

Los Angeles County
Metropolitan Transportation Authority

Westside Purple Line Extension Project, Section 2 Contract C1120

Geotechnical Data Report – Century City Constellation Station

Issued for Solicitation: September 1, 2015
Amendment 8: February 2, 2016



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U.S. Department
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Federal Transit
Administration

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SUMMARY OF REVISIONS TO THE SEPTEMBER, 2015 GDR (IFS)

Chapter	Revisions	Page Nos.
List of Appendices	Added suspension logging data	
3.1.1.2	Added section on suspension logging	3-3
Appendix A (A.1.3)	Added "City of Beverly Hills"	A-2
Appendix A (A.1.6)	Revised section to add noise mitigation measures undertaken used for Section 2-City of Beverly Hills investigation	A-2, A-3
Appendix A (A.2.1)	Deleted sentence to include all drilling activities in Section 2; added additional drillers used for Section 2-City of Beverly Hills investigation; Added hammer efficiency	A-3
	Added a note to state that at select locations, monitoring wells were installed	A-4
Appendix A (A-2.1.1.1)	Added "unloading modulus" as one of the parameters derived from pressuremeter test	A-5
Appendix A (A.2.4)	Added Section A.2.4 to include a description for continuous core borings	A-6, A-7
Appendix A	Corrected Section Nos.	A-7, A-8
Appendix A (A.2.5)	Added "Adv. PE phase" to indicate CPTs were performed in Adv. PE phase	A-7
Appendix A (A.3.1)	Added additional driller used for groundwater well installation and correct size of the borehole	A-9
Appendix C	Added Adv. PE phase suspension logging results as Figure C-2	
Appendix D (Table D-1)	Added a note to indicate corrosion testing was also performed by AP Engineering	D-1
Appendix D (D.1)	Added a sentence to state that for reports submitted for Section, peak shear strength instead of yield shear strength is reported for direct shear tests	D-2
	Added a note to indicate corrosion testing was also performed by AP Engineering	D-5

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1.0 INTRODUCTION

This geotechnical data report (GDR) has been prepared for the Century City Constellation Station as part of the Advanced Preliminary Engineering (Adv. PE) phase for the Los Angeles County Metropolitan Transportation Authority (Metro). The proposed station is part of Section 2 of the proposed Westside Purple Line Extension project (WPLE) project. This report is one of the following six data reports being prepared for the stations and tunnel reaches which together comprise Section 2 of the project:

1. Geotechnical Data Report (GDR), Wilshire/Rodeo Station
2. Geotechnical Data Report (GDR), Century City Constellation Station (this report)
3. Geotechnical Data Report (GDR), Tunnel Reaches 4 and 5
4. Environmental Data Report (EDR), Wilshire/Rodeo Station
5. Environmental Data Report (EDR), Century City Constellation Station
6. Environmental Data Report (EDR), Tunnel Reaches 4 and 5

This report is prepared based on the results of investigations performed by Amec Foster Wheeler and its predecessor companies AMEC and MACTEC during the Advanced Conceptual Engineering (ACE), Preliminary Engineering (PE) and Adv. PE phases of the project. The results of the ACE and PE phase investigations were previously presented in a Geotechnical and Environmental Report (Metro, 2011). The results of the Adv. PE phase investigations along with those for the ACE and PE phases and prior projects are included for the Century City Constellation Station in this report.

1.1 Objective and Scope of Work

The objectives of the geotechnical and environmental investigations were to evaluate subsurface soil, groundwater, subsurface gas, and man-made environmental contamination, for planning, design and construction of the proposed Century City Constellation Station; the results of the man-made environmental contamination investigation are presented separately in the EDR.

Amec Foster Wheeler is the primary geotechnical consultant to the Parsons Brinckerhoff Team (PB Team), Metro's design consultant. Amec Foster Wheeler's predecessor companies AMEC and MACTEC provided geotechnical and environmental services associated with the Alternatives Analysis (AA), ACE phase and PE phases of the project in support of preparation of a Final Environmental Impact Statement/Environmental Impact Report (FEIS/EIR). Amec Foster Wheeler is also planning to conduct Adv. PE phase investigations for the remainder of Section 2 (Wilshire/La Cienega to Century City Constellation) of the WPLE.

Amec Foster Wheeler's scope of work consisted of reviewing the subsurface data from the ACE, PE and Adv. PE phases along with other relevant available data and to provide:

- Evaluation of static physical characteristics of the soil and groundwater conditions
- Evaluation of subsurface gas conditions
- Evaluation of man-made environmental contamination
- Evaluation of corrosion potential of soils

- Development of recommendations for foundation design, excavation support, station box design, dewatering and groundwater control, and for earthwork, and
- Evaluation of the geologic and seismic hazards for the site.

This GDR presents the results of the field explorations and laboratory testing for all but the environmental testing, and the results of the geologic and seismic hazards evaluation for the Century City Constellation Station. Based on the data contained in the GDR, a Geotechnical Design Memorandum (GDM) and a Geotechnical Baseline Report (GBR) have been prepared to include interpretation of the field and laboratory data, parameters for design and construction, and a discussion of the environmental conditions anticipated at the Century City Constellation Station site. Geotechnical recommendations for design of the excavation and station are included in the GDM and on the design drawings. The EDR presents the results of the man-made environmental contamination explorations and assessment. The reports for other station and tunnel reaches will be submitted separately.

1.2 Other Available Data

Amec Foster Wheeler's and predecessor companies (AMEC, MACTEC, Law/Crandall and LeRoy Crandall and Associates) performed numerous geotechnical investigations along Wilshire Boulevard, including many near the proposed Century City Constellation Station site. Prior methane investigations performed by GeoKinetics (2003) for the renovation of the existing building at 2000 Avenue of the Stars/2029 Century Park East (Century Plaza Towers) and GeoKinetics (2009, 2011) for the proposed building at 10131 Constellation Boulevard/1950 Avenue of the Stars were also reviewed. The relevant reports prepared by AMEC's predecessor companies and other consultants are listed in Section 6, Bibliography.

The locations of the borings from prior investigations that are relevant to the Century City Constellation Station are shown on Plate 1, Exploration Plan. Logs of prior borings are presented in Appendix A. Groundwater monitoring well installation diagrams from previously installed wells are shown in Appendix B. Logs of prior Cone Penetration Tests (CPTs) are presented in Appendix C, and Laboratory test and in-situ field test results from prior borings are presented in Appendix D.

In addition to the project-specific documents referenced above, we have reviewed applicable geologic and environmental references in the literature in preparing this GDR. These documents are also cited within the text and full references are provided in Section 6, Bibliography.

1.3 Limitations

The professional services have been performed using the degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical consultants practicing in this or similar localities. No other warranty, expressed or implied, is made as to the information included in this GDR. This GDR has been prepared for Metro and its design consultants and contractors to be used solely for the evaluation for the Century City Constellation Station planned as part of the proposed WPLE project. The GDR has not been prepared for use by other parties, and may not contain sufficient information for purpose of other parties or other uses.

In developing this GDR, Amec Foster Wheeler (PB team member) relied on subsurface information obtained during Adv. PE Phase and by its predecessor companies AMEC and MACTEC in the AA, ACE, and PE phase studies and its other predecessor companies, Law/Crandall and LeRoy Crandall and Associates, as well as subsurface information obtained by other firms. Subsurface conditions are, by their nature,

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uncertain and may vary from those encountered at the locations where visual inspections, borings, surveys, or other explorations were made.

2.0 PROJECT DESCRIPTION

2.1 Station Description

A general plan of the Century City Constellation Station is presented on Plate 1, Exploration. The profile of the station along with geologic contacts is presented on Plates 2-1 through 2-3, Geotechnical Cross-sections. The Century City Constellation Station and associated double crossover structure No. 10 is about 1,225 feet long, from 85 feet west of the west edge of Century Park East to 365 feet west of the west edge of Avenue of the Stars, and extends to a depth of about 85 to 90 feet below Constellation Boulevard.

Based on the plans dated May 2015, an arch roof module is planned for the station box. The approximate top of the station box walls vary from a depth of about 40 to 50 feet bgs; the depth to the top of the arch roof varies from about 30 to 40 feet bgs. The station entrance is planned in the parking lot located northeast of Constellation Blvd and Avenue of the Stars (10131 Constellation Boulevard). There are no existing buildings in the parking lot that need to be demolished for the proposed station entrance.

The majority of the station excavation support is expected to be internally braced with struts. However, tieback systems may be selected by the contractor for portions of the station excavation, or station entrances and appendages.

2.2 Existing Site Conditions

The existing ground surface within the station footprint slopes down from Avenue of the Stars to both the east and west ends of the station. The topographic difference between the highest and lowest points in the ground surface is about 10 feet. Some of the existing adjacent buildings to the north and south have deep subterranean levels extending to depths near and below the planned bottom of the station. One existing major development identified as 2029 Century Park East and 2000 Avenue of the Stars on Plate 1 (known as Century Plaza Towers) extends from Century Park East to Avenue of the Stars; this development has 6 subterranean levels extending to depths of about 70 to 80 feet bgs near Century Park East and about 100 feet bgs at Avenue of the Stars. The Watt Plaza Towers at 1875 Century Park East has one subterranean level extending to a depth of about 15 feet bgs. The Sun America building at 1999 Avenue of the Stars has three subterranean levels extending to a depth of about 40 feet bgs. The existing Century Plaza Hotel at 2025 Avenue of the Stars has four subterranean levels extending to a depth of about 60 feet bgs.

The shoring systems for the excavation support for the construction of existing buildings consisted of soldier piles with tieback anchors. Amec Foster Wheeler's predecessor companies were involved with some of the buildings near the Constellation station and have inspected the installation of tieback shoring at these locations. Tieback anchors from these deeper building basement constructions, particularly the Century Plaza Towers and Sun America building will protrude into the station excavation.

The Century City Constellation Station site is located within an area designated as a "Methane Zone" on the 2004 "Methane and Methane Buffer Zone" map published by City of Los Angeles, Department of Public Works. According to maps published by the California Division of Oil, Gas, and Geothermal Resources (DOGGR, 2006), the station site is located within the boundary of the Beverly Hills Oil Field West Area. Additional details pertaining to oil wells are discussed in Section 5.3.6.

Based on project-specific utility plans, numerous underground utilities are located within the upper 10 to 20 feet of the ground surface.

3.0 FIELD EXPLORATIONS

The site of the Century City Constellation Station was explored with geotechnical and environmental explorations as part of the overall investigation for the WPLE project during the ACE, PE, and Adv. PE phases. A more detailed description of the methodology for the field explorations is presented in Appendix A of this GDR.

3.1 Geotechnical Explorations

Geotechnical explorations at the Century City Constellation Station site consisted of four rotary wash borings, two hollow-stem auger borings, one cone penetration test sounding, in-situ pressuremeter tests within selected borings, primary (p) and secondary (s) wave suspension logging within selected borings and installation of groundwater monitoring wells within selected borings. The applicable geotechnical explorations and depths explored in these boreholes are presented in Table 3-1. In addition, relevant explorations from prior investigations that are located near the station site are listed in Table 3-1. The current and prior exploration locations are also shown on Plate 1.

Groundwater monitoring wells were installed in borings G-412/E-132A/M-407 and G-414/M-410 drilled during the Adv. PE phase and in boring G-168/M-119 drilled in the PE Phase. The logs of rotary-wash borings and hollow-stem auger borings are presented in Appendix A. The groundwater monitoring well construction diagrams are presented in Appendix B. The CPT data is presented in Appendix C. It is noted that the stationing shown on the boring logs reflects the alignment (and stationing) considered at the time of investigation (ACE or PE phase) and may differ from the current alignment (and stationing) shown on Plate 1.

Table 3-1: WPLE Geotechnical Explorations

Exploration Phase (Year)	Exploration No*	Exploration Depth (feet)
PE (2011)	G-168/M-119	112
PE (2011)	G-169	121
PE (2011)	C-121	62
Adv. PE (2015)	G-412/E-132A/M-407	100
Adv. PE (2015)	G-413	180
Adv. PE (2015)	G-414/M-410	130
Adv. PE (2015)	G-415	115
*G-series refers to geotechnical borings; M-series refers to gas monitoring wells installed in G-borings; C-series refers to cone penetration tests; E-series refers to environmental soil sampling in G-borings		

Table 3-2: Prior Geotechnical Explorations

Exploration Phase (Year)	Exploration No*	Exploration Depth (feet)
Prior (1959)	21, 22 (A-59446)	80, 81
Prior (1961)	16 (A-61206)	22
Prior (1962)	2, 3, 4, 5 (A-62353)	150½, 75, 60, 85
Prior (1965)	1 (A-65238)	29
Prior (1965)	1, 2, 4 (A-65409)	25, 30, 30
Prior (1966)	6 (A-66362)	100
Prior (1967)	8, 10, 11 (A-67065)	45, 50, 60
Prior (1967)	19, 21, 22 (A-67065-B)	89, 87, 90½
Prior (1968)	1, 3 (A-68111)	74, 100
Prior (1969)	1, 2, 4, 5, 7, 9 (A-69036)	175, 100, 170, 170, 115, 120
Prior (1969)	11, 18 (A-69046)	88, 76
Prior (1973)	2 (A-73135)	51
Prior (1974)	3 (A-74056)	70
Prior (1979)	5, 6, 7 (79167.ADE)	100, 75½, 75
Prior (1984)	1, 2, 3, 5 (A-84277)	80, 100, 101, 80
Prior (1990)	2, 3 (L90354.ADEO)	100, 75

* Prior borings drilled by AMEC's predecessor companies identified by the boring number

3.1.1 Field Testing

3.1.1.1 Pressuremeter Testing

Pressuremeter tests were performed within Borings G-413 and G-415 to determine the Menard Modulus ($[E_m]$, Briaud, 2005) and at-rest lateral earth pressure coefficient (K_o) of the subsurface soils. Tests were performed at depths ranging from 12½ to 83 feet bgs. A more detailed description of the test procedure is presented in Appendix A of this GDR.

An average total unit weight of 120 pounds per cubic foot (pcf) for soil and a groundwater depth of 80 feet bgs was used in estimating the Menard Modulus (E_m), unloading modulus (E_u) and horizontal stress coefficient (also referred to as at-rest earth pressure coefficient, K_o). The results of the pressuremeter tests are presented in Table 3-3. The pressuremeter test reports are presented in Appendix F.

Table 3-3: Pressuremeter Test Results

Boring No.	Test Depth (ft.)	USCS Soil Classification	Geologic Formation	At-Rest Lateral Earth Pressure Coefficient, K_o	Menard Modulus, E_m (ksf)	Unload Modulus, E_u (ksf)
G-413	27.5	Sandy Lean Clay (CL)	Older Alluvium (Qalo)	0.59	380	755
	47.5	Silty Sand (SM)	Older Alluvium (Qalo)	0.91	820	-
	67.5	Silty Sand (SM)/Sandy Sit (ML)	Older Alluvium (Qalo)	0.69	1,045	1,215
	83	Silty Sand with Gravel (SM)	San Pedro (Qsp)	0.71	1,610	-
G-415	23	Silty/Clayey Sand (SC-SM)	Artificial Fill (Af)	-	205	-
	43	Sandy Lean Clay (CL)	Older Alluvium (Qalo)	-	125	245
	63	Sandy Lean Clay (CL)	Older Alluvium (Qalo)	0.63	450	1,485
	78	Silty Sand (SM)	San Pedro (Qsp)	0.66	1,250	2,035

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Note: In the above table, "-" indicates either a K_o value could not be reliably estimated from the test data or an unload-reload cycle was not performed during the test

3.1.1.2 OYO Suspension Logging

Compressional (p-wave) and shear-wave (s-wave) data were obtained in Borings G-413 and G-415 by GeoVision using the PS suspension logging system manufactured by OYO Corporation. Suspension logging was performed to depths of 104 and 160 feet bgs. The s-wave velocity data was used in performing site response analysis and in computing the racking displacements for the station box for the design level earthquakes. The methodology used for suspension logging is presented in Appendix A of the GDR. The results of the suspension logging are presented in Appendix C.

3.2 Subsurface Gas Explorations

The subsurface gas investigation at the Century City Constellation Station consisted of installation of two monitoring wells during the ACE phase and PE phase; in addition, four additional monitoring wells were installed in the Adv. PE phase.

Each of the monitoring wells typically consisted of two to three nested soil gas (vapor) probes and one or two PVC standpipes installed in a boring. The PVC standpipes were one to two inches in diameter. The probes and standpipes were installed at depths ranging from 15 to 95 feet bgs. This configuration provided a means of measuring soil gas concentrations and pressures within the vadose zone, as well as concentrations of gases dissolved in groundwater at greater depths. The standpipes allowed relatively large quantities of groundwater to be purged prior to sample collection, as well as collection of large-volume water samples for analysis.

The following types of sampling and monitoring were conducted in the wells:

- Gas concentrations were measured in the field within the standpipes and gas probes using hand-held detectors (Landtec GEM 2000+ and RKI Eagle II Gas monitors). The gas pressure in the probe or standpipe was also measured along with the barometric pressure.
- Confirmatory gas samples were collected in Tedlar bags (bags constructed of clear Tedlar® film) for analysis at a State-certified laboratory.
- The groundwater levels in the standpipes were measured.
- Groundwater samples were collected for analysis of dissolved gases, hydrocarbons, metals, VOCs and SVOCs.
- Large volume (on the order of 4 to 5 liters) groundwater samples were collected in Tedlar bags for extraction and analysis of the dissolved gases.

The depths at which the vapor probes and standpipes were installed in the ACE, PE and Adv. PE phase wells at or near the Century City Constellation station site and details of the monitoring phase are presented in Table 3-4 below. The number of monitoring events and the year of monitoring phase is also listed in the table.

Table 3-4: Details of Vapor Probes/Standpipes in ACE, PE and Adv. PE Phase Wells

Boring/ Monitoring Well No.	Vapor Probe Depth (ft. bgs)	Standpipe Screen Intervals (ft. bgs)	Measurement/Sampling Year (number of monitoring events)	Monitoring Phase
M-19	15, 40	60-70	2009, 2011, 2012 (4 events)	ACE, PE
G-168/M-119	15, 25	45-50, 70-75	2011, 2012, 2015 (5 events)	PE, Adv. PE
G-412/M-407/E-132A	65, 70, 75	50-60, 80-90	2015 (3 events)	Adv. PE
E-132C/M-408	40, 70, 95	50-60, 80-90	2015 (3 events)	Adv. PE
E-133A/M-409	40, 70, 105	75-85, 90-100	2015 (2 events)	Adv. PE
G-414/M-410	40, 60, 95	65-75, 80-90	2015 (2 events)	Adv. PE

Monitoring well M-19 was installed in ACE phase and M-119 was installed in the PE phase; the remaining four monitoring wells (M-407 through M-410) were installed during the current Adv. PE phase. It is noted that well M-19 installed during the ACE phase was planned to be re-sampled during the Adv. PE phase. However, the well could not be located in the field at the installed location and is likely covered with asphalt overlay; relatively new asphalt was seen at the approximate location of the well. It is recommended that the well be uncovered so that further monitoring can be performed and the well properly abandoned.

The gas and groundwater measurements for the wells installed in the ACE and PE phase wells are presented in Table 3-5. The gas and groundwater measurements for the wells installed in the Adv. PE phase wells are presented in Table 3-6. Also presented in the table are the test results of laboratory analysis of gas samples available to date. A bar graph of the gas measurements in a profile view are shown on Plate 3. The bar chart values shown on Plate 3 represent the maximum values of the field and laboratory data recorded at any given depth for each well.

In addition, gas probes were installed within the basement of the Century Plaza Towers (P-series' wells in Table 3-7) and in the vacant property located at the northeast corner of the Avenue of the Stars and Constellation Boulevard (B-series' wells in Table 3-7); the gas probes were monitored by GeoKinetics in 2003 and 200, respectively. The field measurements of methane and gas pressure are presented in Table 3-7. Since GeoKinetics' investigation was limited to methane monitoring at these properties, measurement of hydrogen sulfide were not taken in the probes. Furthermore, groundwater levels were not measured since only probes were installed and not PVC standpipes.

Samples of groundwater to evaluate percentage of dissolved gases were also obtained in the Adv. PE phase wells M-409 and M-410; the results of the laboratory analysis are presented in Table 3-8. In addition, the standpipe at screen interval of 90 to 100 feet bgs in M-409 and the standpipe at screen interval 80 to 90 feet bgs in M-410 were developed to obtain groundwater samples for analytical testing.

Table 3-5: 2009 Field and Lab Gas Measurements in ACE and PE Phase Wells M-19 and M-119

Location		Monitoring Date	Standpipe or Gas Probe Depth (feet)	Probe Color	Depth to Water (feet) ¹	Gas Concentration						Standpipe or Gas Probe Pressure (inches H ₂ O) ²	Barometric Pressure (inches Hg)	Comments
						CH ₄ (%) ³		CO ₂ (%)	O ₂ (%)	H ₂ S (ppm) ⁴				
						Field	Lab	Field	Field	Field	Lab			
M-19**	Gas Probe	8/19/2009	15	R		<0.1	NA	NA	NA	0	NA	0.0	NA	
		5/20/2011				<0.1	NA	NA	NA	0	NA	0.0	NA	
		3/30/2012				<0.1	NA	0	20.8	0	NA	0.0	29.63	
		5/24/2012				<0.1	NA	0.3	20.3	0	NA	0.0	29.3	
		8/19/2009	40	B		<0.1	0.031	NA	NA	0	NA	0.0	NA	
		5/20/2011				<0.1	NA	NA	NA	0.017	NA	0.0	NA	
		3/30/2012				<0.1	0.019	25.2	2.2	0	NA	0.0	29.63	
		5/24/2012				<0.1	0.0069	6.2	16.4	0	ND	0.0	29.3	
		8/19/2009	70	Y		0.7	0.29	NA	NA	0	NA	0.0	NA	
		5/20/2011				<0.1	NA	NA	NA	0	NA	0.0	NA	
		3/30/2012				<0.1	NA	0.1	20.8	0	NA	0.1	29.63	
		5/24/2012				<0.1	NA	34.2	6.1	0	NA	0.0	29.3	
	Standpipe	8/19/2009	65 to 70		Dry	NA	NA	NA	NA	NA	NA	NA	NA	
		5/20/2011			Dry	NA	NA	NA	NA	NA	NA	NA	NA	
		3/30/2012			61.9	<0.1	NA	0	20.9	0	NA	0.0	29.63	
		5/24/2012			Dry	<0.1	NA	0.0	20.5	0	NA	0.0	29.3	
M-119	Gas Probe	6/22/2011	15	G		<0.1	0.0013	0.2	1.8	0	ND	0.0	29.5	
		6/23/2011				0.2	NA	0.4	1.3	0	NA	0.0	29.5	
		3/30/2012				<u>1.9</u>	0.0025	2	9.1	0	ND	0.0	29.6	
		5/24/2012				<u>2.6</u>	NA	0.6	0.0	0	NA	0.0	29.4	
		5/13/2015				0.2	NA	4.5	14.3	0	NA	0.0	29.72	
		5/28/2015				<0.1	NA	3.0	16.6	0	NA	0.0	29.55	
		6/22/2011	25	R		<0.1	<u>4.9</u>	0	0.4	0	ND	0.0	29.6	
		6/23/2011				<0.1	NA	0	0.3	0	NA	0.0	29.6	
		3/30/2012				<u>1.7</u>	NA	0.7	0.0	0	NA	0.0	29.6	
		5/24/2012				<u>1.7</u>	NA	0.2	10.8	0	NA	0.0	29.4	
		5/13/2015				0.2	0.043	3.3	0.0	0	<0.20	0.0	29.72	
		5/28/2015				<0.1	NA	0.5	16.8	0	NA	0.0	29.55	

WESTSIDE PURPLE LINE EXTENSION PROJECT

Table 3-5: 2009 Field and Lab Gas Measurements in ACE and PE Phase Wells M-19 and M-119 (Continued)

Location		Monitoring Date	Standpipe or Gas Probe Depth (feet)	Probe Color	Depth to Water (feet) ¹	Gas Concentration						Standpipe or Gas Probe Pressure (inches H ₂ O) ²	Barometric Pressure (inches Hg)	Comments
						CH ₄ (%) ³		CO ₂ (%)	O ₂ (%)	H ₂ S (ppm) ⁴				
						Field	Lab	Field	Field	Field	Lab			
M-119	Standpipe	6/22/2011	45 to 50		Dry	2.7	NA	4.1	1.0	0	NA	0.0	29.6	
		3/30/2012			49.9	<u>3.4</u>	<u>1.46</u>	5.2	1.1	0	ND	0.0	29.6	
		5/24/2012			29.9	<u>2.6</u>	<u>2.48</u>	4.3	4.0	0	ND	0.0	29.4	
		5/13/2015			49.94	0.2	0.24	1.7	13.2	0	<0.20	-0.25	29.72	<1" of water
		5/28/2015			49.98	0.3	NA	1.4	14.8	0	NA	+0.1	29.55	<1" of water
	Standpipe	6/22/2011	70 to 75		Dry	<u>12.1</u>	NA	5.7	4.7	0	ND	0.0	29.6	
		3/30/2012			Dry	<u>2.7</u>	NA	2.1	16.4	0	NA	0.0	29.6	
		5/24/2012			Dry	<u>2.4</u>	NA	1.5	17.0	0	NA	0.0	29.4	
		5/13/2015			Dry	<u>7.6</u>	<u>5.2</u>	6.9	3.0	0	0.52	-0.25	29.72	
		5/28/2015			Dry	<u>1.7</u>	1.4	2.2	15	0	ND	0.0	29.55	
Explanation:														
** Well M-19 appeared to be paved over prior to 2015														
¹ Depth to water measured in 2" PVC pipe screened at indicated depth														
² Readings >0.5 inch of water underlined and italicized; negative values indicates vacuum relative to the atmospheric pressure														
³ Readings >1.25% (= 25% LEL) of methane underlined and italicized														
⁴ Readings >5ppm of H ₂ S underlined and italicized														
CH ₄ = Methane														
CO ₂ = Carbon Dioxide														
O ₂ = Oxygen														
H ₂ S = Hydrogen Sulfide														
B=Blue														
R= Red														
G = Green														
Y=Yellow														
ND = Not detected (below lab equipment reporting limit: 0.2 ppmv for hydrogen sulfide and 0.001% for methane)														
NA = Not analyzed or measured														
"ppm" stands for parts per million														
Field: Used Landtec GEM 2000+ for field measurements, detection limit for methane is 0.1% or 1,000 ppm														

Table 3-6: 2015 Field and Lab Gas Monitoring Data in Adv. PE Phase Gas Monitoring Wells M-407 through M-410

Well No.	Location	Well Dia (in)	Bottom of Well (ft)	Screen Depth (ft)	Probe Color	Sample Probe (ft)	Sampling Date	Depth to Water (ft) ¹	Probe Pressure (inches water) ²	Barometric Pressure (inches Hg)	Gas Concentrations								Notes
											CH ₄ (%) ³		H ₂ S (ppm) ⁴		CO ₂ (%)		O ₂ (%)		
											Field	Lab	Field	Lab	Field	Lab	Field	Lab	
M-407	Corner of Century Park E. & Constellation Blvd				G	65	4/8/2015		-0.4	29.7	<u>28.1</u>	<u>14</u>	0	<0.20	8.9	8.4	0.2	1.7	
							5/13/2015		-0.75	29.68	<u>24.1</u>	NA	0	NA	9.4	NA	0.1	NA	
							5/28/2015		-0.25	29.65	<u>22.1</u>	NA	0	NA	7.9	NA	2.5	NA	
					R	70	4/8/2015		-0.4	29.72	<u>33.3</u>	<u>15</u>	0	<0.20	8.8	8.4	0.2	1.8	
							5/13/2015		-0.75	29.68	<u>27.1</u>	NA	0	NA	9.3	NA	0	NA	
							5/28/2015		-0.2	29.65	<u>15.1</u>	NA	0	NA	5.9	NA	4.4	NA	
					B	75	4/8/2015		-0.6	29.73	<u>52.6</u>	<u>23</u>	0	<0.20	8.6	8.3	0.1	1.6	
							5/13/2015		-0.8	29.68	<u>80.2</u>	<u>43</u>	0	<0.20	8.6	7.8	0.2	1.9	
							5/28/2015		-0.15	29.95	<u>90.4</u>	NA	0	NA	7.5	NA	2.1	NA	
		2	60	50 to 60		Standpipe	4/8/2015	59.8	-0.7	29.72	<u>3.3</u>	<u>3.2</u>	0	<0.20	0.4	0.45	15.4	16	2" of water
							5/13/2015	59.81	-0.65	29.68	<u>90.8</u>	<u>36</u>	0	<0.20	7.4	6.9	1.8	2.9	2" of water
							5/28/2015	59.89	-0.25	29.65	<u>19.8</u>	<u>10</u>	0	<0.20	7.4	6.9	3.6	5.1	< 2" of water, methane peaked @ 90% during purging
		2	90	80 to 90		Standpipe	4/8/2015	Dry	-0.8	29.72	<u>61.8</u>	<u>22</u>	0	<0.20	2.9	2.9	11.3	12	well dry
							5/13/2015	Dry	-0.7	29.68	<u>87.2</u>	NA	0	NA	6.8	NA	4	NA	well dry
							5/28/2015	Dry	+0.1	29.65	<u>89.9</u>	<u>35</u>	0	<0.20	5.9	5.6	4.2	7.4	well dry
M-408	On Constellation Blvd west of Century Park East				G	40	4/8/2015		0.1	29.73	<0.1	0.0038	0	<0.20	3.1	3.1	7.8	9.2	
							5/13/2015		0.15	29.61	0.2	NA	0	NA	4.3	NA	6.4	NA	
							5/28/2015		-0.1	29.55	<0.1	NA	0	NA	3.5	NA	7.0	NA	
					R	70	4/8/2015		0.05	29.69	0.5	0.52	0	<0.20	6	5.9	2.2	3.9	
							5/13/2015		0.2	29.64	0.7	NA	0	NA	7.4	NA	2.3	NA	
							5/28/2015		-0.1	29.55	1.2	NA	0	NA	7.0	NA	2.0	NA	
					B	95	4/8/2015		-0.05	29.69	<u>98.6</u>	<u>92</u>	10	11	1.4	1.5	0	0.61	
							5/13/2015		0.35	29.61	<u>98.6</u>	<u>94</u>	<u>316</u>	<u>290</u>	1.4	1.4	0	0.59	
							5/28/2015		+0.3	29.55	<u>96.2</u>	<u>73</u>	<u>264</u>	<u>330</u>	1.0	1.1	2.8	5.1	
		2	60	50 to 60		Standpipe	4/8/2015	Dry	0.05	29.73	0.2	0.026	1	<0.20	0.3	1.1	15.4	17	well dry
							5/13/2015	Dry	0.15	29.61	0.6	NA	0	NA	0	NA	15.7	NA	well dry
							5/28/2015	Dry	-0.05	29.55	0.1	NA	0	NA	1.9	NA	13.7	NA	well dry

Table 3-6: 2015 Field and Lab Gas Monitoring Data in Adv. PE Phase Gas Monitoring Wells M-407 through M-410 (Continued)

Well No.	Location	Well Dia (in)	Bottom of Well (ft)	Screen Depth (ft)	Probe Color	Sample Probe (ft)	Sampling Date	Depth to Water (ft) ¹	Probe Pressure (inches water) ²	Barometric Pressure (inches Hg)	Gas Concentrations								Notes
											CH ₄ (%) ³		H ₂ S (ppm) ⁴		CO ₂ (%)		O ₂ (%)		
											Field	Lab	Field	Lab	Field	Lab	Field	Lab	
M-408	On Constellation Blvd west of Century Park East	2	95	80 to 90		Standpipe	4/8/2015	Dry	0.05	29.73	<0.1	0.22	1	<0.20	0.9	0.32	16.7	16	well dry
							5/13/2015	Dry	0.05	29.61	<u>11.3</u>	<u>5.3</u>	4	<0.20	6.4	5.6	3.4	5.8	well dry
							5/28/2015	Dry	+0.05	29.55	<u>12.0</u>	<u>5.5</u>	1	ND	4.8	4.9	6.7	8.1	well dry
M-409	On Corner of Constellation Blvd, west of Ave. of the Stars				G	40	4/9/2015		0	29.67	0.3	0.21	0	<0.20	14.9	13	0	4.6	
							5/12/2015		0.1	29.61	0.2	NA	0	NA	14.2	NA	3.1	NA	
					R	70	4/9/2015		0.05	29.67	<u>28.1</u>	<u>12</u>	0	<0.20	13.2	12	9.9	1.5	
							5/12/2015		0.2	29.63	0.3	0.21	0	ND	14.6	13	2.2	3.7	
					B	105	4/9/2015		-0.05	-	-	-	-	-	-	-	-	-	No flow, probe may be plugged, no lab sample
							5/12/2015		<u>0.55</u>	29.63	<u>6.9</u>	NA	0	NA	4.8	NA	15.2	NA	Flow stopped after 5 minutes
		2	85	75 to 85		Standpipe	4/9/2015	Dry	0.25	29.6	<u>1.8</u>	<u>1.8</u>	1	<0.20	1.6	1.9	11.2	13	
							5/12/2015	Dry	0.2	29.63	<u>16.5</u>	<u>8.9</u>	3	ND	7.5	7.4	2.3	4.4	
		2	99	90 to 100		Standpipe	4/9/2015		0	29.6	0.1	0.064	0	<0.20	0	0.07	20.9	22	
							5/12/2015		0.25	29.61	<0.1	NA	0	NA	0	NA	20.1	NA	

Explanation:

¹Depth to water measured in 2" PVC pipe screened at indicated depth
²Readings >0.5 inch of water underlined and italicized; negative values indicates vacuum relative to the atmospheric pressure
³Readings >1.25% (= 25% LEL) of methane underlined and italicized
⁴Readings >5ppm of H₂S underlined and italicized

CH₄ = Methane
CO₂ = Carbon Dioxide
O₂ = Oxygen
H₂S = Hydrogen Sulfide

B=Blue
R= Red
G = Green
Y=Yellow

ND = Not detected (below lab equipment reporting limit: 0.2 ppmv for hydrogen sulfide and 0.001% for methane)
NA = Not analyzed or measured
"ppm" stands for parts per million
" - " indicated sample not taken or analyzed by laboratory
"pen" indicates laboratory results are pending

Field: Used Landtec GEM 2000+ for field measurements, detection limit for methane is 0.1% or 1,000 ppm

Table 3-6: 2015 Field and Lab Gas Monitoring Data in Adv. PE Phase Gas Monitoring Wells M-407 through M-410 (Continued)

Well No.	Location	Well Dia (in)	Bottom of Well (ft)	Screen Depth (ft)	Probe Color	Sample Probe (ft)	Sampling Date	Depth to Water (ft) ¹	Probe Pressure (inches water) ²	Barometric Pressure (inches Hg)	Gas Concentrations								Notes
											CH ₄ (%) ³		H ₂ S (ppm) ⁴		CO ₂ (%)		O ₂ (%)		
											Field	Lab	Field	Lab	Field	Lab	Field	Lab	
M-410	On Constellation Blvd, west of Ave. of the Stars				G	40	4/9/15		0	29.62	<u>14</u>	<u>6.8</u>	0	<0.20	12.6	12	0.1	1.7	
							5/12/15		-0.5	29.61	<u>2.3</u>	NA	0	NA	16.7	NA	0.3	NA	
					R	60	4/9/15		0	29.62	<u>16.1</u>	<u>7.6</u>	0	<0.20	15.4	15	0	1.5	
							5/12/15		-0.55	29.61	<u>7.7</u>	4.4	0	ND	18.2	17	0	2.2	
					B	95	4/9/15		-0.4	29.52	<0.1	0.02	0	<0.20	20.7	0.12	0	19	Low flow, partial sample, may be plugged
							5/12/15		<u>0.55</u>	29.62	0.2	NA	0	NA	4.9	NA	16.4	NA	Low flow
		2	75	65 to 75	W	Standpipe	4/9/15	Dry	0	29.54	<u>1.7</u>	<u>1.5</u>	1	<0.20	1	1.2	16.3	17	well dry
							5/12/15	Dry	-0.55	29.62	0.8	NA	0	NA	0.2	NA	18.7	NA	well dry
							4/9/15	81.58	0	29.62	<u>6.3</u>	<u>4</u>	3	0.66	1.3	1.4	16.5	17	
							5/12/15	81.62	-0.5	29.62	<0.1	NA	0	NA	0	NA	21	NA	

Explanation:

¹Depth to water measured in 2" PVC pipe screened at indicated depth

²Readings >0.5 inch of water in bold; negative values indicates vacuum relative to the atmospheric pressure

³Readings >1.25% (= 25% LEL) of methane in bold

⁴Readings >5ppm of H₂S in bold

CH₄ = Methane

CO₂ = Carbon Dioxide

O₂ = Oxygen

H₂S = Hydrogen Sulfide

B=Blue

R= Red

G = Green

Y=Yellow

ND = Not detected (below lab equipment reporting limit: 0.2 ppmv for hydrogen sulfide and 0.001% for methane)

NA = Not Analyzed or measured

“ppm” stands for parts per million

" - " indicated sample not taken or analyzed by laboratory

"pen" indicates laboratory results are pending

Field: Used Landtec GEM 2000+ for field measurements, detection limit for methane is 0.1% or 1,000 ppm

Table 3-7: 2003-2004 Field Gas Test Data in Nearby Monitoring Wells obtained by GeoKinetics

	Boring/ Well No.	Probe Depth (ft)	Sampling Date	Depth to Water (ft)	Probe Pressure (inches water) ¹	Barometric Pressure (inches Hg)	CH ₄ (%) ²	CO ₂ (%)	O ₂ (%)
							Field	Field	Field
10131 Constellation Blvd.	B-1	5	8/28/2004		-0.65	29.6	0.0	0.0	21.0
			9/10/2004		-0.05	29.5	0.0	0.7	18.0
			9/13/2004		-0.05	29.4	0.0	0.7	18.6
		10	8/28/2004		0.00	29.6	0.0	4.3	15.8
			9/10/2004		0.00	29.5	0.0	4.0	15.6
			9/13/2004		0.00	29.4	0.0	3.9	15.8
		25	8/28/2004		0.00	29.6	0.3	5.6	0.0
			9/10/2004		0.10	29.5	0.2	5.6	0.0
			9/13/2004		0.10	29.4	0.2	5.5	0.1
	B-2	10	8/28/2004		0.00	29.6	0.0	0.3	20.1
			9/10/2004		0.00	29.5	0.0	0.4	17.5
			9/13/2004		0.00	29.5	0.0	2.4	11.6
		20	8/28/2004		0.00	29.6	0.0	7.2	4.4
			9/10/2004		0.00	29.5	0.0	7.7	4.6
			9/13/2004		0.05	29.4	0.0	7.6	4.9
		30	8/28/2004		0.00	29.6	0.9	6.0	1.2
			9/10/2004		0.10	29.5	0.0	8.6	1.2
			9/13/2004		0.10	29.4	0.0	8.5	1.1
		40	8/28/2004		0.00	29.6	0.0	10.1	0.0
			9/10/2004		0.00	29.5	0.7	9.4	0.0
			9/13/2004		0.00	29.4	0.7	9.2	0.0
	B-3	10	8/30/2004		0.40	29.9	0.3	0.3	19.3
			9/10/2004		Flooded probe				
			9/13/2004		Flooded probe				
		20	8/30/2004		0.40	29.9	0.0	0.8	15.2
			9/10/2004		0.00	29.4	0.0	1.8	13.6
			9/13/2004		0.40	29.4	0.0	1.9	13.4
		30	8/30/2004		0.40	29.9	0.0	0.0	19.8
			9/10/2004		0.00	29.4	0.4	2.8	13.6
			9/13/2004		-0.10	29.4	0.0	2.1	16.6
		40	8/30/2004		0.75	29.9	0.0	0.0	19.9
			9/10/2004		-0.80	29.4	0.4	2.6	14.1
			9/13/2004		-1.05	29.1	0.1	2.1	16.8
		50	8/30/2004		0.00	29.9	0.1	0.3	19.7
			9/10/2004		0.00	29.4	0.4	2.4	14.2
			8/30/2004		0.00	29.9	<u>5.3</u>	4.2	1.0
		60	9/10/2004		0.25	29.4	<u>5.8</u>	6.7	0.0
			9/13/2004		0.30	29.4	<u>6.2</u>	6.8	0.0
		70	8/30/2004		0.10	29.9	<u>6.0</u>	7.5	1.5
			9/10/2004		0.25	29.4	<u>5.8</u>	8.4	0.0
			9/13/2004		0.30	29.4	<u>6.0</u>	8.3	0.0
		80	8/30/2004		0.00	29.9	0.2	0.7	7.8
			9/10/2004		-0.21	29.4	0.5	2.6	4.9
			9/13/2004		-0.05	29.4	0.0	14.2	3.5
	B-4	10	8/28/2004		-0.05	29.6	0.0	0.7	12.0
			9/10/2004		-0.05	29.5	0.0	1.1	5.5
			9/13/2004		-0.05	29.4	0.0	1.3	5.1
		20	8/28/2004		-0.05	29.6	0.7	2.5	12.6
			9/10/2004		0.00	29.5	0.0	6.8	0.0
			9/13/2004		0.00	29.4	0.0	6.8	0.0
		30	8/28/2004		0.00	29.6	0.4	8.4	0.0
			9/10/2004		0.15	29.5	0.4	7.9	0.0
			9/13/2004		0.15	29.4	0.2	8.2	0.0
		40	8/28/2004		-0.05	29.6	<u>21.4</u>	15.0	0.0
			9/10/2004		0.10	29.5	<u>16.9</u>	14.9	0.0
			9/13/2004		0.25	29.4	<u>24.3</u>	14.5	0.0
	B-5	5	8/28/2004		-0.05	29.6	0.0	2.8	11.4
			9/10/2004		-0.05	29.2	0.0	3.3	10.1
			9/13/2004		-0.05	29.4	0.0	3.5	8.9
		10	8/28/2004		-0.05	29.6	0.0	3.7	1.2
			9/10/2004		-0.05	29.5	0.0	6.1	1.3
			9/13/2004		-0.05	29.4	0.0	6.3	1.8
		25	8/28/2004		0.00	29.6	0.0	10.5	0.0
			9/10/2004		0.00	29.5	0.0	10.1	0.0
			9/13/2004		0.15	29.4	0.0	9.9	0.0

Table 3-7: 2003-2004 Field Gas Test Data in Nearby Monitoring Wells obtained by GeoKinetics (Continued)

	Boring/ Well No.	Probe Depth (ft)	Sampling Date	Depth to Water (ft)	Probe Pressure (inches water) ¹	Barometric Pressure (inches Hg)	CH ₄ (%) ²	CO ₂ (%)	O ₂ (%)
							Field	Field	Field
10131 Constellation Blvd.	B-6	5	8/30/2004		-0.05	29.6	0.0	0.3	19.7
			9/10/2004		-0.05	29.5	0.0	0.3	19.3
			9/13/2004		-0.05	29.4	0.0	0.4	19.9
		10	8/30/2004		-0.95	29.6	0.0	0.1	18.5
			9/10/2004		-0.25	29.5	0.0	0.1	16.5
			9/13/2004		-0.20	29.4	0.0	0.1	17.2
		25	8/30/2004		-0.90	29.6	0.0	0.3	18.5
			9/10/2004		0.00	29.5	0.0	0.3	18.3
			9/13/2004		-1.00	29.4	0.0	0.1	20.1
	B-7	10	8/30/2004		-0.05	29.9	0.0	0.0	18.7
			9/10/2004		-0.05	29.4	0.0	0.1	19.6
			9/13/2004		-0.05	29.4	0.0	0.1	19.1
		20	8/30/2004		-0.05	29.9	0.0	0.1	19.5
			9/10/2004		-0.05	29.4	0.0	0.2	20.5
			9/13/2004		0.00	29.4	0.0	0.2	20.0
		30	8/30/2004		-0.05	29.9	0.0	0.1	19.3
			9/10/2004		0.00	29.5	0.0	0.3	20.1
			9/13/2004		-0.05	29.4	0.0	0.3	19.7
		40	8/30/2004		0.00	29.9	0.0	0.0	19.3
			9/10/2004		0.00	29.4	0.0	0.1	19.7
			9/13/2004		0.00	29.4	0.0	0.0	19.9
		50	8/30/2004		0.00	29.9	0.0	0.0	19.7
			9/10/2004		0.00	29.4	0.0	0.1	20.0
			9/13/2004		-0.05	29.4	0.0	0.0	19.8
	B-8	10	8/30/2004		-0.05	29.9	0.0	5.0	13.8
			9/10/2004		-0.05	29.4	0.0	5.9	13.5
			9/13/2004		-0.05	29.4	0.0	5.9	13.7
		20	8/30/2004		-0.05	29.9	0.0	1.6	13.1
			9/10/2004		0.00	29.4	0.0	2.5	12.7
			9/13/2004		0.05	29.4	0.0	2.6	12.9
		30	8/30/2004		0.00	29.9	0.0	1.5	17.3
			9/10/2004		-1.00	29.4	0.0	2.4	14.4
			9/13/2004		-1.10	29.4	0.0	2.4	14.4
		40	8/30/2004		0.00	29.9	0.0	0.8	16.8
			9/10/2004		-2.00	29.4	0.0	1.9	12.0
			9/13/2004		-2.00	29.4	0.0	2.3	11.0
		50	8/30/2004		0.00	29.9	0.0	9.1	6.0
			9/10/2004		0.00	29.4	0.0	10.5	5.0
			9/13/2004		0.10	29.4	0.0	10.3	5.0
		60	8/30/2004		0.05	29.9	0.0	9.6	5.0
			9/10/2004		1.00	29.4	0.0	10.4	4.4
			9/13/2004		0.15	29.4	0.0	10.3	4.4
		70	8/30/2004		-0.20	29.9	0.0	1.1	18.1
			9/10/2004		-0.75	29.4	0.0	3.5	15.7
			9/13/2004		-0.75	29.4	0.0	2.3	17.7
	B-9	10	8/28/2004		-0.05	29.6	0.0	0.7	16.8
			9/10/2004		-0.05	29.5	0.0	1.0	14.7
			9/13/2004		-0.05	29.4	0.0	0.9	15.7
		20	8/28/2004		-0.05	29.6	0.0	0.6	16.4
			9/10/2004		-0.05	29.5	0.0	1.9	13.3
			9/13/2004		-0.05	29.4	0.0	2.3	13.6
		30	8/28/2004		-0.05	29.6	0.0	0.6	16.4
			9/10/2004		0.00	29.5	0.0	2.5	12.3
			9/13/2004		0.00	29.4	0.0	2.9	12.4
		40	8/28/2004		-0.05	29.6	0.1	5.3	12.3
			9/10/2004		0.05	29.5	0.0	6.5	12.0
			9/13/2004		0.00	29.4	0.0	6.3	12.2
		50	8/28/2004		-0.05	29.6	0.0	7.4	12.4
			9/10/2004		0.05	29.5	0.0	7.1	12.3
			9/13/2004		0.00	29.4	0.0	6.7	12.4
	B-10	10	8/30/2004		-0.05	29.9	0.1	1.8	16.6
			9/10/2004		-0.05	29.5	0.0	2.6	16.5
			9/13/2004		-0.05	29.4	0.0	2.6	16.6
		20	8/30/2004		-0.05	29.9	0.0	2.8	15.9
			9/10/2004		-0.05	29.4	0.0	3.9	15.6
			9/13/2004		-0.05	29.4	0.0	3.8	15.4

Table 3-7: 2003-2004 Field Gas Test Data in Nearby Monitoring Wells obtained by GeoKinetics (Continued)

	Boring/ Well No.	Probe Depth (ft)	Sampling Date	Depth to Water (ft)	Probe Pressure (inches water) ¹	Barometric Pressure (inches Hg)	CH ₄ (%) ²	CO ₂ (%)	O ₂ (%)
							Field	Field	Field
10131 Constellation Blvd	B-10	30	8/30/2004		-0.05	29.9	0.0	1.8	16.1
			9/10/2004		-0.05	29.4	0.0	3.4	15.4
			9/13/2004		-0.05	29.4	0.0	3.5	15.3
		40	8/30/2004		0.00	29.9	0.0	1.6	14.8
			9/10/2004		0.15	29.4	0.0	2.9	13.7
			9/13/2004		0.10	29.4	0.0	3.1	13.4
		50	8/30/2004		0.00	29.9	0.0	5.0	10.4
			9/10/2004		0.15	29.5	0.0	7.1	9.5
			9/13/2004		0.10	29.4	0.0	7.2	9.3
		60	8/30/2004		0.00	29.9	0.0	7.8	9.0
			9/10/2004		0.15	29.5	0.0	8.6	8.6
			9/13/2004		0.10	29.4	0.0	8.2	8.5
		70	8/30/2004		0.00	29.9	0.0	0.0	20.0
			9/10/2004		0.00	29.5	0.0	2.9	16.0
			9/13/2004		0.00	29.4	0.0	2.9	14.5
	B-11	10	8/28/2004		-0.05	29.6	0.0	1.5	19.0
			9/10/2004		-0.05	29.5	0.0	1.4	19.1
			9/13/2004		-0.05	29.4	0.0	1.5	18.7
		20	8/28/2004		0.00	29.6	0.0	2.8	16.9
			9/10/2004		0.00	29.4	0.0	2.6	17.5
			9/13/2004		-0.05	29.4	0.0	2.7	17.1
		30	8/28/2004		-0.05	29.6	0.0	2.4	17.0
			9/10/2004		0.00	29.5	0.0	3.1	16.7
			9/13/2004		0.00	29.4	0.0	3.0	16.6
		40	8/28/2004		-0.05	29.6	0.0	4.5	15.5
			9/10/2004		0.00	29.4	0.0	4.5	15.5
			9/13/2004		0.00	29.4	0.0	4.2	15.3
		50	8/28/2004		Flooded probe				
			9/10/2004		-0.10	29.4	0.0	2.2	18.0
			9/13/2004		-0.10	29.4	0.0	2.2	17.7
2029 Century Park East	P-1	5	1/16/2003		0.00	29.8	0.2	12.1	0.0
	P-2	5	1/16/2003		0.00	29.8	0.0	0.3	19.2
		8	1/16/2003		0.00	29.8	<u>4.8</u>	12.5	0.0
	P-3	2	1/16/2003		0.00	29.8	<u>17.8</u>	8.8	1.3
	P-4	7	1/16/2003		0.00	29.9	<u>132.5</u>	6.5	0.0
	P-5	2	1/16/2003		0.00	29.8	0.0	6.0	10.1
	P-6	5	1/16/2003		0.00	29.8	<u>1.6</u>	12.2	0.0
	P-7	5	1/16/2003		0.00	29.8	<u>93.9</u>	5.5	0.0
	P-8	8	1/16/2003		0.00	29.8	<u>75.5</u>	6.8	0.2
	P-9	1.5	1/16/2003		0.00	29.8	<u>13.1</u>	9.1	0.0
	P-10	5	1/16/2003		0.00	29.8	<u>93.6</u>	3.9	0.0
	P-11	5	1/16/2003		0.00	29.9	0.0	3.1	10.0
		10	1/16/2003		0.00	29.9	0.0	1.2	16.7
		20	1/16/2003		0.00	29.9	0.2	8.9	0.0
	P-12	5	1/16/2003		0.00	29.9	<u>28.8</u>	5.9	6.2
	P-13	5	1/16/2003		0.00	29.8	0.0	0.3	16.5
		10	1/16/2003		0.00	29.8	0.0	2.8	2.5
	P-14	2	1/16/2003		0.00	29.9	<u>31.1</u>	9.8	0.0
	P-15	5	1/16/2003		0.00	29.9	<u>3.8</u>	6.0	0.0
		10	1/16/2003		0.00	29.9	<u>9.0</u>	6.7	0.0
		20	1/16/2003		0.00	29.9	<u>13.5</u>	7.0	0.0
	P-16	5	1/16/2003		0.00	29.9	0.3	9.2	0.0
		10	1/16/2003		0.00	29.9	0.2	8.2	0.0
		20	1/16/2003		0.00	29.9	<u>96.3</u>	3.2	0.0
	P-17	6	1/16/2003		0.00	29.9	<u>36.1</u>	12.3	0.0
	P-18	5	1/16/2003		0.00	29.9	<u>11.4</u>	6.2	0.0
		10	1/16/2003		0.00	29.9	<u>17.7</u>	7.2	0.0
		20	1/16/2003		0.00	29.9	<u>22.6</u>	7.5	0.0
	P-19	5	1/16/2003		0.00	29.9	<u>5.9</u>	10.7	0.0
		10	1/16/2003		0.00	29.9	<u>37.1</u>	7.5	4.0
		20	1/16/2003		0.00	29.9	<u>59.7</u>	10.2	0.0

Explanation

¹Readings >0.5 inch of water underlined and italicized; negative values indicates vacuum relative to the atmospheric pressure
²Readings >1.25% (= 25% LEL) of methane underlined and italicized

CH₄ = Methane
CO₂ = Carbon Dioxide
O₂ = Oxygen
H₂S = Hydrogen Sulfide

Field: Used GA-90 Infrared Gas Analyzer and FID for field measurements, detection limit for methane is 0.1% or 1,000 ppm (GA-90) and 0.1 ppm (FID)

ND = Not detected
NA = Not Analyzed or measured
“ppm” stands for parts per million

- Notes:
1. Groundwater depths cannot be measured in gas probes; PVC standpipes were not installed as part of methane monitoring system performed by GeoKinetics
 2. Wells B-1 through B-11 were installed within the topographically depressed vacant lot at the northeast corner of Avenue of the Stars and Constellation Boulevard
 3. Wells P-1 through P-19 were installed within the basement of Century Plaza Towers; probe depths correspond to depths below the lowest subterranean floor slab
 4. Hydrogen sulfide concentrations were not measured by GeoKinetics as the investigation was limited to methane monitoring



Table 3-8: 2015 Lab Dissolved Gas Test Data in Water Samples Collected from Monitoring Wells (Adv. PE Phase)

Monitoring Well Location		Date Sampled	Screen Interval (ft, btoc)	Depth to Water (ft)	Water Volume Extracted from Well (cm3)	Gas Volume Extracted from Sample (cm3)	Methane Gas Concentration (%)	Methane Volume Extracted (cm3)	Methane Mass Extracted (mg)	Methane Dissolved Concentration (mg/L)	Relative Methane Saturation (%)	H2S Gas Concentration (ppm)	H2S Volume Extracted (cm3)	H2S Dissolved Concentration (mg/L)	Relative H2S Saturation (%)	CO2 Gas Concentration (%)	CO2 Volume Extracted (cm3)	CO2 Mass Extracted (mg)	CO2 Dissolved Concentration (mg/L)	Relative CO2 Saturation (%)	O2 Gas Concentration (%)
M-409	Standpipe	5/12/2015	75-85	Dry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			90-100	87.2	3006	20	0.4	0.08	0.006	0.002	<0.01	0	0.00	0	0	1.3	0.26	0.51	0.17	<0.01	18.7
M-410	Standpipe	5/12/2015	65-75	Dry	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
			80-90	81.6	2236	40	10.6	4.2	3.0	1.34	5.9	850	0.034	0.0006	<0.001	2.1	0.84	1.6	0.74	0.04	15.1
Explanation: "NA " indicates laboratory sample not taken																					
Note: Wells M-119, M-407, M-408 were developed for water sampling, however the standpipes were dry																					

3.2.1 Summary of Field Measurements

A summary of the field and lab measurements collected in monitoring wells installed at and in the vicinity of the Century City Constellation station are presented in the following sections:

3.2.1.1 Gas Pressures

The highest recorded gas pressure in probes and standpipes near the station site was 0.55 inches of equivalent water height in well M-410 at a depth of 95 feet bgs and well M-409 at a depth of 105 feet bgs. At several depths in the wells, negative probe pressure was observed indicating that the geologic formation at the screened probe and standpipe depths is under vacuum (relative to the atmospheric pressure) at the time of monitoring.

3.2.1.2 Methane

The highest recorded methane concentration in probes and standpipes near the station site was 98.6 percent in well M-408 at a depth of 95 feet bgs. This is higher than any of the readings obtained in wells M-19 and M-119 previously installed in ACE and PE phases. In the monitoring wells installed for the adjacent properties (2029 Century Park East and 10131 Constellation Boulevard), methane concentrations varied from 24.3 to 96.3 percent in probes installed between depths of 5 and 100 feet bgs.

3.2.1.3 Hydrogen Sulfide

The highest recorded hydrogen sulfide concentration in probes and standpipes near the station site was 316 parts per million (ppm) in well M-408 at a depth of 95 feet bgs. This is higher than readings obtained in the remaining wells installed at the station where the hydrogen sulfide concentrations were between 0 and 4 ppm. Hydrogen sulfide concentrations from wells installed for adjacent properties (2029 Century Park East and 10131 Constellation Boulevard) are not available.

3.2.1.4 Groundwater

Several groundwater monitoring wells with multiple screens were installed at the station. In the wells screened at depths of about 45 to 70 feet bgs, only a few inches of groundwater was measured in the standpipes over a one to two-month monitoring period, indicating that the water encountered at these shallower depths is either a result of water entering the screen zone during the well installation or from localized water seepage. In the wells screened at depths of 80 to 100 feet bgs, significant quantities of groundwater was observed at depths of about 81.5 to 87 feet bgs; the wells at these screen depths were developed to obtain groundwater samples for analytical testing. The depth to the true (non-perched) groundwater level at the station site is estimated to be at a depth of about 80 feet bgs or deeper.

3.3 Phase II Environmental Site Assessment

Within the station area, seven explorations (E-132, E-132A, E-132B, E-132C, E-133, E-133A and E-134) were performed during the PE and Adv. PE phases using direct-push CPT sampling and hollow-stem auger drilling equipment. The exploration locations were selected based on the findings of previous preliminary (FEIS/EIR and ACE phase) environmental site assessment reports that identified suspect source of environmental concern with the highest likelihood to impact the station. Each exploration location was initially marked as close as possible to the suspect source of concern (e.g., former oil

exploration site) while staying within the public street area under which the proposed station is being considered. A summary of the suspect source locations and the list of explorations are presented in Table 3-9. The locations of the environmental explorations are shown on Plate 1, Exploration Plan.

Table 3-9: Summary of Suspect Sources at Phase II Environmental Explorations

Exploration No.	Suspect Source
E-132, E-133, E-134 E-132A*, E-132B*, E-132C*, E-133A*	Former oil exploration activities (Century City area)
*borings drilled during Adv. PE phase	

Additional details of the field explorations including soil and groundwater sampling procedures, analytical laboratory test results, findings and conclusions are presented in the EDR (Metro, 2015).

4.0 LABORATORY TESTING

4.1 Geotechnical Exploration Testing

Laboratory tests were performed on selected samples obtained from the geotechnical borings drilled during the PE and Adv. PE Phase to aid in the classification of the soils and to determine the pertinent engineering properties of the soil. A list of the laboratory tests performed on the samples is presented in Table 4-1. A more detailed description of the laboratory test procedures is presented in Appendix D of this GDR.

Table 4-1: Geotechnical Laboratory Tests

Laboratory Test	Laboratory	ASTM Designation (or) other	PE Phase	Adv. PE Phase
Field Moisture Content	AMEC/AP Engineering	D 2216	X	X
Field Dry Density	AMEC/AP Engineering	D 2937	X	X
Sieve Analysis	AMEC/AP Engineering	D 422	X	X
Passing No. 200 Sieve	AMEC/AP Engineering	D 1140	X	X
Atterberg Limits	AMEC/AP Engineering	D 4318	X	X
Direct Shear	AMEC/AP Engineering	D 3080	X	X
Specific Gravity	AMEC/AP Engineering	C 127/128	X	X
Triaxial Unconsolidated-Drained	AP Engineering	D 4767	NA	X
Consolidation/Hydroconsolidation	AMEC/AP Engineering	D 2435	X	X
Expansion/Collapse	AMEC/AP Engineering	D 2435	X	X
Corrosion	AP Engineering	Caltrans method	X	X
Abrasion	Tonon USA	NTNU-SINTEF	NA	X

NA – not analyzed or tested

The laboratory test results of the PE and Adv. PE phase investigations are presented in Appendix D. Relevant laboratory test results from prior investigations are also included in Appendix D. A summary of the test results in a tabular form is presented in Table 4-2 for PE and Adv. PE phase investigations.

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Table 4-2: Summary of Geotechnical Laboratory Test Results (PE and Adv. Phase)

Boring No.	Sample Depth (ft)	Sample Type	USCS Group Symbol	Geologic Formation	Field Blow Count (blows/ft)	Moisture Content (%)	Dry Density (pcf)	Grain Size			Atterberg Limits			Expansion /Collapse (%)	Specific Gravity	Corrosion				Compression Index		Void Ratio	NTNU Soil Abrasion Index	Direct Shear (Peak Strength)		Triaxial Consolidated-Undrained (Peak Strength)	
								Gravel (%)	Sand (%)	Fines (%)	LL (%)	PL (%)	PI (%)			pH	Sulfate (ppm)	Chloride (ppm)	Minimum Resistivity (ohm-cm)	Cc	Cr			Cohesion (psf)	Friction Angle (deg)	Cohesion (psf)	Friction Angle (deg)
G-168/ M-119	5.5	CR	SC	Af	30	15.3	118																	550	27		
	8.5	SPT	SM	Qalo	26	13.7																					
	11.5	CR	SM	Qalo	13	12.2	113															0.47		270	31		
	14.5	SPT	CL	Qalo	15	22.1																					
	17.5	CR	CL	Qalo	19	26.7	95				49	28	21									0.77					
	20.5	SPT	CL	Qalo	16	31.5																					
	23.5	CR	CL	Qalo	34	23.7																					
	26.5	SPT	CL	Qalo	30	26.6					41	20	21														
	29.5	CR	CL	Qalo	37	17.3	107															0.57		1,430	23		
	32.5	SPT	CL	Qalo	28	29.7																					
	35.5	CR	CL	Qalo	36	18.7	113															0.49					
	38.5	SPT	CL	Qalo	24	17.2		0	13	87						7.3	25	21	840								
	41.5	CR	CL	Qalo	50	32.1	87															0.93		0	28		
	45.5	SPT	ML	Qlw	68	25.8																					
	49.5	CR	SM	Qlw	75/9"	18.4	105															0.59					
	53.5	SPT	SP	Qlw	97/9"	17.9																					
	57.5	CR	SM	Qlw	100/5"	12.7	112			15												0.49					
	62.5	SPT	SP	Qsp	93/9"	10.2																					
	67.5	CR	SM	Qsp	50/5"	22.0	100	0	79	21										0.060	0.010	0.67					
	72.5	SPT	SP	Qsp	50/5"	18.0										8.2	51	13	3,040								
	77.5	CR	SP	Qsp	50/3"	14.4	100							0.14								0.67					
	82.5	SPT	SM	Qsp	50/3"	13.1		0	77	23					2.69												
	87.5	NR	SM	Qsp	100/4.5"																						
	90.5	CR	SP	Qsp	70/5"	27.2	92															0.81		0	37		
	97.5	SPT	CH	Qsp	43	10.3		0	19	81	51	27	24														
	104.5	CR	SM	Qsp	75/5"	9.9	119															0.40		0	35		
	111.5	SPT	SM	Qsp	50/4"	13.8		26	55	19																	
G-169	1 - 5	BULK	CL-ML	Af	N/A											8.2	27	4	1,680								
	5.5	CR	CL	Af	15	25.7	93															0.81					
	8.5	SPT	SM	Af	14	14.2																					
	11.5	CR	CL	Af	10	17.5	109															0.54					
	14.5	CR	CL	Af	4/6"	21.1					39	20	19														
	17.5	CR	CL	Af	11	25.9	101															0.66		1,180	7		

Table 4-2: Summary of Geotechnical Laboratory Test Results (PE Phase) - Continued

Boring No.	Sample Depth (ft)	Sample Type	USCS Group Symbol	Geologic Formation	Raw Blow Count (blows/ft)	Moisture Content (%)	Dry Density (pcf)	Grain Size			Atterberg Limits			Expansion /Collapse (%)	Specific Gravity	Corrosion				Compression Index		Void Ratio	NTNU Soil Abrasion Index	Direct Shear (Peak Strength)		Triaxial Consolidated-Undrained (Peak Strength)		
								Gravel (%)	Sand (%)	Fines (%)	LL (%)	PL (%)	PI (%)			pH	Sulfate (ppm)	Chloride (ppm)	Minimum Resistivity (ohm-cm)	Cc	Cr			Cohesion (psf)	Friction Angle (deg)	Cohesion (psf)	Friction Angle (deg)	
G-169	20.5	SPT	CL	Af	15	21.2																						
	23.5	CR	CL	Af	17	27.3	97														0.73							
	26.5	SPT	CL	Af	25	27.2										7.9	672	99	920									
	29.5	CR	SC	Qlw	41	13.0	120				26	15	11								0.39							
	32.5	SPT	SM	Qlw	43	15.7				43																		
	35.5	CR	SM	Qlw	72/11"	14.7	109														0.53							
	38.5	SPT	SP-SM	Qlw	90	14.9		0	88	12																		
	41.5	CR	SP-SM	Qlw	94/8"	19.0	101																					
	44.5	SPT	SP-SM	Qlw	96/11"	18.4																						
	47.5	CR	SP-SM	Qlw	50/5"	12.8	106																	520	27			
	52.5	SPT	SM	Qlw	84	24.2																						
	57.5	CR	SP-SM	Qlw	93/10"	17.7	107				26																	
	62.5	SPT	SM	Qlw	63	21.8																						
	67.5	CR	SM	Qsp	93/10"	18.3	94	0	67	33				0.05							0.80			0	33			
	72.5	SPT	SP-SM	Qsp	50/6"	22.9									2.67	7.8	358	58	960									
	77.5	CR	SM	Qsp	66	30.5	86	0	85	15										0.100	<0.0001	0.90						
	82.5	SPT	SM	Qsp	93	14.6																						
	85.5	CR	SW-SM	Qsp	90/11"	19.0	103	22	67	11															1,040	25		
	90.5	SPT	SP	Qsp	50/4"	29.4									2.64													
	95.5	CR	CL	Qsp	51	17.3	112	1	44	55	36	19	17							0.100	<0.0001	0.50						
	100.5	SPT	ML	Qsp	44	13.4										7.7	968	45	640									
	105.5	CR	ML	Qsp	87/8"	14.6	116															0.40						
	110.5	SPT	SP	Qsp	50/4"	23.8																						
	115.5	NR	SP	Qsp	91/9"																							
	120.5	SPT	SM	Qsp	50/6"	27.1																						
E-132B	6.5	SPT	CL	Qalo	27	10.1																						
	10.5	CR	CL	Qalo	35	13.8	116	5	38	57	36	13	23	6.17						0.171	0.036	0.45						
	15.5	SPT	CH	Qalo	11	18.7										7.3	78	357	1,186									
	20.5	CR	CH	Qalo	17	26.3	97	0	15	85	53	14	39	2.65						0.252	0.059	0.74		950	28			
	25.5	SPT	CL	Qalo	12	20.0										7.2	188	140	1,221									
	30.5	CR	CL	Qalo	31	16.4	113	0	36	64	44	13	31	7.04						0.182	0.045	0.49						

Table 4-2: Summary of Geotechnical Laboratory Test Results (PE Phase) - Continued

Boring No.	Sample Depth (ft)	Sample Type	USCS Group Symbol	Geologic Formation	Raw Blow Count (blows/ft)	Moisture Content (%)	Dry Density (pcf)	Grain Size			Atterberg Limits			Expansion /Collapse (%)	Specific Gravity	Corrosion				Compression Index		Void Ratio	NTNU Soil Abrasion Index	Direct Shear (Peak Strength)		Triaxial Consolidated-Undrained (Peak Strength)		
								Gravel (%)	Sand (%)	Fines (%)	LL (%)	PL (%)	PI (%)			pH	Sulfate (ppm)	Chloride (ppm)	Minimum Resistivity (ohm-cm)	Cc	Cr			Cohesion (psf)	Friction Angle (deg)	Cohesion (psf)	Friction Angle (deg)	
E-132B	35.5	SPT	CL	Qalo	16	23.4																						
	40.5	CR	CL	Qalo	33	20.2	106														0.57			400	32.			
	45.5	SPT	ML	Qlw	41																							
	50.5	CR	SP-SM	Qlw	69	4.5	93	0	91	9											0.78			150	32			
	55.5	SPT	SP-SM	Qlw	77	4.1																						
	60.5	CR	SP-SM	Qlw	92/9"	8.8	104	28	60	12				-0.25						0.138	0.010	0.62						
	65.5	SPT	SP-SM	Qsp	73	5.7										7.9	39	85	5,020									
	70.5	CR	SM	Qsp	71	15.9	102							-0.04						0.066	0.012	0.66						
	75.5	SPT	SM	Qsp	44	14.6										7.6	1037	65	1,524									
	80.5	CR	SM	Qsp	74	10.9	93															0.77			300	32		
	85.5	SPT	SP	Qsp	50/6"	1.5																						
	90.5	SPT	SP	Qsp	75	1.3																						
	95.5	CR	SP	Qsp	100/10"	21.2																						
100	NR	SP	Qsp	50/4"																								
E-132C/ M-408	6.5	SPT	CL	Af	1	19.3																						
	10.5	CR	SC	Af	5	18.2	110	8	49	43	37	13	24	0.40						0.219	0.028	0.53			500	29		
	15.5	SPT	SC	Af	10	26.4																						
	20.5	CR	CL	Qalo	26	32.6	100															0.66						
	25.5	SPT	CL	Qalo	10	19.9																						
	30.5	CR	CH	Qalo	25	22.7	104	0	14	86	52	15	37									0.59			1,600	22		
	35.5	SPT	SM	Qlw	54	20.7																						
	40.5	CR	SM	Qlw	43	11.8	105							0.65						0.074	0.016	0.60						
	45.5	SPT	SM	Qlw	33	6.2																						
	48	CR	SW	Qlw	93/11"	8.2	116															0.42						
	50.5	SPT	SM	Qlw	44	14.9		26	50	24																		
	53	CR	SM	Qlw	42	8.0	95															0.75						
	55.5	SPT	SM	Qlw	57	6.8		12	72	16																		
	58	CR	SM	Qlw	68	10.9	101															0.64			100	32		
	60.5	SPT	SM	Qlw	28	18.3																						
	63	CR	SM	Qsp	77	13.8	106	0	84	16				0.06						0.060	0.011	0.59						
	65.5	SPT	SM	Qsp	28																							
	68	CR	SM	Qsp	72/11"	6.8	94	0	75	25												0.76			1,500	27		

Table 4-2: Summary of Geotechnical Laboratory Test Results (PE Phase) - Continued

Boring No.	Sample Depth (ft)	Sample Type	USCS Group Symbol	Geologic Formation	Raw Blow Count (blows/ft)	Moisture Content (%)	Dry Density (pcf)	Grain Size			Atterberg Limits			Expansion /Collapse (%)	Specific Gravity	Corrosion				Compression Index		Void Ratio	NTNU Soil Abrasion Index	Direct Shear (Peak Strength)		Triaxial Consolidated-Undrained (Peak Strength)		
								Gravel (%)	Sand (%)	Fines (%)	LL (%)	PL (%)	PI (%)			pH	Sulfate (ppm)	Chloride (ppm)	Minimum Resistivity (ohm-cm)	Cc	Cr			Cohesion (psf)	Friction Angle (deg)	Cohesion (psf)	Friction Angle (deg)	
E-132C/ M-408	70.5	SPT	SM	Qsp	32	7.8																						
	73	CR	SM	Qsp	75/9"	12.9	107														0.54							
	75.5	SPT	SP-SM	Qsp	50/5"	2.7																						
	78	CR	SP-SM	Qsp	85	7.7	91														0.81							
	80.5	SPT	SP-SM	Qsp	55	5.9																						
	83	CR	SP-SM	Qsp	77/11"	6.0	92	1	93	6				-0.44					0.137	0.013	0.83							
	85.5	SPT	SP-SM	Qsp	72	4.9																						
	88	CR	SP-SM	Qsp	41	7.9	110														0.50							
	90.5	SPT	SM	Qsp	50/5"	17.7																						
	93	CR	SM	Qsp	69	13.1	119	0	63	37				< 0.01						0.081	0.010	0.38		550	31			
	95.5	SPT	SM	Qsp	84	10.1																						
99	CR	SP-SM	Qsp	91/9"	5.6	101														0.64								
E-133A/ M-409	6.5	SPT	CL	Af	11	8.8																						
	10.5	CR	CL	Af	16	13.8	118	4	38	58	38	13	25								0.41				620	27		
	15.5	SPT	CL	Af	6	16.8																						
	20.5	CR	CL	Af	11	14.8	116	5	44	51	36	13	23	0.76						0.147	0.019	0.46						
	25.5	SPT	CL	Af	6	17.4																						
	30.5	CR	SC	Qalo	18	11.8	120	4	48	48	33	12	21								0.38				750	31		
	35.5	SPT	SC	Qalo	14	9.4																						
	40.5	CR	SM	Qlw	31	8.7	105	0	81	19				< 0.01						0.054	0.011	0.54		250	33			
	45.5	SPT	CH	Qlw	13	34.7					94	21	73															
	50.5	CR	SM	Qlw	64	5.1	103														0.61							
	55.5	SPT	SM	Qlw	53	12.2				20																		
	60.5	CR	SM	Qlw	77	12.0	92	0	69	31				0.01						0.167	0.015	0.84						
	65.5	SPT	SM	Qsp	33	16.6																						
	70.5	CR	SM	Qsp	41	14.1	110	0	64	36											0.51				250	38		
	75.5	SPT	SP-SM	Qsp	64	6.8																						
	80.5	CR	SP-SM	Qsp	48	4.9	95	2	90	8											0.74			100	32			
	85.5	SPT	SP-SM	Qsp	80	4.2																						
	90.5	CR	SP-SM	Qsp	25	22.6	102														0.62							
	95.5	SPT	SM	Qsp	50/6"	22.0																						
	100.5	CR	CL	Qsp	30	27.3	96	0	32	68				2.51						0.143	0.030	0.79			600	34		

Table 4-2: Summary of Geotechnical Laboratory Test Results (PE Phase) - Continued

Boring No.	Sample Depth (ft)	Sample Type	USCS Group Symbol	Geologic Formation	Raw Blow Count (blows/ft)	Moisture Content (%)	Dry Density (pcf)	Grain Size			Atterberg Limits			Expansion /Collapse (%)	Specific Gravity	Corrosion				Compression Index		Void Ratio	NTNU Soil Abrasion Index	Direct Shear (Peak Strength)		Triaxial Consolidated-Undrained (Peak Strength)			
								Gravel (%)	Sand (%)	Fines (%)	LL (%)	PL (%)	PI (%)			pH	Sulfate (ppm)	Chloride (ppm)	Minimum Resistivity (ohm-cm)	Cc	Cr			Cohesion (psf)	Friction Angle (deg)	Cohesion (psf)	Friction Angle (deg)		
E-133A/ M-409	105.5	SPT	CL	Qsp	35	24.6																							
	110	CR	CL	Qsp	50/5"	15.8	107	1	42	57	40	16	24	0.77						0.170	0.031	0.57							
G-412/ E-32A/ M-407	6.5	CR	CL	Qalo	21	17.1	108															0.54							
	10.5	SPT	CL	Qalo	13	14.9		1	41	58																			
	15.5	CR	CL	Qalo	17	14.6	115	0	22	78	43	12	31									0.43				1250	25		
	20.5	SPT	CL	Qalo	20	12.5																							
	25.5	CR	CH	Qalo	28	25.0	99	0	3	97	71	18	53									0.67			1,550	31			
	30.5	SPT	CH	Qalo	19	18.7																							
	35.5	CR	CH	Qalo	27	17.6	111						37									0.50							
	40.5	SPT	CH	Qalo	17	20.7																							
	43	CR	CH	Qalo	33	18.2	108	0	8	92	60	17	43									0.53				2100	22		
	45.5	SPT	SC	Qlw	22	15.4																							
	48	CR	CL	Qlw	27	16.5	111	0	49	51	34	8	26									0.48			600	29			
	50.5	SPT	SP-SM	Qlw	50/6"	4.6																							
	53	CR	SP-SM	Qlw	80	5.0	105															0.58							
	55.5	SPT	SP-SM	Qlw	66	5.1																							
	58	CR	SW-SM	Qlw	79	5.8	93	0	88	12												0.77			450	30			
	60.5	SPT	SW-SM	Qlw	50/6"	2.9																		44*					
	63	CR	SW	Qlw	50/6"	1.1																							
	65.5	SPT	SP-SM	Qsp	92	1.2																	29*						
	68	CR	SM	Qsp	69			0	73	27					-1.38	2.65													
	70.5	SPT	SM	Qsp	70	13.6																		29*					
	73	CR	SM	Qsp	85/9"	19.0	106															0.55							
	75.5	SPT	ML	Qsp	39	25.4		0	16	84						2.77													
	78	CR	SP-SM	Qsp	84/10"	5.4	98																0.69						
	80.5	SPT	SP-SM	Qsp	67	10.1										2.66													
	83	CR	SP-SM	Qsp	81/11"	4.1	99	0	90	10					-0.21						0.135	0.012	0.67						
	85.5	SPT	SM	Qsp	55	11.1																							
	88	CR	SM	Qsp	64	17.0	103				45												0.61			750	32		
	90.5	SPT	SP-SM	Qsp	81	4.5		0	90	10																			
	93	NR	SP-SM	Qsp	50/2"																								
	95	SPT	SM	Qsp	50/6"	3.0		14	64	22				42															

Table 4-2: Summary of Geotechnical Laboratory Test Results (PE Phase) - Continued

Boring No.	Sample Depth (ft)	Sample Type	USCS Group Symbol	Geologic Formation	Raw Blow Count (blows/ft)	Moisture Content (%)	Dry Density (pcf)	Grain Size			Atterberg Limits			Expansion /Collapse (%)	Specific Gravity	Corrosion				Compression Index		Void Ratio	NTNU Soil Abrasion Index	Direct Shear (Peak Strength)		Triaxial Consolidated-Undrained (Peak Strength)			
								Gravel (%)	Sand (%)	Fines (%)	LL (%)	PL (%)	PI (%)			pH	Sulfate (ppm)	Chloride (ppm)	Minimum Resistivity (ohm-cm)	Cc	Cr			Cohesion (psf)	Friction Angle (deg)	Cohesion (psf)	Friction Angle (deg)		
G-412/ E-32A/ M-407	99	SPT	SM	Qsp	50/1"	4.4																							
G-413	6.5	SPT	CL	Af	10	16.3																							
	9.5	CR	CL	Af	14	20.3	105	2	37	61	40	14	26	1.76		8.0	16	35	1,352	0.209	0.036	0.62			300	31			
	15.5	SPT	CL	Qalo	9	27.5																							
	18.5	CR	CL	Qalo	16	20.6	106	0	16	84	48	13	35								0.56					700	30		
	21.5	SPT	CL	Qalo	15	16.8										7.9	34	29	911										
	24.5	CR	CL	Qalo	20	18.1	111	0	44	56	32	12	20									0.49				550	36		
	30.5	SPT	CL	Qalo	16	22.8					40	14	26																
	35.5	CR	SM	Qlw	71	11.0	105	0	55	45												0.57			300	33			
	40.5	SPT	SM	Qlw	26	14.0																							
	45.5	CR	SM	Qlw	59	9.2	108	0	87	13				< 0.01						0.045	0.011	0.56							
	50.5	SPT	SM	Qlw	62	14.8																							
	55.5	CR	SM	Qlw	82	9.7	118															0.40							
	60.5	SPT	SM	Qlw	34	21.4																							
	65.5	CR	SP-SM	Qlw	85	16.6	103	0	86	14												0.60			100	34			
	70.5	SPT	SM	Qsp	76	17.6											7.8	195	99	1,550									
	75.5	NR	SM	Qsp	50/1"																								
	80.5	SPT	SP-SM	Qsp	82	12.9																							
	85.5	CR	SP-SM	Qsp	91/11"	11.3	112	20	63	17												0.48			100	40			
	90.5	SPT	SM	Qsp	50/3"	12.6											5.8	3823	108	774									
	95.5	CR	SM	Qsp	65	16.0	117							0.99							0.075	0.017	0.44						
	100.5	SPT	SP	Qsp	97/11"	13.8																							
	105.5	CR	SP	Qsp	70/6"			41	54	5																			
	110.5	SPT	SM	Qsp	91/11"	17.3																							
	115.5	CR	SM	Qsp	96/9"	13.7	94				16			0.01							0.065	0.011	0.77			150	31		
	120.5	SPT	SM	Qsp	67/6"	15.5																							
	125.5	CR	SM	Qsp	91/9"	19.0	102																0.62						
	130	SPT	SM	Qsp	95/11"	11.1																							
	135.5	CR	SM	Qsp	77/11"	19.6	82																1.03						
	140	SPT	SM	Qsp	63	38.5																							
	145.5	CR	SM	Qsp	98/8"	18.5	95																0.74						

Table 4-2: Summary of Geotechnical Laboratory Test Results (PE Phase) - Continued

Boring No.	Sample Depth (ft)	Sample Type	USCS Group Symbol	Geologic Formation	Raw Blow Count (blows/ft)	Moisture Content (%)	Dry Density (pcf)	Grain Size			Atterberg Limits			Expansion /Collapse (%)	Specific Gravity	Corrosion				Compression Index		Void Ratio	NTNU Soil Abrasion Index	Direct Shear (Peak Strength)		Triaxial Consolidated-Undrained (Peak Strength)		
								Gravel (%)	Sand (%)	Fines (%)	LL (%)	PL (%)	PI (%)			pH	Sulfate (ppm)	Chloride (ppm)	Minimum Resistivity (ohm-cm)	Cc	Cr			Cohesion (psf)	Friction Angle (deg)	Cohesion (psf)	Friction Angle (deg)	
G-413	150.5	SPT	SM	Qsp	75	33.8																						
	155.5	CR	SM	Qsp	63	47.5	68														1.44							
	160.5	CR	SM	Qsp	50/5"	24.9	99														0.68							
	165.5	SPT	SM	Qsp	66	27.8																						
G-414/ M-410	6.5	CR	CL	Af	17	15.7	113															0.46			700	28.0		
	10.5	SPT	CL	Af	4	13.6										7.7	223	23	1,215									
	15.5	CR	CL	Af	9	10.7	118	1	34	65	37	12	25	2.40						0.159	0.020	0.42			600	29.0		
	20.5	SPT	CL	Af	14	14.9										7.4	398	66	806									
	25.5	CR	CL	Af	14	16.7	111	2	39	59	37	12	25									0.49					400	31
	30.5	SPT	CL	Af	27	5.8																						
	35.5	CR	CL	Qalo	24	13.3	117	1	51	48	27	13	14									0.41					1050	32
	40.5	SPT	SC	Qalo	17	7.6																						
	45.5	CR	SM	Qalo	13	14.5	109			35												0.52						
	48.5	SPT	CL	Qalo	5	15.9										7.6	180	206	1,223									
	51.5	CR	CL	Qalo	38	13.7	119	1	38	61	34	12	22									0.39					800	29
	54.5	SPT	CL	Qalo	50/4.5"																							
	57.5	SPT	SM	Qlw	42	13.1																						
	60.5	CR	SM	Qlw	54	16.9	98	0	51	49												0.68			850	30.0		
	63.5	SPT	SM	Qlw	40	16.4										7.6	128	251	1,936									
	66.5	CR	SM	Qlw	69	18.9	104							0.20						0.076	0.013	0.61						
	69.5	SPT	SM	Qsp	40	19.4																						
	72.5	CR	SM	Qsp	65	13.2	112	15	47	38												0.48			600	30.0		
	75.5	SPT	SM	Qsp	49	9.1																						
	78.5	CR	SM	Qsp	61	26.2	95							0.11						0.127	0.016	0.77						
	81.5	SPT	SP	Qsp	60	4.1																						
	84.5	CR	SP	Qsp	58	17.1	108															0.53						
	87.5	SPT	SP	Qsp	22	17.5																						
	90.5	CR	SP	Qsp	36	12.6	109	3	90	7												0.52			150	35.0		
	93.5	SPT	SM	Qsp	49	23.7																						
	96.5	CR	SM	Qsp	68	20.3	106							0.28						0.085	0.013	0.58			50	32.0		
	99.5	SPT	SP-SM	Qsp	50/6"	7.4			6	78	16																	
	104.5	CR	CL-ML	Qsp	60	15.1	111															0.49						

Table 4-2: Summary of Geotechnical Laboratory Test Results (PE Phase) - Continued

Boring No.	Sample Depth (ft)	Sample Type	USCS Group Symbol	Geologic Formation	Raw Blow Count (blows/ft)	Moisture Content (%)	Dry Density (pcf)	Grain Size			Atterberg Limits			Expansion /Collapse (%)	Specific Gravity	Corrosion				Compression Index		Void Ratio	NTNU Soil Abrasion Index	Direct Shear (Peak Strength)		Triaxial Consolidated-Undrained (Peak Strength)	
								Gravel (%)	Sand (%)	Fines (%)	LL (%)	PL (%)	PI (%)			pH	Sulfate (ppm)	Chloride (ppm)	Minimum Resistivity (ohm-cm)	Cc	Cr			Cohesion (psf)	Friction Angle (deg)	Cohesion (psf)	Friction Angle (deg)
G-414/ M-410	109.5	SPT	ML	Qsp	21	24.6					47	17	30														
	114.5	CR	SM	Qsp	77/10"	14.7	109			46				0.19						0.073	0.023	0.55					
	119.5	SPT	SP-SM	Qsp	50/5"	4.7																					
	124.5	CR	SP-SM	Qsp	76/9"	11.1	95															0.74					
	129.5	SPT	SP-SM	Qsp	50/6"																						
G-415	6.5	SPT	CL	Af	3	12.7																					
	9.5	CR	CL	Af	3	19.2	107	5	34	61	38	12	26	0.54						0.254	0.033	0.59		350	28.0		
	15.5	CR	CL	Af	13	19.6	107															0.54					
	18.5	SPT	CL	Af	9	16.6																					
	20.5	CR	SC-SM	Af	18	18.2	112															0.48					
	25.5	CR	CL	Af	18	13.5	116	1	42	57	35	11	24									0.43				1180	23
	28.5	SPT	CL	Af	10	15.7										7.9	494	289	1,002								
	31.5	CR	CL	Af	24	16.2	114															0.45		600	25.0		
	34.5	SPT	SC	Af	9	13.4																					
	37.5	CR	CL	Af	16	17.3	109	1	30	69	36	14	22	0.96						0.168	0.026	0.54					
	40.5	CR	CL	Af	14	18.7	109															0.52					
	45.5	CR	SM	Af	16	18.8	108									7.5	136	71	1,838			0.53					
	50.5	SPT	SM	Af	8																						
	55.5	CR	CL	Af	20	16.6	115							0.10	2.63					0.101	0.011	0.10					
	60.5	CR	CL	Af	23	17.7	113	8	33	59	30	12	18									0.46				1000	30
	65.5	CR	SM	Qlw	42	17.9	104	0	60	40	NP	NP	NP		2.69							0.62		200	33.0		
	70.5	SPT	SM	Qsp	37	19.5										7.9	92	50	2,159								
	75.5	CR	SM	Qsp	62	14.9	106															0.57	27*				
	80.5	CR	SM	Qsp	39	21.7	95	0	70	30	NP	NP	NP		2.66	7.5	51	44	1,628			0.74		250	30.0		
	85.5	SPT	SM	Qsp	68	16.6																	27*				
	90.5	CR	CH	Qsp	23	38.2	82	0	6	94	75	21	54		2.72							1.07				200	29
	95.5	SPT	SM	Qsp	52	25.5																					
	100.5	CR	SP-SM	Qsp	50/5"			0	91	9																	
<div>CR SPT "Gravel" "Sand" "Fines" NP Quaternary Younger Alluvium – Qal, Quaternary Older Alluvium – Qalo, Lakewood – Qlw, San Pedro – Qsp</div> <div>* Indicates that a composite sample from the same boring was used for NTNU Soil Abrasion Test</div> <div>^For Expansion/Collapse Test : "-" indicates expansion of the sample upon saturation, otherwise collapse</div>																											

4.2 Subsurface Gas Testing

The samples of gas collected from gas monitoring wells in Tedlar bags were analyzed at a state-certified laboratory for hydrogen sulfide, methane, longer-chain hydrocarbons (e.g. butane, propane, etc.), and fixed gases using standard EPA testing procedures. The laboratory test results of the samples obtained from the ACE and PE phase wells are presented in Table 3-5 and Table 3-6. The laboratory analytical reports for gas testing are included in Appendix E.

The groundwater samples obtained from Adv. PE phase wells M-409 and M-410 were analyzed for dissolved methane, hydrogen sulfide, and other fixed gases using standard EPA analytical procedures and the results are presented in Table 3-8. The laboratory analytical reports for groundwater testing are included in Appendix E.

4.2.1 Summary of Lab Measurements

- The highest measured methane level in samples analyzed from probes/standpipes at the station site was 94 percent in well M-408.
- The highest measured hydrogen sulfide in samples analyzed from probes/standpipes at the station site was 330 ppm in well M-408.
- The recorded dissolved methane and hydrogen sulfide levels in the water sample from M-409 and M-410 were 0.4 percent and 0 ppm, respectively; in groundwater sample collected in M-410, the dissolved methane and hydrogen sulfide were 10.6 percent (1.34 mg/L) and 850 ppm (0.0006 mg/L), respectively.

4.3 Phase II Environmental Testing

The soil and groundwater samples collected from the borings were transported under standard chain-of-custody protocol and delivered to a state-certified lab for testing. Depending on the suspect source near which a boring was drilled, the soil and groundwater samples were analyzed for one or more of the following constituents:

- Total petroleum hydrocarbons as gasoline/diesel/oil (TPH-g/d/o) by EPA Method 8015B
- Volatile organic compounds and fuel oxygenates (VOCs+Oxy) by EPA Method 8260B
- Polynuclear aromatic hydrocarbons (PAHs) by EPA Method 8270C
- Title 22 metals by EPA Methods 6010B/7471A

The summary of the laboratory test results are presented in the EDR dated August 2015 (Metro, 2015).



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5.0 PROJECT GEOLOGY

The following sections provide an overview of the geologic setting, stratigraphic conditions, geologic structure, and groundwater conditions as encountered at the Century City Constellation Station site. The geologic and seismic hazards such as fault rupture, tectonic deformation and liquefaction are also discussed.

5.1 Geologic Setting of Study Area

The southern California region is comprised of several tectonomorphic provinces characterized by distinct structural fabrics and geomorphic elements. The Century City Constellation Station site is located near the boundary between the northwestern end of the Peninsular Ranges geomorphic province and the southern margin of the Transverse Ranges geomorphic province. The Peninsular Ranges province is characterized by elongated northwest-southeast trending geologic structures such as the nearby Newport-Inglewood fault zone. In contrast, the Transverse Ranges geomorphic province is characterized by east-west trending geologic structures such as the Santa Monica fault, the Hollywood fault, and the Santa Monica Mountains. The Santa Monica and Hollywood faults are considered the boundary between the two geomorphic provinces within the area of the alignment.

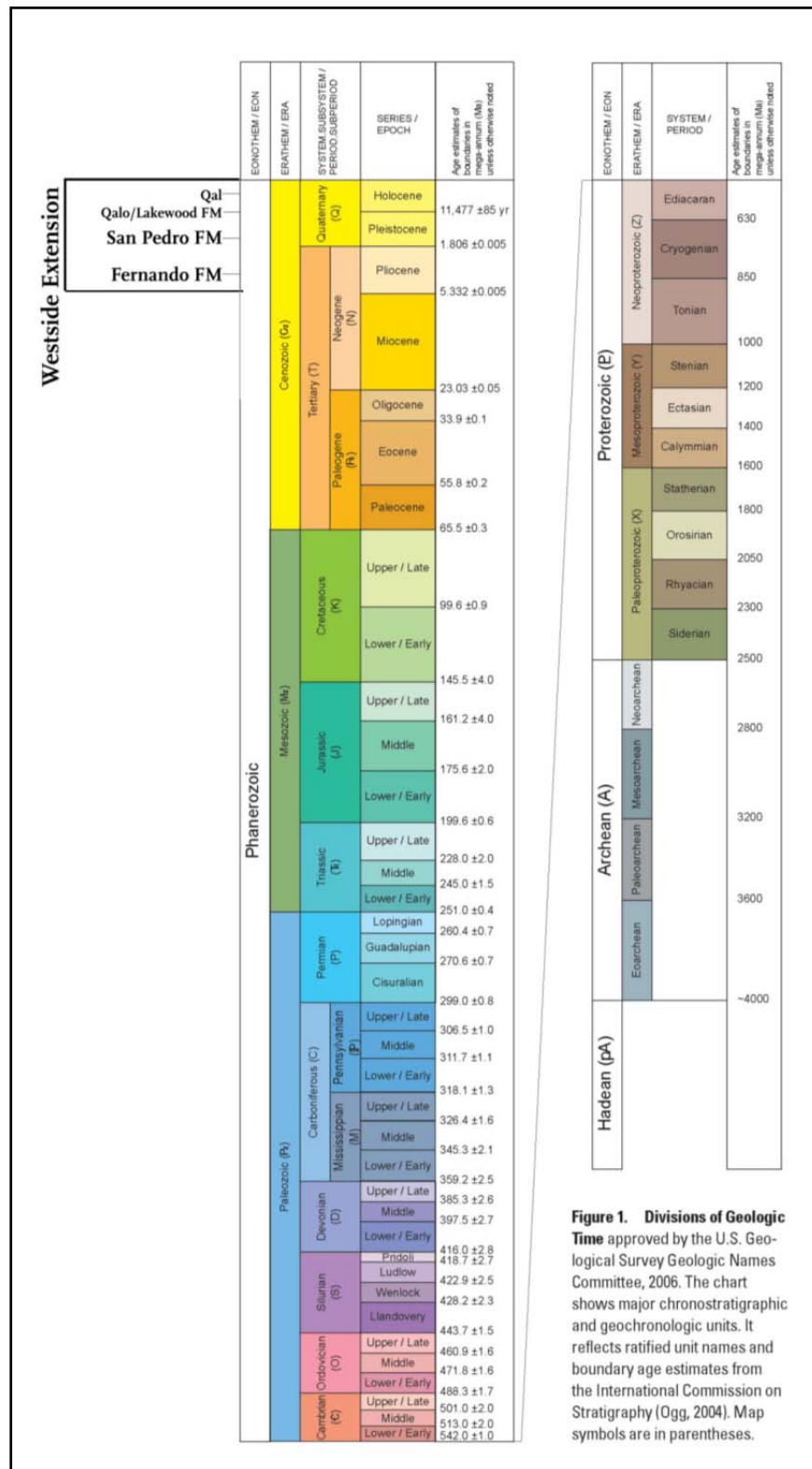
The station site is located in the northern portion of the Los Angeles Basin, approximately 2.5 miles south of the Santa Monica Mountains. This sedimentary basin occupies the northernmost portion of the Peninsular Ranges geomorphic province. The Los Angeles Basin is a major elongated northwest-trending structural depression that has been filled with sediments up to 31,000 feet thick since the middle Miocene. The geologic time scale is shown in Figure 5-1 for reference.

The La Brea plain comprises the primary geomorphic surfaces at the station site. The gently sloping alluvial surface extends from the Santa Monica Mountains toward the south and was formed by accumulation of sediments that had been shed from the mountain front over the course of the late Pleistocene epoch (Poland et al., 1959). This process was accelerated by tectonic uplift along the eastern portion of the Santa Monica Mountain range front, which has resulted in relatively high rates of erosional down-cutting in the mountain range. Repeated tectonic uplift and base level changes caused varying rates of channel incision and aggradations of sediments to areas of gentler topographic gradient. The net result of periodic tectonic uplift was the formation of alluvial surfaces at varying elevations and ages adjacent to the mountain front. Older alluvial surfaces are located at generally higher elevations with respect to younger surfaces due to tectonic uplift and also show greater dissection by stream channels.

5.2 Stratigraphy

The geologic units that will be encountered in the station excavation, from oldest to youngest in geologic age, are the Pleistocene-age San Pedro and Lakewood Formations, Pleistocene-age older alluvium, and modern artificial fill. The Lakewood Formation and underlying San Pedro Formation will be encountered at variable depths in the subsurface beneath a variably thick section of older alluvial deposits and artificial fill. The deeper Pliocene-age sedimentary rock of the Fernando Formation is not anticipated to be encountered in excavations for the station or shoring elements.

Figure 5-1: Geologic Time Scale



The areal distribution of geologic units and major Quaternary faults (Campbell et al., 2014) in close proximity to the alignment and the station site is shown in Figure 5-2. The interpretation of the subsurface contacts between the geologic units is shown on Plates 2-1 and 2-2. The general lithologic compositions of the geologic units that are present at the station site are discussed in the following sections. A more detailed stratigraphy is presented in the borings logs included in Appendix A.

5.2.1 Artificial Fill (Profile symbol: af)

Artificial fill underlies the station site from beneath the road base and adjacent ground surface to approximate depths that range from 5 to 35 feet below ground surface (bgs). Much of the fill was placed in the early 1960's during mass grading of the former Fox studio backlot area. Former southerly trending drainages were filled in to create large graded building pads. Substructure plans indicate the presence of sanitary sewers and storm drains beneath Constellation Boulevard at depths to 30 ft depth bgs. Thus, artificial fill is present above utility pipes in prior backfilled trenches beneath Constellation Boulevard. As encountered in the borings, the fill consists predominantly of clay, sandy clay and clayey sand with some asphalt fragments, and minor debris. The geologic profiles presented in Plates 2-1 and 2-2 show the symbol "af" to indicate the artificial fill.

5.2.2 Older Alluvium (Regional geologic map symbol: Qof; Profile symbol: Qalo)

The older alluvial deposits in the area of the Century City Constellation Station consist of sediments deposited by former stream channels and debris flows that had once flowed southward from the Santa Monica Mountains. These deposits formed a series of alluvial fans that spread out southward from the mountain front during late Pleistocene time. The area of the Century City Constellation Station is located near the distal edge of one of the alluvial fans, shown by the symbol Qof2 on the regional geologic map. The composition of the Older Alluvium as encountered in the current and prior borings consist predominantly of clays, silts, and sandy clays in the finer overbank and muddy debris flow deposits. In the coarser grained portions of the Older Alluvium, clayey sands with variable gravel content, silty sands with gravel, and poorly graded sands with gravels were encountered in the current and prior borings. Although local channels with abundant gravels and occasional cobbles may be present, boulders were not encountered in the borings drilled at the station location. The geologic profiles presented in Plates 2-1 and 2-2 show the symbol Qalo to indicate the older alluvial deposits.

5.2.3 Lakewood Formation (Profile symbol: Qlw)

A sequence of inferred near-shore marine deposits unconformably underlies the Older Alluvium at depths that ranged from approximately 33 to 60 feet bgs. These deposits are interpreted to be a part of the Lakewood Formation. Where encountered in current and prior borings in the Century City Constellation Station area, these materials consist primarily of a moderately stratified sequence of pale yellow to brownish yellow, dense, silty sands, pale olive to gray and pale yellow, poorly graded sands with silt, some well-graded sand layers, minor pale olive to olive brown, stiff to hard, sandy silt layers, and lenses of light brown to gray clay. The Lakewood Formation, as encountered in the borings, stratigraphically overlies the San Pedro Formation. The geologic profiles presented in Plates 2-1 and 2-2 show the symbol Qlw to indicate the Lakewood Formation.

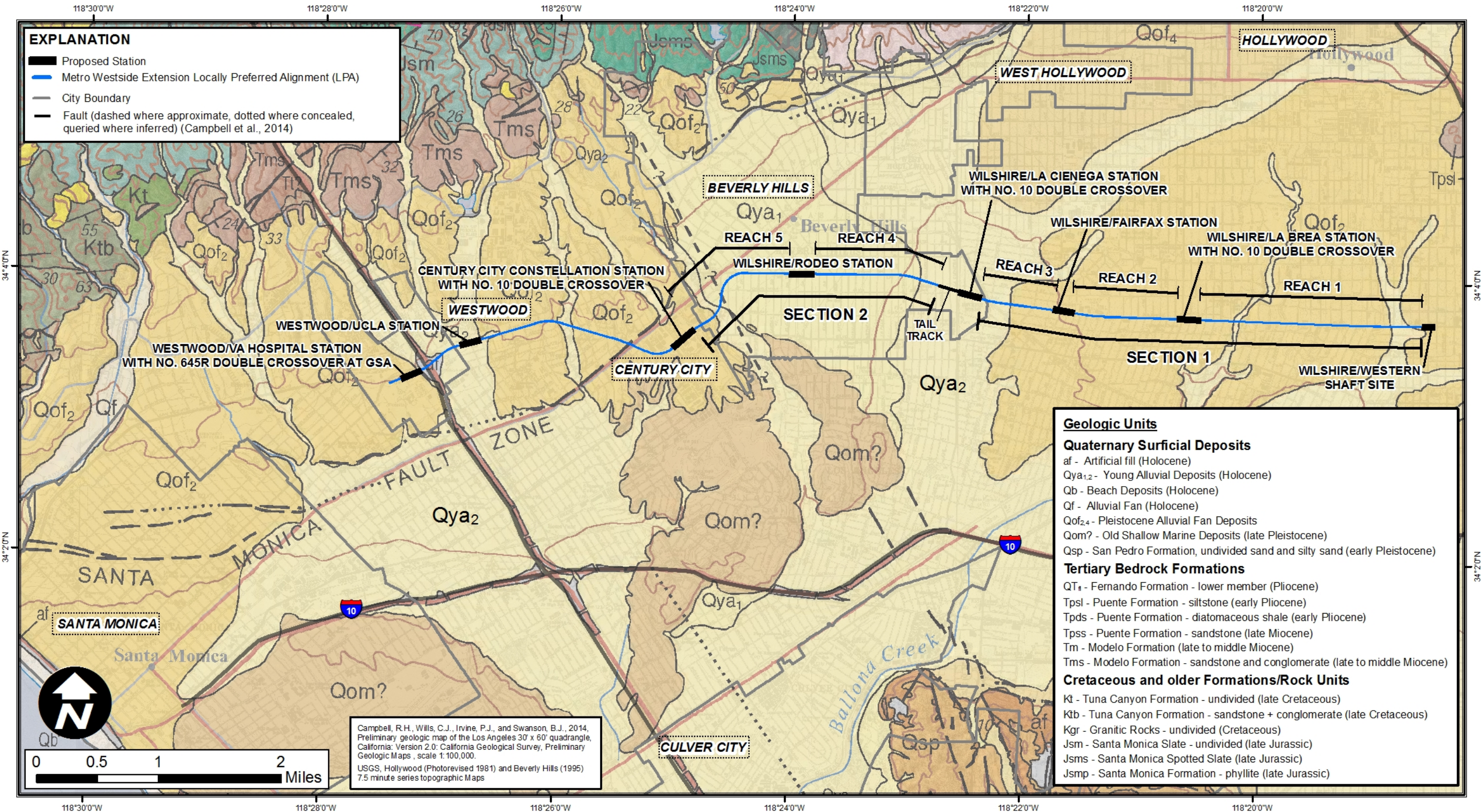
5.2.4 San Pedro Formation (Profile symbol: Qsp)

Primarily marine deposits of the early to mid-Pleistocene age San Pedro Formation underlies the Lakewood Formation at depths that ranged from approximately 65 to 70 feet bgs. The geologic contact

between the two formations appears gradational in some of the current and prior borings. Where encountered in current and prior borings, these deposits consist primarily of light to dark greenish-gray and bluish-gray, dense, silty fine-grained sands, with some interbeds of stiff to hard silts to sandy silts, and some silty to sandy lean clays. Layers of poorly graded, fine- to coarse-grained sands with gravels and sandy gravel layers, and zones of shell fragments were encountered in some of the current and prior borings.

Localized zones of cobbles (but no boulders) were encountered within the formation elsewhere along the alignment. Concretionary deposits and strongly cemented zones, were also encountered in some of the prior borings in the area of the Century City Constellation Station and elsewhere along the tunnel alignment in the San Pedro Formation. Concretionary zones are typically medium strong to strong, lensoidal, and discontinuous, whereas cemented zones are medium strong to strong but typically more laterally continuous. The geologic profiles presented in Plates 2-1 and 2-2 show the symbol Qsp to indicate the San Pedro Formation.

Figure 5-2: Regional Geologic Map



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5.3 Groundwater

5.3.1 Groundwater Basin Hydrogeology

The Century City Constellation station site is located in Section 29 of Township 1 South, Range 15 West, within the Santa Monica Basin hydrogeologic region in Los Angeles County. Faults are reported to subdivide the Santa Monica Basin into five sub-basins: Arcadia, Olympic, Coastal, Charnock and Crestal (MWD, 2007). The Century City Constellation Station is located in the Crestal Sub-basin. Groundwater occurrence in the Santa Monica Basin is generally confined with some areas of unconfined or perched groundwater.

The primary groundwater-producing zones within the Crestal Sub-basin Basin include aquifers within the San Pedro Formation of the Los Angeles Coastal Plain. The aquifers consist generally of permeable sands and gravels separated by semi-permeable to impermeable sandy clay to clay. The relatively shallow groundwater within Older Alluvium has been reported as semi-perched (DWR, 1961).

5.3.2 Groundwater Monitoring Well Measurements

Six groundwater monitoring wells have been installed at the Century City Constellation Station as part of the prior PE phase and current Adv. PE phase. Two of the monitoring wells were installed during the PE phase in 2009 and 2011 and the other four were recently installed in 2015 as part of the Adv. PE phase. Five of the monitoring well locations consist of two separate screens installed inside a single boring. Groundwater level measurements collected in monitoring wells installed during the prior PE phase and the current Adv. PE are presented below. A summary of the well screen intervals, well depths, and groundwater level measurements are presented in Table 5-1.

- The depth to groundwater in M-19 has ranged from 61.9 feet bgs to a depth below the bottom depth of the screen interval (70 feet bgs) based on the monitoring period of August, 2009 to May, 2012.
- The groundwater depth in the shallow well screen in M-119 was approximately 49.9 feet bgs in March, 2012 and 49.9 in May, 2015. It should be noted that this water level depth is only 0.1 feet above the well screen bottom cap and is possibly due to water introduced to the well during the well installation process. Groundwater was not encountered during the monitoring period in the deeper well screen in M-119, which was installed to a depth of 75 feet bgs.
- The groundwater depth measurement in the shallow well screen in M-407 was approximately 59.8 feet bgs, which is about 0.2 feet above the well screen bottom cap. Groundwater was not encountered in the deeper well screen in M-407 or in either of the two (shallow or deep) well screens in M-408.
- The groundwater depth measurement in the deep well screen in M-409 was at approximately 87.1 feet bgs in April and May, 2015. No groundwater was encountered in the shallow well screen in M-409 during the monitoring period. The depths of the well screen intervals are indicated on Table 5-1.
- The groundwater depth measurement in the deep well screen in M-410 was approximately 81.6 feet bgs in April and May, 2015. No groundwater was encountered in the shallow well screen in M-410 during the monitoring period. The depths of the well screen intervals are indicated on Table 5-1.

Groundwater seepage has been reported at various depths in historical borings located to the south and north of Constellation Boulevard. Seepage as shallow as 29 feet bgs (corresponding to Elevation 255 ft

msl) was reported in historical boring MA-69036-B5 drilled in 1969 which was located about 125 feet south of Constellation Boulevard and 250 feet west of Century Park East. A groundwater-level contour map of the Beverly Hills Quadrangle shows the historically highest groundwater level is at approximately 30 to 40 feet bgs at the station location (CDMG, 1998).

Groundwater level depths measured in observation wells, overnight readings measured in soil borings, and depths measured during drilling of borings in ACE, PE and Adv. PE phase explorations are presented on Plates 2-1 and 2-2. Groundwater levels in the observation wells are presented in Table 5-1.

5.4 Geologic/Seismic Hazards

5.4.1 Faults

The numerous faults in Southern California include active, potentially active, and inactive faults. The criteria for these major groups were developed by the California Geological Survey (previously the California Division of Mines and Geology) for the Alquist-Priolo Earthquake Fault Zoning Program (Hart, 1999). By definition, an active fault is one that has had surface displacement within Holocene time (about the last 11,700 years). A potentially active fault is a fault that has demonstrated surface displacement of Quaternary age deposits (last 1.6 million years). Inactive faults have not moved in the last 1.6 million years. A list of the active faults within approximately 100 kilometers of the station site is presented in Table 5-2.

Detailed descriptions of the active faults listed in Table 3-1 along with potentially active faults near the station site are presented in the following section.

5.4.1.1 Active Faults

Santa Monica Fault

The 25-mile-long Santa Monica fault zone extends westward from the western edge of Beverly Hills across West Los Angeles and Santa Monica to Pacific Palisades where it trends offshore and parallels the Malibu coast to near Point Dume (Dolan and Sieh, 1992; Dolan et al., 1995; 2000a). The fault zone exhibits both reverse and left-lateral components of slip (Dolan and Sieh, 1992; Dolan et al., 1997; 2000a). The fault zone may extend eastward as the Hollywood Fault through a ¾-mile-wide left-step, or tear fault, which may coincide with the northern extension of the Newport Inglewood fault zone (Dolan and Sieh, 1992; Dolan et al., 1997; 2000a). The Santa Monica fault zone and Hollywood fault zone are part of a much longer system of oblique left-lateral/reverse faults forming the southern boundary of the Transverse Ranges that extend eastward for more than 150 miles through the northern part of the Los Angeles metropolitan region and to the west offshore (Dolan et al., 2000a).

The Santa Monica fault system is related to the Pliocene-Quaternary structural development of the Santa Monica Mountains. Prior to the late Miocene, the Santa Monica Fault was a normal fault that was reactivated as a reverse fault beginning in the Pliocene (Tsutsumi et al., 2001). In the Century City area, Tsutsumi et al. (2001) interpreted the Santa Monica fault zone to consist of three southern strands and one northern strand with only the northern strand being currently active. Other recent studies (Ziony et al., 1985; Hummon et al., 1992; Dolan and Pratt, 1997; Dolan et al., 2000a) indicate that the northern segment of the Santa Monica fault zone is active and offsets or deforms Holocene sediments.

Dolan et al. (2000a) conducted the most detailed studies of the state of activity of the Santa Monica fault zone in the West Los Angeles area. Their study area was located on the grounds of the Veterans Administration (VA) property just west of the San Diego Freeway, about 1,000 feet south of the proposed Westwood/VA Hospital Station. Trenches revealed a complex zone of faulting that showed evidence for both contractional folding and reverse slip above a north-dipping thrust strand, as well as faulting on dozens of near-vertical, left-lateral strike-slip fault strands that merge downward with the main strand at a depth of 100 to 150 feet (Dolan and Pratt, 1997; Pratt et al., 1998). The total width of this complicated zone of faulting was more than 300 feet.

Radiocarbon dating based on carbon from offset layers indicated definitive evidence for surface rupture on some of these faults between 10,000 and 17,000 years ago, as well as probable evidence for surface rupture on another strike-slip strand between approximately 1,000 and 3,000 years ago (Dolan et al., 2000a). This was cited to be consistent with evidence for slip on the main strand in the most recent earthquake approximately 1,000 to 3,000 years before present (Dolan et al., 2000a).

The location of fault traces within the Santa Monica Fault zone in the Century City area is complex. The Preliminary Geologic Map of the Los Angeles Quadrangle (Campbell et al., 2014) and the Quaternary Fault and Fold Database for the United States (USGS/CGS, 2006) indicate the location of the Santa Monica Fault zone is near Santa Monica Boulevard, about 0.3 miles northwest of the planned Century City Constellation Station.

The location of the Santa Monica Fault zone in the Century City area was investigated as part of the study of tunnel alignment and station locations in Century City and was shown on maps presented in the Century City Area Fault Investigation Report (Metro, 2011). The closest fault trace to the Century City Constellation Station that was identified in the Century City Area Fault Investigation (Metro, 2011) is an east-west trending fault, located approximately 900 feet north of the Century City Constellation Station, and which is probably related to the Santa Monica fault zone. A summary of the main findings of the Century City Area Fault Investigation is presented in Section 6.0 of the Metro Report (2011).

The age of the most recent rupture of the fault trace located approximately 900 feet north of the Century City Constellation Station was undetermined (Metro, 2011). Leighton Consulting (2012) excavated a northerly trending trench on the Beverly Hills High School Campus across an approximate eastward projection of this fault. Leighton (2012) concluded that the fault trace exposed in their northerly trending trench has not ruptured in at least 100,000 years.

Newport-Inglewood Fault Zone

The California Geological Survey show the trace of the Newport-Inglewood Fault zone on the Fault Activity Map of California (Jennings and Bryant, 2010) extending northwest from the Newport Beach offshore area to Beverly Hills. The fault zone is reflected at the surface by a northwest-trending alignment of young anticlinal hills and mesas formed by the folding and faulting of a thick sequence of Pleistocene-age sediments and Tertiary-age sedimentary rocks (Barrows, 1974). However, the geomorphologic expression of the fault zone from Ballona Creek northwest into Beverly Hills is neither well defined, nor well understood.

A north-northwest-trending topographic lineament near the eastern margin of the Cheviot Hills area was identified by Dolan and Sieh (1992) and Dolan et al. (1997; 2000a) as a possible location for the northern extension of the Newport-Inglewood Fault. The lineament is a pronounced topographic

boundary between uplifted and highly dissected older sedimentary units to the west and a gently sloping, younger alluvial plain in Beverly Hills to the east. The lineament exhibits a semi-continuous series of east-facing topographic scarps. These scarps have been eroded and modified by the south-flowing drainage emanating from Benedict Canyon. The location of this topographic lineament is approximately 0.2 miles east of the Century City Constellation Station site.

The approximate trace of the Newport-Inglewood Fault from the Ballona Creek area northwest into Beverly Hills (referred to the Northern Extension by Dolan and Sieh, 1992) has been shown at slightly different locations by the CGS (Campbell et al., 2014, Bedrossian et al., 2012, and Jennings and Bryant, 2010) and the U.S. Geological Survey (2006, 2005) indicating some uncertainty in its location. Based on data presented in the USGS/CGS (2006) Quaternary Fault and Fold Database for the United States, the Century City Constellation Station is approximately 0.3 miles west of the Newport-Inglewood Fault. Only scant geotechnical studies have been conducted in the vicinity of the fault traces shown on the above cited geologic maps. Thus, the fault trace locations shown on the maps are approximate possible locations of the Newport-Inglewood Fault.

The CGS (2010) classified the recency of movement on the northern extension of the Newport Inglewood Fault as Holocene in age. The CGS has not currently established an Alquist-Priolo Earthquake Fault Zone (AP Zone) around the northern extension of the Newport Inglewood Fault in the City of Beverly Hills. The northern end of the current AP Zone for the Newport-Inglewood Fault is located south of the Santa Monica (Interstate 10) Freeway.

In 1933, the southern Los Angeles Basin section of the Newport-Inglewood fault zone ruptured to produce the M6.4 Long Beach earthquake (Hauksson and Gross, 1991). Fault-plane solutions for 39 small earthquakes (between 1977 and 1985) show mostly strike-slip faulting with some reverse faulting along the north segment (north of Dominguez Hills) and some normal faulting along the south segment (south of Dominguez Hills to Newport Beach) (Hauksson, 1987). Recent investigations by Law/Crandall (1993) in the Huntington Beach area indicate that the North Branch segment of the Newport-Inglewood fault zone offsets Holocene-age alluvial deposits in the vicinity of the Santa Ana River.

Hollywood Fault

The active Hollywood fault, trends approximately east-west along the base of the Santa Monica Mountains from the West Beverly Hills Lineament in the West Hollywood-Beverly Hills area (Dolan et al., 2000b and Dolan and Sieh, 1992) to the Los Feliz area of Los Angeles. The fault is about 1.5 miles northeast of the site. Studies by several investigators (Dolan et al., 2000b; Dolan et al., 1997; Dolan and Sieh, 1992; Crook and Proctor, 1992) have indicated that the fault is active, based on geomorphic evidence, stratigraphic correlation between exploratory borings, and fault trenching studies. Additionally, the fault is considered active by the State Geologist (Jennings and Bryant, 2010, and Bryant, 2005).

The location of the Hollywood fault zone in the Hollywood area was identified during prior fault investigations (Earth Technology, 1993) for the Metro Red Line Project at La Brea Avenue and Camino Palmero, north of Franklin Avenue. Geologic profiles developed from continuous core borings drilled for the prior fault investigation revealed a wide zone of stratigraphic offsets of alluvial sediments overlying granitic bedrock along the La Brea Avenue and Camino Palmero transects. Groundwater elevation changes on the order of 40 to 50 feet across the fault were also reported by Earth Technology (1993). Groundwater was encountered at depths ranging from about 45 to 55 feet bgs north of the main fault

WESTSIDE PURPLE LINE EXTENSION PROJECT

zone and at least 90 feet bgs south of the main fault zone (Earth Technology, 1993). This demonstrates that the fault zone is a barrier to the southward flow of groundwater.

Studies by several investigators (Dolan et al., 2000b; Dolan et al., 1997; Dolan and Sieh, 1992; Crook and Proctor, 1992) have indicated that the fault is active based on geomorphic evidence, stratigraphic correlation between exploratory borings, and fault trenching studies. Dolan et al. (1997) evaluated geomorphic elements apparent in the 1926 and 1934 editions of the U.S. Geological Survey topographic map of the Hollywood and Sawtelle Quadrangles. These older edition topographic maps have 5-foot contours allowing for greater resolution of possible topographic scarps and other geomorphic features. Locations of topographic scarps identified by Dolan et al (1997) in the topographic map were then field checked to see whether they may have been related to cultural modifications rather than geologic processes. Their interpretation was illustrated in a tectonic geomorphology map of landforms in the northern portion of the Hollywood and Sawtelle Quadrangles.

The CGS recently delineated an Alquist-Priolo Earthquake Fault Zone around strands of the Hollywood Fault. The zone was based on recent detailed geologic and geotechnical studies for residential and commercial development in the cities of West Hollywood and Los Angeles, which have reported geologic evidence of Holocene displacement at several sites along the Hollywood Fault (Hernandez, J.L., and Treiman, J.T., 2014a).

5.4.1.2 Blind Thrust Faults

Several deep, low-angle blind thrust faults underlie the Los Angeles Basin. These faults are not exposed at the ground surface and do not pose a ground rupture hazard. However, these faults are active features capable of generating future earthquakes. The blind thrust faults postulated to exist within 10 miles of the alignment are included in the following discussion.

Compton Thrust

The Compton blind thrust has been defined from seismic reflection profiles and borehole data (Leon et al., 2009) as a northeast-dipping structure underlying a large portion of the Los Angeles Basin. This blind thrust fault system extends approximately 45 kilometers from southwest Los Angeles County to northern Orange County in a southeastern direction. Leon et al. (2009) has correlated blind faulting at depth to near-surface folding. Six uplift events on the underlying blind thrust ramp have been reported by Leon et al (2009) in the past 14,000 years. The uplift events have been interpreted by investigating deformed Holocene-age layers along buried fold scarps. The minimum uplift in each buried, fold scarp-forming events ranged from 2 to 6 feet or approximately 4.3 to 14 feet s of thrust displacement (Leon et al., 2009). Their study area, which revealed buried folding of Holocene-age layers, is located along Avalon Boulevard in South Los Angeles, located about 10 miles southeast of the Century City Constellation Station. The inferred northwest trend of the fold axis extends from Los Alamitos to the northeastern portion of the Baldwin Hills, about 5 miles southeast of the Century City Constellation Station. Slip rate is estimated to be 0.9 mm/yr (Field et al., 2013). The site is located above a surface projection of the buried, blind thrust fault. The vertical distance from the ground surface at the site to the fault plane at depth is approximately 8 miles.

Puente Hills Thrust

The Puente Hills Blind-Thrust (PHT) fault system is defined based on seismic reflection profiles, petroleum well data and precisely located seismicity (Shaw et. al., 2002). This blind-thrust fault system

extends eastward from downtown Los Angeles to Brea in northern Orange County and overlies the Elysian Park Thrust. The PHT includes three north-dipping segments that are overlain by folds expressed at the surface as the Montebello Hills, the Santa Fe Springs Anticline, and the Coyote Hills. The PHT is believed to be the causative fault of the October 1, 1987, Whittier Narrows Earthquake (ML 5.9) [(Shaw et al., 2002)]. The vertical surface projection of PHT is approximately 4.9 miles east of the Century City Constellation Station site. Postulated earthquake scenarios for the PHT include single segment fault ruptures capable of producing an earthquake of magnitude 6.6 (Mw) and a multiple segment fault rupture capable of producing an earthquake of magnitude 7.1 (Mw). The PHT is not exposed at the ground surface and does not present a potential for surface fault rupture. However, based on deformation of late Quaternary-age sediments above this fault system and the occurrence of the Whittier Narrows earthquake, the PHT is considered an active fault capable of generating future earthquakes beneath the Los Angeles Basin.

Upper Elysian Park Thrust

The Upper Elysian Thrust is a blind thrust fault underlying the central Los Angeles Basin (Petersen et al., 1996). The Upper Elysian Park Thrust, projected vertically to the ground surface, is approximately 8 miles east-southeast of the Century City Constellation Station site at its closest point. As with other blind thrust faults in the Los Angeles area, the Upper Elysian Park Thrust is not exposed at the surface and does not present a potential surface rupture hazard; however, the Upper Elysian Park Thrust should be considered an active feature capable of generating future earthquakes. An average slip rate of 1.5 mm/yr and a maximum magnitude of 6.7 are estimated by Petersen et al. (1996) for the Upper Elysian Park Thrust.

5.4.1.3 Potentially Active Faults

The closest potentially active faults to the site are the Overland fault and the Charnock fault located approximately 1.5 and 4 miles southwest of the site, respectively. The Northridge Hills fault is a potentially active fault located approximately 14 miles north-northwest of the site. The potentially active faults located within 10 miles of the site are discussed in the following section.

Overland Fault

The potentially active Overland fault is located approximately 1.5 miles southwest of the Century City Constellation Station site. The Overland fault trends in a northwest direction between the Charnock fault and the Newport-Inglewood fault zone. The fault extends from the northwest flank of the Baldwin Hills to Santa Monica Boulevard in the vicinity of Overland Avenue. Based on water-level measurements, displacement along the fault is believed to be vertical, with an offset of about 30 feet (Poland, 1959). The west side of the fault has apparently moved downward, relative to the east side, forming a graben (up thrust block) between the Charnock and Overland faults. However, there is no evidence that this fault has offset late Pleistocene or Holocene-age alluvial deposits (County of Los Angeles Seismic Safety Element, 1990). Ziony and Jones (1989) indicate that the fault is potentially active (no displacement of Holocene-age alluvium). Additionally, the State Geologist considers the Overland fault to be potentially active (Jennings, 2010).

Charnock Fault

The potentially active Charnock fault is located approximately 4 miles southwest of the Century City Constellation Station site. The Charnock fault trends in a northwest-southeast direction sub-parallel to

the trend of the Newport-Inglewood fault zone and the Overland fault. Differential water levels across the fault occur in the early Pleistocene-age San Pedro Formation. However, there is no evidence that this fault has offset late Pleistocene- or Holocene-age alluvial deposits (County of Los Angeles Seismic Safety Element, 1990). Ziony and Jones (1989) indicate that the fault is potentially active (no displacement of Holocene-age alluvium). Additionally, the State Geologist considers the Overland fault to be potentially active (Jennings, 2010).

5.4.2 Fault Rupture

Based on the available geologic data and our prior and current investigations, there are no known active or potentially active faults with the potential for surface rupture beneath or projecting towards the station site. The station site is not within a currently established Alquist-Priolo Earthquake Fault Zone (AP Zone) delineated by the State Geologist for surface fault rupture hazards. In addition to the earthquake fault zones established by the state, the City of Los Angeles has established "Fault Rupture Study Areas" to delineate zones of potential surface fault rupture hazards within the City. The site is not in a City of Los Angeles Fault Rupture Study Area. Therefore, the potential for surface rupture at the station site due to fault plane displacement propagating to the surface during the design life of the project is considered low.

Table 5-1: Groundwater Data in Monitoring Wells

Location	Well ID	Total Well Depth (feet bgs)	Screen Intervals (feet bgs)	Date of Measurement	Depth to Water (feet bgs)
Century City Constellation Station	M-19	71	65 – 70	8/19/2009	Dry
				5/20/2011	Dry
				3/30/2012	61.9
				5/24/2012	Dry
	M-119	112	45 – 50	6/22/2011	Dry
				3/30/2012	49.9
				5/24/2012	29.9
				5/13/2015	49.94
				5/28/2015	49.98
			70 – 75	6/22/2011	Dry
				3/30/2012	Dry
				5/24/2012	Dry
				5/13/2015	Dry
				5/28/2015	Dry
	M-407	90	50 – 60	4/9/2015	59.8
				5/13/2015	59.81
				5/28/2015	59.89
			80 – 90	4/9/2015	Dry
				5/13/2015	Dry
				5/28/2015	Dry
	M-408	95	50 – 60	4/9/2015	Dry
				5/13/2015	Dry
				5/28/2015	Dry
			80 – 90	4/9/2015	Dry
				5/13/2015	Dry
				5/28/2015	Dry
	M-409	98	75 – 85	4/9/2015	Dry
				5/12/2015	Dry
			90 – 100	4/9/2015	87.06
				5/12/2015	87.19
	M-410	94	65 – 75	4/9/2015	Dry
				5/12/2015	Dry
			80 – 90	4/9/2015	81.58
				5/12/2015	81.62

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Table 5-2: Major Named Faults Considered to be Active in Southern California

Fault (in increasing distance)	Maximum Magnitude			Slip Rate (mm/yr.)	Distance From Site (mi)	Direction From Site
Compton Thrust*	7.6	(a)	BT	0.9	*	*
Newport-Inglewood Zone	7.1	(a)	SS	1	0.3	ENE
Santa Monica	6.6	(a)	RO	1	0.3	NW
Hollywood	6.4	(a)	RO	0.9	1.5	N
Anacapa-Dune	7.5	(a)	RO	0.39	4.2	WSW
Puente Hills Blind Thrust	7.1	(a)	BT	0.9	4.9	ESE
Upper Elysian Park Thrust	6.4	(a)	BT	1.9	8	ENE
Raymond	6.5	(a)	RO	2	9	ENE
Northridge Thrust	7	(a)	BT	1.5	10	N
Verdugo	6.9	(a)	RO	0.39	11	NNE
Palos Verdes Hills	7.3	(a)	SS	3	12	WSW
Malibu Coast	6.7	(a)	RO	0.3	14	W
Sierra Madre	7.2	(a)	RO	2	15	NE
Sierra Madre (San Fernando)	6.7	(a)	RO	2	15	NNE
Santa Susana	6.7	(a)	RO	6	17	NNW
San Gabriel	7.2	(a)	SS	0.39	19	NNE
Simi-Santa Rosa	7	(a)	RO	0.7	19	NNW
Whittier	6.8	(a)	RO	2.5	21	ESE
Clamshell-Sawpit	6.5	(a)	RO	0.39	24	ENE
Holser	6.5	(a)	RO	0.4	25	N
Oak Ridge	7	(a)	RO	4	30	NNW
San Jose	6.4	(a)	RO	0.39	30	E
San Cayetano	7	(a)	RO	6	30	NNW
San Andreas (Mojave Section)	7.4	(a)	SS	34	37	NE
San Joaquin Thrust	6.6	(a)	BT	0.6	37	SE
Chino	6.7	(a)	RO	1	41	ESE
Cucamonga	6.9	(a)	RO	1.5	43	E
Santa Ynez	7.1	(a)	SS	2	44	NNW
Elsinore (Glen Ivy Section)	6.8	(a)	SS	5	45	ESE
San Jacinto (SB Section)	6.7	(a)	SS	6	54	E
San Andreas (SB Section N)	7.5	(a)	SS	19	55	E

^(a) Cao et al., 2003; Field et al., 2013

Distances from USGS/CGS, 2006

Distances to blind thrust faults are from surface projections.

* Site is within surface projection of blind thrust fault; vertical distance from ground surface at site to fault plane at depth is approximately 8 miles

Blind thrusts faults do not extend into the ground surface and therefore do not have ground surface rupture hazard.

SS-Strike Slip, NO-Normal Oblique, RO-Reverse Oblique

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5.4.2 Historic Earthquakes and Seismicity

A partial list of historic earthquakes, including the magnitude of the earthquake and the distance to the epicenter, is included in Table 5-3. Note that only historic known earthquakes with magnitudes greater than 5.5 and within 60 miles of the station site are shown below.

**Table 5-3: List of Historic Earthquakes with Magnitude greater than 5.5
(within last 150 years and within 60 miles of the Station site)**

Earthquakes (Oldest to Youngest)	Date of Earthquake	Magnitude	Distance to Epicenter (miles)	Direction to Epicenter
Long Beach	March 11, 1933	6.4	38	SSE
San Fernando	February 9, 1971	6.6	25	NNE
Whittier Narrows	October 1, 1987	5.9	19	E
Sierra Madre	June 28, 1991	5.8	29	NE
Northridge	January 17, 1994	6.7	12	NW

Although the site may be subjected to strong ground shaking in the event of an earthquake, this hazard is common in southern California and the effects of ground shaking can be mitigated by proper engineering design and construction in conformance with current codes and construction practices.

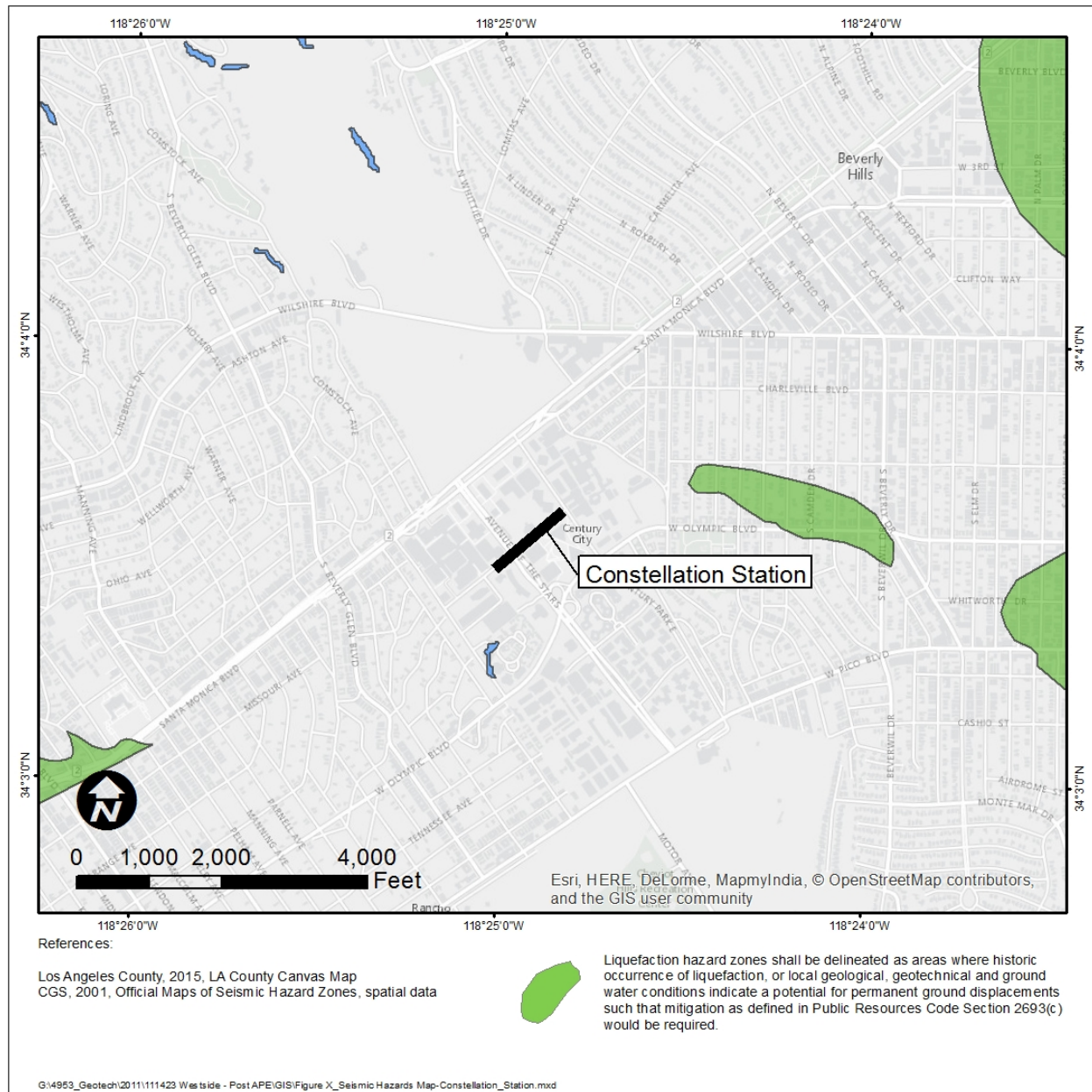
5.4.3 Liquefaction

According to the California Geological Survey (CDMG, 1998) as shown on Figure 5-3, the Century City Constellation Station site is not within an area identified as having a potential for liquefaction due to the presence of older alluvial deposits (Pleistocene age) beneath the site. The older alluvium is comprised primarily of stiff to hard, clay rich sediments with lenses and subordinate layers of dense, silty sands. The older alluvium is underlain by dense sands with some interbedded, very stiff to hard clays of the Lakewood and San Pedro Formations. These older deposits are not susceptible to liquefaction. Therefore, the potential for liquefaction at the Century City Constellation Station site is considered to be low.

5.4.4 Tsunamis, Inundation, Seiches, and Flooding

According to the Safety Element Plan of the City of Los Angeles General Plan (1996), the station site is not located within a potential inundation area by earthquake-induced dam failures or seiches (wave oscillations in an enclosed or semi-enclosed body of water).

According to the Safety Element Plan of the City of Los Angeles General Plan (1996), the station site is not located in a 100-year or 500-year flood plain area. The Century City Constellation Station site is not in a coastal area. The elevation of the site is approximately 285 to 292 feet above msl. Therefore, tsunamis (seismic sea waves) are not considered a hazard at the site.

Figure 5-3: Liquefaction Hazard Map


5.4.5 Gases, Oil Fields and Subsidence

The station site is located within an area designated as “Methane Zone” on the 2004 “Methane and Methane Buffer Zone” map published by City of Los Angeles, Department of Public Works and there is a potential for methane and other volatile gases to occur beneath the site. Therefore, subsurface gas investigations were performed at the station site, as part of the overall geotechnical and environmental study of the WPLE. The results of the subsurface gas investigations are presented in Section 3.2

The station site is located within the limits of the Beverly Hills Oil Field area according to oil field boundary maps published by the California Division of Oil, Gas, and Geothermal Resources (DOGGR,

2006). The Beverly Hills Oil Field was discovered in 1900. It is an east-west trending field that is approximately four miles in length and one-half mile in a north to south direction. The eastern portion of the field was discovered in 1966 and contains two active producing areas located adjacent to Pico Boulevard, which contain directionally drilled oil wells. Active oil production at the western portion of the field consists of the oil well site at the southwestern part of the Beverly Hills High School Campus where there are 15 producing wells and three water injection wells.

A series of oil field boundary maps, prepared by the State of California Division of Oil, Gas, and Geothermal Resources (DOGGR), show the locations of oil wells drilled in the various oil fields of California. The oil field maps indicate the approximate locations and status of the oil wells based on the available records on file with DOGGR. A cluster of 29 abandoned oil wells are shown on DOGGR Oil Field Map 117 W I-5 (dated 10/17/2006) in the area north of the Century City Constellation Station, adjacent to the east side of the Avenue of the Stars. Communication with DOGGR personnel indicates that the accuracy of the well locations shown on the maps is on the order of 100 to 200 feet. Figure 5-4 shows the location of the Constellation Station plotted on the DOGGR Oil Field Map 117 W I-5. Based on DOGGR Oil Field Map 117 W I-5, 29 abandoned and plugged oil wells are shown in the area of the planned station entrance structure.

DOGGR has an on-line well finder mapping system referred to as the DOGGR Online Mapping System (DOMS), in addition to the DOGGR Oil Field Maps, that is based on available well survey data. DOMS (2015) shows two well clusters consisting of a total of 29 abandoned and plugged oil wells near and within the planned station entrance structure. However, there are differences in the plot of the well locations between the on-line digital map (DOMS, 2015) and Oil Field Map 117 W1-5. The on-line digital map (DOMS, 2015) shows the 29 wells located north of Constellation Boulevard in two separate well cluster groups. Seventeen wells are shown in one well cluster adjacent to the northeast side of the intersection of Constellation Boulevard and Avenue of the Stars, ten wells are shown in a second well cluster beneath Avenue of the Stars, and two wells are shown approximately 200 feet north of Constellation Boulevard to the east of the Avenue of the Stars (Figure 5-5).

A geotechnical site investigation report prepared by GeoKinetics (2011) for the property located at 10131 Constellation Boulevard/1950 Avenue of the Stars (adjacent to the north and east sides of Constellation Boulevard and Avenue of the Stars, respectively), included a magnetometer survey and excavation of shallow test pits at the locations of electromagnetic anomalies. Their excavations exposed the top of 27 well casings in the western portion of the site at depths ranging from approximately 0 to 4 feet below ground surface. The well casing locations as identified in the GeoKinetics report, adapted herein as Figure 5-6, appear generally consistent with the configuration of the wells shown in the detail box on the DOGGR Oil Field Map 117. A magnetometer survey was also performed at the suspected location of the oil well designated as Wolfskill 24. An electromagnetic anomaly consistent with the pattern of a well casing at depth was detected by GeoKinetics and appears to be near the location of Wolfskill 24 shown on the DOGGR Oil Field Map 117. The top of the abandoned well casing is believed to be approximately 18 feet below ground surface at this location based upon DOGGR records (GeoKinetics, 2011).

It should be noted that communication with DOGGR personnel indicates the possibility that oil wells may exist in the field which are not shown on DOGGR maps. This possibility exists because records in the early history of the well fields may not be complete or submitted to DOGGR. Magnetometer surveys for

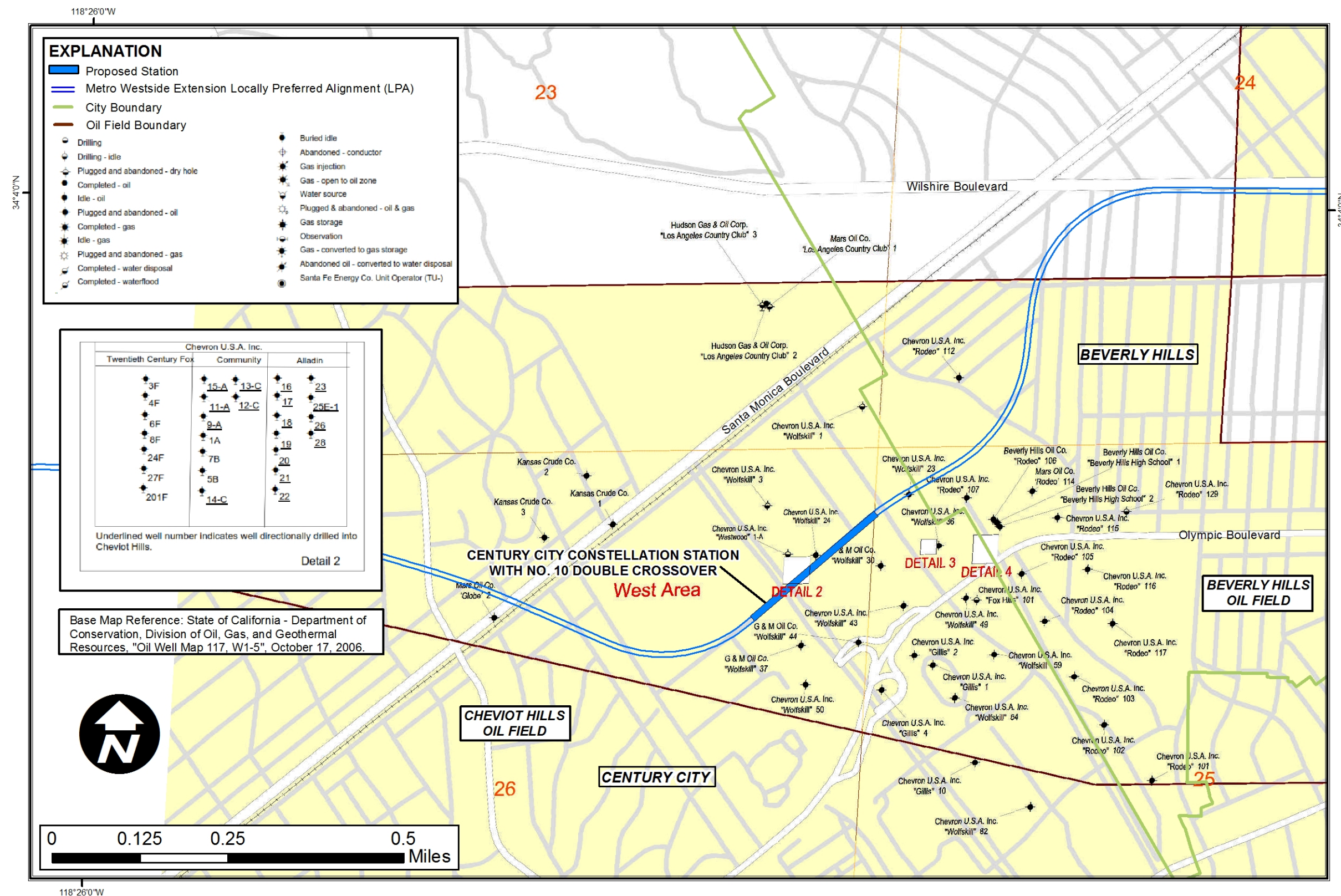
the purpose of detecting possible abandoned oil wells were not performed beneath or adjacent to the Constellation Station during the ACE, PE, or Adv. PE investigation phases.

Regional ground subsidence of relatively minor magnitude has been reported in the areas of the Beverly Hills, Salt Lake, and San Vicente Oil Fields (U.S. Geological Survey, 2003, Hill et al., 1979, Erickson, 1976). The subsidence may be due to on-going tectonic processes in combination with petroleum and groundwater extraction (Erickson, 1976). Oil, natural gas, and groundwater have been extracted from the West Beverly Hills Oil Field for greater than 100 years. Oil production is active in the western portion of the field at Beverly Hills High School and in the eastern portion of the field at well sites adjacent to Pico Boulevard.

Surveys performed by the City of Los Angeles Bureau of Engineering (LABOE) in the Beverly Hills to Hollywood area indicate elevation changes for the period between 1955 and 1970 of approximately 0.20 to 0.25 feet in the area of the Constellation Station, as shown in an elevation change contour map (Hill et al., 1979). The differential subsidence in the area of the Century City Constellation site (for the 15 year period) based on interpolation of elevation contour data was approximately 0.05 feet vertical elevation change over a horizontal distance of 1,000 feet. More recent data collected between 1993 and 1998 by Satellite Interferometric Synthetic Aperture (InSAR) methods indicates subsidence of up to a maximum of 2.2 inches in the Beverly Hills Oil Field in the five year monitoring period (U.S. Geological Survey, 2003).

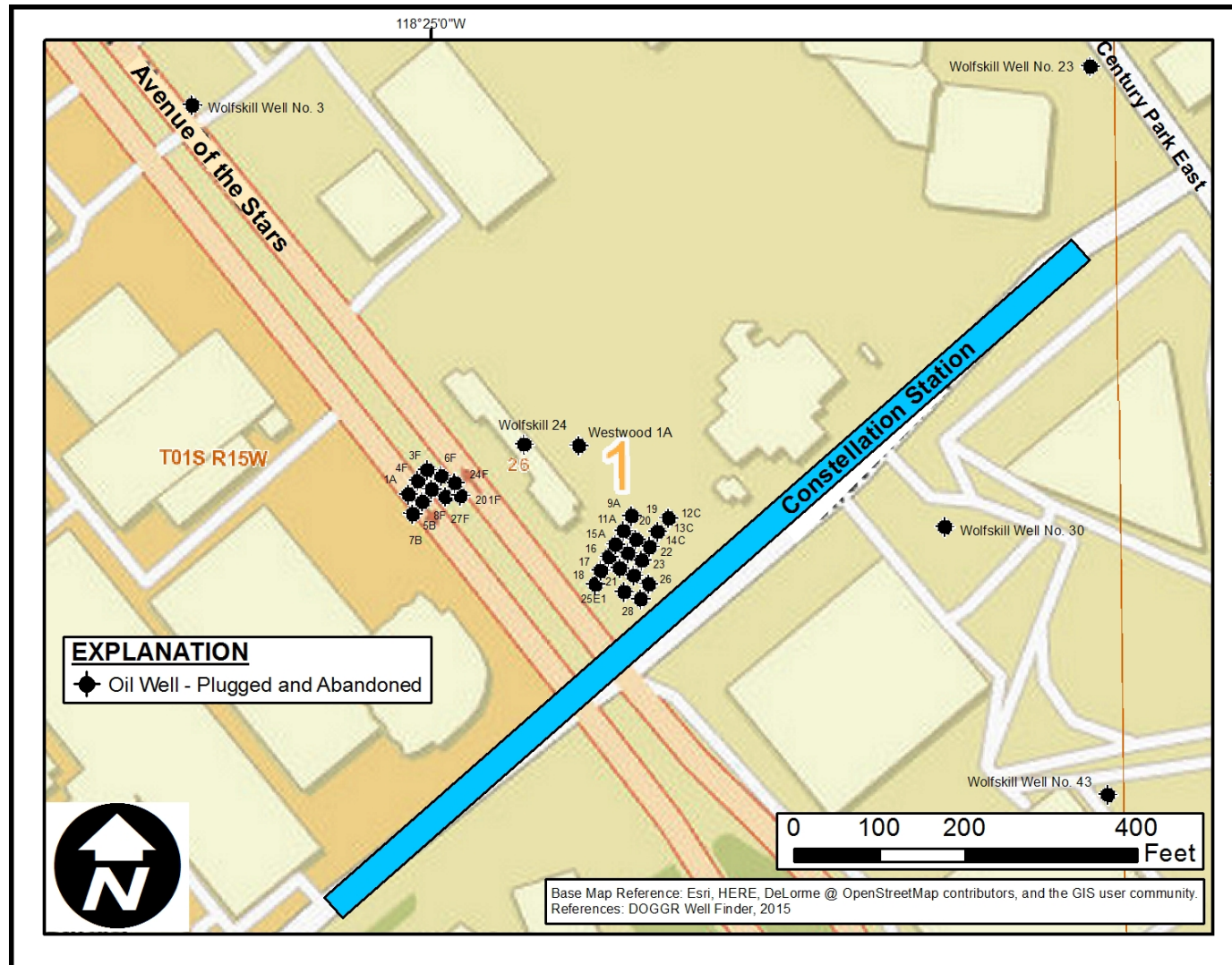
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Figure 5-4: Oil Well Locations shown on DOGGR Oil Field Map 117 W I-5



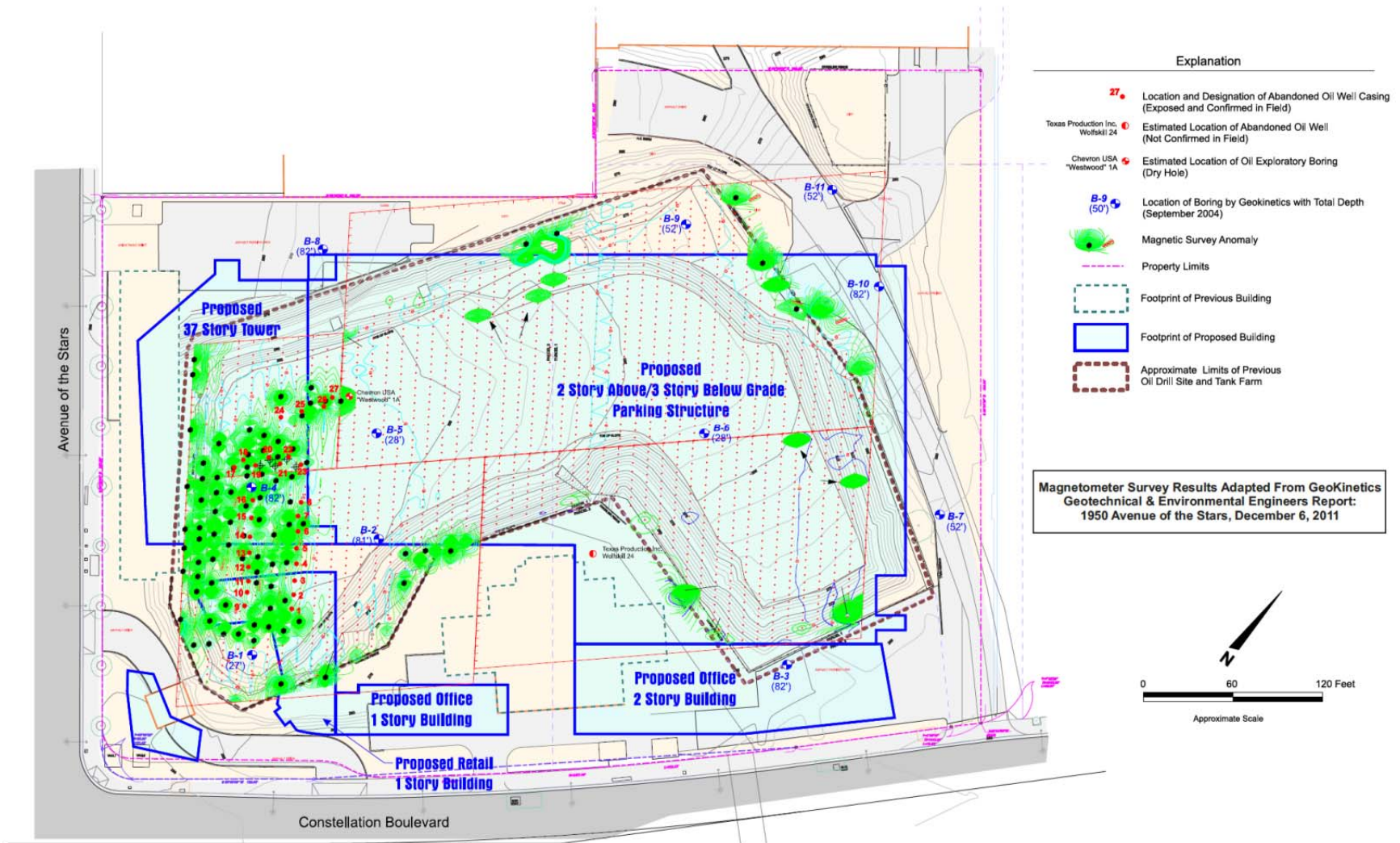
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Figure 5-5: Oil Well Locations shown in DOGGR Online Mapping System (DOMS, 2015)



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Figure 5-6: Magnetometer Survey Results and Oil Well Locations by GeoKinetics (2011)



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APPENDIX A FIELD EXPLORATIONS

Appendix A

Figure A-1.0: Unified Soil Classification System

Figure A-1.1: Logs of Geotechnical Borings (PE Phase)

Figure A-1.2: Logs of Geotechnical Borings (Adv. PE Phase)

Figure A-1.3: Logs of Geotechnical Borings (Prior Projects)

Figure A-1.4: Schematic Diagram of Crandall Sampler

Figure A-2.1: Logs of Subsurface Gas Borings (ACE and PE Phases)

Figure A-2.2: Logs of Subsurface Gas Borings (Adv. PE Phase)

Figure A-2.3: Logs of Subsurface Gas Borings (Prior Projects)

Figure A-3.1: Logs of Phase II Environmental Assessment Explorations (PE Phase)

Figure A-3.2: Logs of Phase II Environmental Assessment Explorations (Adv. PE Phase)

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A.1 DESCRIPTION FIELD EXPLORATIONS

A.1.1 General

The following descriptions of field procedures and methods are applicable for the entire Section 2 of the Westside Purple Line Extension project and hence are not repeated in the reports for other stations or tunnel reaches.

The planning and execution of field explorations consisted of several steps that had to be performed in sequence almost on a daily basis, to ensure that approvals from necessary government agencies were received on-time to plan the field schedule, notify the public of road closures several days prior to field work, and to ensure field work was done safely and to meet Metro's schedule. A work plan was prepared by Amec Foster Wheeler and its predecessor's companies AMEC and MACTEC and submitted to Parsons Brinckerhoff for review, including exhibits that showed proposed explorations. The field explorations were performed in general accordance with the approved work plan, with minor amendments, as suggested or approved by Parsons Brinckerhoff. Some of the key elements of the field program and planning are described below.

A.1.2 Health and Safety Plan

Before the field exploration program was performed, a project-specific health and safety plan (HASP) was prepared to identify potential health and job safety issues and to outline the safe procedures to be followed by the field personnel. The HASP was made available to AMEC's subcontractors for review and to be briefed about the safety hazards and safe practices for hazards expected in the field. In addition, AMEC's subcontractors were briefed about the daily field activities by their respective AMEC field team leader prior to the start of the day's work.

A.1.3 Permits

Permits were obtained from different agencies, as listed below, depending on location of the field work, type of field activities and the hours of field operations:

- City of Los Angeles – Department of Transportation (LADOT), Bureau of Engineering (BOE) and Bureau of Street Services (BSS)
- City of Beverly Hills – Department of Public Works
- County of Los Angeles – Department of Health Services
- Regional Water Quality Control Board
- Los Angeles Police Department (for night work)

The following section provides a brief description of the permitting process followed for the project.

After researching existing utilities from plans obtained electronically from the cities of Beverly Hills or Los Angeles, the locations of the explorations were selected to avoid conflicts with existing utilities and were marked in the field. Accordingly, traffic control plans (TCPs) showing planned traffic lane closures in order to accommodate the exploration activities were submitted to LADOT or the City of Beverly Hills for review and approval. In addition, utility maps prepared for each exploration along with the TCPs were submitted to the City of Los Angeles BOE for an E-Permit or to the City of Beverly Hills. After receiving approval from the agency and paying necessary fees, a permit (designated an E-permit in the

City of Los Angeles) was obtained. If field work required no-parking signs for lanes with paid parking, LA DOT or the City of Beverly Hills was contacted for posting of these signs during field work hours.

In the City of Los Angeles, the E-permit covers a single lane closure, but if two or more lanes required closure, an application was submitted to the Bureau of Street Services (BSS) for multiple lane closures. The approved TCPs and LA DOT sign control numbers were submitted to BSS for further review and approval. After receiving approval from BSS, a necessary fee was paid online to obtain the street use permit. For most explorations, a two-lane closure was sufficient to perform drilling.

Finally, prior to the field work in the City of Los Angeles ~~or City of Beverly Hills, a Los Angeles~~ the City inspector was notified of impending work on a weekly basis. In addition, in the City of Los Angeles, the Police and Fire Departments were notified of street access restrictions that were expected to be caused by drilling activities. For night work in the City of Los Angeles, an approval from the Police Commission was obtained prior to field work.

A.1.4 Mark Borings and Underground Service Alert (Dig Alert)

Before starting the exploration program, a field reconnaissance was conducted to observe site conditions and to mark locations of planned explorations. Electronic versions of utility maps were used in planning exploration locations.

In addition, considering that most of the explorations were within Wilshire Boulevard, and based on our prior drilling experience, a relatively large potential exploration area was marked out on the streets. As required by the State of California, Underground Service Alert (USA) was notified of locations of planned explorations at least 48 hours prior to drilling activities. During this timeframe, based on the USA notification, the utility stakeholders marked out their utilities in the field and provided notification regarding potential utility conflicts affecting exploration locations. The majority of the explorations have been performed within about 50 feet of the planned exploration locations. However, a few of the explorations had to be moved to a greater distance from the originally planned locations to avoid conflict with utilities.

A.1.5 Utility Clearance

USA services are only helpful in identifying potential conflicts with certain utilities in the public right-of-way. For example, non-pressurized sanitary sewers are often not marked by the City of Los Angeles. To further identify potential utilities below exploration locations and to further reduce the risk of damaging utilities, a private utility locator (GeoVision) was subcontracted to locate potential conflicts of underground utilities with exploration locations using geophysical equipment. As a supplemental precaution, explorations were typically performed at least 2 to 3 feet away from the utilities identified with this geophysical method. Finally, the upper 5 to 10 feet of the explorations were excavated using hand and/or vacuum auger equipment. Excavations using hand auger and/or air-vacuum equipment continued until natural soils were encountered.

A.1.6 Traffic Control Measures and Noise Mitigation

Traffic control measures were implemented by A Cone Zone, Inc. of Corona, California (under subcontract to AMEC), when closing traffic or parking lanes during field work. Based on the exploration location and site conditions and governing city requirements, site-specific TCPs were prepared by A Cone Zone, Inc. and submitted to the specified agency for approval of traffic control measures. The

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approved traffic control plans provided procedures for closing lanes and directing street traffic in the field activity area. **When drilling was performed in residential areas and near the Beverly Hills High school, a traffic control officer (TCO) was also provided at each intersection affected by the drilling.**

In order to reduce the noise levels from drilling activities, noise blankets attached to fences around the drilling rig were utilized. In some cases, the upper portion of the drilling mast where the hammer hits the drill rod was also wrapped with a noise blanket. Periodic monitoring of the noise levels was also performed at several distances from the drilling area to ensure the noise levels were below the background traffic noise levels and the nearby businesses and residences were not adversely affected.

A.1.7 Public Notification of Field Work

As requested by Metro, public notifications were prepared detailing field activities, such as the field work area, duration of field activities, types of equipment and traffic lane closures. The notifications were distributed to stakeholders through specified Metro personnel on a weekly basis, prior to the field work.

A.2 GEOTECHNICAL EXPLORATIONS

A.2.1 Rotary-Wash Borings

The borings for the geotechnical explorations during ACE, PE and Adv. PE phases were performed using rotary-wash and hollow-stem auger drilling technique under the supervision of Amec Foster Wheeler's personnel. ~~As the time of this report, Adv. PE phase investigations (only in the City of Los Angeles portion of Section 2 (i.e., on Constellation Boulevard) were performed in 2015. Therefore, the descriptions presented below are valid for the explorations performed thus far.~~

Subcontractors used for the drilling consisted of C&L Drilling (C&L), Fugro Consultants (Fugro), and Tri County Drilling (Tricounty) **and JDK Drilling**. C&L, **and JDK Drilling** performed the ACE, PE and 2015 Adv. PE phase borings while Fugro and Tricounty were primarily used for the PE phase. **JDK Drilling was used enlarge the borehole to install a pumping well at G-408/P-306, but not used to drill and obtain sample.**

The types of drilling rigs used by different subcontractors and the hammer weights and hammer drop used to drive the Crandall and SPT samplers are noted on the respective logs. C&L used a 300 to 380 pound hammer with 18-inch drop for driving the Crandall sampler during the ACE, PE and 2012/2013 Adv. PE phases unless specified in the logs that a 140 pound hammer with 30-inch drop was used for driving both the Crandall and SPT samplers. Tri County and Fugro used 140-pound automatic hammer and 30-inch drop to drive the Crandall sampler. For SPT sampler, all drillers used 140-pound automatic hammer and 30-inch drop as required by ASTM D 1586. The hammer energy ratios (ER) of C&L, Fugro and Tri County SPT hammers in ACE, PE and 2012/2013 Adv. PE phase were 0.60, 0.86, and 0.81, respectively. The hammer energy ratios for SPT hammer in 2015 Adv. PE phase ~~was~~**were 0.70 and 0.76** for C&L.

Bulk samples and relatively undisturbed Crandall ring samples of soil materials were collected at selected depth intervals (about 3 to 5-foot) during drilling activities. The Crandall sampler is similar to the modified California sampler, but has less sample disturbance due to the larger diameter of the Crandall sampler. The Crandall sampler has an inside diameter of 2.625 inches and an outside diameter

of 2.75 inches. The Crandall sample barrel contains six one-inch thick brass rings. A three-dimensional schematic of the Crandall sampler is included in Appendix A.

In addition to obtaining undisturbed samples, standard penetration tests (SPT) were performed in the borings. The number of blows required to drive the Crandall and SPT sampler 12 inches, the hammer weight, and the hammer drop are indicated on the boring logs.

After each Crandall sample was retrieved from the borehole and brought to the ground surface, a photo ionization detector (PID) or a four-gas meter was used to measure the concentrations of volatile organic compounds (VOCs) in the headspace of the samples. The OVA readings are indicated on the boring logs.

Selected Crandall and SPT samples were submitted to the laboratory for testing to evaluate relevant engineering properties. Logs of subsurface conditions encountered in the borings were prepared in the field by Amec Foster Wheeler field personnel. The soils are classified in the accordance with the Unified Soil Classification System described on Figure A-1.0 included in Appendix A. The samples were further reviewed in the laboratory by an engineer and/or a geologist and the logs were revised based on the results of the laboratory tests.

Upon completion of drilling activities, the borings were backfilled with cement/bentonite mix and patched with asphalt concrete. **At select locations, upon completion of drilling activities, gas and/or groundwater monitoring wells were also installed in the borings. Details of the groundwater well installation are presented in the appendix.**

A.2.1.1 Testing in Rotary-Wash Borings

Pressuremeter testing and OYO suspension logging were performed in selected rotary-wash borings. Pressuremeter testing was performed by Amec Foster Wheeler personnel. OYO suspension logging was performed by GEOVision, Inc. Details of these tests are discussed below.

A.2.1.1.1 Pressuremeter Testing

Pressuremeter tests were performed in the ACE, PE, 2012/2013 and 2015 Adv. PE phases. The testing in the PE and Adv. PE phases was more substantial than the testing in ACE phase. Even the limited testing in ACE phase was not applicable for the revised tunnel alignment and station locations considered in the PE and Adv. PE phases.

Pressuremeter tests were performed to determine the Menard modulus (E_m) and at-rest lateral earth pressure coefficient (K_o) of the soil expected along the tunnel and at the stations locations. The pressuremeter tests were performed in accordance with ASTM D 4719-07 using the TEXAM model and an N-size probe that has a diameter of 70 millimeters and is 46 centimeters long.

To conduct a pressuremeter test, the probe was lowered to the test zone, which typically was a 5-foot run, drilled using a 2-7/8 inch diameter tricone auger bit. The rate of penetration of the auger and the drilling mud was controlled such that a clean borehole was achieved and that the borehole diameter met ASTM requirements. The probe was lowered to the test depth, as soon as the drilling of the pressuremeter test hole was completed. A longer delay between drilling and testing could potentially allow sufficient time for caving of borehole, particularly in fine-grained granular soils below groundwater.

A strain controlled test was conducted by applying equal increments of volume (typically 40 cubic centimeters) and taking pressure readings at about 15 second intervals. The test was terminated after the soil reached its plastic zone. In several of the pressuremeter tests, a unload re-load cycle was also performed within the pseudo-elastic zone to evaluate the rebound modulus of the soil and bedrock.

Pressuremeter tests were performed at depths roughly corresponding to the top, center and invert of the tunnel. At station locations, pressuremeter tests were performed at various depths within which station box was planned. The test depths were adjusted in the field, depending on how the drilling program progressed and soil types encountered at these depths. Tests were not performed, if gravelly soils were encountered, since the borehole diameter would be enlarged and would likely not meet the ASTM requirements for borehole size and would also pose a greater risk of damage to the probe in these soils. The estimated Menard modulus (E_m), **unloading modulus (E_u)** and at-rest lateral earth pressure coefficient (K_o) as well as the test results are presented in the report.

A.2.1.1.2 OYO Suspension Logging

Compressional (p-wave) and shear-wave (s-wave) data were obtained in select PE and Adv. PE phase borings by GeoVision, Inc., using the PS suspension logging system manufactured by OYO Corporation. The suspension logging was performed to supplemental the shear-wave data obtained in seismic Cone Penetration Tests.

The suspension logging system consists of two receivers (biaxial geophones) spaced at about 1 meter (3.3 feet) apart and connected to a probe. The probe is lowered into the borehole using a cable after the completion of the drilling of the borehole to the termination depth. The source to generate a wave is located near the tip of the probe. The source creates a horizontally propagating impulsive pressure wave in the fluid filling the borehole and surrounding the source. The pressure is converted to a primary (p-wave) and shear-wave (s-wave) in the surrounding medium (soil and rock) as the pressure wave impinges upon the borehole wall. The waves propagate up through the surrounding medium and create a pressure wave in the drilling fluid surrounding the receivers. Knowing the arrival times of the waves between the two receivers separated by a distance of 3.3 feet, average p and s-wave velocity of the medium is computed. The probe is subsequently lowered to the next depth increment and the process is repeated. The results of the suspension logging are presented in the report.

A.2.2 Hollow-Stem Auger Borings

Hollow-stem auger borings were performed during the 2013 and 2015 Adv. PE phases under the supervision of Amec Foster Wheeler personnel. Martini Drilling was the primarily hollow-stem auger drilling subcontractor. A 140-pound automatic hammer and 30-inch drop was used to drive both SPT and Crandall sampler. The hammer energy ratio (ER) of Martini SPT hammer was reportedly 0.87 in the 2013 Adv. PE phase and 0.7 to 0.78 for the two Martini rigs used in the 2015 Adv. PE phase.

Bulk samples and relatively undisturbed Crandall ring samples of soil materials were collected at selected depth intervals (about 3 to 5-foot) during drilling activities. The Crandall sampler is similar to the modified California sampler, but has less sample disturbance due to the larger diameter of the Crandall sampler. The Crandall sampler has an inside diameter of 2.625 inches and an outside diameter of 2.75 inches. The Crandall sample barrel contains six one-inch thick brass rings. A three-dimensional schematic of the Crandall sampler is included in Appendix A.

In addition to obtaining undisturbed samples, standard penetration tests (SPT) were performed in the borings. The number of blows required to drive the Crandall and SPT sampler 12 inches, the hammer weight, and the hammer drop are indicated on the boring logs.

After each Crandall sample was retrieved from the borehole and brought to the ground surface, a photo ionization detector (PID) or a four-gas meter was used to measure the concentrations of volatile organic compounds (VOCs) in the headspace of the samples. The OVA readings are indicated on the boring logs.

Selected Crandall and SPT samples were submitted to the laboratory for testing to evaluate relevant engineering properties. Logs of subsurface conditions encountered in the borings were prepared in the field by Amec Foster Wheeler field personnel. The soils are classified in the accordance with the Unified Soil Classification System described on Figure A-1.0 included in Appendix A. The samples were further reviewed in the laboratory by an engineer and/or a geologist and the logs were revised based on the results of the laboratory tests.

Upon completion of drilling activities, groundwater monitoring wells were also installed in the borings. Details of the groundwater well installation are presented in the appendix.

A.2.3 Sonic Core Borings

Sonic core borings were performed in the PE phase. The sonic core borings were performed using sonic coring drilling equipment by Boart Longyear. Sonic drilling employs the use of high-frequency, resonant energy to advance a core barrel or casing into subsurface formations. The sonic drilling method advances a casing as the borehole is drilled to prevent caving of the borehole. A 4-inch diameter core barrel was used to retrieve samples. The drilling was performed in 5-foot runs and the samples were collected in bags or 4-inch diameter acrylic tubes.

For the sonic core explorations, samples within a depth range from 10 feet above the tunnel to 20 feet below the tunnel invert were collected in acrylic tubes; the samples outside of this zone were collected in bags. The soils encountered were logged by AMEC field personnel and the samples were transported to the AMEC laboratory for visual inspection, further logging of soil stratigraphy and for laboratory testing. During the visual inspection of bag and tube samples in the laboratory, AMEC personnel also took photographs of the samples and documented them. The photographs of the sonic core borings are also presented in the report.

Upon completion of drilling activities, the borings were backfilled with cement/bentonite mix and patched with asphalt concrete. Details of the groundwater well installation are presented in this appendix.

A.2.4 Continuous Core Borings

Continuous core borings were performed in the Adv. PE phase within the city of Beverly Hills. A total of twenty borings were performed by several subcontracted drillers. One by Cascade Drilling, two by ABC Liovin Drilling, two by JKD Drilling and fifteen by Martini Drilling, Inc. Sample sizes were standard HQ 2.5-inch diameter and PQ 3.3-inch diameter cores. Drill depths ranged between 110 and 245 feet below ground surface (bgs).

Continuous core drilling employed hollow stem drill methods to advance the core barrel into subsurface formations. The hollow stem drill method advances 8-inch diameter augers as a casing as

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the borehole is drilled to prevent caving. Depending on subcontractor drill equipment, either a 3-inch or 4-inch diameter core barrel was used to retrieve samples. The drilling was performed in 5-foot run intervals and the collected core samples were tightly wrapped in plastic, then secured in appropriately labeled wood core boxes.

For the continuous core boring explorations, utility clearance hand augering was performed at each borehole location within the upper 5 to 8 feet bgs. Sample intervals typically began at 5 feet bgs. The soils encountered were logged by Amec Foster Wheeler field personnel and the samples were transported to AFW core storage facility for detail logging of soil stratigraphy and for laboratory testing.

Upon completion of drilling activities, the boreholes were backfilled with cement/bentonite mix and capped with asphalt concrete to match the existing street grade.

A.2.45 Cone Penetration Testing

Cone Penetration Tests (CPTs) were performed in the PE and the Adv. PE phases of the project. The CPTs were performed using a 30-ton truck-mounted CPT rig and a 15 cm² piezocone (CPTu) with enhanced capability of measuring pore water pressures and seismic velocities. The subcontractors used for performing the CPTs for the PE phase were:

1. Kehoe Testing and Engineering, Inc (Kehoe);
2. Gregg Drilling and Testing, Inc (Gregg); and
3. Fugro Consultants (Fugro).

The CPTs were terminated upon reaching the planned exploration depth or upon reaching refusal from hard subsurface conditions. When time permitted, pore pressure dissipation tests were performed at depths below the expected groundwater level to evaluate the static piezometric pressure and to estimate the groundwater level in selected CPTs. Downhole seismic velocity measurements were collected in several of the CPTs at 5-foot intervals. Upon completion of the CPTs, the holes were backfilled with cement bentonite mix, unless the boring was converted into a groundwater monitoring well.

A.2.56 BAT® Groundwater/Gas Sampling in CPTs

BAT® groundwater sampling CPTs were performed in the PE phase of the project. The BAT® procedure allows obtaining of groundwater samples while maintaining the in-situ pressure so that the dissolved gases will not evolve from the groundwater prior to the laboratory testing.

The BAT® groundwater monitoring system (BAT-GMS) sampling is performed first by advancing the CPT to the desired sampling depth and then lowering the BAT® sampler down the CPT drill rods using an extension cable onto the BAT® filter tip. Then, by gravity, the double-ended needle penetrates both the septum in the filter tip and the septum of the sample tube to collect both water and gas samples. The action of both the groundwater pressure and the suction in the sample tube draws groundwater and/or soil gas into the sample tube. Upon lifting the BAT® sampler, the flexible septa in both the filter tip and the sample tube automatically reseal. The liquid and/or gas sample is thereby kept hermetically sealed from the point of sampling to the laboratory. In each sampling run, water and/or gas samples can be collected in up to three 35 milliliter glass tubes.

The collected water samples were stored in an ice chest and transported to environmental labs for analytical testing. Analytical testing of gas tubes (no water/liquid) was performed by Air Technology, Inc. to determine concentrations of Ethane, Methane and Butane in soil gas. Analytical testing of water samples was performed by Orange Coast Analytical to determine concentrations of dissolved VOCs, hydrogen sulfide (H₂S) and fixed gases in groundwater. The results of the analytical testing are presented in the report.

A.2.67 Groundwater Monitoring Wells

Groundwater wells were installed in select geotechnical borings in the ACE, PE and 2012/2015 Adv. PE phases. The purpose of the groundwater monitoring program was to measure the depth to groundwater for an extended period of time. The purpose of installing nested well pairs was to monitor partially or fully hydraulically isolated groundwater bearing intervals within the alluvial deposits (i.e., perched water zones or variable pressure zones at depth). In addition, some of the monitoring wells were also “developed” to permit collection of groundwater samples for water quality testing and to measure concentrations of gases collected in the headspace of the wells.

The groundwater monitoring wells were installed in accordance with requirements set forth in California Well Standards Bulletin 74-90. The monitoring wells for the current exploration were installed using the following procedure:

- The boring was drilled to its target depth; subsequently, the drilling mud was thinned to a level considered feasible by re-circulating clean water through the boring, while using caution to prevent the borehole from caving.
- 1- and/or 2-inch diameter, Schedule-40 PVC pipes with a screened (slotted) depth interval were lowered into the borings. The monitoring well details are provided in the appendix.
- Monterey #3 sand filter pack sand was then placed in the annular space between the PVC pipe and the soil to a depth range from approximately two feet above the top of the screened depth interval to two feet below the bottom of the screened interval.
- Bentonite pellets were placed in the annular space, from the top of the sand filter pack up to the depth of installation for the upper well screen and casing. The bentonite pellets were hydrated in place. The placement of the sand filter pack and bentonite pellet placement was similar for the upper well placement.
- Traffic-rated flush-mounted well-head boxes were installed above the PVC well casing riser and cap. The boxes were set approximately ½ to 1 inch above grade and set in concrete to prevent surface water accumulation.

Well installation and construction details for monitoring wells installed are presented in well construction diagrams included in the GDR. The groundwater wells installed in the ACE, PE and Adv. PE phases were monitored from 2009 through 2015. The monitoring data is included in the GDR.

A.3 SUBSURFACE GAS EXPLORATIONS

A.3.1 Gas Monitoring Wells

Gas monitoring wells installed in the ACE, PE and 2015 Adv. PE phases of the project. Well locations were chosen in consultation with Metro and Parsons Brinckerhoff and were typically selected to be in areas where information on methane and hydrogen sulfide gases was needed.

The monitoring wells were installed by first drilling the boreholes to the required depth using a hollow-stem auger drilling technique. However, gas monitoring wells also installed in few of the borings that were drilling using rotary-wash drilling technique. When drilling mud was used for drilling, the mud was flushed out with water prior to the installation of the wells.

The monitoring well installations typically consisted of two nested soil gas probes and two PVC standpipes within a single boring. The soil gas probes were installed at shallower depths above the groundwater level encountered at the time of drilling. The PVC standpipes were typically screened at, and below, the proposed depth of the tunnel. This configuration provided a means of measuring soil gas concentrations and pressures within the vadose zone, as well as concentrations of gases dissolved in groundwater at the depths of proposed tunneling. The standpipe installations allowed relatively large quantities of groundwater to be purged prior to sample collection, as well as collection of large volume of water samples for analysis. Both of these capabilities were considered important with respect to the accurate measurement of dissolved hydrogen sulfide levels. The gas sampling probes consisted of 1/4-inch diameter polyethylene tubing with a 6-inch long stainless steel screen attached at the bottom. The standpipes typically consisted of 2-inch diameter PVC casings with 5- to 10-foot long screened sections. A traffic-rated well box was set in concrete at the surface to house and protect the installations.

The gas monitoring wells were installed by Amec Foster Wheeler's subcontractors, Jet Drilling, Inc., Martini Drilling Inc., ~~and~~ Gregg Drilling and Testing, Inc **and JDK Drilling**. The drillers provided services under direct supervision of a licensed geologist. In most cases, a dual casing nested well was installed in an 11.25-inch outside diameter (OD) hole with 5- to 10-foot long screens. A few of the wells consisted of a single 2-inch diameter PVC casing placed in an ~~7-25~~**8**-inch diameter hole (with 10- to 20-foot long screened intervals in the casing). **Wells installed for pumping tests were constructed differently and are described in more detail in the pumping test report.** The specific well configuration (i.e. number of gas probes, depth of gas probes, number of standpipes, and depth of screened intervals) was determined in the field by the geologist based on the conditions that were logged at the time of installation. Samples of soil were retrieved during drilling at 5-foot intervals using a Standard Penetration Test barrel to enable lithologic description. Stratigraphic logs and installation schematics for each monitoring well are included in the report. An effort was made to place standpipe screens within saturated zones present near the invert of the proposed tunnel and stations.

The standpipes were immediately sealed (with a PVC cap, equipped with a ¼-inch tubing and a quick connect fitting for head-space gas measurement) following their installation and subsequently developed using nitrogen air lift methods to reduce introduction of oxygen to the subsurface. The introduction of nitrogen into the casing prevented any additional atmospheric oxygen from entering the standpipe during the development process. The standpipes were purged in this manner until the effluent water was relatively clear and without observable suspended solids or sediment.

A.3.2 Sampling Procedures

The following types of sampling and monitoring were performed:

1. Gas concentrations were measured in the standpipes (head-space measurement) and gas probes using hand-held detectors. The gas pressure in the probe or standpipe was also measured along with the barometric pressure.
2. Confirmatory gas samples were collected for analysis at a state-certified laboratory.
3. The groundwater levels in the standpipes were measured.
4. Groundwater samples were collected for analysis of dissolved gases, hydrocarbons, metals, and other substances.
5. Large volume groundwater samples were collected for extraction and analysis of dissolved gases from PE phase wells.

The concentrations of methane, hydrogen sulfide, oxygen, and carbon dioxide in each standpipe and gas probe were measured and recorded during the monitoring events using hand-held infrared gas analyzers (such as Landtec GEM-200 Plus or GA-90 and/or Qrae Plus). The gas probe pressures and the barometric pressure were also recorded during each monitoring event. The gas pressure within the standpipe or gas probe was initially measured using a Magnehelic gauge with a resolution of approximately 0.05 inch of water. This measurement was typically made through a quick-connect fitting that was fixed to the standpipe or gas probe to prevent the loss of gas and potential dissipation of pressure. A multi-gas infrared analyzer was then connected to the installation through a quick-connect fitting. The gas analyzer contained an integral pump that extracted gas from the installation at the rate of approximately 500 cubic centimeters per minute during sampling. The methane, hydrogen sulfide, oxygen, and carbon dioxide levels were monitored continuously while a minimum of one liter of gas was purged from the installation. Significant variations in the indicated gas concentrations generally did not occur during measurement. In each case, the highest indicated gas concentration was recorded. If the recorded highest hydrogen sulfide was in excess of 100 ppm, then a confirmatory reading was obtained using a Draeger tube sampler. In some cases, the gas probes could not be sampled due to accumulation of tar or perched groundwater at the tip depth.

At selected locations, gas samples were collected in Tedlar bags for analysis at a state-certified laboratory.

Following the pressure and gas concentration measurements, the caps were removed from the standpipes and the groundwater level was measured using a conductivity-based water level indicator.

A.3.3 Sampling of Groundwater for Analysis of Dissolved Gases

After standpipes were developed and purged, groundwater samples were collected for fixed lab analysis of dissolved hydrogen sulfide, methane, and other gases (CO₂, ethane, etc.). In some cases groundwater samples were collected for analyses of VOCs, metals, and other substances per the request of Parsons Brinckerhoff/Metro. A dedicated pneumatic pump was installed in each standpipe to facilitate collection of groundwater samples for dissolved gas analysis. The pumps were driven with compressed nitrogen to prevent introduction of air (oxygen) into the standpipes. The nitrogen feed and groundwater effluent lines for in-casing pumps extended to gas-tight fittings at the standpipe cap such that the installations

could be purged, and groundwater samples could be collected, without removing the caps. The groundwater samples were collected in sealed, clear, Schedule 40 PVC sampling containers that were 18-inches long by 2-inches in diameter. A gas-tight quick-connect fitting on one end of the container was connected to the pump discharge line at the well cap. Another gas-tight quick-connect fitting on the other end of the container was connected to an adjustable back-pressure valve. Prior to sampling, the valve was adjusted to maintain a back-pressure equivalent to the hydrostatic pressure at the bottom of the standpipe. Several volumes of groundwater were then purged through the container using the nitrogen driven pneumatic pump. After a minimum of three casing volumes was pumped through the sampling container, the quick-connect fittings were detached and the container was transported to a State-certified laboratory under chain-of-custody protocol. The results of the laboratory testing are presented in the GDR.

A.3.4 Dissolved Gas Extraction

Relatively large volume groundwater samples were collected from the standpipes in 5 to 10 liter Tedlar bags. The bags were evacuated and sealed prior to sample collection. The groundwater was purged from the standpipes using the same dedicated nitrogen-driven pneumatic pumps described above. The groundwater was maintained at, or above, its in-situ hydrostatic pressure until it entered the Tedlar bag. Once filled, the sealed bag was transported to a fixed laboratory and placed in a vacuum chamber. The pressure in the chamber was reduced to less than 1% of atmospheric pressure and the dissolved gases in the sample were allowed to evolve over a period of several hours. At that point, atmospheric pressure was restored and the volume of accumulated gas was measured. The evolved gas was then extracted from the Tedlar bag using a large volume syringe and injected into a train of infrared gas analyzers to quantify methane, hydrogen sulfide, oxygen, and carbon dioxide. The results of this testing are presented in the GDR.

KEY TO SYMBOLS AND DESCRIPTIONS
FOR GEOTECHNICAL EXPLORATION LOGS

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES		Undisturbed Sample		Auger Cuttings		Correlation of Penetration Resistance with Relative Density and Consistency (continued)																																
COARSE GRAINED SOILS (More than 50% of material is LARGER than No. 200 sieve size)	GRAVELS (More than 50% of coarse fraction is LARGER than the No. 4 sieve size)	CLEAN GRAVELS (Little or no fines)	GW	Well graded gravels, gravel - sand mixtures, little or no fines.		X	Split Spoon Sample		Bulk Sample	<u>CRANDALL Sampler (300-lb hammer, 18-inch drop)²</u>																																
			GP	Poorly graded gravels or grave - sand mixtures, little or no fines.			Rock Core							Crandall Sampler																												
		GRAVELS WITH FINES (Appreciable amount of fines)	GM	Silty gravels, gravel - sand - silt mixtures.		Dilatometer	Noise/Vibration		PMT	Pressuremeter		SAND & GRAVEL		SILT & CLAY																												
			GC	Clayey gravels, gravel - sand - clay mixtures.								No Recovery		No. of Blows	Relative Density	No. of Blows	Consistency																									
	SANDS (More than 50% of coarse fraction is SMALLER than the No. 4 Sieve Size)	CLEAN SANDS (Little or no fines)	SW	Well graded sands, gravelly sands, little or no fines.		Water Table at time of drilling	Correlation of Penetration Resistance with Relative Density and Consistency		Water Table after drilling	<u>CRANDALL Sampler (340-lb hammer, 18-inch drop)³</u>																																
			SP	Poorly graded sands or gravelly sands, little or no fines.										<u>SPT Sampler (140-lb hammer, 30-inch drop)</u>																												
		SANDS WITH FINES (Appreciable amount of fines)	SM	Silty sands, sand - silt mixtures		SAND & GRAVEL		SILT & CLAY		SAND & GRAVEL		SILT & CLAY																														
			SC	Clayey sands, sand - clay mixtures.		No. of Blows	Relative Density	No. of Blows	Consistency	No. of Blows	Relative Density	No. of Blows	Consistency																													
	FINE GRAINED SOILS (More than 50% of material is SMALLER than No. 200 sieve size)	SILTS AND CLAYS (Liquid limit LESS than 50)	ML	Inorganic silts and very fine sands, rock flour, silty of clayey fine sands or clayey silts and with slight plasticity.		0 - 4	Very Loose	0 - 1	Very Soft	0 - 5	Very Loose	0 - 1	Very Soft																													
				Inorganic lays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.		5 - 10	Loose	2 - 4	Soft	6 - 11	Loose	2 - 5	Soft																													
CL			Inorganic silts and organic silty clays of low plasticity.		11 - 30	Medium Dense	5 - 8	Medium Stiff	12 - 32	Medium Dense	6 - 9	Medium Stiff																														
			Organic silts and organic silty clays of low plasticity.		31 - 50	Dense	9 - 15	Stiff	33 - 53	Dense	10 - 16	Stiff																														
OL					Over 50	Very Dense	16 - 30	Very Stiff	Over 53	Very Dense	17 - 32	Very Stiff																														
SILTS AND CLAYS (Liquid limit GREATER than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.		<u>CRANDALL Sampler (140-lb hammer, 30-inch drop)¹</u>				<u>CRANDALL Sampler (380-lb hammer, 18-inch drop)⁴</u>																																	
			CH	Inorganic clays of high plasticity, fat clays									SAND & GRAVEL		SILT & CLAY		SAND & GRAVEL		SILT & CLAY																							
		No. of Blows		Relative Density	No. of Blows	Consistency	No. of Blows	Relative Density	No. of Blows	Consistency	No. of Blows	Relative Density	No. of Blows	Consistency																												
		TAR IMPACTED SOILS				0 - 7	Very Loose	0 - 2	Very Soft	0 - 4	Very Loose	0 - 1	Very Soft																													
						8 - 16	Loose	3 - 7	Soft	5 - 10	Loose	2 - 4	Soft																													
BOUNDARY CLASSIFICATIONS: Soils possessing characteristics of two groups are designated by combinations of group symbols.						17 - 47	Medium Dense	8 - 13	Medium Stiff	11 - 29	Medium Dense	5 - 8	Medium Stiff																													
						48 - 77	Dense	14 - 23	Stiff	30- 47	Dense	9 - 14	Stiff																													
<table><tr><td rowspan="2">SILT OR CLAY</td><td colspan="3">SAND</td><td colspan="2">GRAVEL</td><td rowspan="2">Cobbles</td><td rowspan="2">Boulders</td></tr><tr><td>Fine</td><td>Medium</td><td>Coarse</td><td>Fine</td><td>Coarse</td></tr><tr><td colspan="8">No.200 No.40 No.10 No.4 3/4" 3" 12"</td></tr><tr><td colspan="8">U.S. STANDARD SIEVE SIZE</td></tr></table>						SILT OR CLAY	SAND			GRAVEL		Cobbles	Boulders	Fine	Medium	Coarse	Fine	Coarse	No.200 No.40 No.10 No.4 3/4" 3" 12"								U.S. STANDARD SIEVE SIZE								Over 77	Very Dense	25 - 47	Very Stiff	Over 47	Very Dense	15 - 29	Very Stiff
							SILT OR CLAY	SAND			GRAVEL			Cobbles	Boulders																											
Fine	Medium	Coarse	Fine	Coarse																																						
No.200 No.40 No.10 No.4 3/4" 3" 12"																																										
U.S. STANDARD SIEVE SIZE																																										
								Over 47	Hard			Over 29	Hard																													
Reference: The Unified Soil Classification System, Corps of Engineers, U.S. Army Technical Memorandum No. 3-357, Vol. 1, March, 1953 (Revised April, 1960)						NOTES:																																				
						¹ For sampling performed by Tri-County and Fugro Rigs in 2011, C&L Rigs in 2012 and 2015, and Martini Rigs in 2015																																				
						² For sampling performed by C & L Rig #1																																				
						³ For sampling performed by C & L Rig #2 prior to 3/8/2011																																				
						⁴ For sampling performed by C & L Rig #2 after 3/8/2011																																				

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS	DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
										DRILLING METHOD	BOREHOLE LOCATION	G-168
										Rotary Wash	Sta 707+00, Lt 30 feet	
										DATES DRILLED	HOLE DIAMETER	GROUND EL.
										1/12/2011 - 1/14/2011	4-7/8 inches	284 feet
										GROUNDWATER READINGS		
										Ground-water level not measured.		
Century City / Constellation Station										8-inch thick Asphalt Concrete over 10-inch thick Base Course		
										FILL [af]		
										SILTY CLAY - moist, light brown, trace fine sand		
										Becomes more sandy, trace gravel		
										Becomes clayey, trace slate gravel (up to 1/4 inch in size)		
										CLAYEY SAND - moist, brown, trace gravel		
										QUATERNARY OLDER ALLUVIUM [Qalo]		
										SILTY SAND - medium dense, moist, brown and gray, fine to medium-grained, some coarse sand, some gravel		
										Becomes brown, trace clay and slate gravel		
										LEAN CLAY with SAND - stiff, moist, olive brown, fine sand, trace gravel		
	5		1.3	15.3	118	30						
		26	0.7	13.7	-							
	10		1.2	12.2	113	13						
		15	0.8	22.1	-							
			0.9	26.7	95	19						
	20	16	0.7	31.5	-							
			1.3	23.7	-	34						
	25	30	0.6	26.6	-							
			1.5	17.3	107	37						
	30		0.6	29.7	-							
			1.2	18.7	113	36						
	35		0.8	17.2	-		87					
		24										
	40											

(CONTINUED ON FOLLOWING FIGURE)







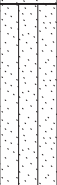
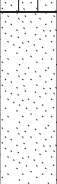

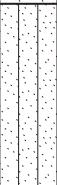
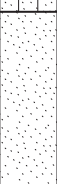


Field Tech: AR
Prepared/Date: JF 3/17/2011
Checked/Date: 9/20/2011

MTA Westside Subway Extension
Los Angeles, California

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LOG OF BORING
Project No.: 4953-11-1423 Figure: A-1.1.1a

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

										DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.	
										C & L Drilling / Mayhew 1000		G-168 (Continued)	
										DRILLING METHOD	BOREHOLE LOCATION		
										Rotary Wash		Sta 707+00, Lt 30 feet	
										DATES DRILLED		HOLE DIAMETER	GROUND EL.
										1/12/2011 - 1/14/2011		4-7/8 inches	284 feet
										GROUNDWATER READINGS			
										Ground-water level not measured.			
ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS				
Century City / Constellation Station			1.4	32.1	87	50		☒			CL	LEAN CLAY - hard, moist, olive gray to greenish gray, cemented silt pods and calcium carbonate nodules	
	45	68	0.5	25.8	-			☒			SM	LAKEWOOD FORMATION [Qlw]	
											ML	SILTY SAND - very dense, moist, blueish gray to light gray, fine to medium-grained SILT - hard, moist, bluish gray, some clay	
											SM	SILTY SAND - very dense, moist, blueish gray to greenish gray, fine-grained	
	50		1.1	18.4	105	75/9"		☒			SP	POORLY GRADED SAND - very dense, moist, light gray, fine to medium-grained 6-inch thick cobble at 50½ feet	
		97/9"	0.4	17.9	-			☒			SM	Becomes greenish gray	
	55										SM	SILTY SAND - very dense, moist, blueish gray, fine to medium-grained, some coarse sand 6 to 8-inch thick cobble at 55½ feet	
			1.4	12.7	112	100/5"	15	☒			SP	Some gravel (up to 1/2 inch in size)	
	60										SP	SAN PEDRO FORMATION [Qsp] POORLY GRADED SAND - very dense, moist, blueish gray to greenish gray, fine to medium-grained	
		93/9"	0.5	10.2	-			☒			SM	Thin layer of Silty Sand	
65										SM	SILTY SAND - very dense, moist, greenish to blueish gray, fine to medium-grained		
		1.3	22.0	100	50/5"	21	☒			SP	POORLY GRADED SAND - very dense, moist, dark gray, fine to medium-grained		
70													
	50/5"	1.0	18.0	-				☒					
75													
		1.2	14.4	100	50/3"			☒					
80													

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: AR
Prepared/Date: JF 3/17/2011
Checked/Date: 9/20/2011

MTA Westside Subway Extension
Los Angeles, California

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LOG OF BORING
Project No.: 4953-11-1423 Figure: A-1.1.1b

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

								DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
								C & L Drilling / Mayhew 1000		G-168 (Continued)
								DRILLING METHOD	BOREHOLE LOCATION	
								Rotary Wash	Sta 707+00, Lt 30 feet	
								DATES DRILLED	HOLE DIAMETER	GROUND EL.
								1/12/2011 - 1/14/2011	4-7/8 inches	284 feet
								GROUNDWATER READINGS		
								Ground-water level not measured.		
ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS	
		50/3"	1.0	13.1	-		22	☒		SM SILTY SAND - very dense, moist, dark gray, fine to medium-grained
	85									
				-	-	100/ 4 1/2"		☐		(Sample not recovered)
	195									
	90		1.2	27.2	92	70/5"		☒		SP POORLY GRADED SAND - very dense, moist, dark gray, fine to medium-grained
	190									
	95									
		43	1.0	10.3	-		81	☒		CH FAT CLAY with SAND - hard, moist, dark gray, fine to medium sand
	185									
	100									
										SP POORLY GRADED SAND - moist, gray, fine to medium-grained, some coarse sand, trace gravel
	180									SM SILTY SAND with GRAVEL - very dense, slightly moist to moist, dark gray, fine to coarse-grained
	105	1.2	9.9	119	75/5"			☒		
	175									
	110	50/4"	1.2	13.8	-		19	☒		Gravel (up to 3/4 inch in size)
	170									END OF BORING AT 112 FEET
	115									NOTES: Hand augered upper 5 feet to avoid damage to utilities. Borehole grouted with cement-bentonite slurry and patched with asphalt concrete.
	165									"N" Value Standard Penetration Test: Number of blows required to drive the SPT sampler 18 inches using a 140 pound automatic hammer falling 30 inches *Number of blows required to drive the Crandall Sampler 12 inches using a 300 pound hammer falling 18 inches **Photo Ionization Detector used for OVA readings
	120									Field Tech: AR Prepared/Date: JF 3/17/2011 Checked/Date: 9/20/2011
MTA Westside Subway Extension Los Angeles, California								amec foster wheeler		LOG OF BORING Project No.: 4953-11-1423 Figure: A-1.1.1c

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

										DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
										C & L Drilling / Mayhew 1000		G-169
										DRILLING METHOD	BOREHOLE LOCATION	
										Rotary Wash		Sta 714+20, Lt 10 feet
										DATES DRILLED		GROUND EL. 292 feet
										1/10/2011 - 1/12/2011		
										HOLE DIAMETER		
										4-7/8 inches		
										GROUNDWATER READINGS		
										Drilling mud bailed on 1/12/2011. Ground-water level measured at 48 feet below the ground surface 30 minutes after bailing of drilling mud.		
ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS			
Century City / Constellation Station											8-inch thick Asphalt Concrete over 6-inch thick Base Course	
										CL-ML	FILL [Af] SILTY CLAY - moist, brown with some gray, trace slate gravel	
	5		0.2	25.7	93	15				CL	LEAN CLAY with SAND - moist, olive brown, fine sand, trace gravel	
		14	0.2	14.2	-					SM	SILTY SAND - moist, light brown, fine to medium-grained	
	10		0.7	17.5	109	10				CL	SANDY LEAN CLAY - moist, brown to dark gray, fine sand	
		4/6"	0.3	21.1	-					CL	LEAN CLAY with SAND - soft, moist, light brown, fine to coarse sand	
			0.4	25.9	101	11					Becomes stiff, thin layer of Silt, trace clay and sand	
	20	15	0.5	21.2	-						Becomes olive brown, trace very fine sand	
			0.1	27.3	97	17						
	25	25	0.1	27.2	-						Becomes very stiff, trace organics	
			0.6	13.0	120	41				SC	LAKEWOOD FORMATION [Olw] CLAYEY SAND - dense, moist, olive brown, fine to medium-grained, trace gravel	
		30	43	0.4	15.7	-		43		SM	SILTY SAND - dense, moist, light brown, fine-grained, with some clay	
	35		0.3	14.7	109	72/11"					Alternating with layers of Poorly Graded Sand, light gray	
		90	0.4	14.9	-		12		SP-SM	POORLY GRADED SAND with SILT - very dense, moist, brown, fine to medium-grained		
40												

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: AR
Prepared/Date: JF 3/30/2011
Checked/Date: 9/20/2011

MTA Westside Subway Extension
Los Angeles, California

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LOG OF BORING
Project No.: 4953-11-1423 Figure: A-1.1.2a

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS	DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
										DRILLING METHOD	BOREHOLE LOCATION	G-169 (Continued)
										Rotary Wash	Sta 714+20, Lt 10 feet	
										DATES DRILLED	HOLE DIAMETER	GROUND EL.
										1/10/2011 - 1/12/2011	4-7/8 inches	292 feet
										GROUNDWATER READINGS		
										Drilling mud bailed on 1/12/2011. Ground-water level measured at 48 feet below the ground surface 30 minutes after bailing of drilling mud.		
Century City / Constellation Station			0.1	19.0	101	94/8"		☒			Becomes light brown, trace iron oxide stains	
	45	96/11"	0.6	18.4	-			☒			Gray to olive brown	
			0	12.8	106	50/5"		☒			▽ Becomes brown	
	50								PMT		Some gravel	
		84	0.2	24.2	-			☒			SILTY SAND - very dense, moist, brown, fine-grained	
	55											
			0.3	17.7	107	93/10"	26	☒			POORLY GRADED SAND with SILT - very dense, moist, light brown to yellowish brown, fine to medium-grained, iron oxide stains	
	60										SILTY SAND - very dense, moist, olive brown, fine to medium-grained, iron oxide stains	
		63	0.1	21.8	-			☒				
	65											
			0	18.3	94	93/10"	33	☒			SAN PEDRO FORMATION [Osp] SILTY SAND - very dense, moist, light bluish gray, fine to medium-grained	
	70											
		50/6"	0.1	22.9	-			☒			POORLY GRADED SAND with SILT - very dense, moist, bluish gray, fine to medium-grained, shell fragments, some slate gravel	
	75											
			0.1	30.5	86	66	15	☒			SILTY SAND - very dense, moist, bluish gray to gray, fine to medium-grained	
	80											

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: AR
Prepared/Date: JF 3/30/2011
Checked/Date: 9/20/2011

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LOG OF BORING
Project No.: 4953-11-1423 Figure: A-1.1.2b

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ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS	DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
										DRILLING METHOD	BOREHOLE LOCATION	G-169 (Continued)
										Rotary Wash	Sta 714+20, Lt 10 feet	
										DATES DRILLED	HOLE DIAMETER	GROUND EL.
										1/10/2011 - 1/12/2011	4-7/8 inches	292 feet
										GROUNDWATER READINGS		
										Drilling mud bailed on 1/12/2011. Ground-water level measured at 48 feet below the ground surface 30 minutes after bailing of drilling mud.		
Century City / Constellation Station	85	93	0.1	14.6	-			☒			Some coarse sand, trace gravel	
	90	50/4"		29.4	-			☒		SW-SM	WELL GRADED SAND with SILT and GRAVEL - very dense, wet, bluish gray to gray, fine to medium-grained, gravel (up to 1 inch in size)	
	95			17.3	112	51	55	☒		SP	POORLY GRADED SAND - very dense, wet, dark gray, fine-grained	
	100	44	1.5	13.4	-			☒		CL	SANDY LEAN CLAY - hard, moist, dark gray, fine sand, trace gravel (up to 3/8 inch in size), some shell fragments	
	105		0	14.6	116	87/8"		☒		ML	SILT - hard, moist, dark bluish gray, trace sand	
	110	50/4"	0	23.8	-			☒			Becomes gray	
	115			-	-	91/9"		☐			Trace gravel	
	120									SP	POORLY GRADED SAND - very dense, wet, dark gray, fine to medium-grained	
											(Sample not recovered)	
										SM	SILTY SAND - very dense, wet, dark gray, fine to medium-grained	

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: AR
Prepared/Date: JF 3/30/2011
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Los Angeles, California

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LOG OF BORING
Project No.: 4953-11-1423 Figure: A-1.1.2c

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS	DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
										DRILLING METHOD	BOREHOLE LOCATION	G-169 (Continued)
										Rotary Wash	Sta 714+20, Lt 10 feet	
										DATES DRILLED	HOLE DIAMETER	GROUND EL.
										1/10/2011 - 1/12/2011	4-7/8 inches	292 feet
										GROUNDWATER READINGS		
										Drilling mud bailed on 1/12/2011. Ground-water level measured at 48 feet below the ground surface 30 minutes after bailing of drilling mud.		
170		50/6"		27.1	-			<input checked="" type="checkbox"/>		<p>END OF BORING AT 121 FEET</p> <p>NOTES:</p> <p>Hand augered upper 5 feet to avoid damage to utilities. Borehole grouted with cement-bentonite slurry and patched with asphalt concrete.</p> <p>"N" Value Standard Penetration Test: Number of blows required to drive the SPT sampler 18 inches using a 140 pound automatic hammer falling 30 inches</p> <p>*Number of blows required to drive the Crandall Sampler 12 inches using a 300 pound hammer falling 18 inches</p> <p>**Photo Ionization Detector used for OVA readings</p> <p>Downhole Test: PMT = Pressuremeter</p>		
125												
165												
130												
160												
135												
155												
140												
150												
145												
145												
150												
140												
155												
135												
160												

Field Tech: AR
Prepared/Date: JF 3/30/2011
Checked/Date: 9/20/2011

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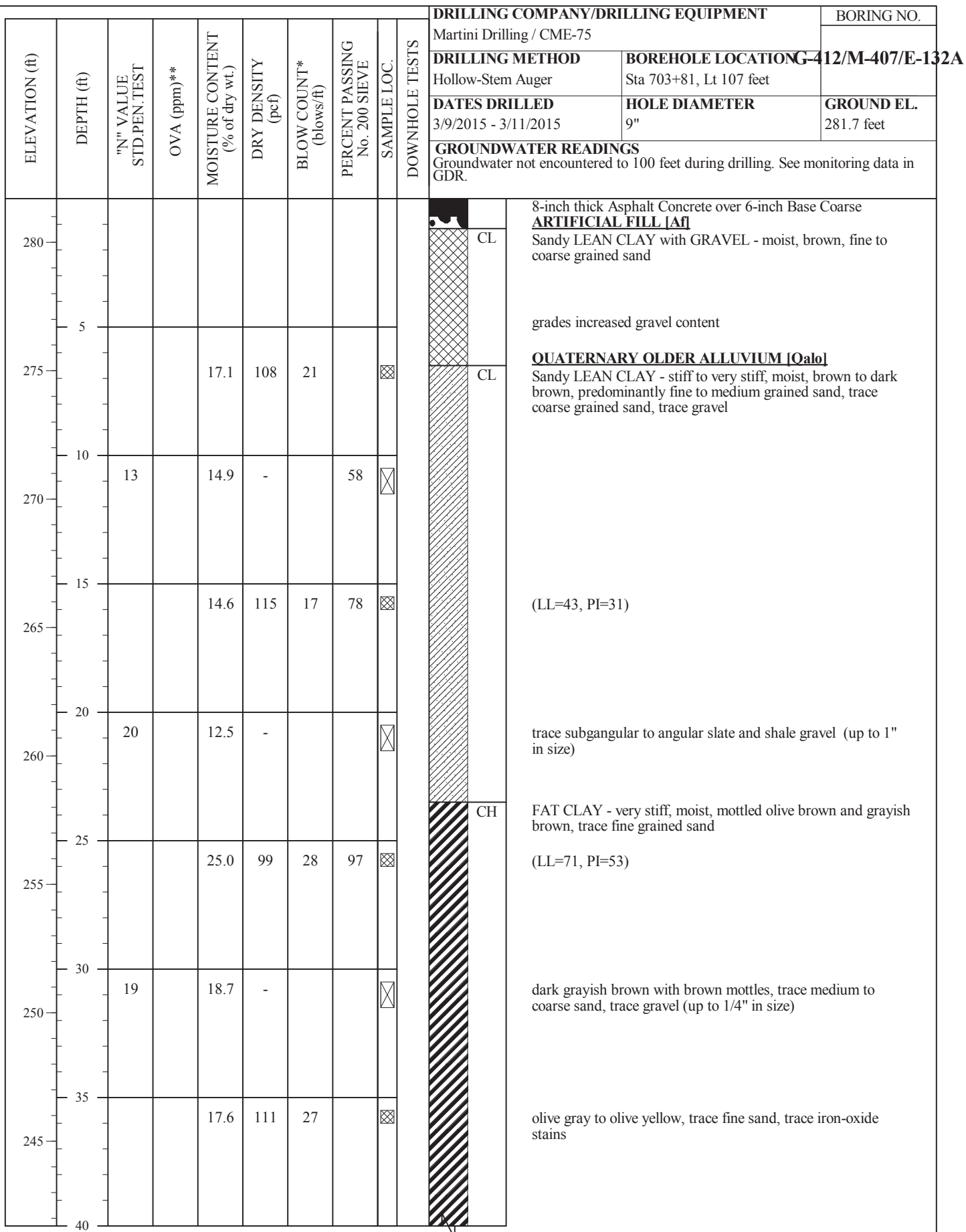
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LOG OF BORING

Project No.: 4953-11-1423 Figure: A-1.1.2d

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.



(CONTINUED ON FOLLOWING FIGURE)

Field Tech: AR
Prepared/Date: KC 5/26/2015
Checked/Date: FW/DLP/HP 5/26/2015

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LOG OF BORING
Project No.: 4953-11-1423 Figure: A-1.2.1a

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

										DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
										Martini Drilling / CME-75		G-412/M-407/E-132A (Continued)
										DRILLING METHOD	BOREHOLE LOCATION	
										Hollow-Stem Auger		Sta 703+81, Lt 107 feet
										DATES DRILLED		GROUND EL.
										3/9/2015 - 3/11/2015		281.7 feet
										GROUNDWATER READINGS		
										Groundwater not encountered to 100 feet during drilling. See monitoring data in GDR.		
ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS			
240		17		20.7	-						pale olive to olive yellow, trace iron-oxide stains	
				18.2	108	33	92				(LL=60, PI=43)	
45		22		15.4	-						LAKEWOOD FORMATION [Qlw]	
235				18.0	111	27	51			SC/ CL	CLAYEY SAND grades to Sandy LEAN CLAY - medium dense/very stiff, moist, olive gray, fine to medium grained sand	
											light gray to pale yellow (LL=34, PI=26)	
50		50/6"	2.3	4.6	-					SP- SM	POORLY GRADED SAND with SILT - very dense, moist, light gray, fine grained sand	
230				5.0	105	80					pale yellow to pale olive, grades to fine to medium grained sand	
55		66	1.6	5.1	-							
225				5.8	93	79	12			SW- SM	WELL GRADED SAND with SILT- very dense, moist, pale yellow to pale olive, fine to medium grained sand,	
60		50/6"		2.9	-					SW	WELL GRADED SAND with GRAVEL - very dense, moist, pale yellow to grayish yellow green, fine to coarse grained sand, gravel up to 3/4"	
220				1.1	-	50/6"				SP- SM	SAN PEDRO FORMATION [Osp]	
											POORLY GRADED SAND with SILT - very dense, moist, grayish yellow green, fine to medium grained sand, trace gravel (up to 3/4" in size)	
65		92		1.2	-					SM	SILTY SAND - very dense, moist, grayish yellow green, fine grained sand, slightly micaceous	
				7.9	86^	69	27					
70		70		13.6	-						pale olive to dusty yellow green, some thin lenses of fine to coarse grained sand, trace slate gravel (up to 1/4" in size)	
				19.0	106	85/9"				ML	SILT with SAND - hard, moist, pale olive to dusty yellow green, fine to medium grained sand, iron oxide mottles	
75		39		25.4	-		84			SP- SM	POORLY GRADED SAND with SILT - very dense, moist, pale olive, fine to medium grained sand, iron-oxide mottles	
				5.4	98	84/10"						
80												

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: AR
Prepared/Date: KC 5/26/2015
Checked/Date: FW/DLP/HP 5/26/2015

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LOG OF BORING
Project No.: 4953-11-1423 Figure: A-1.2.1b

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS	DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
										Martini Drilling / CME-75		G-412/M-407/E-132A
										DRILLING METHOD	BOREHOLE LOCATION	(Continued)
										Hollow-Stem Auger	Sta 703+81, Lt 107 feet	
										DATES DRILLED	HOLE DIAMETER	GROUND EL.
										3/9/2015 - 3/11/2015	9"	281.7 feet
										GROUNDWATER READINGS		
										Groundwater not encountered to 100 feet during drilling. See monitoring data in GDR.		
		67		10.1	-							pale olive to pale yellow, lenses of silty sand
				4.1	99	81/11"	10					
	85	55		11.1	-						SM	SILTY SAND - very dense, moist, pale olive, fine to medium grained sand
	195			17.0	103	64	45					increased moisture content
	90	81		4.5	-		10				SP-SM	POORLY GRADED SAND with SILT- very dense, moist, dark greenish gray, fine to medium grained sand
	190			-	-	50/2"					SP	POORLY GRADED SAND with GRAVEL - very dense, no sample recovered, coarse drilling with estimated 40% gravel and some cobbles within auger cuttings
	95	50/6"		3.0	-		22				SM	SILTY SAND - very dense, moist, dark greenish gray, sand is fine to medium grained, trace lenses of cemented sand or sandstone fragments, trace slate gravel
	185											
		50/1"		4.4	-							with shell fragments
	100											END OF BORING AT 100 FEET
	180											NOTES: Hand augered upper 6 feet to avoid damage to utilities. Borehole backfilled with bentonite, clean sand, and sand/gravel/cement slurry per well construction schedule. Pavement patched with rapid set concrete colored with black oxide.
	105											Groundwater monitoring wells installed with screen intervals at 50'-60' and 80'-90'. Vapor probes installed at 65', 70', and 75'. Refer to GDR for Well Construction Details.
	175											"N" Value Standard Penetration Test: Number of blows required to drive the SPT sampler 18 inches using a 140 pound automatic hammer falling 30 inches *Number of blows required to drive the Crandall Sampler 12 inches using a 140 pound hammer falling 30 inches Hammer Energy Transfer Ratio (ERi) = 70% (Calibrated 04/09/2015)
	110											**Photo Ionization Detector used for OVA readings
	170											^Average dry density for sample when multiple density tests performed on different rings for different tests.
	115											
	165											
	120											

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ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS	DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
										C&L Drilling / Mayhew-1000		G-413
										DRILLING METHOD	BOREHOLE LOCATION	
										Rotary Wash	Sta 709+56, Lt 41 feet	
										DATES DRILLED	HOLE DIAMETER	GROUND EL.
										4/2/2015 - 4/7/2015	4-7/8"	288.1 feet
										GROUNDWATER READINGS		
										Drill mud bailed from borehole to 55.4' bgs on 4/3/2015. Drill mud dropped to 80.2' bgs on 4/6/2015 after allowed to stabilize over the weekend.		
Constellation Station										20-inch thick Asphalt Concrete over 4-inch Base Course		
										ARTIFICIAL FILL [Af]		
										Sandy LEAN CLAY - stiff, moist, light brown, fine to medium grained sand		
	5									4 to 6 inch layer of gravelly lean clay		
		10	0	16.3	-			☒		trace gravel		
	10		0	20.3	105^	14	61	☒		fine to coarse grained sand, trace fine gravel (up to 3/8" in size) (LL=40, PI=26)		
									PMT			
	15	9	0	27.5	-			☒		QUATERNARY OLDER ALLUVIUM [Q_{old}]		
			0	20.6	106	16	84	☒		LEAN CLAY with SAND - stiff, moist, dark grayish brown and yellow brown, predominantly fine grained sand, trace medium grained sand (LL=49, PI=35)		
	20	15	0	16.8	-			☒		LEAN CLAY - very stiff, moist, light olive gray with brownish yellow mottles, trace fine grained sand		
	25		0	18.1	111	20	56	☒		Sandy LEAN CLAY - very stiff, moist, olive, fine to medium grained sand (LL=32, PI=20)		
									PMT			
	30	16	0	22.8	-			☒		LEAN CLAY with SAND - stiff, moist, olive, fine grained sand (LL=40, PI=26)		
	35		0	11.0	105	71	45	☒		LAKEWOOD FORMATION [Q_{lw}]		
										SILTY SAND - dense to very dense, moist, pale olive, minor iron-oxide mottles, fine grained sand		
	40											

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: AR
Prepared/Date: KC 5/26/2015
Checked/Date: FW/DLP/HP 5/26/2015

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Los Angeles, California

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LOG OF BORING
Project No.: 4953-11-1423 Figure: A-1.2.2a

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

								DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
								C&L Drilling / Mayhew-1000		G-413 (Continued)
								DRILLING METHOD	BOREHOLE LOCATION	
								Rotary Wash	Sta 709+56, Lt 41 feet	
								DATES DRILLED	HOLE DIAMETER	GROUND EL.
								4/2/2015 - 4/7/2015	4-7/8"	288.1 feet
								GROUNDWATER READINGS		
								Drill mud bailed from borehole to 55.4' bgs on 4/3/2015. Drill mud dropped to 80.2' bgs on 4/6/2015 after allowed to stabilize over the weekend.		
ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS	
Constellation Station		26	0	14.0	-			☒		ML SANDY SILT - very stiff, moist, pale olive, trace clay; and some very thin layers or seams of silty sand, fine grained sand, trace iron-oxide mottles
	45		0	9.2	108	59	13	☒	PMT	SM SILTY SAND - dense, moist, light yellow brown to pale olive, fine to medium grained sand, grades to poorly grade sand with silt 4 to 6 inch gravel layer with trace clay
	50	62	0	14.8	-			☒		SM-SC SILTY TO CLAYEY SAND - very dense, moist, dark yellowish brown, some gravel (up to 1/2" in size), predominantly fine sand with some medium grained sand mottled brown, orange, and gray with few gravel cobbles at approximately 53'
	55		0	9.7	118	82		☒		SP and SM POORLY GRADED SAND with GRAVEL interlayered with SILTY SAND - dense, moist, olive yellow, fine to medium grained sand estimated 15% to 25% gravels (up to 1/2" in size) (increased gravel content at 57'-59' based on drilling response)
	60	34	0.1	21.4	-			☒		ML SANDY SILT - hard, moist, light olive brown, contains seams/pockets of silty sand, trace clay
	65		0	16.6	103	85	14	☒	PMT	SM SILTY SAND - very dense, moist to wet, light olive brown, fine to medium grained sand, trace mica possible groundwater seepage at 65.5'
	70	76	0.6	17.6	-			☒		ML Sandy SILT - moist, bluish gray, fine grained sand
	75	-	0	-		50/1"		☒		SM SAN PEDRO FORMATION [Osp] SILTY SAND - very dense, moist, dark greenish gray, fine grained sand
	80									approximately 6-inch thick cobble (No Recovery)

(CONTINUED ON FOLLOWING FIGURE)


Field Tech: AR
Prepared/Date: KC 5/26/2015
Checked/Date: FW/DLP/HP 5/26/2015

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Los Angeles, California

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LOG OF BORING
Project No.: 4953-11-1423 Figure: A-1.2.2b

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

										DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.			
										C&L Drilling / Mayhew-1000		G-413 (Continued)			
										DRILLING METHOD	BOREHOLE LOCATION				
										Rotary Wash	Sta 709+56, Lt 41 feet				
										DATES DRILLED	HOLE DIAMETER	GROUND EL.			
										4/2/2015 - 4/7/2015	4-7/8"	288.1 feet			
										GROUNDWATER READINGS					
										Drill mud bailed from borehole to 55.4' bgs on 4/3/2015. Drill mud dropped to 80.2' bgs on 4/6/2015 after allowed to stabilize over the weekend.					
Constellation Station		82	0	12.9	-				☒	PMT		SM	SILTY SAND with GRAVEL - very dense, moist to wet, dark greenish gray, fine to coarse grained sand, fine to coarse gravel (up to 1" in size)		
	85		1.3	11.3	112	91/11"	17	☒				SM	some shell fragments		
	90	50/3"	0	12.6	-				☒				SM	SILTY SAND - very dense, moist, dark greenish, fine to medium grained sand with thin seams of clayey sand, slight hydrogen sulfide smell	
	95		0	16.0	117	65			☒				SM-SC	SILTY to CLAYEY SAND - very dense, moist, dark greenish gray, fine grained sand	
	100	97/11"	0	13.8	-				☒				SP-SM	POORLY GRADED SAND with SILT - very dense, wet, dark greenish gray, fine to medium grained sand, trace gravel (up to 3/4" in size)	
	105		0	-	-	70/6"	5		☒				SP-SM	POORLY GRADED SAND with SILT and GRAVEL - very dense, moist, bluish gray to dark greenish gray, fine to coarse grained sand	
	110	91/11"	0	17.3					☒				SM	SILTY SAND - very dense, moist, dark greenish gray, fine to medium grained sand, trace to few gravel (up to 3/4" in size)	
	115		0	13.7	94^	96/9"	16		☒						hard drilling from 113' to 114' due to cobble and gravel layer
	120														trace gravel

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: AR
Prepared/Date: KC 5/26/2015
Checked/Date: FW/DLP/HP 5/26/2015

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Los Angeles, California

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LOG OF BORING
Project No.: 4953-11-1423 Figure: A-1.2.2c

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS	DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
										C&L Drilling / Mayhew-1000		G-413 (Continued)
										DRILLING METHOD	BOREHOLE LOCATION	
										Rotary Wash	Sta 709+56, Lt 41 feet	
										DATES DRILLED	HOLE DIAMETER	GROUND EL.
										4/2/2015 - 4/7/2015	4-7/8"	288.1 feet
GROUNDWATER READINGS												
Drill mud bailed from borehole to 55.4' bgs on 4/3/2015. Drill mud dropped to 80.2' bgs on 4/6/2015 after allowed to stabilize over the weekend.												
165		67/6"	0	15.5	-			☒		SP-SM	POORLY GRADED SAND with SILT - very dense, moist to wet, dark greenish gray, predominantly fine to medium grained sand, trace coarse grained sand and fine gravel gravelly layers from 122' to 123'	
125			0	19.0	102	91/9"		☒		SM	SILTY SAND - dense to very dense, moist, dark greenish gray, alternates with lenses of clean sand	
160												
130		95/11"	0	11.1	-			☒				
155												
135			0	19.6	82	77/11"		☒			mottled with trace lumps of organic fines, slightly micaceous	
150												
140		63	5.3	38.5	-			☒			with lenses of black peat and organic sand, slightly micaceous	
145												
145			0	18.5	95	98/8"		☒			trace fine gravel (up to 3/4" in size)	
140												
150		75	4.4	33.8	-			☒		ML	SANDY SILT - very dense, moist, dark greenish gray to greenish black, trace clay, organic rich zones (carbonaceous) with apparent decayed root/plant material (peat)	
135												
155			1.2	47.5	68	63		☒			increase organic content	
130												
160												

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: AR
Prepared/Date: KC 5/26/2015
Checked/Date: FW/DLP/HP 5/26/2015

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LOG OF BORING
Project No.: 4953-11-1423 Figure: A-1.2.2d

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ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS	DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
										DRILLING METHOD	BOREHOLE LOCATION	G-413 (Continued)
										Rotary Wash	Sta 709+56, Lt 41 feet	
										DATES DRILLED	HOLE DIAMETER	GROUND EL.
										4/2/2015 - 4/7/2015	4-7/8"	288.1 feet
GROUNDWATER READINGS Drill mud bailed from borehole to 55.4' bgs on 4/3/2015. Drill mud dropped to 80.2' bgs on 4/6/2015 after allowed to stabilize over the weekend.												
125			0	24.9	99	50/5"		☒		SM	SILTY SAND - very dense, moist, dark greenish gray, fine grained sand, contains thin lenses of poorly graded sand and trace silt lenses	
165		66	0.4	27.8	-			☒			increased silt content (Samples not taken from 166 to 180 feet; boring deepened for suspension logging)	
120												
170												
115											thin gravel layers	
175												
110												
180												
105											END OF BORING AT 180.0 FEET NOTES: Hand augered upper 6 feet to avoid damage to utilities. Borehole backfilled with approved cement-bentonite backfill. Pavement patched with rapid set concrete colored with black oxide.	
185											"N" Value Standard Penetration Test: Number of blows required to drive the SPT sampler 18 inches using a 140 pound automatic hammer falling 30 inches *Number of blows required to drive the Crandall Sampler 12 inches using a 140 pound hammer falling 30 inches Hammer Energy Transfer Ratio (ERi) = 76% (Calibrated 03/18/2014)	
100											**Photo Ionization Detector used for OVA readings	
190											^Average dry density for sample when multiple density tests performed.	
95											Downhole Test: PMT = Pressuremeter P-S logging performed to 162.4 feet.	
195												
90												
200												

Field Tech: AR
Prepared/Date: KC 5/26/2015
Checked/Date: FW/DLP/HP 5/26/2015

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LOG OF BORING

Project No.: 4953-11-1423 Figure: A-1.2.2e

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS	DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
										DRILLING METHOD	BOREHOLE LOCATION	G-414/M-410
										Hollow-Stem Auger	Sta 715+61, Lt 3 feet	
										DATES DRILLED	HOLE DIAMETER	GROUND EL.
										3/24/2015 - 3/26/2015	9"	287.5 feet
										GROUNDWATER READINGS		
										Groundwater seepage encountered at 78.0' bgs with possible seepage zones between 60' to 70' and zones below 78' bgs. See monitoring data in GDR.		
Constellation Station										22-inch Asphalt Concrete over 4-inch Base Coarse		
										ARTIFICIAL FILL [Af]		
									CL	Sandy LEAN CLAY - moist, dark brown with some gray, fine to coarse grained sand, trace gravel		
	5									stiff		
			0	15.7	113	17		☒				
	10	4	0.4	13.6	-			☒		medium stiff		
	15		0.7	10.7	118^	9	65	☒		trace fine gravel (up to 3/8" in size) (LL=37, PI=25)		
	20	14	1.2	14.9	-			☒		very stiff, brown to dark brown		
	25		0	16.7	111	14	59	☒		stiff, dark gray brown to dark brown, trace fine gravel (up to 3/8" in size) (LL=37, PI=25)		
	30	27	0	5.8	-			☒		hard, slight organic smell		
										QUATERNARY OLDER ALLUVIUM [Qalo]		
									SC	CLAYEY SAND - medium dense, moist, dark brown, predominantly fine grained sand, some medium and coarse grained sand, trace gravel		
	35		0	13.3	117	24	48	☒		(LL=27, PI=14)		
	40											

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: AR
Prepared/Date: KC 5/26/2015
Checked/Date: FW/DLP/HP 5/26/2015

MTA Westside Subway Extension
Los Angeles, California

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LOG OF BORING
Project No.: 4953-11-1423 Figure: A-1.2.3a

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS	DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
										DRILLING METHOD	BOREHOLE LOCATION	G-414/M-410 (Continued)
										DATES DRILLED	HOLE DIAMETER	GROUND EL.
										3/24/2015 - 3/26/2015	9"	287.5 feet
GROUNDWATER READINGS Groundwater seepage encountered at 78.0' bgs with possible seepage zones between 60' to 70' and zones below 78' bgs. See monitoring data in GDR.												
Constellation Station		17	0	7.6	-					SC	CLAYEY SAND with GRAVEL- medium dense, moist, brown and gray, fine to coarse grained sand, subangular to angular shale and slate gravel fragments (from 1/4" to 1" in size)	
										ML	Sandy SILT - moist, dark yellowish brown, fine grained sand	
	45		0	14.5	109	13	35			SM	SILTY SAND - loose, moist, dark brown, fine to medium grained sand, trace fine gravel	
										CL	Sandy LEAN CLAY with GRAVEL- medium stiff, moist, dark yellow brown, fine grained sand	
	50	5	0	15.9	-						2 to 3-inch layer of silty sand	
			2.9	13.7	119	38	61			CL	Sandy LEAN CLAY - very stiff to hard, moist, dark brown to dark yellow brown, sand is predominantly fine to medium grained (LL=34, PI=22)	
	55	50/4.5"									possible gravel and cobbles from 54' to 56' (No Recovery)	
		42	0	13.1	-					SM	LAKEWOOD FORMATION [Oltw] SILTY SAND - dense to very dense, moist, pale olive to olive, fine grained sand, some lenses of silt, trace gravel	
	60		0	16.9	98	54	49				olive yellow, trace iron and/or manganese-oxide coated grains	
		40	0	16.4	-						light olive gray (primary) with strong brown (secondary) iron oxide mottles	
	65		0	18.9	104	69					lenses of poorly graded sand with silt, pale olive with secondary strong brown iron-oxide zones	
	70	40	0	19.4	-					SM	SAN PEDRO FORMATION [Osp] SILTY SAND - dense, moist, pale olive to olive, fine grained sand, slightly micaceous	
			0	13.2	112	65	38			SM	SILTY SAND with GRAVEL - dense to very dense, moist, pale olive, fine to medium grained sand, fine gravel (up to 1/2" in size), gravels are mostly rounded to subrounded slate and quartzite	
	75	49	0	9.1	-						greenish gray, decreased gravel size	
			0	26.2	95	61				SM	SILTY SAND - dense, wet, dusky yellow green, fine grained sand, few lenses of clean sands, trace gravel, slight groundwater seepage, gravels are mostly slate with some quartzite	
	80											

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: AR
Prepared/Date: K C 5/26/2015
Checked/Date: FW/DLP/HP 5/26/2015

MTA Westside Subway Extension
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LOG OF BORING
Project No.: 4953-11-1423 Figure: A-1.2.3b

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS	DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
										DRILLING METHOD	BOREHOLE LOCATION	G-414/M-410 (Continued)
										DATES DRILLED	HOLE DIAMETER	GROUND EL.
										3/24/2015 - 3/26/2015	9"	287.5 feet
GROUNDWATER READINGS Groundwater seepage encountered at 78.0' bgs with possible seepage zones between 60' to 70' and zones below 78' bgs. See monitoring data in GDR.												
Constellation Station		60	0	4.1	-			☒		SP-SM	POORLY GRADED SAND with SILT - dense to very dense, moist, greenish yellow green to dark greenish gray, fine to medium grained sand	
	85		0	17.1	108	58		☒			wet, possible groundwater seepage	
		22	0	17.5	-			☒		SM	SILTY SAND - medium dense, moist, fine to medium grained sand, trace fine gravel, trace clay, has hydrogen sulfide odor	
	90		3.8	12.6	109	36	7	☒		SP-SM	POORLY GRADED SAND with SILT - medium dense, moist, grayish olive to dusky yellow green, fine to medium sand, trace fine gravel, faint gas odor	
	195										possible thin gravel/cobble layer at 92'	
		49	0	23.7	-			☒		SM	SILTY SAND - very dense, moist, grayish olive green to greenish black, fine grained sand, trace fine gravel, trace shell fragments, some thin lenses of interlayered clayey silt	
	95		17.5	20.3	106^	68		☒			wet, greenish black and grayish olive green, with alternating layers/seams of poorly graded sand with silt and clayey silt	
	190											
	100	50/6"	6.1	7.4	-		16	☒			grayish olive green	
	185											
	105		0	15.1	111	60		☒		CL-ML	trace gravel (up to 3/4" in size) SILTY CLAY - moist, grayish olive green	
	180									CL	Sandy LEAN CLAY - very stiff, moist, grayish olive green, some fine sandy silt seams	
	110	21	0	24.6	-			☒			(LL=47, PI=30)	
	175											
	115		0.4	14.7	109^	77/10"	46	☒		SM	SILTY SAND - very dense, moist, dark greenish gray, fine to coarse grained sand, with clean sand seams, trace fine gravels (up to 1/4" in size)	
	170											
	120	50/5"	0.1	4.7	-			☒		SP-SM	POORLY GRADED SAND with SILT - very dense, moist, blueish gray, fine to medium grained sand, trace fine gravel (up to 1/4" in size)	

(CONTINUED ON FOLLOWING FIGURE)

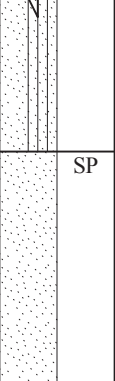
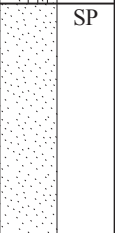





Field Tech: AR
Prepared/Date: KC 5/26/2015
Checked/Date: FW/DLP/HP 5/26/2015

MTA Westside Subway Extension
Los Angeles, California

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LOG OF BORING
Project No.: 4953-11-1423 Figure: A-1.2.3c

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS	DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
										DRILLING METHOD	BOREHOLE LOCATION	G-414/M-410 (Continued)
										Hollow-Stem Auger	Sta 715+61, Lt 3 feet	
										DATES DRILLED	HOLE DIAMETER	GROUND EL.
										3/24/2015 - 3/26/2015	9"	287.5 feet
										GROUNDWATER READINGS		
										Groundwater seepage encountered at 78.0' bgs with possible seepage zones between 60' to 70' and zones below 78' bgs. See monitoring data in GDR.		
165								☒				
125			0.5	11.1	95	76/9"		☒				
160												
130		50/6"	0					☒				
155										END OF BORING AT 130.0 FEET NOTES: Hand augered upper 6 feet to avoid damage to utilities. Borehole backfilled with bentonite, clean sand, and sand/gravel/cement slurry per well construction schedule. Pavement patched with rapid set concrete colored with black oxide. Groundwater monitoring wells installed with screen intervals at 65'-75' and 80'-90'. Vapor probes installed at 40', 60', and 95'. Refer to GDR for Well Construction Details. "N" Value Standard Penetration Test: Number of blows required to drive the SPT sampler 18 inches using a 140 pound automatic hammer falling 30 inches *Number of blows required to drive the Crandall Sampler 12 inches using a 140 pound hammer falling 30 inches Martini used two different CME-75 drill rigs to drill this boring. One rig drilled the upper 20.5' on 3/24/2015 and the other drilled the remainder on 3/25/2014 and 3/26/2015. Hammer Energy Transfer Ratio (ERi) = 79% (Calibrated 01/13/2014) for samples from 0' to 20.5' Hammer Energy Transfer Ratio (ERi) = 70% (Calibrated 04/09/2015) for samples greater than 20.5' **Photo Ionization Detector used for OVA readings ^Average dry density for sample when multiple density tests performed.		
135												
150												
140												
145												
145												
140												
150												
135												
155												
130												
160												

Field Tech: AR
Prepared/Date: KC 5/26/2015
Checked/Date: FW/DLP/HP 5/26/2015

MTA Westside Subway Extension
Los Angeles, California

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LOG OF BORING
Project No.: 4953-11-1423 Figure: A-1.2.3d

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS	DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
										DRILLING METHOD	BOREHOLE LOCATION	G-415
										Rotary Wash	Sta 716+48, Lt 7 feet	
										DATES DRILLED	HOLE DIAMETER	GROUND EL.
										3/30/2015 - 4/1/2015	4-7/8"	283.2 feet
										GROUNDWATER READINGS		
										Drill mud bailed from borehole to 87' on 4/1/2015. Groundwater measured at 79' the following day (4/2/2015).		
Constellation Station										8-inch Asphalt Concrete over 4-inch Base Coarse		
										<u>ARTIFICIAL FILL [Af]</u>		
										Sandy LEAN CLAY - soft, moist, dark grayish brown to olive gray, fine to medium grained sand, trace coarse grained sand, trace gravel		
	5	3	0	12.7	-			☒				
	10		1.3	19.2	107^	3	61	☒		olive gray and very moist (LL=38, PI=26)		
	15		0	19.6	107	13		☒		LEAN CLAY with SAND - stiff, moist, light brown to brown, fine to medium grained sand, trace gravel		
	20	9	0	16.6	-			☒		thin dark gray layer, trace to few gravel		
	25		8.1	18.2	112	18		☒		SILTY, CLAYEY SAND - moist, dark gray, fine to coarse grained sand		
	30	10	0	15.7	-			☒		Sandy LEAN CLAY - stiff, moist, light brown to brown, dark gray at bottom of sample, fine to medium grained sand, trace gravel (LL=35, PI=14)		
	35	9	0	13.4	-		37	☒		mottled olive to dark brown		
										mottled dark gray and brown		
										<u>QUATERNARY OLDER ALLUVIUM [Q_{old}]</u>		
										SILTY, CLAYEY SAND - medium dense, moist, dark brown, fine to medium grained sand		
										SILTY SAND - moist, dark brown, fine to medium grained sand		
										Sandy LEAN CLAY - stiff, moist, yellowish brown, fine to medium grained sand, trace fine gravel (up to 3/4" in size) (LL=36, PI=22)		
	40		0	17.3	109	16	69	☒				

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: AR
Prepared/Date: KC 5/26/2015
Checked/Date: FW/DLP/HP 5/26/2015

MTA Westside Subway Extension
Los Angeles, California

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LOG OF BORING
Project No.: 4953-11-1423 Figure: A-1.2.4a

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

DRILLING COMPANY/DRILLING EQUIPMENT										BORING NO.	
C&L Drilling / Mayhew-1000										G-415 (Continued)	
DRILLING METHOD					BOREHOLE LOCATION						
Rotary Wash					Sta 716+48, Lt 7 feet					GROUND EL. 283.2 feet	
DATES DRILLED					HOLE DIAMETER						
3/30/2015 - 4/1/2015					4-7/8"						
GROUNDWATER READINGS											
Drill mud bailed from borehole to 87' on 4/1/2015. Groundwater measured at 79' the following day (4/2/2015).											
ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD.PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS		
Constellation Station			0	18.7	109	14		☒	PMT	CL	LEAN CLAY with SAND - stiff, moist, mottled grayish brown and yellowish brown, fine grained sand, trace fine subangular slate gravel (up to 1/4" in size)
	45		0	18.8	108	16		☒		SM	grades to sandy clay or clayey sand from 45' to 45.7'
	50	8						☒			SILTY SAND - medium dense, moist, yellowish brown to brown, fine to medium grained sand, some silt seams, trace organics (possible peat)
	55		0	16.6	115	20		☒		CL	Sandy LEAN CLAY with GRAVEL - very stiff, moist, brown, fine to coarse sand, subangular to angular slate gravel (up to 1" in size)
	60		0	17.7	113	23	59	☒		GC	CLAYEY GRAVEL - brown, moist, subangular to angular slate and minor siltstone gragments (up to 2" in size)
			0	17.7	113	23	59	☒		CL	Sandy LEAN CLAY - very stiff, moist, brown, fine to coarse grained sand, few gravel (up to 1" in size) (LL=30, PI=18)
	65		0	17.9	104	42	40	☒		SM	LAKEWOOD FORMATION [Olw] SILTY SAND - dense, moist, pale yellow to pale olive, fine grained sand (LL=NP, PI=NP)
	70	37	0	19.5	-			☒		SC-SM	SAN PEDRO FORMATION [Osp] CLAYEY, SILTY SAND - dense to very dense, moist, pale olive, fine grained sand
	75		0	14.9	106	62		☒		SM	SILTY SAND with GRAVEL - dense to very dense, moist, greenish gray, predominantly fine grained sand, some medium to coarse grained sand, contains about 15%-25% subrounded to subangular slate, phyllite, shale, quartzite, and minor granitic gravels
	80								☒	PMT	

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: AR
Prepared/Date: KC 5/26/2015
Checked/Date: FW/DLP/HP 5/26/2015

MTA Westside Subway Extension
Los Angeles, California

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LOG OF BORING
Project No.: 4953-11-1423 Figure: A-1.2.4b

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

										DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS	C&L Drilling / Mayhew-1000		G-415 (Continued)
										DRILLING METHOD	BOREHOLE LOCATION	
										DATES DRILLED	HOLE DIAMETER	GROUND EL.
										Rotary Wash	Sta 716+48, Lt 7 feet	
										3/30/2015 - 4/1/2015	4-7/8"	283.2 feet
GROUNDWATER READINGS												
Drill mud bailed from borehole to 87' on 4/1/2015. Groundwater measured at 79' the following day (4/2/2015).												
			0	21.7	95	39	30	☒				SILTY SAND with GRAVEL (continued from above) with some poorly graded fine sand seams (LL=NP, PI=NP)
												alternating with layers of poorly graded sand, fine to medium grained
	85	68	0	16.6	-			☒				grades to fine to coarse grained sand, dusky yellow green, wet, has hydrogen sulfide odor
195												
	90		0	38.2	82	23	94	☒		CH		FAT CLAY - very stiff, moist, grayish olive, trace fine grained sand
												(LL=75, PI=54)
190										SM		SILTY SAND - very dense, moist, very dark grayish brown, fine to medium grained sand, with seams of poorly graded fine to medium sand
	95	52	0	25.5	-		42	☒				thin clay lens
	185											4 to 5-inch cobble
												alternating with clay lenses
	100		0	-	-	50/5"	9	☒		SP-SM		4 to 5-inch cobble POORLY GRADED SAND with SILT - very dense, moist, grayish olive, fine grained sand (LL=NP, PI=NP) (Samples not obtained from 101 to 115 feet; borehole deepened for suspension logging)
180												
	105											
175												8-inch cobble
	110											
	170									CL-ML		SILTY CLAY - moist, blueish gray, trace to few fine grained sand
	115									GP		POORLY GRADED GRAVEL with SAND
												END OF BORING AT 115.0 FEET
	165											NOTES: Hand augered upper 6 feet to avoid damage to utilities. Borehole backfilled with approved cement-bentonite backfill. Pavement patched with rapid set concrete colored with black oxide.
120												

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: AR
Prepared/Date: KC 5/26/2015
Checked/Date: FW/DLP/HP 5/26/2015

MTA Westside Subway Extension
Los Angeles, California

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LOG OF BORING
Project No.: 4953-11-1423 Figure: A-1.2.4c

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS	DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
										DRILLING METHOD	BOREHOLE LOCATION	G-415 (Continued)
										Rotary Wash	Sta 716+48, Lt 7 feet	
										DATES DRILLED	HOLE DIAMETER	GROUND EL.
										3/30/2015 - 4/1/2015	4-7/8"	283.2 feet
										GROUNDWATER READINGS		
										Drill mud bailed from borehole to 87' on 4/1/2015. Groundwater measured at 79' the following day (4/2/2015).		
160										<p>"N" Value Standard Penetration Test: Number of blows required to drive the SPT sampler 18 inches using a 140 pound automatic hammer falling 30 inches *Number of blows required to drive the Crandall Sampler 12 inches using a 140 pound hammer falling 30 inches Hammer Energy Transfer Ratio (ERi) = 76% (Calibrated 03/18/2014)</p> <p>**Photo Ionization Detector used for OVA readings</p> <p>^Average dry density for sample when multiple density tests performed.</p> <p>Downhole Test: PMT = Pressuremeter P-S suspension logging performed to 102.7 feet.</p> <p>NP = Non plastic</p>		
125												
155												
130												
150												
135												
145												
140												
140												
145												
135												
150												
130												
155												
125												
160												

Field Tech: AR
Prepared/Date: KC 5/26/2015
Checked/Date: FW/DLP/HP 5/26/2015

MTA Westside Subway Extension
Los Angeles, California

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LOG OF BORING
Project No.: 4953-11-1423 Figure: A-1.2.4d

JOB L90354.ADEO DATE 1/11/91 F.T. LS DR. ph O.E. HBL W.P. ph CHKD F.L.

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated. It is not warranted to be representative of subsurface conditions at other locations and times.

						BORING 2 *	
						DATE DRILLED:	December 27 & 28, 1990
						EQUIPMENT USED:	5" - Diameter Rotary Wash
						Project No.:L90354-ADEO	
DEPTH (ft.)	"N" VALUE STD.PEN.TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.		
5		15.1	109	5		ML	CLAYEY SILT - some Sand, brown
		21.0	102	8			Layers of Silty Sand and Silty Clay
		23.9	95	7			
10		17.0	104	6			
		17.3	107	8			
15		17.7	111	10			
		15.4	117	7		ML	SANDY SILT - brown
20		25.4	100	5			Layers of Clayey Silt, greyish brown
25							
		22.8	103	5		ML	CLAYEY SILT - greyish brown
30		24.4	99	13		CL	SILTY CLAY - grey
							Layers of Silt
35	42						
		24.0	103	17		SP	SAND - fine, grey
40							

* Boring 1 deferred due to lack of access.

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

Figure A-1.3.1

BORING 2 (Continued)

DATE DRILLED: December 27 & 28, 1990
EQUIPMENT USED: 5" - Diameter Rotary Wash
Project No.: L90354-ADEO

DEPTH (ft.)	"N" VALUE STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
45	50 (5" pen)	8.3	108	31	
50	50 (5" pen)				
55	60 (5" pen)	24.2	97	28	
60		20.3	109	28	
65		22.0	102	23	
70		20.0	102	26	
75		27.5	96	51	
80		28.1	93	26	

Light greyish brown

Seams of Silt

SILTY SAND - fine, bluish grey

About 20% Gravel

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LAW / CRANDALL, INC.



PLATE A-1.1b

Figure A-1.3.2

JOB 190354-ADEO DATE 1/11/91 F.T. LS DR. ph O.E. HBL W.P. ph CHKD ph

Note: The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated.
It is not warranted to be representative of subsurface conditions at other locations and times.

DEPTH (ft.)	"N" VALUE STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
85		25.3	100	28	
90		20.5	104	15	CL
95		19.8	104	18	ML
100		19.7	113	38	

BORING 2 (Continued)
 DATE DRILLED: December 27 & 28, 1990
 EQUIPMENT USED: 5" - Diameter Rotary Wash
 Project No.: L90354-ADEO

No Gravel

SILTY CLAY - few seashells, dark grey

CLAYEY SILT - some Sand, dark grey

NOTE: Drilling mud used in drilling process. Mud removed at completion of drilling. Water level measured at 54' 10 minutes after removal of mud. Boring grouted with cement and bentonite.

LOG OF BORING

LAW / CRANDALL, INC.



PLATE A-1.1c

Figure A-1.3.3

JOB

L90354.ADEO DATE 1/11/91

F.T. J.S.

DR.

ph

O.E.

HRL

W.P.

ph

CHKD

Note : The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated.
It is not warranted to be representative of subsurface conditions at other locations and times.

							BORING 3	
							DATE DRILLED: December 27, 1990	
							EQUIPMENT USED: 5" - Diameter Rotary Wash	
							Project No.: L90354-ADEO	
	DEPTH (ft.)	"N" VALUE STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.		
			23.2	106	6		CL	FILL - SILTY CLAY - brown
	5		11.2	108	6		ML	FILL - SANDY SILT - about 20% Gravel, layer of Clayey Sand, brown and grey
			29.2	93	5		ML	SURFACE OF NATURAL SOIL CLAYEY SILT - greyish brown Layer of Silty Sand
	10		35.0	86	4		CL	SILTY CLAY - greyish brown
			21.1	106	6			Dark brown
	15		17.8	109	10		ML	CLAYEY SILT - greyish brown
			17.8	102	6		ML	SANDY SILT - greyish brown
	20		23.6	102	6		ML	CLAYEY SILT - brownish grey
								Layers of Sandy Silt
	25							
			26.8	98	8			
	30		35.1	86	9		CL	SILTY CLAY - brownish grey
			27.1	97	5		ML	CLAYEY SILT - layers of Sandy Silt, white and greyish brown
	35							Some Sand
			24.6	100	13			
	40						SP	SAND - fine, grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LAW / CRANDALL, INC.



PLATE A-1.2a

Figure A-1.3.4

Note : The log of subsurface conditions shown hereon applies only at the specific boring location and at the date indicated.
It is not warranted to be representative of subsurface conditions at other locations and times.

	DEPTH (ft.)	"N" VALUE STD.PEN.TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
			10.2	107	28	
			10.1	103	31	
45			14.0	115	66	
			15.5	104	51	
50						
			15.7	92	26	
55						
			18.2	111	26	
60						
			19.4	103	28	
65						
			20.6	106	18	
70						
			18.5	110	28	
75						

BORING 3 (Continued)
 DATE DRILLED: December 27, 1990
 EQUIPMENT USED: 5" - Diameter Rotary Wash
 Project No.: L90354-ADEO

Light yellowish brown

About 30% Gravel, grey and brown

No Gravel, light yellowish brown

SM
SILTY SAND - fine greyish brown

Bluish grey

Some Gravel

NOTE: Drilling mud used in drilling process. Mud removed at completion of drilling. Water level measured at 58-1/2' 16 hours after removal of mud. Boring grouted with cement and bentonite.
















LOG OF BORING

LAW/CRANDALL, INC.



PLATE A-1.2b

Figure A-1.3.5

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

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

PARTICLE SIZE LIMITS

SILT OR CLAY	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		
	NO. 200	NO. 40	NO. 10	NO. 4	3/4 in.	3 in.	(12 in.)
	U. S. STANDARD SIEVE SIZE						

UNIFIED SOIL CLASSIFICATION SYSTEM

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

LAW/CRANDALL, INC.



BORING I

DATE DRILLED: September 10, 1984

EQUIPMENT USED: 18"-Diameter Bucket

Project No.:A-84277

ELEVATION 281.1*

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
280							ML
	5	12.0	116	2			
275							
	10	18.0	107	3			
270							
	15	16.8	112	5			
265							CL
	20	17.5	110	5			
260							
	25	16.7	115	6			
255							
	30	18.4	110	6			
		12.3	124	12			

3" Asphaltic Paving
FILL - SANDY SILT - some Clay, some gravel,
pieces of plastic, wood, and asphaltic
paving, greyish-brown

FILL - SANDY CLAY - some Silt, some gravel,
brown

Pieces of asphaltic paving

Greyish-brown

Piece of wood

Pieces of paper

Pieces of wood and asphaltic paving

Pieces of brick and asphaltic paving

(CONTINUED ON FOLLOWING PLATE)

*Elevations refer to datum of reference
drawing; see Plate 1.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

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

BORING 1 (CONTINUED)

DATE DRILLED: September 10, 1984

EQUIPMENT USED: 18"-Diameter Bucket

Project No.:A-84277

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

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
(ft.)	(ft.)		(% of dry wt.)	(lb./cu. ft.)	(ft.-kips/ft.)		
250		8.3	118	5			SM
35		16.1	114	6			ML
245		8.5	103	5			
40		20.7	108	5			SM
240		19.1	96	6			
45		12.8	100	9			
235		12.4	100	4			
50		7.2	127	14			
230		30.3	92	5			ML
55							
225							
60							

SILTY SAND - fine to medium, some gravel, dark brown
Brown

SANDY SILT - brown
Some layers of Sand, some gravel

SILTY SAND - fine, some gravel, greyish-brown

Fine to coarse, about 30% gravel, grey

SANDY SILT - grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

BORING I (CONTINUED)

DATE DRILLED: September 10, 1984

EQUIPMENT USED: 18"-Diameter Bucket

Project No.:A-84277

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

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
(ft.)	(ft.)		(% of dry wt.)	(lbs./cu. ft.)	(ft.-kips/ft.)		
220							SC
	65	5.7	120	22			
215							
	70	21.4	106	11			SM
210							
	75	14.3	110	14			SP
205							
	80	24.9	105	16			

CLAYEY SAND - fine to medium, some gravel, grey and brown

SILTY SAND - fine, light yellowish-grey

Light grey

SAND - fine, light bluish-grey

Some lenses of Silt and Silty Sand, some gravel

NOTE: Water level measured at 75'. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

BORING 2

DATE DRILLED: September 13, 1984

EQUIPMENT USED: 5"-Diameter Rotary Wash

Project No.:A-84277

ELEVATION 281.6

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
280		12.4	122	5			CL
	5						
275		17.6	115	5			
	10						
270		14.9	116	4			
	15	15.1	118	5			
265							
	20	17.1	116	2			
260							
	25	13.5	117	6			
255		17.2	114	3			SM
	30						
250		15.2	116	6			
	35	11.9	118	11			
245		21.1	101	7			
	40	12.5	110	9			SM

3" Asphaltic Paving
FILL - SANDY CLAY - some gravel, greyish-brown

FILL - SILTY SAND - fine, layers of Silt, brownish-grey

Grey and dark grey

About 30% gravel, dark brown

Greyish-brown

SILTY SAND - fine, greyish-brown

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

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

BORING 2 (CONTINUED)

DATE DRILLED: September 13, 1984
EQUIPMENT USED: 5"-Diameter Rotary Wash
Project No.:A-84277

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

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
240		13.3	116	11			
45		10.1	117	11			SW SAND - well graded, about 20% gravel, light brown
235							Light grey
50		1.0	132	29			
230							About 30% gravel
55		14.4	115	48			Grey
225							
60		13.2	107	27			SP SAND - fine, some gravel, brown
220							
65		10.6	123	39			SW SM SAND and SILTY SAND - fine to coarse, about 40% gravel, grey and brown
215							
70		23.2	103	25			SM SILTY SAND - fine, light yellowish-grey
210							Yellowish-brown
75		19.1	109	43			
205							SP SAND - fine, light grey
80		24.9	100	39			

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

BORING 2 (CONTINUED)

DATE DRILLED: September 13, 1984
EQUIPMENT USED: 5"-Diameter Rotary Wash
Project No.:A-84277

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

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
200							
	85	18.3	113	39			SW
195							
	90	16.6	114	54			
190							
	95	24.0	102	25			ML
185							SW
							SP
100		8.4	110	36			

SAND - well graded, about 20% gravel, grey

Light grey

SANDY SILT - dark grey

SAND - well graded, about 20% gravel, grey

SAND - fine, grey

NOTE: Drilling mud used in drilling process.
Removed mud after completion of drilling.
Water level measured at 59' on September 21, 1984.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

BORING 3

DATE DRILLED: September 18, 1984

EQUIPMENT USED: 5"-Diameter Rotary Wash

Project No.:A-84277

ELEVATION 286.4

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
285		15.6	112	5			CL
	5						
280		20.8	108	5			
	10						
275		18.2	114	10			
	15						
270		17.3	111	6			
	20						
265		14.2	121	13			
	25						
260		15.4	116	9			ML
	30						
255		14.1	113	11			CL
	35						
250		13.2	125	10			ML
	40						
		12.9	116	10			SM
		15.1	118	11			

3" Asphaltic Paving
FILL - SILTY CLAY - few gravel, brown
Few pieces of metal

Greyish-brown

Some Sand

Little to no Sand

Some Sand

FILL - CLAYEY SILT - some Sand, greyish-brown

FILL - SILTY CLAY - dark grey

SANDY SILT - slightly Clayey, few gravel,
dark grey

SILTY SAND - fine to medium, some gravel,
greyish-brown

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

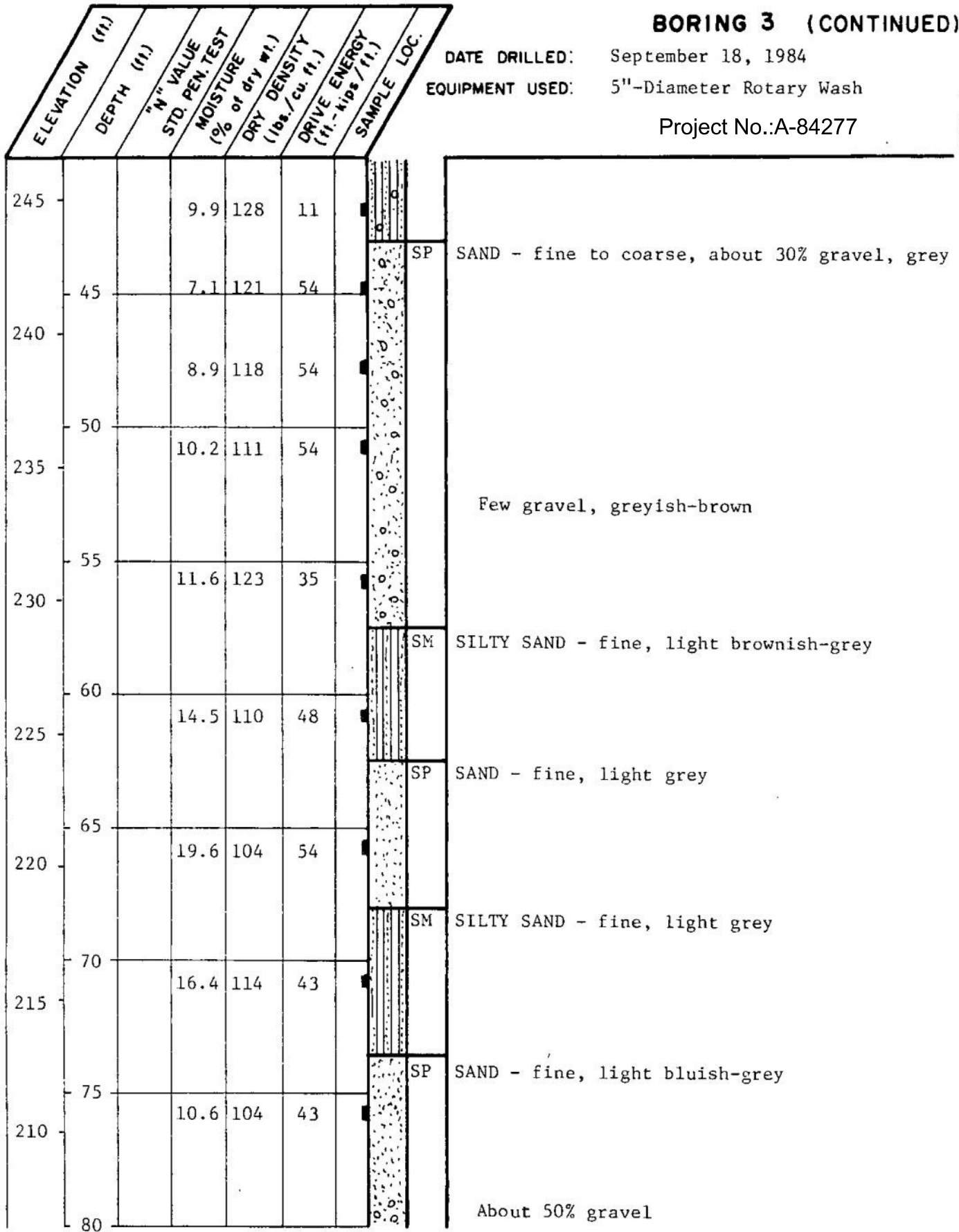
LeROY CRANDALL AND ASSOCIATES

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

BORING 3 (CONTINUED)

DATE DRILLED: September 18, 1984
EQUIPMENT USED: 5"-Diameter Rotary Wash
Project No.:A-84277

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



(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

BORING 3 (CONTINUED)

DATE DRILLED: September 18, 1984

EQUIPMENT USED: 5"-Diameter Rotary Wash

Project No.:A-84277

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

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
205		27.7	93	62			
85							
200		15.6	107	72			
90							
195		19.5	107	72			
95							SM
190							
100		7.6	115	108			SP
185							
105							

Few gravel

Light grey

SILT SAND - fine, dark grey

SAND - fine, light bluish-grey

NOTE: Drilling mud used in drilling process.
Removed mud after completion of drilling.
Water level not established.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

BORING 5

DATE DRILLED: September 11 and 12, 1984

EQUIPMENT USED: 18"-Diameter Bucket

Project No.:A-84277

ELEVATION 290.1

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
290							SM
	5	13.4	113	2			
285							
	10	16.8	114	6			
280							
	15	16.3	110	2			
275							CL
	20	16.8	111	2			
270							
	25	23.9	104	2			
265							
	30	18.3	114	6			
260							
	35	15.5	117	6			
255							
	40	12.2	121	8			
		12.9	116	7			

3" Asphaltic Paving
FILL - SILTY SAND - fine, some Clay, some gravel, greyish-brown

Piece of metal

Fine to coarse, about 10% gravel

FILL - SANDY CLAY - dark grey

Greyish-brown

Petroleum odor
Dark grey

Some bricks

About 40% gravel

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

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

BORING 5 (CONTINUED)

DATE DRILLED: September 11 and 12, 1984

EQUIPMENT USED: 18"-Diameter Bucket

Project No.:A-84277

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

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
250		9.2	116	11			
		7.1	108	10			
245	45	8.5	111	11			
		36.0	85	11			
240	50	10.0	114	17			
235	55	15.8	103	14			
		13.7	115	17			
230	60	6.5	106	17			
225	65	14.4	108	17			
220	70	12.3	106	14			
215	75	7.7	111	13			
80							

SM	SILTY SAND - fine, light yellowish-brown
SP	SAND - fine, yellowish-brown
CL	SILTY CLAY - grey
SP	SAND - fine, lenses of Silt and Clay, yellowish-brown
SM	SILTY SAND - fine, yellowish-brown
	Light grey
SP	SAND - fine, light grey
SM	SILTY SAND - fine, lenses of Clay, light grey
SP	SAND - fine, about 20% gravel, light bluish-grey

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

BORING 5

DATE DRILLED: June 23, 1979

EQUIPMENT USED: 5'-Diameter Rotary Wash

Project No.: ADE-79167

ELEVATION 31.8

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

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	
80		19.3	103	5			CL	2" Asphaltic Paving SILTY CLAY - brown
	5	18.4	109	8			ML	SANDY SILT - few gravel, brown
75		7.0	117	16			SW	SAND - about 30% gravel, greyish-brown
	10	13.7	115	12			CL	SILTY CLAY - brown
70		17.1	113	9				Reddish-brown
	15	18.8	105	13				Some gravel
65		15.0	115	19				About 10% gravel
	20	13.1	118	16			SC	CLAYEY SAND - well graded, about 20% gravel, greyish-brown
60		9.6	115	26				
	25	10.1	117	32				
55		20.3	106	13			CL	SILTY CLAY - greyish-brown
	30						SM	SILTY SAND - fine, light brown
50							CL	SILTY CLAY - grey
45		21.3	103	16				
40								

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
				(% of dry wt.)	(lbs./cu. ft.)	(ft.-kips/ft.)	
40							
45		19.9	110	26			
35							
50		21.0	102	16			
30							
55		21.7	102	19			
25							
60		19.2	108	29			
20							
65		10.4	119	43			
15							
70		7.3	106	43			
10							
75		8.8	111	67			
5							
80		12.9	117	67			

BORING 5 (CONTINUED)

DATE DRILLED: June 23, 1979

EQUIPMENT USED: 5'-Diameter Rotary Wash

Project No.: ADE-79167

CLAYEY SAND - fine, light greyish-brown

SAND - fine, light grey

About 20% gravel

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

Figure A-1.3.20

PLATE A-1.5b

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

DATE 4-22-67 CW KD

1-2-22 DATE 22-1-79

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

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
0							
85		21.6	100	38			
-5							
90		19.7	105	38			
-10							
95		20.4	106	38			
-15							
100		19.5	108	38			

BORING 5 (CONTINUED)
 DATE DRILLED: June 23, 1979
 EQUIPMENT USED: 5'-Diameter Rotary Wash
 Project No.: ADE-79167

Layer of Sandy Silt

SILTY SAND - fine, light grey

NOTE: Drilling mud used in drilling process. Water level not established. Installed 3"-diameter P.V.C. pipe to depth of 97' for downhole seismic survey. Annular space around outside of pipe backfilled with gravel.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

1-7-77
 DATE
 W.F.
 CW
 DI
 18-1

BORING 6

DATE DRILLED: June 23, 1979
 EQUIPMENT USED: 24"-Diameter Bucket

Project No.: ADE-79167

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

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.	ELEVATION	82.2
							ML		2" Asphaltic Paving
80		9.3	114	8			SC		SANDY SILT - light brown CLAYEY SAND - fine, brown
	5	5.8	110	8			SW		SAND - well graded, about 10% gravel, brown
75		11.2	120	10			SC		CLAYEY SAND - well graded, about 30% gravel, brown
	10	14.3	115	6			CL		SANDY CLAY - brown
70		17.7	110	6			CL		SILTY CLAY - brown
	15	20.3	108	6					
65		10.2	119	8			CL		SANDY CLAY - few gravel, brown
	20	11.3	124	11					
60		11.5	119	10			CL		SILTY CLAY - grey
	25	6.7	113	10			SW		SAND - well graded, few gravel, grey
55							SM		SILTY SAND - few gravel, grey
	30						CL		SILTY CLAY - grey
50		18.3	104	6					
	35								
45									
40									

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

BORING 6 (CONTINUED)

DATE DRILLED: June 23, 1979

EQUIPMENT USED: 24"-Diameter Bucket

Project No.: ADE-79167

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

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
40		17.1	111	6			
45		22.2	100	8			
50		23.8	101	6			
55		16.9	111	8			
60		4.1	105	17			
65		3.4	101	13			
70		7.3	116	18			
75		4.7	107	20			
80							

CL SANDY CLAY - grey

SP SAND - fine, light grey

Few gravel

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

BORING 7

DATE DRILLED: June 23, 1979

EQUIPMENT USED: 24"-Diameter Bucket

Project No.: ADE-79167

ELEVATION 82.0

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

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	DRIVE ENERGY (ft.-kips/ft.)	SAMPLE LOC.
80							ML
		7.8	109	6			SW
75	5	6.4	106	6			
		20.3	105	6			ML
70	10	17.8	109	6			CL
	15	13.1	116	10			
65		16.0	110	6			
	20	17.7	108	8			SM
60		20.6	104	8			CL
	25						
55		25.7	98	5			CL
	30						
50		20.0	106	6			
	35						
45		17.9	109	5			
40							

3" Asphaltic Paving
FILL - SANDY SILT - brown
SAND - well graded, few gravel, brown
Few cobbles (to 6" in size)
SANDY SILT - few gravel, brown
SANDY CLAY - some silt, reddish-brown
Few gravel
SILTY SAND - fine, brown
Few gravel
SANDY CLAY - grey
SILTY CLAY - grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

BORING 7 (CONTINUED)

DATE DRILLED: June 23, 1979

EQUIPMENT USED: 24"-Diameter Bucket

Project No.: ADE-79167

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

ELEVATION (ft.)	DEPTH (ft.)	"N" VALUE	STD. PEN. TEST	MOISTURE	DRY DENSITY	DRIVE ENERGY	SAMPLE LOC.
				(% of dry wt.)	(lbs./cu. ft.)	(ft.-kips/ft.)	
40							ML
	45	23.8	102	6			
35							CL
	50	22.3	99	8			
30							
	55	10.7	121	16			SP
25							
	60	3.1	104	25			
20							
	65	4.3	104	16			
15							
	70	4.9	103	26			
10							
	75	8.4	105	24			

CLAYEY SILT - grey

SILTY CLAY - grey

Some alkali
















SAND - fine, grey

Some gravel

NOTE: Water not encountered. No caving.

LOG OF BORING

LeROY CRANDALL AND ASSOCIATES

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

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

P A R T I C L E S I Z E L I M I T S											
SILT OR CLAY		SAND			GRAVEL		COBBLES	BOULDERS			
		FINE	MEDIUM	COARSE	FINE	COARSE					
NO. 200		NO. 40	NO. 10	NO. 4	¾ in.	3 in.	(12 in.)				
U. S. S T A N D A R D S I E V E S I Z E											

UNIFIED SOIL CLASSIFICATION SYSTEM

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

LeROY CRANDALL AND ASSOCIATES

JOB A74056 DATE 4-2-74 R. *ML* O.E. *7/8* CHKD. *6/10/74*

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

BORING 3						DATE DRILLED: March 22, 1974	EQUIPMENT USED: 24"-Diameter Bucket
ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	BLOWS	SAMPLE	Project No.:A-74056	
ELEVATION 279.4							
ML CL SP						2" Asphaltic Paving	
						FILL - SILT, CLAY and SAND - mottled brown	
275	5	16.3	112	0			
		17.8	108	0			
270	10	17.8	106	0			
		14.9	107	0			
265	15	18.3	108	0			
		15.6	106	1			
260	20	15.4	90	0		Large piece of concrete	
		18.8	105	0			
255	25	14.2	117	8		Few gravel	
		12.7	108	7			
250	30	13.9	119	8		Large piece of concrete, pieces of wood	
245	35	13.5	120	6			

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

Figure A-1.3.27

PLATE A-5

J¹ CHKD. O.E. R. FEL
 JOB A74056 DATE 4-2-74

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

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	BLOWS	SAMPLE
240	40	12.9	119	9	ML
235	45	19.1	105	4	
230	50	12.1	113	6	SW
225	55	5.7	129	6	
220	60	9.2	114	7	SM
215	65	13.7	107	8	
210	70	21.9	105	9	

BORING 3 (CONTINUED)

DATE DRILLED: March 22, 1974

EQUIPMENT USED: 24"-Diameter Bucket

Project No.: A-74056

Few pieces of concrete

SANDY SILT - thin layers of Silty Sand, few gravel, brown
















SAND - well graded, about 20% gravel, dark brown

SILTY SAND - fine, light brown

NOTE: Water not encountered. No caving.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

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

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

P A R T I C L E S I Z E L I M I T S							
SILT OR CLAY	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		
	NO. 200	NO. 40	NO. 10	NO. 4	$\frac{3}{4}$ in.	3 in.	(12 in.)
	U. S. S T A N D A R D S I E V E S I Z E						

UNIFIED SOIL CLASSIFICATION SYSTEM

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

LEROY CRANDALL & ASSOCIATES

JOB A73135 DATE 7-20-73 DR. RL O.E. 6 CHKD. 6

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

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	BLOWS *	SAMPLE
285	5	14.1	102	3	CL ML SP
		18.8	97	1	
280	10	12.4	110	1	
		17.1	112	1	
275	15	18.5	106	1	
		18.2	108	1	
270	20	15.7	108	0	

(CONTINUED ON FOLLOWING PLATE)

BORING I
DATE DRILLED: June 29, 1973
EQUIPMENT USED: 24"-Diameter Bucket

Project No.: A-73135

ELEVATION 289.5**

FILL - CLAY - SILT - SAND - few gravel,
mottled brown

Few pieces of brick

*Number of blows required to drive LC&A sampler
12".

Driving Weights:

0' - 25' = 1640 lbs.
below 25' = 810 lbs.

Stroke = one foot

**Elevations refer to datum of reference drawing,
see Plate 1

Soils classified in accordance with the Unified
Soil Classification System.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

JOB A-73135 DATE 7-20-73 O.E. CHKD.

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

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	BLOWS	SAMPLE
265	25	15.7	111	1	SM
		17.5	112	1	
260	30	14.8	112	5	SC
		13.2	116	10	
255	35	24.9	100	8	CL
		18.9	104	14	SM
250	40	13.7	108	12	
245	45	5.3	108	16	SP
		9.2	103	17	
240	50	6.0	108	14	

BORING 1 (CONTINUED)

DATE DRILLED: June 29, 1973
EQUIPMENT USED: 24"-Diameter Bucket

Project No.: A-73135

SILTY SAND - well graded, about 30% gravel, brown

CLAYEY SAND - well graded, about 20% gravel, brown

SILTY CLAY - grey and brown

SILTY SAND - fine, light brown

Thin layers of Sand and Clay

SAND - fine, yellowish-brown

NOTE: Water not encountered. No caving.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

PLATE A-2

Figure A-1.3.31

JOB A73135 DATE 7-20-73 DR. RLC O.E. 75 CHKD. VR
 dd

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

ELEVATION (ft.)		DEPTH (ft.)		MOISTURE (% of dry wt.)		DRY DENSITY (lbs./cu ft.)		BLOWS		SAMPLE	
285		5		25.1		97		1		CL ML SP	
280		10		18.7		102		0			
275		15		15.6		114		1			
270		20		13.9		115		3			
265		25		12.8		111		2			
260		30		12.5		106		3			
				16.4		114		1			
				19.2		108		1			
				19.0		105		4			
				16.1		114		4			

(CONTINUED ON FOLLOWING PLATE)

BORING 2

DATE DRILLED: June 29, 1973
 EQUIPMENT USED: 24"-Diameter Bucket

Project No.: A-73135

ELEVATION 289.2

FILL - CLAY - SILT - SAND - mottled brown

Few gravel, few roots, some organic matter

Some organic matter

Brown
 Weeds and pieces of metal

Large amounts of wood

Pieces of concrete

Pieces of wood and metal

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

JOB 413135 DATE 7-20-73 DR. *CC* O.E. *VC* a CHKD. *VC*

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

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	BLOWS	SAMPLE
255	35	18.7	106	5	CL
		19.8	107	6	SM
250	40	4.3	95	10	
		4.3	105	12	SP
245	45	3.8	103	14	
		6.6	103	16	
240	50	6.6	100	17	
235	55				

BORING 2 (CONTINUED)
 DATE DRILLED: June 29, 1973
 EQUIPMENT USED: 24"-Diameter Bucket

Project No.: A-73135

SILTY CLAY - dark grey

Mottled brown

SILTY SAND - fine, light brown

SAND - fine, yellowish-brown

Black lenses

NOTE: Water not encountered. No caving.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

Figure A-1.3.33

PLATE A-4

JOB A73135 DATE 1-20-73 DR. RL O.E. pk CHKD. VC

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

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	BLOWS	SAMPLE
BORING 3					
DATE DRILLED: June 30, 1973					
EQUIPMENT USED: 24"-Diameter Bucket					
Project No.: A-73135					
ELEVATION 286.8					
285					CL ML SP
	5	21.4	100	1	FILL - CLAY - SILT - SAND - mottled brown
					Few gravel
280		10.6	118	1	
	10	18.7	105	1	
275		16.5	111	2	Dark grey and brown
	15	18.6	108	2	Pieces of wood
270		17.7	108	1	
	20	18.7	107	2	
265		14.1	117	3	Thin layers of Sand
	25	18.3	110	7	
260					ML
30					SANDY SILT - few gravel, dark grey

(CONTINUED ON FOLLOWING PLATE)

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

JOB A73135 DATE 7-20-73 DR. RR O.E. 6 dd 6 CHKD. VS

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

	ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	BLOWS	SAMPLE
255		12.9	114	5		
		19.1	106	11		CL
35						
250		22.3	100	10		
		12.9	120	6		
40						
245		14.8	116	5		ML
		18.6	108	8		SC
45						
240		11.3	120	10		
50						SP
235		9.0	102	18		
55						

BORING 3 (CONTINUED)
 DATE DRILLED: June 30, 1973
 EQUIPMENT USED: 24"-Diameter Bucket

Project No.: A-73135

SILTY CLAY - few gravel, dark grey
 Dark brown

SANDY SILT - few gravel, brown

CLAYEY SAND - fine, brown
 Few gravel















SAND - fine, yellowish-brown

NOTE: Water not encountered. No caving.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

Project No.:A-73135

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

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

P A R T I C L E S I Z E L I M I T S							
SILT OR CLAY	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		
	NO. 200	NO. 40	NO. 10	NO. 4	3/4 in.	3 in.	(12 in.)
	U. S. S T A N D A R D S I E V E S I Z E						

UNIFIED SOIL CLASSIFICATION SYSTEM

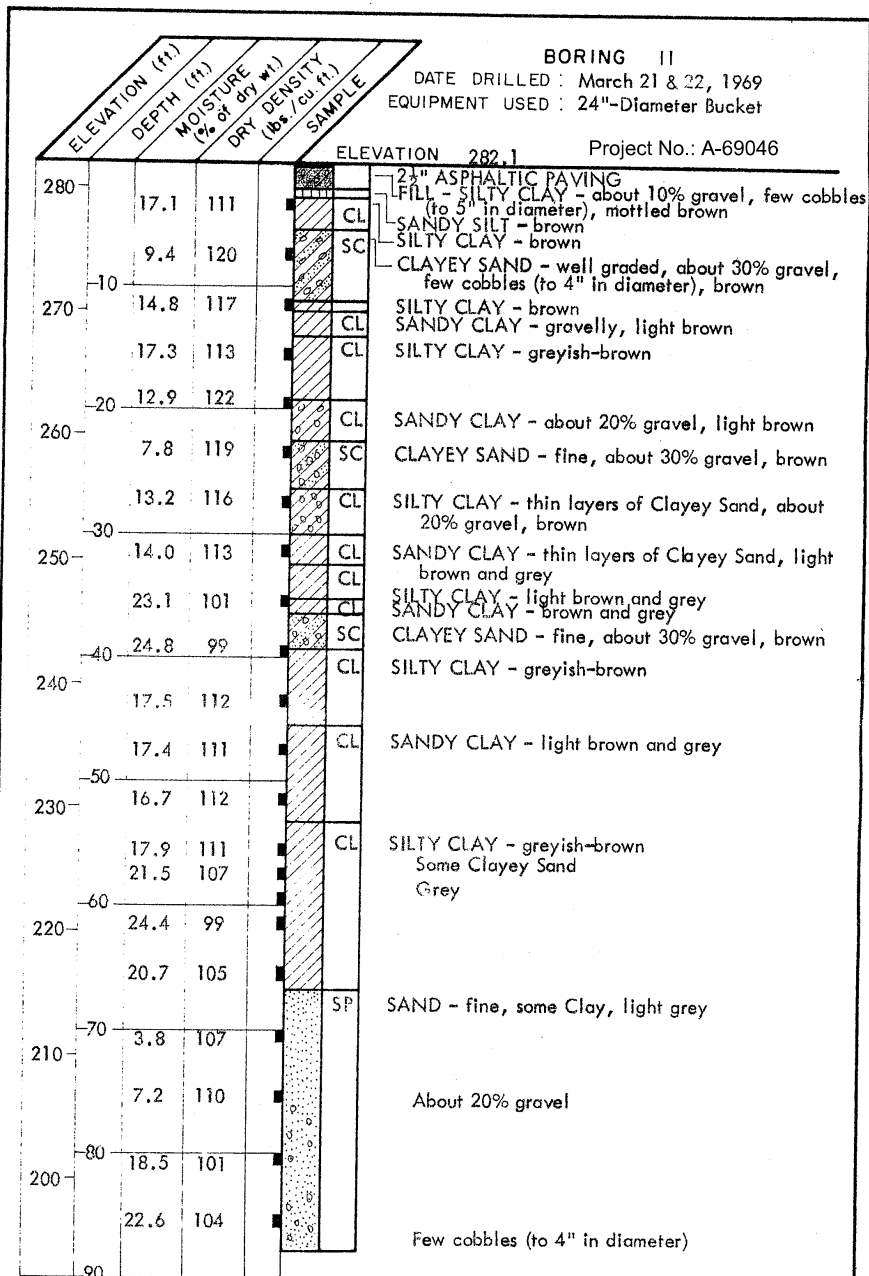
Reference :
 The Unified Soil Classification System, Corps of Engineers, U. S. Army Technical Memorandum No. 3-357, Vol. I, March, 1953. (Revised April, 1960)

LEROY CRANDALL & ASSOCIATES

Figure A-1.3.36

PLATE B

JOB A-69046 DATE 4-10-69
 CHKD. *nc*

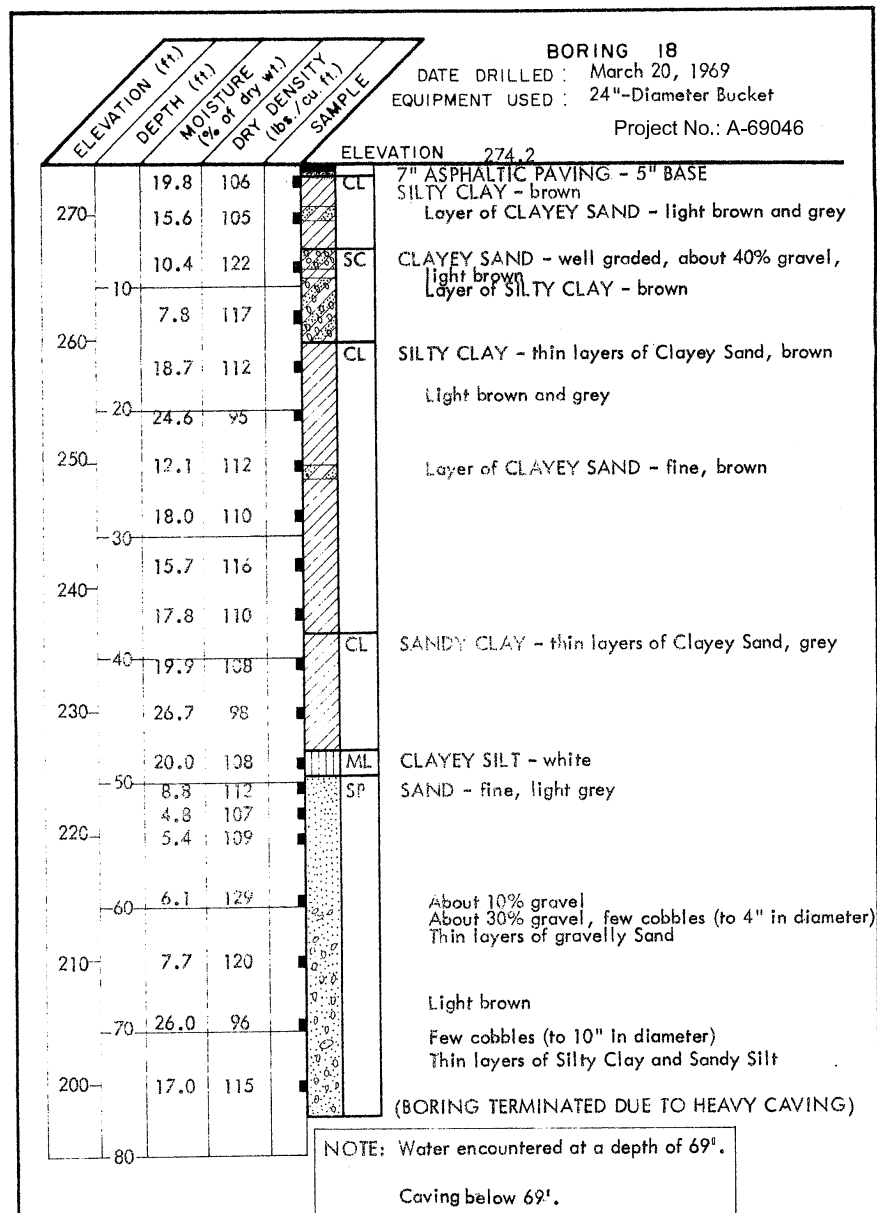


NOTE: Slight water seepage was encountered at depths of 50 1/2' and 79'. Water level at 27 1/2' at completion of drilling.

Caving from 50' to 51' (to 3' in diameter) and from 79' to 87 1/2'.

LOG OF BORING

JOB 4-69-45 DATE 4-10-69 DR. J. O. E. VB. CHKD. REC.



LOG OF BORING

Project No.: A-69036

BORING 2

DATE DRILLED: February 17, 1969

EQUIPMENT USED: 18"-Diameter Bucket to 70'
5"-Diameter Rotary Wash below 70'

Project No. A-09000

BORING 2

DATE DRILLED : February 17, 1969

EQUIPMENT USED : 18"-Diameter Bucket to 70'
5"-Diameter Rotary Wash below 70'

ELEVATION 272.4

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lb./cu. ft.)	SAMPLE
270	19.8	106		CL
	16.4	115		
260	17.5	111		
	26.1	99		
	26.3	99		
250	16.6	111		SM
	5.6	106		SP
240	5.1	102		
	5.4	124		
	9.7	109		SM
230	10.8	97		
	17.5	100		
220	10.3	99		
	19.7	100		
	10.4	105		
	8.8	106		
210	14.5	108		
	4.4	106		SP
200	7.2	118		
	9.3	104		
190	5.5	107		
	10.7	126		SM
180	11.1	107		
	8.6	118		

FILL - SILTY CLAY - mottled greyish-brown
SILTY CLAY - very silty, some Sand, greyish-brown

SILTY SAND - fine, some Clay, bluish-grey

SAND - fine, few gravel, light grey

SILTY SAND - fine, few gravel, light grey to brownish-grey

Layers of SILTY CLAY

SAND - fine, few gravel, grey
20% to 25% gravel
Cemented layer

(GAD AND CHOPPING BUCKET USED FROM 68 TO 70 FEET; BUCKET HOLE TERMINATED BECAUSE OF HARDNESS OF CEMENTED LAYER)

Dark grey
Few gravel

Large amount of gravel

SILTY SAND - fine, few gravel dark grey

NOTE: Water not encountered and no caving in bucket hole.
Drilling mud used in drilling process in rotary wash
hole. Water level not established.

LOG OF BORING

CHKD. *[Signature]*

DATE 4-16-69

DATE 4-16-69

JOB A-69036

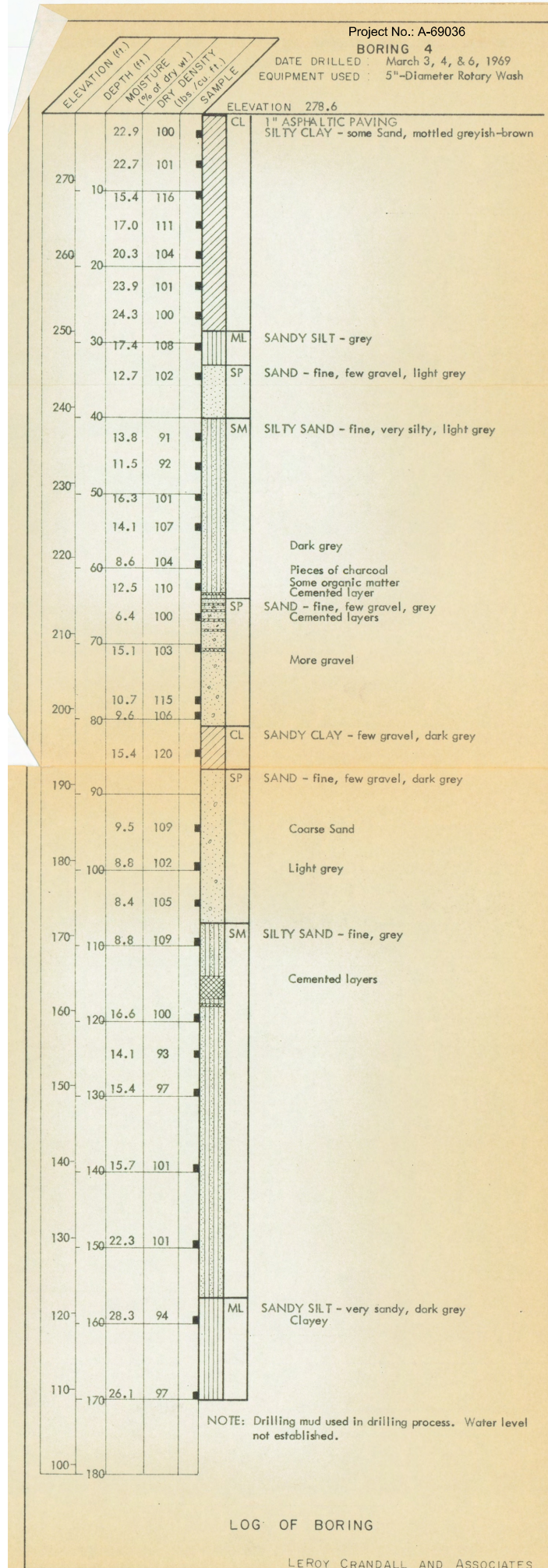
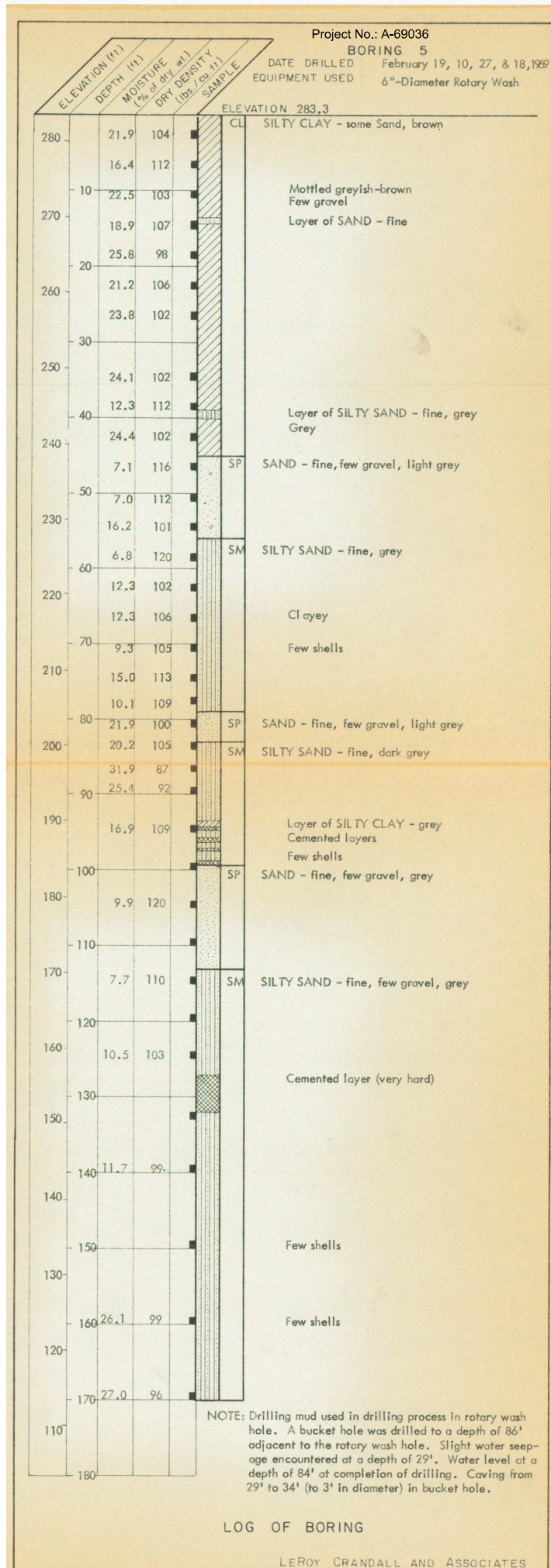


Figure A-1.3.40 PLATE A-4

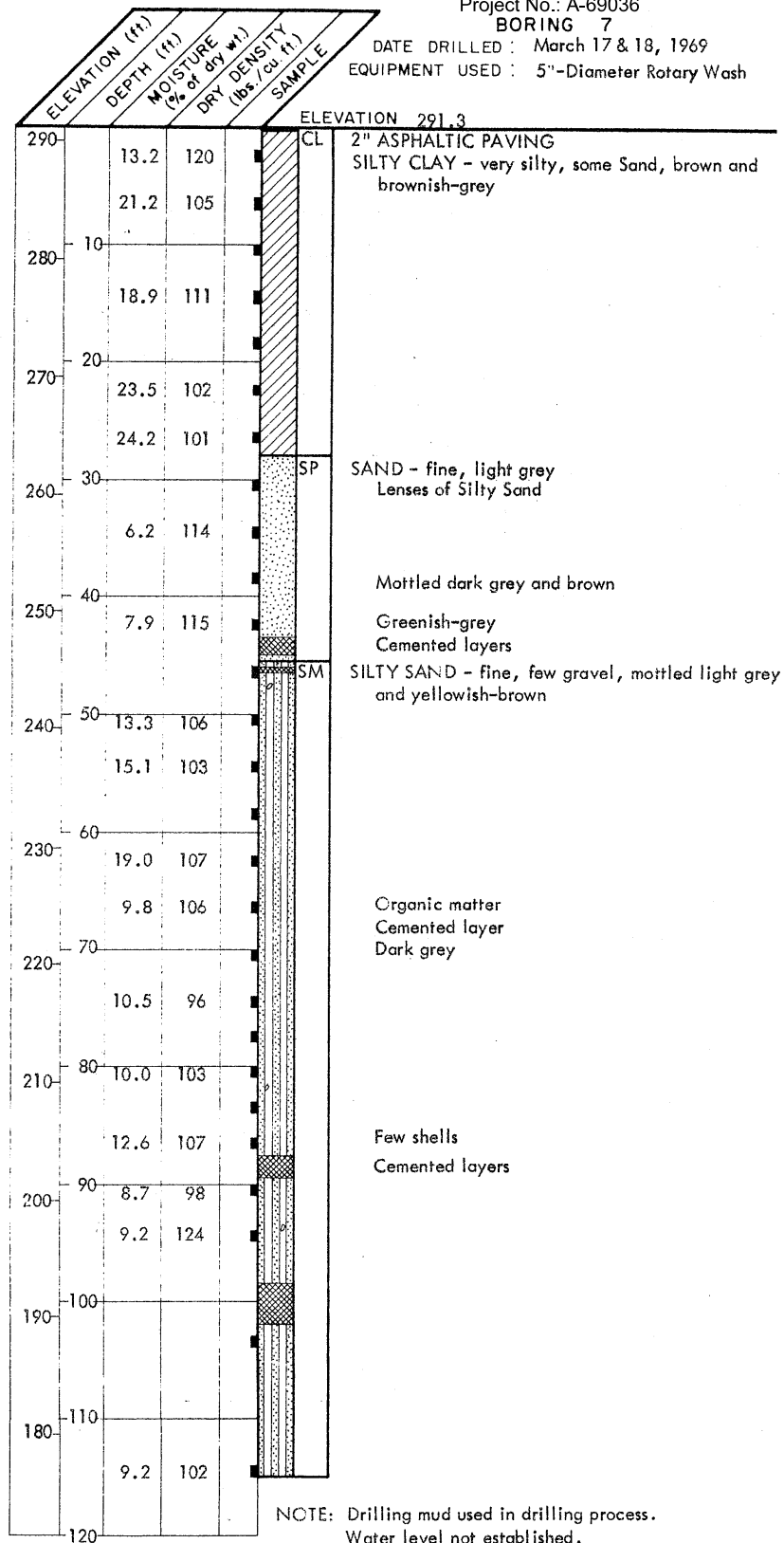


Project No.: A-69036

BORING 7

DATE DRILLED: March 17 & 18, 1969

EQUIPMENT USED: 5"-Diameter Rotary Wash



LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

Figure A-1.3.42

PLATE A-7

15' CHKD.

DATE 4-16-69

DATE 4-16-69

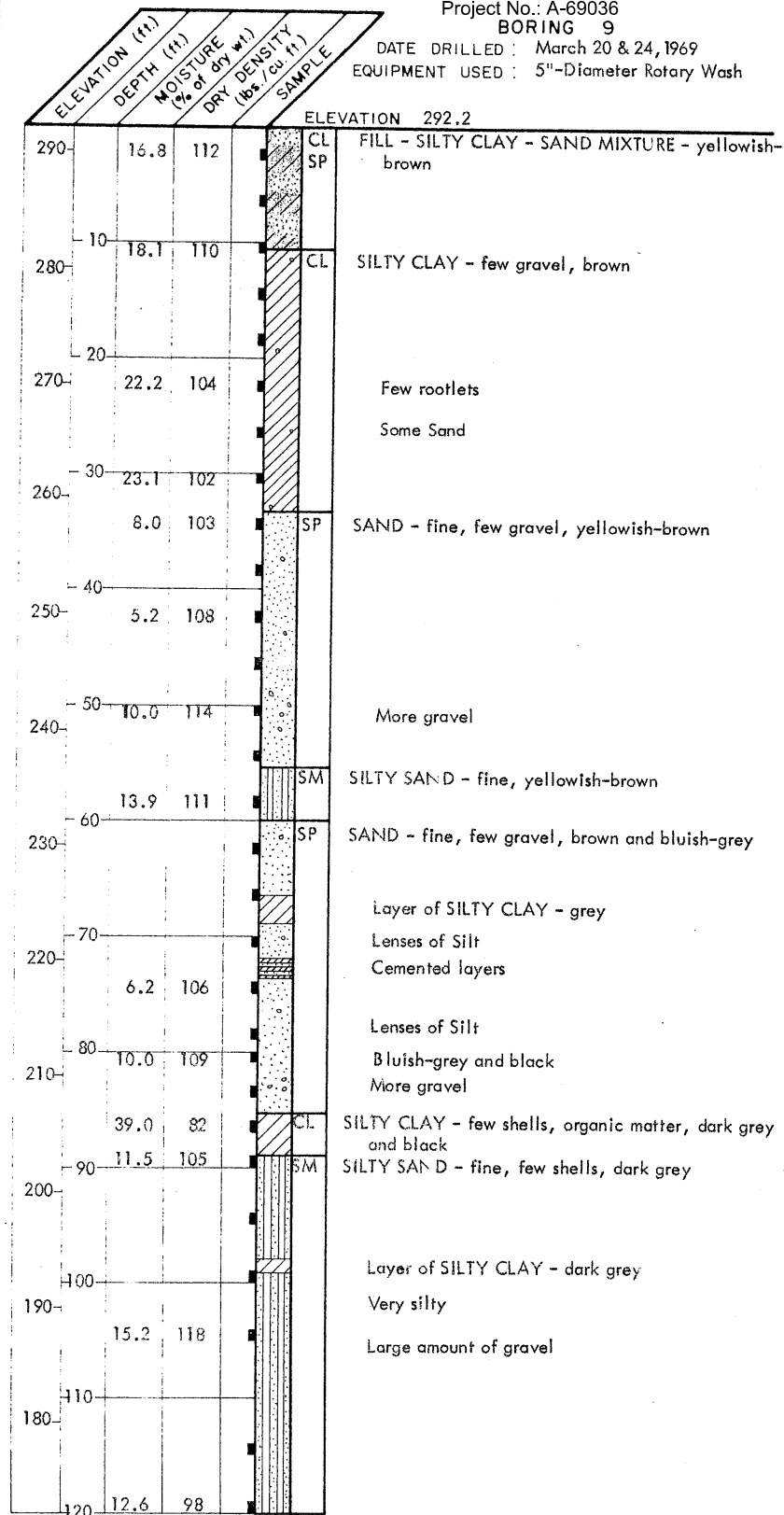
DATE 4-16-69

Project No.: A-69036

BORING 9

DATE DRILLED : March 20 & 24, 1969

EQUIPMENT USED : 5"-Diameter Rotary Wash



NOTE: Drilling mud used in drilling process.
Mud removed after drilling completed;
no water observed in the hole one-half
hour after removing mud.

LOG OF BORING

JOB A-69036 DATE 4-10-69 CHKD O E

Project No.: A-69036

BORING 10

DATE DRILLED : February 19, 1969

EQUIPMENT USED : 18"-Diameter Bucket to 75'
5"-Diameter Rotary Wash below 75'

Project No.: A-69036
BORING 10















DATE DRILLED : February 19, 1969
EQUIPMENT USED : 18"-Diameter Bucket to 75'
5"-Diameter Rotary Wash below 75'

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE % of dry wt.	DRY DENSITY (lbs. cu. ft.)	SAMPLE	DESCRIPTION
ELEVATION 278.9					
	19.7	108		CL	2" ASPHALTIC PAVING FILL - SILTY SAND - well graded, brown SILTY CLAY - some Sand, brownish-grey Very silty
270	22.9	103			
10	17.5	113			
	16.2	111		SM	SILTY SAND - fine, light grey
260	15.4	111			Lenses of Silty Clay
20	5.4	111		SP	SAND - fine, light grey Lenses of Clay, dark grey
250	7.1	108			
30	10.2	118		SC	CLAYEY SAND - fine, few gravel, greyish-brown
	18.3	115		SM	SILTY SAND - fine, few gravel, light grey
240	12.1	103			
40	14.0	105			
	16.6	109			Lenses of Clayey Silt, brown
230	12.0	110			
50	11.3	111			Few cobbles
220	8.7	101		SP	SAND - fine, few gravel, grey
60	3.4	112			
	10.7	101			
210	36.8	85		CL	SILTY CLAY - dark grey Few shells
70	10.0	95		SM	SILTY SAND - fine, few gravel, few shells, grey Cemented layers
	11.4	91			(GAD USED IN CEMENTED LAYERS; BUCKET HOLE TERMINATED BECAUSE OF HARDNESS OF CEMENTED LAYERS)
200	15.6	120			Layer of SILTY CLAY
80	7.1	124			
190	7.0	103			
90	12.1	122			
180	7.2	98			
100					
170					

NCTE: Water not encountered and no caving in bucket hole
Drilling mud used in drilling process in rotary wash

LOG OF BORING

Project No.: A-69036

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

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

PARTICLE SIZE LIMITS

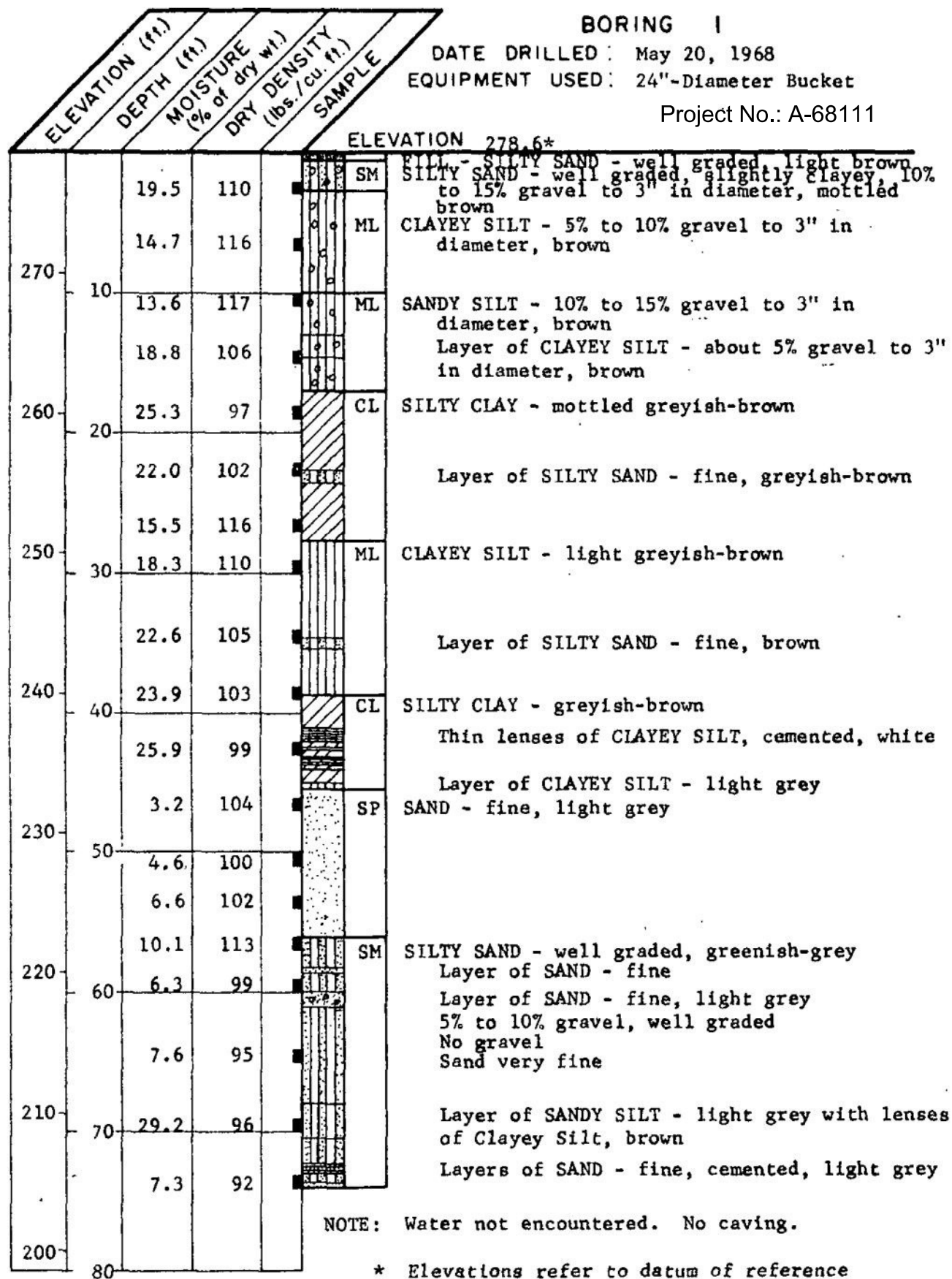
SILT OR CLAY	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		
	NO. 200	NO. 40	NO. 10	NO. 4	3/4 in.	3 in.	(12 in.)
	U. S. STANDARD SIEVE SIZE						

UNIFIED SOIL CLASSIFICATION SYSTEM

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

LEROY CRANDALL & ASSOCIATES

JOB A 68111 DATE 6-28-68 DR. C. H. O. E. AS. 16 CHKD. *SC*



LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

Figure A-1.3.46

PLATE A-1

JOB A-68111 DATE 6-26-68 L.H. O.E. CHKD. 422

BORING 3				DATE DRILLED : May 21, 1968	
EQUIPMENT USED : 24"-Diameter Bucket				Project No.: A-68111	
ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu ft.)	ELEVATION 278.0	
				CL	3" ASPHALTIC PAVING FILL - SILTY SAND - well graded, light brown SILTY CLAY - brown
270	24.5	99		ML	SANDY SILT - brown
	11.7	115		ML	CLAYEY SILT - brown
10	16.0	117		CL	SILTY CLAY - mottled brown
	18.5	106		ML	SANDY SILT - mottled brown
	22.3	104		ML	CLAYEY SILT - greyish-brown
260	24.6	102		CL	SILTY CLAY - mottled brown and greyish-brown Grey
	8.4	111		SM	SILTY SAND - fine, light grey
250	24.8	103		ML	SANDY SILT - grey
30	4.9	104		ML	CLAYEY SILT - grey
	5.3	116		SP	SAND - fine, light grey
240	8.4	92		SM	SILTY SAND - fine, 10% to 15% gravel and cobbles to 6" in diameter,
40	12.6	100			No gravel About 5% coarse gravel
230	7.6	102			Lens of Sand, medium
50	10.5	110		ML	SANDY SILT - lenses of fine Sand, grey Layer of SILTY SAND - fine
	7.0	98		SM	Lenses of SILTY CLAY - black SILTY SAND - fine, grey
220	9.5	104			Bits of shells
60	11.0	109			Layers of SILT and SAND - shells, few cobbles to 4" in diameter, cemented, grey
210	4.7	117		SP	SAND - fine, grey 10% to 15% well graded gravel
70	2.7	101			Layer of SAND - fine, cemented, grey 5% to 10% fine gravel
	3.3	107			No gravel
200	12.4	124		SM	SILTY SAND - fine, grey, with lenses of Silty Clay, black
80	5.2	135		CL	SANDY CLAY - grey
	4.0	109		SC	CLAYEY SAND - fine, few concretions to 4" in diameter, grey
190	8.5	94		SP	SAND - fine, grey
90	9.0	93		SM	SILTY SAND - fine, about 5% gravel to 3" in diameter, 10% to 15% gravel to 3" in diameter Layer of SAND - fine, 5% to 10% gravel to 3" in diameter Few concretions to 8" in diameter No gravel About 5% gravel to 1½" in diameter
180					
100					













NOTE: Water not encountered. Caving from 63' to 78' (to 42" in diameter).

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

Figure A-1.3.47

PLATE A-3

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

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

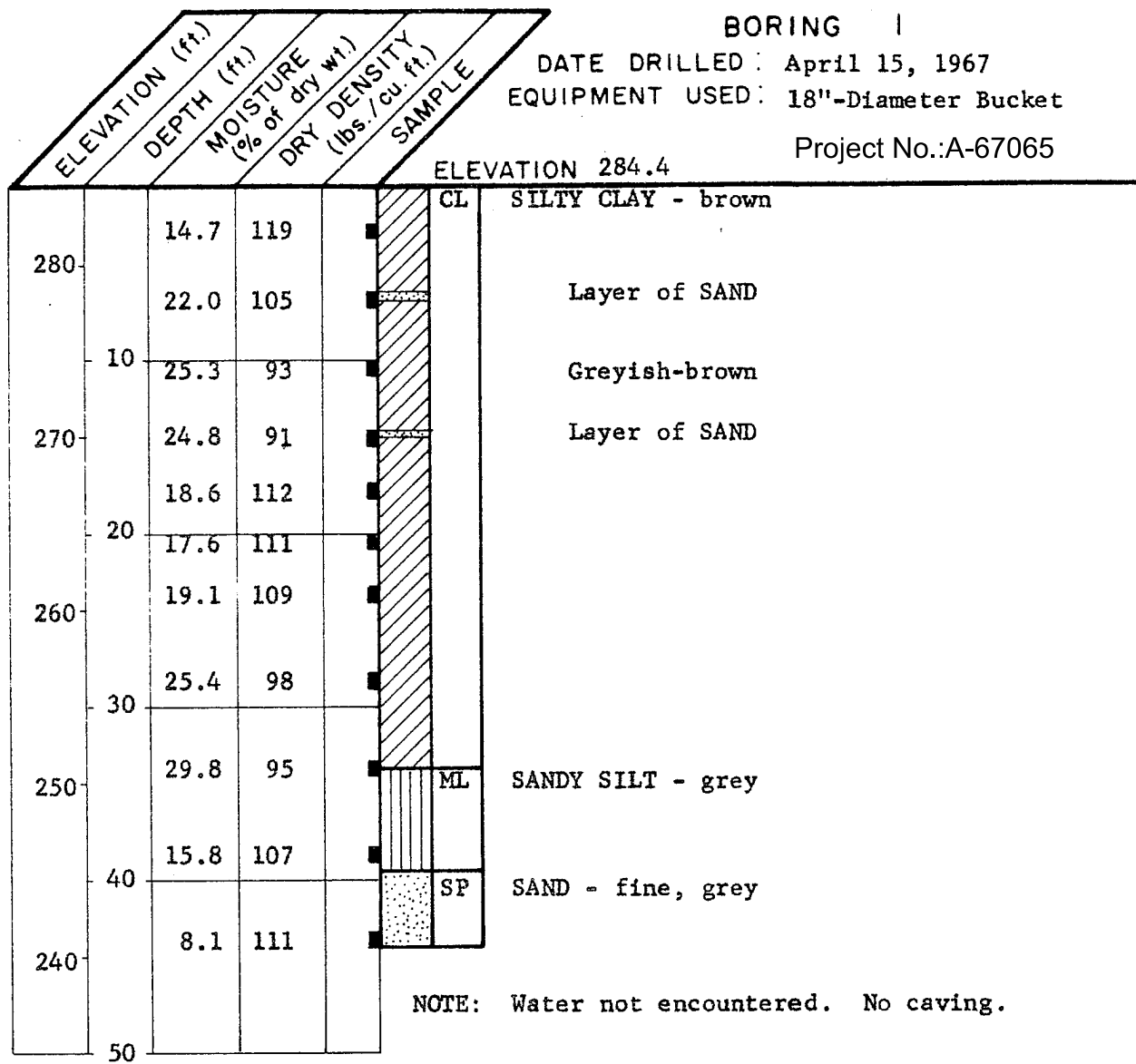
P A R T I C L E S I Z E L I M I T S						
SILT OR CLAY	SAND			GRAVEL		BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE	
	NO. 200	NO. 40	NO. 10	NO. 4	3/4 in.	3 in.
						(12 in.)
	U. S. S T A N D A R D S I E V E S I Z E					

UNIFIED SOIL CLASSIFICATION SYSTEM

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

LEROY CRANDALL & ASSOCIATES

JOB A-67065 DATE 4-26-67 DR U.M. O.E.B. CR CHKD. rel. C/N



*Elevations refer to datum of reference survey; see Plate 1.

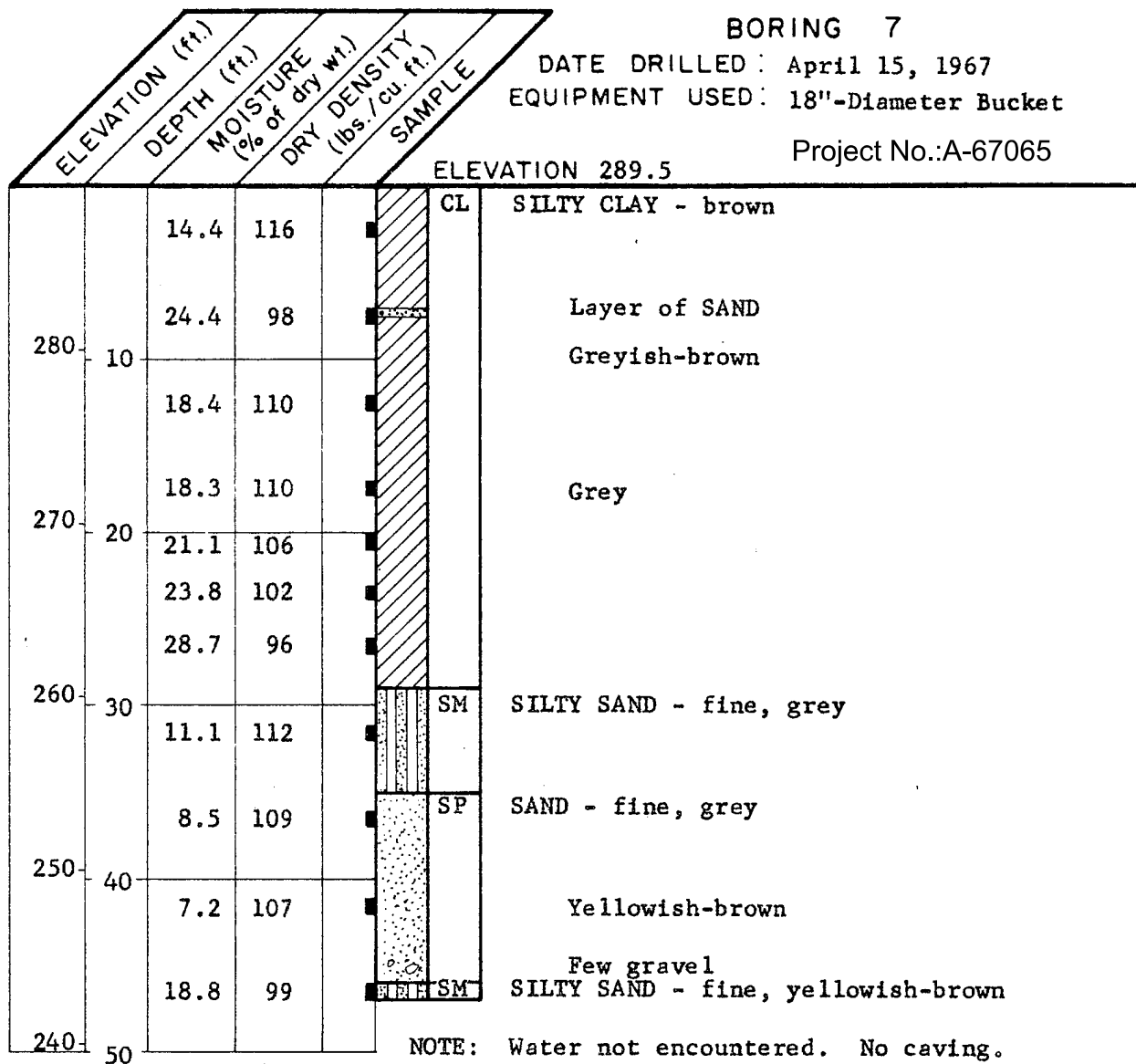
Soils classified in accordance with the Unified Soil Classification System.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

Figure A-1.3.49

JOB A-67065 DATE 4-26-67 DR V.M. O.E. 4,1
 CKD. 4,1

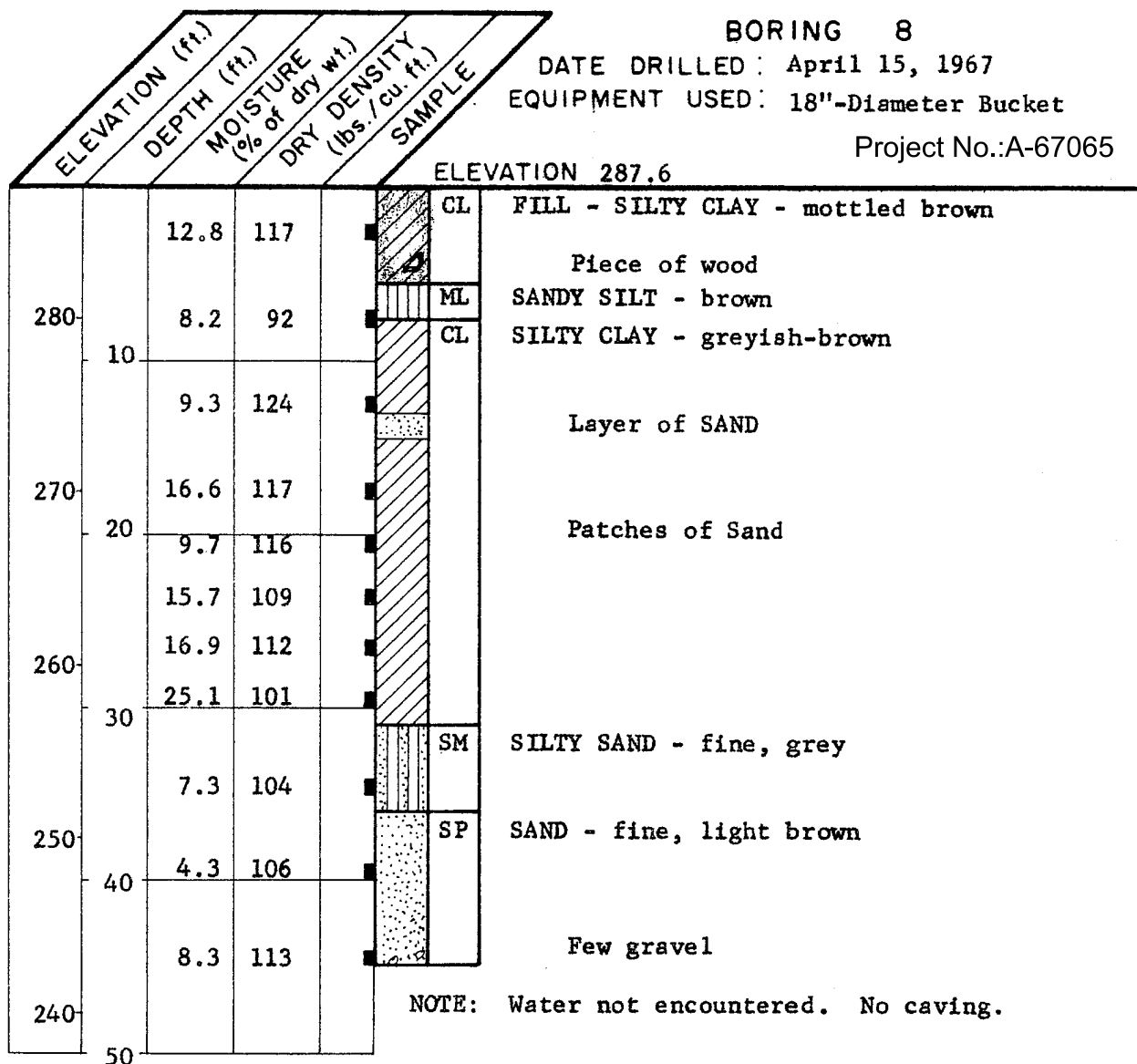


LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

Figure A-1.3.50

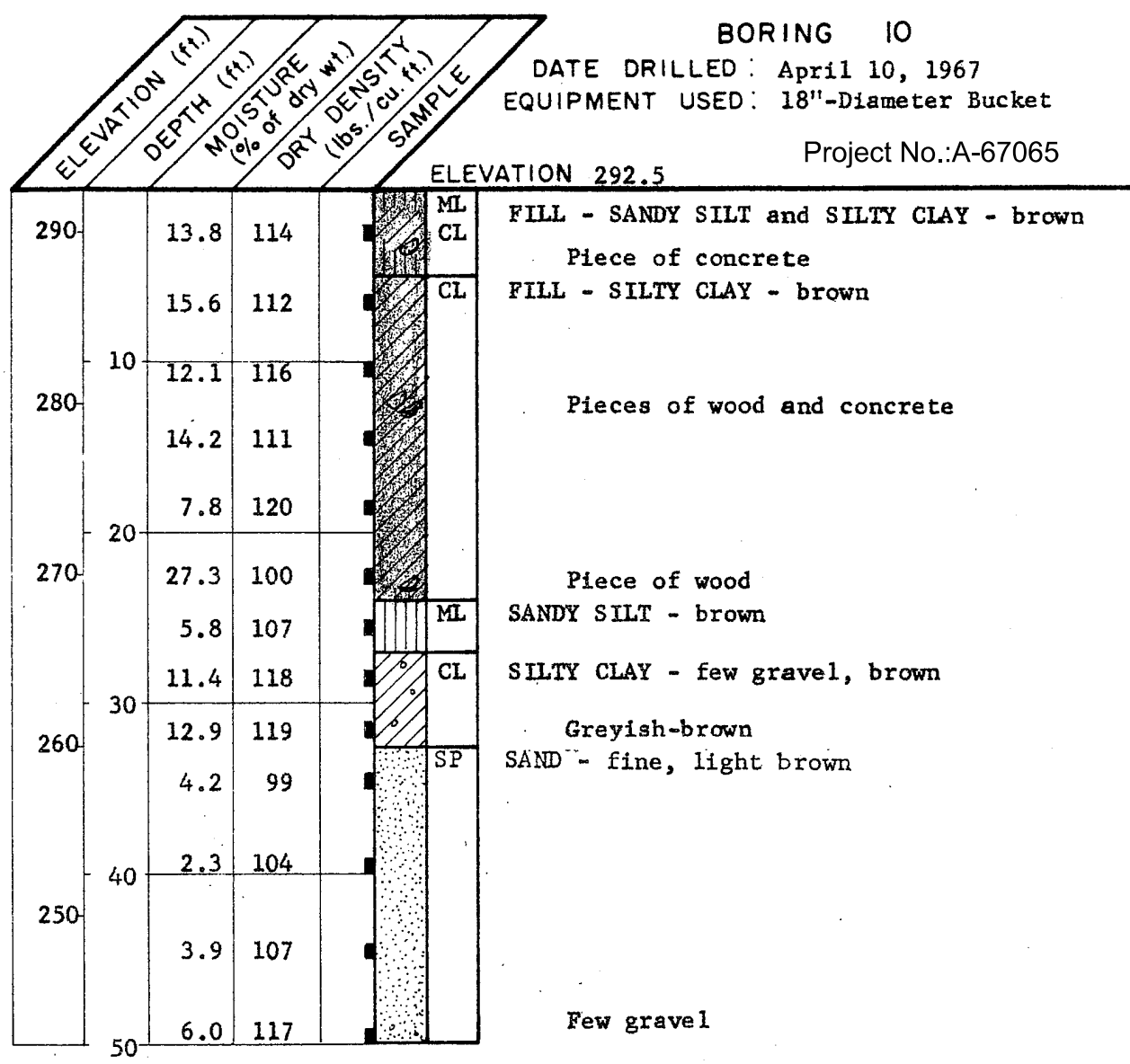
JOB A-67065 DATE 4-26-67 DR WY O.E. W CHKD. RL CA



LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

JOB A-67065 DATE 4-26-67 DR [initials] O.E.J. CT CHKD. sec. [initials]

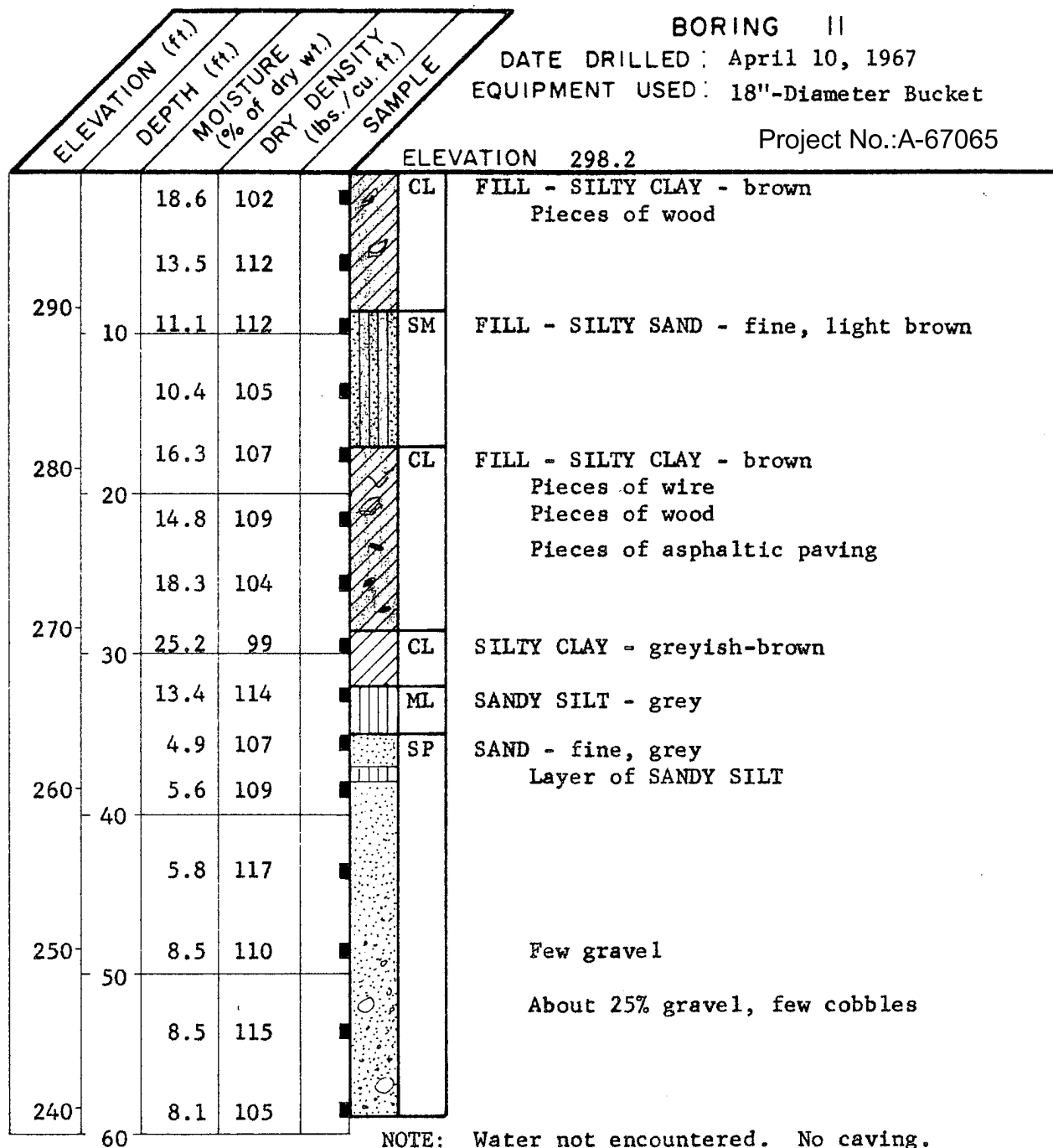


NOTE: Water not encountered. No caving.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

JOB A-67065 DATE 4-26-67 DR V.M. O.E. V.2 CHKD. REC. *SL*

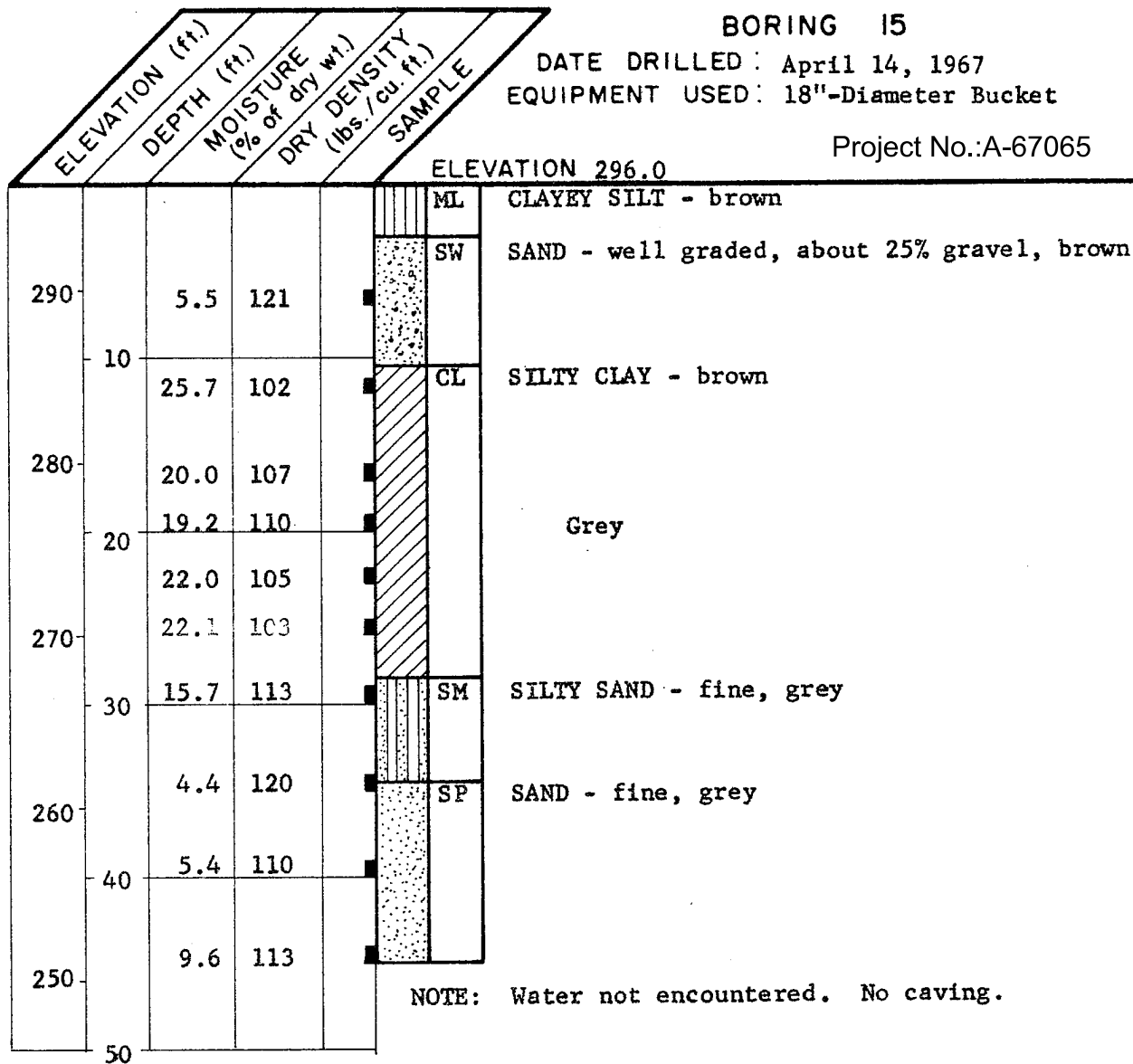


LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

Figure A-1.3.53

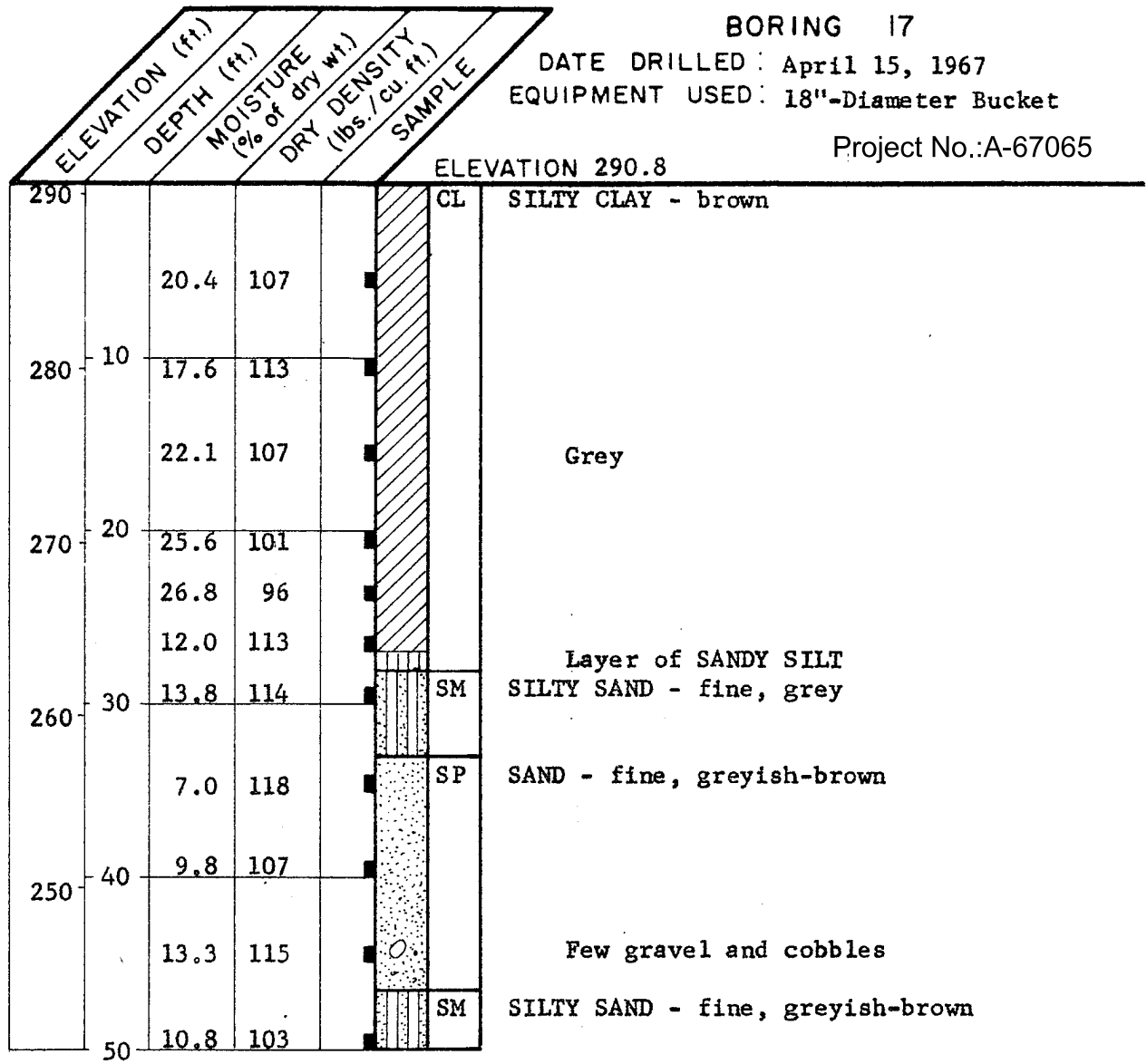
JOB A-67065 DATE 4-26-67 DR J.M. O.E. CHKD. *REL* *CH*



LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

JOB A-67065 DATE 4-26-67 DR U.M.O.E. CHKD. REC. *ck*


















NOTE: Water not encountered. No caving.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

Figure A-1.3.55

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

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

PARTICLE SIZE LIMITS

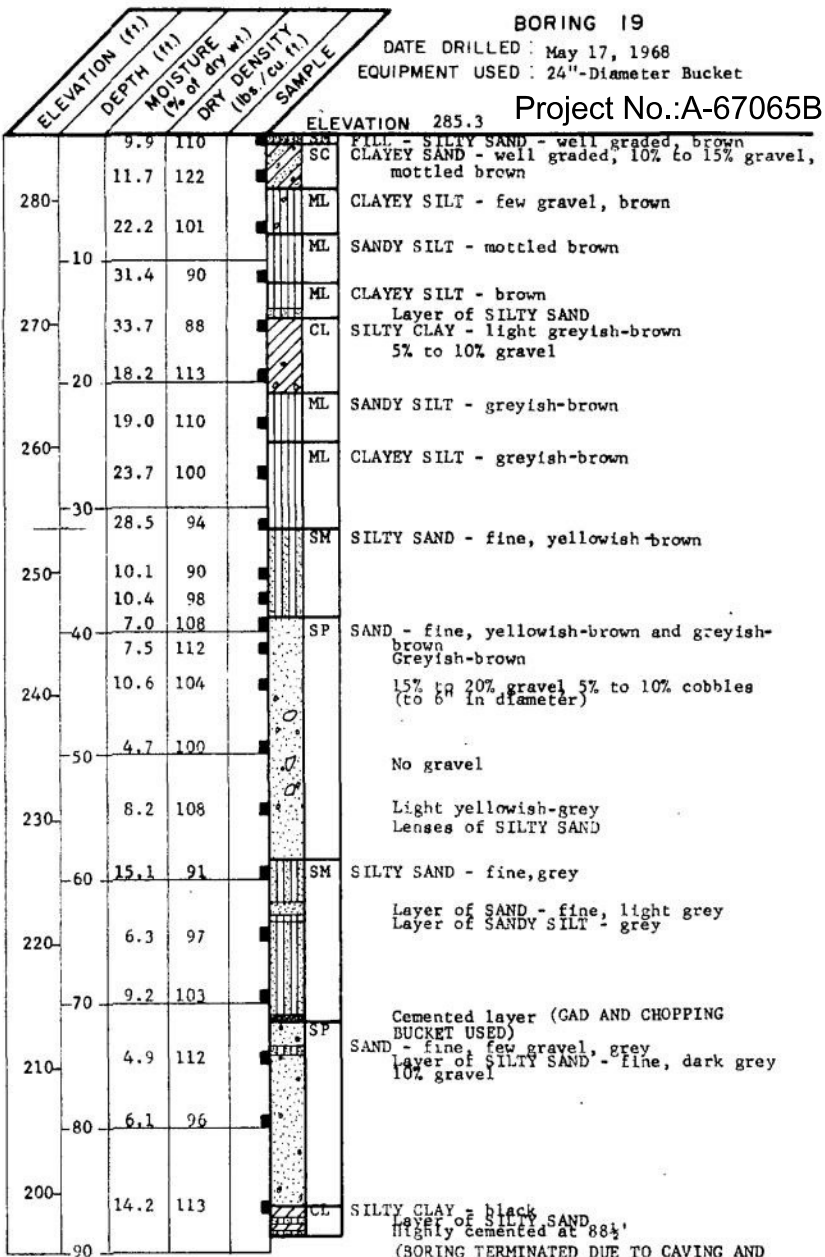
SILT OR CLAY	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		
	NO. 200	NO. 40	NO. 10	NO. 4	3/4 in.	3 in.	(12 in)
	U. S. STANDARD SIEVE SIZE						

UNIFIED SOIL CLASSIFICATION SYSTEM

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

LEROY CRANDALL & ASSOCIATES

JOB A-67065B DATE 6-14-68 /man O.E. CHKD. all



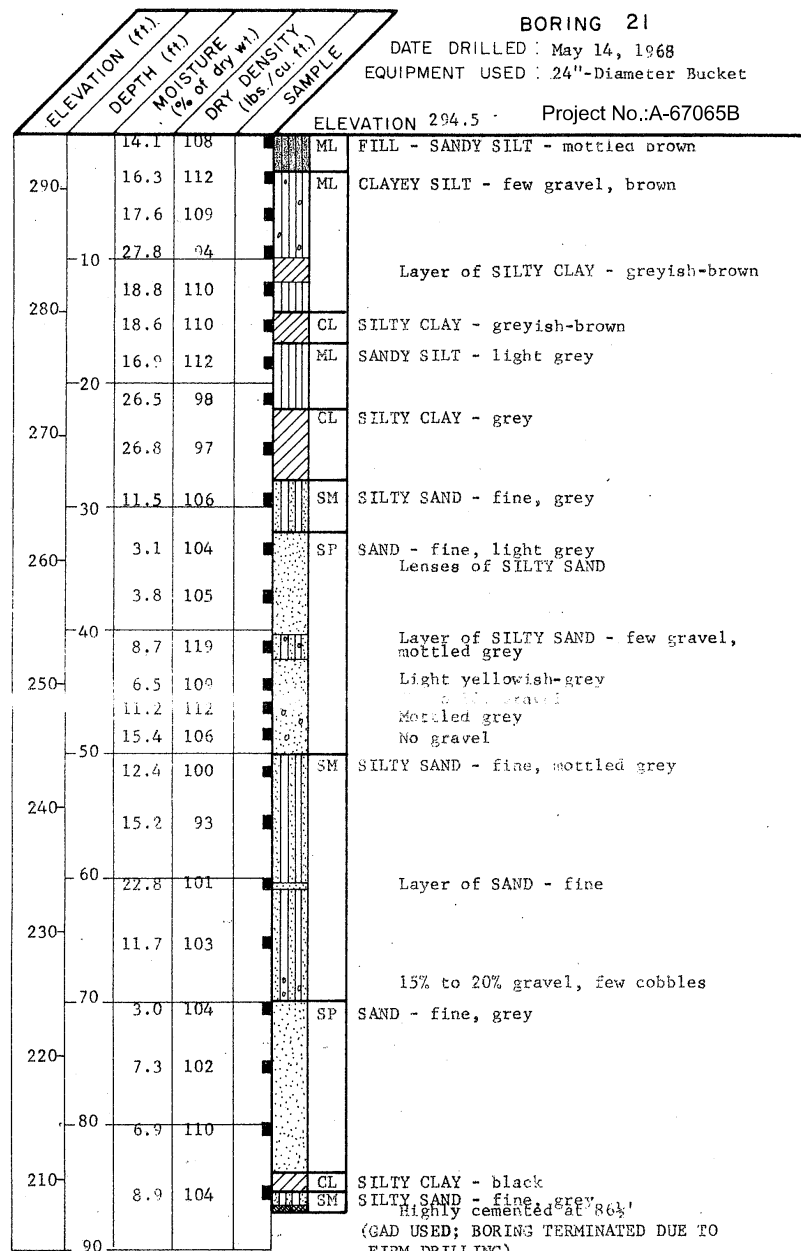
NOTE: Water not encountered. Heavy caving from 84' to 86 1/2'.

LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

Figure A-1 3.57

JOB A-67065-B DATE 6-14-68 / man O.E. SC CHKD. ACI



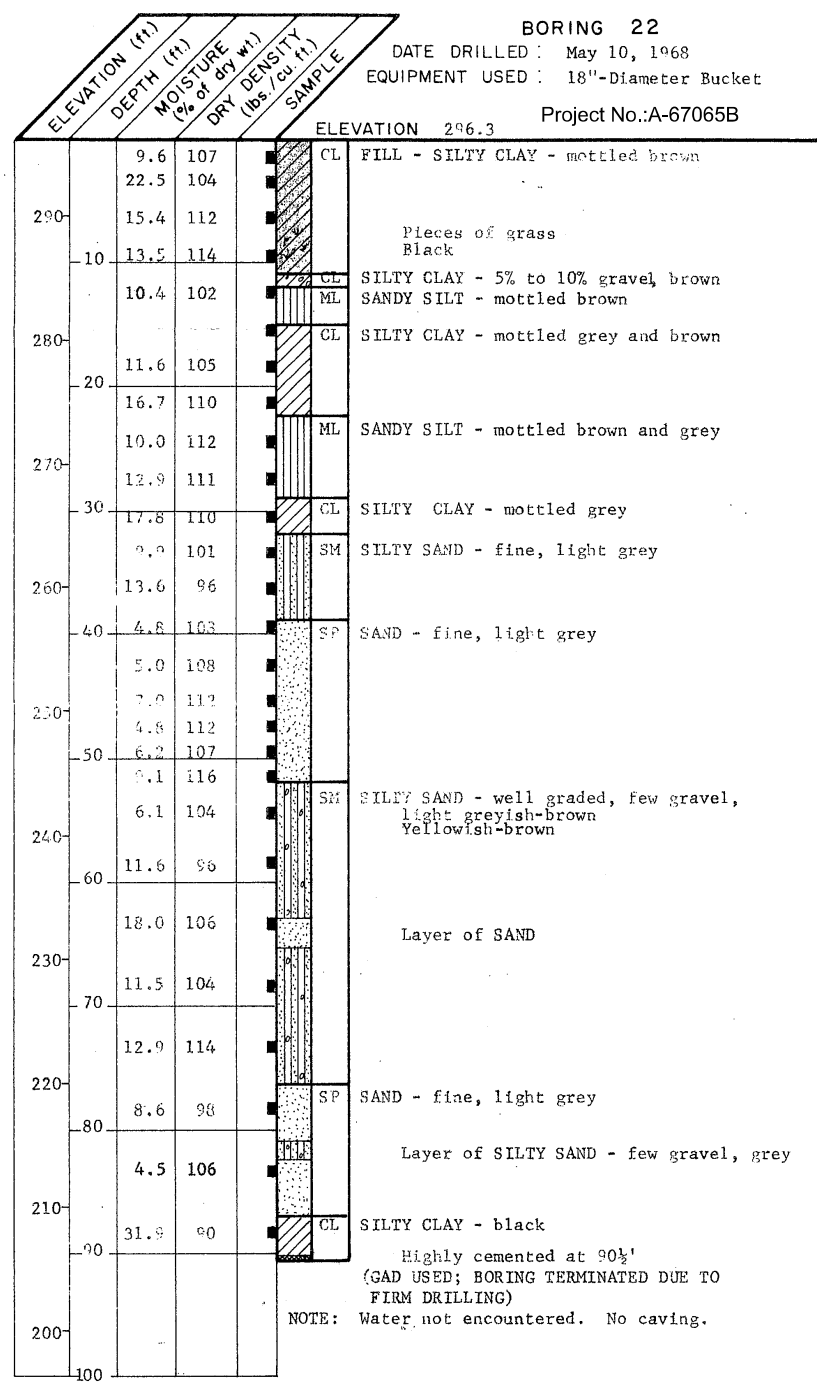
LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

Figure A-1.3.58

PLATE 2-D

JOB A-67065B DATE 6-14-68 SC CHKD. ML
 () 100% O.E.

















LOG OF BORING

LEROY CRANDALL AND ASSOCIATES

Figure A-1.3.59

PLATE 2-E

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

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

PARTICLE SIZE LIMITS

SILT OR CLAY	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		
	NO. 200	NO. 40	NO. 10	NO. 4	3/4 in.	3 in.	(12 in.)
	U. S. STANDARD SIEVE SIZE						

UNIFIED SOIL CLASSIFICATION SYSTEM

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

LERoy CRANDALL & ASSOCIATES

ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu ft.)	SAMPLE
280	16.6	109		ML
	21.5	105		
270	10	17.7	113	CL
	9.9	123		
260	20	17.7	111	
	13.8	111		
	29.9	94		
250	30	19.8	109	
	19.6	111		
	17.4	114		
240	40	23.2	103	
	21.6	108		
230	50	18.6	111	
	6.2	113		SP
220	60	5.3	111	
	6.7	111		
210	70	8.2	131	
	10.4	111		SM
200	80	21.4	105	
	13.3	111		
190	90	23.0	105	
	15.3	118		SP
100	12.7	114		

ELEVATION 282.2

BORING 6

DATE DRILLED : December 23 & 30, 1966
EQUIPMENT USED : 18"-Diameter Bucket to 50'
6"-Diameter Rotary Wash to 100'

Project No.:A-66362

2" ASPHALTIC PAVING
SANDY SILT - brown

SILTY CLAY - few gravel, brown

Sandy

Layer of CLAYEY SAND - about 15% gravel

Less sandy

Patches of Sand, greyish-brown

Grey

SAND - fine, grey

Few gravel

SILTY SAND - fine, grey

SAND - fine, few gravel, grey

NOTE: Water level not established. Slight water seepage at 41' in boring drilled with bucket drilling equipment. No caving with bucket drilling equipment. Drilling mud used with rotary wash drilling equipment.
















LOG OF BORING

LEROY CRANDALL & ASSOCIATES

Figure A-1-3.61

PLATE A-6

JOB A-66362 DATE 1-6-67 O.E. 28 CHKD. 28

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

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

PARTICLE SIZE LIMITS

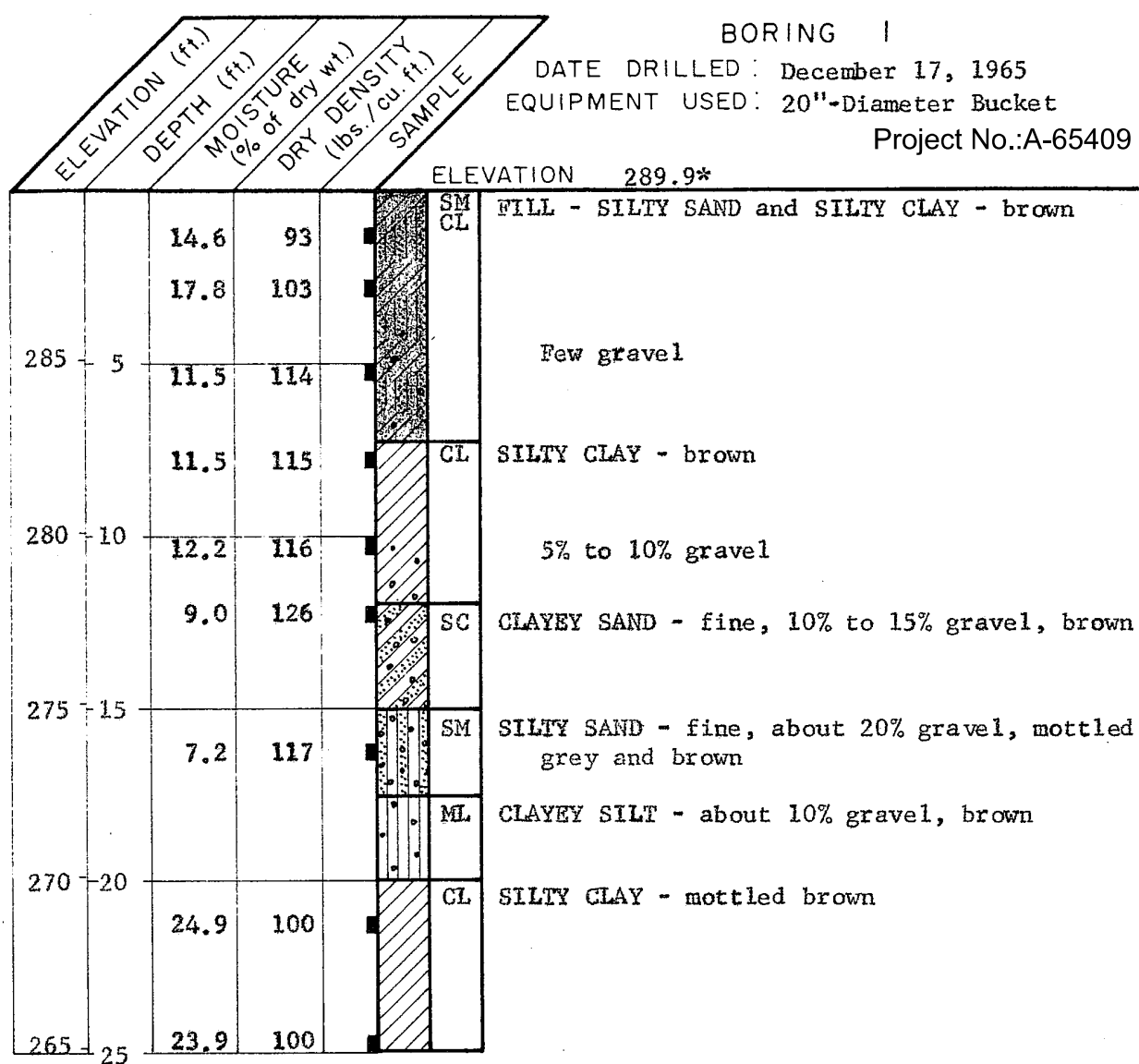
SILT OR CLAY	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		
	NO. 200	NO. 40	NO. 10	NO. 4	$\frac{3}{4}$ in.	3 in.	(12 in.)
	U. S. STANDARD SIEVE SIZE						

UNIFIED SOIL CLASSIFICATION SYSTEM

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

LEROY CRANDALL & ASSOCIATES

JOB A-65409 DATE 12-23-65 DR SM O.E. Sam CHKD. SL



NOTE: Water not encountered; no caving.

*Elevations refer to datum of reference drawing; see Plate 1 for benchmark.

Soils classified in accordance with the Unified Soil Classification System.

LOG OF BORING

LEROY CRANDALL & ASSOCIATES

PLATE A-1A

Figure A-1.3.63

JOB A-65409 DATE 12-23-65 DR U.M. O.E. 28 am CHKD. r.l. Cpl

BORING 2					DATE DRILLED : December 17, 1965		EQUIPMENT USED : 20"-Diameter Bucket		Project No.:A-65409	
ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	SAMPLE	ELEVATION	290.0				
				ML CL		FILL - SANDY SILT and SILTY CLAY - mottled brown				
	8.3	126		SP		FILL - GRAVELLY SAND - mottled grey and brown				
285	5	9.9	116	SM		FILL - SILTY SAND - mottled grey and brown				
	13.0	117		CL		SILTY CLAY - few gravel, mottled brown 10" cobble				
280	10	23.1	100							
	24.2	102		SM		SILTY SAND - fine, reddish-brown				
275	15	28.2	92	CL		CLAY - brown				
	26.4	94				Grey				
270	20	24.0	101	CL		SILTY CLAY - mottled grey				
	20.7	105				Mottled brown				
265	25									
	17.5	111								
260	30									

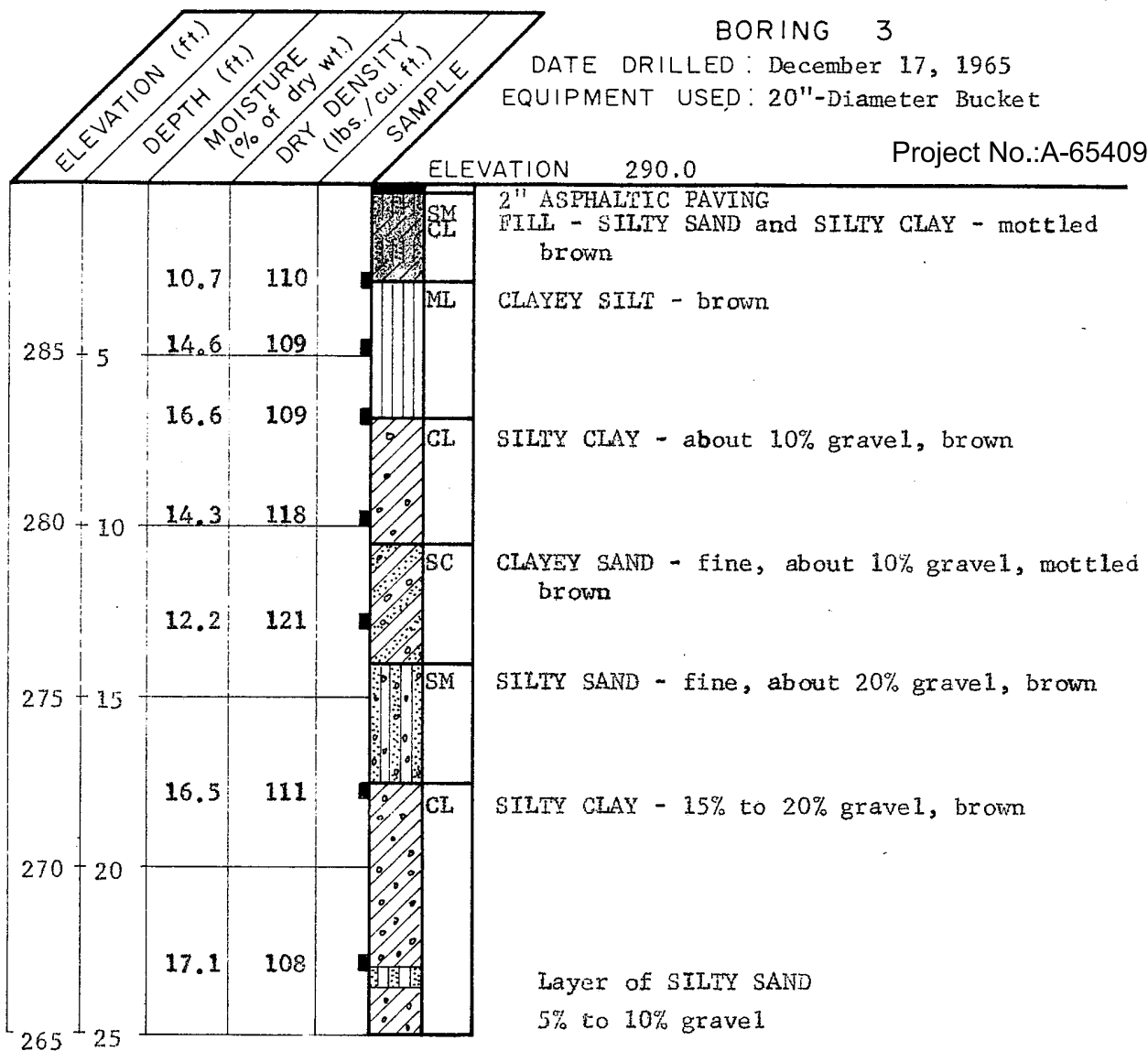
NOTE: Water not encountered; no caving.

LOG OF BORING

LEROY CRANDALL & ASSOCIATES

PLATE A-1B

JOB A-65409 DATE 12-23-65 DR. V.M. O.E. 28am CHKD. [initials]



NOTE: Water not encountered; no caving.

LOG OF BORING

LEROY CRANDALL & ASSOCIATES

PLATE A-1C

Figure A-1.3.65

JOB A-65409 DATE 12-23-65 DR. J.M. O.E. 28am CHKD. M. S.S.

BORING 4				DATE DRILLED: December 17, 1965	
				EQUIPMENT USED: 20"-Diameter Bucket	
				Project No.: A-65409	
ELEVATION (ft.)	DEPTH (ft.)	MOISTURE (% of dry wt.)	DRY DENSITY (lbs./cu. ft.)	SAMPLE	
290				SM	FILL - SILTY SAND and SILTY CLAY - mottled brown
	17.2	93		CL	
	5.3	116		SP	FILL - GRAVELLY SAND - 15% to 20% gravel, mottled brown
285	5				
	5.5	117			
	9.7	116		SC	FILL - CLAYEY SAND - few gravel, mottled brown
280	10				
	10.9	117			
	8.8	121			
275	15			CL	SILTY CLAY - brown
	22.6	102			
	22.4	100			Lenses of SILTY SAND
270	20				
	21.0	105			Few fine gravel
265	25				
	18.9	109			
	17.6	110		ML	CLAYEY SILT - mottled grey
30					

NOTE: Water not encountered; no caving.

LOG OF BORING

LEROY CRANDALL & ASSOCIATES

JOB A-65409 DATE 12-23-65 DR. DM O.E. 28 am CHKD. SK

ELEVATION (ft.)
 DEPTH (ft.)
 MOISTURE
 (% of dry wt.)
 DRY DENSITY
 (lbs./cu. ft.)
 SAMPLE

BORING 5

DATE DRILLED: December 17, 1965
 EQUIPMENT USED: 20"-Diameter Bucket

Project No.: A-65409

ELEVATION 290.1					
290					SM CL 2" ASPHALTIC PAVING FILL - SILTY SAND and SILTY CLAY - mottled brown
					SM SILTY SAND - fine, about 10% gravel, brown
285	5				SP GRAVELLY SAND - fine, 10% to 15% gravel, mottled brown
					SC CLAYEY SAND - fine, 5% to 10% gravel, brown
280	10				
	15				
















NOTE: Water not encountered; no caving.

LOG OF BORING

LEROY CRANDALL & ASSOCIATES

PLATE A-1E

Figure A-1.3.67

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

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

P A R T I C L E S I Z E L I M I T S

SILT OR CLAY	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		
	NO. 200	NO. 40	NO. 10	NO. 4	3/4 in.	3 in.	(12 in.)
	U. S. STANDARD SIEVE SIZE						

UNIFIED SOIL CLASSIFICATION SYSTEM

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

LERoy CRANDALL & ASSOCIATES

and undisturbed samples were obtained for laboratory inspection and testing. The logs of the borings are summarized below:

LOG OF BORING 1
Elevation: 298.10

0 - 4' - Fill - Clay and Clayey Sand - moderately firm
4' - 6' - Fill - Sand - moderately firm
6' - 7½' - Fill - Clay and Clayey Sand - moderately firm
7½' - 10' - Fill - Sand - few gravel, moderately firm
10' - 15' - Fill - Clay and Clayey Sand - moderately soft, some wire
15' - 21' - Fill - Sand - soft
21' - 22½' - Fill - Clay - soft, chunks of asphaltic paving
22½' - 29' - Clayey Silt - firm

Water not encountered; no caving.

LOG OF BORING 2
Elevation: 305.38

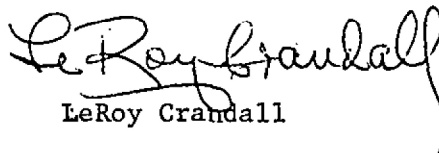
0 - 18½' - Fill - Clay - moderately firm, some asphaltic concrete
18' - 20' - Fill - Sand - moderately soft
20' - 27' - Silty Clay - firm

Water not encountered; no caving.

The data obtained in our field explorations and our preliminary analyses will be retained in our files for future reference. We would be pleased to render further service on this project should the need arise.

Yours very truly,

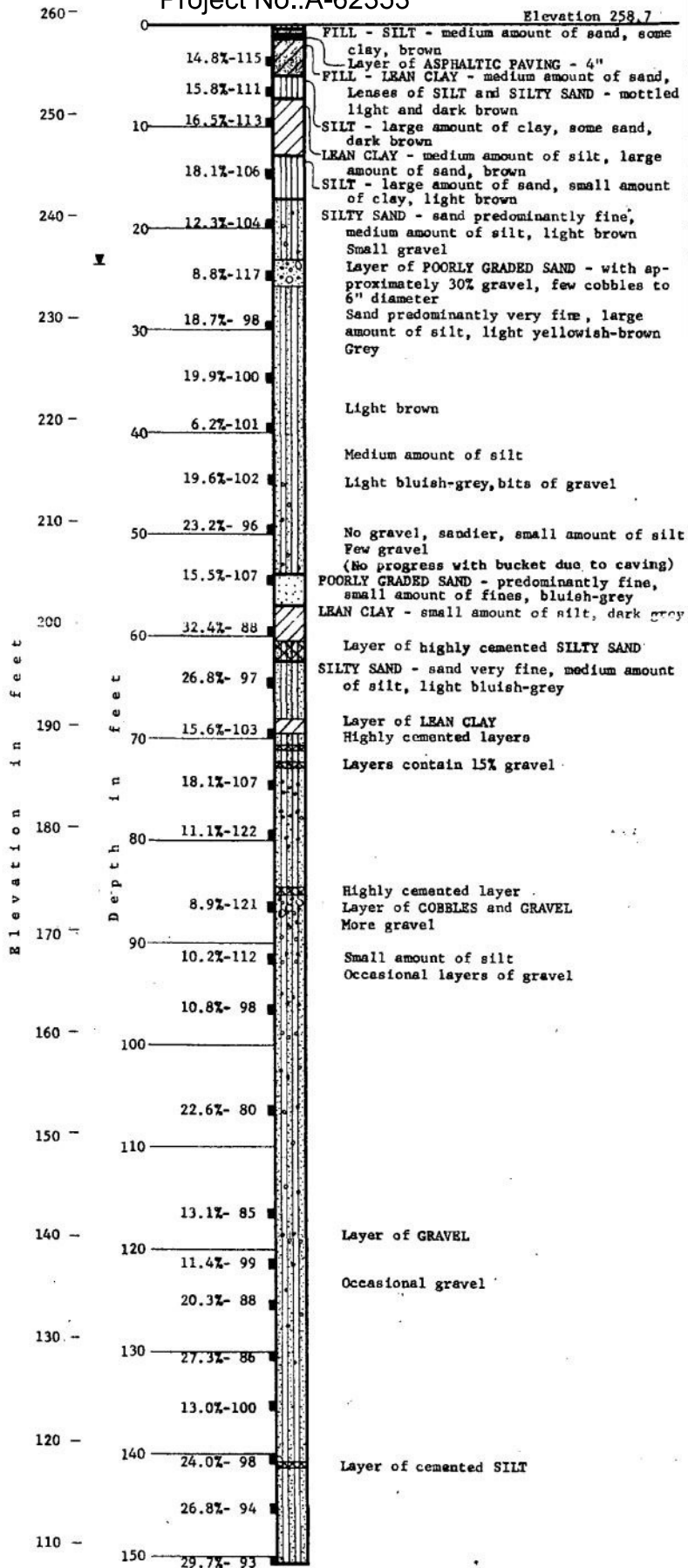
LeROY CRANDALL AND ASSOCIATES

by 
LeRoy Crandall

LC-JK:lb
(4 copies submitted)

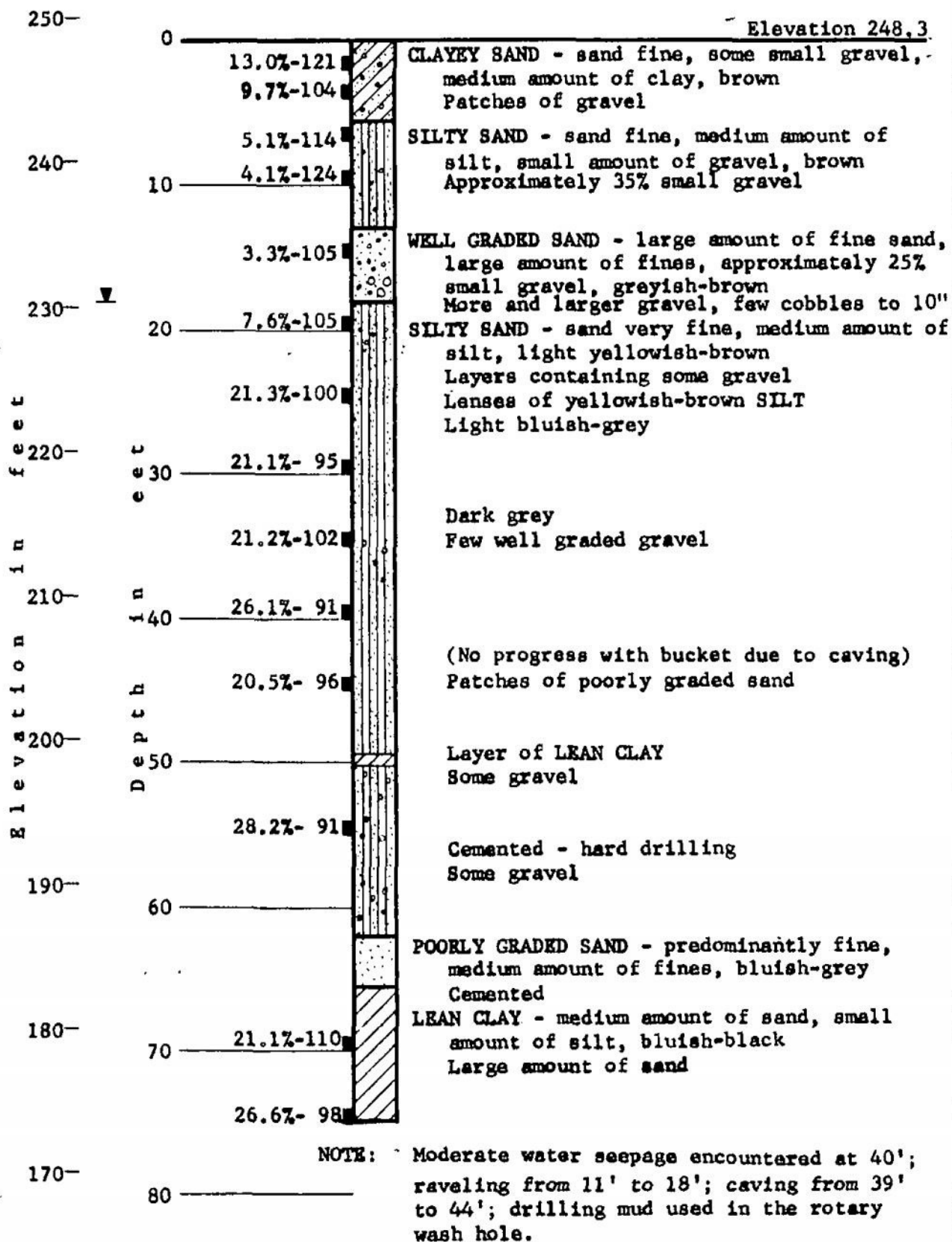
cc: Daniel, Mann, Johnson & Mendenhall (2)
Attn: Mr. James H. Thompson

Project No.: A-62353



NOTE: Water seepage encountered at 49'; caving in the bucket hole between 49' to 54'; drilling mud used throughout the rotary wash hole.

LOG OF BORING 3
 18"-Diameter Rotary Bucket Hole to 44'
 6"-Diameter Rotary Wash Hole below 44'
 Drilled June 11, and June 18, 1962



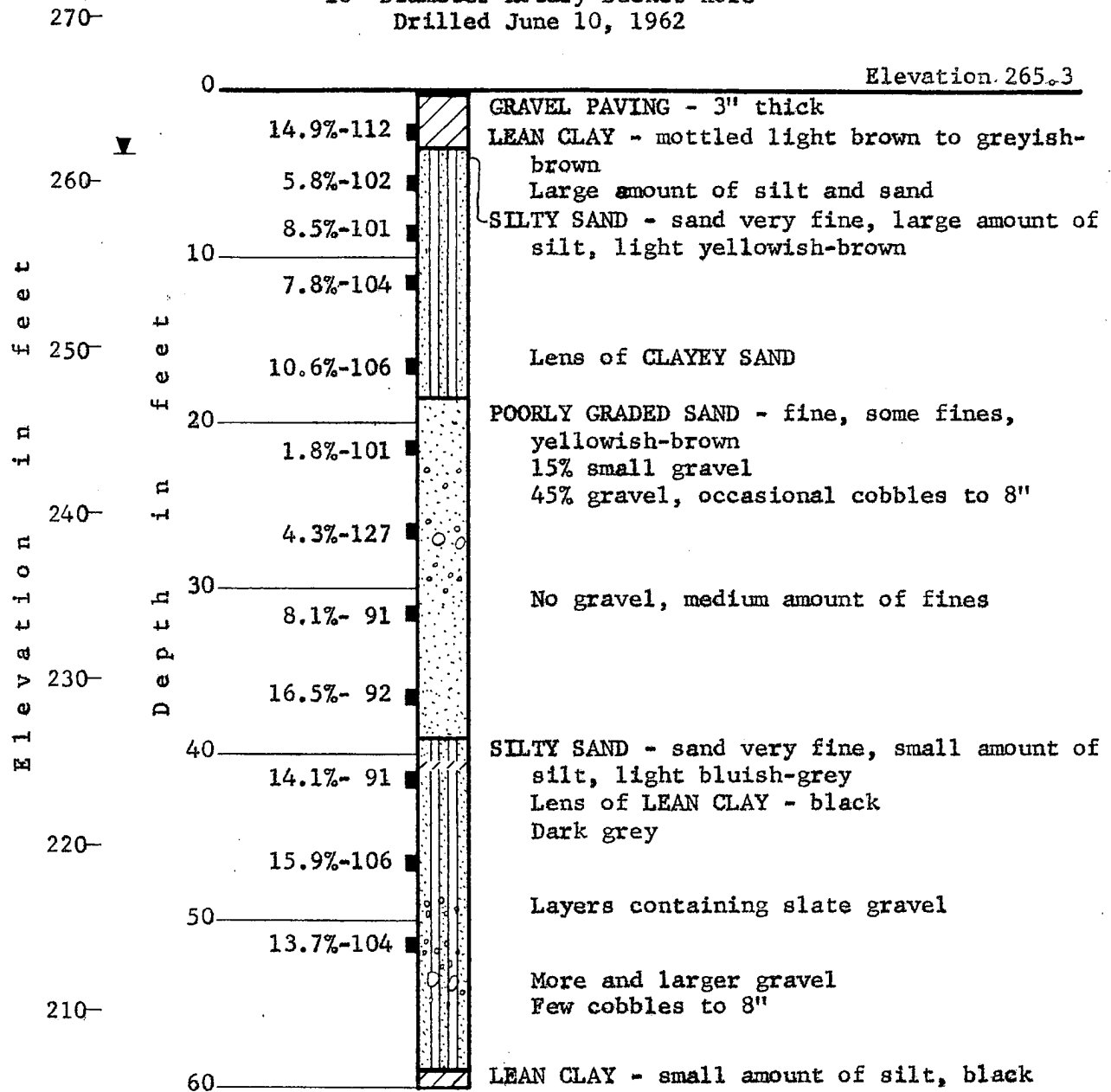
LEROY CRANDALL & ASSOCIATES

Figure A-1.3.71

PLATE A-1C

JOB 62353 DATE 6-27-62 BY 1080

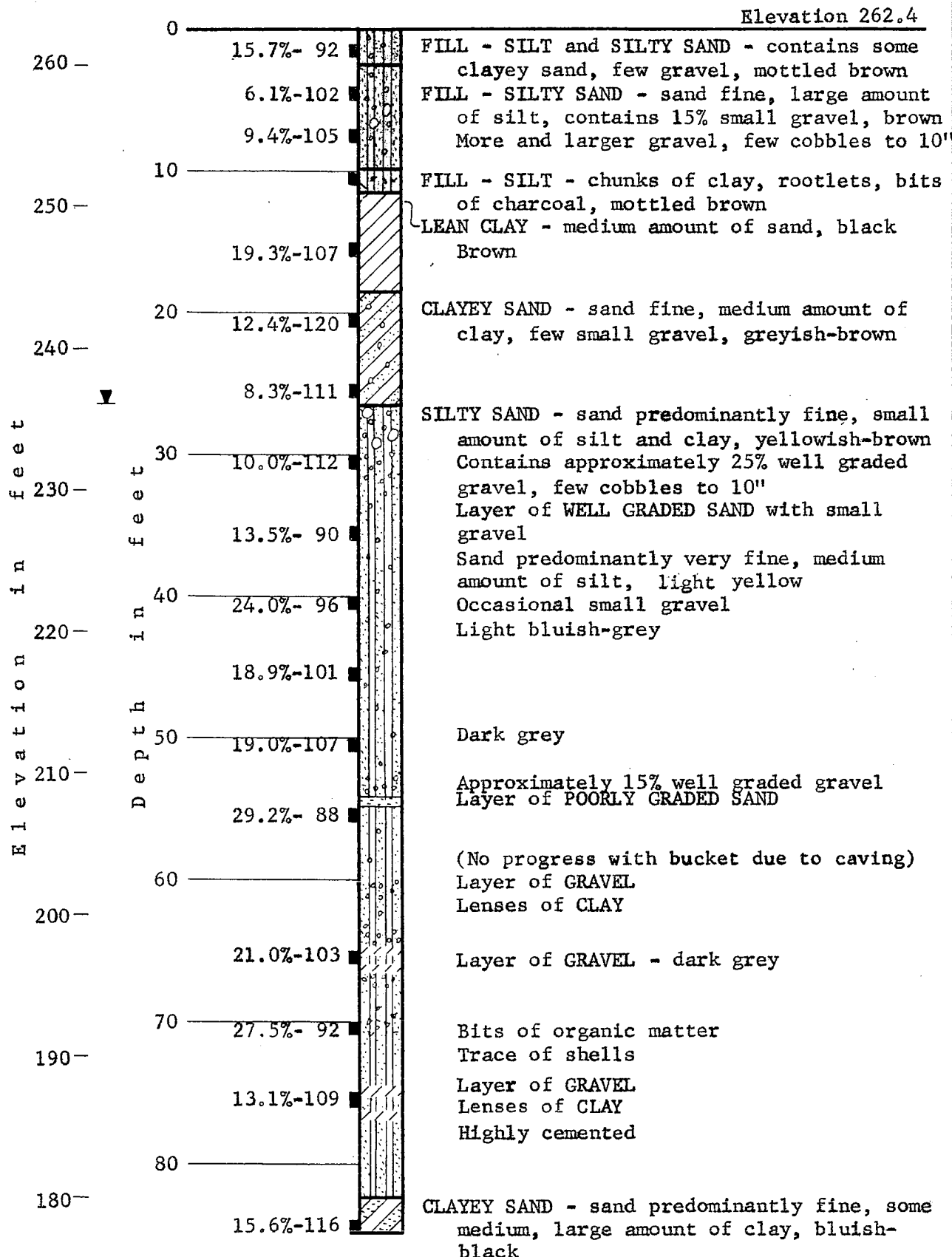
LOG OF BORING 4
18"-Diameter Rotary Bucket Hole
Drilled June 10, 1962



NOTE: Water seepage encountered at 54'; caving from 54' to 59'.

LOG OF BORING 5
18"-Diameter Rotary Bucket Hole to 60'
6"-Diameter Rotary Wash Hole below 60'
Drilled June 8, and June 15, 1962

Project No.:A-62353



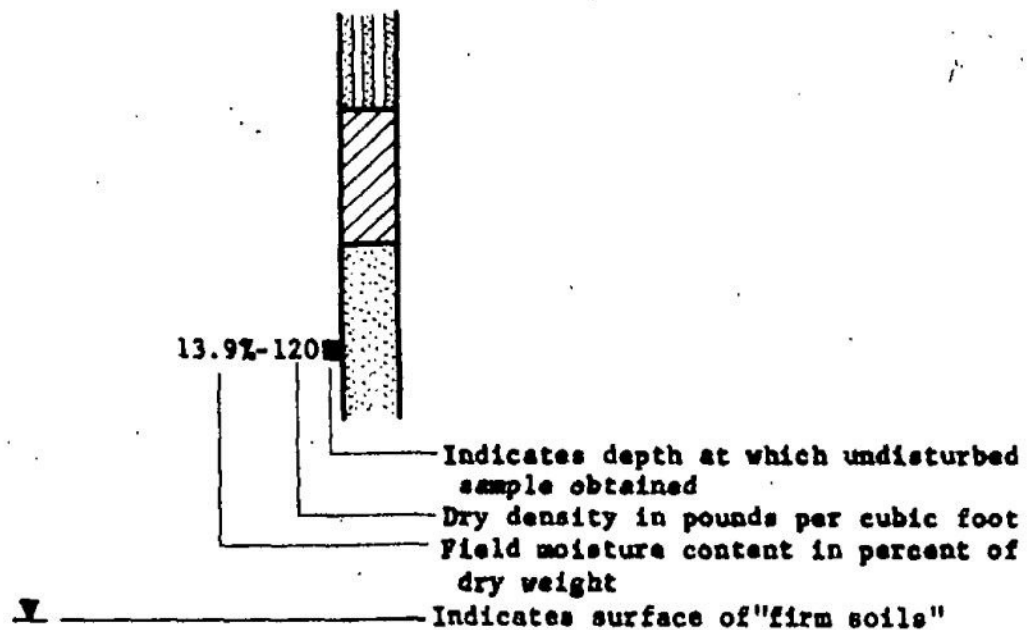
NOTE: Water seepage encountered at 53'; caving between 53' to 60'. Drilling mud used in rotary wash hole.

LEROY CRANDALL & ASSOCIATES

Figure A-1.3.73

KEY TO LOGS OF BORINGS

Soils are classified in accordance with the Unified Soil Classification System shown on Plate A-2. Boring elevations refer to topographic maps prepared by Sullivan-Peoms-Young, Engineers, Surveyors. Revised by Pafford & Associates.



IDENTIFICATION, CLASSIFICATION AND DESCRIPTION OF SOILS

UNIFIED SOIL CLASSIFICATION SYSTEM

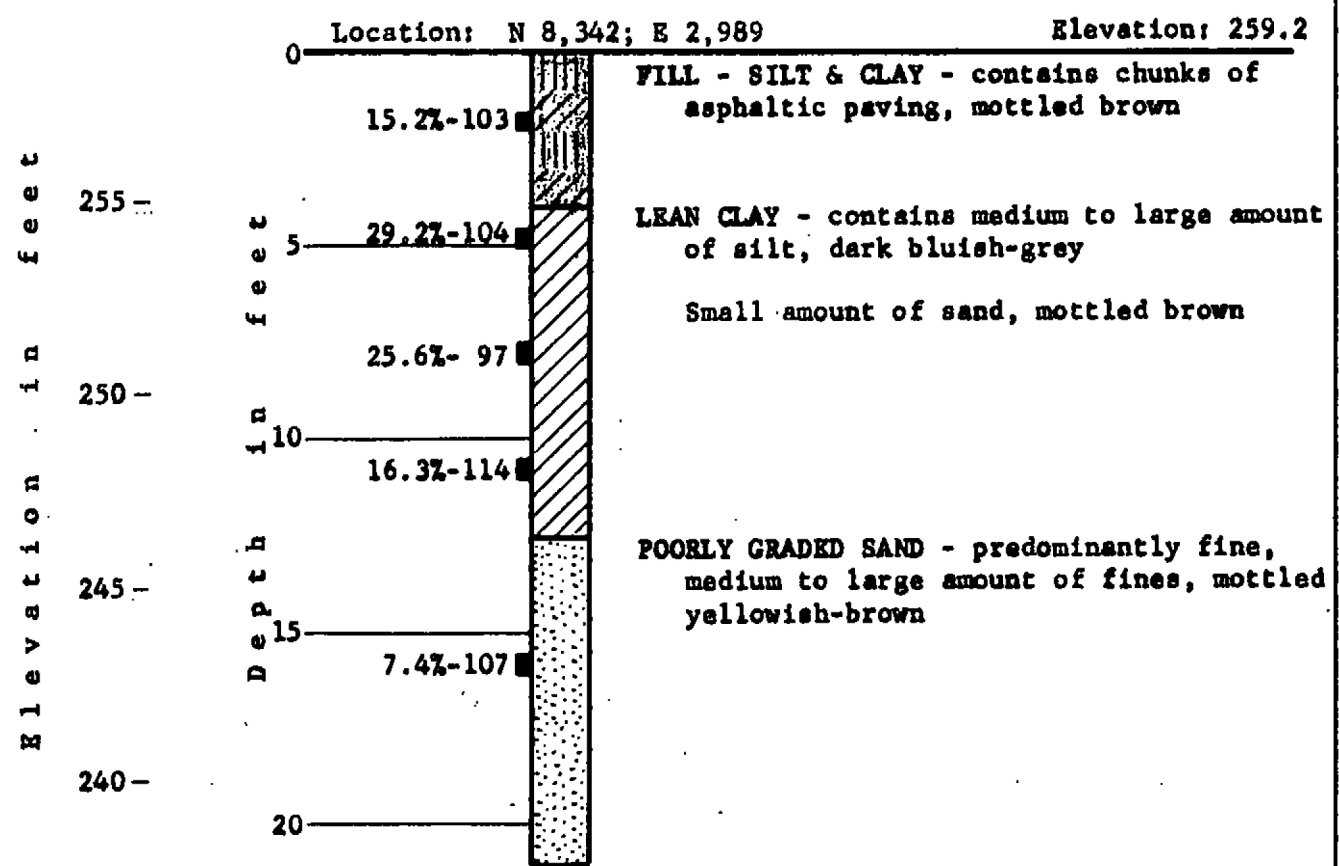
MAJOR DIVISIONS & SUBDIVISIONS			STANDARD NAMES AND SOIL GROUP DESCRIPTIONS	SYMB.	DESCRIPTIVE INFORMATION TO BE ADDED TO THE STANDARD NAMES FOR DESCRIPTION
COARSE GRAINED SOILS Less than one-half the total soil passing the 200 mesh sieve.	GRAVELLY SOILS Less than one-half the coarse grains passing the No. 4 sieve	GRAVELS "clean" material Little or no fines	WELL GRADED GRAVEL (GW) Well-graded gravels or gravel-sand mixtures, little or no fines.		Maximum size, angularity and surface conditions, friability or hardness, and approximate percentage of sand, if any.
			POORLY GRADED GRAVEL (GP) Poorly graded gravels or sand-gravel mixtures, little or no fines.		Maximum size, predominant size, angularity, surface conditions, friability or hardness, and approximate percentage of sand, if any.
		GRAVEL WITH FINES "dirty" material Apprec. amount of fines	SILTY GRAVEL (GM) Silty gravels, or poorly graded gravel-sand-silt mixtures.		Maximum size, predominant size, friability or hardness; describe fines as being very silty, moderately silty, or slightly silty.
			CLAYEY GRAVEL (GC) Clayey gravels or gravel-sand-clay mixtures.		Well or poorly graded, maximum size, predominant size if poorly graded, angularity, friability or hardness; describe fines as slightly, moderately, or very clayey or type of binder in well graded gravels with clay binder.
	SANDY SOILS More than one-half the coarse grains passing the No. 4 sieve.	SANDS "clean" material Little fines	WELL GRADED SAND (SW) Well graded sands or gravelly sands, little or no fines.		Angularity, particle shape, friability or hardness, approximate color, percentage of gravel, if any.
			POORLY GRADED SAND (SP) Poorly graded sands or gravelly sands, little or no fines.		Coarse, medium, or fine particle, particle shape, clean or slightly-dirty, approximate percentage of gravel, if any.
		SANDS WITH FINES "dirty" material Apprec. amount of fines	SILTY SAND (SM) Silty sands or poorly graded sand-silt mixtures.		Fine, medium, or coarse particles, shape and hardness of particles, large, medium or small proportion of silt, color, approximate percentage of gravel, if any.
			CLAYEY SAND (SC) Clayey sands or sand-clay mixture.		Well graded or poorly graded, predominant size if poorly graded, quality of binder if well graded, large medium, or small amount of clay, color, approximate percentage of gravel, if any.
FINE GRAINED SOILS More than one-half the total soil passing the 200 mesh sieve.	SILT AND CLAY SOILS with low compressibility		SILT (ML) Inorganic silts and very fine sand, silty or clayey fine sands.		Presence of clay or sand, and color, degree of plasticity, if any.
			LEAN CLAY (CL) Inorganic clays of low to medium plasticity, gravelly or sandy.		Degree of plasticity, silt, sand, or gravel content, and color.
			ORGANIC SILT (OL) Organic silts and organic silt-clays of low plasticity.		Visibility of organic material, odor, plasticity, and color.
	SILT AND CLAY SOILS with high compressibility		ELASTIC SILT (MH) Very compressible silts, micaceous or diatomaceous sandy or silt soil.		Presence of clay, degree of plasticity, and color.
			FAT CLAY (CH) Very compressible clays, inorganic clays of high plasticity.		Color, presence of gravel and other significant factors.
			ORGANIC CLAY (OH) Organic clays of medium to high plasticity, very compressible.		Odor, degree of plasticity, and color.
ORGANIC SOILS			PEAT (PT) Peat and other highly organic swamp soils.		Odor, presence of fibrous material, color.

LEROY CRANDALL & ASSOCIATES

JOB 6/206 DATE 5/1/81 BY GML JML

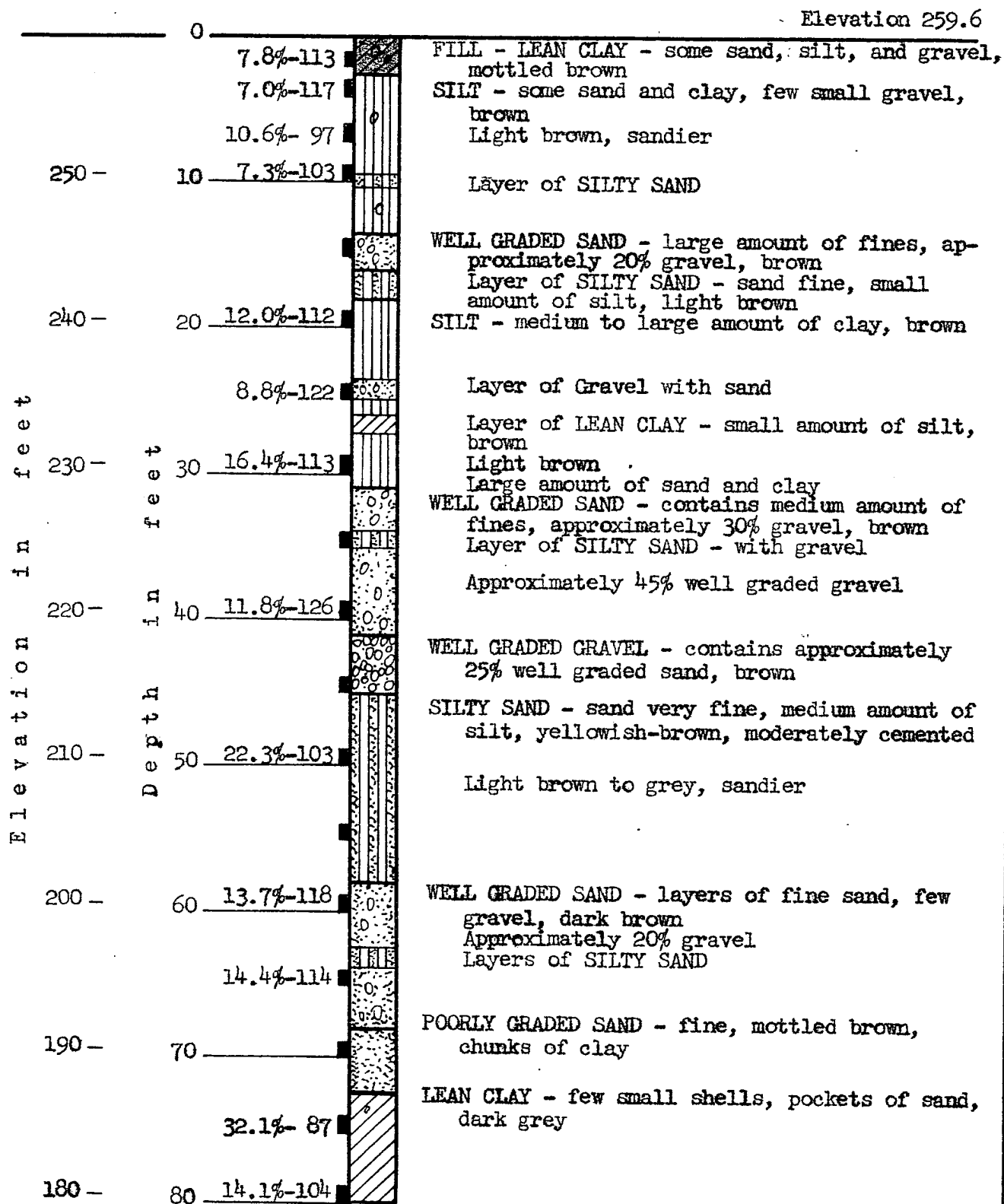
Project No.:A-61206

LOG OF BORING 16
18"-Diameter Rotary Bucket Hole
Drilled May 9, 1961



NOTE: Groundwater not encountered; no caving.

LOG OF BORING 21
18"-Diameter Rotary Bucket Hole
Drilled October 20 and October 21, 1959

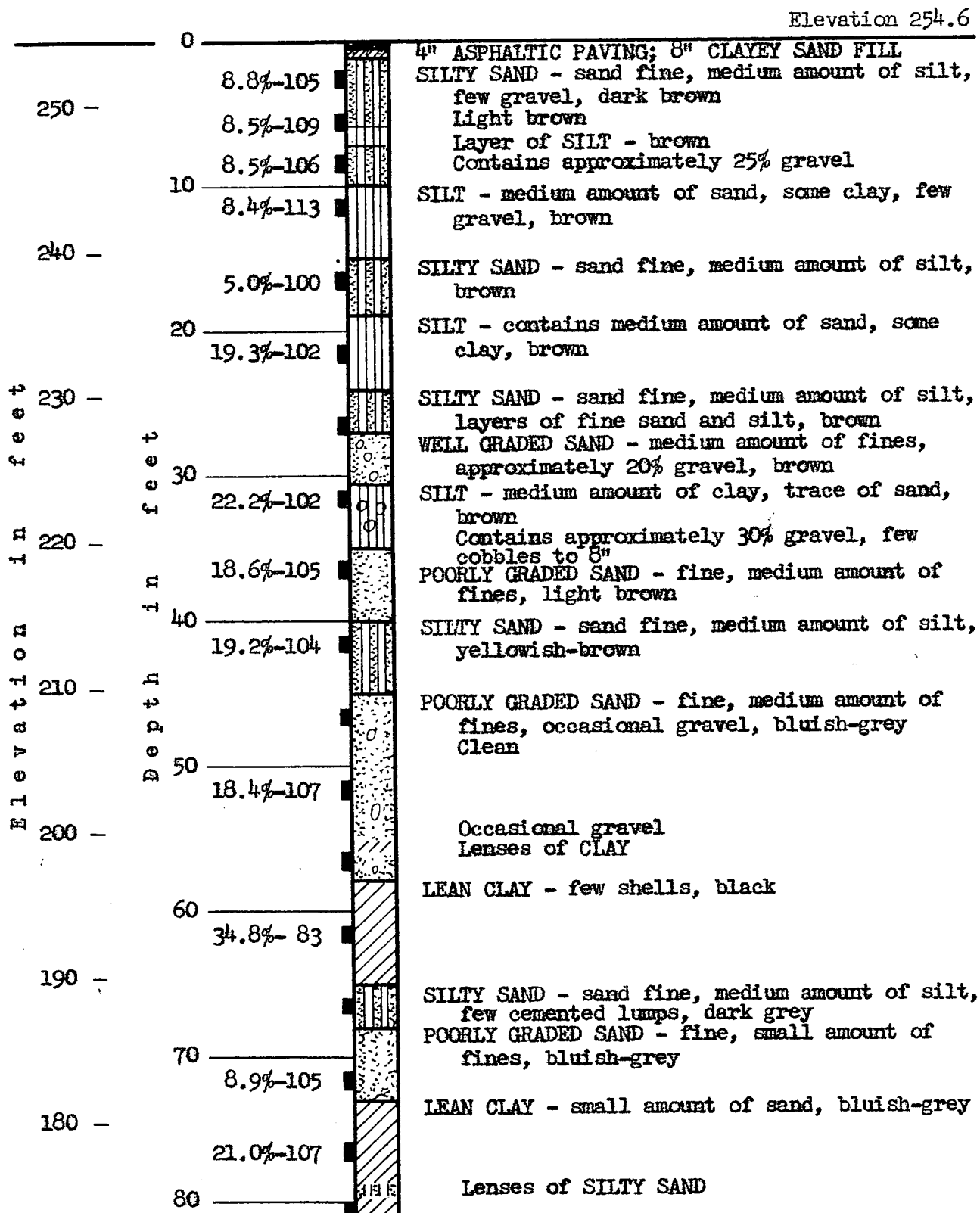


NOTE: Groundwater encountered at 38'; no caving.

LERoy CRANDALL & ASSOCIATES

Figure A-1.3.77

LOG OF BORING 22
 18"-Diameter Rotary Bucket Hole to 37'
 6"-Diameter Rotary Wash Hole below 37'
 Drilled October 21, November 30, and December 1, 1959



NOTE: Groundwater encountered at 35'; no caving in bucket hole. Drilling mud used to prevent caving in rotary wash hole.

LERoy CRANDALL & ASSOCIATES

Figure A-1.3.78

PLATE A-11

IDENTIFICATION, CLASSIFICATION AND DESCRIPTION OF SOILS

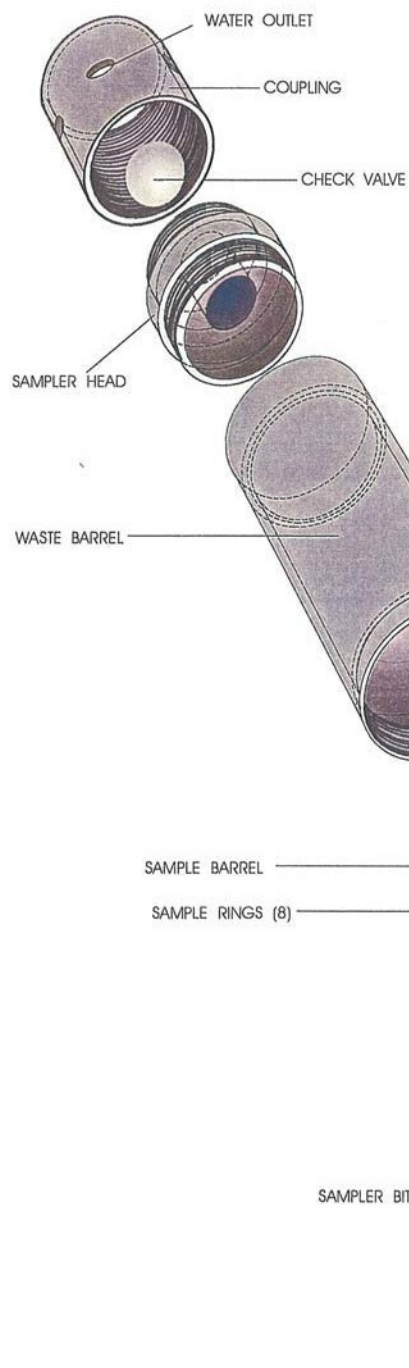
UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS & SUBDIVISIONS			STANDARD NAMES AND SOIL GROUP DESCRIPTIONS	SYMB.	DESCRIPTIVE INFORMATION TO BE ADDED TO THE STANDARD NAMES FOR DESCRIPTION
COARSE GRAINED SOILS Less than one-half the total soil passing the 200 mesh sieve.	GRAVELLY SOILS Less than one-half the coarse grains passing the No. 4 sieve	GRAVELS "clean" material Little or no fines	WELL GRADED GRAVEL (GW)		Maximum size, angularity and surface conditions, friability or hardness, and approximate percentage of sand, if any.
			POORLY GRADED GRAVEL (GP)		Maximum size, predominant size, angularity, surface conditions, friability or hardness, and approximate percentage of sand, if any.
		GRAVEL WITH FINES "dirty" material Apprec. amount of fines	SILTY GRAVEL (GM)		Maximum size, predominant size, friability or hardness; describe fines as being very silty, moderately silty, or slightly silty.
			CLAYEY GRAVEL (GC)		Well or poorly graded, maximum size, predominant size if poorly graded, angularity, friability or hardness; describe fines as slightly, moderately, or very clayey or type of binder in well graded gravels with clay binder.
	SANDY SOILS More than one-half the coarse grains passing the No. 4 sieve.	SANDS "clean" material Little fines	WELL GRADED SAND (SW)		Angularity, particle shape, friability or hardness, approximate color, percentage of gravel, if any.
			POORLY GRADED SAND (SP)		Coarse, medium, or fine particle, particle shape, clean or slightly dirty, approximate percentage of gravel, if any.
		SANDS WITH FINES "dirty" material Apprec. amount of fines	SILTY SAND (SM)		Fine, medium, or coarse particles, shape and hardness of particles, large, medium or small proportion of silt, color, approximate percentage of gravel, if any.
			CLAYEY SAND (SC)		Well graded or poorly graded, predominant size if poorly graded, quality of binder if well graded, large medium, or small amount of clay, color, approximate percentage of gravel, if any.
FINE GRAINED SOILS More than one-half the total soil passing the 200 mesh sieve.	SILT AND CLAY SOILS with low compressibility		SILT (ML)		Presence of clay or sand, and color, degree of plasticity, if any.
			LEAN CLAY (CL)		Degree of plasticity, silt, sand, or gravel content, and color.
			ORGANIC SILT (OL)		Visibility of organic material, odor, plasticity, and color.
	SILT AND CLAY SOILS with high compressibility		ELASTIC SILT (MH)		Presence of clay, degree of plasticity, and color.
			FAT CLAY (CH)		Color, presence of gravel and other significant factors.
			ORGANIC CLAY (OH)		Odor, degree of plasticity, and color.
ORGANIC SOILS			PEAT (PT)		Odor, presence of fibrous material, color.

LEROY CRANDALL & ASSOCIATES

LEROY CRANDALL & ASSOCIATES

CRANDALL SAMPLER



CRANDALL SAMPLER

	Length	ID	OD
Assembled Sampler	22.5"	2.625"	3.187"
Coupling	3.5"	2.0"	3.0"
Sampler Head	3.0"	1.125"	3.125"
Waste Barrel	10.0"	2.625"	3.125"
Sample Rings	1.0"	2.625"	2.750"
Sample Barrel	8.0"	2.750"	3.125"
Sampler Bit	3.0"	2.625"	3.187"

Corel Draw • Drawn by Juliana M • Date August 7, 1995



AMEC ENVIRONMENT & INFRASTRUCTURE
5628 E. SLAUSON AVE. • LOS ANGELES, CALIFORNIA 90040
(323) 889-5300 • fax (323) 889-5398

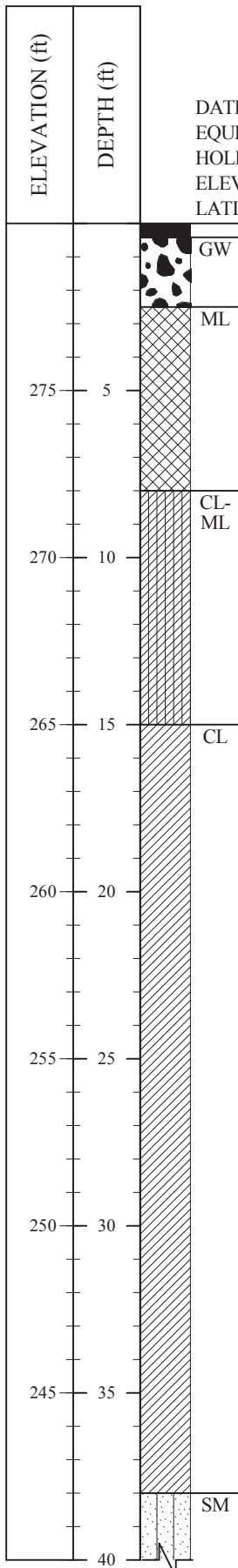
FIGURE A-1.4 - Crandall Sampler

JOB NO.: 4953-11-1421	REVISIONS:
DATE: 12-11-09	
SCALE:	
DRAWN BY: NH	
CHECKED BY: MKT	

BORING M-19

DATE DRILLED: June 9, 2009
 EQUIPMENT USED: Hollow Stem Auger
 HOLE DIAMETER (in.): 8
 ELEVATION: 280 *
 LATITUDE: 34.05894 ° LONGITUDE: -118.41602

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.



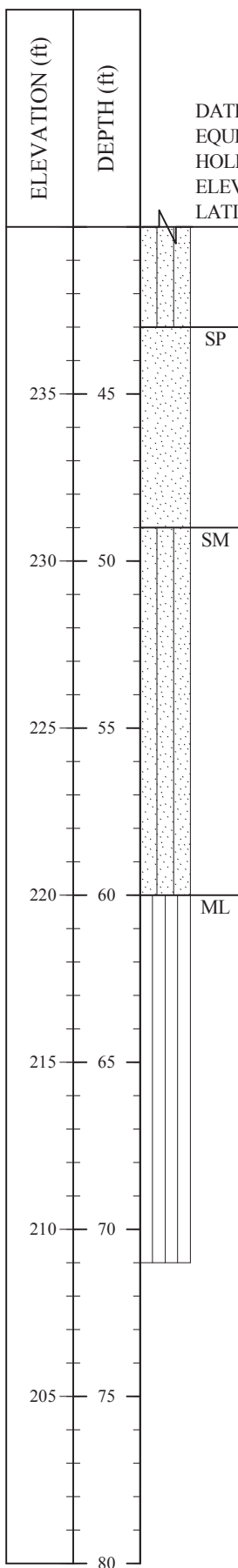
(CONTINUED ON FOLLOWING FIGURE)

Field Tech: PK
 Prepared By: NH
 Checked By:

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

BORING M-19 (Continued)

DATE DRILLED: June 9, 2009
EQUIPMENT USED: Hollow Stem Auger
HOLE DIAMETER (in.): 8
ELEVATION: 280 *
LATITUDE: 34.05894 ° LONGITUDE: -118.41602



END OF BORING AT 71 FEET

NOTES:

Soil logged from cuttings only.
Hand augered top 5 feet due to utilities.
Ground water not encountered at time of drilling.
Installed nested soil vapor probes at 15 feet (red), 40 feet (blue), and 70 feet (yellow). See well construction diagram for M-19.

Field Tech: PK
Prepared By: NH
Checked By:

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

BORING M-119

DATE DRILLED: 1/18/2011 - 1/20/2011
EQUIPMENT USED: CME-75, Jet Drilling
HOLE DIAMETER (in.): 10
ELEVATION: N/A*

ELEVATION (ft)	DEPTH (ft)	SAMPLE ID	OVA (ppm)	SAMPLE LOC.
				SM
	5			
	10	27	0.0	
	15	20	0.0	
	20	16	0.0	
	25	32	0.0	
	30	24	0.0	
	35	28	0.0	
	40			

0.5 feet of Asphalt

FILL

SILTY SAND with Asphalt (sm) - asphalt and gravel fragments present

SILTY SAND with GRAVEL (sm) - (10YR, 3/3) dark brown, slightly moist, some asphalt fragments present, siltier zone at top of sampler

NATIVE ALLUVIUM (Qal)

SILT (ml) - (10YR, 3/2) dark brown, slightly moist, mottled, oxidation staining

Same as above, with caliche nodules present

Becomes more dense

SANDY SILT to SILT (sm/ml) - (10YR, 4/4) dark yellowish brown, slightly moist, fine sand, mottled with oxidation staining



LAKEWOOD FORMATION (Qlw)

SILT (ml) - (2.5Y, 4/3) olive brown, wet, trace of sand, mottled with oxidation staining, micaceous

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: RM
Prepared By: KP
Checked By:



THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

ELEVATION (ft)	DEPTH (ft)	SAMPLE ID	OVA (ppm)	SAMPLE LOC.
	45	75	0.0	X
	50			
	55	50/6"	0.0	X
	60			
	65	80	0.0	X
	70			
	75	68	0.0	X
	80			

BORING M-119 (Continued)

DATE DRILLED: 1/18/2011 - 1/20/2011
EQUIPMENT USED: CME-75, Jet Drilling
HOLE DIAMETER (in.): 10
ELEVATION: N/A*

SP

FINE SAND to SILTY FINE SAND (sp) - (GLE Y1, 4/5GY) dark greenish gray, wet, micaceous

SILTY SAND with GRAVEL (sp) - greenish gray, mottled with rounded gravel and broken shale fragments, orthoclase, mottled with reddish brown silt, possible Basil scour zone

FINE SAND (sp) - (GLE Y1 4/10GY) dark greenish gray, wet, some gravel fragments, micaceous

FINE SAND (sp) - (GLE Y1, 4/10Y) dark greenish gray, wet

NOTES:

Total depth = 76 feet bgs
Groundwater encountered at 35 feet bgs
Hand augered to 6.5 feet bgs
The boring was drilled with 10-inch O.D. augers and later reamed with 11.25-inch O.D. augers.

Field Tech: RM
Prepared By: KP
Checked By:

(CONTINUED ON FOLLOWING FIGURE)

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

ELEVATION (ft)	DEPTH (ft)	SAMPLE ID	OVA (ppm)	SAMPLE LOC.
	85			
	90			
	95			
	100			
	105			
	110			
	115			
	120			

BORING M-119 (Continued)

DATE DRILLED: 1/18/2011 - 1/20/2011
EQUIPMENT USED: CME-75, Jet Drilling
HOLE DIAMETER (in.): 10
ELEVATION: N/A*

A nested well was installed. See well construction diagram for details.

Field Tech: RM
Prepared By: KP
Checked By:

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

								DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
								Martini Drilling / CME-75		E-132C/M-408
								DRILLING METHOD	BOREHOLE LOCATION	
								Hollow-Stem Auger	Sta 709+45, Lt 35 feet	
								DATES DRILLED	HOLE DIAMETER	GROUND EL.
								3/19/2015 - 3/23/2015	9"	287.1 feet
								GROUNDWATER READINGS		
								Groundwater encountered at 90' with possible seepage at 63' during drilling. See monitoring data in GDR.		
Constellation Station	ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS
		5	1	0	19.3	-				
		10		0	18.2	109^	5	43		
		15	10	0.2	26.4	-				
		20		0	32.6	100	26			
		25	10	2.2	19.9	-				
		30		0.6	22.7	104	25	86		
		35	54	0.4	20.7	-				
		40								
<div> <div>11.5-inch thick Asphalt Concrete over 7-inch Base Course</div> <div>FILL [Aft]</div> <div>LEAN CLAY - very soft, moist, brown, fine to medium grained sand, trace to few gravel (up to 3/4" in size)</div> <div>CL</div> <div>CLAYEY SAND - very loose, moist, brown, fine to coarse grained sand, trace to few gravel (up to 3/4" in size) (LL=37, PI=24)</div> <div>SC</div> <div>medium dense</div> <div>QUATERNARY OLDER ALLUVIUM [Qalo]</div> <div>LEAN CLAY - very stiff, moist, brown and gray, trace fine grained sand, seams with iron oxide staining</div> <div>CL</div> <div>stiff, light yellow brown to pale olive, trace coarse sand and trace slate fragments (up to 1/4" in size)</div> <div>CH</div> <div>FAT CLAY - very stiff, moist, brown and gray, trace fine grained sand, seams with iron oxide staining very stiff, olive gray to olive, trace to some fine sand (LL=52, PI=37)</div> <div>CH</div> <div>LAKEWOOD FORMATION [Qlwl]</div> <div>SILTY SAND - dense to very dense, moist, pale olive, fine grained sand, trace clay, minor iron-oxide mottles</div> <div>SM</div> </div>										

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: AR
Prepared/Date: KC 5/26/2015
Checked/Date: FW/DLP/HP 5/29/2015

MTA Westside Subway Extension
Los Angeles, California

amec foster wheeler

LOG OF BORING
Project No.: 4953-11-1423 Figure: A-2.2.1a

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS	DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
										DRILLING METHOD	BOREHOLE LOCATION	E-132C/M-408 (Continued)
										DATES DRILLED	HOLE DIAMETER	GROUND EL.
										3/19/2015 - 3/23/2015	9"	287.1 feet
										GROUNDWATER READINGS Groundwater encountered at 90' with possible seepage at 63' during drilling. See monitoring data in GDR.		
			0	11.8	105	43						SILTY SAND, pale yellow to pale olive, fine grained sand
	45	33	1.4	6.2	-							grades slightly less silty
			0.1	8.2	116	93/11"					SW	WELL GRADED SAND with GRAVEL - very dense, moist, light brownish yellow, fine to coarse grained sand, gravel includes black slate fragments up to 2", trace silt
	50	44	0.3	14.9	-		24				SM	SILTY SAND with GRAVEL - very dense, moist, brown, fine to coarse grained sand, gravel up to 1"
			0.2	8.0	95	42					SM	SILTY SAND - very dense, moist, pale yellow, fine grained sand
	55	57	1.0	6.8	-		16					grades fine to coarse grained sand with few to little subrounded slate and quartzite gravel (up to 1" in size)
				10.9	101	68						pale yellow and brownish yellow mottling, grades fine to medium grained sand
	60	28	2.9	18.3	-							dense, becomes olive yellow, grades to fine grained sand
			0.1	13.8	106	77	16				SM	SAN PEDRO FORMATION [Qspl] SILTY SAND - dense to very dense, moist, pale olive and brownish yellow, fine to medium sand
	65	28	0	-	-							SILT - moist, greenish gray
			0	6.8	94	72/11"	25				SM	SILTY SAND - dense to very dense, moist, light olive gray, few shell fragments, fine grained sand, trace mica
	70	32	1.7	7.8	-							dark greenish gray to dusky yellow green, slightly micaceous
			0	12.9	107	75/9"						few shell fragments (coarse gravel in sampling shoe)
	75	50/5"	4.3	2.7	-						SP-SM	POORLY GRADED SAND with SILT - very dense, moist, greenish gray, fine to coarse grained sand, few subrounded to subangular granitic and slate gravel up to 3/4", trace shell fragments
			0	7.7	91	85						
	80											

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: AR
Prepared/Date: KC 5/26/2015
Checked/Date: FW/DLP/HP 5/29/2015

MTA Westside Subway Extension
Los Angeles, California

amec foster wheeler

LOG OF BORING
Project No.: 4953-11-1423 Figure: A-2.2.1b

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS	DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
										DRILLING METHOD	BOREHOLE LOCATION	E-132C/M-408 (Continued)
										DATES DRILLED	HOLE DIAMETER	GROUND EL.
										3/19/2015 - 3/23/2015	9"	287.1 feet
GROUNDWATER READINGS												
Groundwater encountered at 90' with possible seepage at 63' during drilling. See monitoring data in GDR.												
Constellation Station		55	0.6	5.9	-							olive gray to dusky yellow green, grades fine to medium grained sand, trace subrounded to subangular gravel (up to 1" in size)
			0	6.0	92	77/11"	6					grades to predominantly fine grained sand with trace medium grains, some slate gravels (up to 1/4" in size)
	85	72	0	4.9	-							dusky yellow green
				7.9	110	41						wet, sand grades fine to coarse grained, trace fine gravel (up to 1/4" in size)
	90											SILTY CLAY - saturated, dark gray, trace fine grained sand
		50/5"	3.1	17.7	-							SILTY SAND - very dense, moist, dark greenish gray to grayish black, fine to medium grained sand, trace gravel up to 3/4"
	95			13.1	120^	69	37					greenish black, increased silt content, few shell fragments
		84	38.8	10.1	-							dark greenish gray, grades less silty
	100		3.9	5.6	101	91/9"						POORLY GRADED SAND with SILT - very dense, moist, dark gray, fine to medium grained sand, trace fine gravel (up to 1/4" in size)
	105											END OF BORING AT 100 FEET
	110											NOTES: Hand augered upper 6 feet to avoid damage to utilities. Borehole backfilled with bentonite, clean sand, and sand/gravel/cement slurry per well construction schedule. Pavement patched with rapid set concrete colored with black oxide. Groundwater monitoring wells installed with screen intervals at 50'-60' and 80'-90'. Vapor probes installed at 40', 70', and 95'. Refer to GDR for Well Construction Details. "N" Value Standard Penetration Test: Number of blows required to drive the SPT sampler 18 inches using a 140 pound automatic hammer falling 30 inches *Number of blows required to drive the Crandall Sampler 12 inches using a 140 pound hammer falling 30 inches Hammer Energy Transfer Ratio (ERi) = 70% (Calibrated 04/09/2015) **Photo Ionization Detector used for OVA readings ^Average dry density for sample when multiple density tests performed.set concrete colored with

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

DRILLING COMPANY/DRILLING EQUIPMENT										BORING NO.
Martini Drilling / CME-75										E-133A/M-409
DRILLING METHOD					BOREHOLE LOCATION					
Hollow-Stem Auger					Sta 714+19, Lt 30 feet					
DATES DRILLED					HOLE DIAMETER					GROUND EL.
3/16/2015 - 3/18/2015					9"					291.6 feet
GROUNDWATER READINGS										
Groundwater encountered at 90.5' during initial drilling and at 90' after leaving open overnight. See monitoring data in GDR.										
Constellation Station	ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS
		5	11	0	8.8	-				
		10		0	13.8	118	16	58		
		15	6	0	16.8	-				
		20		0	14.8	114^	11	51		
		25	6	0	17.4	-				
		30		0	11.8	120	18	48		
		35	14	0	9.4	-				
		40								
					</					

Constellation Station

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: AR
Prepared/Date: KC 5/26/2015
Checked/Date: FW/DLP/HP 5/29/2015

MTA Westside Subway Extension
Los Angeles, California

amec foster wheeler

LOG OF BORING
Project No.: 4953-11-1423 Figure: A-2.2.2a

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

										DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
										Martini Drilling / CME-75		E-133A/M-409 (Continued)
										DRILLING METHOD	BOREHOLE LOCATION	
										Hollow-Stem Auger	Sta 714+19, Lt 30 feet	
										DATES DRILLED	HOLE DIAMETER	GROUND EL.
										3/16/2015 - 3/18/2015	9"	291.6 feet
										GROUNDWATER READINGS		
										Groundwater encountered at 90.5' during initial drilling and at 90' after leaving open overnight. See monitoring data in GDR.		
Constellation Station			0	8.7	107^	31	19	☒				SILTY SAND (continued from previous page)
	45	13	1.7	34.7	-			☒		CH		FAT CLAY - very stiff, moist, light brown and gray, trace fine grained sand (LL=94, PI=73)
	50		0	5.1	103	64		☒		SM		SILTY SAND - dense to very dense, moist, light brownish yellow with some iron-oxide staining, fine to coarse grained sand, trace gravel coarse drilling from 52' to 54' (potential gravel layer)
	55	53	2.3	12.2	-		20	☒				light yellowish brown, trace subangular to angular slate fragments (up to 1" in size), very thin silt lenses light yellow brown and olive yellow, fine grained sand
	60		0	12.0	92	77	31	☒				
	65	33	0.5	16.6	-			☒		SM		SAN PEDRO FORMATION [Qsp] SILTY SAND - dense, moist, light olive gray, fine grained sand, micaceous, trace clay
	70		0	14.1	110	41	36	☒				moist to wet
	75	64	1.9	6.8	-			☒		SP-SM		POORLY GRADED SAND with SILT - medium dense to very dense, moist, olive gray, fine to coarse grained sand, trace gravel (up to 3/8" in size)
	80											

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: AR
Prepared/Date: KC 5/26/2015
Checked/Date: FW/DLP/HP 5/29/2015

MTA Westside Subway Extension
Los Angeles, California

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LOG OF BORING
Project No.: 4953-11-1423 Figure: A-2.2.2b

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ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS	DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
										DRILLING METHOD	BOREHOLE LOCATION	E-133A/M-409 (Continued)
										DATES DRILLED	HOLE DIAMETER	GROUND EL.
										3/16/2015 - 3/18/2015	9"	291.6 feet
										GROUNDWATER READINGS		
										Groundwater encountered at 90.5' during initial drilling and at 90' after leaving open overnight. See monitoring data in GDR.		
Constellation Station			0	4.9	95	48	8	☒		few to little black colored sand particles POORLY GRADED SAND with SILT (continued from previous page)		
	85	80	2.2	4.2	-			☒		trace gravel (up to 3/4" in size)		
	90		0.2	22.6	102	25		☒		▽		
									CL	LEAN CLAY - moist to wet, grayish olive green to greenish black, fine grained sand		
	95	50/6"		22.0	-			☒	SM	SILTY SAND - very dense, wet, dark gray, fine grained sand		
	100		0	27.3	95^	30	68	☒	CL	Sandy LEAN CLAY - very stiff, dark greenish black, fine to medium grained sand		
	190									with some peat fragments		
	105	35	0	24.6	-			☒		hard		
	185											
	110			15.8	107	50/5"	57	☒		grayish olive green, trace slate fragments up to 1/4" in size (LL=40, PI=24)		
	180									END OF BORING AT 110.5 FEET		
										NOTES: Hand augered upper 6 feet to avoid damage to utilities. Borehole backfilled with bentonite, clean sand, and sand/gravel/cement slurry per well construction schedule. Pavement patched with rapid set concrete colored with black oxide.		
	115									Groundwater monitoring wells installed with screen intervals at 75'-85' and 90'-100'. Vapor probes installed at 40', 70', and 105'. Refer to GDR for Well Construction Details.		
	175									"N" Value Standard Penetration Test: Number of blows required to drive the SPT sampler 18 inches using a		
	120											

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: AR
Prepared/Date: KC 5/26/2015
Checked/Date: FW/DLP/HP 5/29/2015

MTA Westside Subway Extension
Los Angeles, California

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LOG OF BORING
Project No.: 4953-11-1423 Figure: A-2.2.2c

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS
170									
125									
165									
130									
160									
135									
155									
140									
150									
145									
145									
150									
140									
155									
135									
160									

DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
Martini Drilling / CME-75		E-133A/M-409
DRILLING METHOD	BOREHOLE LOCATION	(Continued)
Hollow-Stem Auger	Sta 714+19, Lt 30 feet	
DATES DRILLED	HOLE DIAMETER	GROUND EL.
3/16/2015 - 3/18/2015	9"	291.6 feet
GROUNDWATER READINGS		
Groundwater encountered at 90.5' during initial drilling and at 90' after leaving open overnight. See monitoring data in GDR.		

140 pound automatic hammer falling 30 inches
 *Number of blows required to drive the Crandall Sampler
 12 inches using a 140 pound hammer falling 30 inches
 Hammer Energy Transfer Ratio (ERi) = 70% (Calibrated
 04/09/2015)
 **Photo Ionization Detector used for OVA readings
 ^Average dry density for sample when multiple density tests
 performed.

Field Tech: AR
 Prepared/Date: KC 5/26/2015
 Checked/Date: FW/DLP/HP 5/29/2015

MTA Westside Subway Extension
 Los Angeles, California

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LOG OF BORING
 Project No.: 4953-11-1423 Figure: A-2.2.2d

Moisture (%)	Dry Density (pcf)	Penetration Resistance (Blows/Foot)	Sample Type	Depth (Feet)	Lithology	BORING LOG NO.: 1	Elevation (Feet)
						Description of Subsurface Materials: Classification, (USCS) color, mixture, consistency, etc.	
					CL	Older Alluvium (Qoa); Dark Brown Sandy CLAY (CL), stiff, moist.	
16.2	104.2	8 18 24	R-1	5	SM	Grayish Brown Silty SAND (SM); moist; medium dense, fine to coarse grained sand.	
			B				
12.7	105.6	21 50 for 4"	R-2	10	SP-SM	Bedrock (San Pedro Formation); Light Brown Poorly Graded SAND with silt (SP-SM); moist; dense to very dense, fine to coarse grained sand.	
10.2	104.1	10 22 50 for 5"	R-3	15	SP	Light Brown Poorly Graded SAND (SP), Slightly moist, very dense	
11.5	113.0	27 50 for 5"	R-4	20		Dark Grayish Brown Silty GRAVEL with Sand (GM); moist, dense to very dense, subangular rocks to 1-inch diameter.	
			B		GM		
18.6	101.0	24 50 for 3"	R-5	25	SP-SM	Olive Gray Poorly Graded SAND with Silt (SP-SM); moist, dense to very dense, fine to medium grained sand.	
						Total Depth = 26.5 ft. Groundwater not encountered. Methane Gas Probes set at 5, 10 and 25 ft. bgs.	
				30			
				35			

GeoKinetics
Geotechnical &
Environmental Engineers

Project Name: Century City Constellation

Project No.: 1934

Sample Types:

- ☐ Bulk Sample
☐ Rock Core
☐ Ring Sample
☐ Standard Split Spoon
☐ Tube Sample

Location: See Boring Location Plan

Logged by: JRN

Date Drilled: 8/18/04

Equipment Used: CME-81


Ring Type: 2.5"

Ground Elevation: 256.2

Notes: 140 lb downhole hammer with 30-inch drop

Figure A-2.3.1

Moisture (%)	Dry Density (pcf)	Penetration Resistance (Blows/Foot)	Sample Type	Depth (Feet)	Lithology	BORING LOG NO.:2	Elevation (Feet)
						Description of Subsurface Materials: Classification, (USCS) color, mixture, consistency, etc.	
						Older Alluvium (Qoa): Dark Brown Silty CLAY (CL), stiff, moist.	
21.2	102.1	12 30 26	R-1 B	5	CL	Light Brown Silty CLAY (CL); moist, stiff to hard 1/8-inch Siltstone fragments, iron oxide staining.	
25.5	96.0	13 16 28	R-2	10	CH	Brown Fat CLAY with Sand (CH), moist, very stiff, high plasticity clay with pockets of mottled fine sand.	
20.7	101.7	7 10 16	R-3	15	CL	Light Brown Sandy CLAY (CL); moist, very stiff.	
12.4	93.0	13 17 50 for 5"	R-4	20	SP-SM	Bedrock (San Pedro Formation): Light Yellowish Brown Poorly Graded Sand (SP); moist, dense to very dense, medium grained sand with iron oxide staining.	
5.7	110.5	18 25 50 for 3"	R-5	25	GP/GM	Brown Sandy GRAVEL with Silt (GP/GM); slightly moist, very dense, up to 0.5-inch diameter shale fragments.	
8.9	105.2	22 34 50 for 3"	R-6	30	SM	Yellowish Brown Silty SANDSTONE; ; slightly moist, very dense, iron oxide staining	
18.9	100.5	19 26 50 for 5"	R-7	35	SM	Light Grayish Brown Silty SANDSTONE (SM)	



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Project Name: Century City Constellation
Project No.: 1934

Sample Types:

☐ Bulk Sample
☐ Rock Core
☐ Ring Sample
☐ Standard Split Spoon
☐ Tube Sample


Location: See Boring Location Plan Logged by: V.R.

Date Drilled: 8/17/04 Equipment Used: BK-81 Drill Rig Ring Type: 2.5" Diameter

Ground Elevation: 254 Notes: 140 lb downhole hammer with 30-inch drop

Figure A-2.3.2

Moisture (%)	Dry Density (pcf)	Penetration Resistance (Blows/Foot)	Sample Type	Depth (Feet)	Lithology	BORING LOG NO.: 2		Elevation (Feet)
						Description of Subsurface Materials: Classification, (USCS) color, mixture, consistency, etc.		
11.4	106.4	24 50 for 5"	R-8	40		Olive Gray Silty SANDSTONE (SM), slightly moist, very dense		
16.4	105.6	28 35 50 for 3"	R-9	45	SP-SM	Bluish Gray Poorly Graded SANDSTONE with Silt (SP-SM), moist, very dense		
19.4	107.3	21 29 44	R-10	50		Bluish Gray Poorly Graded SANDSTONE with Silt (SP-SM)		
28.0	91.2	14 17 20	R-11	55	SM	Light Bluish Gray Silty SANDSTONE (SM), wet, dense.		
		11 16 24	R-12	60		(No recovery)		
		7 10 13	R-13	65		(No recovery - added sand catcher to sampler)		
26.5		24 50 for 5"	R-14	70	SC	Dark Gray Clayey SANDSTONE (SC) Disturbed, wet, very dense.		
22.8	103.6	29 50 for 5"	R-15	75		Dark Gray Clayey SANDSTONE with Gravel sized rocks, wet.		



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Project Name: Century City Constellation
Project No.: 1934

Sample Types:

☐ Bulk Sample
☐ Rock Core
☐ Ring Sample
☐ Standard Split Spoon
☐ Tube Sample

Location: See Boring Location Plan Logged by: V.R.

Date Drilled: 8/17/04 Equipment Used: BK-81 Drill Rig Ring Type: 2.5"x1" Diameter

Ground Elevation: 254 Notes: 140 lb downhole hammer with 30-inch drop

Figure A-2.3.3

[illegible]

Figure A-2.3.4

Moisture (%)	Dry Density (pcf)	Penetration Resistance (Blows/Foot)	Sample Type	Depth (Feet)	Lithology	BORING LOG NO.:3	Elevation (Feet)
						Description of Subsurface Materials: Classification, (USCS) color, mixture, consistency, etc.	
					CL	Older Alluvium (Qoa): Dark Brown Sandy CLAY (CL), stiff, moist.	
12.7	118.2	16 21 25	R-1	5	SC	Dark Grayish Brown Clayey SAND with Gravel (SC), moist, medium dense.	
			B				
13.8	119.1	11 7 26	R-2	10		Dark Brown Clayey SAND (SC),	
14.5	115.2	12 20 23	R-3	15		Dark Brown Clayey SAND with Gravel (SC),	
17.2	114.1	10 15 22	R-4	20		Dark Brown Clayey SAND with Gravel (SC),	
22.4	100.2	11 18 21	R-5	25	SC/CL	Dark Grayish Brown Sandy CLAY (SC/CL); moist to wet, medium dense / very stiff.	
19.1	111.4	10 15 29	R-6	30		Dark Grayish Brown Sandy CLAY (CL); moist, very stiff to hard	
					CL		
18.9	106.9	8 14 18	R-7	35		Brown Sandy CLAY (CL); moist, very stiff to hard	
			B				

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Project Name: Century City Constellation

Project No.: 1934

Sample Types:

- ☐ Bulk Sample
☐ Rock Core
☐ Ring Sample
☐ Standard Split Spoon
☐ Tube Sample

Location: See Boring Location Plan


Logged by: J. Norman

Date Drilled: 8/20/04 Equipment Used: CME-81 Drill Rig Ring Type: 2.5"

Ground Elevation: 286.5 Notes: 140 lb downhole hammer with 30-inch drop

Figure A-2.3.5

Moisture (%)	Dry Density (pcf)	Penetration Resistance (Blows/Foot)	Sample Type	Depth (Feet)	Lithology	BORING LOG NO.:3	Elevation (Feet)
						Description of Subsurface Materials: Classification, (USCS) color, mixture, consistency, etc.	
20.1	104.4	12 19 28	R-8	40	CL	Grayish Brown Sandy CLAY (CL)	
29.9	90.9	14 17 28	R-9	45	CH	Olive Gray Fat CLAY (CH); moist to wet, very stiff	
28.9	94.7	19 22 26	R-10	50	CL	Grayish Brown Sandy CLAY (CL); moist to wet, hard	
7.3	102.2	20 50 for 5"	R-11	55	SP	Bedrock (San Pedro Formation): Light Gray Poorly Graded SAND (SP); slightly moist, very dense, fine to medium grained sand	
9.4	103.5	24 50 for 4"	R-12	60	GP	Light Grayish Brown Sandy GRAVEL (GP); slightly moist, very dense, rounded dark gray shale and cherty fragments.	
8.8	91.9	33 50 for 5"	R-13 B	65	SM	Light Gray Silty (fine) SAND (SM); slightly moist, very dense.	
13.6	96.0	20 31 39	R-14	70		Light Gray Silty (fine) SAND (SM); slightly moist, very dense.	
26.7	97.1	24 50 for 3"	R-15	75	ML	Bluish Gray Sandy SILT (ML); moist to wet, very stiff to hard.	



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Sample Types:

☐ Bulk Sample

☐ Rock Core

☐ Ring Sample

☐ Standard Split Spoon

☐ Tube Sample

Location: See Boring Location Plan Logged by: J. Norman

Date Drilled: 8/20/04 Equipment Used: CME-81 Drill Rig Ring Type: 2.5"


Ground Elevation: 286.5 Notes: 140 lb downhole hammer with 30-inch drop

Project Name: Century City Constellation

Project No.: 1934

Figure A-2.3.6

Moisture (%)	Dry Density (pcf)	Penetration Resistance (Blows/Foot)	Sample Type	Depth (Feet)	Lithology	BORING LOG NO.: 3	Elevation (Feet)
						Description of Subsurface Materials: Classification, (USCS) color, mixture, consistency, etc.	
8.9	98.1	25 50 for 3"	R-16	80	SM	Light Gray Silty SAND (SM); slightly moist, very dense	
						Boring Terminated at 81.5 feet. Temporary standpipe installed to 80 ft. bgs. Casing slotted 75 to 80 ft. bgs. Water level @ 79 ft. bgs. on 8/28/04 Methane gas probes installed @ 10, 20, 30 & 40 ft. bgs.	
				85			
				90			
				95			
				100			
				105			
				110			
				115			



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Project Name: Century City Constellation

Project No.: 1934

Sample Types:

☐ Bulk Sample

☐ Rock Core

☐ Ring Sample

☐ Standard Split Spoon

☐ Tube Sample

Location: See Boring Location Plan

Date Drilled: 8/20/04

Ground Elevation: 286.5

Equipment Used: CME-81 Drill Rig

Notes: 140 lb downhole hammer with 30-inch drop

Ring Type: 2.5"

Logged by: J. Norman

Figure A-2.3.7

Moisture (%)	Dry Density (pcf)	Penetration Resistance (Blows/Foot)	Sample Type	Depth (Feet)	Lithology	BORING LOG NO.: 4	Elevation (Feet)
						Description of Subsurface Materials: Classification, (USCS) color, mixture, consistency, etc.	
						Older Alluvium (Qoa): Dark Brown Sandy CLAY (CL), stiff, moist.	
18.6	111.3	9 11 11	R-1 B	5	CL	Dark Brown Sandy CLAY (CL); moist, stiff	
19.2	110.7	10 11 20	R-2	10		Dark Grayish Brown Sandy CLAY (CL); moist, stiff	
9.7	99.1	17 28 33	R-3 B	15	SP-SM	Dark Brown Poorly Graded SAND with Silt (SP-SM); slightly moist, dense, fine to coarse grained sand	
11.5	109.9	24 50 for 5"	R-4	20	SP	Bedrock (San Pedro Formation): Dark Brown Poorly Graded SAND with Gravel (SP); slightly moist, very dense.	
11.6	93.7	28 31 41	R-5 B	25	SM	Light Grayish Brown Silty (fine) SAND (SM); slightly moist, dense, fine grained sand.	
9.4	101.3	34 50 for 4"	R-6	30	SP	Light Brown Poorly Graded SAND (SP); slightly moist, very dense, medium to coarse grained sand.	
22.1	104.3	25 38 50 for 5"	R-7	35	SM	Light Brown Silty SAND (SM); moist, very dense, medium grained sand.	

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Project Name: Century City Constellation
Project No.: 1934

Sample Types:

- ☐ Bulk Sample
☐ Rock Core
☐ Ring Sample
☐ Standard Split Spoon
☐ Tube Sample

Location: See Boring Location Plan


Logged by: J. Norman

Date Drilled: 8/19/04 Equipment Used: CME-81 Ring Type: 2.5"

Ground Elevation: 253.2 Notes: 140 lb downhole hammer with 30-inch drop

Figure A-2.3.8

Moisture (%)	Dry Density (pcf)	Penetration Resistance (Blows/Foot)	Sample Type	Depth (Feet)	Lithology	BORING LOG NO.: 4	Elevation (Feet)
						Description of Subsurface Materials: Classification, (USCS) color, mixture, consistency, etc.	
13.4	101.0	31 33 50 for 3"	R-8	40	SM	Light Olive Gray Silty (fine) SAND (SM)	
			B				
15.9	113.7	22 30 39	R-9	45		Bluish Gray Silty SAND with Gravel (SM); moist, dense Seepage encountered @ 46.5 feet during drilling	
18.6	99.0	26 27 40	R-10	50		Bluish Gray Poorly Graded SAND with Silt (SP-SM); wet, dense to very dense.	
					SP-SM		
15.8	111.7	30 50 for 4"	R-11	55		Bluish Gray Poorly Graded SAND with Silt (SP-SM); wet, dense to very dense.	
17.8	110.6	10 17 28	R-12	60		Grayish Brown Poorly Graded SAND (SP); wet, medium dense.	
					SP		
15.0	118.5	23 50 for 2"	R-13	65		Grayish Brown Poorly Graded SAND (SP); wet, medium dense.	
29.6	91.5	20 22 24	R-14	70		Dark Bluish Gray Silty CLAY (CL); wet, stiff.	
					CL		
12.1	106.0	34 50 for 5"	R-15	75		Dark Bluish Gray Silty SAND with Clay (SM/SC); slightly moist, very dense.	
					SM/SC		



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Project No.: 1934

Sample Types:

☐ Bulk Sample

☐ Rock Core

☐ Ring Sample

☐ Standard Split Spoon

☐ Tube Sample

Location: See Boring Location Plan

Date Drilled: 8/19/04

Ground Elevation: 253.2

Notes: 140 lb downhole hammer with 30-inch drop


Logged by: J. Norman

Equipment Used: CME-81

Ring Type: 2.5"

Figure A-2.3.9

BORING LOG NO.: 5						Elevation (Feet)
Moisture (%)	Dry Density (pcf)	Penetration Resistance (Blows/Foot)	Sample Type	Depth (Feet)	Lithology	
Description of Subsurface Materials: Classification, (USCS) color, mixture, consistency, etc.						
					Older Alluvium (Qoa): Medium Brown, Stiff Sandy Clay (CL), Moist.	
15.3	115.3	8 14 21	R-1	5	CL Grayish Brown Sandy CLAY (CL) Stiff, Low Plasticity Clay Trace Gravel	
17.9	104.6	8 8 17	R-2	10	Olive Gray Sandy CLAY (CL)	
			B	15		
21.0	104.5	11 12 21	R-3		Olive Brown Silty (fine) SAND (SM/ML), Slightly moist, very stiff	
				20	SM/ML	
7.4	109.9	20 36 50 for 4"	R-4		Bedrock (San Pedro Formation): Light Reddish Brown Poorly Graded SAND with Silt (SP-SM), slightly moist, very dense.	
				25	SP-SM	
7.8	109.5	27 50 for 3"	R-5		GP Light Grayish Brown Sandy GRAVEL (GP), Slightly Moist, very dense.	
					Boring Terminated @ 27.5 ft. bgs. No Groundwater Encountered. Methane Gas Probes Installed at 5, 10 and 25 ft bgs.	



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Project Name: Century City Constellation

Project No.: 1934

Sample Types:

☐ Bulk Sample

☐ Rock Core

☐ Ring Sample

☐ Standard Split Spoon

☐ Tube Sample

Location: See Boring Location Plan


Date Drilled: 8/17/04 Equipment Used: B-61 Ring Type: 2.5" Diameter

Ground Elevation: 253.3 Notes: 140 lb downhole hammer with 30-inch drop

Logged by: J. Norman

Figure A-2.3.11

Moisture (%)	Dry Density (pcf)	Penetration Resistance (Blows/Foot)	Sample Type	Depth (Feet)	Lithology	BORING LOG NO.: 6		Elevation (Feet)
						Description of Subsurface Materials: Classification, (USCS) color, mixture, consistency, etc.		
						Older Alluvium (Qoa): Dark Brown Sandy Clay (CL), stiff, moist.		
13.8	105.7	8 18 31	R-1 B	5	CL	Dark Brown Sandy CLAY (CL), moist, very stiff, iron oxide staining		
19.8	108.6	10 17 22	R-2	10		Dark Brown Silty CLAY (CL)		
17.1	112.5	8 18 26	R-3	15		Light Brown Sandy CLAY (CL)		
20.0	108.4	19 11 21	R-4	20		Light Brown Clayey SAND (SC), moist, very stiff, iron oxide staining		
26.3	98.6	5 19 30	R-5	25	SC/SM	Grayish Brown Silty CLAY (CL), moist, very stiff.		
						Boring Terminated @ 27.5 ft. No Groundwater Encountered. Methane gas probes installed @ 5, 10, & 25 ft. bgs.		



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Sample Types:

☐ Bulk Sample

☐ Rock Core

☐ Ring Sample

☐ Standard Split Spoon

☐ Tube Sample

Project Name: Century City Constellation

Project No.: 1934

Location: See Boring Location Plan Logged by: V.R.

Date Drilled: 8/17/04 Equipment Used: BK-81 Ring Type: 2.5" Diameter

Ground Elevation: 262.3 Notes: 140 lb downhole hammer with 30-inch drop

Figure A-2.3.12

Moisture (%)	Dry Density (pcf)	Penetration Resistance (Blows/Foot)	Sample Type	Depth (Feet)	Lithology	BORING LOG NO.: 7		Elevation (Feet)
						Description of Subsurface Materials: Classification, (USCS) color, mixture, consistency, etc.		
						Older Alluvium (Qoa): Medium Brown Sandy Clay (CL), Slightly Moist, Stiff.		
10.6	113.2	15 38 50 for 2"	R-1 B	5	CL	Brown Sandy CLAY (CL), Slightly moist, hard		
8.3	121.1	19 21 50 for 5"	R-2	10		Brown Sandy CLAY with Gravel (CL), Slightly moist, hard		
3.8		37 50 for 2"	R-3	15	GC	Light Brown Clayey GRAVEL (GC) Disturbed, Slightly moist, very dense		
10.0	112.3	30 50 for 5"	R-4	20	SC	Brown Sandy Clayey SAND (SC), slightly, moist, hard		
8.8	101.4	27 50 for 5"	R-5 B	25	SP/SC	Brown Poorly Graded SAND with Clay (SP/SC), Slightly moist, very dense		
16.8	111.5	16 32 50 for 2"	R-6	30	CL	Brown Sandy CLAY (CL), Slightly moist, hard		
16.7	112.7	16 33 50 for 3"	R-7	35		Light Brown Sandy CLAY (CL), Slightly moist, hard		

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Project Name: Century City Constellation
Project No.: 1934

Sample Types:

☐ Bulk Sample
☐ Rock Core
☐ Ring Sample
☐ Standard Split Spoon
☐ Tube Sample

Location: See Boring Location Plan Logged by: JRN

Date Drilled: 8/19/04 Equipment Used: CME-81 Drill Rig Ring Type: 2.5"

Ground Elevation: 280.4 Notes: 140 lb downhole hammer with 30-inch drop

Figure A-2.3.13

Moisture (%)	Dry Density (pcf)	Penetration Resistance (Blows/Foot)	Sample Type	Depth (Feet)	Lithology	BORING LOG NO.: 7	Elevation (Feet)
						Description of Subsurface Materials: Classification, (USCS) color, mixture, consistency, etc.	
19.6	106.4		R-8	40	CH	Grayish Brown Fat CLAY with Sand (CH), moist, stiff, hard	
28.0	96.4	20 31 50 for 4"	R-9	45	CL/CH	Light Olive Gray Silty CLAY (CL/CH), wet, stiff	
29.2	93.9	18 32 41	R-10	50	CH	Light Olive Gray Fat CLAY with Siltstone Fragments (CH), light olive gray fat clayey siltstone, wet, stiff	
						Total Depth = 51.5 ft. No Groundwater Encountered. Methane Gas Probes Set @ 10, 20, 30, 40 & 50 ft. bgs.	

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Project Name: Century City Constellation

Project No.: 1934

Sample Types:

☒ Bulk Sample

☒ Rock Core

☒ Ring Sample

☒ Standard Split Spoon

☒ Tube Sample

Location: See Boring Location Plan

Date Drilled: 8/19/04

Ground Elevation: 280.4


Logged by: JRN

Equipment Used: CME-81 Drill Rig

Notes: 140 lb downhole hammer with 30-inch drop

Figure A-2.3.14

BORING LOG NO.: 8							Elevation (Feet)
Moisture (%)	Dry Density (pcf)	Penetration Resistance (Blows/Foot)	Sample Type	Depth (Feet)	Lithology	Description of Subsurface Materials: Classification, (USCS) color, mixture, consistency, etc.	
						Older Alluvium (Qoa): Medium Brown Silty Sand (SM), Slightly Moist, Dense.	
3.9	119.7	16 25 49	R-1	5	SM	Dark Brown Silty SAND with Gravel (SM), Slightly moist, dense	
6.4	115.2	20 24 34	R-2	10	GP	Dark Brown Silty GRAVEL (GP), Slightly moist, dense	
11.2	113.5	29 50 for 5"	R-3	15	SC	Dark Brown Clayey SAND (SC), moist, very dense	
18.9	100.8	19 28 34	R-4	20		Light Brown Silty CLAY (CL), Slightly moist, very stiff	
11.7	122.4	22 28 50	R-5	25	CL	Brown Silty CLAY (CL), Slightly moist, very stiff	
6.0	119.6	19 35 50 for 5"	R-6	30		Light Brown Silty CLAY (CL), Slightly moist, very stiff	
18.1	112.1	33 45 50 for 4"	R-7	35		Brown Silty CLAY (CL), Slightly moist, very stiff	



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Project Name: Century City Constellation
Project No.: 1934

Sample Types:

☐ Bulk Sample
☐ Rock Core
☐ Ring Sample
☐ Standard Split Spoon
☐ Tube Sample

Location: See Boring Location Plan Logged by: J. Norman

Date Drilled: 8/21/04 Equipment Used: CME-81 Ring Type: .25" Brass

Ground Elevation: 278.1 Notes: 140 lb downhole hammer with 30-inch drop

Figure A-2.3.15

Moisture (%)	Dry Density (pcf)	Penetration Resistance (Blows/Foot)	Sample Type	Depth (Feet)	Lithology	BORING LOG NO.:8	Elevation (Feet)
						Description of Subsurface Materials: Classification, (USCS) color, mixture, consistency, etc.	
34.6	86.1	16 30 41	R-8	40	CH	Grayish Brown Fat CLAY (CH), moist, hard	
17.7	106.5	27 50 for 5"	R-9	45	CL	Light Grayish Brown Silty CLAY (CL), Slightly moist, hard	
16.1	105.0	38 50 for 5"	R-10	50		Light Grayish Brown Sandy CLAY (CL)	
5.4	107.4	50 for 5"	R-11	55	SM	Light Yellowish Brown Silty SAND with Gravel (SM), Slightly moist, very dense	
			B				
3.1	98.8	11 26 50 for 4"	R-12	60	SP	Bedrock (San Pedro Formation): Light Gray Poorly Graded SAND (SP), Slightly moist, very dense.	
26.1	98.0	21 50 for 4"	R-13	65	SM	Light Grayish Brown Silty (fine) SAND (SM); moist, very dense	
20.3	101.6	34 50 for 5"	R-14	70	SP-SM	Groundwater Encountered @ 70' bgs during drilling Light Gray Poorly Graded SAND with Silt (SP-SM), wet, very dense	
21.1	102.7	18 31 42	R-15	75		Bluish Gray Poorly Graded SAND with Silt (SP-SM)	

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Project Name: Century City Constellation

Project No.: 1934

Sample Types:

- ☐ Bulk Sample
☐ Rock Core
☐ Ring Sample
☐ Standard Split Spoon
☐ Tube Sample

Location: See Boring Location Plan

Logged by: J. Norman

Date Drilled: 8/21/04 Equipment Used: CME-81 Ring Type: 2.5" Brass


Ground Elevation: 278.1 Notes: 140 lb downhole hammer with 30-inch drop

Figure A-2.3.16

[illegible]

Figure A-2.3.17

Moisture (%)	Dry Density (pcf)	Penetration Resistance (Blows/Foot)	Sample Type	Depth (Feet)	Lithology	BORING LOG NO.: 9		Elevation (Feet)
						Description of Subsurface Materials: Classification, (USCS) color, mixture, consistency, etc.		
					CL	Older Alluvium (Qoa): Dark Brown Sandy Clay (CL); Slightly Moist, Stiff.		
12.1	95.3	15 19 28	R-1 B	5		Dark Brown Sandy CLAY (CL); slightly moist, very stiff		
11.4	118.0	21 50 for 5"	R-2	10		Dark Brown Sandy CLAY (CL); slightly moist, very stiff		
15.6	102.7	16 24 39	R-3	15		Light Brown , Silty CLAY (CL)		
8.3	122.5	20 50 for 5"	R-3	20		Dark Brown Silty CLAY (CL)		
13.3	115.0	18 20 34	R-4	25		Light Brown Silty CLAY (CL)		
13.5	116.7	23 31 50	R-5	30		Light Brown Sandy CLAY (CL), Stiff		
16.6	111.5	25 34 50 for 4"	R-6	35		Light Grayish Brown Sandy CLAY (CL)		



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Project Name: Century City Constellation

Project No.: 1934

Sample Types:

☐ Bulk Sample

☐ Rock Core

☐ Ring Sample

☐ Standard Split Spoon

☐ Tube Sample

Location: See Boring Location Plan

Date Drilled: 8/19/04

Ground Elevation: 269.1

Equipment Used: CME-81 Drill Rig

Notes: 140 lb downhole hammer with 30-inch drop

Ring Type: 2.5"

Logged by: J. Norman

Figure A-2.3.18

Moisture (%)	Dry Density (pcf)	Penetration Resistance (Blows/Foot)	Sample Type	Depth (Feet)	Lithology	BORING LOG NO.: 9	Elevation (Feet)
						Description of Subsurface Materials: Classification, (USCS) color, mixture, consistency, etc.	
22.8	103.8	23 50 for 5"	R-7 B	40	CL	Light Gray Silty CLAY (CL), moist, very stiff	
2.8	106.7	39 50 for 4"	R-7	45	SP-SM	Bedrock (San Pedro Formation): Light Grayish Brown Poorly Graded SAND with Silt (SP-SM), Slightly moist, very dense	
4.2	102.3	33 50 for 2"	R-7	50	SP	Light Yellowish Brown Poorly Graded SAND (SP), slightly moist, very dense	
						Total Depth for Augers = 51.5 ft. Groundwater Not Encountered Methane Gas Probes Set @ 15', 20', 30', 40', & 50'	
				55			
				60			
				65			
				70			
				75			

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Project Name: Century City Constellation

Project No.: 1934

Sample Types:

- ☐ Bulk Sample
☐ Rock Core
☐ Ring Sample
☐ Standard Split Spoon
☐ Tube Sample

Location: See Boring Location Plan

Logged by: J. Norman

Date Drilled: 8/19/04

Equipment Used: CME-81 Drill Rig


Ring Type: 2.5"

Ground Elevation: 269.1

Notes: 140 lb downhole hammer with 30-inch drop

Figure A-2.3.19

Moisture (%)	Dry Density (pcf)	Penetration Resistance (Blows/Foot)	Sample Type	Depth (Feet)	Lithology	BORING LOG NO.: 10		Elevation (Feet)
						Description of Subsurface Materials: Classification, (USCS) color, mixture, consistency, etc.		
						Older Alluvium (Qoa): Dark Brown Clayey Sand to Sandy (SC) Clay (CL), Moist, stiff.		
14.4	108.1	8 23 30	R-1 B	5	SC	Dark Brown Clayey Sand to Sandy CLAY with Gravel (SC/CL); moist, medium dense		
11.6	114.9	18 24 36	R-2	10		Dark Brown Clayey SAND with Gravel (SC); moist, medium dense		
9.9	121.6	29 50 for 5"	R-3	15		Dark Brown Clayey SAND (SC)		
17.4	104.7	21 24 28	R-4	20		Brown Clayey SAND (SC)		
11.0	98.6	20 29 40	R-5	25	SM	Brown Silty SAND (SM); slightly moist, dense		
16.0	114.9	9 31 41	R-6	30	CH	Dark Grayish Brown Fat CLAY with Sand (CH), slightly moist, very stiff		
7.1	118.8	31 50 for 5"	R-7	35	SC	Light Grayish Brown Clayey SAND (SC), slightly moist, very dense		



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Project Name: Century City Constellation

Project No.: 1934

Sample Types:

☐ Bulk Sample

☐ Rock Core

☐ Ring Sample

☐ Standard Split Spoon

☐ Tube Sample

Location: See Boring Location Plan

Date Drilled: 8/18/04

Ground Elevation: 275.7


Equipment Used: CME-81


Notes: 140 lb downhole hammer with 30-inch drop

Ring Type: 2.5"

Logged by: J. Norman

Figure A-2.3.20

Moisture (%)	Dry Density (pcf)	Penetration Resistance (Blows/Foot)	Sample Type	Depth (Feet)	Lithology	BORING LOG NO.: 10	Elevation (Feet)
						Description of Subsurface Materials: Classification, (USCS) color, mixture, consistency, etc.	
7.4	119.1	29 50 for 3"	R-8		SC	Light Grayish Brown Clayey SAND (SC); slightly moist, very dense	
25.0	100.5	19 28 33	R-9 B	45	CH	Grayish Brown Fat CLAY (CH), moist, very stiff	
17.5	108.2	38 50 for 3"	R-10	50	CL	Light Gray Silty CLAY (CL), slightly moist, hard	
3.4	101.8	42 50 for 4"	R-11 B	55	SP	Bedrock (San Pedro Formation): Light Gray Poorly Graded SAND (SP), slightly moist, very dense	
6.2	100.7	27 50 for 3"	R-12	60	SP-SM	Light Yellowish Brown Poorly Graded SAND (SP), slightly moist, very dense	
3.3	105.4	50 for 15"	R-13	65		Light Brown Poorly Graded SAND with Silt (SP-SM)	
15.1	93.7	27 50 for 3"	R-14	70		Olive Gray Poorly Graded SAND with Silt (SP-SM)	
						Groundwater encountered @ 73' during drilling	
17.7	101.5	30 50 for 4"	R-15	75		Bluish Gray Poorly Graded SAND with Silt (SP-SM), Wet	



GeoKinetics
Geotechnical &
Environmental Engineers

Project Name: Century City Constellation
Project No.: 1934

Sample Types:

☐ Bulk Sample

☐ Rock Core

☐ Ring Sample

☐ Standard Split Spoon

☐ Tube Sample

Location: See Boring Location Plan

Logged by: J. Norman

Date Drilled: 8/18/04

Equipment Used: CME-81


Ring Type: 2.5"

Ground Elevation: 275.7

Notes: 140 lb downhole hammer with 30-inch drop

Figure A-2.3.21

Moisture (%)	Dry Density (pcf)	Penetration Resistance (Blows/Foot)	Sample Type	Depth (Feet)	Lithology	BORING LOG NO.: 10	Elevation (Feet)
						Description of Subsurface Materials: Classification, (USCS) color, mixture, consistency, etc.	
21.3	106.3	35 50 for 5'	R-16	80	SP-SM	Bluish Gray Silty (fine) SAND (SM), wet, very dense	
				85		Boring terminated at 81.5 ft. Groundwater Encountered at 73 ft. during drilling. Water Level at 76 ft. on 8/28/04 Methane Gas Probes set at 10, 20, 30, 40, 50, 60, & 70 ft bgs. Temporary standpipe set to 80 ft bgs. Slotted 75 to 80 ft. bgs.	
				90			
				95			
				100			
				105			
				110			
				115			



GeoKinetics
Geotechnical &
Environmental Engineers

Project Name: Century City Constellation

Project No.: 1934

Sample Types:

☐ Bulk Sample

☐ Rock Core

☐ Ring Sample

☐ Standard Split Spoon

☐ Tube Sample

Location: See Boring Location Plan

Date Drilled: 8/18/04

Ground Elevation: 275.7

Notes: 140 lb downhole hammer with 30-inch drop

Logged by: J. Norman

Equipment Used: CME-81

Ring Type: 2.5"

Figure A-2.3.22

Moisture (%)	Dry Density (pcf)	Penetration Resistance (Blows/Foot)	Sample Type	Depth (Feet)	Lithology	BORING LOG NO.: 11	Elevation (Feet)
						Description of Subsurface Materials: Classification, (USCS) color, mixture, consistency, etc.	
						Older Alluvium (Qoa): Medium Brown Sandy Clay (CL), Moist, Stiff.	
14.9	108.5	19 28 34	R-1	5	CL	Brown Sandy CLAY (CL), slightly moist, very stiff.	
			B				
9.1	117.6	26 50 for 5'	R-2	10	SC	Dark Brown Clayey SAND with Gravel (SC), slightly moist, very dense	
6.5	117.3	33 50 for 4'	R-3	15	GC	Brown Clayey GRAVEL (GC), slightly moist, very dense	
7.7	114.1	29 50 for 5'	R-4	20		Dark Brown Clayey GRAVEL (GC)	
22.2	86.4	21 39 50 for 5'	R-5	25	CL	Dark Brown Silty CLAY (CL), moist to wet, hard	
			B				
16.3	103.7	29 35 50 for 5'	R-6	30		Dark Brown Silty CLAY (CL), moist to wet, hard	
13.4	117.6	17 32 50 for 5'	R-7	35		Dark Brown Sandy CLAY (CL), moist to wet, hard	

GeoKinetics
Geotechnical &
Environmental Engineers

Project Name: Century City Constellation

Project No.: 1934

Sample Types:

- ☐ Bulk Sample
☐ Rock Core
☐ Ring Sample
☐ Standard Split Spoon
☐ Tube Sample

Location: See Boring Location Plan

Logged by: J. Norman

Date Drilled: 8/18/04

Equipment Used: CME-81

Ring Type: 2.5"

Ground Elevation: 274.6

Notes: 140 lb downhole hammer with 30-inch drop

Figure A-2.3.23

Moisture (%)	Dry Density (pcf)	Penetration Resistance (Blows/Foot)	Sample Type	Depth (Feet)	Lithology	BORING LOG NO.: 11		Elevation (Feet)
						Description of Subsurface Materials: Classification, (USCS) color, mixture, consistency, etc.		
10.6	119.8	19 50 for 5'	R-8	40	CL	Dark Brown Silty CLAY (CL), slightly moist, hard		
18.7	109.9	27 37 50 for 5'	R-9	45		Dark Brown Silty CLAY (CL), slightly moist, hard		
23.3	103.3	43 50 for 5'	R-10	50	CH	Grayish Brown Fat CLAY (CH), moist, hard		
						Total Depth = 51.5 ft. No Groundwater Encountered Methane Gas Probes installed at 10, 20, 30, 40, & 50 ft. bgs.		
				55				
				60				
				65				
				70				
				75				

GeoKinetics

Geotechnical & Environmental Engineers

Project Name: Century City Constellation

Project No.: 1934

Sample Types:

☐ Bulk Sample

☐ Rock Core

☐ Ring Sample

☐ Standard Split Spoon

☐ Tube Sample

Location: See Boring Location Plan

Date Drilled: 8/18/04

Ground Elevation: 274.6

Notes: 140 lb downhole hammer with 30-inch drop

Logged by: J. Norman

Equipment Used: CME-81

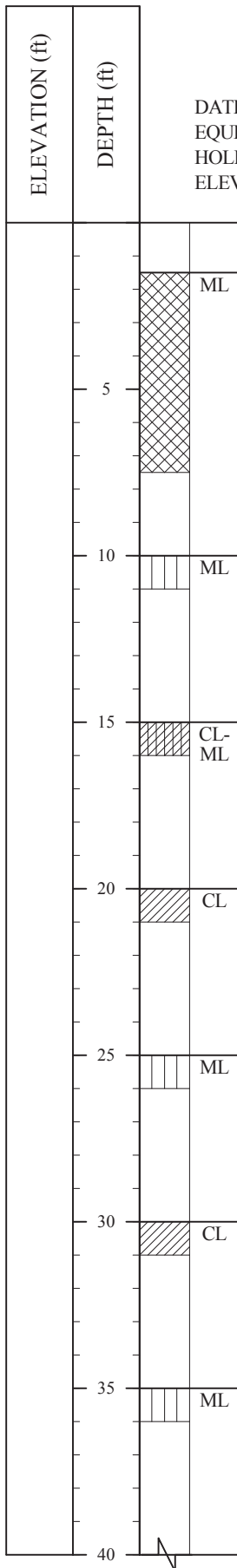
Ring Type: 2.5"

Figure A-2.3.24

BORING E-132

DATE DRILLED: September 20, 2011
EQUIPMENT USED: Kehoe CPT Direct Push and HSA Rigs
HOLE DIAMETER (in.): 2 and 8
ELEVATION: 270 feet *

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.



(CONTINUED ON FOLLOWING FIGURE)

Field Tech: PK
Prepared By: LH/APR/YN
Checked By:

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

BORING E-132 (Continued)

DATE DRILLED: September 20, 2011
EQUIPMENT USED: Kehoe CPT Direct Push and HSA Rigs
HOLE DIAMETER (in.): 2 and 8
ELEVATION: 270 feet *

ELEVATION (ft)	DEPTH (ft)		
		ML	CLAYEY SILT - very stiff, moist, olive brown (2.5Y 4/4), no odor
	45	ML	SILT - trace clay, olive gray (5Y 5/1), moist, very stiff, no odor, yellowish brown discoloration
	50	SM	SILTY SAND - very fine grained, greenish gray (GLE Y1 5/1), moist, very dense, no odor
	55	SM	SILTY SAND - very fine to fine grained, some medium grained sand, trace fine gravel, greenish gray (GLE Y1 5/1), very moist, very dense, no odor
	60	SM	SANDY SILT - very fine grained, greenish gray (GLE Y1 5/1), very moist to damp, hard, no odor
	65	SM	SILTY SAND - very fine to fine grained, greenish gray (GLE Y1 5/1), very moist, dense, no odor
	70	SM	SILTY SAND - very fine to fine grained, greenish gray (GLE Y1 5/1), moist, very dense, no odor, damp at bottom of sampler
	75	SM	SILTY SAND - very fine to fine grained, very dark greenish gray (GLE Y1 3/1), moist, very dense, no odor, damp at bottom of sampler
	80		

Field Tech: PK
Prepared By: LH/APR/YN
Checked By:

(CONTINUED ON FOLLOWING FIGURE)

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

BORING E-132 (Continued)

DATE DRILLED: September 20, 2011
EQUIPMENT USED: Kehoe CPT Direct Push and HSA Rigs
HOLE DIAMETER (in.): 2 and 8
ELEVATION: 270 feet *

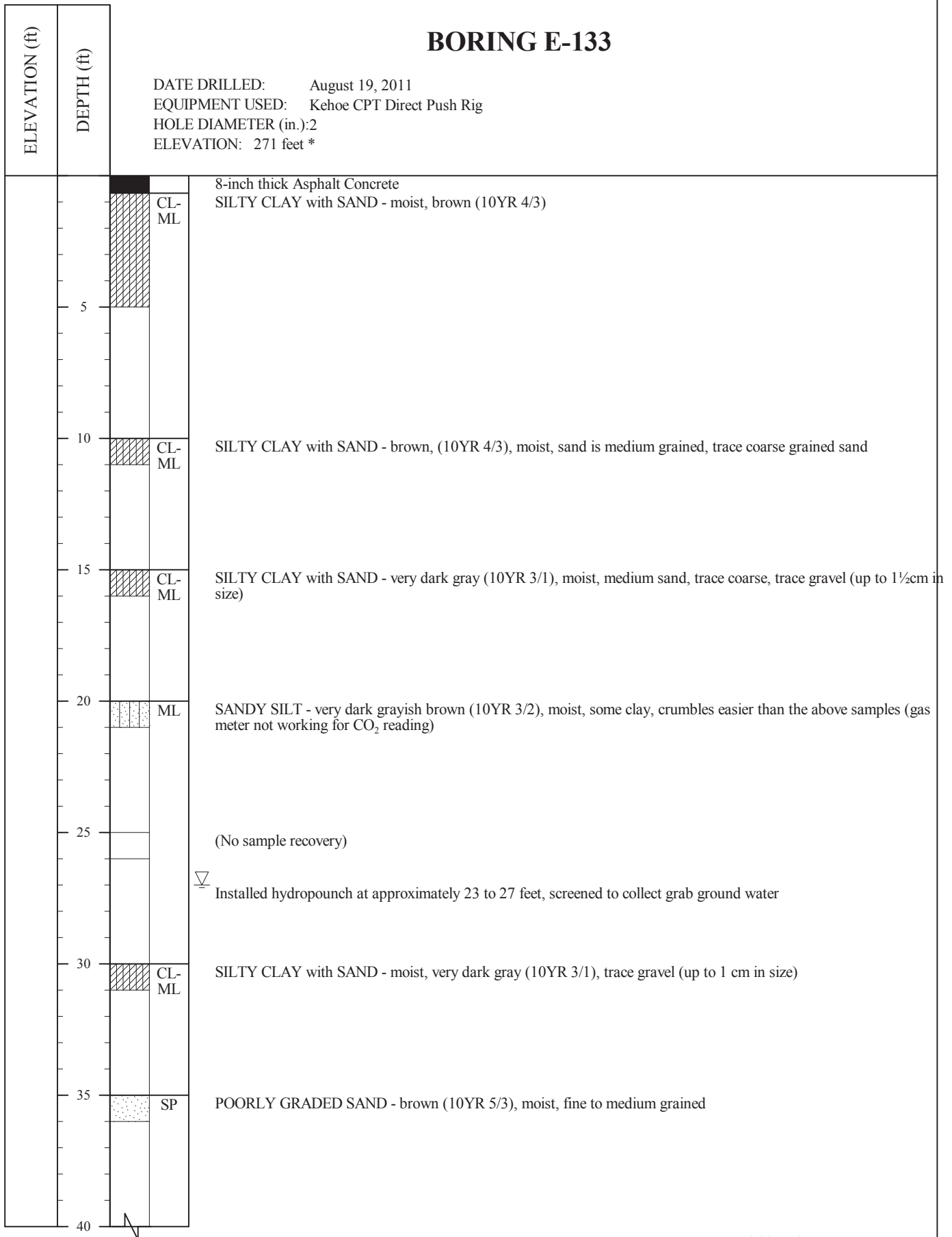
ELEVATION (ft)	DEPTH (ft)		
		SP	SAND - poorly graded, very fine to fine, dark greenish gray (GLEY1 3/1), moist to damp, very dense, no odor
	85	SP	SAND - poorly graded, very fine to fine, dark greenish gray (GLEY1 3/1), saturated, very dense, no odor
			END OF BORING AT 85 FEET
			NOTES: Hand augered upper 7½ feet to avoid damage to utilities. Ground-water sample not collected. Borehole grouted with cement-bentonite slurry and patched with quick setting concrete.
	90		
	95		
	100		
	105		
	110		
	115		
	120		

Field Tech: PK
Prepared By: LH/APR/YN
Checked By:

BORING E-133

DATE DRILLED: August 19, 2011
EQUIPMENT USED: Kehoe CPT Direct Push Rig
HOLE DIAMETER (in.): 2
ELEVATION: 271 feet *

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.



(CONTINUED ON FOLLOWING FIGURE)

Field Tech: RM
Prepared By: LH/APR/YN
Checked By:

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

BORING E-133 (Continued)

DATE DRILLED: August 19, 2011
EQUIPMENT USED: Kehoe CPT Direct Push Rig
HOLE DIAMETER (in.): 2
ELEVATION: 271 feet *

ELEVATION (ft)	DEPTH (ft)		
		SP	POORLY GRADED SAND - very dense, moist, brown (7.5YR 4/3), no odor
	45	SP	POORLY GRADED SAND - very dense, very moist, brown (7.5YR 4/3), no odor
	50	SM	SILTY SAND with GRAVEL - very dense, very moist, brown (7.5YR 4/3), fine to medium-grained, fine gravel
	55	SM	SILTY SAND - very dense, very moist, yellowish brown (10YR 4/4), trace coarse gravel
	60	SP	POORLY GRADED SAND - very dense, moist, brown (10YR 4/4) with olive gray discoloration, no odor
	65	SM	SILTY SAND - very dense, moist to wet, brown (7.5YR, 4/4), fine-grained
	70	SM	SILTY SAND - very dense, moist to wet, dark greenish gray (GLE Y 4/1), fine-grained
	75	SP	POORLY GRADED SAND - dense, moist, greenish gray (GLE Y 5/1)
	80		

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: RM
Prepared By: LH/APR/YN
Checked By:

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

BORING E-133 (Continued)

DATE DRILLED: August 19, 2011
EQUIPMENT USED: Kehoe CPT Direct Push Rig
HOLE DIAMETER (in.): 2
ELEVATION: 271 feet *

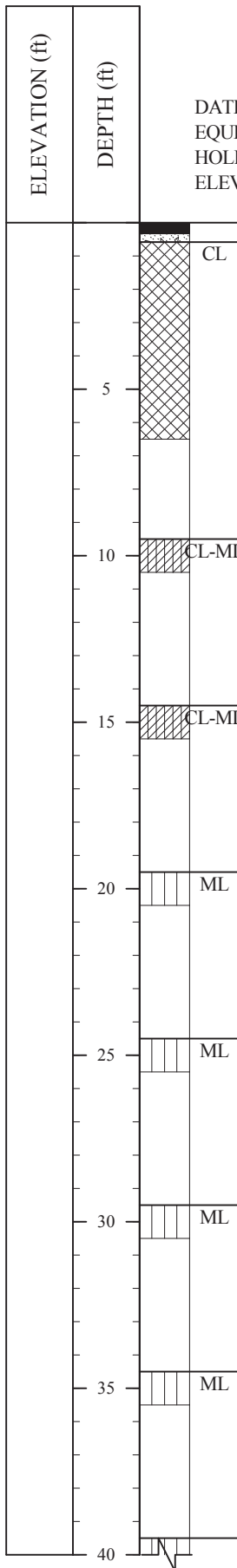
ELEVATION (ft)	DEPTH (ft)		
		SP	POORLY GRADED SAND - dense, moist, greenish gray (GLEY 5/1), trace gravel
	85	SP	POORLY GRADED SAND - very dense, moist, greenish gray (GLEY 5/1), trace gravel
	90	SM	SILTY SAND - very dense, moist, dark greenish gray (GLEY 3/1), fine-grained
			END OF BORING AT 90 FEET
			NOTES: Hand augered to 5 feet bgs to avoid damage to utilities. Ground-water sample collected at the shallowest depth of 27 feet below the ground surface. Borehole grouted with cement-bentonite slurry and patched with quick setting concrete.
	95		
	100		
	105		
	110		
	115		
	120		

Field Tech: RM
Prepared By: LH/APR/YN
Checked By:

BORING E-134

DATE DRILLED: 9/6/2011 and 9/22/2011
EQUIPMENT USED: Kehoe CPT Direct Push and HSA Rigs
HOLE DIAMETER (in.): 2 and 8
ELEVATION: 277 feet *

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.



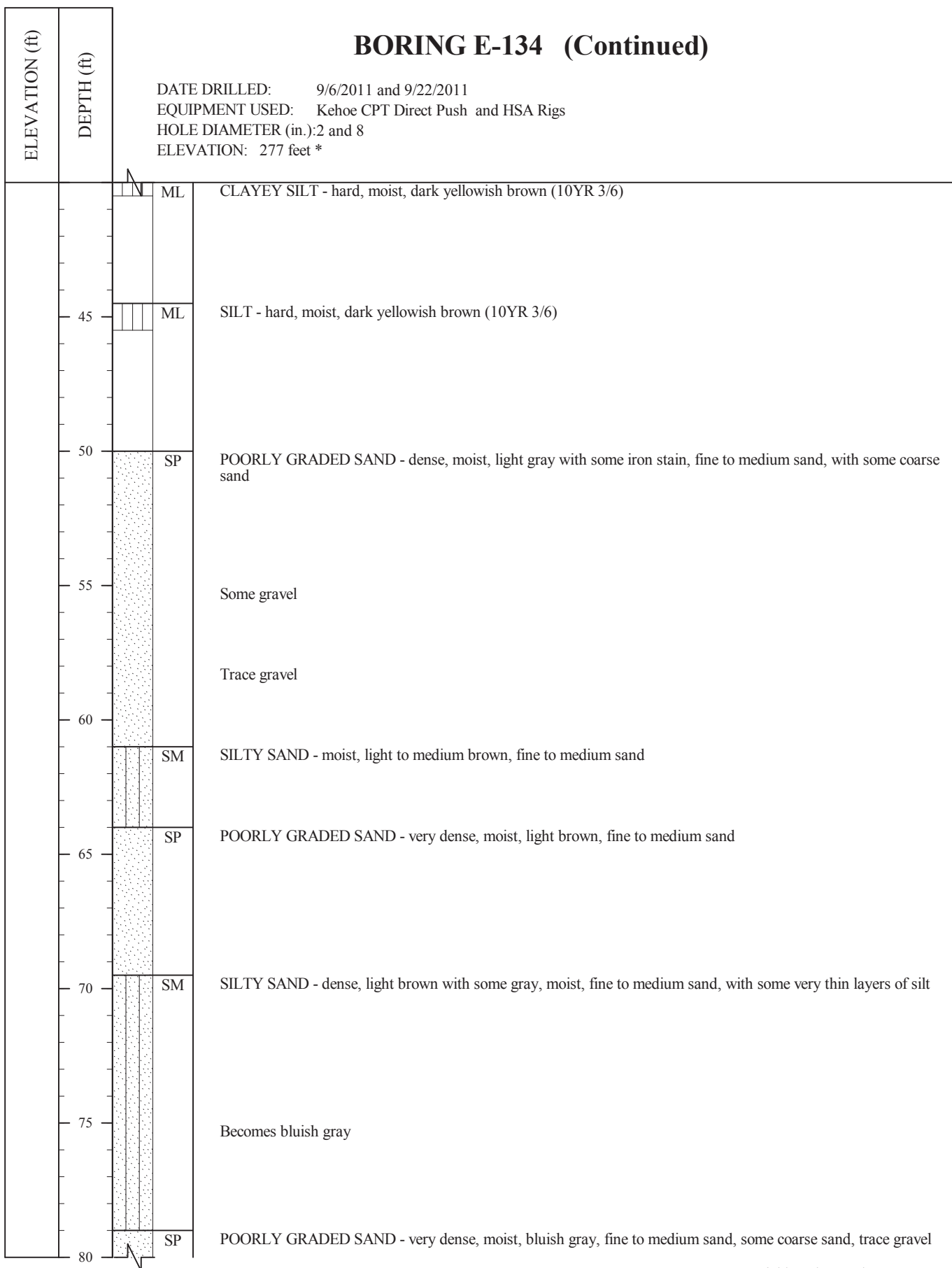
(CONTINUED ON FOLLOWING FIGURE)

Field Tech: PK/AR
Prepared By: LH/APR/YN
Checked By:

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

BORING E-134 (Continued)

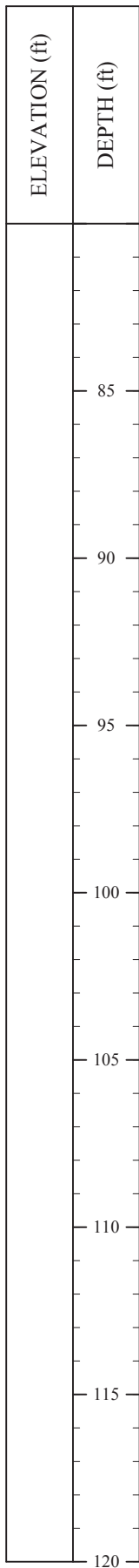
DATE DRILLED: 9/6/2011 and 9/22/2011
EQUIPMENT USED: Kehoe CPT Direct Push and HSA Rigs
HOLE DIAMETER (in.): 2 and 8
ELEVATION: 277 feet *



(CONTINUED ON FOLLOWING FIGURE)

Field Tech: PK/AR
Prepared By: LH/APR/YN
Checked By:

THIS RECORD IS A REASONABLE INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.



BORING E-134 (Continued)

DATE DRILLED: 9/6/2011 and 9/22/2011
EQUIPMENT USED: Kehoe CPT Direct Push and HSA Rigs
HOLE DIAMETER (in.): 2 and 8
ELEVATION: 277 feet *

Thin layer of Silty Sand



END OF BORING AT 91½ FEET

NOTES:

Hand augered to 6½ feet bgs to avoid damage to utilities.
Ground-water sample collected at the shallowest depth of 85 feet below the ground surface.
Borehole grouted with cement-bentonite slurry and patched with quick setting concrete.

Field Tech: PK/AR
Prepared By: LH/APR/YN
Checked By:

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS	DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
										DRILLING METHOD	BOREHOLE LOCATION	E-132B
										Hollow-Stem Auger	Sta 706+23, Lt 19 feet	
										DATES DRILLED	HOLE DIAMETER	GROUND EL.
										3/12/2015 & 3/13/2015	9"	283.3 feet
										GROUNDWATER READINGS		
										Groundwater encountered at 97.1' during initial drilling and at 97.2' the following day.		
										11.5-inch thick Asphalt Concrete over 4-inch Base Course		
										FILL [Af]		
										Sandy SILTY CLAY - brown, moist, fine to medium grained sand		
										QUATERNARY OLDER ALLUVIUM [Qalo]		
										Sandy LEAN CLAY - stiff to very stiff, moist, brown, fine to coarse grained sand, trace slate gravel (up to 3/4" in size)		
	5	27	0	10.1	-			☒				
	10		0	13.8	116	35	57	☒				
	15	11	0	18.7	-			☒				
	20		0	26.3	97^	17	85	☒				
	25	12	0	20.0	-			☒				
	30		0	16.4	113	31	64	☒				
	35	16	0.8	23.4	-			☒				
	40											

Constellation Station

11.5-inch thick Asphalt Concrete over 4-inch Base Course

FILL [Af]
Sandy SILTY CLAY - brown, moist, fine to medium grained sand

QUATERNARY OLDER ALLUVIUM [Qalo]
Sandy LEAN CLAY - stiff to very stiff, moist, brown, fine to coarse grained sand, trace slate gravel (up to 3/4" in size)

trace gravel (5%), fragments of slate, minor shale from 1/4" to 2" in size
(LL=36, PI=23)

FAT CLAY with SAND - stiff to very stiff, moist, dark grayish brown, fine to medium grained sand seams, yellow brown

grades to FAT CLAY
(LL=53, PI=39)

LEAN CLAY with SAND - stiff, moist, olive brown, about 15% fine to medium grained sand

Sandy LEAN CLAY - very stiff, moist, mottled olive gray and yellow brown, fine to medium grained sand, trace to few gravel (up to 3/4" in size)
(LL=44, PI=31)

olive gray

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: AR
Prepared/Date: KC 5/26/2015
Checked/Date: FW/DLP/HP 5/29/2015

MTA Westside Subway Extension
Los Angeles, California

amec foster wheeler

LOG OF BORING
Project No.: 4953-11-1423 Figure: A-3.2.1a

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS	DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
										DRILLING METHOD	BOREHOLE LOCATION	E-132B (Continued)
										Hollow-Stem Auger	Sta 706+23, Lt 19 feet	
										DATES DRILLED	HOLE DIAMETER	GROUND EL.
										3/12/2015 & 3/13/2015	9"	283.3 feet
										GROUNDWATER READINGS		
										Groundwater encountered at 97.1' during initial drilling and at 97.2' the following day.		
				20.2	106	33		☒			trace fine grained sand	
	45	41	0.8					☒			ML	
	50		0.7	4.5	93	69	9	☒			SP-SM	
	55	77	0.8	4.1	-			☒				
	60		0	8.8	104	92/9"	12	☒			SP-SM	
	65	73	0.9	5.7	-			☒			SP-SM	
	70		0.4	15.9	102	71	24	☒			SM	
	75	44	0	14.6	-			☒				
	80											

Constellation Station

LAKEWOOD FORMATION [Qlw]
SILT - hard, moist, light gray, trace fine grained sand, with clay seams, calcium carbonate cement (strong reaction with HCl)

POORLY GRADED SAND with SILT - very dense, moist, pale yellow, fine to medium grained sand

light olive gray

coarse drilling from approximately 58' to 60' (potential gravel layer)

POORLY GRADED SAND with SILT and GRAVEL - very dense, moist, grayish yellow green, fine to coarse grained sand, fine to coarse gravel (up to 2" in size)

SAN PEDRO FORMATION [Qsp]
POORLY GRADED SAND with SILT - very dense, moist, pale olive, fine grained sand, trace mica

SILTY SAND - very dense, moist, grayish yellow green, predominantly fine grained sand, trace medium grained sand

olive gray to olive

(CONTINUED ON FOLLOWING FIGURE)

Field Tech: AR
Prepared/Date: KC 5/26/2015
Checked/Date: FW/DLP/HP 5/29/2015

MTA Westside Subway Extension
Los Angeles, California

amec foster wheeler

LOG OF BORING
Project No.: 4953-11-1423 Figure: A-3.2.1b

THIS RECORD IS AN INTERPRETATION OF SUBSURFACE CONDITIONS AT THE EXPLORATION LOCATION. LATITUDE AND LONGITUDE OF BORING LOCATION SHOWN ON LOGS ARE APPROXIMATE. SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND AT OTHER TIMES MAY DIFFER. INTERFACES BETWEEN STRATA ARE APPROXIMATE. TRANSITIONS BETWEEN STRATA MAY BE GRADUAL.

ELEVATION (ft)	DEPTH (ft)	"N" VALUE STD. PEN. TEST	OVA (ppm)**	MOISTURE CONTENT (% of dry wt.)	DRY DENSITY (pcf)	BLOW COUNT* (blows/ft)	PERCENT PASSING No. 200 SIEVE	SAMPLE LOC.	DOWNHOLE TESTS	DRILLING COMPANY/DRILLING EQUIPMENT		BORING NO.
										DRILLING METHOD	BOREHOLE LOCATION	E-132B (Continued)
										Hollow-Stem Auger	Sta 706+23, Lt 19 feet	
										DATES DRILLED	HOLE DIAMETER	GROUND EL.
										3/12/2015 & 3/13/2015	9"	283.3 feet
										GROUNDWATER READINGS		
										Groundwater encountered at 97.1' during initial drilling and at 97.2' the following day.		
			0.7	10.9	93	74	31	☒				
	85	50/6"	0.2	1.5	-			☒				
	195											
	90	75		1.3	-			☒				
	190											
	95			21.2	-	100/ 10"		☒				
	185											
	100	50/4"		-	-			☒				
	180											
	105											
	175											
	110											
	170											
	115											
	165											
	120											

SILTY SAND, fine grained sand, trace medium grains, dusky yellow green

SP

POORLY GRADED SAND - very dense, moist, olive gray to dark greenish gray, fine to medium grained sand, trace mica

SP

POORLY GRADED SAND with GRAVEL - very dense, moist, olive gray to dark greenish gray, fine grained sand, fine to coarse gravel comprised of rounded to subangular slate, granitic, and shale fragments (up to 1" in size)

wet

▽

(Sample not recovered)

END OF BORING AT 100.5 FEET

NOTES:

Hand augered upper 6 feet to avoid damage to utilities.

Borehole backfilled with 100-E-100 slurry. Pavement patched with rapidset concrete colored with black oxide.

"N" Value Standard Penetration Test: Number of blows required to drive the SPT sampler 18 inches using a 140 pound automatic hammer falling 30 inches

*Number of blows required to drive the Crandall Sampler 12 inches using a 140 pound hammer falling 30 inches

Hammer Energy Transfer Ratio (ERi) = 70% (Calibrated 04/09/2015)

**Photo Ionization Detector used for OVA readings

^Average dry density for sample when multiple density tests performed.

Field Tech: AR
Prepared/Date: KC 5/26/2015
Checked/Date: FW/DLP/HP 5/29/2015

MTA Westside Subway Extension
Los Angeles, California

amec foster wheeler

LOG OF BORING
Project No.: 4953-11-1423 Figure: A-3.2.1c

APPENDIX B MONITORING WELL DIAGRAMS

Appendix B

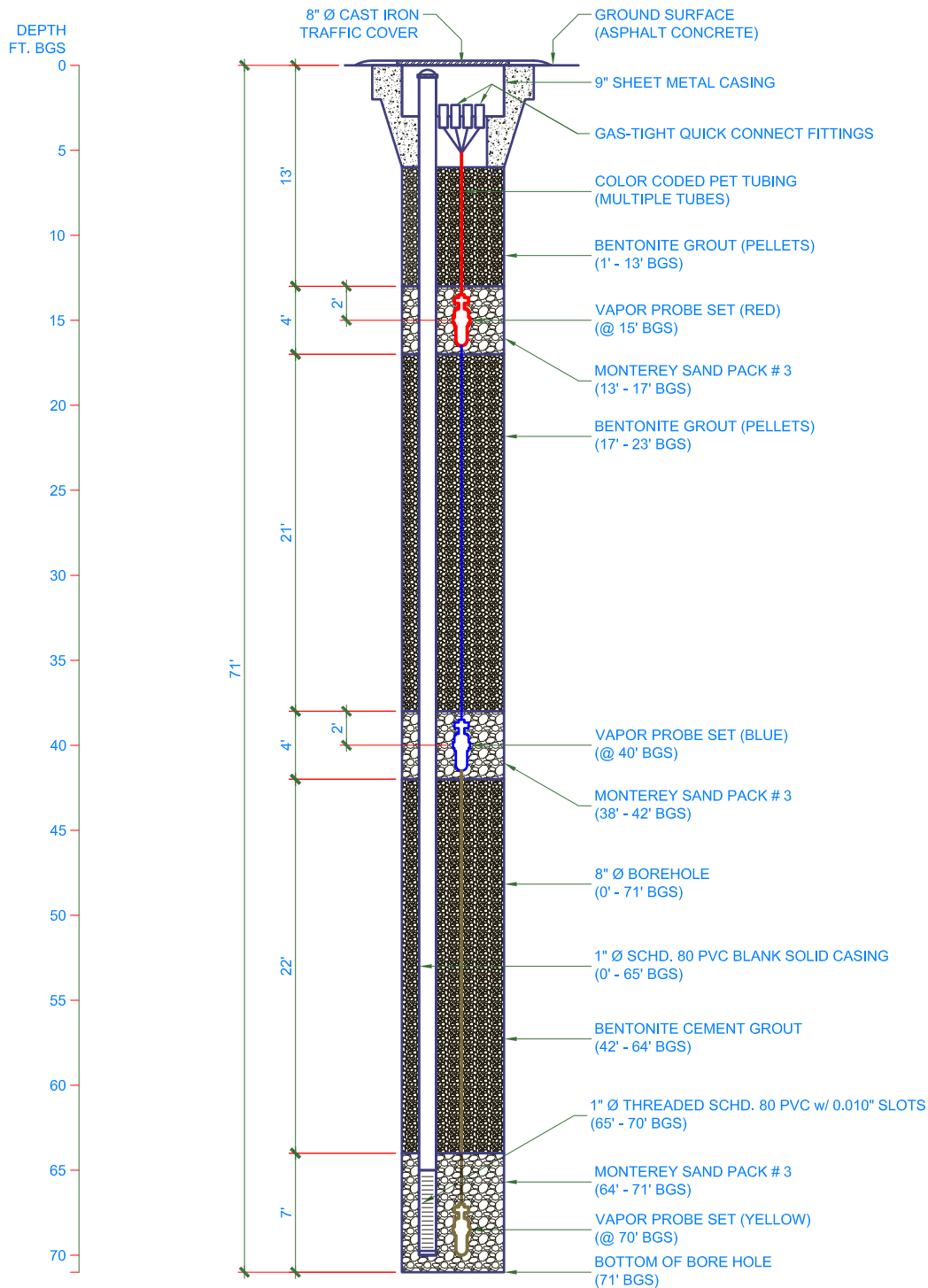
Figure B-1: Gas/Groundwater Monitoring Well Diagrams (ACE Phase)

Figure B-2: Gas/Groundwater Monitoring Well Diagrams (PE Phase)

Figure B-3: Gas/Groundwater Monitoring Well Diagrams (Adv. PE Phase)

BORING M-19 MONITORING WELL DETAIL

METHANE



Vertical Scale: 1" = 10'-0"
Horizontal Scale Exaggerated

Key

BGS	Below Ground Surface
TOC	Top Of Casing
'	Feet
"	Inches



AMEC Environment & Infrastructure
5628 E. Slauson Avenue, Los Angeles, California 90040
Phone (323) 889-5300 Fax (323) 889-5398

WELL NO.:	M-19	DRAWN:	L. Morley
INSTALLED:	06/09/2009	CHKD:	Jag
SCALE:	1" = 10' Vertical	DATE:	December 2, 2011
DRILL CO.:	Cascade Drilling	TECHNIQUE:	Hollow Stem
FIELD PERSONNEL:	Paul Kane		
PROJECT NAME:	MTA Westside Subway Extension		
WELL LOCATION:	Avenue of the Stars & Constellation		

MTA WESTSIDE SUBWAY EXTENSION
Parsons Brinckerhoff

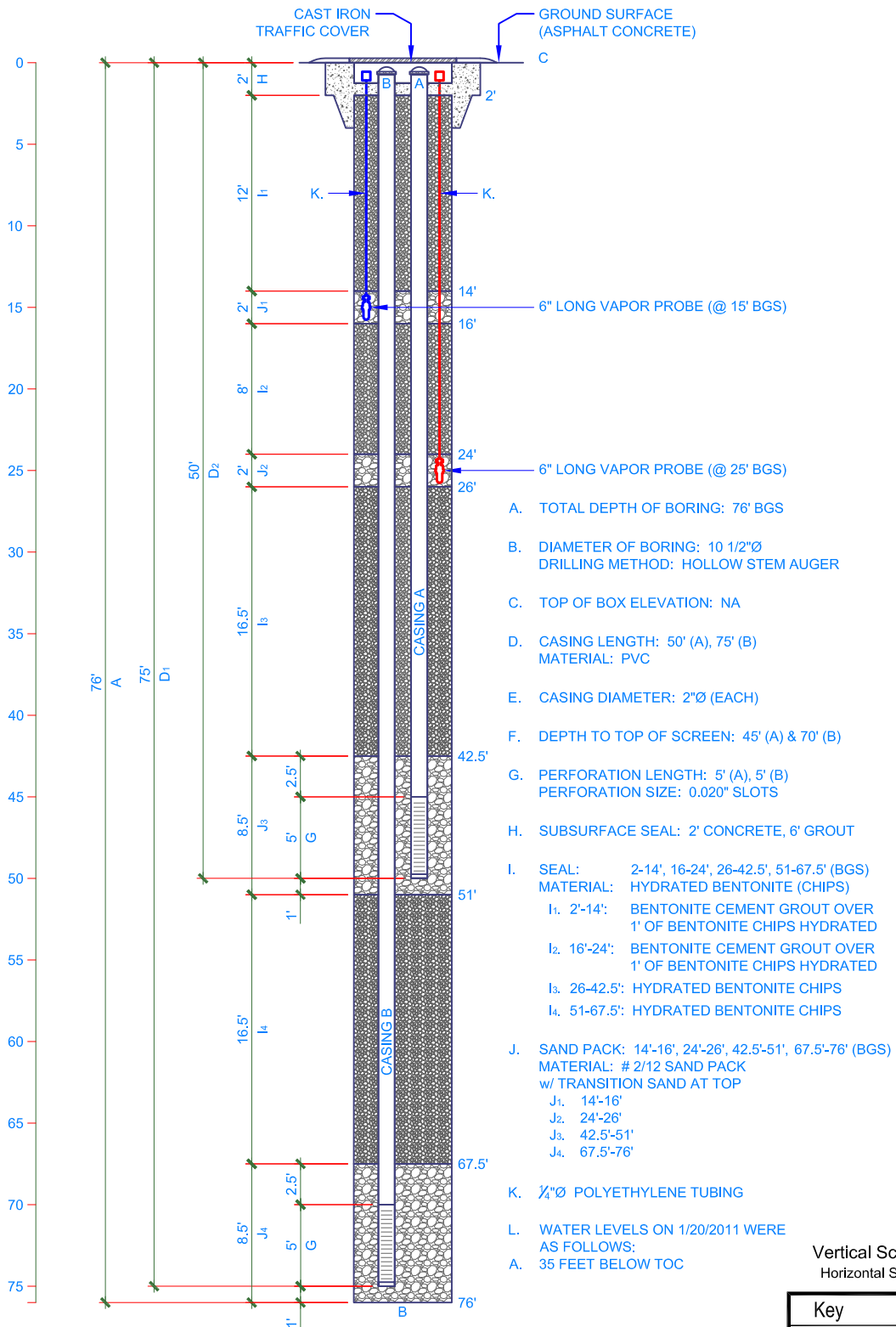
WELL CONSTRUCTION
DETAIL
Methane Gas Monitoring Well

FIGURE NO.

B-1

PROJECT NO.
4953-11-1421

METHANE VAPOR MONITORING WELL M-119



Vertical Scale: 1" = 10'-0"
Horizontal Scale Exaggerated

Key	
BGS	Below Ground Surface
TOC	Top Of Casing
'	Feet
"	Inches



AMEC Environment & Infrastructure
5628 E. Slauson Avenue, Los Angeles, California 90040
Phone (323) 889-5300 Fax (323) 889-5398

WELL NO.:	M-119	DRAWN:	L. Morley
INSTALLED:	01/20/2011	CHKD:	J. Neuhaus
SCALE:	1" = 10' Vertical	DATE:	December 2, 2011
DRILL CO.:	Jet Drilling	TECHNIQUE:	Hollow Stem
FIELD PERSONNEL:	Rachel Mills		
PROJECT NAME:	MTA Westside Subway Extension		
WELL LOCATION:	Wilshire W of Century Park, Los Angeles, CA		

MTA WESTSIDE EXTENSION
Parsons Brinckerhoff

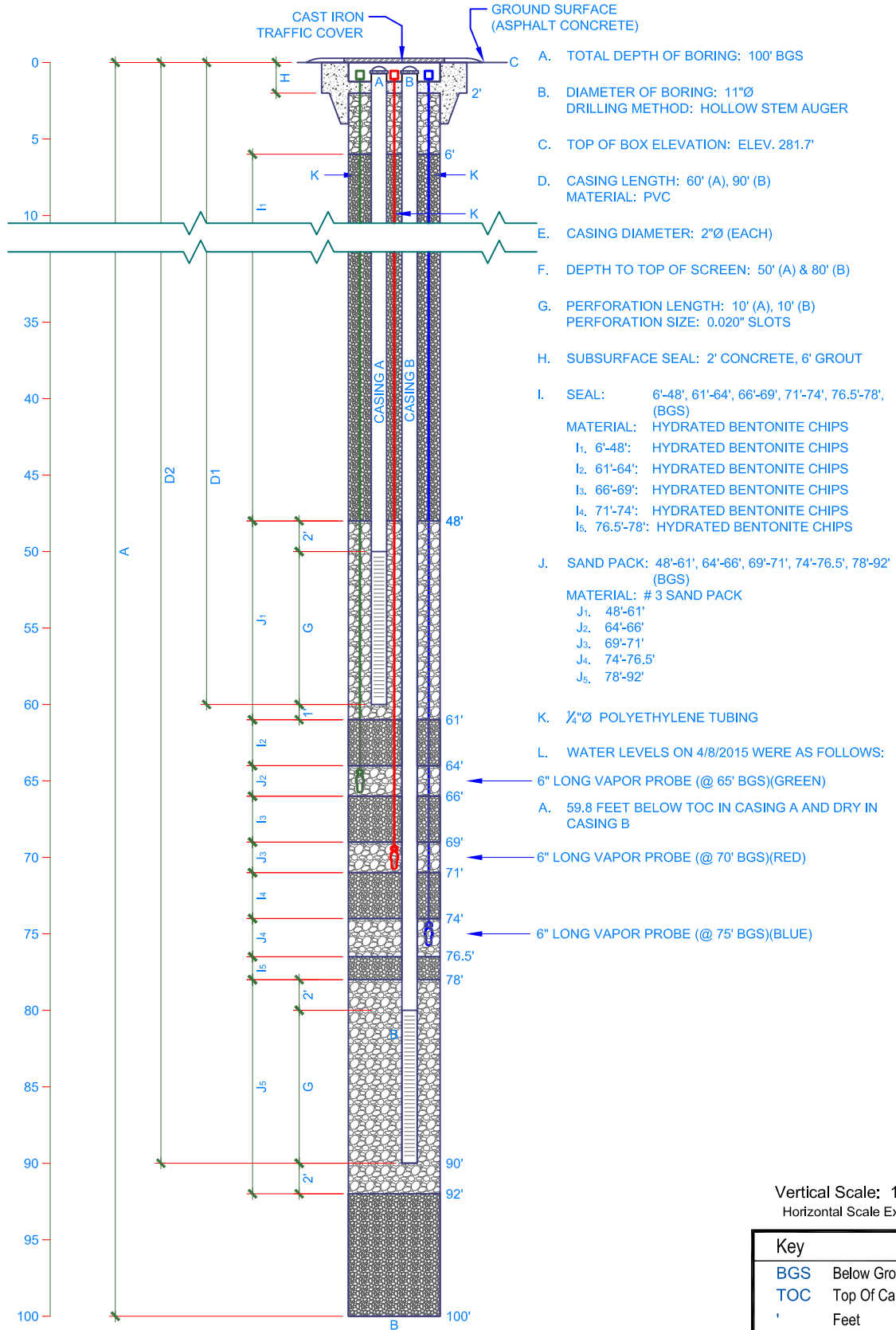
WELL CONSTRUCTION
DETAIL
Methane Gas Monitoring Well

FIGURE NO.

B-2

PROJECT NO.
4953-11-1421

SOIL GAS/GROUND WATER MONITORING WELL M-407



Vertical Scale: 1" = 10'-0"
Horizontal Scale Exaggerated

Key	
BGS	Below Ground Surface
TOC	Top Of Casing
'	Feet
"	Inches

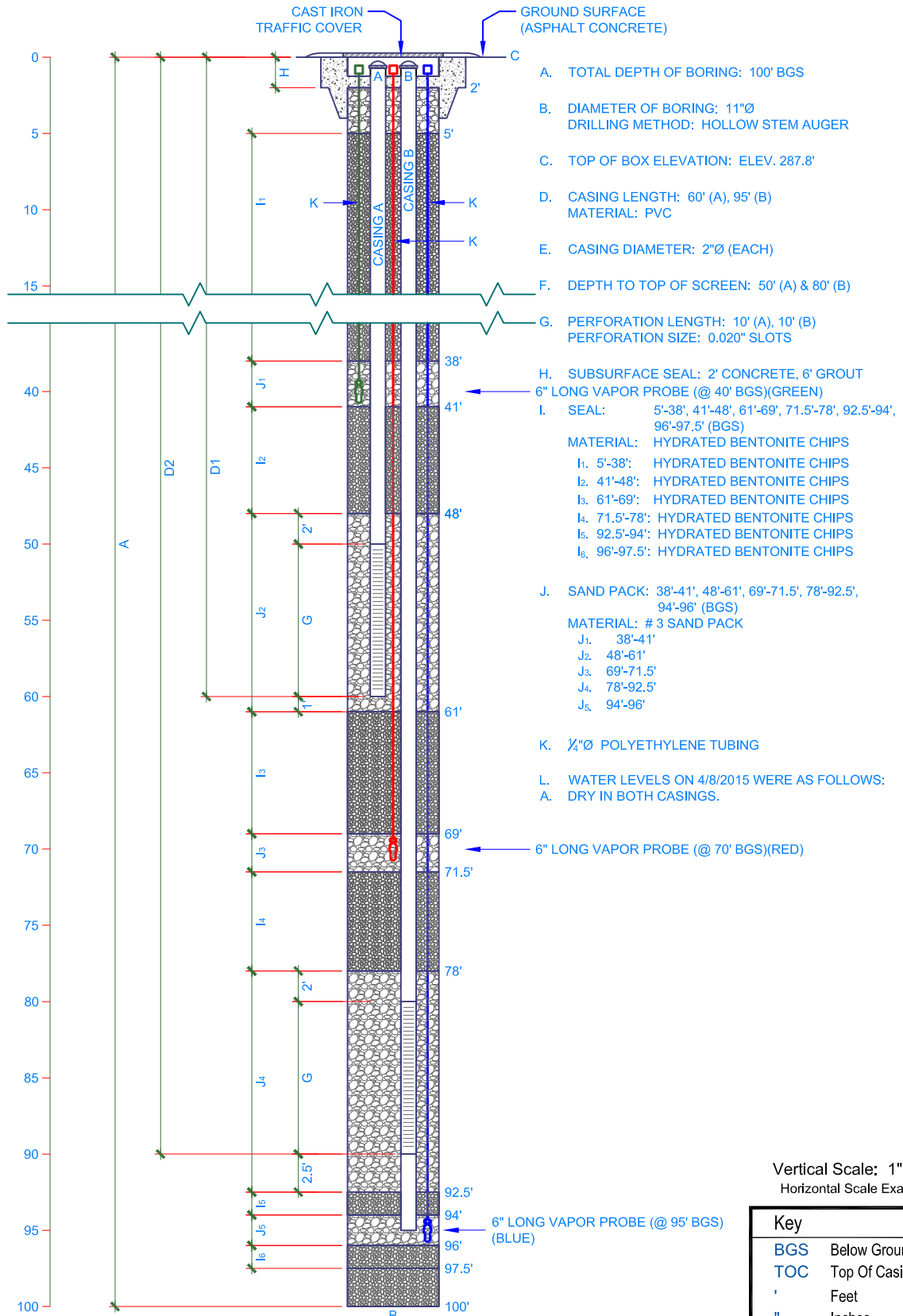
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Date: May 07, 2015 - 1:12pm By: ogouflier



WELL NO.:	M-407	PREPARED BY:	KO/KC
INSTALLED:	03/11/2015	CHKD:	F. WANG
SCALE:	1" = 10' vertical	DATE:	May 6, 2015
DRILL CO.:	Martini Drilling	TECHNIQUE:	Hollow Stem
FIELD PERSONNEL:	Ron Lopez/Angel Recio		
PROJECT NAME:	MTA Westside Subway Extension		
WELL LOCATION:	Constellation Blvd and Century Park East		

MTA WESTSIDE EXTENSION Parsons Brinckerhoff	
WELL CONSTRUCTION DETAIL Soil Gas/Ground Water Monitoring Well	
WELL NO.	B-3.1
PROJECT NO.	4953-11-1423

SOIL GAS/GROUND WATER MONITORING WELL M-408



Vertical Scale: 1" = 10'-0"
 Horizontal Scale Exaggerated

Key	
BGS	Below Ground Surface
TOC	Top Of Casing
'	Feet
"	Inches

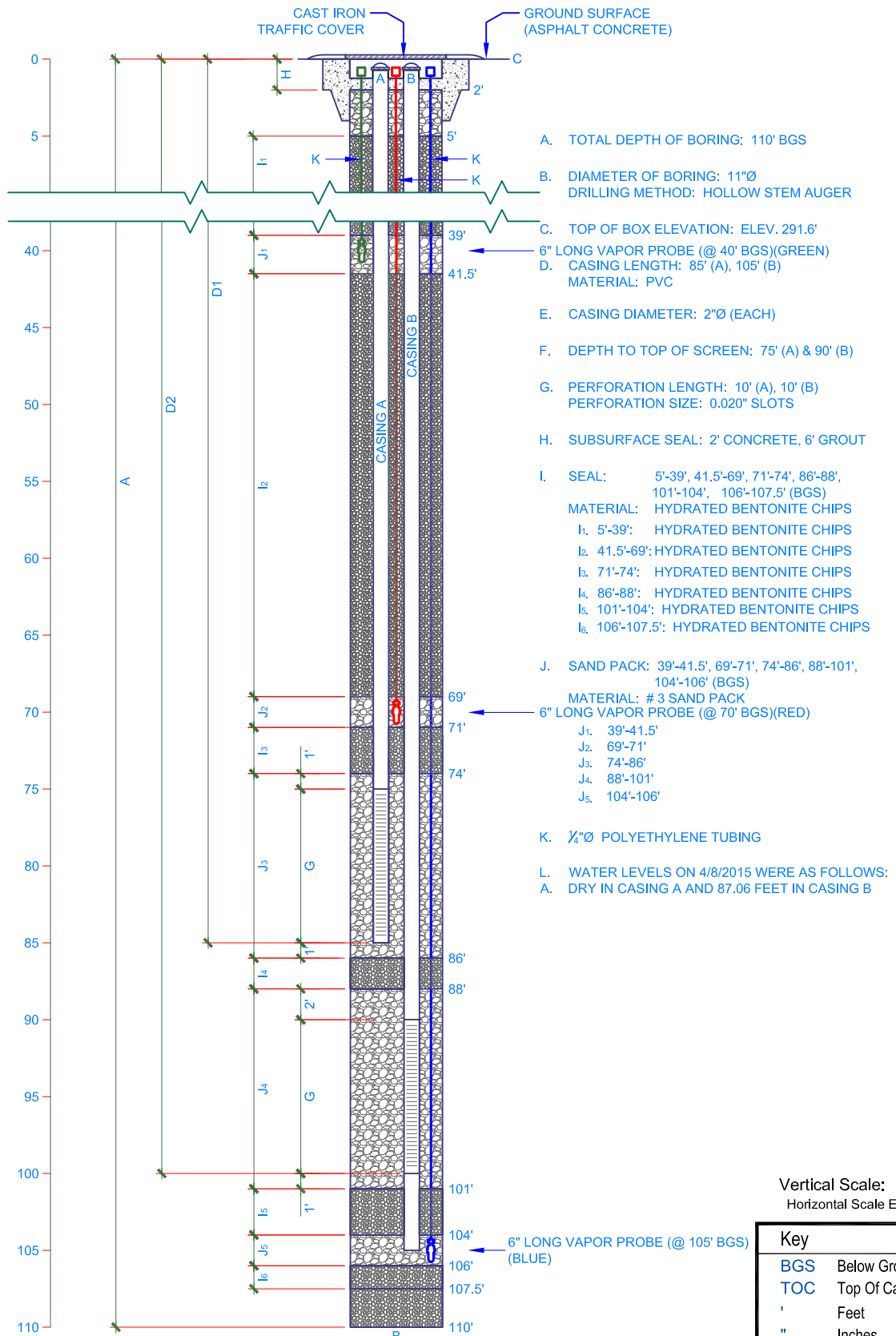
Path: S:\ACAD\2015-105 WSE Purple Line\Well Diagram\4953-11-1423_PEL\Well M-408.dwg [M-408]
 Date: May 07, 2015 - 1:13pm By: ogouflier



WELL NO.:	M-408	PREPARED BY:	KO/KC
INSTALLED:	03/23/2015	CHKD:	F. WANG
SCALE:	1" = 10' Vertical	DATE:	May 6, 2015
DRILL CO.:	Martini Drilling	TECHNIQUE:	Hollow Stem
FIELD PERSONNEL:	Ron Lopez/Angel Recio		
PROJECT NAME:	MTA Westside Subway Extension		
WELL LOCATION:	Constellation Blvd between Avenue of the Stars and Century Park East		

MTA WESTSIDE EXTENSION Parsons Brinckerhoff	
WELL CONSTRUCTION DETAIL Soil Gas/Ground Water Monitoring Well	
WELL NO.	B-3.2
PROJECT NO.	4953-11-1423

SOIL GAS/GROUND WATER MONITORING WELL M-409



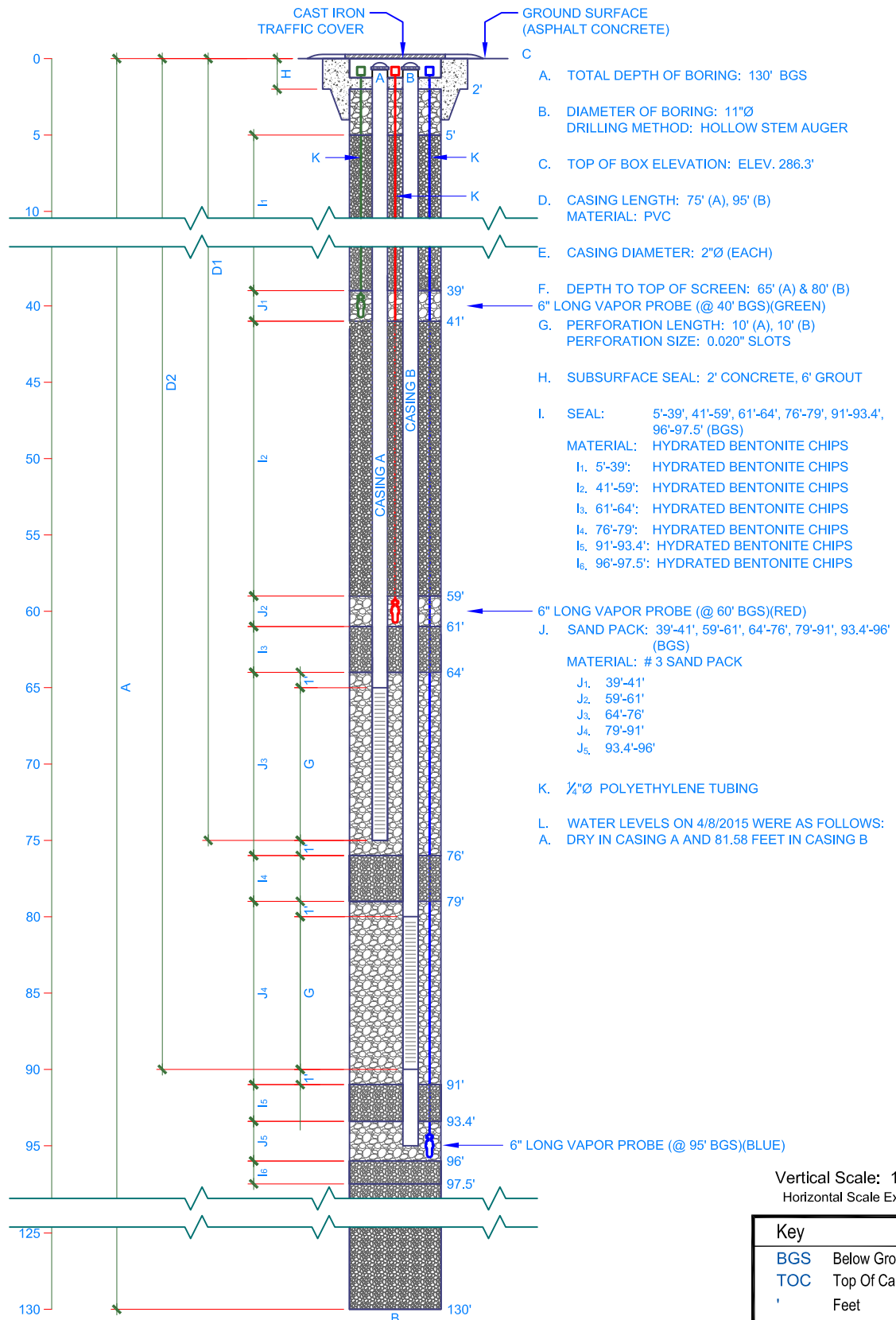
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Date: May 12, 2015 - 8:26am By: ogoutlier



WELL NO.:	M-409	PREPARED BY:	KO/KC
INSTALLED:	03/18/2015	CHKD:	F. WANG
SCALE:	1" = 10' Vertical	DATE:	May 6, 2015
DRILL CO.:	Martini Drilling	TECHNIQUE:	Hollow Stem
FIELD PERSONNEL:	Ron Lopez/Angel Recio		
PROJECT NAME:	MTA Westside Subway Extension		
WELL LOCATION:	Constellation Blvd and West of Avenue of the Stars		

MTA WESTSIDE EXTENSION Parsons Brinckerhoff	
WELL CONSTRUCTION DETAIL Soil Gas/Ground Water Monitoring Well	WELL NO. B-3.3 PROJECT NO. 4953-11-1423

SOIL GAS/GROUND WATER MONITORING WELL M-410



Vertical Scale: 1" = 10'-0"
Horizontal Scale Exaggerated

Key	
BGS	Below Ground Surface
TOC	Top Of Casing
'	Feet
"	Inches

Path: S:\ACAD\2015-105 WSE Purple Line\WellDiagram\4953-11-1423_PEL\WellM(2015.02.05).dwg [M-410]
Date: May 12, 2015 - 8:28am By: ogoutlier



WELL NO.:	M-410	PREPARED BY:	KO/KC
INSTALLED:	03/27/2015	CHKD:	F. WANG
SCALE:	1" = 10' Vertical	DATE:	May 6, 2015
DRILL CO.:	Martini Drilling	TECHNIQUE:	Hollow Stem
FIELD PERSONNEL:	Ron Lopez/Angel Recio		
PROJECT NAME:	MTA Westside Subway Extension		
WELL LOCATION:	Constellation Blvd between Avenue of the Stars and Solar Way (MGM Drive)		

MTA WESTSIDE EXTENSION Parsons Brinckerhoff	
WELL CONSTRUCTION DETAIL Soil Gas/Ground Water Monitoring Well	WELL NO. B-3.4 PROJECT NO. 4953-11-1423

APPENDIX C CONE PENETRATION TEST RESULTS

Appendix C

Figure C-1: Cone Penetration Test Results (PE Phase)

Figure C-2: Suspension Logging Test Results (Adv. PE Phase)



CPT Data

Job Number 04.0911-0016

CPT Number C-121

Location W. Subway Ext. Los Angeles-CA

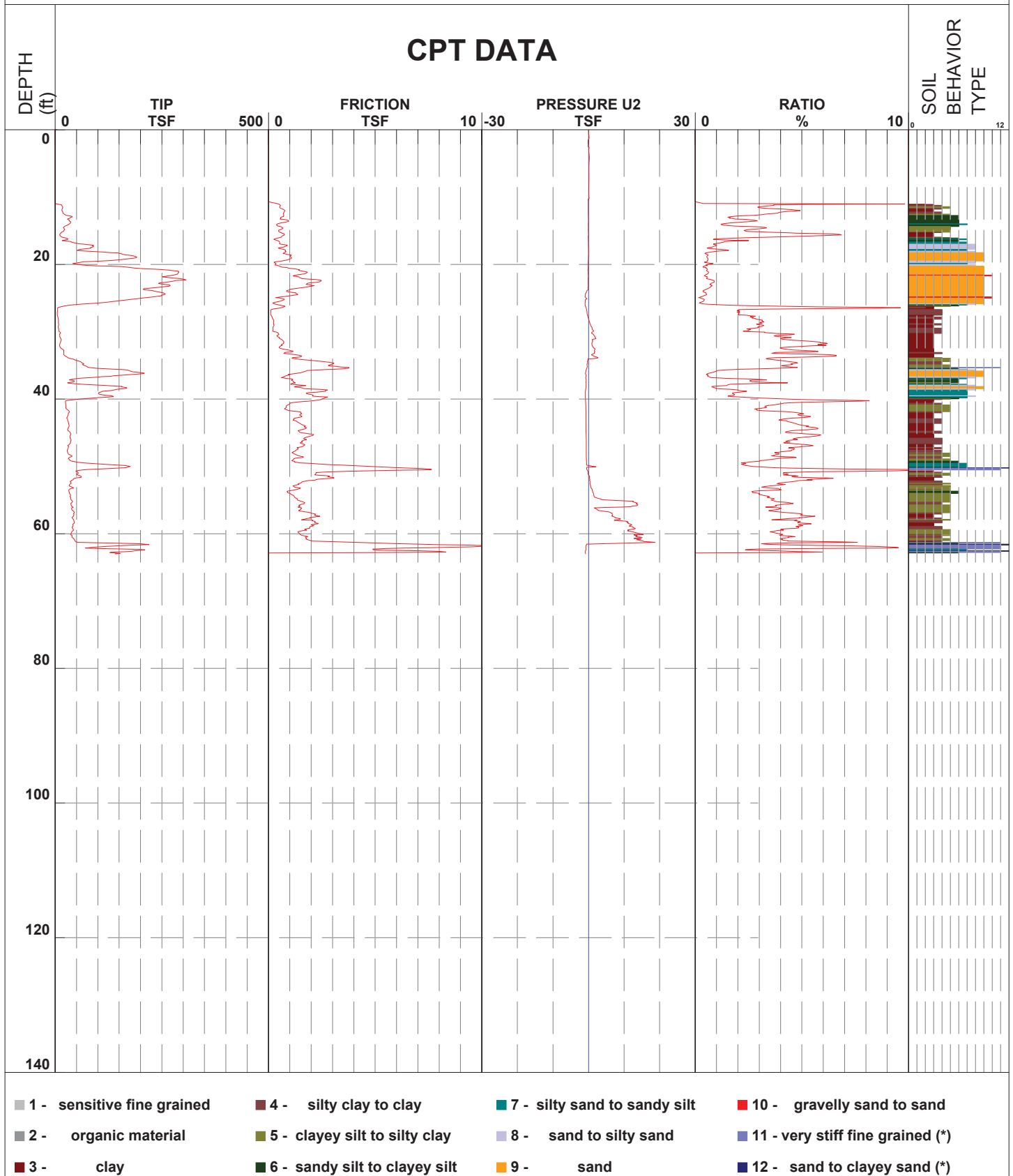
Operator Daniel Garza

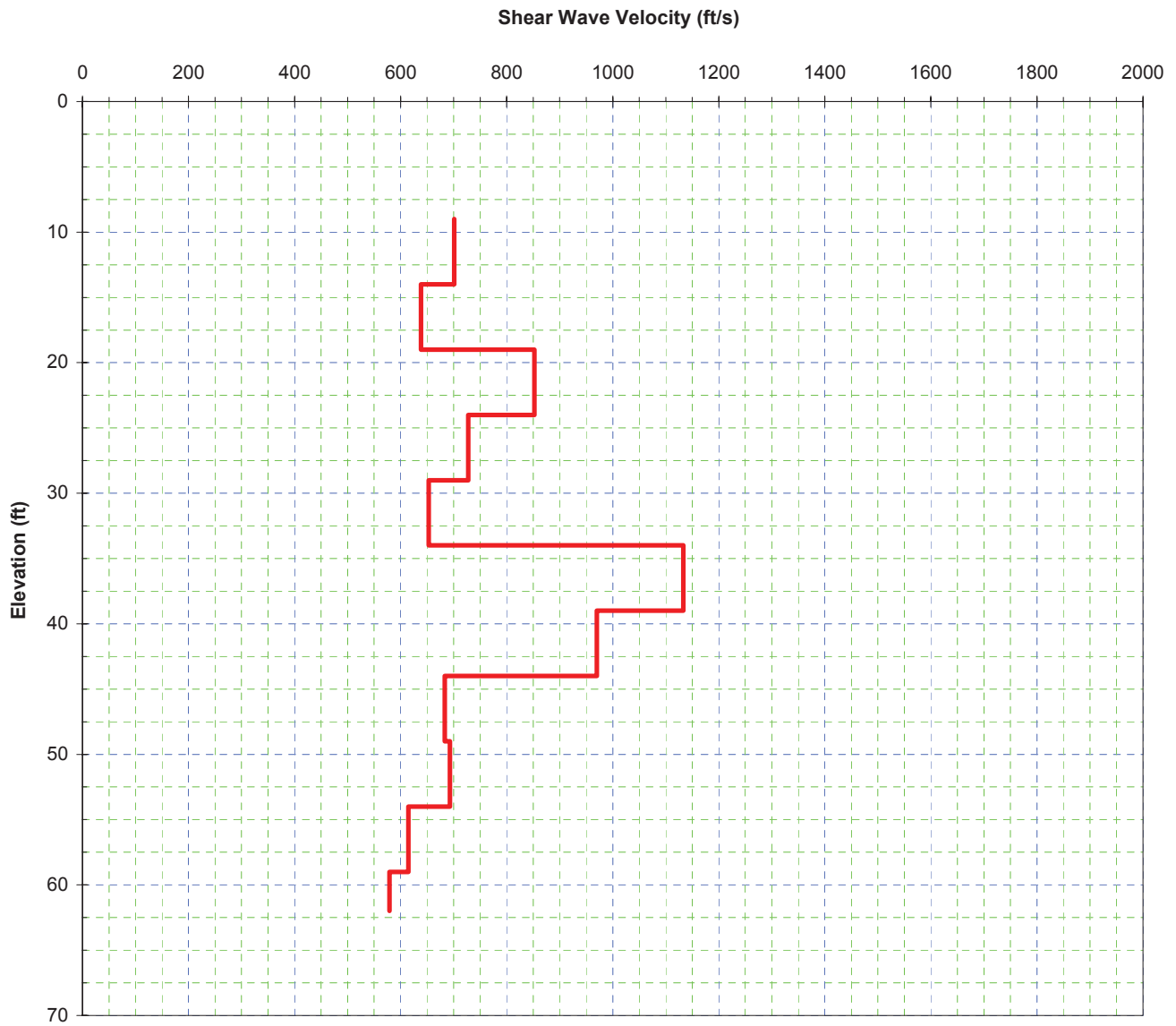
Date and Time 28-Jun-2011 09:55:45

Cone Number F7.5CKE2HA3S1645

Client MACTEC

Hand augered 6'





SEISMIC CONE PENETRATION TEST RESULTS - C-121
Wilshire Blvd.
MACTEC



**WESTSIDE METRO EXTENSION PHASE II
WEST LOS ANGELES
SUSPENSION PS VELOCITIES
BORING G-413 & G-415**

**April 30, 2015
Report 15056-01 rev 0**

**WESTSIDE METRO EXTENSION PHASE II
WEST LOS ANGELES
SUSPENSION PS VELOCITIES
BORING G-413 & G-415**

Prepared for

**AMEC Foster Wheeler
6001 Rickenbacker Rd
Los Angeles, California 90040
(323) 889-5300**

Prepared by

**GEO*Vision* Geophysical Services
1124 Olympic Drive
Corona, California 92881
(951) 549-1234
Project 15056**

**April 30, 2015
Report 15056-01 rev 0**

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APPENDICES

APPENDIX A SUSPENSION VELOCITY MEASUREMENT QUALITY ASSURANCE SUSPENSION SOURCE TO RECEIVER ANALYSIS RESULTS

APPENDIX B GEOPHYSICAL LOGGING SYSTEMS - NIST TRACEABLE CALIBRATION RECORDS

INTRODUCTION

Suspension PS velocity measurements were collected in two borings at Constellation Boulevard and Avenue of the Stars in west Los Angeles, California. Data acquisition was performed on April 1st, 2015 by Glenn Gloss and April 7th, 2015 by Emily Feldman of **GEOVision**. Data analysis and report preparation were performed by Emily Feldman and Jonathan Jordan, respectively, and reviewed by John Diehl of **GEOVision**. The work was performed for AMEC Foster Wheeler (AMEC) with Angel Recio serving as the point of contact.

This report describes the field measurements, data analysis, and results of this work.

SCOPE OF WORK

This report presents the results of boring geophysical measurements collected on April 1th, 2015 and April 7th, 2015 as detailed in Table 1. The purpose of this study was to supplement stratigraphic information obtained during AMEC's geotechnical sampling program and to acquire shear wave velocities and compressional wave velocities as a function of depth.

The OYO Suspension PS Logging System (Suspension System) was used to obtain in-situ horizontal shear (S_H) and compressional (P) wave velocity measurements in one uncased boring at 1.6 foot intervals. Measurements followed **GEOVision** Procedure for P-S Suspension Seismic Velocity Logging, revision 1.5. The acquired data was analyzed and a profile of velocity versus depth was produced for both compressional and horizontally polarized shear waves.

A detailed reference for the suspension PS velocity measurement techniques used in this study is:

Guidelines for Determining Design Basis Ground Motions, Report TR-102293,
Electric Power Research Institute, Palo Alto, California, November 1993, Sections
7 and 8.

INSTRUMENTATION

Suspension Velocity Instrumentation

Suspension velocity measurements were performed using the suspension PS logging system, manufactured by OYO Corporation, and their subsidiary, Robertson Geologging. This system directly determines the average velocity of a 3.3-foot high segment of the soil column surrounding the boring of interest by measuring the elapsed time between arrivals of a wave propagating upward through the soil column. The receivers that detect the wave, and the source that generates the wave, are moved as a unit in the boring producing relatively constant amplitude signals at all depths.

The suspension system probe consists of a combined reversible polarity solenoid horizontal shear-wave source (S_H) and compressional-wave source (P), joined to two biaxial receivers by a flexible isolation cylinder, as shown in Figure 1. The separation of the two receivers is 3.3 feet, allowing average wave velocity in the region between the receivers to be determined by inversion of the wave travel time between the two receivers. The total length of the probe as used in these surveys is approximately 22 feet, with the center point of the receiver pair 12.5 feet above the bottom end of the probe.

The probe receives control signals from, and sends the digitized receiver signals to, instrumentation on the surface via an armored conductor cable. The cable is wound onto the drum of a winch and is used to support the probe. Cable travel is measured to provide probe depth data using a sheave of known circumference fitted with a digital rotary encoder.

The entire probe is suspended in the boring by the cable, therefore, source motion is not coupled directly to the boring walls; rather, the source motion creates a horizontally propagating impulsive pressure wave in the fluid filling the boring and surrounding the source. This pressure wave is converted to P and S_H -waves in the surrounding soil and rock as it passes through the casing and grout annulus and impinges upon the wall of the boring. These waves propagate through the soil

and rock surrounding the boring, in turn causing a pressure wave to be generated in the fluid surrounding the receivers as the soil waves pass their location. Separation of the P and S_H-waves at the receivers is performed using the following steps:

1. Orientation of the horizontal receivers is maintained parallel to the axis of the source, maximizing the amplitude of the recorded S_H -wave signals.
2. At each depth, S_H-wave signals are recorded with the source actuated in opposite directions, producing S_H-wave signals of opposite polarity, providing a characteristic S_H-wave signature distinct from the P-wave signal.
3. The 6.3 foot separation of source and receiver 1 permits the P-wave signal to pass and damp significantly before the slower S_H-wave signal arrives at the receiver.
4. In saturated soils, the received P-wave signal is typically of much higher frequency than the received S_H-wave signal, permitting additional separation of the two signals by low pass filtering.
5. Direct arrival of the original pressure pulse in the fluid is not detected at the receivers because the wavelength of the pressure pulse in fluid is significantly greater than the dimension of the fluid annulus surrounding the probe (feet versus inches scale), preventing significant energy transmission through the fluid medium.

In operation, a distinct, repeatable pattern of impulses is generated at each depth as follows:

1. The source is fired in one direction producing dominantly horizontal shear with some vertical compression, and the signals from the horizontal receivers situated parallel to the axis of motion of the source are recorded.
2. The source is fired again in the opposite direction and the horizontal receiver signals are recorded.
3. The source is fired again and the vertical receiver signals are recorded. The repeated source pattern facilitates the picking of the P and S_H-wave arrivals; reversal of the source changes the polarity of the S_H-wave pattern but not the P-wave pattern.

The data from each receiver during each source activation is recorded as a different channel on the recording system. The Suspension PS system has six channels (two simultaneous recording channels), each with a 1024 sample record. The recorded data are displayed as six channels with a common time scale. Data are stored on disk for further processing.

Review of the displayed data on the recorder or computer screen allows the operator to set the gains, filters, delay time, pulse length (energy), and sample rate to optimize the quality of the data before recording. Verification of the calibration of the Suspension PS digital recorder is performed every twelve months using a NIST traceable frequency source and counter, as presented in Appendix B.

MEASUREMENT PROCEDURES

Suspension Velocity Measurement Procedures

Borings G-413 and G-415 were logged, uncased and filled with freshwater mud. Measurements followed the **GEOVision** Procedure for P-S Suspension Seismic Velocity Logging, revision 1.5. Prior to each logging run, the probe was positioned with the top of the probe even with a stationary reference point. The electronic depth counter was set to the distance between the mid-point of the receiver and the top of the probe, minus the height of the stationary reference point, if any, verified with a tape measure, and recorded on the field logs. The probe was lowered to the bottom of the borings, stopping at 1.6 foot intervals to collect data, as summarized in Table 2.

At each measurement depth the measurement sequence of two opposite horizontal records and one vertical record was performed, and the gains were adjusted as required. The data from each depth were viewed on the computer display, checked, and recorded on disk before moving to the next depth.

Upon completion of the measurements, the probe zero depth indication at the depth reference point was verified prior to removal from the boring.

DATA ANALYSIS

Suspension Velocity Analysis

Using the proprietary OYO program PSLOG.EXE version 1.0, the recorded digital waveforms were analyzed to locate the most prominent first minima, first maxima, or first break on the vertical axis records, indicating the arrival of P-wave energy. The difference in travel time between receiver 1 and receiver 2 (R1-R2) arrivals was used to calculate the P-wave velocity for that 1.0 meter segment of the soil column. When observable, P-wave arrivals on the horizontal axis records were used to verify the velocities determined from the vertical axis data. The time picks were then transferred into a Microsoft Excel® template (version 2003 SP2) to complete the velocity calculations based upon the arrival time picks made in PSLOG. The Microsoft Excel® analysis files are included on the data disk that accompanies this report.

The P-wave velocity over the 6.3-foot interval from source to receiver 1 (S-R1) was also picked using PSLOG, and calculated and plotted in Microsoft Excel®, for quality assurance of the velocity derived from the travel time between receivers. In this analysis, the depth values as recorded were increased by 4.8 feet to correspond to the mid-point of the 6.3-foot S-R1 interval. Travel times were obtained by picking the first break of the P-wave signal at receiver 1 and subtracting 0.4 milliseconds, the calculated and experimentally verified delay from source trigger pulse (beginning of record) to source impact. This delay corresponds to the duration of acceleration of the solenoid before impact.

As with the P-wave records, the recorded digital waveforms were analyzed to locate clear S_H-wave pulses, as indicated by the presence of opposite polarity pulses on each pair of horizontal records. Ideally, the S_H-wave signals from the 'normal' and 'reverse' source pulses are very nearly inverted images of each other. Digital Fast Fourier Transform – Inverse Fast Fourier Transform (FFT – IFFT) lowpass filtering was used to remove the higher frequency P-wave signal from the S_H-wave signal. Different filter cutoffs were used to separate P- and S_H-waves at different depths, ranging from 600 Hz in the slowest zones to 4000 Hz in the regions of highest velocity. At each depth, the

filter frequency was selected to be at least twice the fundamental frequency of the S_H -wave signal being filtered.

Generally, the first maxima were picked for the 'normal' signals and the first minima for the 'reverse' signals, although other points on the waveform were used if the first pulse was distorted. The absolute arrival time of the 'normal' and 'reverse' signals may vary by ± 0.2 milliseconds, due to differences in the actuation time of the solenoid source caused by constant mechanical bias in the source or by boring inclination. This variation does not affect the R1-R2 velocity determinations, as the differential time is measured between arrivals of waves created by the same source actuation. The final velocity value is the average of the values obtained from the 'normal' and 'reverse' source actuations.

As with the P-wave data, S_H -wave velocity calculated from the travel time over the 6.3-foot interval from source to receiver 1 was calculated and plotted for verification of the velocity derived from the travel time between receivers. In this analysis, the depth values were increased by 4.8 feet to correspond to the mid-point of the 6.3-foot S-R1 interval. Travel times were obtained by picking the first break of the S_H -wave signal at the near receiver and subtracting 0.4 milliseconds, the calculated and experimentally verified delay from the beginning of the record at the source trigger pulse to source impact.

These data and analysis were reviewed by John Diehl as a component of **GEOVision's** in-house data validation program.

Figure 2 shows an example of R1 - R2 measurements on a sample filtered suspension record. In Figure 2, the time difference over the 3.3 foot interval of 1.88 milliseconds for the horizontal signals is equivalent to an S_H -wave velocity of 1745 feet/second. Whenever possible, time differences were determined from several phase points on the S_H -waveform records to verify the data obtained from the first arrival of the S_H -wave pulse. Figure 3 displays the same record before filtering of the S_H -waveform record with a 1400 Hz FFT - IFFT digital lowpass filter, illustrating

the presence of higher frequency P-wave energy at the beginning of the record, and distortion of the lower frequency S_H -wave by residual P-wave signal.

RESULTS

Suspension Velocity Results

Suspension R1-R2 P- and S_H -wave velocities for Boring G-413 are plotted in Figure 4 and Boring G-415 are plotted in Figure 5. The suspension velocity data presented in this figure are also presented in Table 3 and Table 4, respectively. The Microsoft Excel[®] analysis file is included in the data directory that accompanies this report.

P- and S_H -wave velocity data from R1-R2 analysis and quality assurance analysis of S-R1 data are plotted together in Figure A-1 to aid in visual comparison. It should be noted that R1-R2 data are an average velocity over a 3.3-foot segment of the soil column; S-R1 data are an average over 6.3 feet, creating a significant smoothing relative to the R1-R2 plots. The S-R1 velocity data displayed in this figure are also presented in Table A-1 and included in the Microsoft Excel[®] analysis file available in the boring-specific subdirectory that accompanies this report. The Microsoft Excel[®] analysis file includes Poisson's Ratio calculations, tabulated data and plots.

SUMMARY

Discussion of Suspension Velocity Results

Suspension PS velocity data are ideally collected in an uncased fluid filled boring, drilled with rotary mud (rotary wash) methods, as were these borings.

Suspension PS velocity data quality is judged based upon 5 criteria:

	Criteria	Results for G-413 and G-415
1	Consistent data between receiver to receiver (R1 – R2) and source to receiver (S – R1) data.	Yes.
2	Consistency between data from adjacent depth intervals.	Yes
3	Consistent relationship between P-wave and S_H -wave (excluding transition to saturated soils)	Yes G-413: Saturated zone starts at approximately 150 ft. G-415: Saturated zone starts at 77ft, but there is a lack of saturation at 95ft
4	Clarity of P-wave and S_H -wave onset, as well as damping of later oscillations.	Very good
5	Consistency of profile between adjacent borings, if available.	Similar and consistent to approximately 77 feet, the apparent saturation depth in G-415

Quality Assurance

These borehole geophysical measurements were performed using industry-standard or better methods for measurements and analyses. All work was performed under **GEOVision** quality assurance procedures, which include:

- Use of NIST-traceable calibrations, where applicable, for field and laboratory instrumentation
- Use of standard field data logs
- Use of independent verification of velocity data by comparison of receiver-to-receiver and source-to-receiver velocities
- Independent review of calculations and results by a registered professional engineer, geologist, or geophysicist.

Suspension Velocity Data Reliability

P- and S_H-wave velocity measurement using the Suspension Method gives average velocities over a 3.3-foot interval of depth. This high resolution results in the scatter of values shown in the graphs. Individual measurements are very reliable with estimated precision of +/- 5%. Standardized field procedures and quality assurance checks contribute to the reliability of these data.

Table 1. Boring locations and logging dates

BORING DESIGNATION	DATES LOGGED	LOCATION ⁽¹⁾ (DEGREES)	
		LATITUDE	LONGITUDE
G-413	4/7/2015	34° 3'33.76"N	118°24'53.57"W
G-415	4/1/2015	34° 3'28.44"N	118°25'1.25"W

⁽¹⁾ Coordinates estimated from Google Earth, as directed by AMEC

Table 2. Logging dates and depth ranges

BORING NUMBER	TOOL AND RUN NUMBER	DEPTH RANGE (FEET)	CASED OR UNCASED	SAMPLE INTERVAL (FEET)	DATE LOGGED
G-413	SUSPENSION PS 1	3.2– 161.10	UNCASED	1.6	4/7/2015
G-415	SUSPENSION PS 1	0.8-102.7	UNCASED	1.6	4/1/2015

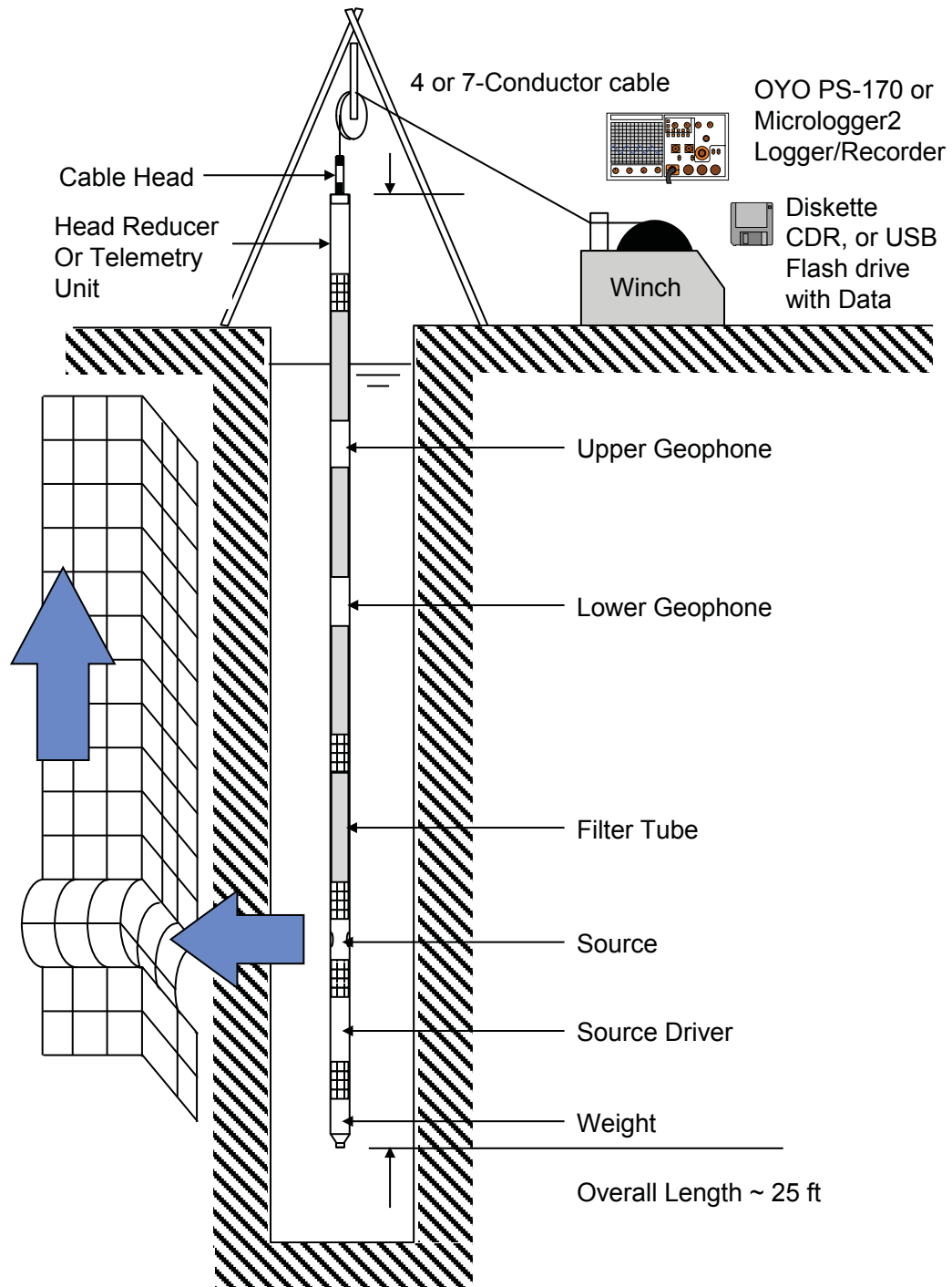


Figure 1: Concept illustration of P-S logging system

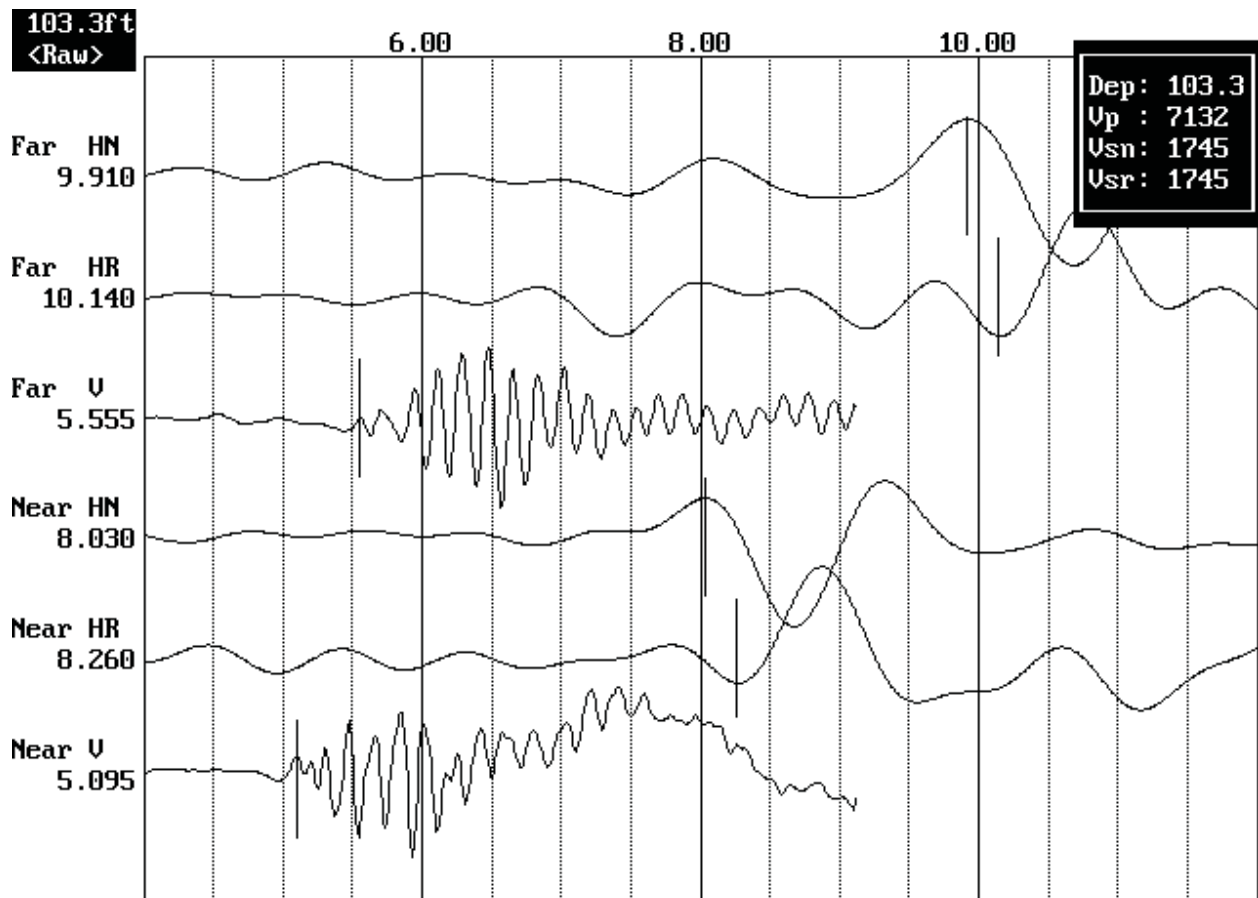


Figure 2: Example of filtered (1400 Hz lowpass) suspension record

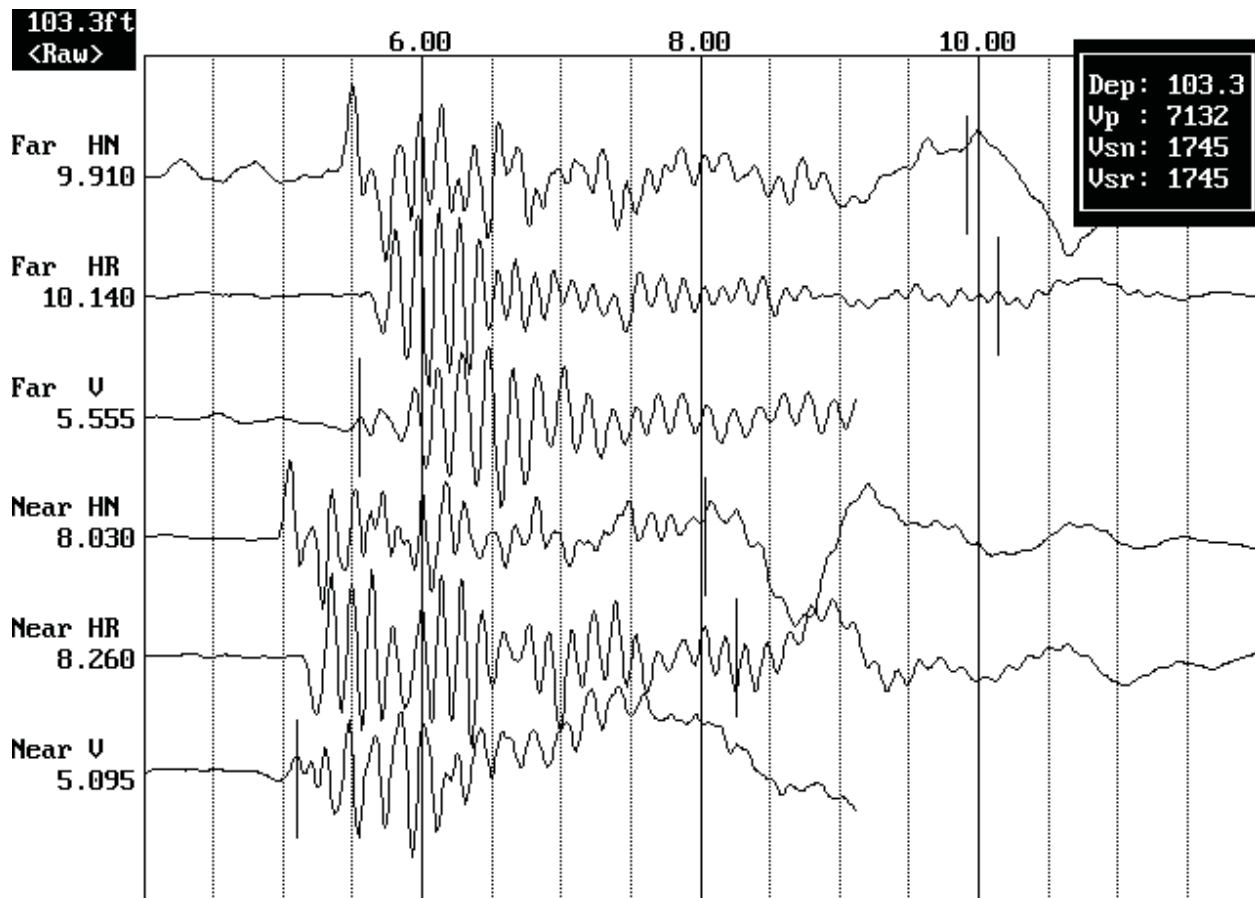


Figure 3. Example of unfiltered suspension record

METRO WESTSIDE EXTENSION BOREHOLE G-413 **Receiver to Receiver V_s and V_p Analysis**

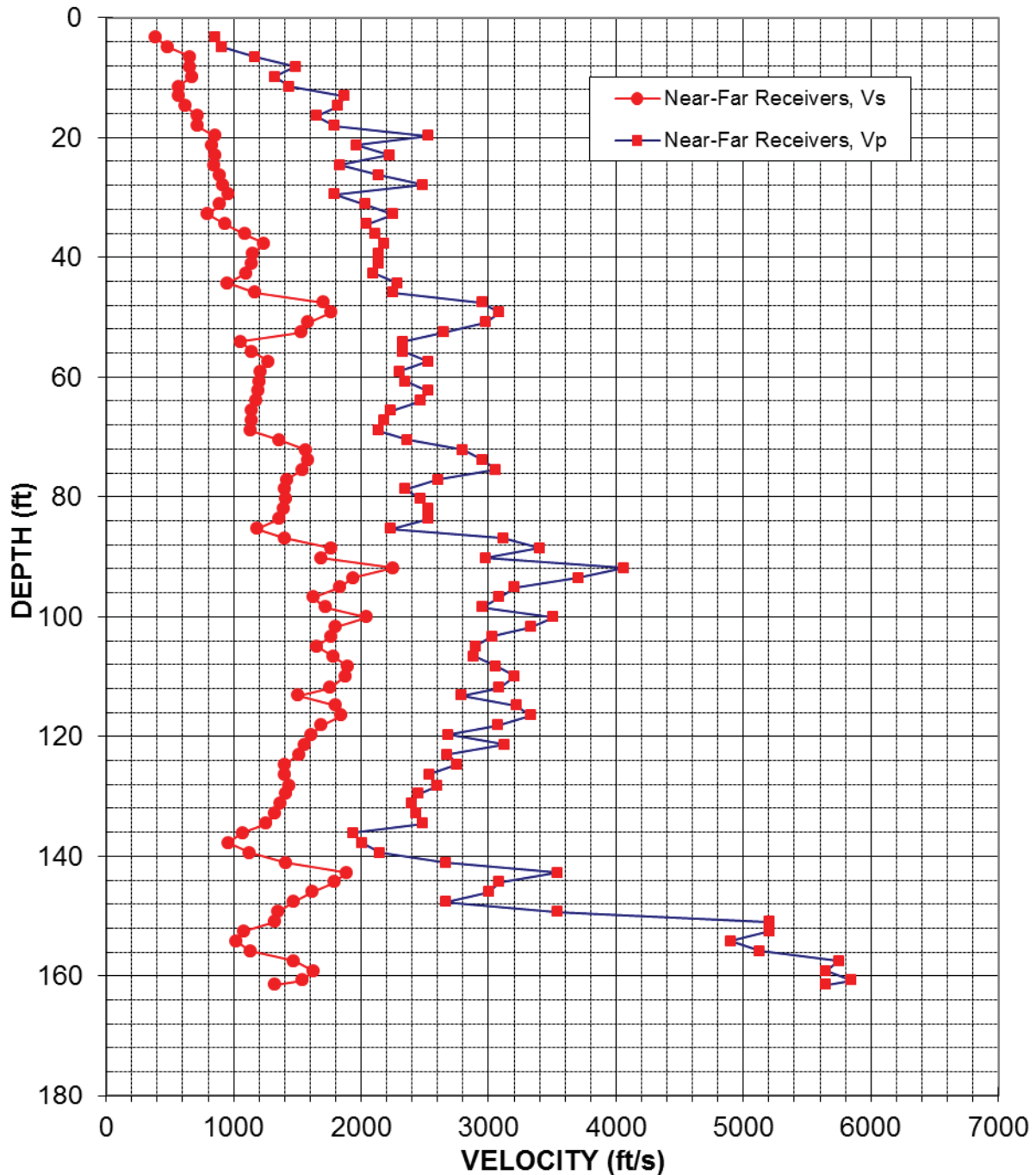


Figure 4: Boring G-413, Suspension R1-R2 P- and S_H -wave velocities

Table 3. Boring G-413, Suspension R1-R2 depths and P- and S_H-wave velocities

**Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio
Based on Receiver-to-Receiver Travel Time Data - Borehole G-413**

American Units				Metric Units			
Depth at Midpoint Between Receivers	Velocity		Poisson's Ratio	Depth at Midpoint Between Receivers	Velocity		Poisson's Ratio
	V _s	V _p			V _s	V _p	
(ft)	(ft/s)	(ft/s)		(m)	(m/s)	(m/s)	
3.3	390	850	0.37	1.0	120	260	0.37
4.9	480	910	0.31	1.5	150	280	0.31
6.6	660	1170	0.27	2.0	200	360	0.27
8.2	660	1490	0.38	2.5	200	450	0.38
9.8	670	1320	0.33	3.0	200	400	0.33
11.5	570	1440	0.41	3.5	170	440	0.41
13.1	570	1870	0.45	4.0	170	570	0.45
14.8	620	1820	0.43	4.5	190	560	0.43
16.4	710	1650	0.39	5.0	220	500	0.39
18.0	720	1790	0.40	5.5	220	550	0.40
19.7	850	2530	0.44	6.0	260	770	0.44
21.3	830	1960	0.39	6.5	250	600	0.39
23.0	860	2220	0.41	7.0	260	680	0.41
24.6	840	1830	0.37	7.5	260	560	0.37
26.3	890	2140	0.39	8.0	270	650	0.39
27.9	920	2490	0.42	8.5	280	760	0.42
29.5	960	1790	0.30	9.0	290	550	0.30
31.2	890	2030	0.38	9.5	270	620	0.38
32.8	800	2250	0.43	10.0	240	690	0.43
34.5	940	2040	0.37	10.5	290	620	0.37
36.1	1090	2110	0.32	11.0	330	640	0.32
37.7	1240	2180	0.26	11.5	380	660	0.26
39.4	1150	2140	0.29	12.0	350	650	0.29
41.0	1150	2140	0.30	12.5	350	650	0.30
42.7	1100	2100	0.31	13.0	340	640	0.31
44.3	960	2280	0.39	13.5	290	700	0.39
45.9	1170	2250	0.32	14.0	360	690	0.32
47.6	1710	2950	0.25	14.5	520	900	0.25
49.2	1760	3090	0.26	15.0	540	940	0.26
50.9	1590	2980	0.30	15.5	480	910	0.30
52.5	1530	2650	0.25	16.0	470	810	0.25
54.1	1050	2330	0.37	16.5	320	710	0.37
55.8	1150	2330	0.34	17.0	350	710	0.34
57.4	1270	2530	0.33	17.5	390	770	0.33
59.1	1210	2300	0.31	18.0	370	700	0.31

**Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio
Based on Receiver-to-Receiver Travel Time Data - Borehole G-413**

American Units				Metric Units			
Depth at Midpoint Between Receivers	Velocity		Poisson's Ratio	Depth at Midpoint Between Receivers	Velocity		Poisson's Ratio
	V _s	V _p			V _s	V _p	
(ft)	(ft/s)	(ft/s)		(m)	(m/s)	(m/s)	
60.7	1200	2350	0.32	18.5	370	720	0.32
62.3	1190	2530	0.36	19.0	360	770	0.36
64.0	1180	2470	0.35	19.5	360	750	0.35
65.6	1150	2240	0.32	20.0	350	680	0.32
67.3	1150	2180	0.31	20.5	350	660	0.31
68.9	1130	2140	0.30	21.0	350	650	0.30
70.5	1360	2360	0.26	21.5	410	720	0.26
72.2	1560	2800	0.27	22.0	480	850	0.27
73.8	1580	2950	0.30	22.5	480	900	0.30
75.5	1540	3060	0.33	23.0	470	930	0.33
77.1	1420	2600	0.29	23.5	430	790	0.29
78.7	1400	2350	0.22	24.0	430	720	0.22
80.4	1410	2470	0.26	24.5	430	750	0.26
82.0	1390	2530	0.28	25.0	430	770	0.28
83.7	1360	2530	0.30	25.5	410	770	0.30
85.3	1180	2240	0.31	26.0	360	680	0.31
86.9	1400	3120	0.37	26.5	430	950	0.37
88.6	1760	3400	0.32	27.0	540	1040	0.32
90.2	1680	2980	0.26	27.5	510	910	0.26
91.9	2250	4070	0.28	28.0	690	1240	0.28
93.5	1940	3700	0.31	28.5	590	1130	0.31
95.1	1830	3210	0.26	29.0	560	980	0.26
96.8	1630	3090	0.31	29.5	500	940	0.31
98.4	1720	2950	0.24	30.0	520	900	0.24
100.1	2040	3510	0.24	30.5	620	1070	0.24
101.7	1800	3330	0.30	31.0	550	1020	0.30
103.4	1770	3030	0.24	31.5	540	920	0.24
105.0	1650	2900	0.26	32.0	500	880	0.26
106.6	1780	2890	0.19	32.5	540	880	0.19
108.3	1890	3060	0.19	33.0	580	930	0.19
109.9	1880	3210	0.24	33.5	570	980	0.24
111.9	1760	3090	0.26	34.1	540	940	0.26
113.2	1510	2790	0.29	34.5	460	850	0.29
114.8	1800	3220	0.27	35.0	550	980	0.27
116.5	1850	3330	0.28	35.5	560	1020	0.28
118.1	1690	3070	0.28	36.0	520	940	0.28
119.8	1610	2690	0.22	36.5	490	820	0.22
121.4	1560	3130	0.34	37.0	470	950	0.34

**Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio
Based on Receiver-to-Receiver Travel Time Data - Borehole G-413**

American Units				Metric Units			
Depth at Midpoint Between Receivers	Velocity		Poisson's Ratio	Depth at Midpoint Between Receivers	Velocity		Poisson's Ratio
	V _s	V _p			V _s	V _p	
(ft)	(ft/s)	(ft/s)		(m)	(m/s)	(m/s)	
123.0	1510	2680	0.27	37.5	460	820	0.27
124.7	1400	2750	0.32	38.0	430	840	0.32
126.3	1400	2530	0.28	38.5	430	770	0.28
128.3	1440	2590	0.28	39.1	440	790	0.28
129.6	1410	2450	0.25	39.5	430	750	0.25
131.2	1370	2400	0.26	40.0	420	730	0.26
132.9	1330	2430	0.29	40.5	400	740	0.29
134.5	1260	2490	0.33	41.0	380	760	0.33
136.2	1070	1940	0.28	41.5	330	590	0.28
137.8	960	2010	0.35	42.0	290	610	0.35
139.4	1130	2150	0.31	42.5	340	660	0.31
141.1	1410	2670	0.31	43.0	430	810	0.31
142.7	1880	3550	0.30	43.5	570	1080	0.30
144.4	1790	3090	0.25	44.0	550	940	0.25
146.0	1620	3000	0.30	44.5	490	920	0.30
147.6	1470	2670	0.28	45.0	450	810	0.28
149.3	1350	3550	0.42	45.5	410	1080	0.42
150.9	1320	5210	0.47	46.0	400	1590	0.47
152.6	1080	5210	0.48	46.5	330	1590	0.48
154.2	1020	4900	0.48	47.0	310	1490	0.48
155.8	1130	5130	0.47	47.5	340	1560	0.47
157.5	1470	5750	0.46	48.0	450	1750	0.46
159.1	1630	5650	0.45	48.5	500	1720	0.45
160.8	1540	5850	0.46	49.0	470	1780	0.46
161.4	1320	5650	0.47	49.2	400	1720	0.47

METRO WESTSIDE EXTENSION BOREHOLE G-415 **Receiver to Receiver V_s and V_p Analysis**

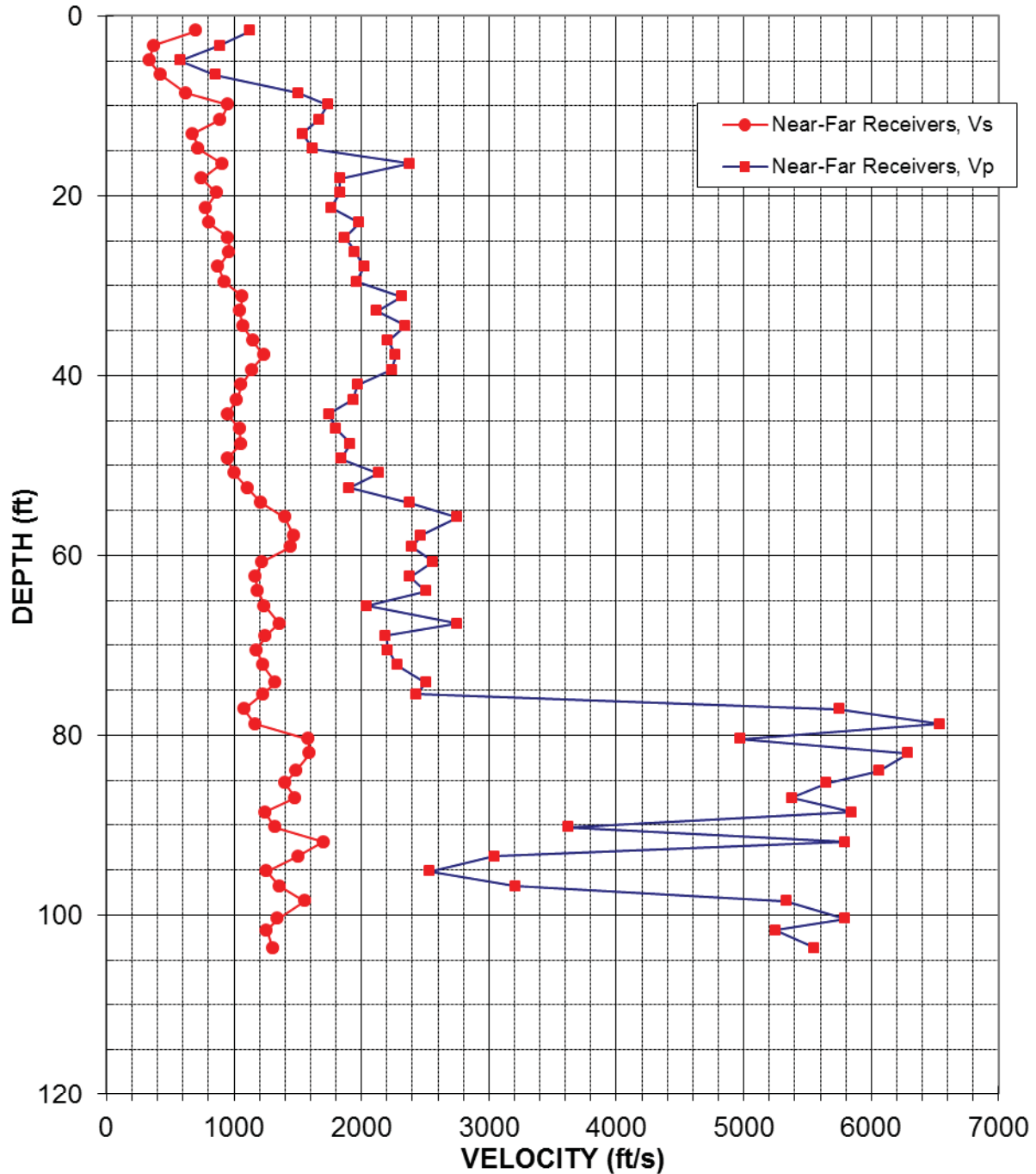


Figure 5: Boring G-415, Suspension R1-R2 P- and S_H -wave velocities

Table 4 Boring G-415, Suspension R1-R2 depths and P- and S_H-wave velocities

**Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio
Based on Receiver-to-Receiver Travel Time Data - Borehole G-415**

American Units				Metric Units			
Depth at Midpoint Between Receivers	Velocity		Poisson's Ratio	Depth at Midpoint Between Receivers	Velocity		Poisson's Ratio
	V _s	V _p			V _s	V _p	
(ft)	(ft/s)	(ft/s)		(m)	(m/s)	(m/s)	
1.6	710	1130	0.18	0.5	220	340	0.18
3.3	370	890	0.39	1.0	110	270	0.39
4.9	340	580	0.24	1.5	100	180	0.24
6.6	430	850	0.33	2.0	130	260	0.33
8.5	620	1500	0.40	2.6	190	460	0.40
9.8	950	1740	0.28	3.0	290	530	0.28
11.5	890	1670	0.30	3.5	270	510	0.30
13.1	680	1540	0.38	4.0	210	470	0.38
14.8	720	1620	0.38	4.5	220	490	0.38
16.4	910	2380	0.41	5.0	280	730	0.41
18.0	750	1830	0.40	5.5	230	560	0.40
19.7	860	1830	0.36	6.0	260	560	0.36
21.3	780	1760	0.38	6.5	240	540	0.38
23.0	800	1980	0.40	7.0	240	600	0.40
24.6	950	1870	0.33	7.5	290	570	0.33
26.3	960	1950	0.34	8.0	290	590	0.34
27.9	880	2020	0.38	8.5	270	620	0.38
29.5	930	1960	0.36	9.0	280	600	0.36
31.2	1070	2310	0.36	9.5	330	710	0.36
32.8	1040	2120	0.34	10.0	320	650	0.34
34.5	1070	2350	0.37	10.5	330	720	0.37
36.1	1150	2210	0.31	11.0	350	670	0.31
37.7	1230	2270	0.29	11.5	380	690	0.29
39.4	1140	2240	0.32	12.0	350	680	0.32
41.0	1060	1970	0.30	12.5	320	600	0.30
42.7	1020	1940	0.31	13.0	310	590	0.31
44.3	950	1750	0.29	13.5	290	530	0.29
45.9	1040	1800	0.25	14.0	320	550	0.25
47.6	1050	1920	0.28	14.5	320	580	0.28
49.2	950	1840	0.32	15.0	290	560	0.32
50.9	1000	2140	0.36	15.5	310	650	0.36
52.5	1100	1900	0.25	16.0	340	580	0.25
54.1	1210	2380	0.33	16.5	370	730	0.33
55.8	1400	2750	0.33	17.0	430	840	0.33
57.7	1470	2470	0.23	17.6	450	750	0.23
59.1	1440	2400	0.22	18.0	440	730	0.22

**Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio
Based on Receiver-to-Receiver Travel Time Data - Borehole G-415**

American Units				Metric Units			
Depth at Midpoint Between Receivers	Velocity		Poisson's Ratio	Depth at Midpoint Between Receivers	Velocity		Poisson's Ratio
	V _s	V _p			V _s	V _p	
(ft)	(ft/s)	(ft/s)		(m)	(m/s)	(m/s)	
60.7	1220	2560	0.35	18.5	370	780	0.35
62.3	1170	2380	0.34	19.0	360	730	0.34
64.0	1190	2510	0.36	19.5	360	760	0.36
65.6	1240	2040	0.21	20.0	380	620	0.21
67.6	1360	2750	0.34	20.6	410	840	0.34
68.9	1250	2190	0.26	21.0	380	670	0.26
70.5	1180	2210	0.30	21.5	360	670	0.30
72.2	1230	2280	0.30	22.0	370	700	0.30
74.2	1330	2510	0.30	22.6	400	760	0.30
75.5	1230	2430	0.33	23.0	370	740	0.33
77.1	1080	5750	0.48	23.5	330	1750	0.48
78.7	1170	6540	0.48	24.0	360	1990	0.48
80.4	1580	4980	0.44	24.5	480	1520	0.44
82.0	1590	6290	0.47	25.0	490	1920	0.47
84.0	1490	6060	0.47	25.6	450	1850	0.47
85.3	1400	5650	0.47	26.0	430	1720	0.47
86.9	1480	5380	0.46	26.5	450	1640	0.46
88.6	1240	5850	0.48	27.0	380	1780	0.48
90.2	1320	3620	0.42	27.5	400	1100	0.42
91.9	1700	5800	0.45	28.0	520	1770	0.45
93.5	1500	3040	0.34	28.5	460	930	0.34
95.1	1260	2530	0.34	29.0	380	770	0.34
96.8	1360	3210	0.39	29.5	410	980	0.39
98.4	1550	5330	0.45	30.0	470	1630	0.45
100.4	1340	5800	0.47	30.6	410	1770	0.47
101.7	1260	5250	0.47	31.0	380	1600	0.47
103.7	1300	5560	0.47	31.6	400	1690	0.47

APPENDIX A

SUSPENSION VELOCITY MEASUREMENT QUALITY ASSURANCE SUSPENSION SOURCE TO RECEIVER ANALYSIS RESULTS

METRO WESTSIDE EXTENSION BOREHOLE G-413 **Source to Receiver and Receiver to Receiver Analysis**

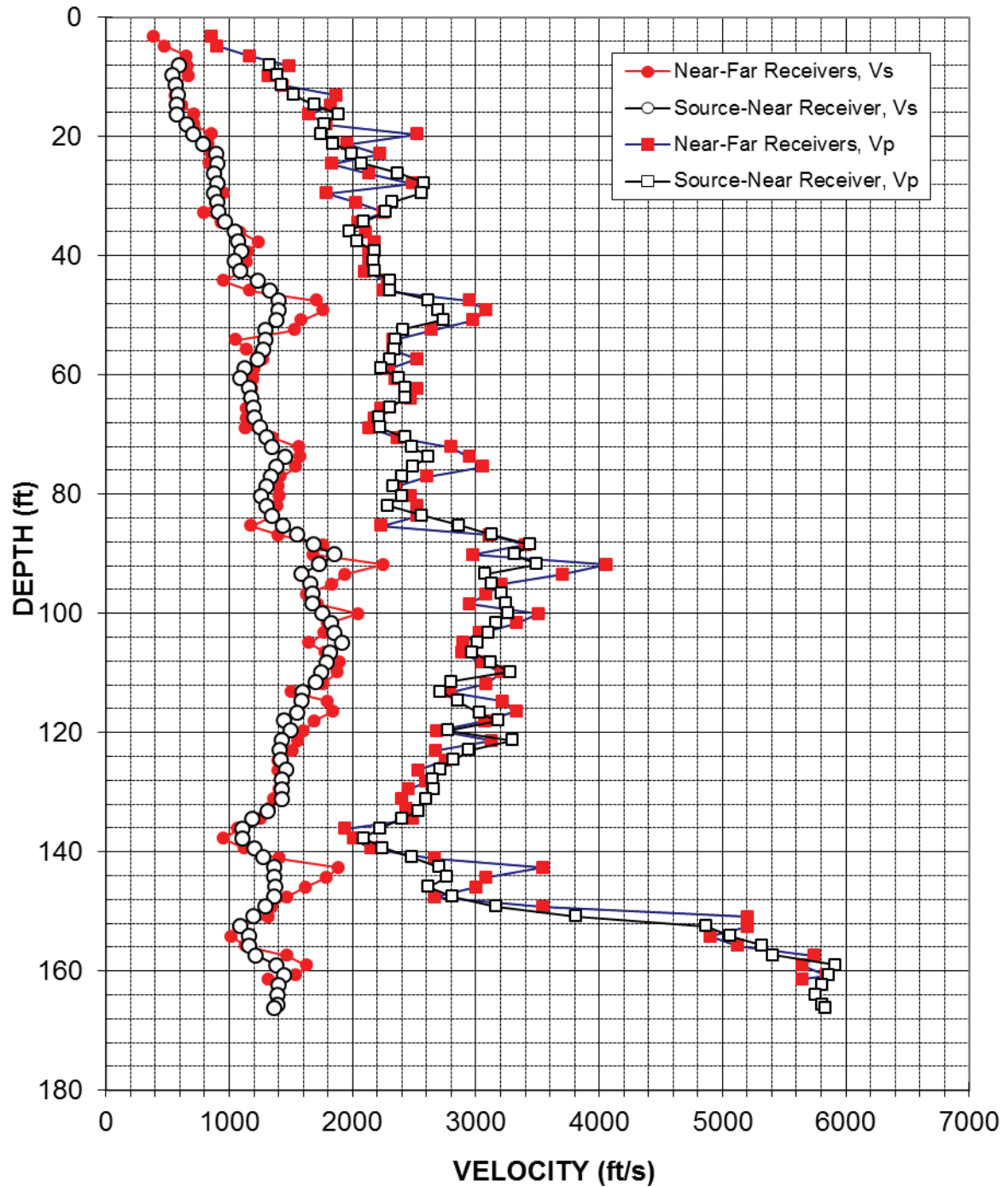


Figure A-1: Boring G-413, Suspension S-R1 P- and S_H-wave velocities

Table A-1. Boring G-413, S - R1 quality assurance analysis P- and S_H-wave data

**Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio
Based on Source-to-Receiver Travel Time Data - Borehole G-413**

American Units				Metric Units			
Depth at Midpoint Between Source and Near Receiver	Velocity		Poisson's Ratio	Depth at Midpoint Between Source and Near Receiver	Velocity		Poisson's Ratio
	V _s	V _p			V _s	V _p	
(ft)	(ft/s)	(ft/s)		(m)	(m/s)	(m/s)	
8.1	590	1330	0.38	2.5	180	410	0.38
9.8	540	1390	0.41	3.0	160	420	0.41
11.4	570	1430	0.41	3.5	170	440	0.41
13.0	580	1530	0.42	4.0	180	460	0.42
14.7	580	1690	0.43	4.5	180	510	0.43
16.3	570	1890	0.45	5.0	170	580	0.45
18.0	650	1770	0.42	5.5	200	540	0.42
19.6	710	1740	0.40	6.0	220	530	0.40
21.2	790	1850	0.39	6.5	240	560	0.39
22.9	900	2000	0.37	7.0	270	610	0.37
24.5	900	2080	0.38	7.5	280	630	0.38
26.2	870	2370	0.42	8.0	270	720	0.42
27.8	900	2580	0.43	8.5	280	790	0.43
29.4	870	2560	0.43	9.0	270	780	0.43
31.1	900	2320	0.41	9.5	280	710	0.41
32.7	910	2270	0.40	10.0	280	690	0.40
34.4	960	2090	0.36	10.5	290	640	0.36
36.0	1050	1980	0.31	11.0	320	600	0.31
37.6	1070	2040	0.31	11.5	330	620	0.31
39.3	1100	2180	0.33	12.0	340	670	0.33
40.9	1040	2170	0.35	12.5	320	660	0.35
42.6	1090	2180	0.33	13.0	330	670	0.33
44.2	1230	2300	0.30	13.5	370	700	0.30
45.8	1330	2300	0.25	14.0	410	700	0.25
47.5	1400	2620	0.30	14.5	430	800	0.30
49.1	1400	2690	0.31	15.0	430	820	0.31
50.8	1380	2740	0.33	15.5	420	840	0.33
52.4	1290	2410	0.30	16.0	390	730	0.30
54.0	1290	2340	0.28	16.5	390	710	0.28
55.7	1280	2340	0.29	17.0	390	710	0.29
57.3	1230	2300	0.30	17.5	370	700	0.30
59.0	1130	2240	0.33	18.0	340	680	0.33
60.6	1090	2380	0.37	18.5	330	730	0.37
62.2	1160	2430	0.35	19.0	350	740	0.35
63.9	1170	2430	0.35	19.5	360	740	0.35
65.5	1200	2300	0.31	20.0	360	700	0.31
67.2	1200	2210	0.29	20.5	370	670	0.29

**Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio
Based on Source-to-Receiver Travel Time Data - Borehole G-413**

American Units				Metric Units			
Depth at Midpoint Between Source and Near Receiver	Velocity		Poisson's Ratio	Depth at Midpoint Between Source and Near Receiver	Velocity		Poisson's Ratio
	V _s	V _p			V _s	V _p	
(ft)	(ft/s)	(ft/s)		(m)	(m/s)	(m/s)	
68.8	1250	2220	0.27	21.0	380	680	0.27
70.5	1300	2430	0.30	21.5	400	740	0.30
72.1	1340	2480	0.29	22.0	410	760	0.29
73.7	1460	2620	0.28	22.5	440	800	0.28
75.4	1390	2490	0.28	23.0	420	760	0.28
77.0	1340	2400	0.27	23.5	410	730	0.27
78.7	1310	2330	0.27	24.0	400	710	0.27
80.3	1250	2400	0.31	24.5	380	730	0.31
81.9	1310	2290	0.26	25.0	400	700	0.26
83.6	1340	2560	0.31	25.5	410	780	0.31
85.2	1440	2860	0.33	26.0	440	870	0.33
86.9	1550	3130	0.34	26.5	470	960	0.34
88.5	1680	3440	0.34	27.0	510	1050	0.34
90.1	1860	3310	0.27	27.5	570	1010	0.27
91.8	1720	3500	0.34	28.0	530	1070	0.34
93.4	1590	3070	0.32	28.5	480	940	0.32
95.1	1650	3130	0.31	29.0	500	960	0.31
96.7	1670	3210	0.31	29.5	510	980	0.31
98.3	1670	3250	0.32	30.0	510	990	0.32
100.0	1750	3260	0.30	30.5	530	990	0.30
101.6	1820	3170	0.25	31.0	560	960	0.25
103.3	1860	3100	0.22	31.5	570	950	0.22
104.9	1910	3010	0.16	32.0	580	920	0.16
106.5	1820	2970	0.20	32.5	550	910	0.20
108.2	1790	3120	0.25	33.0	550	950	0.25
109.8	1740	3280	0.30	33.5	530	1000	0.30
111.5	1700	2800	0.21	34.0	520	850	0.21
113.1	1590	2720	0.24	34.5	480	830	0.24
114.7	1580	2850	0.28	35.0	480	870	0.28
116.7	1550	3030	0.32	35.6	470	920	0.32
118.0	1450	3180	0.37	36.0	440	970	0.37
119.7	1490	2770	0.30	36.5	460	840	0.30
121.3	1430	3300	0.38	37.0	430	1000	0.38
122.9	1410	2940	0.35	37.5	430	900	0.35
124.6	1420	2820	0.33	38.0	430	860	0.33
126.2	1460	2710	0.30	38.5	440	830	0.30
127.9	1430	2650	0.30	39.0	430	810	0.30
129.5	1430	2660	0.30	39.5	440	810	0.30
131.1	1430	2590	0.28	40.0	430	790	0.28

**Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio
Based on Source-to-Receiver Travel Time Data - Borehole G-413**

American Units				Metric Units			
Depth at Midpoint Between Source and Near Receiver	Velocity		Poisson's Ratio	Depth at Midpoint Between Source and Near Receiver	Velocity		Poisson's Ratio
	V _s	V _p			V _s	V _p	
(ft)	(ft/s)	(ft/s)		(m)	(m/s)	(m/s)	
133.1	1310	2540	0.32	40.6	400	770	0.32
134.4	1190	2400	0.34	41.0	360	730	0.34
136.1	1110	2230	0.34	41.5	340	680	0.34
137.7	1110	2090	0.30	42.0	340	640	0.30
139.3	1200	2240	0.30	42.5	370	680	0.30
141.0	1270	2480	0.32	43.0	390	760	0.32
142.6	1360	2710	0.33	43.5	410	820	0.33
144.3	1370	2760	0.34	44.0	420	840	0.34
145.9	1370	2620	0.31	44.5	420	800	0.31
147.6	1360	2810	0.35	45.0	410	860	0.35
149.2	1290	3170	0.40	45.5	390	960	0.40
150.8	1190	3810	0.45	46.0	360	1160	0.45
152.5	1090	4870	0.47	46.5	330	1480	0.47
154.1	1160	5060	0.47	47.0	350	1540	0.47
155.8	1160	5320	0.47	47.5	350	1620	0.47
157.4	1210	5410	0.47	48.0	370	1650	0.47
159.0	1380	5920	0.47	48.5	420	1800	0.47
160.7	1440	5860	0.47	49.0	440	1790	0.47
162.3	1400	5810	0.47	49.5	430	1770	0.47
164.0	1390	5750	0.47	50.0	420	1750	0.47
165.6	1390	5810	0.47	50.5	420	1770	0.47
166.3	1360	5830	0.47	50.7	420	1780	0.47

METRO WESTSIDE EXTENSION BOREHOLE G-415 **Source to Receiver and Receiver to Receiver Analysis**

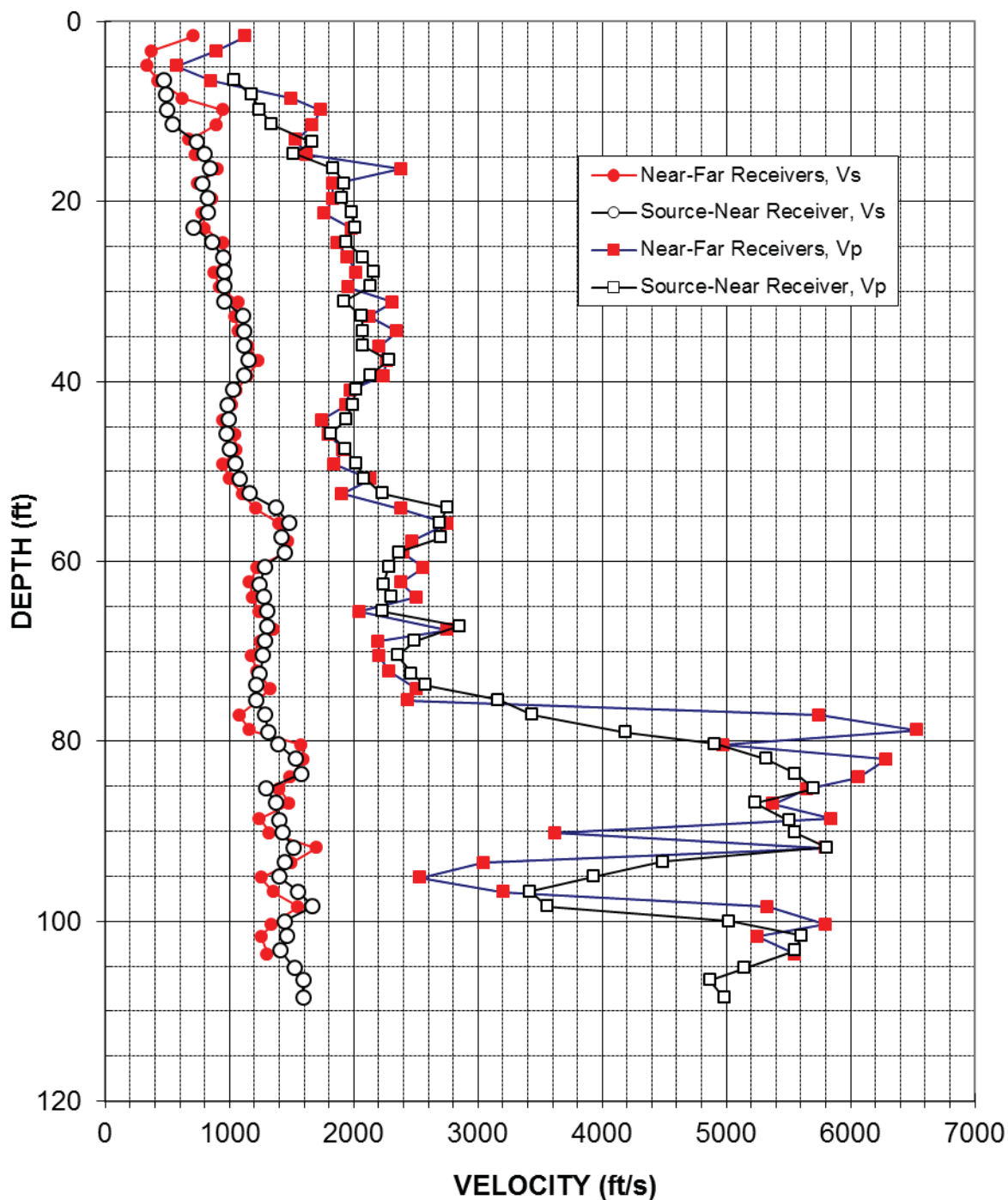


Figure A-2: Boring G-415, Suspension S-R1 P- and S_H-wave velocities

Table A-2. Boring G-413, S - R1 quality assurance analysis P- and S_H-wave data

**Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio
Based on Source-to-Receiver Travel Time Data - Borehole G-415**

American Units				Metric Units			
Depth at Midpoint Between Source and Near Receiver	Velocity		Poisson's Ratio	Depth at Midpoint Between Source and Near Receiver	Velocity		Poisson's Ratio
	V _s	V _p			V _s	V _p	
(ft)	(ft/s)	(ft/s)		(m)	(m/s)	(m/s)	
6.5	470	1040	0.37	2.0	140	320	0.37
8.1	490	1180	0.40	2.5	150	360	0.40
9.8	500	1240	0.41	3.0	150	380	0.41
11.4	540	1340	0.40	3.5	160	410	0.40
13.4	740	1660	0.38	4.1	230	510	0.38
14.7	800	1520	0.31	4.5	240	460	0.31
16.3	840	1830	0.37	5.0	260	560	0.37
18.0	780	1920	0.40	5.5	240	590	0.40
19.6	830	1900	0.38	6.0	250	580	0.38
21.2	830	1980	0.39	6.5	250	600	0.39
22.9	710	2010	0.43	7.0	220	610	0.43
24.5	860	1940	0.38	7.5	260	590	0.38
26.2	950	2080	0.37	8.0	290	630	0.37
27.8	960	2160	0.38	8.5	290	660	0.38
29.4	960	2130	0.37	9.0	290	650	0.37
31.1	960	1920	0.33	9.5	290	590	0.33
32.7	1100	2060	0.30	10.0	340	630	0.30
34.4	1120	2080	0.30	10.5	340	630	0.30
36.0	1120	2080	0.30	11.0	340	630	0.30
37.6	1150	2290	0.33	11.5	350	700	0.33
39.3	1120	2130	0.31	12.0	340	650	0.31
40.9	1030	2020	0.32	12.5	310	610	0.32
42.6	980	1990	0.34	13.0	300	610	0.34
44.2	990	1940	0.32	13.5	300	590	0.32
45.8	980	1810	0.30	14.0	300	550	0.30
47.5	1000	1930	0.32	14.5	300	590	0.32
49.1	1040	2020	0.32	15.0	320	620	0.32
50.8	1080	2080	0.32	15.5	330	630	0.32
52.4	1160	2230	0.32	16.0	350	680	0.32
54.0	1370	2750	0.33	16.5	420	840	0.33
55.7	1480	2690	0.29	17.0	450	820	0.29
57.3	1420	2710	0.31	17.5	430	820	0.31
59.0	1440	2360	0.20	18.0	440	720	0.20
60.6	1280	2290	0.27	18.5	390	700	0.27
62.6	1240	2240	0.28	19.1	380	680	0.28
63.9	1280	2300	0.28	19.5	390	700	0.28

**Summary of Compressional Wave Velocity, Shear Wave Velocity, and Poisson's Ratio
Based on Source-to-Receiver Travel Time Data - Borehole G-415**

American Units				Metric Units			
Depth at Midpoint Between Source and Near Receiver	Velocity		Poisson's Ratio	Depth at Midpoint Between Source and Near Receiver	Velocity		Poisson's Ratio
	V _s	V _p			V _s	V _p	
(ft)	(ft/s)	(ft/s)		(m)	(m/s)	(m/s)	
65.5	1300	2230	0.24	20.0	400	680	0.24
67.2	1310	2850	0.37	20.5	400	870	0.37
68.8	1290	2490	0.32	21.0	390	760	0.32
70.5	1270	2350	0.30	21.5	390	720	0.30
72.4	1240	2460	0.33	22.1	380	750	0.33
73.7	1210	2570	0.36	22.5	370	780	0.36
75.4	1210	3170	0.41	23.0	370	960	0.41
77.0	1290	3440	0.42	23.5	390	1050	0.42
79.0	1310	4190	0.45	24.1	400	1280	0.45
80.3	1390	4910	0.46	24.5	420	1500	0.46
81.9	1530	5320	0.45	25.0	470	1620	0.45
83.6	1580	5550	0.46	25.5	480	1690	0.46
85.2	1290	5700	0.47	26.0	390	1740	0.47
86.9	1370	5230	0.46	26.5	420	1590	0.46
88.8	1400	5500	0.47	27.1	430	1680	0.47
90.1	1420	5550	0.46	27.5	430	1690	0.46
91.8	1520	5810	0.46	28.0	460	1770	0.46
93.4	1450	4490	0.44	28.5	440	1370	0.44
95.1	1400	3930	0.43	29.0	430	1200	0.43
96.7	1550	3420	0.37	29.5	470	1040	0.37
98.3	1670	3560	0.36	30.0	510	1080	0.36
100.0	1440	5020	0.46	30.5	440	1530	0.46
101.6	1470	5600	0.46	31.0	450	1710	0.46
103.3	1410	5550	0.47	31.5	430	1690	0.47
105.2	1520	5150	0.45	32.1	460	1570	0.45
106.5	1590	4870	0.44	32.5	480	1480	0.44
108.5	1590	4980	0.44	33.1	480	1520	0.44

Figure C-2.34

APPENDIX B

**BORING GEOPHYSICAL LOGGING
SYSTEMS - NIST TRACEABLE
CALIBRATION RECORDS**



MICRO PRECISION CALIBRATION, INC
12686 HOOVER ST
GARDEN GROVE CA 92841
714-901-5659



Certificate of Calibration

Date: Jun 9, 2014

Cert No. 220081222150938

Customer:

GEOVISION
1124 OLYMPIC DRIVE
CORONA CA 92881

MPC Control #: AM6767
Asset ID: 160023
Gage Type: LOGGER
Manufacturer: OYO
Model Number: 3403
Size: N/A
Temp/RH: 71°F / 45 %

Work Order #: LA-90014198
Purchase Order #: OH-140603-01
Serial Number: 160023
Department: N/A
Performed By: STEVE BORING
Received Condition: IN TOLERANCE
Returned Condition: IN TOLERANCE
Cal. Date: May 30, 2014
Cal. Interval: 12 MONTHS
Cal. Due Date: May 30, 2015

Calibration Notes:

See attached data sheet for calculations.
Calibrated IAW customer supplied data form Rev 2.1
Frequency measurement uncertainty = 0.0005 Hz
Unit calibrated with Laptop Panasonic s/n: 5GKSA39492

Standards Used to Calibrate Equipment

I.D.	Description.	Model	Serial	Manufacturer	Cal. Due Date	Traceability #
BD9000	CALIBRATOR	5500A	7375008	FLUKE	Jun 24, 2014	220081202132159
T1100	UNIVERSAL COUNTER	53131A	3546A09912	HEWLETT PACKARD	Jan 31, 2015	220081222058147

Procedures Used in this Event

Procedure Name	Description
GEOVISION SEISMIC	Suspension PS Seismic Logger/Recorder Calibration Procedure

Calibrating Technician:

STEVE BORING

QC Approval:

Jim Williams

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k=2$, which for normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with EA's Publication and NIST Technical Note 1297, 1994 Edition. Services rendered comply with ISO 17025:2005, ISO 9001:2008, ANSI/NCSL Z540-1, MPC Quality Manual, MPC CSD and with customer purchase order instructions.

Calibration cycles and resulting due dates were submitted/approved by the customer. Any number of factors may cause an instrument to drift out of tolerance before the next scheduled calibration. Recalibration cycles should be based on frequency of use, environmental conditions and customer's established systematic accuracy. The information on this report, pertains only to the instrument identified.

All standards are traceable to SI through the National Institute of Standards and Technology (NIST) and/or recognized national or international standards laboratories. Services rendered include proper manufacturer's service instruction and are warranted for no less than thirty (30) days. This report may not be reproduced in part or in a whole without the prior written approval of the issuing MPC lab.

AM 6767



SUSPENSION PS SEISMIC LOGGER/RECORDER CALIBRATION DATA FORM

INSTRUMENT DATA

System mfg.:	OYO	Model no.:	3403
Serial no.:	160023	Calibration date:	5/30/2014
By:	Steve Boring	Due date:	5/30/2015
Counter mfg.:	Hewlett Packard	Model no.:	53131A
Serial no.:	3546A09912 (MPC T1100)	Calibration date:	1/31/2014
By:	Micro Precision Calibration	Due date:	1/31/2015
Signal generator mfg.:	Fluke	Model no.:	5500A
Serial no.:	7375008 (MPC BD9000)	Calibration date:	6/24/2013
By:	FLUKE SERVICE CENTER	Due date:	6/24/2014
Laptop controller mfg.:	Panasonic	Model no.:	CF-29
Serial no.:	5GKSA39492	Calibration date:	N/A

SYSTEM SETTINGS:

Gain:	2
Filter	LCF: 5Hz; HCF: 10kHz
Range:	See sample period in table below
Delay:	0 ms
Stack (1 std)	1
System date = correct date and time	5/30/2014 14:50

PROCEDURE:

Set sine wave frequency to target frequency with amplitude of approximately 0.25 volt peak
 Note actual frequency on data form.
 Set sample period and record data file to disk. Note file name on data form.
 Pick duration of 9 cycles using PSLOG.EXE program, note duration on data form, and save as .sps file. Calculate average frequency for each channel pair and note on data form.
 Average frequency must be within +/- 1% of actual frequency at all data points.

Maximum error ((AVG-ACT)/ACT*100)%	As found	0.12%	As left	0.12%
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Target Frequency (Hz)	Actual Frequency (Hz)	Sample Period (microS)	File Name	Time for 9 cycles Hn (msec)	Average Frequency Hn (Hz)	Time for 9 cycles Hr (msec)	Average Frequency Hr (Hz)	Time for 9 cycles V (msec)	Average Frequency V (Hz)
50.00	50.00	200	501	180.2	49.94	179.8	50.06	180.0	50.00
100.0	100.0	100	502	90.00	100.0	90.00	100.0	90.00	100.0
200.0	200.0	50	503	44.95	200.2	45.00	200.0	44.95	200.2
500.0	500.0	20	504	18.00	500.0	18.00	500.0	18.00	500.0
1000	1000	10	505	9.010	998.9	9.000	1000	9.000	1000
2000	2000	5	506	4.500	2000	4.500	2000	4.500	2000

Calibrated by:	Steve Boring	5/30/2014	
	Name	Date	Signature
Witnessed by:	Emily Feldman	5/30/2014	
	Name	Date	Signature

Suspension PS Seismic Recorder/Logger Calibration Data Form Rev 2.1 February 7, 2012

