-Dichloroethane	ug/L	5	ND
2-Butanone	ug/L	50	ND
cis-1,2-Dichloroethene	ug/L	5	ND
Chloroform	ug/L	5	ND
1,2-Dichloroethane	ug/L	5	ND
1,1,1-Trichloroethane	ug/L	5	ND
Carbon tetrachloride	ug/L	5	ND
Benzene	ug/L	5	ND
Trichloroethene	ug/L	5	ND
1,2-Dichloropropane	ug/L	5	ND
Bromodichloromethane	ug/L	5	ND
cis-1,3-Dichloropropene	ug/L	5	ND
trans-1,3-Dichloropropene	ug/L	5	ND
1,1,2-Trichloroethane	ug/L	5	ND
Dibromochloromethane	ug/L	5	ND
Bromoform	ug/L	5	ND
4-Methyl-2-pentanone	ug/L	50	ND
Toluene	ug/L	5	ND
2-Hexanone	ug/L	50	ND
1,1,2,2-Tetrachloroethane	ug/L	5	ND
Tetrachloroethene	ug/L	5	ND

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QUALITY CONTROL DATA

November 15, 1992
PACE Project Number: 721026509

Client Reference: 92-2050-02

VOLATILE ORGANICS
Batch: 75 03898
Samples: 75 0149397

METHOD BLANK:

Parameter	Units	MDL	Method Blank
Chlorobenzene	ug/L	5	ND
Ethylbenzene	ug/L	5	ND
Styrene	ug/L	5	ND
Xylenes (Total)	ug/L	5	ND
1,3-Dichlorobenzene	ug/L	5	ND
1,4-Dichlorobenzene	ug/L	5	ND
1,2-Dichlorobenzene	ug/L	5	ND
1,2-Dichloroethane-d4 (Surrog. Recovery	%		96.1
Toluene-d8 (Surrog. Recovery	%		95.6
4-Bromofluorobenzene (Surrog. Recovery	%		102

SPIKE AND SPIKE DUPLICATE:

Parameter	Units	MDL	750149397 SM-11	Spike	Spike Recv	Spike Dupl Recv	RPD
1,1-Dichloroethene	ug/L	5	ND	50	98%	84%	15%
Benzene	ug/L	5	ND	50	98%	102%	4%
Trichloroethene	ug/L	5	ND	50	102%	104%	1%
Toluene	ug/L	5	ND	50	113%	107%	5%
Chlorobenzene	ug/L	5	ND	50	102%	99%	2%

LABORATORY CONTROL SAMPLE:

Parameter	Units	MDL	Reference Value	Recv
1,1-Dichloroethene	ug/L	5	50	76%
Benzene	ug/L	5	50	94%
Trichloroethene	ug/L	5	50	97%
Toluene	ug/L	5	50	94%
Chlorobenzene	ug/L	5	50	101%

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FOOTNOTES
for pages 7 through 21

November 15, 1992
PACE Project Number: 721026509

Client Reference: 92-2050-02

MDL	Method Detection Limit
NC	No calculation due to value below detection limit.
ND	Not detected at or above the MDL.
RPD	Relative Percent Difference

APPENDIX G

OTHER LABORATORY ANALYSES

APPENDIX G
OTHER LABORATORY ANALYSES

G.1 X-RAY DIFFRACTION

X-ray diffraction is used to identify particles to about 10^{-8}mm (1 angstrom = 10^{-7}mm). In the diffractometer, a powered sample mounted on a glass slide is rotated at a fixed angular rate in a x-ray beam. A recording device rotates around the same axis, detecting the diffracted x-rays. The detected impulse is transmitted and recorded on a strip chart. Expressions are available relating wave length of x-ray radiation and the angle of rotation to the spacing of a particular set of crystal planes, from which the mineral is identified.

Samples were submitted to University of Utah Research Institute, Earth Science Laboratory for analyses. The results are provided in Table 5-9. The method for semi-quantitative x-ray diffraction (XRD) analysis of bulk samples is derived from the extensive methods outlined in USGS Bulletin #1563. The method performed includes sample preparation by hand-grinding in acetone to <325 mesh, x-ray diffraction scan from 2 to 65°2θ at 2°2θ per minute, glycolation and scan from 2 to 10°2θ, identification of minerals present and determination of the approximate weight percentage of each mineral.

The method for semi-quantitative x-ray diffraction analysis of clay mineralogy includes extraction, from bulk samples of the $<2\mu$ (or $<5\mu$) fraction by light crushing, sonic disaggregation in de-ionized water, Stokes Law settling and centrifugation. The resulting slurry, sedimented on glass slides, is x-rayed at 1°2θ per minute following air-drying (to 37°2θ), vapor glycolation of 60°C for 24 hours (2 to 22°2θ), and if necessary, heating to 250°C for one hour (2 to 15°2θ) and heating to 550°C to one hour (2 to 15°2θ). Clay minerals are identified and their approximate weight percentages (of the total layer silicate fraction) are determined by comparison of selected peak intensities with those generated by mixtures of standard clay minerals in known percentages. Verification analysis was conducted by Dr. Robert E. Winchell for one sample. A copy of his letter dated January 11, 1993 is included in this appendix.

G.2 THIN SECTION ANALYSES

Thin sections of representative rock core samples were analyzed microscopically. The thin sections were prepared by San Diego Petrographics, Escondido, California. The thin section was prepared by mounting a trimmed slab of rock on to a standard 27 x 46 glass slide. The mounted slab of rock was ground to a uniform thickness of 0.03mm, polished and covered with a thin piece of glass. The rock slab was impregnated with resin prior to grinding to bind the sample together if the rock was poorly cemented, highly fractured, or porous. A petrographic polarizing microscope was used to examine each thin section.

G.3 MICROPALEONTOLOGY

Micropaleontologic analyses were conducted by Micropaleo Consultants, Inc. in Encinitas, California for microfossil and pollen identification. The results of the analyses are presented in their letter dated December 8, 1992.

Detailed descriptions of each thin section are provided in this Appendix.

X-RAY DIFFRACTION RESULTS BY DR. ROBERT E. WINCHELL

DR. ROBERT E. WINCHELL
6411 WEBER CIRCLE
HUNTINGTON BEACH, CA 92647

January 11, 1993

Mr. Matthew C. Curtis
Senior Staff Geologist
The Earth Technology Corporation
13900 Alton Parkway, Suite 120
Irvine, CA 92718

Dear Mr. Curtis:

I have now been able to compete the work on the sample SM-9-149-664.9 for which you wished additional x-ray work done. The sample was described as a basalt core obtained as part of your Project 92-2050-02 from the Metro Red Line, Segment 3.

A hand specimen examination of the core indicates that does have the general appearance of a basalt but I would describe it as an altered, possibly deuterically altered and/or metamorphosed, basalt or gabbro breccia. It appears to be of somewhat variable composition and has thin white veinlets and stringers running through it, filling what appear to be fractures in the material. The material also shows slickensides.

You also provided information concerning diffraction work done by the University of Utah Research Institute (UURI) concerning this sample.

I agreed to run up to two samples, as necessary, of the core material provided. Hand specimen examination of the material indicated that the bulk of the material seemed to be composed of a black and a olive green material, exclusive of the material in the veinlets. Consequently, I examined the two former materials by x-ray diffraction. I did not examine the material in the veinlets by x-ray diffraction but an acid test indicates that that material is predominantly, if not completely, calcite.

Standard smear mounts of the black and olive green materials were prepared by routine methods. Oriented slides of the materials, as commonly are used for routine identification of clay-fraction minerals, were not prepared, since it did not seem necessary on the basis of the information obtained from the standard smear mounts. Based on the result obtained, each of the two samples prepared were glycolated for approximately 22 hours to determine the presence or absence of an expandable/contractible clay mineral.

The diffraction patterns obtained for these two materials are included. The G suffix to the chart number indicates the result obtained for the respective sample after glycolation.

Analysis of these patterns provided the following results:

1. The olivine green material (diffraction charts 1 and 1G) is composed of analcite and what I would take as a mixed layer, predominantly smectitic clay mineral. Though it would be necessary to correct for absorption differences in order to provide quantitative results, the analcite appears to predominate with somewhat lesser amounts of the smectitic clay mineral.

2. The black material (diffraction charts 2 and 2G) seems to be completely composed of a mixed layer, nonexpandable/noncontractible clay mineral, perhaps a smectite-chlorite, though there may also be, allowing for absorption differences, minor to very minor serpentine present. Since nonintegral spacings are possible in these clays, it is not possible to indicate with surety whether the spacings at 6.6A., 4.6A. and 1.54A., among other possible diffractions, belong to the clay or not. I have checked for a number of common minerals which might be expected in a sample of the sort provided but have not been able to find any conclusive evidence of the presence of any of these.

With regard to the analyses made by UURI, I might make the following comments:

For the olivine green material:
1. I find no evidence of the presence of quartz in the materials I x-rayed, but since only a trace was indicated and the material is variable, I may not have had exactly the same material as they examined.

2. As for quartz, I did not observe the presence of calcite and perhaps for the same reason.

3. Vermiculite is a member of the smectite clay mineral group but has been differentiated on the basis of it higher cation-exchange capacity and its more limited expansion in water. Perhaps UURI has information to support this choice among the smectites, but I do not and did not examine the material in this regard. I have, therefore, considered it a member of the smectite group and, because of its failure to expand the 17A., to be a mixed layer clay with a predominant smectite composition.

4. Both analcite and a smectitic clay mineral are present as indicated for the UURI sample. Though, as indicated, I did not attempt corrections for absorption and did not use standards for comparison, a rough comparison of analcite peak heights for this sample to those for pure analcite run under the same conditions as the olivine green material indicates that there is much more than 11% analcite in the green material I examined. Again, since the material is somewhat variable, the material which I examined may be different that the UURI material, particularly if they used a random, general sample of the material in which the black material predominated.

The black material corresponds more closely to the preponderance of "vermiculite" indicated in the UURI results but does not appear to contain any analcite, perhaps for the same reason indicated above.

These x-ray results confirm the presence and abundance of analcite and a clay mineral or clay minerals of smectite composition in the rock. The UURI work seems to have been done on a grab sample of variable material which ranges in composition from predominantly if not almost completely analcite to almost completely a mixed layer clay. This is not unexpected, if one considers the geological provenance of this material.

You raised the question about what other determinative work might be done if the sample was not amenable to x-ray work. The thin section work is complementary and may provide some further substantiation of this composition for the analcite as well as information on other minerals which might be present. The textural information ought to be useful as well perhaps. If you require further substantiation of this and other mineralogy and about the clays and it is cost effective to have this information, the next step would be to obtain chemical information such as compositional and ion exchange information as might be provided, for instance, by scanning electron microscopy (SEM), energy dispersive analysis (EDAX) and ion exchange analysis.

I have attached an invoice for services as agreed.

If you have questions about this work or I can be of further assistance to you, please contact me at your convenience at (310) 985-4920.

Sincerely,

Robert E. Winchell

Robert E. Winchell
Registered Geologist #001035

THIN-SECTION DESCRIPTIONS

THIN SECTION DESCRIPTIONS

SM-2 (407.2' to 407.6')

Granite -- metamorphosed to greenschist grade. The rock includes quartz, orthoclase, plagioclase, kaersutite(?), muscovite, zeolite, sericite, and chlorite (penninite). Accessory phases include spinel, zircon, garnet and hematite(?). Quartz, orthoclase, plagioclase and kaersutite are ophitic. Chlorite is replacing kaersutite, and may also have replaced biotite. The feldspars are substantially altered to sericite, beginning along cleavages, so it is difficult to tell orthoclase from plagioclase. Muscovite (minor) occurs in a sheared form, so it is metamorphic, but it is not possible to tell what it replaced. A fibrous zeolite is replacing garnet. Indications of tectonic strain include the following; 1) a few through-going irregular fractures healed by chlorite, 2) kinked twin lamellae and partial recrystallization in plagioclase, and 3) ubiquitous undulose extinction in quartz. There is no particular planar or linear fabric evident in this section.

	%	
Quartz	20.2	
Orthoclase	14.4	
Plagioclase	5.3	
Kaersutite(?)		20.2 .
Chlorite (penninite)	6.2	
Sericite	24.5	
Muscovite	1.9	
Hematite(?)	3.8	
Spinel	0.5	
Zircon	<0.5	
Garnet	1.0	
Zeolite	2.0	

SM-3 (264.2' to 264.4')

Quartz monzonite (holocrystalline) including quartz, potassium feldspar (microcline?), plagioclase, biotite, and hornblende. Minor phases include spinel, zircon and hematite(?). Quartz, potassium feldspar and plagioclase are hypidiomorphic; biotite and hornblende are ophitic. The feldspars have minor to moderate alteration to sericite along cleavages; all other phases appear unaltered. Indications of tectonic strain include the following; 1) a few through-going irregular fractures, 2) frequent partially healed irregular intragranular fractures (not cleavage) and inclusion trains in feldspar, 3) occasional undulose extinction and recrystallization in quartz, 4) patchy recrystallization of plagioclase evidenced by disappearance of twin lamellae, and 5) limited grain-boundary recrystallization with interpenetration. There is no particular planar or linear fabric evident in the section although a planar fabric is evident in the core.

	%
Quartz	20.9
Potassium feldspar (microcline?)	33.0
Plagioclase	17.6
Biotite	7.9
Hornblende	17.7
Spinel	<0.5
Zircon	0.9
Hematite(?)	0.5
Sericite	0.5
Other	0.9

SM-3 (346.0' to 346.3')

Quartz monzonite (holocrystalline) including quartz, orthoclase, plagioclase, biotite, hornblende, and chlorite (penninite). Minor phases include spinel, zircon and hematite(?). Quartz, orthoclase and plagioclase are hypidiomorphic; biotite and hornblende are ophitic. Chlorite is a replacement of most of the biotite and some of the hornblende. The feldspars have minor to moderate alteration to sericite along cleavages. Indications of tectonic strain include the following; 1) a few through-going irregular fractures healed by chlorite and feldspar, 2) frequent partially healed irregular intragranular fractures (not cleavage) and inclusion trains in feldspar and quartz, 3) frequent undulose extinction and recrystallization in quartz, 4) kinked twin lamellae, crushing and partial recrystallization of plagioclase, and 5) widespread grain-boundary recrystallization with interpenetration. Hornblende has a weak linear fabric in this section.

	%
Quartz	24.6
Orthoclase	28.8
Plagioclase	26.7
Biotite	<0.4
Hornblende	12.7
Chlorite (penninite)	5.1
Spinel	0.4
Zircon	<0.4
Hematite(?)	0.8
Other	0.8

SM-4 (363.8' to 364.0')

Contact between quartz monzonite and basalt. A fracture at the contact is coated with calcite and chlorite.

Quartz monzonite including quartz, orthoclase, plagioclase, kaersutite(?), sericite, and chlorite (penninite). Minor phases include spinel, and hematite(?). Quartz, orthoclase, plagioclase and kaersutite are hypidiomorphic. Chlorite is replacing kaersutite, and may also have replaced biotite. The feldspars are moderately to highly altered to sericite, beginning along cleavages. Indications of tectonic strain include the following; 1) frequent partially healed irregular intragranular fractures (not cleavage) and inclusion trains in feldspar and quartz, 2) extensive undulose extinction and recrystallization in quartz, 4) a few through going irregular fractures healed with chlorite and quartz, and 4) frequent grain-boundary recrystallization with interpenetration. There is no particular planar or linear fabric evident in this section.

	%
Quartz	31.0
Orthoclase	13.4
Plagioclase	7.0
Kaersutite	7.0
Chlorite (penninite)	12.7
Sericite	28.9
Hematite(?)	<0.7
Spinel	<0.7

Basalt (hydrothermally altered) including plagioclase, chlorite, aegerine-augite, antigorite, and accessory pyrite(?) and garnet. Plagioclase (which appears to have a trimodal distribution of crystal sizes) averages about 30% replacement by antigorite. The groundmass is wholly altered to antigorite. Aegerine-augite is almost entirely replaced by chlorite. There is a chilled margin (fewer phenocrysts) at the contact with the quartz monzonite.

	%
Plagioclase	15.3
Chlorite	16.6
Aegerine-augite	2.5
Antigorite	65.0
Pyrite(?)	0.6
Garnet	<0.6

SM-4 (418.1' to 418.6')

Granodiorite (holocrystalline) including quartz, orthoclase, plagioclase, biotite, hornblende, pyroxene (relict) and chlorite (penninite). Minor phases include spinel, zircon, hematite and sericite. Quartz, orthoclase and plagioclase are hypidiomorphic; biotite and hornblende are ophitic. Chlorite is a replacement of most of the biotite and pyroxene and some of the hornblende. The feldspars have minor to moderate alteration to sericite along cleavages. Indications of tectonic strain include the following; 1) patchy recrystallization of plagioclase evidenced by disappearance of twin lamellae, 2) frequent partially healed irregular intragranular fractures (not cleavage) and inclusion trains in feldspar and quartz, 3) extensive undulose extinction and recrystallization in quartz, 4) kinked twin lamellae, crushing and partial recrystallization of plagioclase, and 5) widespread grain-boundary recrystallization with interpenetration. Hornblende-crystal alignment causes a moderate linear fabric in this section.

	%
Quartz	32.8
Orthoclase	19.9
Plagioclase	25.4
Biotite	5.5
Hornblende	6.0
Chlorite (penninite)	3.0
Spinel	0.5
Zircon	<0.5
Hematite(?)	0.5
Sericite	5.0
Pyroxene	1.5

SM-4 (491' to 491.4')

Hydrothermally altered basalt including plagioclase, antigorite, prochlorite, olivine(?) and hematite. Plagioclase averages about 20% replaced by antigorite and prochlorite. Olivine(?) is only locally preserved as relics being replaced by antigorite and pyrite. The groundmass is wholly replaced by antigorite. The rock is crisscrossed by a network of fine, irregular fractures and shears, along which the transition to antigorite is more pronounced. Much of the plagioclase, particularly the larger crystals, has undulose extinction, indicating strain.

	%
Plagioclase	12.9
Antigorite	36.7
Prochlorite	47.6
Olivine(?)	1.4
Hematite	1.4

SM-5 (555.7' to 556.0)

Lithic graywacke with two interbeds of tuff; both are metamorphosed to chlorite grade.

Lithic graywacke including angular to subangular, fine to coarse-sand sized detrital grains of quartz, orthoclase and plagioclase, with subrounded fine-gravel sized rock fragments. The matrix has been metamorphosed to chlorite. Magnetite is present as detrital grains with overgrowths. Chlorite and minor calcite appear to be the cement. Possible effects of deformation are limited to undolose extinction in some quartz grains.

	%
Quartz	25.2
Orthoclase	6.1
Plagioclase	4.8
Chlorite	46.9
Magnetite	2.7
Rock fragments	12.9
Calcite	1.4

Tuff -- probably originally a crystal-vitric tuff -- including plagioclase, chlorite, calcite and magnetite. Chlorite is replacing plagioclase (along cleavages), but is probably principally a replacement for the vitric components. Calcite appears to be replacing plagioclase. Magnetite appears to be secondary.

	%
Plagioclase	26.9
Chlorite	68.3
Magnetite	<0.7
Calcite	4.8

SM-5 (605.8' to 606.3')

Mylonite incorporating two lithologies from the albite-epidote-hornfels facies. One side of the mylonite is a quartz-epidote rock with accessory pyrite. The epidote appears to have comprised very small remnant cores of epidote(?) surrounded by much larger rims of clinozoisite(?) (iron-free epidote). Quartz, epidote and clinozoisite are finely fractured and sheared. The other side of the mylonite is a quartz-albite-chlorite rock with accessory epidote(?) and pyrite; the quartz, albite and epidote are also finely fractured and sheared. Chlorite has crystallized along the fractures and shears. A few calcite-healed fractures cross the section.

	%
Quartz	31.9
Albite	2.4
Epidote(?)	6.3
Clinozoisite(?)	36.7
Chlorite	21.7
Pyrite	1.0
Calcite	<0.5

SM-6 (727.5' to 727.8')

Quartz monzonite -- crushed and metamorphosed to greenschist grade. The rock includes quartz, orthoclase, plagioclase, kaersutite(?), and chlorite (penninite and prochlorite). Minor phases include, zircon, hematite(?) and clay. Original igneous textures are almost entirely masked by cataclasis, replacement and recrystallization. Based on other thin-sections in the suite, chlorite is likely to be principally a replacement of biotite, and also appears to be replacing kaersutite(?). The feldspars have minor to moderate penetrative alteration to sericite. Some hematite(?) appears to be altered with limonite fringes. Cataclastic effects (in order of decreasing frequency) include 1) throughgoing zones of crushed, brecciated and healed feldspar and quartz, 2) healed enechalon microfractures, 3) throughgoing chlorite-filled irregular fractures (predating the crushed zones), 4) kinked twin lamellae, crushing and partial recrystallization of plagioclase, and 5) grain-boundary recrystallization with interpenetration. Chlorite veins give the rock a moderate planar fabric.

	%	
Quartz	19.4	
Orthoclase	21.3	
Plagioclase	12.6	
Kaersutite(?)		1.5
Penninite	14.6	
Prochlorite	3.4	
Zircon	<0.5	
Hematite(?)	5.8	
Sericite	21.3	

SM-7 (303' to 303.7')

Feldspathic graywacke including angular to subangular detrital grains of orthoclase, plagioclase, quartz (vein and igneous varieties), biotite, and pyrite in a matrix of cementing montmorillonite. Pyrite also occurs locally as a precipitated cement. The sand-size fraction is moderately sorted. Prochlorite and biotite are being replaced by montmorillonite. Deformation -- which may be due simply to consolidation -- is evidenced by 1) slight dissolution and penetration at sand grain contacts, 2) bent biotite grains, 3) undulose extinction in feldspar grains, and 4) quartz grains that have been fractured and pulled-apart. Quartz and feldspar are fresh.

	%
Plagioclase	2.4
Orthoclase	19.7
Quartz	45.2
Biotite	4.8
Pyrite	<0.5
Montmorillonite	26.9
Porosity	1.0

SM-7 (353.9' to 354.2')
Lithic graywacke (poorly sorted) composed of silt- to fine sand-sized subrounded to subangular quartz, biotite, feldspar and sericite grains, and medium to coarse sand-sized rounded to subrounded rock fragments. The rock fragments are principally orthoquartzite, quartzite and quartz-rich metasedimentary rocks; quartzofeldspathic igneous rocks and basic igneous rocks are less common. Sericite appears to be the cementing material. The section contains minor secondary porosity, likely due to dissolution of sericite. A few fractured grains of coarse sand appear to be the only deformation effects. The minerals appear fresh.

	%	
Quartz grains		30.9
Biotite	2.4	
Sericite	16.4	
Feldspar grains	13.0	
Rock fragments very high in quartz	12.6	
Other rock fragments	19.8	
Porosity	4.5	
Pyrite	0.5	

SM-7 (702.5' to 702.9')
Subgraywacke (poorly sorted) composed of silt- to fine sand-sized subrounded to subangular quartz, biotite, feldspar and sericite grains, and medium-sand to fine gravel-sized rounded to subrounded rock fragments. The rock fragments are principally orthoquartzite, quartzite and quartz-rich metasedimentary rocks; quartzofeldspathic igneous rocks and basic igneous rocks are less common. Sericite appears to be the cementing material. The section contains minor secondary porosity, likely due to dissolution of sericite. A few throughgoing planar

fractures, including one which offsets a quartzite pebble, appear to be the only deformation effects. The minerals appear fresh. The section appears to be largely a sample of the matrix of a coarse conglomerate; large clasts are evident in the core.

	%	
Quartz grains		16.3
Biotite	1.9	
Sericite	13.5	
Feldspar grains	16.8	
Rock fragments very high in quartz	3.4	
Other rock fragments	38.9	
Porosity	9.1	

SM-8 (345.0' to 345.4')
Scoriaceous basalt (hydrothermally altered) including plagioclase, chlorite (prochlorite and clinochlore[?]), analcite, vermiculite(?), antigorite, and accessory hematite(?). Plagioclase averages about 70% replacement by antigorite. The groundmass is wholly altered to antigorite. Several generations or species of chlorite occur: 1) as a replacement for clinopyroxene (prochlorite), 2) as a replacement for pyroxene (clinochlore[?]), 3) filling a few irregular fractures and, 4) filling vesicles (prochlorite). Analcite is also a vesicle filling, and vermiculite(?) is a primary lining of several vesicles. Vesicles comprise about 40% of the slide. The only evidence of strain is a few irregular, chlorite-healed fractures.

	%
Plagioclase	7.2
Prochlorite	34.0
Clinochlore(?)	1.9
Analcite	6.2
Vermiculite(?)	4.3
Antigorite	45.9
Hematite(?)	0.9

SM-8 (442.2' to 442.5')
Basalt (hydrothermally altered) including plagioclase, chlorite, analcite, antigorite, and accessory pyrite(?). Plagioclase averages about 10% replacement by antigorite. The groundmass is wholly altered to antigorite. Several generations or species of chlorite occur: 1) as a replacement for clinopyroxene, 2) as a replacement for olivine(?), and 3) filling a few vugs and a few irregular fractures. Analcite is a filling with chlorite in a few irregular fractures.

	%
Plagioclase	15.9
Chlorite	37.3
Analcite	2.0
Antigorite	42.8
Pyrite(?)	1.5
Other	0.5

SM-8 (474.8' to 475.1')

Basalt including plagioclase, glass, tridymite, chalcedony, fayalite, and accessory pyrite. This section is quite unlike the others in that 1) it has no signs of hydrothermal alteration and 2) the groundmass is glass. Chalcedony is precipitated in several vugs, and the glass adjacent to the vugs is progressively altered to tridymite. A few cracks (with tridymite alteration) appear to be due to aging of the glass rather than tectonic origins.

	%	
Plagioclase	15.9	
Fayalite	7.2	
Chalcedony	2.4	
Glass	15.9	
Tridymite	58.0	
Pyrite(?)	<0.5	
Other		0.5

SM-8 (568.8' to 569.0')

Subgraywacke (poorly sorted) composed of fine to medium sand-sized angular to subangular quartz, feldspar grains, fine detrital pyrite grains, and medium to coarse sand-sized subangular to subrounded rock fragments cemented by calcite. The rock fragments include quartzite, quartz-rich metasedimentary rock, shell fragments, quartzofeldspathic igneous rocks and basic igneous rock. Locally, the quartz and feldspar are being replaced by calcite. Pyrite has secondary overgrowths. Deformation effects are limited to fracturing and pulling-apart of quartz and feldspar grains.

	%	
Quartz grains		27.7
Calcite	27.7	
Feldspar grains	17.5	
Rock fragments very high in quartz	13.1	

Other rock fragments	12.1
Pyrite	1.0
Porosity	0.5
Other	0.5

SM-8 (720.1' to 720.4')
Feldspathic graywacke including angular to subangular detrital grains of orthoclase, plagioclase, quartz (vein and igneous varieties), muscovite, biotite and pyrite and a small amount of montmorillonite. Montmorillonite (possibly along with silica) appears to be the cementing agent. Pyrite also occurs locally as a precipitated cement. The sand-size fraction is moderately sorted. Biotite is being replaced by montmorillonite. About 25% of the orthoclase grains show minor sericitization (probably predepositional). Otherwise, quartz and feldspar are fresh. Deformation -- which may be due simply to consolidation -- is evidenced by 1) slight dissolution and penetration at sand grain contacts, 2) bent biotite grains, and 3) undulose extinction in feldspar and quartz grains.

	%
Plagioclase	6.3
Orthoclase	19.3
Quartz	46.9
Biotite	1.4
Muscovite	2.4
Pyrite	2.9
Montmorillonite	20.3
Porosity	0.5

SM-8 (729.3' to 729.6')
Metamorphosed (chlorite grade) subarkose (poorly sorted) composed of silt- to medium sand-sized angular to subangular quartz, biotite, muscovite, feldspar and chlorite grains, and medium sand to medium gravel-sized subangular to subrounded rock fragments. The rock fragments are principally orthoquartzite, quartzite and quartz-rich metasedimentary rocks; quartzofeldspathic igneous rocks and basic igneous rocks are less common. Chlorite, based on other thin-sections, has probably replaced sericite. The secondary porosity observed in other sections is here occluded by pyrite. Deformation-related features include 1) quartz and feldspar grains that have been fractured and pulled-apart, 2) undulose extinction in quartz, and 3) relatively common breakage and penetration at grain-to-grain contacts.

	%
Quartz grains	30.0

Biotite	1.0
Chlorite	3.9
Muscovite	<0.5
Feldspar grains	25.6
Rock fragments very high in quartz	1.9
Other rock fragments	36.2
Pyrite	0.5
Porosity	1.0

SM-8 (786.2' to 786.5')

Arkose including angular to subangular detrital grains of orthoclase, plagioclase, quartz (vein and igneous varieties), muscovite, biotite and pyrite and a small amount of montmorillonite. Montmorillonite (possibly along with silica) appears to be the cementing agent. Pyrite also occurs locally as a precipitated cement. The sand-size fraction is moderately sorted. Biotite is being replaced by montmorillonite. About 25% of the orthoclase grains show minor sericitization (probably predepositional). Otherwise, quartz and feldspar are fresh. Deformation -- which may be due simply to consolidation -- is evidenced by 1) slight dissolution and penetration at sand grain contacts, 2) bent biotite grains, 3) undulose extinction in feldspar and quartz grains, and 4) feldspar and quartz grains which have been fractured and pulled apart. The section has minor secondary porosity which appears to be due to dissolution of montmorillonite.

	%
Plagioclase	5.8
Orthoclase	18.7
Quartz	42.8
Biotite	7.2
Muscovite	0.5
Pyrite	1.0
Montmorillonite	6.2
Porosity	17.0
Rock fragments	0.5

SM-9 (409.8' to 410.1')

Brecciated vesicular basalt (hydrothermally altered) including plagioclase, chlorite (prochlorite, and penninite), analcite, vermiculite(?), antigorite, and accessory hematite. Plagioclase averages about 50% replaced by antigorite. In one half of the section the groundmass is wholly altered to antigorite; in the other half the antigorite appears to be superseded by vermiculite(?). Several generations or species of chlorite occur: 1) as a replacement for clinopyroxene (prochlorite) and, 2) in several fractures (prochlorite) and, 3) in vugs and vesicles (penninite[?]). Vermiculite(?) is the primary lining of numerous vesicles and fractures. Post-vermiculite refracturing is healed by prochlorite and analcite.

	%
Plagioclase	1.9
Prochlorite	40.7
Penninite	<0.5
Analcite	1.4
Vermiculite(?)	9.6
Antigorite	45.4
Pyrite(?)	1.0

SM-9 (652.0' to 652.3')

Vessicular basalt (hydrothermally altered), possibly originally an agglomerate, including plagioclase, chlorite (prochlorite, and penninite), analcite, vermiculite(?), antigorite, natrolite(?), and accessory pyrite(?). Plagioclase averages about 60% replaced by antigorite. The groundmass is wholly altered to antigorite. Several generations or species of chlorite occur: 1) as a replacement for clinopyroxene (prochlorite) and, 2) filling numerous shears and fractures (prochlorite) and, 3) filling vugs and vesicles (penninite[?]). Analcite and natrolite(?) (along with chlorite) occur in the irregular fractures. Vermiculite(?) is the primary lining of numerous vesicles. Evidence of strain includes 1) throughgoing zones of multiply sheared rock that is entirely altered to chlorite and antigorite with secondary analcite and natrolite(?) mineralization, 2) discontinuous irregular chlorite-filled fractures, and 3) patches of strained (non-isotropic) analcite.

	%
Plagioclase	1.4
Prochlorite	34.3
Penninite	2.4
Analcite	23.8
Vermiculite(?)	4.8
Natrolite(?)	2.4
Antigorite	30.9
Pyrite(?)	<0.5

SM-11 (301.5' to 302.0')

Medium-sand sized arkose overlying graded laminae of fine-sand sized lithic graywacke. The arkose is moderately well sorted and includes angular to subangular, medium-sand sized detrital grains of quartz, plagioclase, orthoclase, chlorite, muscovite, rock fragments and hematite in calcite cement. The graded laminae include fine-sand to silt-sized, subangular detrital grains of quartz, orthoclase, chlorite and hematite; the cement appears to be chlorite and hematite.

	%
Quartz	55.1
Orthoclase	12.6
Plagioclase	4.8
Chlorite	11.1
Muscovite	<0.5
Hematite	4.8
Calcite	4.3
Rock fragments	7.2

RESULTS OF MICROPALEONTOLOGY

MICROPALEO
CONSULTANTS, INC.

December 8, 1992

Mr. Dennis Burke
The Earth Technology Corporation
13900 Alton Parkway, Suite 120
Irvine, California 92718

Dear Dennis:

Enclosed is our report on the two samples you recently sent us. We examined sample B-8 for Foraminifera and palynology; only Foraminifera were done on sample SM-1.

Sample B-8 contains no definite fossils and, therefore, is age indeterminate. The lithology appears to be some sort of muddy sandstone containing abundant plutonic fragments. It is possible, however, the sample is 100% fault gouge.

Sample SM-1 is certainly sedimentary. We believe it represents Modelo deposition, but it could be as old as Topanga.

Our invoice is also enclosed. If you have any questions about either the bill or the report, give me a call.

Sincerely,

Rick Boettcher

Richard S. Boettcher
MICROPALEO CONSULTANTS, INC.

RSB:be

Enclosures

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Laboratory: 4569 Mission Gorge Place • Suite K • San Diego, California 92120 • (619) 284-7703

SAMPLE SM-1

FORAMINIFERA

Age:	Middle to Late Miocene, Probable Luisian to "Delmontian" Equivalent. Topanga/Modelo Formation(s).
Environment:	Open Marine
Fossils:	Arenaceous spp. (C), *Haplophragmoides* spp. (F), *Globigerina bulloides* (C), *G. quadrilatera*? (C), *G.* spp. (A), Fish remains (R), Radiolaria (F)
Remarks:	The lithology of this sample is a light brown/gray shale/mudstone, plus some white tuff. The fossils are not highly age restrictive except to say middle to late Miocene (roughly Luisian to "Delmontian"). There is possibly slightly more evidence to suggest assignment to the younger part of this age range, say Mohnian to "Delmontian", although this is speculative. The maximum range of formational assignment would be from the Topanga to the Modelo (= Puente). Again, if we are correct in our speculation that the fauna implies a Mohnian/"Delmontian" age, then the Modelo would be preferable to the Topanga. The arenaceous species do not provide much paleodepth information; the abundant planktonics indicate an open marine setting.

Interpreted by:

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Hideyo Haga by RSB

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SAMPLE B-8

FORAMINIFERA

Age: Indeterminate

Environment: Indeterminate

Fossils: Arenaceous spp.? (R)

Remarks: The lithology consists of a light gray muddy sandstone?, with abundant plutonic fragments. There are no definite Foraminifera in this sample. The arenaceous spp.? recorded may well be some inorganic occurrences that in a general way mimic crushed arenaceous Foraminifera. In view of this uncertainty, we prefer to categorize both the age and environment as indeterminate.

PALYNOLOGY

Age: Indeterminate

Environment: Indeterminate

Remarks: Barren of organics.

APPENDIX H

GEOLOGY AND GROUNDWATER CONDITIONS

APPENDIX H
GEOLOGY AND GROUNDWATER CONDITIONS

H.1 GEOLOGIC UNITS

Most of the tunnel will be advanced in consolidated bedrock of various types. Only a limited portion of the tunnel is to be excavated in unconsolidated alluvial deposits. The bedrock material occurring along the Segment 3 tunnel alignment consists of three general types, namely plutonic, volcanic and sedimentary rock types. These general rock types can be grouped into several geologic units that are based on lithology and geologic age. From oldest to youngest, and also from south to north along the alignment, the geologic units include Cretaceous plutonic rocks, Cretaceous conglomerate and sandstone of the Chico Formation, Paleocene conglomerate and sandstone of the Semi Conglomerate and Las Virgenes Sandstone, Miocene sandstone and conglomeratic sandstone of the Lower Topanga Formation, Miocene basalt and interbedded sandstone of the Middle Topanga Formation and Miocene sandstone, conglomeratic sandstone, siltstone and shale of the upper Topanga Formation. Miocene shale and claystone of the Puente Formation, the youngest rock unit encountered during the exploration, occurs as a sliver within the Hollywood fault zone at the south end of the alignment.

The stratigraphic nomenclature described above is based on the various geologic reports reviewed for the project (Section 2.0). The nomenclature however, most closely follows terminology used by Dibblee (1991) with some minor modifications.

Plutonic Rocks

The plutonic rocks underlie the south flank of the Santa Monica Mountains study area. The rocks extend from the Hollywood fault zone on the south, where they are in fault contact with alluvial deposits, to a postulated fault that separates the plutonic rocks from the sedimentary section that occurs to the north (Plate 2). A total of eight borings (SM-1, SM-1A, SM-1B, SM-2, SM-3, SM-4, SM-5 and SM-6) encountered the plutonic rocks. The rock may be correlative with other plutonic rocks that occur at the east end of the Santa Monica Mountains in the Griffith Park area according to Dibblee (1991).

The plutonic rock is generally a medium to light gray, medium-to coarse-grained holocrystalline rock with a composition that ranges from quartz monzonite to quartz diorite (granodiorite being intermediate and typical). The rock is largely composed of white to pale gray plagioclase and orthoclase feldspar and translucent quartz with lesser amounts of dark colored hornblende and biotite mica. The feldspar content (based on x-ray defraction and thin section analyses) generally ranges from 15 to 56 percent with quartz providing from 10 to 33 percent of the total rock mineralogy. Up to 25 percent of the rock's composition consists of hornblende and mica. Segregation of the light and dark colored minerals imparts a locally well developed gneissic foliation to the rock mass. Foliated rock was observed locally in outcrop as well as periodically in core samples. Occasional inclusions (xenoliths) of darker colored more mafic rock, schist and gneiss were observed and generally range up to several feet in size. Many of these inclusions appear to be oriented somewhat along foliation and have contacts that are transitional with the host granodiorite. Dikes of basalt and quartz aplite also occur locally within the granodiorite. The basaltic dikes generally have irregular boundaries and range up to several tens of feet in thickness. Petrographic analysis of core samples (Boring SM-4) indicates that the basalt has been hydrothermally altered with much of the rocks original mineralogy converted to chlorite and serpentine group minerals. The quartz aplite dikes are typically light colored, contrasting with the relatively darker granodiorite. These dikes are usually several inches thick.

At the ground surface, the rock is completely weathered and it readily disintegrates into sand-to gravel-sized fragments and prominent naturally occurring outcrops are absent. Less weathered rock however, is exposed locally in the bottom of Runyon Canyon where surface-water runoff has stripped away the more weathered material. Based on the borings, the degree of rock weathering decreases with depth. Weathering extends to depths ranging from 80 to 100 feet in the canyon bottoms (Borings SM-3 and SM-4) and up to 200 feet deep on the ridges (Boring SM-2). Rock below these depths is generally fresh but the rock mass is extensively fractured at depth.

Chico Formation

Marine sedimentary rocks of Late Cretaceous age overlie the granodiorite. The contact between these two rock types appears to be a fault zone in the project area. This conclusion is based on the presence of a chaotic zone of crushed, sheared and brecciated rock occurring at the base of the sedimentary section observed in core obtained from Boring SM-5 and observed in outcrop during geologic mapping. In other areas of the Santa Monica Mountains, the base of the Cretaceous sedimentary rocks is an unconformity with the materials being deposited on an erosion surface developed on the older basement rocks.

The Chico Formation generally underlies the highest elevations present along the alignment and is exposed in the upper part of Runyon Canyon and along the west-facing slopes of Nichols Canyon. Naturally occurring outcrops are subdued due to the highly weathered nature of ground surface exposures: however, there are some good road-cut out crops present along upper Runyon Canyon Road and along the dirt extension of Solar Drive near Boring SM-5. In addition to Boring SM-5, Borings SM-6 and SM-7 penetrated the Chico Formation. The upper part of the formation was encountered in Boring SM-7 and the lower part in Borings SM-5 and SM-6.

Locally the Chico Formation consists of crudely bedded sandy conglomerate and conglomeratic sandstone with intervals of sandstone. Claystone beds occur but are rare. In Boring SM-5, the clay content of the matrix increases near the contact with the plutonic rocks, transitioning into a distinctive two-foot thick dark gray claystone layer present at the base. They claystone layer was also observed at the contact in Boring SM-6. Most of the conglomerate intervals are supported by a medium-to coarse-grained sand matrix. However, some intervals are clast supported. The clasts are typically hard, coherent and have well rounded, polished surfaces. They are composed mostly of volcanic clasts with metamorphic and plutonic clasts in lesser abundance (Colburn, 1973). The metamorphic rocks include schists, quartzite and slate-hornfels. The conglomerate clasts range in size from gravels, pebbles and cobbles but rarely exceed 8 inches in size. Larger clasts up to 24 inches in size are rare, but have been observed. The quartzite clasts are often disintegrate along microfractures into gravel-sized fragments where as the plutonic clasts are usually intact. The matrix to clasts ratio is extremely variable with some intervals containing as much as 80 percent rock clasts. Bedding is poorly defined in the conglomerate intervals.

The sandstone beds are usually conglomeratic though occasional relatively thick beds of coarse-to very coarse-grained arkosic sandstone occur. Individual sandstone beds are often lenticular and range from a few inches to several feet thick and are often transitional with adjacent materials.

Weathering appears to extend to depths of 100 and 170 feet deep based on Borings SM-5 and SM-6, respectively. In the weathered zone, the rock is typically discolored brown and yellow. Gray colors dominate the remaining portion of the rock in the unweathered zone. In the weathered zone, both the clasts and matrix have undergone some decomposition. Clasts in the weathered section have a tendency to break apart and separate readily from the matrix.

Cementation varies greatly throughout the unit. It is generally weak in clast-supported layers and moderate in sandstone and conglomeratic layers. The cementing agents appear to be both calcareous and noncalcareous materials with sericite (a mica derived by the decomposition of feldspar), montmorillonite, chlorite, minor calcite and minor pyrite being identified in thin section.

Simi Conglomerate

The Paleocene age sediments of the nonmarine Simi Conglomerate were deposited on an erosion surface that developed on the Chico Formation conglomerates. At various locations, including the Runyon Canyon area, the erosion surface is characterized by a red mudstone bed and red-weathered conglomerate (Colburn and Novak, 1989). A similar appearing zone of red-brown conglomerate was described in the Los Angeles City Sewer Tunnel geologic log (Station 404+76) directly below a quartzite-rich conglomerate which is indicative of the base of the Simi Conglomerate and has been interpreted to be part of the Martinez Formation (Durrell, 1954) and is included in the Santa Susana Formation by Dibblee (1991).

The Simi Conglomerate is exposed in a narrow band which crosses the northern part of Runyon Canyon Park (Plate 1). As with the underlying Chico Formation, the Simi Conglomerate does not form prominent outcrops due to the highly weathered nature of surface exposures. Good road cut exposures occur along the upper part of the Runyon Canyon Road where the stratigraphic section described and measured by Colburn and Novak (1989) is located. Boring SM-7 was the only boring that encountered the Simi Conglomerate.

In the project area, the Simi Conglomerate consists of a cobble and boulder conglomerate with coarse sandstone lenses. The lower half of the unit is made up almost entirely of lavender-colored quartzite (quartz arenite of Colburn and Novak, 1989) clasts which accounts for up to 60 percent of the clasts in the Runyon Canyon area. Clasts of granite/granitic gneiss are next in abundance with volcanic clasts being rare. The upper half of the unit is dominated by granite/granite gneiss and volcanic clasts with quartzite clasts being rare. Overall, the clasts are typically well rounded and have polished surfaces, which appears to be a result of tectonic deformation. Clasts as large as six inches in size are common contained both in matrix-supported and clast-supported beds, but clasts as large as one- to two-feet in size occur (clasts up to three feet in size are reported to occur at other localities). The matrix is an arkosic mix of moderately rounded feldspar, quartz and lesser dark mineral grains and is typically only weakly to moderately cemented. Individual clasts appear to be loose in the matrix and easily separate. The quartzite clasts are microfractured, as with the Chico Formation clasts, and disintegrate into gravel-sized angular fragments. Interstratified with the conglomerate are numerous gravelly, coarse sandstone beds and sandstone lenses. The composition of these intervals are similar to the matrix materials described above.

The poorly cemented nature of this unit is apparent in weathered surface exposures. Surface exposures tend to be moderately friable with the material readily disintegrating into its component parts.

Las Virgenes Sandstone

The Simi Conglomerate conformably transitions into the partially nonmarine and marine Las Virgenes Sandstone also of Paleocene age. The unique white arkosic sandstone and overlying claystone beds of the Las Virgenes Sandstone, as with the Simi Conglomerate, are included in the Martinez Formation of Durrell (1954) and the Santa Susana Formation (Dibblee, 1991). Similar strata are named the Coal Canyon Formation in the central Santa Monica Mountains (Yerkes and Campbell, 1979).

The Las Virgenes Sandstone is exposed in a narrow band of strata which crosses the northern part of Runyon Canyon Park (Plate 2). Due to the friable nature of surficial exposures, the unit does not form prominent outcrops. Good road-cut exposures of the unit are available along the upper part of Runyon Canyon Road and along La Questa Drive in the vicinity of Boring SM-7. Colburn and Novak (1989) described and measured the Las Virgenes Sandstone section from exposures occurring along the upper part of Runyon Canyon Road. Boring SM-7 encountered the lower portion of the Las Virgenes Sandstone.

The Las Virgenes sandstone is dominated lithologically by white arkosic sandstone with scattered pebbles and pebble lenses. The sandstone grades into a greenish micaceous claystone. Thin layers of both red and green siltstone are interbedded within the sandstone. A thin bentonite bed is reported to be present near the base (Colburn and Novak, 1989). The sandstone consists of medium to very coarse-grained sand that is moderately sorted and weakly cemented. The cementing material is reportedly a secondary unidentified clay mineral (Colburn and Novak, 1989). The composition of the sandstone consists of 30 to 45 percent quartz grains and 54 to 69 percent feldspar grains with biotite accounting for approximately 1 to 2 percent (Colburn and Novak, 1989). The composition of the pebbles is predominantly granite and granite gneiss with lesser amounts of quartzite, schist and other rock types. The clasts are typically well rounded and range up to three inches in size, but fine-gravel sizes predominate. Bedding is generally massive with infrequent intervals that are laminated. Pebble stringers define the structural orientation of the unit.

The sandstone sequence grades upward into a vaguely bedded micaceous silty claystone. Very hard, well cemented lenses of sandstone up to several feet thick are interbedded. The claystone interval was observed only at one place (along Runyon Canyon Road) in the project area and, therefore, appears to be of limited extent. Similar materials were not reported in the Los Angeles Sewer Tunnel.

Surface exposures are typically highly weathered with the rock material being partly friable. Weathering extends to a depth of approximately 70 feet in Boring SM-7.

Topanga Formation

In the project area, the middle Miocene marine strata are subdivided into lower and upper parts that are separated by a sequence of volcanic rocks. Collectively, the three parts are named the Topanga Formation (Durrell, 1954) or Topanga Group (Yerkes and Campbell, 1979). Various names have been given to the different parts of the formation (Yerkes and Campbell, 1979). However, we have adopted the designations of Durrell (1954) that are used by Dibblee (1991) for his geologic map of the Hollywood and Burbank (south 1/2) quadrangles. These designations are the Lower Topanga, Middle Topanga and Upper Topanga formations.

Lower Topanga Formation

The lower Topanga Formation consists of approximately 350 to 400 feet of thick bedded sandstone and conglomerate sandstone present between the Paleocene and volcanic rocks. Naturally occurring exposures are rare because of the highly weathered condition of the rock at the surface but good road-cut exposures are present along Nichols Canyon Road and along upper Runyon Canyon Road (Plate 2). The contact with the underlying Paleocene rocks is identified as an unconformity by Dibblee (1991) and may be fault controlled according to Colburn and Novak (1989). The unit was encountered in the subsurface in Boring SM-8. The percentages assigned to the lithologies that follow are based on the thicknesses of each penetrated by the boring.

The Lower Topanga Formation consists of sandstone (85 percent) and conglomeratic sandstone (10 percent) with rare intervals of conglomerate (5 percent) and siltstone (5 percent) interbeds. The sandstone, as well as the conglomeratic sandstone, is generally massive but medium to thick beds and laminated intervals occur. It is composed of gray to greenish gray fine- to coarse-grained, angular to subangular sand that is moderately to well cemented in the subsurface. The thin section analyses (Section 6.0) indicate that quartz accounts for the majority of the sand grains and it ranges from 28 to 47 percent of the rock examined in thin section. Feldspar grains comprise from 18 to 26 percent of the rock and lithic fragments (granitic and mafic igneous rocks, quartzite and quartz-rich meta sedimentary rocks) account for up to 36 percent. The cementing agent varies from calcite (up to 28 percent of one sample) to montmorillonite (up to 20 percent of one sample) with chlorite, silica and pyrite occurring in amounts up to 10 percent. Bulk mineralogy by x-ray diffraction analysis indicate similar results (Section 6.0).

The conglomerate intervals occur in beds or lenses up to three feet thick and are typically matrix supported with zones that are clast supported. The clasts are subrounded to well rounded and are composed essentially of granite, granodiorite quartzite and various volcanic and sedimentary rock types. Clast sizes range from fine gravel to small cobbles with clasts up to 18 inches in size observed, although rarely. Cementation of the conglomerate is poor with gravelly zones being very friable.

Siltstone intervals are typically bluish gray in color and range from thin seams to intervals that are up to five feet thick. The intervals are often thinly bedded to laminated.

Middle Topanga Formation

The Middle Topanga Formation consist of approximately 1200 to 1500 feet of predominantly basaltic volcanic rocks with some lenticular sandstone intervals interbedded. These rocks are probably correlative with the Conejo Volcanics (Yerkes and Campbell, 1979). Naturally occurring outcrops of the volcanic rocks are rare because of the high degree of weathering; however, the rock is well exposed in the central portion of the study area in roadcuts along Mulholland Drive (Plate 2). The sandstone interbeds are generally less weathered and, because of their moderate to strong cementation, form prominent, craggy outcrops. In most places, the strata of the Middle Topanga Formation are conformable with the underlying sandstone and conglomeratic sandstone of the Lower Topanga Formation. Borings SM-8 and SM-9 penetrated portions of the volcanic rock. The borings did not encounter any sandstone interbeds suggesting they may be either lenticular or truncated by faults.

The volcanic rocks consist of alternating and interbedded dark gray to greenish black basaltic breccias, mudflow breccias, flows, pillow breccias and tuff with minor interbedded, locally fossiliferous volcanic sandstone and siltstone. Locally, a black shaly marine siltstone is present at the base. According to Hoots (1930), the lower part of the basalt is pyroclastic consisting of angular fragments embedded in a fine-grained matrix. The upper part is generally massive having been fractured into angular blocks. However, the core obtained from Borings SM-8 and SM-9 indicate that the basalt is predominantly brecciated with massive intervals intercalated. The massive intervals may represent a series of individual flows that range from two to ten feet thick. The tops of the flows are characterized by a zone of reddish discoloration (a zone of weathering and oxidation) and an increase in the frequency of filled vesicles. The brecciated intervals consist of subangular fragments of coherent basalt up to several inches in size that are suspended in a relatively softer matrix.

Thin section analyses indicate that the basalt (both brecciated and massive intervals) has been hydrothermally altered with much of the original mineral constituents and matrix replaced by chlorite group and serpentine group minerals (chlorite, prochlorite and antigorite). Serpentine group mineral (antigorite) content ranges from 31 to 65 percent and the content of chlorite group minerals ranges from 17 to 68 percent of the rock. Vermiculite, a micaceous clay mineral, which is mineralogically related to chlorite, was identified by x-ray diffraction as well as in thin section. Chlorite vermiculite, zeolites and calcite fill vesicles and heal fractures.

A dark-colored shaly siltstone reportedly occurs locally at the base of the basalt (Yerkes and Campbell, 1979). This relationship was not observed in Boring SM-8, which penetrated the contact between the basalt and underlying sedimentary rocks. However, a mudstone and sandstone sequence was observed at the base of the basalt in the Los Angeles Sewer Tunnel excavation. The sequence was described in the sewer tunnel log as "fine to medium grained, hard, gray sandstone and mudstone or argillite that is generally massive." At the upper end of the sequence, basalt interbeds begin to occur before transitioning into the main body of the basalt. According to the sewer tunnel geologic log, this transition takes place over a distance of approximately 200 feet.

Surface exposures of the basalt are usually highly weathered to completely weathered and readily disintegrate into sand and gravel sizes. Weathered rock is discolored yellowish brown while the fresh material is greenish black to dark gray. Data from Borings SM-8 and SM-9 indicate that the depth of the weathered zone is variable, ranging from 45 to 85 feet below grade. Weathered material is not anticipated to occur within the tunnel zone except possibly along fractures or shears.

Upper Topanga Formation

The Upper Topanga Formation is subdivided into a lower sandstone and conglomerate section and an upper interbedded sandstone and siltstone/shale section. The contact between these two sections is transitional and is inferred to occur north of the intersection of Multiview Drive with Mulholland Drive (Plate 2). The basal contact between these sedimentary rocks and the underlying basalt is primarily conformable and often interfingering (Dibblee, 1991). Strata of the Upper Topanga Formation underlie the north flank of the Santa Monica Mountains and extend to the hills at Universal City. Upper Topanga sediments also underlie the alluvium within Cahuenga Pass. The rock is poorly exposed except for scattered roadcut outcrops along Mulholland Drive, Multiview Drive and other residential streets on the south slope of the mountains. Our exploration of this formation included four borings. Boring SM-10 encountered the lower sandstone and conglomerate section and Borings SM-11, SM-12, SM-13 and SM-14 encountered the upper interbedded sandstone and siltstone/shale section.

Lower Section

The lower section of the upper Topanga Formation consists of approximately 1,100 feet of mostly medium gray, medium- to coarse-grained sandstone that is partly conglomeratic. Approximately 80 percent of the material encountered by Boring SM-10 is sandstone containing scattered conglomerate clasts. The boring also penetrated about 15 percent conglomeratic sandstone and 5 percent conglomerate. According to the Los Angeles Sewer Tunnel geologic log, the base of the lower section consists of matrix supported conglomerate. Boring SM-10 was not drilled deep enough to reach the conglomerate at the base of the lower section. The clasts are subangular to subrounded, ranging in size up to 24 inches. At other localities, basalt boulders as large as 4 feet in size are reported (Hoots, 1930). The clasts are of various rock types and include basalt, various plutonics, quartzite, shale and other volcanic types. The matrix consists of angular to subangular medium- to coarse-grained sand that is moderately cemented. Thick beds of medium- to coarse-grained sandstone and minor thin siltstone layers are interbedded.

Sandstone predominates the upper part of the lower section. Intervals of conglomerate still occur but become less common. Thin siltstone interbeds are present periodically. The sandstone generally consists of moderately cemented, medium- to very coarse-grained sand that is thickly to massively bedded and locally conglomeratic. Fine-grained sandstone intervals are interbedded and are frequently laminated. Thin sections indicate that the sand is composed of approximately 15 to 30 percent quartz grains with intervals that contain up to 55 percent. Feldspar grains account for 18 to 37 percent of the sandstone and lithic fragments (volcanics, plutonics and metamorphics) contribute from 7 to 45 percent. The sandstone is moderately cemented with the cementing materials being primarily calcite.

Thin siltstone layers are infrequently interbedded within the lower section sediments. The layers are laminated and generally do not exceed one or two inches in thickness.

At the ground surface, the rocks of the lower sedimentary sequence are highly weathered with the rock material being partly friable. Weathering extends to a depth of approximately 115 feet in Boring SM-10.

Upper Section

The upper section of the Upper Topanga Formation consists of over 3,200 feet of interbedded sandstone and siltstone/shale with the content of siltstone/shale increasing to the north. Intervals of conglomerate or conglomeratic sandstone are present but are very infrequent. The composition of the sandstone is similar to the sandstones described above, but it is generally finer grained. Bedding is better developed than in the sandstones occurring in the lower section with thin to thick beds being common and some laminated intervals present. Cementation is variable with weathered material being poorly cemented and unweathered material being moderately cemented. Well cemented intervals as well as uncemented friable zones occur but are infrequent. The cementing agent probably is calcite with some intervals cemented with an unidentified noncalcareous material.

The siltstone/shale intervals are dark gray and commonly well laminated. Layers of sandstone are interbedded as are very thin seams of clay. Seams of pebbly conglomerate and lignite and intervals of siltstone rip-up clasts are occasionally interbedded as well. The clay seams and siltstone/shale intervals act as planes of weakness in the rock since the rock has a tendency to break apart where they are located.

The sediments of the upper sequence are highly weathered at the ground surface. Weathering effects penetrate to depths ranging from 37 feet in Boring SM-11 to 60 feet in Boring SM-13.

Puente Formation

The middle to late Miocene-age Marine Puente Formation is not exposed at the ground surface in the study area. Puente Formation sediments were encountered in the subsurface by borings (SM-1 and SM-1B) drilled to study the Hollywood Fault zone (Earth Technology, 1993). The shale is generally olive gray to black in color, laminated and has intervals of clay gouge interstratified. In Boring SM-1B, the interstratified zones of gouge contain fragments of plutonic rock that range in size from coarse sand to gravel. The shale may extend as far south as Boring SM-1C where a thin zone of sheared clay occurs between the weathered granodiorite and underlying alluvium. These data indicate that the Puente Formation was faulted from an unknown depth to the near surface as a sliver within the Hollywood fault zone.

Alluvium

Alluvial sediments occur at the base of the Santa Monica Mountains along its north and south flanks. Alluvium also occurs in the bottom of Runyon Canyon and within the Cahuenga Pass area (Plate 2). The alluvial sediments consist of several material types that generally reflect the bedrock source materials from which they were derived and range in composition from clayey to silty sand to silt and clay. Alluvium was encountered in Borings SM-1, SM-1A, SM-1B located at the south base of the mountains; Boring SM-3 located within Runyon Canyon; and Borings SM-12, SM-13, and SM-14 located in the alluvium of Cahuenga Pass area.

Other Surficial Deposits

Other surficial deposits that are shown on Plate 2 or encountered by our borings include landslide debris, colluvium, and artificial fill.

H.2 STRUCTURAL GEOLOGY

H.2.1 General

The Santa Monica Mountains, in the site area, are characterized structurally as an east-west trending asymmetrical anticline bounded by major faults along the north and south flanks of the range. The range has undergone a relatively short but very intensive structural history over the past five million years. Bedrock associated with the range is considerably older than the structures, ranging from Mesozoic age granitic rocks and sedimentary and volcanic sequences of Cretaceous and Tertiary age. The core of the range (anticline) consists of a Jurassic age metamorphic slate which is exposed about 3-miles west of the project site area. The granitic rocks exposed on the south flank of the range intruded the slates prior to uplift and even prior to deposition of the overlying Tertiary sedimentary sequence.

Prior to uplift of the range, shallow marine seas occupied the area and were actively accumulating thick sequences of clastic sediments derived from ancestral uplands from the east and possibly from the west. Regional north-south compression slowly uplifted the range by folding and related faulting processes which are still active today. As uplift continued, subsequent erosion removed all of the sediments along the south flank of the rapidly forming anticline. Streams cut deeply into the underlying granitics forming deep incised canyons of today. The sediments on the north flank of the anticline plunge beneath the alluvial basin to the north. The Santa Monica Mountains anticlinal axis is not discernable in the site area but is judged to lie somewhere in the granitic terrain on the south flank of the mountain.

Two major faults have been identified on either side of the range and both will be crossed in the tunnel sections. The active Hollywood fault trends nearly east-west along the southern flank of the mountains. The amount of total vertical displacement is unknown, but a few thousand feet of movement are necessary to have exposed the older bedrock present in the mountains.

At the tunnel alignment the Benedict Canyon fault is located near the toe of the north flank of the range. The fault is a near vertical feature with evidence of vertical and left lateral displacement (Dibblee, 1991, Hoots, 1930 and AEG 1982).

Other less significant faults and sedimentary rock flexures have been identified in the study area. These and the major faults are described in more detail in Section. All of the identified faults and flexures are shown in Plate 2 in both plan and profile. Second order structural features mapped are discussed in the following section.

H.2.2 Faults

Plate 2 shows mapped faults delineated from this and previous studies in the corridor. The majority of these local faults coincide with aerial photographic lineaments and/or geologic contacts. Due to the urbanization of the area, most of these features could not be directly accessed in the field for study. With little doubt, some of the mapped features do not represent actual faults or fault zones but probably coincide with topographic anomalies, vegetation and tonal contrasts. Shear and fault zones will be encountered at several locations in the tunnel based on the boring logs and previous tunnels. Three major faults have been identified within the corridor and all will be crossed by the proposed tunnels. These include the Hollywood fault, Benedict Canyon fault and unnamed fault that separates the granitic rocks from the sedimentary sequence.

The Hollywood fault projects across the corridor near the south end of the Segment 3 as shown in Plate 2. Detailed studies have been conducted on the fault for the Metro Red Line project which are described in detail in the report of The Earth Technology Corporation (1992). Dr. Kerry Sieh and Dr. James F. Dolan of the Caltech Seismology Department participated in the investigation and reviewed the report prior to submittal. Twenty four borings drilled up to 199 feet deep were used to characterize the local faulting conditions. Section 7.0 summarizes the anticipated tunneling subsurface conditions within the fault zone. The following description of the Hollywood fault is based on the Earth Technology report (1993) summarizing the field investigations of the fault.

The Hollywood Fault zone trends generally in an east-northeast direction and dips north approximately 60 degrees beneath the Santa Monica Mountains. At the tunnel alignment crystalline rocks north of the fault zone have been faulted against younger rocks and the alluvial deposits present to the south. The overall sense of movement is reverse slip with a significant left slip component resulting in uplift of the north side relative to the south side of the fault.

The fault consists of a zone of shearing up to 120 feet wide with the most recently active part being approximately 20 feet wide.

The most recent stratigraphic units affected by faulting include a buried paleosol of late Pleistocene age and possibly the overlying sediments which thicken at the fault. The overlying friable sediments that have no argillic (clay) horizon are interpreted to be Holocene in age and do not appear to be affected by faulting.

The main fault trace forms a ground water barrier across which tunneling conditions change from wet to dry (north to south). The north side the fault has shallow ground water conditions (i.e. 9.5 feet); whereas on the southside of the fault, ground water was not encountered even below the tunnel depth at La Brea Avenue (to 199 feet).

Near the north end of the corridor, the tunnel will traverse the east-northeast trending Benedict Canyon fault zone. The fault is not exposed at the ground surface and is contained to bedrock units of the Miocene Upper Topanga Formation. Alluvium conceals the bedrock surface at the fault. The zone is estimated to be roughly 100 feet thick in the bedrock and probably will consist of chaotic and intensely sheared and brecciated bedrock inclusive of shale, siltstone and sandstone fragments. The fault is mapped as a vertical feature with left lateral (Dibblee, 1991) and vertical slip (Hoots 1930) movement with the north side downdropped relative to the south side. Hoots (1930), estimated about 1.5 miles of lateral offset of several stratigraphic units of Modelo age (late Miocene) and a similar amount of offset of the Santa Monica Mountain anticline axis. The age of last movement has not been well constrained other than there is no evidence to indicate Quaternary age slip (Jennings, 1992, Mualchin and Jones, 1992).

An unnamed fault lies at the contact between the granitics and the Chico formation near Station 666+10 at the ground surface. This fault-contact was intercepted also in borings SM-5 and SM-6. The fault appears to have a relatively planar surface that trends approximately N65W and dips to the north at about 65 degrees. The zone of shearing, brecciation and gouge development may vary between only a few inches to a zone in excess of 15 feet thick based on boring logs. The overlying conglomerate rocks are deformed to a much greater degree than the underlying granitics. The sense and amount of the displacement are unknown. The feature appears to be old and is judged to have formed during the initial uplift of the range. No field or aerial photographic evidence was found to suggest this fault has moved in Quaternary time.

H.2.3 Rock Mass Discontinuities

Rock mass discontinuities are planes of weakness that interrupt the internal fabric of the rock. Discontinuities occurring in the rock units other than faults include bedding contacts in the sedimentary rocks, foliation planes in the plutonic rocks, joints and shears. Rock mass discontinuities that have very irregular surfaces with no apparent structural origin or regularity, are characterized as fractures. This is used in description terms such as "highly fractured zones" where the rock is intensely broken.

Bedding and Foliation

Bedding attitudes in the sedimentary units are generally regular striking to the northwest and dipping northeast. Locally on the north flank of the Santa Monica Mountains, the sedimentary units are folded. Dip angles are moderate to steep varying from 30 to 70 degrees with steeper dips becoming more common in the Upper Topanga Formation sandstone and shale. Plate 1 shows bedding plane orientations measured during the field investigation. Bedding ranges from indistinct to thick bedded in the coarse sediments (conglomerate and sandstone) to well developed and often laminated in the finer grained deposits (shale and siltstone).

Segregation of minerals into parallel layers imparts a foliated texture to the plutonic rocks. Preferred foliation orientation was not discernable except in vague and discontinuous northward-dipping trends.

Jointing and Shearing

Jointing and shearing were the most pronounced discontinuities noted along the alignment. Extensive weathering of the rock at the surface tends to mask these structures. Overall, the texture of the rock is very blocky and fragmented due to a complex pattern of joints and shears.

The rock mass discontinuity descriptions for the rock units that follow are based on observations made in the field during mapping and core logging. The definitions of the terms used in the descriptions are provided in Appendix A. Only general inferences can be made on the orientations (maximum inclination) of the discontinuities since the core obtained was unoriented.

Granodiorite

Discontinuities within the granodiorite rock mass include foliation, joints, and zones of shearing and rock brecciation. Foliated rock was observed locally in outcrop as well as in core samples. The foliation is inclined from 10 to 70 degrees with 30 to 50 degree inclinations being most common. There is no obvious preferred orientation to the foliation except for a northward inclination.

Joints are generally very closely to closely spaced in two or more sets. Shallow and steeply inclined joint sets that intersect at nearly 90 degrees are best developed. Other very steep to vertical joints constitute a third well developed set that occurs locally. Joints throughout the rock have mostly planar surfaces that are slightly rough to rough. Iron-oxide staining of joint surfaces and thin clay linings are common in weathered rock. Unweathered rock has many joints that contain finely- to coarsely-crystalline calcite up to 1 cm thick, but are commonly less than 5 mm thick. The calcite-filled joints are often accompanied by chlorite-lined joints having similar thicknesses and orientations.

Intervals of shearing and rock brecciation occur in the rock at various depths. These intervals vary from thin zones of sheared clay to finely brecciated granodiorite in a clay matrix as much as 5 feet thick. Shearing and brecciation appear to be mostly developed along the more shallow-dipping joint set.

Chico Formation and Simi Conglomerate

Discontinuities within the mostly conglomerate-bearing Chico Formation and Simi Conglomerate include bedding, joints and shears. A zone of mylonitic rock occurs within the shear zone present at the base of the conglomerates.

Bedding is generally poorly developed within the conglomerates. It is usually discernable by infrequent interbeds of coarse-grained sandstone, rare seams of claystone or siltstone, and intervals of conglomerate with imbricated or oriented clasts. Bedding inclinations generally range from 10 to 70 degrees with 40 to 60 degree inclinations being most common.

Jointing pervades the entire rock mass but is best developed (and more apparent) in the finer-grained beds. A single joint set that dips from 20 to 40 degrees predominates. A more steeply inclined set that intersects the predominate set at right angles is less well developed. Steep to vertical randomly oriented joints occur also. Joints are generally closely to moderately closely spaced and have mostly planar surfaces that are slightly rough. The joints are generally lined with both clay and non-clay materials. Clay linings appear to be more common in the younger Simi Conglomerate while calcite healed joints predominate in the Chico Formation.

Shear zones occur intermittently and are frequently up to 1 foot thick. A zone of shearing approximately 15 feet thick was observed at the base of the Chico Formation in Boring SM-5. The zones of shearing consist of brecciated clasts contained within slickensided clay gouge. Shearing appears to be largely developed along the more prominent, shallow dipping joint set.

Lower Topanga Sandstone and Las Virgenes Sandstone

Discontinuities within the predominantly sandstone bearing Lower Topanga Formation and underlying Las Virgenes Sandstone include bedding, joints and shears. Although the sandstone is predominantly massive, laminated intervals and infrequent shaly interbeds indicate that the strata is generally inclined from 30 to 60 degrees. Jointing is not as prevalent as it is in the older formations with random joints being characteristic. In several intervals, a single joint set was identified superimposed on the predominant random set. Joints are generally closely to widely spaced and inclined primarily from 30 to 60 degrees. Joint surfaces are typically planar and slightly rough to smooth. Slickensided surfaces were observed but are infrequent. Most joints have been healed with calcite resulting in a relatively high RQD for the rock.

Middle Topanga Formation Basalt

Discontinuities in the Middle Topanga Formation basalt consist predominantly of joints, some shears and intervals of crushed rock. Two joint sets were observed at moderate and steep inclinations with a random set superimposed. The joints are generally inclined from 25 to 65 degrees with 45 degrees being average. Joint spacing ranges from very closely spaced to moderately closely spaced with very closely spaced joints being most common. Joint surfaces are primarily planar with some that are wavy. The surfaces are mostly slightly rough with rough surfaces occurring periodically. Many joints are healed and filled with various minerals including calcite, zeolite and chlorite generally less than 5 mm thick. The chlorite-lined joints are commonly sheared and display slickensided surfaces. Crushed intervals were observed but are infrequent. The crushed zones are generally less than one foot thick and have shallow inclinations.

Upper Topanga Formation Sandstone and Sandstone/Shale

Discontinuities in the lower section of the Upper Topanga Formation include joints, shears and bedding planes. Joints are generally moderately closely spaced (ranging from closely to widely spaced) with no obvious orientation or regular pattern. They are typically planar with surfaces that are slightly rough. Many joints are tightly healed with calcite and some have clay fillings up to 5mm thick. The clay fillings are characteristically sheared and the rock has a tendency to break along these discontinuities. Bedding planes are infrequent in the mostly thick-bedded sandstone of the lower section. Bedding inclinations range from 40 to 70 degrees. Infrequent clay seams up to a half-inch thick are interbedded and are typically sheared.

Discontinuities in the upper section of the Upper Topanga Formation consists predominantly of sheared bedding planes. Few joints intersect bedding at high angles.

Periodic thin zones of crushed rock are present. Bedding is well developed with laminated intervals common. Bedding is moderately to steeply inclined varying from 50 to 90 degrees. Steeper inclinations become more frequent in the northern portion of the upper section and are near vertical adjacent to the Benedict Canyon fault. Reversals in dip direction occur as a result of numerous folds. Bedding plane surfaces are commonly planar, lined with clay and are often sheared. The rock tends to readily separate along these surfaces.

Joints are generally widely spaced and planar with intervals that contain moderately closely spaced joints. Most of the joint surfaces are slightly rough, and stepped where they intersect beds. The joints generally intersect bedding plans at near right angles and are inclined from 10 to 90 degrees with 30 to 40 degrees being typical.

H.3 GROUNDWATER CONDITIONS

H.3.1 General

The proposed tunnel will encounter three general groundwater regimes: 1) the Hollywood Basin; 2) the Santa Monica Mountains; and 3) the San Fernando Valley Basin. Both the Hollywood Basin and the San Fernando Valley Basin are alluvial aquifers. Bedrock materials of the Santa Monica Mountains are described as essentially non-water bearing, yielding only small amounts of water. The majority of the proposed tunnel will be located within the bedrock terrain of the Santa Monica Mountains. At the south flank of the mountains (south of Station 628 + 00), the tunnel will be excavated in alluvium of the Hollywood basin. At the north flank of the mountains particularly near the Universal City station, the tunnel is expected to be within saturated alluvium at the south side of San Fernando Valley basin.

Within the Santa Monica Mountains, the bedrock formations are expected to yield varying amounts of water throughout the tunnel section depending on the degree of local fracturing in the bedrock materials. At the surface, small springs locally exist, principally in the canyon bottoms, that flow as seeps at a few gallons per minute. Annual stream flows are ephemeral but have been increased artificially due to irrigation of backyards by local residents.

The groundwater conditions along the proposed Red Line tunnel alignment described in this section are based on field geologic mapping, static water elevations in borings, logs of exploratory borings, and packer tests within the tunnel zone. Even with the available information, our understanding of the tunnel hydrogeology is incomplete due to the complexity of the geology controlling water flow in the subsurface.

Three vastly different geologic bedrock terrains exist in the Santa Monica Mountains with several different episodes of tectonic deformation superimposed upon the original rock structure and texture. These geologic factors result in permeability being controlled in some areas by discontinuities (igneous and volcanic rock) only and other areas by varying frequencies of discontinuities and primary permeability (in sedimentary rock). In two borings, artesian conditions were indicated suggesting that semi-confined water occurs within the sedimentary sequence (sandstones and siltstones of the upper Topanga Formation).

H.3.2 Water Levels

Water level measurements have been taken in the open borings and monitoring wells and are plotted in Plate 2 to illustrate the generalized potentiometric groundwater surface anticipated along the tunnel alignment profile. For Borings SM-1 and SM-11, the first-encountered groundwater elevation is plotted rather than static water in Plate 2. The reasons for plotting "first water" rather than static water levels are due to unique geologic conditions at each boring as explained later in this section.

Plate 2 indicates that the groundwater elevations of the borings generally mimic the ground surface. The maximum elevation of the groundwater is located at Boring SM-5 which is also the highest elevation of the borings drilled for this project. The static groundwater elevation is 1,133 feet above sea level and represents 737 feet of elevation difference between the static water and the tunnel crown at that location. As the topography descends to the north and south, the elevation of the static groundwater also decreases. Locally, the groundwater of the mountains intersects the ground surface resulting in springs (seeps) within local canyons draining north to San Fernando Valley or south to Hollywood.

H.3.3 Artesian Flow

Indications of artesian groundwater conditions were observed during this field investigation as well as during the 1953 investigations of a sewer tunnel for the City of Los Angeles. Water flowing from the boring at the ground surface was reported for exploratory Test Hole No. 4 drilled into the Topanga Formation sandstones and siltstones for the Los Angeles Sewer Tunnel. The field notes indicate that the apparent artesian condition may have been related to return flows of water from the formation into the boring which was drilled with water under pressure. In Borings SM-10 and SM-11 (drilled for this investigation), water was encountered at greater depths than where the static water level eventually settled. At Boring SM-10, water rose from a depth of 95 feet where water was first measured to 83 feet deep where it finally stabilized. During drilling of SM-11, water began flowing from the boring casing onto the ground surface. Flows ranged from 0.5 to 2.0 gpm at SM-11. With a pipe extension added to the boring casing, the water level stabilized approximately three feet above the ground surface. These apparent "artesian" conditions may result either from return of drilling water or from the boring intersecting a permeable sandstone bed or fracture system confined by siltstone beds within the Topanga Formation that daylights (intersects the ground surface) at a higher elevation. Locally, recharge by surface water percolation could result in a hydrostatic pressure head where the boring intersects the water-bearing zone. Rather than allow surface flow of water from SM-11, it was abandoned upon drilling completion using a cement-bentonite mix.

H.3.4 Hollywood and Benedict Canyon Faults

At the south side of the Santa Monica Mountains, the Hollywood fault separates the bedrock groundwater from the Hollywood Basin. The fault forms a barrier to groundwater moving from the fractured and weathered crystalline bedrock (granite and granodiorite) to the alluvium of the Hollywood Basin. Based on borings (SM-1 and SM-1A) completed as piezometers in the hanging wall (north or upthrown side of the fault) and the foot wall (south or down thrown side of the fault) a minimum 189.5-foot difference in static groundwater elevation exists across the main fault. Boring SM-1 was drilled through the hanging wall (granitic rock), where static water was approximately 9.5 feet in depth, through the fault into the hanging wall (Hollywood basin sediments) to a depth of 199 feet. No water was encountered within the alluvium that comprises the down-dropped side of the fault. The piezometer was completed within the tunnel zone and remains dry. Groundwater on the south side of the fault could be encountered at an unknown depth below the tunnel. Based on the extreme difference in elevation of the groundwater between Borings SM-1 and SM-1B (17 feet apart) across the Hollywood fault, the fault must be an effective groundwater barrier at that location.

At the north side of the Santa Monica Mountains, groundwater elevations descend nearly parallel to the topography. At SM-13, the groundwater table was measured at 12 feet (Elevation 578 feet) below ground surface in alluvium. At the proposed Universal Station, also located in alluvium, the groundwater was reported to be approximately 15 to 20 feet below the ground surface at elevations 555 to 560 feet above sea level (Plate 2). Between the Universal Station and Boring SM-13, the Benedict Canyon fault is projected across the tunnel alignment. No groundwater barrier is suggested by the available data from borings.