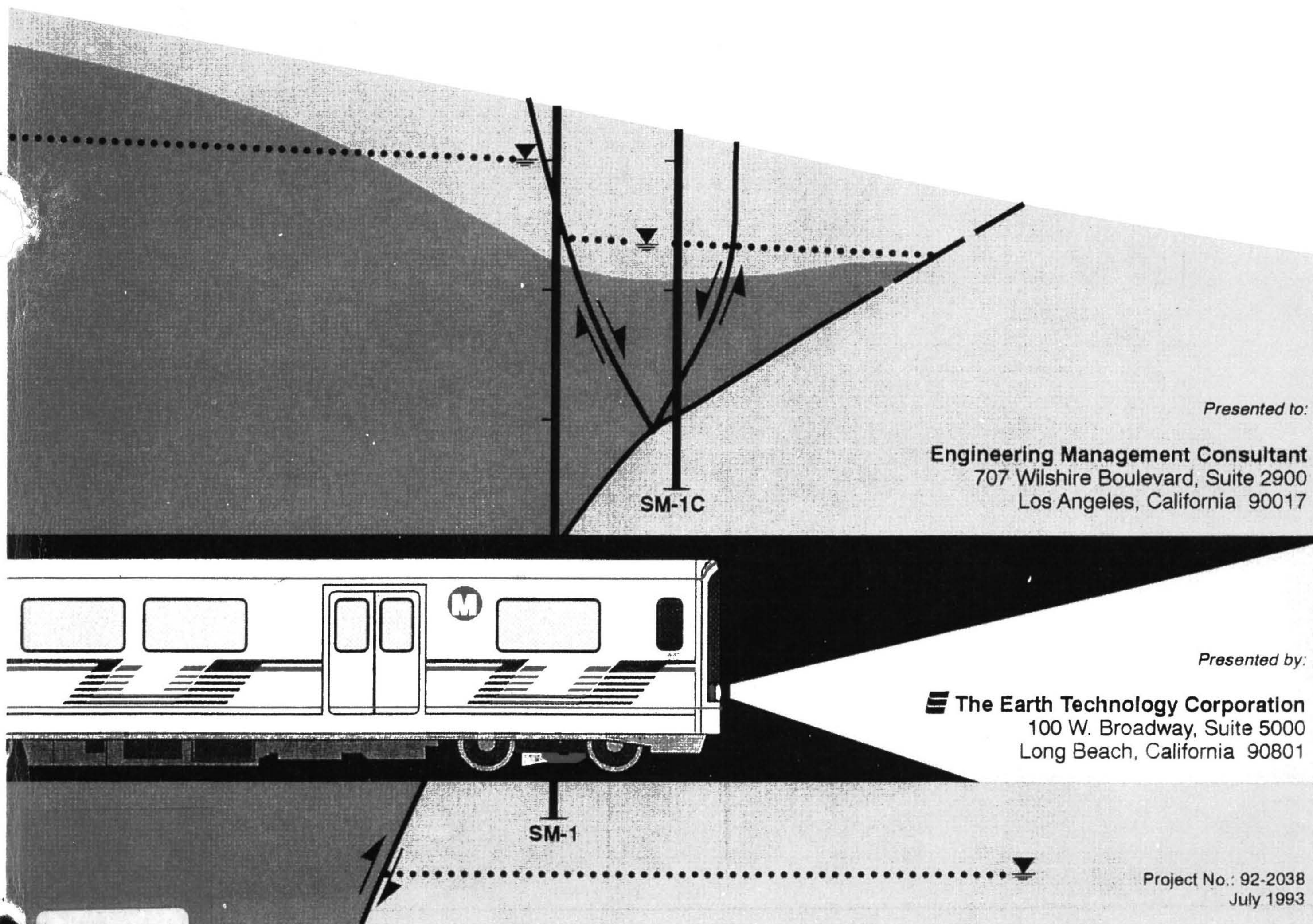
Investigations of the Hollywood Fault Zone
Segment 3, Metro Red Line



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INVESTIGATIONS OF THE HOLLYWOOD FAULT ZONE METRO RED LINE SEGMENT 3

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1.0 INTRODUCTION

This report presents the results of the Earth Technology Corporation's (Earth Technology) investigations to provide information on the Hollywood fault zone for the Metro Red Line, Segment 3 project. Since the early planning stages for the Metro Rail project it was recognized that the tunnel alignment would intersect the Hollywood fault zone at some location. However, the location and nature of the fault zone was not well defined. A site-specific investigation for the Metro Red Line project was, therefore, considered necessary to define the fault location and the characteristics of the sheared rock at the tunnel heading.

Earth Technology was contracted by Engineering Management Consultant (EMC) to conduct field investigations to delineate the fault zone location and geometry where the fault would intersect the tunnel alignment, and to interpret the subsurface conditions for tunnel construction at the depth where the alluvium/bedrock transition occurs. In a parallel study, EMC contracted with two independent consultants, Dr. Kerry Sieh and Dr. Clarence Allen, to evaluate the issue of active faulting with respect to the Metro Red Line design at the Santa Monica Mountains. Dr. Sieh and Dr. Allen participated in planning our field investigations and used the findings in their evaluation of the latest age of fault activity, anticipated style of faulting (i.e. slip vector), amount of displacement per event, recurrence interval and appropriate design earthquake magnitude associated with the fault zone for design. Dr. James Dolan, conducting post-doctoral research on the Santa Monica and Hollywood fault zones at the California Institute of Technology, assisted Dr. Sieh. The results of their studies are presented in a separate report to EMC (Sieh, 1993). A copy of that report is attached in Appendix D and a copy of Dr. Dolan's letter to Los Angeles County Department of Public Works summarizing the results of the Vista Street storm drain excavation observations is attached in Appendix E.

Earth Technology's objectives for study of the Hollywood fault zone were two fold: (1) to provide subsurface information and recommendations for tunnel construction at the fault zone; and (2) to collect field data for use by Dr. Sieh in his interpretation of active faulting for tunnel design considerations. Coordination between Earth Technology and Dr. Sieh was essential in order to optimize the data collection for both objectives. Principally, the investigations for tunnel construction focused on locating fault strands, defining the width of the fault zone, and describing the fault controlled transition from alluvium to bedrock. The location of the fault and character of the bedrock would help determine the change in construction methods and construction contracts.

The scope of the Hollywood fault zone investigation was discussed and planned at an initial meeting held on February 19, 1992 between the staff from EMC and Earth Technology, Dr. Sieh and Dr. Allen. Subsequently, the investigation was expanded as per several discussions held between EMC and Earth Technology.

1.1 SCOPE

Previously completed borings (B-7 and B-8; see Earth Technology, 1992) for geotechnical studies had helped bracket the location of the Hollywood fault zone intersecting the proposed Metro Red Line. After reviewing the findings from this earlier work in conjunction with the site conditions (paved streets and residential area), we decided that a series of borings could help locate the principal fault traces. These borings were sampled continuously so that stratigraphic units and perhaps soil horizons could be used to identify vertical offsets due to faulting. Once fault trace locations were narrowed between borings, the plan was to strategically locate bucket auger borings for geologists to log down hole and to allow direct observation of faulting in shallow-depth sediments. This method of subsurface exploration was favored over trench excavation due to the anticipated thickness of Holocene sediments exceeding trenching depths, which would not allow examination of possible faulting of Pleistocene or early Holocene-age sediments. Another consideration was minimizing the disruption to neighborhood residents and avoiding blockage of driveways.

A phased exploration program for the fault investigation was performed to provide the flexibility to change emphasis based on findings as the program progressed. This allowed the freedom to vary the type of drilling, depths and locations of borings to meet the needs of the project and optimize the information collected. The resultant scope of work was as follows:

- Data review and conference with local geology experts.

- Field Exploration
  - Phase 1 — Consisted of drilling two deep (240 feet maximum) and three shallow rotary wash and hollow-stem auger borings (90.5 feet minimum) to evaluate offsets in alluvium and rock conditions at the tunnel depth along Camino Palmero.

  - Phase 2 — Consisted of drilling three shallow hollow-stem auger borings and one shallow (50 feet deep) bucket auger boring on Camino Palmero to evaluate offsets in alluvium across the defined fault zone and to describe the nature of shears in alluvium where the fault is located.

  - Phase 3 — Consisted of drilling 15 shallow (54.5 feet to 60.5 feet deep) hollow-stem auger borings along Camino Palmero and Martel Avenue to evaluate if additional faulting exists south of the area of suspected faulting and to evaluate the variation in thickness of the faulted soils.

- Phase 4 — Consisted of drilling three deep (199 feet maximum) and two shallow borings (75.5 feet maximum) on La Brea Avenue to evaluate the bedrock conditions at tunnel depth, the transition from basin fill alluvium to bedrock across the fault, and offsets in alluvium.

- Phase 5 — Consisted of evaluating the shallow soils exposed in a trench excavated during the construction of a storm drain on Vista Street that crosses the suspected trace of the fault.

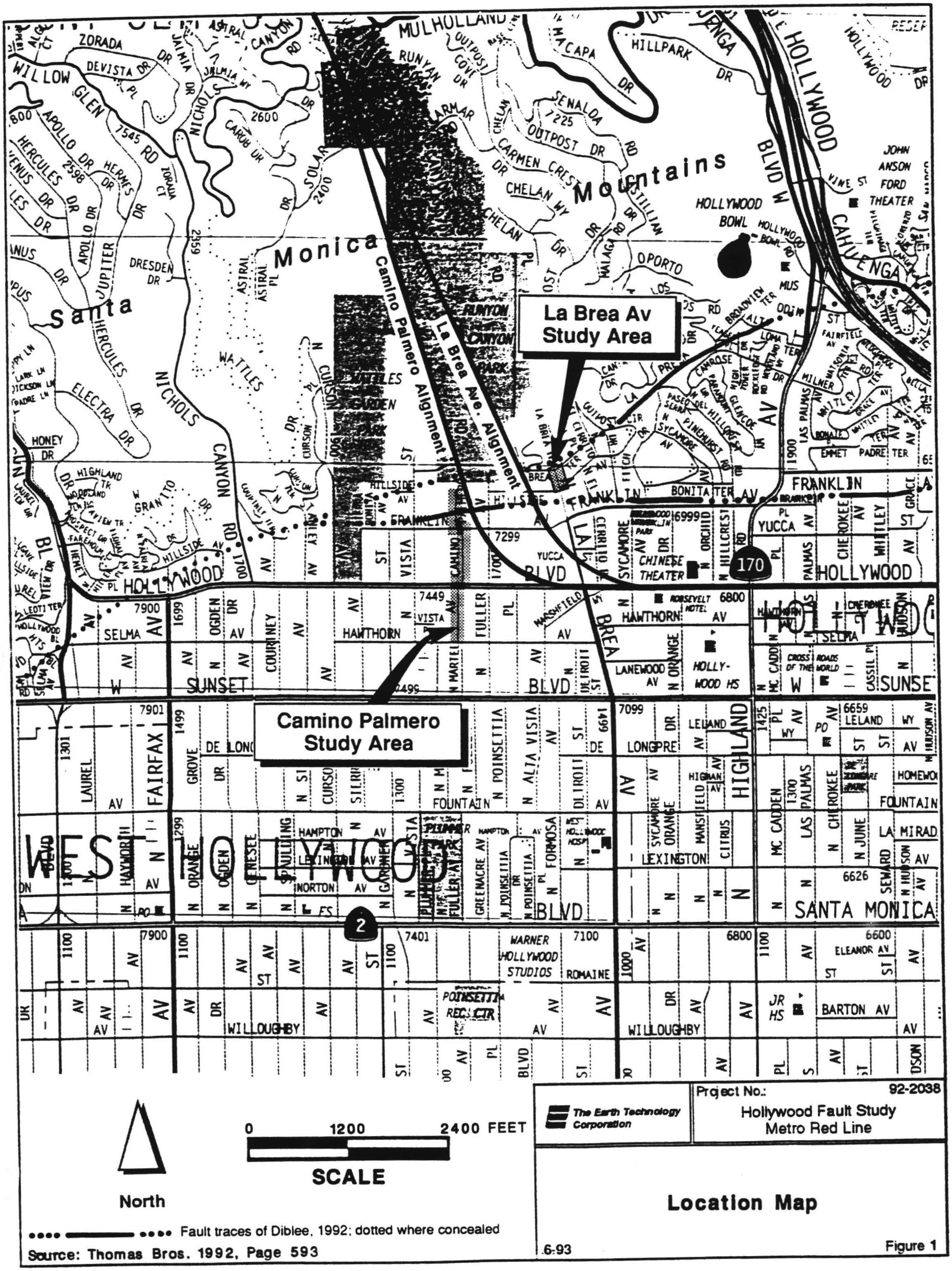
- o Data Evaluation

- o Report preparation to document field exploration activities, findings, interpretations, and conclusions.

1.2 BACKGROUND INFORMATION

The field exploration was conducted at two locations: (1) along the north-south alignment of Camino Palmero and Martel Avenue and (2) along the approximate north-south alignment of La Brea Avenue (Figure 1). The north-south alignment for exploratory borings was selected to provide a cross sectional view across the generally east-west trending faults. The Camino Palmero boring locations were selected because the tunnel alignment was originally proposed to enter the mountains beneath Camino Palmero north of Franklin Avenue. Two previous borings, B-7 and B-8 (The Earth Technology Corporation, 1992), were drilled along the Camino Palmero alignment to the depth of the tunnel for geotechnical information. These two borings revealed a sudden drop in the alluvium-bedrock contact suggesting that faulting has occurred between the borings. The location and nature of the contact was unknown. Boring B-8 revealed a fault-gouge zone that raised questions about the width of faulting and introduced the need for additional exploration to obtain site-specific structural and age-of-faulting data. During the planning process of the investigation, the tunnel alignment was relocated just west of La Brea Avenue, about 1000 feet east of the Camino Palmero alignment (Figure 1). Based on the existing geologic data at Camino Palmero, investigations were initiated there first. A field exploration program was also conducted near the La Brea Avenue alignment to help locate the fault and evaluate the subsurface conditions compared to Camino Palmero data. The width of the fault zone, geometry, and the nature of the alluvium-bedrock contact could vary between the two locations but should be representative of the actual conditions at the tunnel alignment.

The selected tunnel alignment (as of December 1992) crosses the fault trace approximately 200 feet to 300 feet west of La Brea Avenue. Specific information at that location is not available due to surface access limitations. Therefore, the fault characteristics at the tunnel alignment are extrapolated between La Brea Avenue and Camino Palmero for this report. In addition, we reviewed as-built documents of the La Cienega and San Fernando Valley relief sewer tunnel construction by the City of Los Angeles Department of Public Works (Department of Public Works, 1954-1955). The tunnel passed through the fault zone at the southern portal. In this report we refer to the tunnel as the Los Angeles Sewer Tunnel. We also evaluated the shallow alluvial soils that were exposed by a trench that was excavated for the construction of a storm drain on Vista Street. The storm drain trench crossed the suspected trace of the fault between Franklin and Hillside Avenues. The results of that evaluation are presented in a document prepared by Dr. James Dolan to Department of Public Works, County of Los Angeles and summarized in Section 3.2.3. A copy of Dr. Dolan's letter is attached in Appendix E.


La Brea Av Study Area
Camino Palmero Study Area
Camino Palmero Alignment
La Brea Ave. Alignment
Santa Monica Mountains
WEST HOLLYWOOD
HOLLYWOOD BOWL
CHINESE THEATER
HOLLY-WOOD HS
WARNER HOLLYWOOD STUDIOS
RUNYON CANYON PARK
170
2
0
1200
2400 FEET
SCALE
North
Fault traces of Diblee, 1992; dotted where concealed
Source: Thomas Bros. 1992, Page 593
The Earth Technology Corporation
Project No.:
92-2038
Hollywood Fault Study
Metro Red Line
Location Map
6-93
Figure 1

2.0 GEOLOGIC INVESTIGATIONS

2.1 GENERAL

The field investigations were designed to investigate the mapped traces of both the Santa Monica and Hollywood faults as defined by Dibblee (1991) (Figure 2). A great deal of confusion and contradiction exists in the literature regarding the locations and name designations of the Santa Monica and Hollywood faults. In general the Hollywood fault has been mapped closer to the mountain front than the Santa Monica fault. The trace of the Santa Monica fault is shown on maps by different geologists up to 2.5 miles south of the mountain front in the west Los Angeles area. The Metro Rail field investigations were carefully planned to clarify the relationship of the two faults, and to encompass both faults as they were mapped crossing Camino Palmero by Dibblee. West of Camino Palmero, Dibblee infers that the two faults join and continue westerly. East of La Brea Avenue, the Hollywood fault is mapped by Dibblee to trend into the Santa Monica Mountains and die out within the Miocene-age rocks. This has also been referred to as the Hollywood Bowl fault. Most investigators, however, consider that Dibblee's Santa Monica fault trace shown on Figure 2 is actually the Hollywood fault as it continues to the east. Recent investigators have redefined the Santa Monica fault as being located west of the Newport-Inglewood structural zone and the Hollywood fault as being located to the east. Geomorphic evidence for the continuation of the Santa Monica fault east of the structural zone is limited or absent (Crook and Proctor, 1992 and Dolan and Sieh, 1992a). For the purpose of this report, fault traces shown by Dibblee's map will be referred to as the north and south strands of the Hollywood fault zone.

In addition to evaluating the fault traces shown on the Dibblee map, our investigations included field exploration southward to Hawthorn Avenue to investigate topographic anomalies (possible fault scarps) identified by Dr. Sieh and Dr. Dolan. Those anomalies appear on topographic maps of the area prepared in 1926 by the U.S. Geological Survey according to Dr. Sieh (1993).

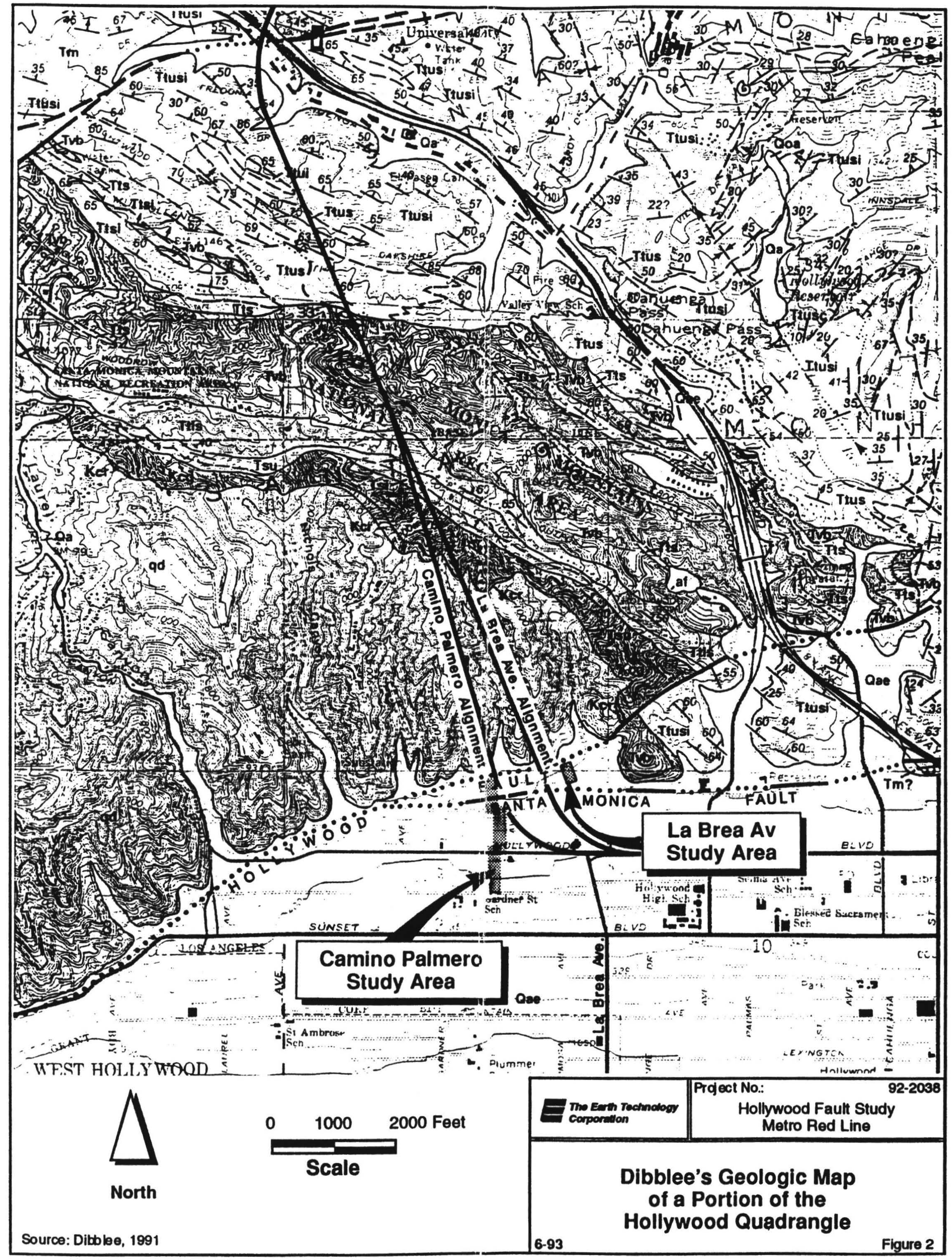
EXPLANATION

Geologic Units

	Surficial Sedements
Qa	Alluvium
Qae	Older Alluvium
Qoa	Older Alluvium
	Monterey Formation
Tm	Shale
	Upper Topanga Formation
Ttusi	Shale
Ttus	Sandstone
Ttusc	Sandstone and Conglomerate
Ttucg	Conglomerate
	Middle Topanga Formation
Ttsi	Sandstone and Shale
Tts	Sandstone
Tvb	Basaltic Rocks
	Lower Topanga Formation
Ttls	Sandstone
	Santa Susana Formation
Tsu	Sandstone
Tsi	Conglomerate
	Unnamed Strata
Kcg	Conglomerate
Kcr	Conglomerate
	Granitic Rocks
qd	Quartz Diorite

Symbols

- Formation Contact, dashed where inferred
- Member Contact
- Fault, dashed where indefinite or inferred, dotted where concealed
- Synclinal Fold, arrow on axial trace shows direction of plunge; dotted where concealed
- Bedding, strike and dip
- Shear, strike and dip
- Overturned Bedding, strike and dip



Dibblee's Geologic Map of a Portion of the Hollywood Quadrangle

Figure 2

2.2 FIELD EXPLORATION METHODS

Field exploration activities were performed in four phases of drilling. The drilling method, dates drilled, penetration depth, and approximate depth to bedrock and the first occurrence of groundwater are listed for each boring in Table 1. Detailed logs for each of the borings are presented in Appendix A.

2.2.1 Drilling Methods

The borings were advanced by using one or a combination of drilling methods (Table 1). Borings B-10, B-13 and B-14 were advanced by 6- to 8-inch diameter hollow-stem augers until the method could not penetrate further (refusal depth), at which time mud-rotary coring was used to continue the borings to completion. Boring B-15 was entirely drilled to completion using a bucket-auger rig which resulted in a 24-inch diameter borehole. The remaining borings were drilled using 6- to 8-inch diameter hollow-stem augers.

Several methods were used for those borings drilled on La Brea Avenue. Borings SM-1, SM-1A, and SM-1B were punch cored to refusal and completed to final depth by diamond coring. Both of these methods employ a wireline-retrieval system using both 5-foot long split- and solid-inner tubes to recover the core. A tungsten carbide bit was used during punch coring, and impregnated and surface set diamond bits were used in harder material. Borings SM-1C and SM-1D were drilled by hollow-stem auger.

The depths of the borings are shown on Table 1. The borings drilled during Phase 1 ranged from 90.5 feet to 240 feet deep, while Phase 2 borings ranged from 50 feet to 120.5 feet deep. Phase 3 borings ranged in depth from 50 feet to 60.5 feet and Phase 4 borings ranged from 45.5 feet to 199 feet deep.

TABLE 1. SUMMARY OF DRILLING PROGRAM

	Boring No.	Dates Drilled (1992)	Method (1)	Approximate Ground Surface Elevation (ft)	Total Depth (ft)	Depth to Bedrock (ft)	Depth to Groundwater (ft)
Phase 1	B-9	6-29	HSA	507.5	90.5	None Encountered	None Encountered
	B-10	6-15 to 6-20	HSA/RC	515.5	240	114.5, 178.5 (2)	43 (3)
	B-11	6-30	HSA	502.0	90.5	None Encountered	None Encountered
	B-12	7-1 to 7-2	HSA	512.0	96.5		90 (3)
	B-13	7-3 to 7-10	HSA/RC	532.5	155	17.5	47 (3)
Phase 2	B-14	7-29 to 7-31	HSA/RC	523.5	120.5	45	None Encountered (4)
	B-15	8-4 to 8-5	BA	519.0	50	None Encountered	45 (3)
	B-16	8-6	HSA	519.0	102.5	None Encountered	47 (3)
	B-17	8-8	HSA	514.5	99.5	None Encountered	55 (3)
Phase 3	B-18	9-3	HSA	514.0	50	None Encountered	48.5 (3)
	B-19	9-10	HSA	512.0	50	None Encountered	None Encountered
	B-20	10-7	HSA	509.5	50	None Encountered	None Encountered
	B-22	9-9	HSA	491.0	60.5	None Encountered	None Encountered
	B-24	9-10	HSA	486.0	57	None Encountered	None Encountered
	B-27	9-3	HSA	474.5	54.5	None Encountered	None Encountered
	B-31	9-8	HSA	464.0	54.5	None Encountered	None Encountered
	B-34	9-4	HSA	453.0	56	None Encountered	None Encountered
	B-38	9-9	HSA	440.0	54.5	None Encountered	None Encountered
	B-41	9-1	HSA	429.5	54.5	None Encountered	None Encountered
	B-42	8-31	HSA	418.5	54.5	None Encountered	None Encountered
	B-43	8-31	HSA	410.0	60.5	None Encountered	None Encountered
	B-44	9-1	HSA	405.5	54.5	None Encountered	None Encountered
	B-45	9-2	HSA	396.5	54.5	None Encountered	None Encountered
	B-46	9-2	HSA	385.5	54.5	None Encountered	None Encountered

Notes:

(1) HSA: Hollow- Stem Auger
RC: Rotary Core
BA: Bucket Auger
PC: Punch Core

(2) Bedrock found overlying alluvium at two depths

(3) Groundwater encountered during drilling (apparently perched)

(4) Switched to mud rotary at 36 feet

(5) Bedrock found overlying alluvium

(6) Piezometer installed, static water level

(7) Static water level

(8) Piezometer screened below the fault within the tunnel zone
Upon development, piezometer was dry

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TABLE 1. SUMMARY OF DRILLING PROGRAM (Continued)

	Boring No.	Dates Drilled (1992)	Method (1)	Approximate Ground Surface Elevation (ft)	Total Depth (ft)	Depth to Bedrock (ft)	Depth to Groundwater (ft)
Phase 4	SM-1	11-6	PC/RC	468.5	199	45 (5)	9.5 (7)(8)
	SM-1A	11-18	PC/RC	491.5	180	8	16.4 (6)
	SM-1B	11-24	PC/RC	484.5	170	29 (5)	13.4 (7)
	SM-1C	12-17	HSA	481.0	80	46 (5)	24.0 (3)
	SM-1D	12-21	HSA	476.5	45.5	33.5 (5)	41.5 (3)

Notes:

(1) HSA: Hollow- Stem Auger
RC: Rotary Core
BA: Bucket Auger
PC: Punch Core

(2) Bedrock found overlying alluvium at two depths

(3) Groundwater encountered during drilling (apparently perched)

(4) Switched to mud rotary at 36 feet

(5) Bedrock found overlying alluvium

(6) Piezometer installed, static water level

(7) Static water level

(8) Piezometer screened below the fault within the tunnel zone
Upon development, piezometer was dry

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2.2.2 Sampling Methods

Continuous samples were obtained from the borings beginning at a depth of 5 feet below the ground surface. The upper 5 feet of each of the borings was excavated by hand as a precaution to check the possible presence of buried utility lines. In most cases, native materials were able to be identified at 5 feet in depth so deeper hand augering was unnecessary. Where utilities were suspected or actually encountered, the boring was moved to one side and the process was repeated. Continuous drive samples were obtained during hollow-stem auger drilling to completion or refusal. An unlined California-type drive sampler (3-inch O.D.) was used to obtain the soil samples. The sampler was driven 18 inches into the soil using a down-hole hammer with a 140-pound hammer falling 30 inches directly on the sampler. A 300-pound uphole hammer (dropping on rods attached to the sampler) was used to sample Boring B-10 only. After the sampler was retrieved from the boring, the sample barrel was split and the recovered soil was placed in a waxed-cardboard core box. The samples, as they were obtained, were systematically placed in the core box from left to right and from top to bottom. Wooden spacer blocks, labeled with the sample number and depth were placed at the beginning of each sampled interval.

For those borings that needed to be advanced beyond the hollow-stem auger refusal depth (B-10, B-13 and B-14), wireline mud-rotary coring was used. Coring was accomplished in alluvial and soft bedrock materials using several different types of HQ-sized tungsten carbide bits. An HQ-sized surface-set diamond bit was used for harder bedrock materials. Core-bit types and changes are noted on the boring logs. A 10-foot long split inner barrel was used to recover the core. After completing a core run, which ranged from 3 inches to 9.5 feet in length, the inner barrel was extracted from the drill-rod column. At the surface, the inner barrel was split open and the recovered core was transferred to waxed-cardboard core boxes in the manner described above for the drive samples.

The bucket-auger boring, B-15, was sampled by a Certified Engineering Geologist after drilling was completed. Continuous soil samples were collected from the sidewall of the boring beginning at a depth of approximately 5 feet to a depth of approximately 45 feet. The samples were placed in labeled zip-lock plastic bags with each bag containing material from a 6-inch interval. Bulk samples were also collected from the distinctive soil horizons encountered in the boring.

2.2.3 Logging Methods

Drive samples and cores obtained from the borings were logged and photographed by a Certified Engineering Geologist (CEG) registered in California. The walls of the bucket-auger boring were examined and logged in detail downhole by the CEG. A standard format log was completed for each boring (Appendix A) by the CEG.

The alluvial materials encountered were described in accordance with the Unified Soil Classification System (USCS). Descriptions include material type, color, moisture, density or consistency, texture or plasticity of the dominant constituent, amount and sizes of secondary constituents, and other descriptors such as porosity, carbonate and soil structure. Colors used in the descriptions were selected by comparison with the Munsell Soil Color Chart. In providing a color description, the color chip or a range of color chips closest to the actual color of the soil was noted on the log. The Munsell-Soil Color Chart provides a standardized method to describe the color of soils by name, hue, value, and chroma. Thus, dark reddish brown (5YR 3/2) is defined by hue (5YR), value (3) and chroma (2). The hue notation of a color indicates its relation to Red, Yellow, Green, Blue, and Purple; the value notation indicates its lightness, and chroma notation indicates its strength (Munsell Color, 1992).

Bedrock descriptions include the rock type, color, moisture, texture, degree of weathering and other characteristics, such as the nature of structural discontinuities, cementation and mineralogy. The Rock Quality Designation (RQD) was also calculated for each core run in bedrock. Colors used in the description for rock are based on the Rock Color Chart published by The Geological Society of America (1991) which is based on the Munsell system.

2.2.4 Boring Abandonment Methods

Each boring, with the exception of bucket-auger Boring B-15, was abandoned by backfilling the boring with a Portland cement-bentonite mix. The upper 6 inches to 2 feet of each boring was filled with asphalt to the road surface. The bucket-auger boring was filled with concrete from the bottom of the boring to a depth of 14 feet below the ground surface. After allowing the concrete to harden, a Portland cement (3/4 sack mix) and sand mix was placed from 14 feet to within 2 feet of the road surface. The remaining 2 feet of the boring was filled with asphalt to the road surface.

2.2.5 Piezometer (Observation Well) Installations

Piezometers were installed in Borings SM-1 and SM-1A. The piezometers were constructed to evaluate the groundwater conditions adjacent to the Hollywood fault. Both 1- and 2-inch diameter Schedule 80 PVC flush-threaded casing and screen were used to construct the piezometers. Well screen with 0.01-inch slots and #2/12 Monterey filter sand were used to construct the piezometers because of the high percentage of fine-grained materials encountered by the borings. A seal consisting of hydrated bentonite pellets and chips were placed over the filter sand. The remaining portion of the boring was filled with a portland cement-bentonite slurry to within approximately 1 foot of the ground surface. A steel traffic box was set in the cement level with the road surface. Specific details associated with the installation of the piezometers are provided in Appendix B.

2.3 FIELD EXPLORATION PHASES

The phased approach to exploration was necessary for this study because planning of subsequent phases depended on results from the prior phases. A total of four phases of field investigations were developed. An explanation of each phase is presented below with discussions of purpose and findings.

2.3.1 Phase 1

The Phase 1 program consisted of drilling and sampling five exploratory borings (B-9 through B-13), located on the east side of Camino Palmero north of Franklin Avenue (Plate 1). These borings were drilled between June 15 and July 10, 1992. The principal objectives of this phase of our investigation were to:

- Evaluate fault traces mapped through the area by Dibblee (1991).
- Evaluate a topographic anomaly identified by Dolan and others (1992) that appears to correspond with Dibblee's mapped Santa Monica fault trace (south strand of the Hollywood fault zone).
- Evaluate the abrupt difference in the depth to bedrock observed between two borings (B-7 and B-8) drilled in the area during an earlier investigation (Earth Technology, 1992). Logs are included within Appendix A.
- Evaluate the width of the fault zone and nature of the alluvium, fault zone, and bedrock transition at the tunnel invert depth.

Boring B-10 was located near previously drilled Boring B-8. It was drilled with a hollow-stem auger (HSA) rig to 62 feet and a rotary wash core rig to a depth of 240 feet in an attempt to penetrate bedrock (granitic rock) suspected to be in fault contact with alluvium beneath the bedrock (hanging wall). Continuous sampling was attempted with recovery of approximately 77 percent from HSA and 45 percent from rotary wash methods of drilling. Three shallow HSA borings (B-9, B-11 and B-12) were drilled downslope of

Boring B-10, each to a depth of approximately 90 feet, to check continuity of distinct soil horizons observed in Boring B-10. Boring B-13 was drilled by HSA to 51 feet and rotary cored to a depth of 155 feet where it terminated within the planned tunnel crown. This boring was required to help characterize the rock conditions at tunnel depth, upslope of the fault zone observed in Boring B-10, and to provide information on the thickness of alluvium adjacent to the mountain front. The thickness of alluvium was important to evaluate the presence or absence of the fault trace (north strand of the Hollywood fault zone) inferred by Dibblee (1991) at the north end of Camino Palmero.

2.3.2 Phase 2

Phase 2 consisted of drilling four borings (B-14 through B-17, Plate 1) between July 29 and August 8, 1992. The borings were located on the east side of Camino Palmero north of Franklin Avenue. Except for Boring B-15, which was a bucket auger boring, the borings were drilled with a hollow-stem auger rig and rotary wash conversion after hollow-stem augering was not possible.

The intent of the Phase 2 borings was to determine the bedrock surface for evaluating possible fault traces between Borings B-10 and B-13, and to confirm the dip of the gouge zone previously identified in Boring B-8. These borings provided data on the depth, types, continuity and thickness of the shallow soils identified during Phase 1 that were used to recognize offsets due to faulting. Boring B-14 was drilled adjacent to Boring B-8 (Earth Technology, 1992). Boring B-8 was drilled during a previous study and was cored only in the tunnel zone. The alluvium overlying the bedrock was not sampled in Boring B-8. Boring B-14 provided a continuous record of the soils overlying the bedrock and helped locate the bedrock surface with greater confidence than could be interpreted from the results of Boring B-8. The boring also helped confirm the dip of the fault gouge zone disclosed in Boring B-8. Boring B-15, was located between Borings B-10 and B-14. It was drilled with a bucket auger rig to allow direct observation of the soils and possible offsets of soil in situ, and to establish the bedrock surface. This boring was terminated at a depth of 50 feet after encountering groundwater, and severe sloughing and caving of the side walls below the water table. Boring B-16 was drilled by hollow-stem auger adjacent to Boring B-15 and was advanced past the groundwater-bearing zone to a depth approximately 25 feet below the bedrock surface. Boring B-17 was the last boring drilled during Phase 2. It was located between Borings B-10 and B-12 to refine the position of the fault interpreted between them and to provide additional data on the youngest faulted soils.

2.3.3 Phase 3

After evaluating the results of Phases 1 and 2, Phase 3 exploratory borings were drilled between August 31 and October 7, 1992. Phase 3 consisted of 15 hollow-stem auger borings (B-18, B-19, B-20, B-22, B-24, B-27, B-31, B-34, B-38 and B-41 through B-46) ranging in depth between 50 feet and 60.5 feet.

These borings were located on the west side of Camino Palmero north of Franklin Avenue, on the north side of Franklin Avenue near its intersection with Camino Palmero, on the west side of Camino Palmero between Franklin Avenue and Hollywood Boulevard, and on the east side of Martel Avenue between Hollywood Boulevard and Hawthorn Avenue (Plate 1).

The purpose of the Phase 3 borings was to evaluate the continuity of the uppermost and older soils south of the area explored during Phases 1 and 2, and to assess whether or not these soils have been affected by faulting. In addition to evaluating the potential for faulting to the south, three borings (B-18 through B-20) were drilled across from Borings B-12 and B-17 on Camino Palmero. These borings were drilled to evaluate the thickness variations of the youngest faulted soils observed during the previous phases. These data were needed for use by Dr. Sieh and Dr. Dolan to assess the style of faulting, fault activity and magnitude of slip per earthquake.

2.3.4 Phase 4

The exploratory borings drilled during the fourth phase were completed between November 6 and December 21, 1992. A total of five borings were drilled, with two (SM-1C and SM-1D) completed as part of this study and the remaining three (SM-1, SM-1A, and SM-1B) completed as part of the geotechnical investigation of the tunnel segment through the Santa Monica Mountains. These borings are located on the west and east sides of La Brea Avenue north of Hillside Avenue (Plate 2) and ranged in depth between 45.5 feet and 199 feet.

The purpose of the Phase 4 borings was to evaluate the nature of the Hollywood fault zone and bedrock and groundwater conditions in an area located near the La Brea Avenue tunnel alignment and to confirm the consistency of the observations made at Camino Palmero. Boring SM-1 was drilled by rotary methods to intercept the fault zone at depth and to characterize the subsurface conditions within the tunnel zone. Since Boring SM-1 encountered the anticipated fault relationship (alluvium occurring beneath bedrock) at a depth above the tunnel crown, Boring SM-1A was placed north of the boring to evaluate the rock and groundwater conditions at tunnel depth upslope of the fault zone. Boring SM-1B was drilled adjacent to Boring SM-1 by rotary methods in order to evaluate the inclination of the fault zone encountered in Boring SM-1. Borings SM-1C and SM-1D were located downslope of Boring SM-1 with the intent of penetrating the fault plane in the shallow/younger soils occurring near the ground surface. Borings SM-1C and SM-1D were drilled by hollow-stem auger.

Piezometers were installed in Borings SM-1 and SM-1A to monitor groundwater levels on both sides of the fault zone.

2.3.5 Phase 5

Phase 5 consisted of evaluating the shallow soils exposed in a trench that was excavated during the construction of a storm drain on Vista Street. The trench which began at Hollywood Boulevard extended north on Vista Street and ended north of Hillside Avenue. The trench was located on the east side of Vista Street and ranged in depth from 10 feet to 13 feet. The trench was logged by Dr. James Dolan while construction progressed from Hollywood Boulevard. He was assisted by an Earth Technology certified engineering geologist after the excavation reached Franklin Avenue. The trench north of Franklin Avenue was logged between April 5 and April 8, 1993.

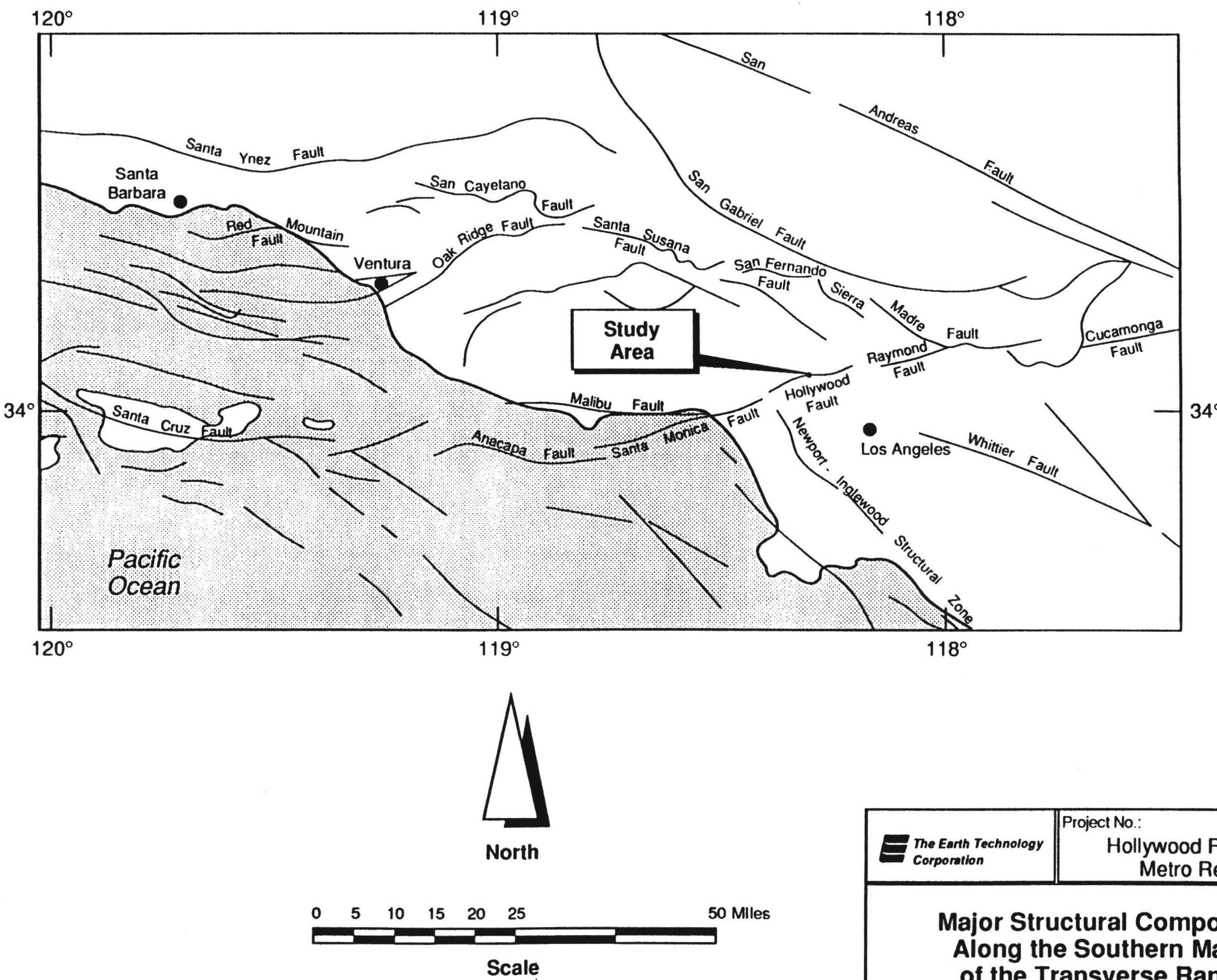
The trench excavation was logged in order to evaluate if the Hollywood fault has displaced the shallow alluvial soils exposed by the trench. Based on the results of the previous phase and the data obtained from the Los Angeles sewer tunnel as-built documents, in our opinion the most likely place where the trench would intersect the trace of the fault was between Franklin and Hillside Avenues.

3.0 GEOLOGIC CONDITIONS

3.1 GENERAL GEOLOGIC SETTING

The Hollywood fault zone occurs along the base of the Santa Monica Mountains where it separates uplifted bedrock units located north of the fault zone from alluvial deposits present to the south. The fault zone is part of a major tectonic boundary that separates the Transverse Ranges geomorphic province on the north from the Los Angeles basin and Peninsular Ranges province to the south. Major Transverse Ranges structural components of this boundary in the general region include the Santa Cruz Island, Anacapa, Malibu Coast, Santa Monica, Hollywood, Raymond, Sierra Madre and Cucamonga faults (Figure 3). The Santa Monica fault zone is reported up to approximately 2.5 miles south of the mountain front and is expressed as a series of topographic scarps that extend eastward from Santa Monica Bay to the Newport-Inglewood fault at Beverly Hills. Beyond (east) Beverly Hills, there appears to be no topographic or geomorphic evidence of the Santa Monica fault zone in a straight line projection to the east, rather it seems to step over to the Hollywood fault (Figure 3). Recent paleoseismologic and geomorphic studies along the trace of the fault zone in West Los Angeles suggest probable Holocene activity of the Santa Monica fault zone (Dolan and others, 1992).

The Hollywood fault zone as mapped by Weber (1979) is primarily expressed at the ground surface by an aligned series of south-facing faceted ridges and topographic scarps in the alluvial deposits near the base of the range front. The presence of these youthful geomorphic features suggests that the Hollywood fault zone is possibly of Holocene age (Ziony and Jones, 1989; and Ziony and Yerkes, 1985). According to State of California guidelines, a Holocene age fault is active (Hart, 1990). The recent California Division of Mines and Geology (CDMG, 1992) publication, Preliminary Fault Map of



From: Morton and Yerkes, 1987.

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Major Structural Components Along the Southern Margin of the Transverse Ranges

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Figure 3

California, indicates that the Hollywood fault is Holocene in age. Weber's Hollywood trace is identical to the Santa Monica fault shown on Dibblee's (1991) map (Figure 2). The tendency to interchange the Santa Monica fault designation for the Hollywood fault east of the Beverly Hills area has created confusion in published literature. For clarity in this report we will refer to the fault traces east of the Newport-Inglewood fault as the Hollywood fault zone and those mapped by Dibblee (1991) as the north strand and south strand of the Hollywood fault zone.

The Hollywood fault zone trends generally in an east-northeast direction parallel to the base of the steep south-facing flank of the Santa Monica Mountains. Basement rocks north of the fault zone have been juxtaposed against younger rocks and alluvial deposits present to the south. The overall sense of movement is reverse slip with a significant left slip component resulting in uplift of the north side relative to the south side of the fault. The dip of the fault zone is not well documented from available data but may vary between vertical and 60 degrees to the north, if based primarily on the inclination of sedimentary rocks in its vicinity and on the presence of a steep gravity gradient that coincides with the fault zone at depth (Weber, 1979). The geologic records for the Los Angeles City Sewer Tunnel (Department of Public Works, 1954-1955) construction indicate a gouge zone and fault zone that is approximately 150 feet in width at the south portal of the tunnel. Shear planes and dominant structural trends documented for the tunnel construction indicate an east-west strike and a 10 to 15 degree northward dip (Department of Public Works, 1954-1955). The tunnel portal where the fault was encountered is located directly west of Sierra Bonita Avenue at Wattles Park approximately 1,000 feet west of Camino Palmero or 2,200 feet west of the proposed Metro Red Line tunnel near La Brea Avenue.

The location of the Los Angeles City Sewer Tunnel portal area is shown in Plate 3 with a geologic cross section of the south portal of the tunnel interpreted from the as-built geology logs of the tunnel construction and exploratory borings for the trench excavation south of the portal. Also shown on the cross section are the approximate locations of exploratory trenches excavated across the fault at Wattles Park by Crook and Proctor (1992). The trenches appear to have spanned across the main fault trace (transition between alluvium and bedrock) but no evidence of offset alluvium was reported.

During our review of the boring logs for the Los Angeles City Sewer trench excavation in 1954, we noted that the alluvium had been logged as decomposed granite (Plate 3). If this terminology was also used to describe the tunnel geology, the main fault contact between alluvium and granitic rock may be at station 352+20 in Plate 3. This is possible because the alluvium and decomposed granite are similar in appearance where the alluvium is derived from the granitic materials. Alternatively, if the decomposed granite is correctly identified in the tunnel log, then the main fault trace would lie south of the tunnel portal as queried in Plate 3.

3.2 SUBSURFACE CONDITIONS AND EVIDENCE OF FAULTING

3.2.1 Camino Palmero

Evidence of the presence of the Hollywood fault zone on Camino Palmero was observed from the information obtained from borings drilled during Phases 1 and 2 of this study. Cross section A-D (Plate 1) represents our interpretation of the subsurface conditions based on the borings drilled during the first three phases. The most important boring for interpreting the geologic structure is Boring B-10 which passes through two fault planes that juxtapose granitic rock (quartz diorite) over alluvium as described below.

Boring B-10 encountered 109.5 feet of alluvial materials overlying weathered quartz diorite. The quartz diorite continues to a depth of 130.7 feet where it is faulted against alluvium underlying the quartz diorite. Quartz diorite was encountered again at a depth of 178.5 feet. At a depth of 198.5 feet, alluvial materials were again encountered which continue beyond the bottom of the boring at a depth of 240 feet. Based on these data, it appears that at least two distinct fault planes were observed in Boring B-10. The base of the bedrock intervals at 130.7 feet and 198.5 feet are fault contacts between the bedrock and underlying alluvium. This implies that the bedrock has been uplifted and faulted on top of alluvium at 130.7 feet and 198.5 feet in depth. This relationship is expected given that the Hollywood fault is a reverse-slip fault with a strike-slip component of slip.

The alluvium encountered in Boring B-10 generally consists of yellowish brown fine- to coarse-grained sand with varying amounts of silt and clay. Gravel, consisting predominantly of weathered and decomposed clasts of quartz diorite, occurs as thin beds or lenses within a sandy matrix or is scattered throughout as isolated clasts. Less common are clasts composed of hard rounded quartzite, weathered volcanics (primarily basalt), weathered mafic plutonic rocks, friable sandstone and siliceous shale. The alluvium in the upper 15 feet is generally very friable because of the absence or limited amount of clay. A distinctive argillic pedogenic soil horizon occurs in the upper part of Boring B-10 from a depth of about 30 feet to 43 feet. This interval is typically very clayey and has a dark brown color indicative of some organic content. Scattered charcoal fragments were observed and were collected and provided to Dr. Dolan for age-dating purposes. Reported results indicate the dark brown soil is pre-Holocene in age (Sieh, 1993). Dark reddish brown clayey soils were observed overlying the bedrock as well. Shears were observed in the cores of bedrock and alluvium at various depths. The shears are typically clay and/or carbonate lined and are generally inclined about 70 degrees or steeper.

Bedrock was encountered in Borings B-13, B-14 and B-16 at depths of 17.5, 45 and 73.5 feet, respectively. These borings were all located upslope from B-10. The depths to bedrock from these borings and B-10 indicate a very rapid, likely stepped dropoff of the buried bedrock surface and is indicative of faulting between these borings. The inclination of the bedrock surface defined between Borings B-13 and B-14 is in agreement with the general slope of the bedrock mountain front and likely represents an erosional surface that is not affected by faulting (Plate 1), and is buried by the alluvium.

These data preclude an offset of the bedrock surface at Dibblee's inferred location of the Hollywood fault (north strand) at the upper end of Camino Palmero (Dibblee, 1991). It is not likely that a fault trace exists at the upper end of Camino Palmero. The actual mountain front at the alluvium appears to be a buried fault-line scarp rather than the actual fault trace. Borings B-16 and B-10 indicate a rapid drop-off of the bedrock surface south of B-14 which helps locate at least two faults that offset the bedrock surface. As shown in Plate 1, we have interpreted one fault related to the clay gouge zone penetrated in Borings B-8 and B-14. Another fault is interpreted between Borings B-10 and B-16 because the bedrock surface steps down again. Based on these data, the Hollywood fault appears to consist of a main fault trace where granitic rock is faulted against alluvium and severely weathered and sheared granitic rock that extends for a distance of 100 feet to 120 feet north of the main fault trace. Numerous fault planes and gouge zones comprise the sheared bedrock with a decreasing frequency of shearing north of the main fault trace. Other shears likely exist within the bedrock north of the main shear zone.

A distinctive dark brown paleosol soil was encountered in all of the borings across the area of interpreted faulting. The dark brown soil is the shallowest well-developed paleosol and youngest pedogenic soil with the exception of the modern surface soils. The dark brown soil appears to be continuous and unaffected by faulting except between Borings B-12 and B-17 where it appears to be down dropped on the north relative to the south side of a fault projecting upward from 130.7 feet in depth at Boring B-10. Continuity of the dark brown soil both south of Boring B-12 and north of Boring B-17 indicates that faulting has either not occurred in those areas since the soil developed, or that vertical offsets have been too small to be detected by the investigative techniques used. The youngest faulting event(s) appears to be isolated between Borings B-12 and B-17.

The upper dark brown soil occurs as two distinctive soils in Boring B-12 and southward, whereas in Boring B-17 and northward it generally occurs as a single thick soil wedge or two less distinct soils that thin to the north as the alluvium laps up onto the erosional bedrock surface at the mountain front. The thickened dark brown soil and the fact that it is down dropped relative to the soil in Boring B-12 suggest that the soil was developing while surface faulting events occurred. The thick wedge of soil north of the fault appears to have developed in a topographic depression or was perhaps trapped by an uphill-facing fault scarp that developed during surface faulting. This could have occurred as single or multiple surface-faulting events. Another possibility for the observed relationship is the development of the dark brown soil at different locations along the mountain front followed by lateral faulting that juxtaposed the two soils at the site of exploration. In our opinion, this is unlikely because of the apparent low level of fault activity and the general regularity of soil development south of boring B-12 on Camino Palmero indicating consistent wide-spread pedogenic soil development conditions extending beyond the possible limits of lateral offset.

3.2.2 La Brea Avenue

The Hollywood fault zone was encountered again at La Brea Avenue based on the information obtained from the borings drilled during Phase 4. Cross section E-F (Plate 2) illustrates our interpretation of the subsurface conditions based on the borings drilled during this phase and during our geotechnical investigation of the tunnel segment planned through the Santa Monica Mountains. Boring SM-1 was the key boring for evaluating the fault zone at La Brea Avenue and the locations of subsequent borings were based on its findings.

Boring SM-1 encountered approximately 45 feet of alluvium overlying highly weathered quartz diorite. The quartz diorite continues to a depth of 93 feet where it is faulted against shale of the Puente Formation underlying the quartz diorite. At a depth of 115 feet, alluvium is again encountered and it continues beyond the bottom of the boring at a depth of 199 feet. Based on these data, it appears that a distinct fault zone was observed in Boring SM-1 and implies that the bedrock material has been uplifted and faulted over the alluvium at a depth of 115 feet. The Puente Formation shale was also encountered in Boring SM-1B at a depth of 105 feet where it occurs beneath quartz diorite. Samples from Boring SM-1 were sent to Micropaleo Consultants, Inc. for microfossil and pollen identification. The results indicate a Middle to Late Miocene age for the shale with preference given to the later. This would correspond to the Puente Formation, an age equivalent to the Modelo Formation in the Los Angeles basin area. Quartz diorite bedrock was encountered again below the Puente Formation at a depth of 120 feet and continues to 143 feet. At 143 feet, alluvium was found to continue to the depth explored.

The alluvium encountered in Boring SM-1 generally consists of dark brown to reddish brown clayey sand to sandy clay. The sand ranges from fine to coarse grained with thin intervals of predominantly coarse grained sand present. Gravel is rare with clasts composed mostly of weathered plutonic (quartz diorite) rock. The high clay content and dark color of the alluvium contrasts with the yellowish brown, very friable sediments encountered in the shallow subsurface at Camino Palmero. The characteristics of the alluvium are similar to the dark brown paleosol encountered in Boring B-10 at a depth of 30 feet at Camino Palmero and may be of a similar age. This material was also found in Borings SM-1B, SM-1C and SM-1D. This indicates that the younger soils of possible Holocene age are absent at La Brea Avenue.

Each of the borings encountered bedrock at various depths. The bedrock consists of highly weathered to completely weathered plutonic rock having a quartz diorite to granodiorite composition and Puente Formation shale. The plutonic rock is typically very friable having been weathered mostly to yellowish and orangish coarse to very coarse sand- and gravel-sized material. Intervals of sheared clay gouge are common and fractures are generally lined with clay or soft calcium carbonate or are stained. The buried bedrock surface, based on the borings, appears to rapidly descend to the south between Borings SM-1A and SM-1 and then flattens between Borings SM-1 and SM-1C. The bedrock surface rises between Borings SM-1C and SM-D, sloping to the north in the opposite direction. Based on the borings, the buried bedrock surface appears to define a topographic depression that may be controlled by faulting forming a small graben structure.

Puente Formation shale was penetrated by Borings SM-1 and SM-1B. The shale is generally olive gray to black in color, laminated and has intervals of clay gouge interstratified. Laminae are inclined from 40 degrees to 70 degrees with intermediate inclinations being most common. In Boring SM-1B, the interstratified zones of gouge contain fragments of quartz diorite that range in size from coarse sand to gravel. The sliver of Puente shale may extend as far as boring SM-1C where a thin zone of sheared clay occurs between the weathered quartz diorite and underlying alluvium. Puente Formation materials were not observed in Borings SM-1A or SM-1D.

Alluvium was encountered again underlying the bedrock materials in each of the borings (except SM-1A which encountered plutonic rock). The underlying alluvium is generally dark reddish brown to brown and consists of clayey sand, sandy clay and clay with infrequent intervals of friable silty sand, sand and gravel. Calcium carbonate-lined fractures and unlined shears were observed in Boring SM-1.

The main fault trace is interpreted to correspond with the transition between bedrock and underlying alluvium. The inclination of the fault plane, based on the borings, is approximately 60 degrees and flattens to approximately 30 degrees south of Boring SM-1. The topographic depression in the buried bedrock surface occurs above the bend in the fault plane and could represent a graben structure that formed in response to local tensional stress developed over the change in dip of the fault plane.

3.2.3 Vista Street

The Vista Street storm drain trench excavation exposed two distinct buried soil horizons buried beneath massive, friable alluvium and fill. None of these materials revealed any evidence of displacement across the estimated trace of the Hollywood fault (Dolan, 1993; Appendix E). The friable surficial alluvium and uppermost buried soil overlie a much better developed reddish-brown clayey soil. The reddish brown soil was intermittently exposed only in the deepest sections of the trench excavation and for this reason it could not be clearly demonstrated to overlie the fault zone continuously as an undisturbed horizon. The uppermost soil however, was logged continuously across the suspected trace of the fault. The upper surface of the uppermost soil is irregular due to channelization, but it is undisturbed by faulting. This indicates that no surface faulting earthquake has occurred since deposition of the friable surficial alluvium.

3.3 AGE OF FAULTING

The results of carbon dating of the youngest paleosol and overlying alluvial sediments was evaluated by Dr. James Dolan who collected carbon samples from a storm drain trench on Fuller Street. Results indicate that the upper friable soils and alluvium are Holocene in age. The shallowest dark brown paleosol is believed to be pre-Holocene in age (Sieh, 1993). These data are reported in a separate document prepared by Dr. Sieh (1993), a copy of which is attached in Appendix D. For this report the ages of the sediments and soil are interpreted from a combination of carbon dating, general geomorphology, stratigraphy and pedogenic soil development to estimate the latest age of faulting.

The Camino Palmero site is located on a well developed conical shaped alluvial fan at the mouth of Runyon Canyon. The apex of the fan coincides with the mouth of Runyon Canyon and the flanks of the fan radiate symmetrically extending roughly from La Brea Avenue to Vista Street and as far south into the basin as Sunset Boulevard. The Runyon Canyon fan is superimposed on the broad alluvial surface that spreads across the basin. The fan formed as pulses of sediment washed out of Runyon Canyon as alluvium and mud flows and were deposited at the foot of the Hollywood Hills. No lateral offset of this fan from its source area is apparent. However, the conical shape of the fan at the mountain front indicates tectonic uplift of the mountains.

As climates changed locally during the late Pleistocene and Holocene, the fan surface underwent weathering, oxidation and other pedogenic processes that formed organic and argillic (clayey) soils. In the borings, we located numerous buried soils indicating pedogenic soil development on the fan surface, burial by younger sediment and soil development again. This cyclical pattern of repeated burial preserved at the Camino Palmero site indicates a long history of sedimentation and pedogenesis that is suggestive of both climatic changes and possible tectonic uplift. For the purposes of this report, the upper sediments (clayey and friable) and the shallowest clayey paleosol (buried soil approximately 20 to 30 feet below the ground surface) are the most significant to interpreting the latest age of faulting. Other deeper paleosols exist but are not discussed other than to say the dark red hue and chroma (1OYR) of the soils combined with the pedogenic clay are indicative of great antiquity, probably older than 100,000 years.

Evidence of faulting in the sediments that bury the dark brown clayey paleosol is not visible in the core and drive samples. This may be due to the virtual absence of clay content in the younger sediments and the friable nature of the sediments (cores crumble when handled). The sediments that directly overly the dark brown paleosol thicken between Borings B-17 and B-12 giving the appearance of vertical offset and resultant thickening of the sediments where the paleosol is faulted downward. Thus, we interpret the alluvium overlying the youngest clayey paleosol to be faulted as well. The friable sediments, which are youngest of all, do not appear to be affected by faulting within the resolution possible from borehole data.

The age of the friable sediments is inferred to be Holocene because of the following evidence:

- Results of carbon-age dating of sediments from boring B-15 and similar sediments that were exposed in a storm drain trench on Fuller Avenue indicate a Holocene age (Sieh, 1993).

- The absence of a pedogenic clay horizon in the sediments and the new organic soil development at the ground surface preclude long-term argillic soil development, which is exclusively Pleistocene in age in southern California.

Evidence for the buried argillic soils being late Pleistocene is as follows:

- Results of carbon dating of the dark brown paleosol indicate a late Pleistocene age (Sieh, 1993).

- The depositional conditions appear to favor episodic deposition and pedogenesis without much erosion resulting in a nearly continuous time record in the stratigraphy. Erosion of the older soils is unlikely as they have been protected and preserved by the overlying friable alluvial sediments.

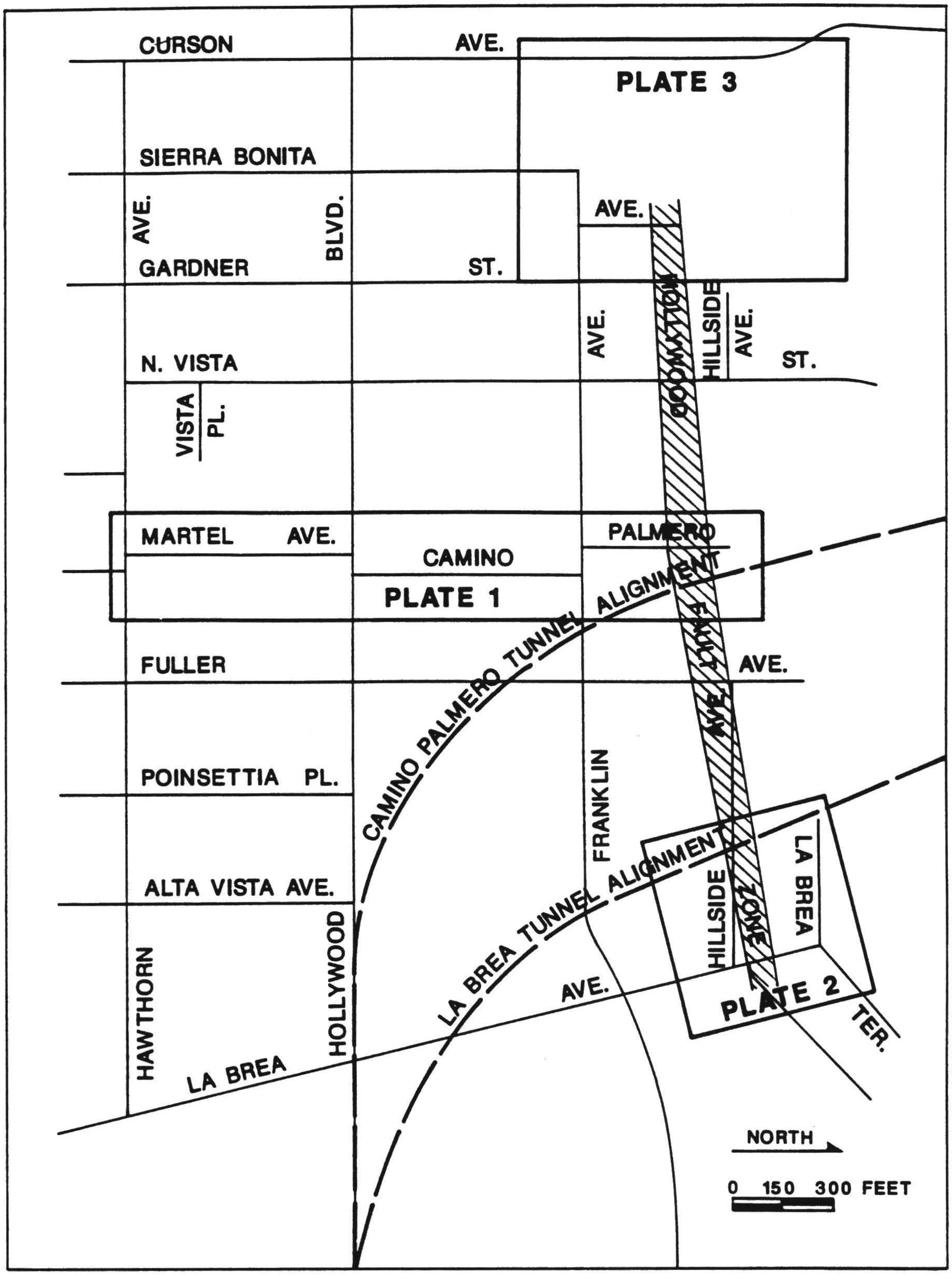
- The underlying buried soils at the site are clearly late Pleistocene in age because of the high clay content, moderately strong pedogenic texture, clay coatings on clasts and grains, and dark brown and reddish brown soil color (5YR and 10YR) (developed through long exposure to an oxidizing environment).

Based on the results of carbon dating at Fuller Street reported by Dr. Sieh (1993), the pedogenic and geomorphic evidence supports a Holocene age of the friable upper sediments at Camino Palmero Street and Vista Street. These sediments do not seem to be affected by faulting. Given the age of buried paleosols as Late Pleistocene there could be as much as 8 feet of vertical separation of the Late Pleistocene soils as measured on Section A-D in Plate 1. The conclusions drawn from the field exploration are that no surface faulting events have occurred on the Hollywood fault for at least one to two thousand years and that surface faulting probably occurs infrequently but is possible in the future.

3.4 GEOLOGY AT TUNNEL INVERT

The transition from the bedrock of the Santa Monica Mountains to the basin alluvium will occur at the Hollywood fault zone. Although site exploration is not possible at the current alignment (Figure 4) to pinpoint the exact location of the fault and describe rock conditions, the information obtained from borings at Camino Palmero and La Brea Avenue allows a representative understanding of anticipated conditions.

The detailed investigations at Camino Palmero indicate that the alluvium-bedrock transition occurs as a sharp break controlled by faulting. Plate 1 shows an abrupt, nearly vertical contact of alluvium on the south versus highly weathered and sheared quartz diorite on the north at a tunnel depth of approximately 160 feet below the ground surface. The quartz diorite is highly weathered to a residual soil texture (or decomposed granite) as indicated in Boring B-10. At Boring B-8, the quartz diorite is severely sheared and consists of clay gouge and rock fragments. The rock between Borings B-8 and B-10 is inferred to be highly sheared and fractured for a distance of 90 feet along the planned tunnel. Boring B-13 was also cored to the depth of the tunnel to check if such poor rock quality was present farther into the bedrock (north). Boring B-13 is located approximately 80 feet north of Boring B-8. A very thick weathered zone was encountered in Boring B-13 to a depth of at least 90 feet. The rock in this interval has been mostly decomposed to a friable material that is intensely sheared and in places brecciated. Intervals of clay gouge were also observed. In this boring, the rock below 90 feet and at the tunnel depth is relatively competent having fractures spaced from 3 inches to 6 inches apart. The rock is typically coarsely crystalline and generally massive. Intervals of gneissic foliation occur locally.



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Area Map Showing Locations of Study Areas

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Figure 4

The borings at La Brea Avenue also define the main fault as an abrupt transition from alluvium on the south side to weathered and sheared granitic rock on the north side of the transition. The most intensely sheared granitic rock is interpreted to extend for at least 100 feet north of the main fault within the tunnel alignment. At La Brea Avenue, four borings penetrated the main fault which was marked by bedrock overlying alluvium in fault contact. The boring data indicate that the fault at the tunnel depth dips approximately 60 degrees to the north, although near the surface the fault flattens to approximately 25 degrees. As at Camino Palmero, the bedrock materials at La Brea Avenue consist of highly weathered and sheared quartz diorite although a sliver of Puente Formation shale was encountered above the tunnel crown. The Puente material was faulted into place within the zone of shearing that comprises the Hollywood fault. The Puente Formation was dragged upward within the fault zone by the reverse fault slip characteristic of the Hollywood fault zone. The relationship indicates that the subsurface conditions presented in Plates 1 and 2 are quite simplified being interpreted from exploratory borings.

The transition from alluvium to quartz diorite bedrock in the Santa Monica Mountains at the proposed tunnel is expected to be abrupt, fault controlled, and very steeply dipping (approximately 60 degrees). Once into the quartz diorite, a gradual change from highly weathered, clayey decomposed quartz diorite (soil-like) to fragmented and sheared quartz diorite (fault zone) occurs over a distance of approximately 120 feet horizontally. The sheared quartz diorite will likely include zones of clay gouge and large (several feet) rock fragments. The quality of the quartz diorite will become less sheared and weathered, northward of the fault zone.

3.5 GROUNDWATER CONDITIONS

The Hollywood fault is reported to act as a regional barrier to groundwater flow with groundwater elevations typically higher north of the fault than south of the fault (Crook and Proctor, 1992). During this study, groundwater conditions were evaluated to validate the reported regional condition. Groundwater was encountered in several of the borings

(Table 1 and illustrated in Plates 1 and 2) typically as a saturated zone. The materials above and below the saturated zone were drier relatively suggesting that groundwater in the areas studied is perched above the fault plane.

Most of the borings were drilled entirely or to refusal by hollow-stem auger (see Table 1) before changing to rotary coring. This method provided a means to accurately locate the first occurrence of groundwater in the borings while drilling. For those borings drilled with fluids, the static water depth was measured periodically during drilling. Piezometers were constructed in Borings SM-1 and SM-1A on La Brea Avenue to provide long-term groundwater level monitoring adjacent to the range front. The piezometer for Boring SM-1, which passed through the fault, was screened only below the fault to monitor groundwater conditions within the tunnel zone. The annular space located above the fault zone was completely sealed to prevent groundwater from entering the piezometer above the fault. The piezometer installed in Boring SM-1A was screened from a depth of 150 feet (the lower 30 feet of the borehole caved upon removal of the drilled rods) to within 10 feet of the ground surface to monitor groundwater conditions near the tunnel zone north of the fault.

Groundwater observations and measurements based on the borings and piezometers indicate that the Hollywood fault acts as a groundwater barrier with groundwater at shallow depths north of the fault and not within the tunnel heading south of the fault. Along Camino Palmero, groundwater depths range from approximately 43 feet to 55 feet below the ground surface north of the fault and is 90 feet or deeper south of the fault. Along La Brea Avenue, groundwater occurs at depths much shallower than at Camino Palmero. There, the depth to groundwater ranges from approximately 9.5 feet to 24 feet below the ground surface north of the fault and was not observed within the depths drilled (199 feet in SM-1) south of the fault. A thin wet zone was encountered in Boring SM-1D in the alluvium directly beneath the fault plane and may be the result of groundwater flow along the fault or perhaps cascading over the fault. The piezometer in Boring SM-1, screened entirely below the fault, was found to be dry several days after installation.

4.0 CONCLUSIONS

The Hollywood fault zone traverses the proposed Metro Red Line at the foot of the Santa Monica Mountains. The fault investigation, which extended along Camino Palmero and Martel Avenue from the toe of the mountains to Hawthorn Avenue and at La Brea Avenue, disclosed only one fault where evidence of faulting affects the alluvium and younger soils. Evidence of faulting was not observed in the sediments exposed by the Vista Street storm drain trench excavation but secondary faulting was disclosed in a storm drain trench on Fuller Avenue. The fault is located north of Franklin Avenue and corresponds with the south strand of the Hollywood fault zone (Dibblee's Santa Monica fault). The north strand of Dibblee's does not appear to affect the alluvium and may be an indication of fault zone width rather than a separate fault trace as mapped by Dibblee. The following are our conclusions:

- o Based on our review of the Los Angeles City Sewer tunnel geology and our subsurface explorations of the faults reported in literature, we conclude that the Hollywood fault exists as a single fault trace in the area of La Brea Avenue and Camino Palmero. The width of the zone of shearing is consistent with that encountered in the Los Angeles Sewer Tunnel excavation.

- o The most recent stratigraphic units affected by faulting include a buried paleosol of late Pleistocene age and possibly the overlying sediments which thicken at the fault. The overlying friable sediments that have no argillic horizon are interpreted to be Holocene in age (1 to 2 thousand years) and do not appear to be affected by faulting.

- o The predominant sense of slip appears to be reverse slip which causes granitic rock to be lifted over alluvium along a steeply north-dipping fault plane. The dip of the fault nearest the tunnel alignment is expected to be approximately 60 degrees or more northward.

- At both Camino Palmero and La Brea Avenue, a wedge of thicker overlying sediments and paleosol may indicate a graben-like structure over the fault at depth. This could be caused by either flattening of the fault near the surface as discovered at La Brea Avenue or by a lateral component of slip accompanied by a localized bend in the fault trace.

- Although the most recently active fault trace is confined to a zone approximately 20 feet wide at Camino Palmero, the zone of shearing and gouge associated with the fault in bedrock may be at least 120 feet in horizontal width. This zone is expected to consist of gouge, crushed rock, and sections of hard rock and may be considered to be a mixed face condition for tunneling. Other zones of shearing and gouge are likely to be discovered north of the main zone of shearing but are likely to be smaller.

- The main fault trace (transition from bedrock to alluvium) forms a groundwater barrier across which tunneling conditions change from wet to dry. The north side of the fault has shallow groundwater conditions (as shallow as 9.5 feet); whereas, on the south side of the fault, groundwater was not encountered even below the tunnel depth at La Brea Avenue (to 199 feet). In the highly weathered quartz diorite, the sandy nature of the decomposed material may result in running ground within the fault zone.

6.0 LIMITATIONS

The findings, recommendations, and professional opinions in this report are based on the subsurface conditions as disclosed by the field exploration program and available geologic data. The borings may not reflect variations in subsurface conditions which are likely to exist in the unexplored areas. Thus, subsurface conditions should be monitored and verified in the field during construction. Should significant differences between the described and the actual subsurface conditions be revealed during excavation, it may be necessary to re-evaluate the conclusions in this report, based on onsite observation of the variations or additional field exploration.

The findings, recommendations, and professional opinions presented in this report were developed in general accordance with applicable principles and practices of the engineering geological and geotechnical engineering professions at the time of this report preparation. There is no other warranty, either express or implied.

5.0 REFERENCES

California Division of Mines and Geology, 1992. Preliminary Fault Activity Map of California. Open-file Report 92-03.

Crook, R., Jr. and Proctor, R.J., 1992. The Santa Monica and Hollywood Faults and the Southern Boundary of the Transverse Ranges Province in Proctor, R.J. and Pipkin, B.W. (editors), Engineering Geology Practice in Southern California. Association of Engineering Geologists Southern California Section Special Publication No. 4., p. 233-246.

Department of Public Works, City of Los Angeles, 1954-1955. Geotechnical Data for the La Cienega and San Fernando Valley Relief Sewer Tunnel through the Santa Monica Mountains, City of Los Angeles.

Dibblee, T.W., Jr., 1991. Geologic Map of the Hollywood and Burbank (South 1/2) Quadrangles, Los Angeles County, California. Dibblee Geological Foundation DF-30.

Dolan, J.F. and Sieh, K., 1992a. Tectonic Geomorphology of the Northern Los Angeles Basin: Seismic Hazards and Kinematics of Young Fault Movement in Ehlig, P.L. and Steiner, E.A. (compilers), Engineering Geology Field Trips: Orange County, Santa Monica Mountains and Malibu. Association of Engineering Geologists Southern California Section 35th Annual Meeting, October 2-9. p. B-20 through B-26.

Dolan, J.F. and Sieh, K.E., 1992b. Structural Style and Tectonic Geomorphology of the Northern Los Angeles Basin: Seismic Hazards and Kinematics of Recent Fault Movement in Ehlig, P.L. and Steiner, E.A. (compilers), Engineering Geology Field Trips: Orange County, Santa Monica Mountains and Malibu. Association of Engineering Geologists Southern California Section 35th Annual Meeting, October 2-9. p. B-27 and B-28.

Dolan, J.F., Sieh, K.E., and Rockwell, T.K., 1992, Paleoseismology and Geomorphology of the Northern Los Angeles Basin: Evidence for Holocene Activity on the Santa Monica Fault and Identification of New Strike - Slip Faults through Downtown Los Angeles. American Geophysical Union 1992 Fall meeting (unpublished abstract).

Dolan, J.F., 1993. Letter Concerning Storm Drain Excavation on Vista Street in Hollywood, California; Addressed to Mr. Gary Johnson, Los Angeles County Department of Public Works, 900 South Fremont Avenue, 8th Floor, Alhambra, California 91803-1331, dated May 21, 1993.

Earth Technology, 1992. Supplementary Geotechnical Report, Investigation 3, Tunnel from Highland Avenue to Foot of the Santa Monica Mountains, Metro Red Line. Report prepared for Metro Rail Transit Consultants dated February 1992.

The Geological Society of America, 1991. Rock-Color Chart.

Hart, E.W., 1990. Fault Rupture Hazard Zones in California; Revised 1990, with Addendum. California Division of Mines and Geology Special Publication, SP 42.

Hoots, H.W., 1930. Geology of the Eastern Part of the Santa Monica Mountains, Los Angeles County, California. U.S. Geological Survey Professional Paper 165-C. 134 p.

Morton, D.M and Yerkes, R.F., 1987. Recent Reverse Faulting in the Transverse Ranges, California. U.S. Geologic Survey Professional Paper 1339., p. 1-5.

Munsell Color, 1992 (Revised Edition). Munsell Soil Color Charts. Kollmorgen Instrument Corp.

Sieh, K.E., 1993. Letter to Engineering Management Consultant, Chief Tunnel Engineer dated February 1, 1993.

Weber, H.F. Jr., 1979. Geology and Surface Features Related to Character and Recency of the Movement along Faults, North-Central Los Angeles Area, Los Angeles County, California - A Preliminary Report in Earthquake Hazards Associated with Faults in the Greater Los Angeles Metropolitan Area, Los Angeles County, California, Including Faults in the Santa Monica - Raymond, Verdugo - Eagle Rock, and Benedict Canyon Fault Zones. California Division of Mines and Geology Open-file Report 79-16 LA. p. D1 - D56.

Ziony, J.I. and Jones, L.M., 1989. Map Showing Late Quarternary Faults and 1978-84 Seismicity of the Los Angeles Region, California, U.S. Geologic Survey Miscellaneous Investigation Series Map MF-1964.

Ziony, J.I. and Yerkes, R.F., 1985. Evaluating Earthquake and Surface - Faulting Potential in Evaluating Earthquake Hazards in the Los Angeles Region - An Earth Science Perspective. U.S. Geologic Survey Professional Paper 1360.

APPENDIX A

BORING LOGS

SAMPLE/TEST TYPE	
D	$2^1/_2$" DIA., 12" DRIVE SAMPLE
NR	NO RECOVERY
C	CORE SAMPLE

EXPLANATIONS

PENETRATION RESISTANCE (BLOW COUNT)

- BLOW COUNTS FOR 6" INTERVALS EXCEPT AS NOTED

DESCRIPTIVE TERM	DESCRIPTIVE TERM
TRACE	<5%
SOME	5-15%
WITH	15-30%
USE MODIFIER	>30%
DRY	ABSENCE OF WATER, DRY TO TOUCH
MOIST	DAMP BUT NO VISIBLE WATER
WET	VISIBLE FREE WATER

COLOR DESCRIPTION

Colors used in the description of alluvial materials and bedrock materials were selected by comparison with the Munsell-soil Color Chart and the Geological Society Of America Rock Color Chart. The color charts provide a standardized method to describe the color by name (dark reddish brown), hue (5yr), value (3), and chroma (2).

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Key for Logs of Boring

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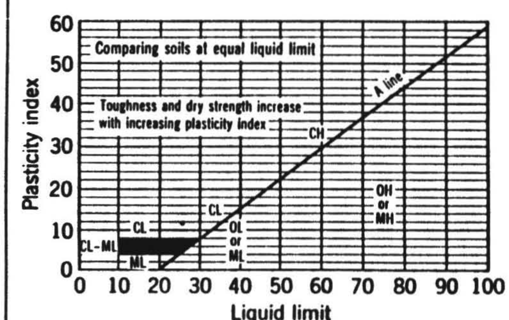
Figure A-1

Major divisions			Field Identification Procedures (Excluding particles larger than 3 in. and basing fractions on estimated weights)	Group Symbols [a]	Typical Names	Information Required for Describing Soils	Laboratory Classification Criteria
Coarse-grained soils. More than half of material is *larger* than No. 200 sieve size[b] (The No. 200 sieve size is about the smallest particle visible to naked eye)	Gravels. More than half of coarse fraction is larger than No. 4 sieve size (For visual classification, the ¼ in. size may be used as equivalent to the No. 4 sieve size)	Clean gravels (little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	*GW*	Well graded gravels, gravel-sand mixtures, little or no fines	Give typical name; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbols in parentheses. For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics. Example: *Silty sand*, gravelly; about 20% hard, angular gravel particles ½-in. maximum size; rounded and subangular sand grains coarse to fine, about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; *(SM)*	Use grain size curve in identifying the fractions as given under field identification. Determine percentages of gravel and sand from grain size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follows: Less than 5% *GW, GP, SW, SP*; More than 12% *GM, GC, SM, SC*; 5% to 12% *Borderline* cases requiring use of dual symbols. $C_U = \frac{D_{60}}{D_{10}}$ Greater than 4; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or a range of sizes with some intermediate sizes missing	*GP*	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for *GW*
		Gravels with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures see *ML* below)	*GM*	Silty gravels, poorly graded gravel-sand-silt mixtures		Atterberg limits below "A" line, or *PI* less than 4. Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
			Plastic fines (for identification procedures, see *CL* below)	*GC*	Clayey gravels, poorly graded gravel-sand-clay mixtures		Atterberg limits above "A" line, with *PI* greater than 7
	Sands. More than half of coarse fraction is smaller than No. 4 sieve size	Clean sands (little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes	*SW*	Well graded sands, gravelly sands, little or no fines		$C_U = \frac{D_{60}}{D_{10}}$ Greater than 6; $C_C = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			Predominantly one size or a range of sizes with some intermediate sizes missing	*SP*	Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for *SW*
		Sands with fines (appreciable amount of fines)	Nonplastic fines (for identification procedures, see *ML* below)	*SM*	Silty sands, poorly graded sand-silt mixtures		Atterberg limits below "A" line or *PI* less than 5. Above "A" line with *PI* between 4 and 7 are *borderline* cases requiring use of dual symbols
			Plastic fines (for identification procedures, see *CL* below)	*SC*	Clayey sands, poorly graded sand-clay mixtures		Atterberg limits below "A" line with *PI* greater than 7

Identification Procedures on Fraction Smaller than No. 40 Sieve Size

Major divisions		Dry Strength (crushing characteristics)	Dilatancy (reaction to shaking)	Toughness (consistency near plastic limit)	Group Symbols	Typical Names	Information Required for Describing Soils
Fine-grained soils. More than half of material is *smaller* than No. 200 sieve size	Silts and clays liquid limit less than 50	None to slight	Quick to slow	None	*ML*	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name; indicate degree and character of plasticity, amount and maximum size of coarse grains; colour in wet condition, odour if any, local or geologic name, and other pertinent descriptive information, and symbol in parentheses. For undisturbed soils add information on structure, stratification, consistency in undisturbed and remoulded states, moisture and drainage conditions. Example: *Clayey silt*, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; *(ML)*
		Medium to high	None to very slow	Medium	*CL*	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
		Slight to medium	Slow	Slight	*OL*	Organic silts and organic silt-clays of low plasticity	
	Silts and clays liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium	*MH*	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	
		High to very high	None	High	*CH*	Inorganic clays of high plasticity, fat clays	
		Medium to high	None to very slow	Slight to medium	*OH*	Organic clays of medium to high plasticity	
Highly Organic Soils		Readily identified by colour, odour, spongy feel and frequently by fibrous texture			*Pt*	Peat and other highly organic soils	



Plasticity chart
for laboratory classification of fine grained soils

From Wagner, 1957.
[a] *Boundary classifications*. Soils possessing characteristics of two groups are designated by combinations of group symbols. For example *GW-GC*, well graded gravel-sand mixture with clay binder.
[b] All sieve sizes on this chart are U.S. standard.

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Hollywood Fault Study
Metro Red Line

Unified Soil Classification System

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Figure A-2

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LOG OF BORING SM-1

Client: **PB/DMJM**	Project: **Metro Red Line-Segment 3**	Project No.: **92-2050**
Location: **N4150650/E4183060**	Surface Elevation (ft): **486.5**	Boring No.: **SM-1**
Inclination (Deg.): **90**	Bearing: **NA** / Depth (ft): **199.0**	Depth to Water Table (ft):
Started: **11/6/92** / Finished: **11/10/92**	Core Dia. (in.): **2.4**	No. of Core Boxes: **11**
Driller: **PC Exploration, Inc.**	Drilling Method: **Mud rotary** / Fluids: **Bentonite/Clear mud**	Drilling Equipment: **Mobile B-53**
Logged By: **P. Dunster**	Checked By: **G. Miller**	Page No.: **1 of 6**

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

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LOG OF BORING SM-1

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

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

LOG OF BORING SM-1

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

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Fracture Frequency	Structural/Discontinuity Description: Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R16	16:25 16:26	20	0	-	-	-	-	-	-	-	CW RS			**GRANODIORITE (gd)**; grayish orange to moderate yellowish brown, decomposed to fine- to coarse-grained sand with plastic clay, massive	
	R17	- 16:47	20	0	-	-	-	-	-	-	-	CW RS				
70	R18	10:56 11/7 11:03	0	0	-	-	-	-	-	-	-	-			[changed to rotary coring using diamond impregnated bit]	70
75	R19	11:26 11:32	20	0	1.0	S	A	-	SK	W	IV	CW RS	70		- closely spaced clay-lined slickensided shears	75
80	R20	11:45 11:57	52	0	-	S J	A	-	SK SR	W	IV	IV	50		alternating soft clayey gouge zones with gravel-sized granodiorite clasts and decomposed granodiorite [driller reports hard from 83-85']	80
85	R21	12:03 12:13	60	0	-	S	A	-	SK	W	IV	CW RS	50 20 70		- poorly defined joints and clay-lined slickensided and polished shears - very closely spaced clay-lined, slickensided and polished shears	85
90	R22	12:22 12:35	65	0	-	J S	B1	VT L	SK SR	W	V111	CW HW	30 30		scattered cobble-sized granodiorite fragments - 10 cm wide red clay-lined, slickensided and polished shear zone	90
95	R23	13:03 13:19	100	47	2.0	S	B	TH	SK S	W D	IV VII II	HW	30 30 30 30		**PUENTE FORMATION (Tp)**: CLAYSTONE; grayish olive to olive gray, highly plastic clay, laminated, localized extremely closely spaced slickensided and polished shear zones; interbedded sandstone at 98.5'	95
100																100

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LOG OF BORING SM-1

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

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

LOG OF BORING SM-1

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

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

LOG OF BORING SM-1

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

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

LOG OF BORING SM-1A

Client: PB/DMJM	Project: Metro Red Line-Segment 3	Project No.: 92-2050
Location: N4150685/E4183025	Surface Elevation (ft): 491.5	Boring No.: SM-1A
Inclination (Deg.): 85	Bearing: N0E; Depth (ft): 180.0	Depth to Water Table (ft): 16.4
Started: 11/18/92; Finished: 11/21/92	Core Dia. (in.): 2.4	No. of Core Boxes: 8
Driller: PC Exploration, Inc.	Drilling Method: Mud rotary; Fluids: Bentonite/Clear mud	Drilling Equipment: Mobile B-53
Logged By: P. Dunster	Checked By: G. Miller	Page No.: 1 of 6

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

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LOG OF BORING SM-1A

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

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

The Earth Technology Corporation

LOG OF BORING SM-1A

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

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

The Earth Technology Corporation

LOG OF BORING SM-1A

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

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Fracture Frequency	Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
	R35	08:12 08:16	90	0	-	S	A	-	S SK	D	III VI	SW MW			**GRANODIORITE (gd)**: grayish green, greenish gray to dark greenish gray, medium grained, some areas decomposed to very fine- to coarse-grained sand within soft clay matrix, very friable, randomly oriented polished shears, clay-lined joints and intervals of clay gouge, alternating irregular hard and soft zones	
	R36	- -	83	0	-	S	A	-	S SK	D	III VI	SW MW				
105	R37	08:50 08:56	61	0	-	S	A	-	SK	D	III	SW F				105
	R38	09:16 -	80	0	-	S	A	-	SK	D	III VI	SW F			[change to split inner tube]	
110	R39	09:58 10:03	80	0	-	S	B1	-	SK	D W	VIII III VI		10 10			110
	R40	10:16 10:20	73	0	5	S J	B1	VT	SK SR	D W P	I III VIII	F SW	15 30 40		randomly oriented red clay-lined shears	
115	R41	10:31 10:37	38	0	-	S	A	VT L	SK	D	III VI	F SW MW			- soft, chaotic clay gouge	115
	R42	10:45 10:47	0	0	-	-	-	-	-	-	-	-				
120	R43	10:58 11:04	43	0	-	S J	B1	VT	SK	D P	III VI VIII	F MW	60 60		- scattered red clay-lined shears	120
	R44	11:16 11:18	73	0	-	S J	A	VT L	SK	D	III VI VIII	F MW	25		- 0.4 m wide sheared gouge zone, remaining core chaotic with indistinguishable structures	
125	R45	11:28 11:32	73	0	-	S J	A	VT L	SK	D P W	III VI	F MW	90 90		- <1 mm wide red clay-lined shear - <1 mm wide green clay-lined shear	125
	R46	11:40 11:45	43	0	-	S	A	L VT	SK	D	III VI	F MW			- soft, chaotic, randomly oriented polished shears	
130	R47	12:35 12:39	67	0	-	S	A	-	SK	D W	VI	F	10		- 7 mm wide clay gouge zone	130
135	R48	12:47	50	0	-	-	-	-	-	-	-	-				135

LOG OF BORING SM-1A

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

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

LOG OF BORING SM-1A

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

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

LOG OF BORING SM-1B

Client: **PB/DMJM**	Project: **Metro Red Line-Segment 3**	Project No.: **92-2050**
Location: **N4150635/E4183065**	Surface Elevation (ft): **484.5**	Boring No.: **SM-1B**
Inclination (Deg.): **90**	Bearing: **NA** / Depth (ft): **170.0**	Depth to Water Table (ft): **13.4**
Started: **11/23/92** / Finished: **12/7/92**	Core Dia. (in.): **2.4**	No. of Core Boxes: **10**
Driller: **PC Exploration, Inc.**	Drilling Method: **Mud rotary** / Fluids: **Bentonite/Clear mud**	Drilling Equipment: **Mobile B-53**
Logged By: **P. Dunster/M. Curtis**	Checked By: **G. Miller**	Page No.: **1 of 6**

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Fracture Frequency	Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)	Sketch	Lithic Description	Packer Test Interval
0	R1	11/23													**ASPHALT**	0
															ALLUVIUM (Qal): CLAY (CL); dark yellowish brown, low plastic clay, some silt and fine- to coarse-grained sand, massive, scattered rootlets [The upper 3 feet were drilled dry. Changed to Punch coring with tungsten carbide bit below 3 feet; using solid inner barrel]	
5	R2	08:07 11/24	64													5
10	R3	-	70													10
													70		- 5 mm wide sheared clay	
															SANDY CLAY (CL); moderate to dark yellowish brown with olive gray mottling, low plastic clay, fine- to coarse-grained sand	
15	R4	09:23	87												- moderate brown	15
	R5	09:26 09:30	70												mottled light brown and light olive gray, scattered black charcoal flecks	
20	R6	09:35 09:42	50													20
25	R7	09:55 10:31	90	0	-	-	-	-	-	-	-	-			[changed to split inner tube]	25
		10:37													**GRANODIORITE (gd)**; see below	
30																30

LOG OF BORING SM-1B

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

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

LOG OF BORING SM-1B

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

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

LOG OF BORING SM-1B

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

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

The Earth Technology Corporation

LOG OF BORING SM-1B

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

Depth (feet)	Run No.	Begin/End Time (hrs)	Core Recovery (%)	RQD (%)	Fracture Frequency	Type	Joint Set Character.	Spacing	Roughness	Planarity	Discont. Filling	Weathering	Dip (Deg.)
	R43	10:40 -	100	0	-	S	A	L	-	D	-	CW	
	R44	11:44	60	0	-	-	-	-	-	D	-	RS	
140	R45	11:49 12:01	100	0	-	-	-	-	-	-	-	CW RS	
145	R46	12:15 12:24	100										
150	R47	12:40 12:53	100										
155	R48	13:15 13:25	100										
160	R49	13:45 - 12/7 -	100										
	R50	-	98										
165	R51	- -	98										
170		11:50											

Depth (feet)	Lithic Description
~136–143	**GRANODIORITE (gd)**; light olive brown, light olive gray, dark yellowish brown, moderate yellowish brown, medium grained, decomposed to fine- to medium-grained sand with clay and silt, some remnant gravel and cobble-sized fragments of granodiorite, scattered discontinuous clay-lined shears [core R43 blocked off]
~143	**ALLUVIUM (Qal)**: CLAY (CL); yellowish brown to olive brown, dry to slightly moist, plastic clay with fine- to coarse-grained sand, trace gravel-sized granodiorite clasts, scattered powdery caliche
150	grades to SANDY CLAY (CL); strong brown
~154	CLAYEY SAND/SANDY CLAY (SC/CH); yellowish red, dry to slightly moist, highly plastic clay, fine- to coarse-grained sand, massive, noncalcareous
	- yellowish brown
~158	SANDY CLAY (CH); dark reddish brown, dry to slightly moist, high plastic clay with medium-grained sand, trace gravel
	- distinct contact
~165	SILTY SAND/SANDY SILT (SM/ML); yellowish red, dry to slightly moist, medium- to coarse-grained sand and low plastic silt, trace gravel, massive

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LOG OF BORING SM-1B

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

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

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

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

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

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

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Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: SM-1C		Sheet 3 of 6

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

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: SM-1C	Sheet 4 of 6

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

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

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

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

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

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

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

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

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

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

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

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

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

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FIGURE S-A-VII LOG OF BORING B-7

Project Name: Metro Rail - Los Angeles			
Project Number: 92-2002	Boring Number: B-7		Sheet 1 of 7
Boring Location: Franklin/Fuller		Elevation and Datum(feet): 488.0	
Health and Safety: Level D	Date Started: 11/15/91		Date Finished: 11/18/91
Drilling Equipment: Mayhew 1000	Total Depth (feet): 166.0		Depth to Bedrock(feet): -
Drilling Method: Rotary Wash	Number of Samples: 14		Depth to Water (feet): -
Boring Diameter: 5-inch	Completion Information: Grouted to Surface		
Hammer Information: SPT Hammer: 140-lb and 30-inch drop. Downhole Hammer: 300-lb and 18-inch drop.	Logged By: Pat Smith		Checked By: K.K. Muraleetharan

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	OVA (ppm)	Dry Density (pcf)	Moisture Content(%)	Background OVA(ppm)
		1-foot thick ASPHALT.										
		1-foot thick GRAVEL and FILL material.										
5		GRAVELLY CLAY; Dark yellow brown, moist, medium stiff, medium to high plasticity clay, trace medium- to coarse-grained sand, with gravel.	CL	A2							--	
10		GRAVELLY SAND; Light gray, medium- to coarse-grained sand, fine-gravel.	SP	A1								
15												

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FIGURE S-A-VII LOG OF BORING B-7

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2002	Boring Number: B-7	Sheet 2 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	OVA (ppm)	Dry Density (pcf)	Moisture Content (%)	Background OVA (ppm)
		SILTY SAND; Yellowish brown, fine- to coarse-grained sand, trace low plasticity fines, trace fine-gravel.	SM	A3								
25		Drill chatter between 25 and 27 feet. Drill cuttings show increasing clay content.										
		SILTY SAND; Yellowish brown, fine- to medium-grained sand, trace coarse-grained sand, trace low plasticity fines.	SM	A3								
		Heavy drill chatter at 28 feet.										
30												
35												
40												
45												
		Drill chatter at 47 feet.										
			SP	A3								

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FIGURE S-A-VII LOG OF BORING B-7

Project Name: Metro Rail - Los Angeles

Project Number: 92-2002 | Boring Number: B-7 | Sheet 3 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	OVA (ppm)	Dry Density (pcf)	Moisture Content (%)	Background OVA (ppm)
		SAND; Light gray, medium-grained sand, trace uniform sub-angular to sub-round gravel.										
		Drill cuttings show increasing clay content, little sand and no gravel.										
55												
		Light to moderate drill chatter between 58 and 66 feet.										
60												
65		SAND; Light gray, fine- to medium-grained sand. Drill cuttings show less sand content.	SP	A3								
		Drilling stopped on 11/15/91 and resumed on 11/16/91.										
70		Drill chatter at 70 feet.										
		Heavy drill chatter at 72 feet. Drill cuttings show increasing sand content and gravel.	SP	A3								
75												
		Drill chatter at 77 feet.										

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FIGURE S-A-VII LOG OF BORING B-7

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2002	Boring Number: B-7	Sheet 4 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	OVA (ppm)	Dry Density (pcf)	Moisture Content (%)	Background OVA (ppm)
85			SP	A3								
90												
95												
100		CLAYEY SAND; Brown, moist, very dense, fine- to medium-grained sand.	SC	A3	1	D	50 50/4"	9"/10"				
		Heavy drill chatter at 102.5 feet.										
105			SC	A3	2	S	30 38 51/5"	17"/17"				

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FIGURE S-A-VII LOG OF BORING B-7

Project Name:	Metro Rail - Los Angeles
Project Number: 92-2002	Boring Number: B-7	Sheet 5 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	OVA (ppm)	Dry Density (pcf)	Moisture Content (%)	Background OVA (ppm)
		CLAYEY SAND; Reddish brown, fine- to medium-grained sand, medium plasticity clay.	SC	A4	3	D	55 50/4"	10" /10"	4.2	120	15	4.2
115		Same as above.	SC	A3	4	S	30 58	12" /12"	4.2			4.2
120		Same as above except trace fine-gravel. Drilling stopped and resumed on 11/18/91.	SC	A3	5	D	100	6" /6"	4.2	123	13	4.2
125												4.2
		SILTY SAND; Dark brown, moist, dense, fine- to medium-grained sand, trace fine-gravel, low plasticity fines. Light to moderate drill chatter.	SM	A3	6	S	56	6" /6"	4.2			4.2
130		Same as above except very dense.	SM	A3	7	D	81	6" /6"	4.2	120	14	4.2
135			SM	A3	8	S	62 20/1"	7" /7"				
		Same as above except brown and trace mica.							4.2			4.2
140												

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FIGURE S-A-VII LOG OF BORING B-7

Project Name: Metro Rail - Los Angeles

Project Number: 92-2002 | Boring Number: B-7 | Sheet 6 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Samples: Type	Samples: Blow Count	Samples: Recovery	Samples: OVA (ppm)	Samples: Dry Density (pcf)	Samples: Moisture Content (%)	Background OVA (ppm)
		SILTY SAND; Dark brown, very dense, fine- to medium-grained sand, trace coarse-grained sand, trace fine-gravel, low plasticity fines.	SM	A3	9	D	122	6"/6"	4.3	123	14	4.2
145		CLAYEY SAND; Dark yellowish brown, moist, very dense, low to medium plasticity clay, fine- to medium-grained sand.	SC	A3	10	S	96	4.5"/6"	4.3			4.2
150		Same as above except dark reddish brown and trace coarse-grained sand. Moderate drill chatter.	SC	A3	11	D	100	6"/6"	4.2	123	15	4.2
155		Same as above except brown and low plasticity clay.	SC	A3	12	S	46 48/2"	8"/8"	4.2			4.2
160		SILTY SAND; Dark brown, very dense, fine- to medium-grained sand, trace coarse-grained sand, low plasticity fines.	SM	A3	13	D	90	6"/6"	4.2			4.2
165		CLAYEY SAND; Dark brown, moist, dense, fine- to medium-grained sand, trace low to medium plasticity fines.	SC	A3	14	S	50 50/4"	10"/10"	4.3			4.3
		Boring terminated at 166 feet.										
170												

FIGURE S-A-VII LOG OF BORING B-7

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2002	Boring Number: B-7	Sheet 7 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	OVA (ppm)	Dry Density (pcf)	Moisture Content (%)	Background OVA (ppm)
175		NOTE: This boring log is based on field classification and visual soil description and is further modified to include results of laboratory classification tests, where available. This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with passage of time. The data presented is simplification of actual conditions encountered. The stratification lines represent the approximate boundary between subsurface material types and the transition may be gradual.										
180												
185												
190												
195												
200												

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FIGURE S-A-VIII LOG OF BORING B-8

Project Name: Metro Rail - Los Angeles			
Project Number: 92-2002	Boring Number: B-8		Sheet 1 of 7
Boring Location: Franklin/Camino Palmero		Elevation and Datum(feet): 527.0	
Health and Safety: Level D	Date Started: 11/11/91		Date Finished: 11/15/91
Drilling Equipment: Mayhew 1000	Total Depth (feet): 180.5		Depth to Bedrock(feet): 83.0
Drilling Method: Rotary Wash	Number of Samples: 15		Depth to Water (feet): -
Boring Diameter: 5-inch	Completion Information: Grouted to Surface		
Coring Information: NX Sinlge Tube Core Barrel.	Logged By: Pat Smith		Checked By: Paul Guptil

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	OVA (ppm)	Dry Density (pcf)	Moisture Content(%)	Background OVA(ppm)
		1-foot thick ASPHALT.										
		NOTE: USED 4 7/8-INCH DIA. TRICONE BIT TO ADVANCE THE BORING.										
5		GRAVELLY SAND; Moderately brown, some clay, medium- to coarse-grained sand, with gravel.	SP	Qt(?)/Qal							--	
10												
15												

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FIGURE S-A-VIII LOG OF BORING B-8

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2002	Boring Number: B-8	Sheet 2 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	OVA (ppm)	Dry Density (pcf)	Moisture Content (%)	Background OVA (ppm)
		Same as above with medium to high plasticity clay.	SP									
25		SANDY CLAY; Moderately brown, high plasticity clay, fine- to coarse-grained sand.	CL	Qt(?) /Qal								
		Drill chatter from 27 to 32 feet.										
30												
35		Same as above.										
40		Same as above with more sand content.										
		Drill chatter at 42 feet.										
45		Same as above with more clay content.										

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FIGURE S-A-VIII LOG OF BORING B-8

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2002	Boring Number: B-8	Sheet 3 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	OVA (ppm)	Dry Density (pcf)	Moisture Content (%)	Background OVA (ppm)
		Same as above.	CL	Qt(?)/Qal								
55												
		Drill chatter at 57 feet.										
		Drill chatter at 59 feet.										
60												
		Same as above with medium- to coarse-grained sand. Occasional drill chatter from 64 to 67 feet.									---	
65												
70												
75												
		Same as above. Drill chatter at 77 feet.										

FIGURE S-A-VIII LOG OF BORING B-8

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2002	Boring Number: B-8	Sheet 4 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	OVA (ppm)	Dry Density (pcf)	Moisture Content (%)	Background OVA (ppm)
			CL	Qt(?)/Qal								
85		GRANITIC ROCK and some CLAY GOUGE; Cuttings show medium- to coarse-grained crystalline rock particles. At top, some particles appear rounded as in conglomerate.		Kg								
90												
95												
100												
105												

FIGURE S-A-VIII LOG OF BORING B-8

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2002	Boring Number: B-8	Sheet 5 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	OVA (ppm)	Dry Density (pcf)	Moisture Content (%)	Background OVA (ppm)
		Same as above.										
115												
		NOTE: STARTED CORING USING TUNGSTEN CARBIDE BIT AT 120 FEET.										
120												
					1	D						
		QUARTZ DIORITE; Overall grayish yellow with individual crystals ranging from white to olive gray, moist, very strong, highly to moderately weathered, highly fractured, mineral crystals			1	R		<1				
		range from 1/8 -1/4 inch consisting of feldspar quartz,			1	R		60				
125		biotite and hornblende, weak foliation, weak Hcl reaction. Foliation at 50 deg. from										
		horizontal, fractured fequently, 35 deg filled, cemented sand, 1/2" wide. 60 Deg across foliation, rough, limonite stained. Horizontal irregular break with cemented silt. 40 deg smooth			2	R		50				
130		sheared fracture, slight clay coating. Much of core in small 1-2" fragments.										
		Sheared Clay gouge and Quartz diorite fragments.		Qg	3	R		50				
		LIMESTONE AND CLAY GOUGE; Light gray to medium light gray, moist, strong limestone, stiff clay, some inclusions of diorite										
135		fragments, strong Hcl reaction. Fracture in limestone at 80 deg, irregular and lined with 1/16										
		inch calcite crystals. Vertical 30 deg, slickensided, shear through clay.			4	R		35				
		CLAY GOUGE AND QUARTZ DIORITE FRAGMENTS; Medium light gray, moist and medium stiff clay, fragments range from 0-2" in diam. Sheared surface between										
140												

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FIGURE S-A-VIII LOG OF BORING B-8

Project Name: Metro Rail - Los Angeles

Project Number: 92-2002 | Boring Number: B-8 | Sheet 6 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Samples Type	Samples Blow Count	Samples Recovery	Samples OVA (ppm)	Samples Dry Density (pcf)	Samples Moisture Content (%)	Background OVA (ppm)
		clay and rock fragments. Random shears in clay.										
		Same as above.			5	R		50				
		NOTE: STARTED CORING WITH SURFACE SET DIAMOND CORE BIT AT 141 FEET.										
145												
					6	R		30				
150												
		No recovery obtained.			7	R		0				
155												
		Same as above.			2	B						
160												
165					3	B						
170					4	B						

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FIGURE S-A-VIII LOG OF BORING B-8

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2002	Boring Number: B-8	Sheet 7 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	OVA (ppm)	Dry Density (pcf)	Moisture Content (%)	Background OVA (ppm)
		Same as above.										
					5	B						
175												
					6	B						
					7	B						
180					8	B						
		Boring terminated at 180.5 feet.										
185												
190		NOTE: This boring log is based on field classification and visual soil description and is further modified to include results of laboratory classification tests, where available. This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with passage of time. The data presented is simplification of actual conditions encountered. The stratification lines represent the approximate boundary between subsurface material types and the transition may be gradual.										
195												
200												

Project Name:	Metro Rail - Los Angeles				
Project Number:	92-2038	Boring Number:	B-9	Sheet 1 of 7	
Boring Location:	1822 Camino Palmero	Elevation and Datum(feet):	507.5		
Health and Safety:	-	Date Started:	6/29/92	Date Finished:	6/29/92
Drilling Equipment:	Mobile B61	Total Depth (feet):	90.5	Depth to Bedrock(feet):	-
Drilling Method:	Hollow Stem Auger	Number of Samples:	57	Depth to Water (feet):	-
Boring Diameter:	7-inch	Completion Information:	Grouted to Surface		
Hammer Information: Downhole Hammer:140-lb and 30-inch drop.		Logged By: Grant Miller		Checked By: Paul Guptill	

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content(%)	Begin/End Time(hr)
0		SILTY SAND; dark yellowish brown (10YR 4/4), dry, medium dense, medium- to coarse-grained sand, trace gravel, low to non plastic fines	SM	Qal								
5					1	D	8/8/10	12"/18"				
					2	D	5/7/10	12"/18"				
					6	D	10/10/15	14"/18"				
					4	D	13/15/21	18"/18"				
10												

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Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-9	Sheet 2 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
10		-grades to yellowish brown (10YR 5/4), gravelly, angular plutonic clast to 1-inch in size	SM	Qal								
					5	D	7/8/13	14"/18"				
					6	D	9/12/19	12"/18"				
					7	D	9/13/24	15"/18"				
15												
					8	D	6/12/15	13"/18"				
					9	D	9/15/12	15"/18"				
		-gravelly interval										
		CLAYEY SAND; yellowish brown (10YR 5/4), slightly moist, medium dense, coarse- to very coarse-grained sand, medium plastic fines, massive	SC									
					10	D	12/12/14	14"/18"				
		------------------------------ grades to brown (7.5YR 4/3)										
20					11	D	9/9/11	12"/18"				
					12	D	11/14/15	12"/18"				
		CLAYEY SAND TO SANDY CLAY; dark brown (7.5YR 3/2), very clayey with scattered angular plutonic gravel to 1/2-inch in size, paleosol	SC/CL		13	D	15/19/31	12"/18"				
					14	D	8/13/23	12"/18"				
25												

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Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-9		Sheet 3 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND TO SANDY CLAY; dark brown (7.5YR 3/2), very clayey with scattered angular plutonic gravel-sized clasts to 1/2-inch in size, paleosol	SC/CL	Qal								
					15	D	12/15/16	10"/18"				
					16	D	18/27/40	16"/18"				
		hard drilling at 28 feet										
		SILTY TO CLAYEY SAND; brown (10YR 4/3), less clay, coarse- to very coarse-grained angular sand, trace rounded sand	SM/SC		17	D	15/23/43	11"/18"				
30												
					18	D	15/27/39	14"/18"				
					19	D	21/29/36	14"/18"				
					20	D	23/49/43	14"/18"				
		increasing clay content										
35		SANDY CLAY TO CLAYEY SAND; dark reddish brown (5YR 3/2), dry to slightly moist, very stiff to hard, medium plastic clay with medium- to coarse-grained sand, trace plutonic, scattered subrounded fine-gravel (plutonic), paleosol	CL/SC		21	D	29/40/57	18"/18"				
		hard drilling, water added intermittently from 36.5' to 73.5'.			22	D	19/32/50	17"/18"				
		CLAYEY SAND; dark reddish brown (5YR 3/2), scattered highly weathered plutonic and sedimentary clasts to 3/4-inch, paleosol	SC		23	D	30/56/72	18"/18"				
		grades to reddish yellowish brown (5YR 4/3)			24	D	20/40/75	15"/18"				
40												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-9	Sheet 4 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND; reddish brown (5YR 4/3), dry to slightly moist, hard, medium- to coarse-grained sand, mostly angular plutonics and mafics	SC	Qal								
					25	D	30/49/78	14"/18"				
					26	D	26/66/111	18"/18"				
		abundant weathered plutonic clasts, mafic plutonics, volcanics and sandstone										
					27	D	20/50/56	15"/18"				
45												
					28	D	25/41/33	16"/18"				
		angular plutonic clast to 1.5-inch in size										
					29	D	20/26/30	13"/18"				
		GRAVELLY SAND TO CLAYEY GRAVELLY SAND; yellowish brown (10YR 4/4), dry, medium dense, medium- to coarse-grained sand with angular gravel clasts to 3/4-inch in size	SM/SC		30	D	18/29/36	12"/18"				
50					31	D	26/26/23	10"/18"				
		-clayey interval										
					32	D	15/22/34	14"/18"				
		CLAYEY SAND; dark reddish brown to brown (5YR 3/3 to 7.5YR 4/3), dry, medium dense, medium- to coarse-grained sand, some angular weathered plutonic rock fragments, paleosol	SC		33	D	17/26/35	14"/18"				
		SILTY TO CLAYEY SAND; brown (7.5YR 4/3)	SM/SC		34	D	14/21/28	13"/18"				
55												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-9	Sheet 5 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		SILTY TO CLAYEY SAND; brown (7.5YR 4/3), dry, medium dense, medium- to coarse-grained sand, some weathered angular plutonic clasts, gneiss clast > 2-inch in size, scattered to abundant rock fragments below	SM/SC	Qal								
					35	D	18/35/44	14"/18"				
					36	D	14/22/29	16"/18"				
		CLAYEY TO SILTY SAND; brown (7.5YR 4/3), as above	SC/SM		37	D	19/27/39	14"/18"				
60												
					38	D	20/36/40	17"/18"				
		SILTY SAND; brown (7.5YR 4/3) as above, angular quartzite clasts to 1/2-inch	SM		39	D	33/33/57	13"/18"				
					40	D	44/37/45	8"/18"				
		CLAYEY TO SILTY SAND; reddish brown (5YR 4/3) as above with intervals of angular very coarse-grained sand and fine gravel, poorly sorted	SC/SM									
65					41	D	17/31/46	12"/18"				
					42	D	19/32	16"/18"				
		SILTY SAND; brown (7.5YR 4/3), weathered plutonic clasts to 1/2 to 3/4 inch	SM		43	D	25/40/49	15"/18"				
		-interval of reddish brown (5YR 4/3)										
		-weathered granitic clast to 2-inch, quartzite clast			44	D	55/75/70	10"/18"				
70												

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Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-9		Sheet 6 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		SILTY SAND; brown (7.5YR 4/3), as above	SM	Qal								
		CLAYEY TO SILTY SAND; reddish brown (5YR 4/3), very clayey, scattered angular rock fragments	SC/SM		45	D	32/59/79	13"/18"				
					46	D	27/17/21	17"/18"				
					47	D	23/24/33	15"/18"				
75		-weathered plutonic clast > 2-inch in size										
					48	D	27/38/63	18"/18"				
		-scattered rock fragments (plutonic - mafic plus silicic)			49	D	33/51/70	17"/18"				
		SILTY SAND; brown (7.5YR 4/3)	SM		50	D	35/50/69	17"/18"				
80					51	D	32/55/62	17"/18"				
		CLAYEY TO SILTY SAND; reddish brown (5YR 4/3) - sharp transition, becomes very coarse-grained sand at 81.5 feet	SC/SM									
					52	D	24/34/30	13"/18"				
		----------------------------- becomes finer grained, less coarse to very coarse-grained sand, red tones increasing										
					53	D	22/32/38	16"/18"				
					54	D	32/48/70	14"/18"				
85												

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

Project Number: **92-2038** | Boring Number: **B-9** | Sheet 7 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY TO SILTY SAND; reddish brown (5YR 4/3)	SC/SM	Qal								
		----------------------------										
		some rounded, weathered plutonic clasts to several inches, red tones decreasing			55	D	55/80/110	15"/18"				
		-well rounded, highly weathered plutonic clast, approximately 2-inch in size			56	D	21/36/55	16"/18"				
					57	D	31/49/72	11"/18"				
90												
		Boring terminated at 90.5 feet. No free groundwater observed.										
95												
100												

Project Name:	Metro Rail - Los Angeles				
Project Number:	92-2038	Boring Number:	B-10	Sheet 1 of 17	
Boring Location:	1822 Camino Palmero	Elevation and Datum(feet):	515.5		
Health and Safety:	-	Date Started:	6/15/92	Date Finished:	6/20/92
Drilling Equipment:	Mobile B53	Total Depth (feet):	240.0	Depth to Bedrock(feet):	114.5
Drilling Method:	HSA & Mud Rotary	Number of Samples:	57	Depth to Water (feet):	43.0
Boring Diameter:	6.5" & 4"	Completion Information:	Grouted to Surface		
Hammer Information: Downhole Hammer:140-lb and 30-inch drop.		Logged By: Grant Miller		Checked By: Paul Guptill	

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
0		SILTY SAND; dark reddish brown (5YR 3/4), dry, medium dense, medium- to coarse-grained sand, some gravel	SM	Qal								
5		CLAYEY TO SILTY SAND; dark reddish brown (5YR 3/4), slightly moist, medium dense, medium- to coarse-grained sand	SC/SM		1	D	6/5/5	11"/18"				
		with quartz diorite clasts			2	D	23/7/5	18"/18"				
		----------------------------- very coarse-grained sand			3	D	3/4/5	12"/18"				
					4	D	3/3/4	11"/12"				
10												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-10		Sheet 2 of 17

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
10		CLAYEY TO SILTY SAND; brown (7.5YR 4/3), slightly moist, medium dense, very coarse-grained sand	SC/SM	Qal								
					5	D	2/3/5	15"/18"				
		---------------------------- grades to dark yellowish brown (10YR 4/4)										
					6	D	2/6/8	16"/18"				
		with quartz diorite clasts			7	D	2/4/5	12"/18"				
15												
		---------------------------- grades to brown (7.5YR 4/3), moist, micaceous			8	D	3/5/5	13"/18"				
					9	D	4/5/5	13"/18"				
					10	D	4/3/4	14"/18"				
20												
		SILTY TO CLAYEY SAND; yellowish brown (10YR 5/4) to dark yellowish brown (10YR 4/4), fines content increasing	SM/SC		11	D	4/4/5	9"/18"				
					12	D	21/5/5	16"/18"				
		with finer grained (clayey) intervals										
					13	D	21/28/43	15"/18"				
25												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-10		Sheet 3 of 17

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		carbon flecks (roots)	SM/SC	Qal	14	D	5/4/3	14"/18"				
		clay content increasing, roots			15	D	6/7/7	16"/18"				
		CLAYEY SAND; reddish brown (5YR 4/3), roots, porous, medium- to coarse-grained sand	SC		16	D	3/3/4	17"/18"				
30		dark reddish brown (5YR 3/2), porous, roots, paleosol			17	D	2/3/5	14"/18"				
		medium plastic clay interval approximately 6-inch thick			18	D	2/3/6	17"/18"				
		dark reddish brown (5YR 3/2 to 5YR 2.5/2), highly porous, abundant roots, paleosol			19	D	2/3/4	17"/18"				
35		dark reddish brown (5YR 3/2) to dark yellowish brown (10YR 4/4), moderately porous, roots, with intervals of very coarse-grained sand			20	D	2/3/7	17"/18"				
		brown (7.5YR 4/3), slightly porous, roots			21	D	2/5/7	8"/18"				
		dark yellowish brown (10YR 4/4), highly weathered quartz diorite cobble			22	D	2/3/6	11"/18"				
					23	D	2/4/8	16"/18"				
40												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-10		Sheet 4 of 17

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND; dark reddish brown (5YR 3/2) with moderate olive brown (5YR 4/4) mottling, medium- to coarse-grained sand with intervals of very coarse-grained sand, clay content increasing, paleosol	SC	Qal	24	D	2/7/10	11"/18"				
					25	D	4/6/8	18"/18"				
		brown (7.5YR 4/3) to yellowish brown (10YR 5/4); with highly weathered quartz diorite clasts			26	D	6/12/13	18"/18"				
		very sandy, very coarse-grained sand										
45					27	D	4/10/15	9"/18"				
		yellowish brown (10YR 5/4) with olive gray (5YR 5/2) mottling			28	D	5/7/9	14"/18"				
		with patches of reddish discoloration			29	D	6/7/9	10"/18"				
		with highly weathered quartz diorite clasts			30	D	4/6/8	13"/18"				
50												
		CLAYEY TO SILTY SAND; yellowish brown (10YR 5/4), moist, medium dense, very coarse-grained sand, low to medium plastic fines	SC/SM		31	D	7/5/5	9"/18"				
		brown (7.5YR 4/3), fine- to medium-gravel to 3/4-inch in size (weathered, felsic, plutonic), angular			32	D	5/6/8	13"/18"				
		yellowish brown (10YR 5/4)			33	D	4/9/9	15"/18"				
55												

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Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number:	B-10	Sheet 5 of 17

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY TO SILTY SAND; yellowish brown (10YR 5/4), moist, medium dense, very coarse-grained sand, low to medium plastic fines	SC/SM	Qal								
		----------------------------- with highly weathered plutonic clasts and highly micaceous intervals (weathered metamorphics), very coarse-grained at 56 feet			34	D	6/12/13	12"/18"				
					35	D	12/18/42	18"/18"				
		abundant highly weathered angular clasts to 1-inch in size			36	D	5/18/35	18"/18"				
60												
		SILTY SAND TO SAND; yellowish brown (10YR 5/4) to dark yellowish brown (10YR 4/4), moist, dense to very dense, very coarse-grained sand with trace to some angular gravel (mafic and felsic, plutonics and volcanics)	SC/SM		37	D	19/32/43	18"/18"				
		Switched to mud rotary coring (Tungsten-Carbide bit) at 62 feet CLAYEY TO SILTY SAND; brown (7.5YR 4/3), moist, medium dense, medium plastic, abundant angular gravel and cobble clasts (some highly weathered, others unweathered) -Driller indicates finer material at 63 feet			1	C		3"/36"	0.0			11:15
65												11:21
					2	C		10"/60"	11.6			11:32
		much coarser, mafic and silicic plutonic clasts and volcanics										
70												11:39

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Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-10		Sheet 6 of 17

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		As above, subrounded quartzite clast and highly weathered plutonics, slight rig chatter	SC/SM	Qal	3	C		3"/12"	0.0			11:56
					4	C		7"/12"	0.0			11:58 12:08
		brownish yellow (10YR 6/6) to brown (7.5YR 4/3) with olive gray (5Y 5/2), medium- to coarse-grained sand, some very coarse-grained sand, slight chatter at 73 feet			5	C		12"/24"	0.0			12:10 12:35
		------------------------------ light olive brown (2.5YR 5/6) with subangular quartzite clasts to 1-inch in size			6	C		24"/36"	66.6			12:38 12:54
75		------------------------------ brown (7.5YR 4/3) with trace well rounded hard quartzite clasts										
		-driller indicates harder at 76 - 77 feet, softer below, abundant weathered clasts										
		--------------------------- brown (7.5YR 4/3)			7	C		14"/36"	20.8			13:05 13:11
		slight rig chatter at 78.5 feet, abundant subangular to subrounded and rounded clasts (volcanics, plutonics, quartzite)										
80					8	C		0"/24"	25.0			13:16 13:25
		------------------------------ yellowish brown (10YR 5/4), very coarse-grained sand (rock fragments), some hard subrounded plutonics and quartzite										
		CLAYEY SAND; brown (7.5YR 4/3), moist, medium dense, fine- to medium-grained sand with low to medium plastic clay	SC		9	C		8"/24"	33.3			13:30 13:40
		highly plastic clay with sand at 84 feet			10	C		36"/36"	100.0			13:52 15:18
85												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-10	Sheet 7 of 17

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND; yellowish brown (10YR 5/4), coarse- to very coarse-grained sand, trace highly weathered mafic clasts to 1/2-inch in size	SC	Qal								
		CLAYEY SAND TO SANDY CLAY; brown (7.5YR 4/3), medium- to some coarse-grained sand, with rare olive gray (5YR 5/2), highly plastic sandy clay patches	SC/CL		11	C		39"/48"	81.2			15:25 15:37
90												
					12	C		36"/36"	100.0			15:56 16:10
		very clayey, medium plastic, trace fine-gravel										
		with olive gray (5YR 5/2) intervals less than 1/2-inch thick			13	C		32"/36"	88.9			16:40 16:55
95		-carbon flecks at 95 feet										
		CLAYEY SAND; brown (7.5YR 4/3)	SC		14	C		33"/36"	91.6			17:17 07:40
100												07:54

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-10		Sheet 8 of 17

Depth (feet)	Description	USCS Classification	Geologic Unit	Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
	CLAYEY SAND; yellowish red (5YR 5/6) to brown (7.5YR 4/3)	SC	Qal	15	C		11"/36"	94.4			08:03
	-weathered plutonic clast to 1-inch in size, some fine gravel at tip, driller indicates finer material at 102.5 feet										08:23
	--------------------------- grades to brownish yellow (10YR 6/6), scattered felsic plutonic clasts to 1/4-inch in size			16	C		12"/72"	16.7			08:35
105											
	--------------------------- abundant highly weathered plutonic clasts to >1.5-inch in size										09:01
	CLAYEY GRAVEL TO CLAYEY SAND; with intervals of pale olive (5Y 6/4), abundant plutonic clasts to 1-inch in size (highly weathered), clasts separated by clayey sand matrix	GC/SC		17	C		60"/66"	90.9			09:12
110											
	-calcium carbonate infilling (vigorous reaction to HCL)										
	-calcium carbonate infilling (vigorous reaction to HCL)										
	Driller indicates harder drilling										09:28
	QUARTZ DIORITE; grayish orange (10YR 7/4), dark yellowish orange (10YR 6/6) and very pale orange		qd	18	C		73"/78"	93.6			09:45
115											

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Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-10		Sheet 9 of 17

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		(10YR 8/2)		qd								
		QUARTZ DIORITE; grayish orange (10YR 7/4), dark yellowish orange (10YR 6/6) and very pale orange (10YR 8/2) streaks and patches (calcareous), moist, very weak, highly to completely weathered, massive with irregular intervals of silty clay										
		fractures and shears inclined approximately 60 degrees, narrow to wide, filled with clay and calcium carbonate										
120												
		-calcium carbonate infilling			19	C		36"/36"	100.0			10:06 10:20
		-wavy calcium carbonate infilling										
		-calcium carbonate infilling, driller indicates coring very smooth			20	C		9'/9.5'	94.7			10:31 10:49
125		dusky yellow (5YR 6/4) with whitish carbonate streaks, similar to above, irregular zones of clayey silt throughout										
		completely weathered, some steeply inclined shearing										
130												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-10		Sheet 10 of 17

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		QUARTZ DIORITE; dusky yellow (5YR 6/1); with whitish calcium carbonate streaks, irregular zones of clayey silt throughout, completely weathered		qd								
		CLAY TO SANDY CLAY; olive (5YR 4/4) with white patches and brown streaks, with intervals of fine- to medium-grained sand, scattered coarse- and very coarse-grained sand, trace fine gravel, calcareous	CL	Qal								
		laminated interval, inclined approximately 60 degrees										11:20
135		SANDY SILT; yellowish brown (10YR 5/4) with clay, coarse-sand sized plutonic clasts	ML		21	C		20"/24"	83.3			11:35
		driller indicates harder material at 136 feet										
		CLAYEY SAND; olive (5Y 5/6) with brown (7.5YR 4/3) patches, slightly moist to moist, medium dense to very dense, medium- to very coarse-grained sand, medium plastic clay, massive	SC		22	C		32"/32"	100.0			11:46 12:13
					23	C		69"/72"	95.8			12:35 ?
140		calcium carbonate filled fracture, narrow to wide, inclined approximately 60 degrees										
		grades to brown (7.5YR 4/3), coarse- to very coarse-grained sand, medium plastic fines, occasional calcareous zones, weathered plutonic clast > 1.5-inch in size										
145												13:18

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-10	Sheet 11 of 17

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND; brown (7.5YR 4/3), coarse- to very coarse-grained sand, medium plastic fines, occasional calcareous zones	SC	Qal	24	C		72"/72"	100.0			14:39
150		SILTY TO CLAYEY SAND; brownish yellow (10YR 6/6) and yellowish brown (10YR 5/4), single subrounded to rounded quartz clast to 1-inch in size, clay content decreasing, driller indicates loosing some circulation at approximately 153 feet	SM/SC									
												15:06
					25	C		12"/18"	66.7			15:21
					26	C		0"/9.5'	0.0			
												15:32
												15:51
155												
160												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-10	Sheet 12 of 17	

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		SILTY TO CLAYEY SAND; brownish yellow (10YR 6/6) and moderate yellowish brown (10YR 5/4), less clay than above	SM/SC	Qal								
		SANDY CLAY TO CLAYEY SAND; dusky red (10R 3/4) to moderate brown (5YR 4/4), moist, medium dense, medium plastic clay, massive, narrow to wide, discolored fracture inclined 50 degrees	CL/SC		27	C		6"/6"	100.0			16:21 ?
					28	C		36"/36"	100.0			7:38
		-2-inch thick interval of yellowish brown (10YR 5/4), scattered plutonic rock fragments to 1/4-inch, clay content increasing, massive										
165												
					29	C		72"/72"	100.0			7:46 8:05
		CLAYEY SAND; yellowish red (5YR 5/6) with olive (5Y 5/6) mottling	SC									
170												
		faint bedding, inclined 30 degrees at 171 feet										
					30	C		90"/90"	100.0			8:43 9:02
		CLAYEY SAND TO SILTY SAND; olive (5Y 5/6) mottled with yellowish brown (10YR 5/4), bedding, inclined 40 degrees	SC/SM									
		-bedding, inclined 50 degrees										
175												

Project Name: Metro Rail - Los Angeles

Project Number: 92-2038 | Boring Number: B-10 | Sheet 13 of 17

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		SILTY SAND TO CLEAN SAND; predominantly yellowish brown (10YR 5/4), driller indicates slightly harder drilling	SM/SP	Qal								
		-oily discharge in mud										
		-gradational contact										
		QUARTZ DIORITE; moderate yellowish brown (10YR 5/4) to dark yellowish brown (10YR 4/2), moist to very moist, very weak to weak (decomposed to SP/SM), highly weathered to completely weathered		qd								
					31	C		0"/30"	0.0			9:49 10:09
180												
					32	C		0"/36"	0.0			10:41 11:06
185		-foliated			33	C		0"/24"	0.0			11:21 12:37
		-changing to kris bit (combination diamond/carbide)										
		-------------------------------										
		dark yellowish brown (10YR 6/6) to moderate yellowish brown (10YR 5/4), moist to very moist, very weak, coarsely crystalline			34	C		34"/48"	45.7			13:17 16:07
190												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-10		Sheet 14 of 17

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		QUARTZ DIORITE; dark yellowish brown (10YR 6/6) to moderate yellowish brown (10YR 5/4), moist to very moist, friable, coarsely crystalline		qd								16:18
					35	C		6"/6"	100.0			16:41
		---------------------------- with zones stained moderate brown (5YR 3/4)			36	C		13"/30"	43.3			16:56
												17:15
		periodically loosing circulation fluid; changed to tungsten carbide bit			37	C		11"/18"	38.9			17:34
195												17:42
		-changed to surface set diamond bit			38	C		0"/30"	0.0			16:28
		driller indicates soft at 197 feet										
												16:37
					39	C		4"/18"	22.2			16:50
		SAND; moderate yellowish brown (10YR 5/4), medium- to some coarse-grained sand, trace angular to rounded gravel to 1/4-inch in size (basalt, quartzite), angular sand grains	SP	Qal								16:57
		-slight rig chatter at 199.5 feet, smooth drilling below			40	C		0"/6"	0.0			17:19
200					41	C		6"/6"	100.0			17:34
		-mafic rock fragment to 1/2-inch in size			42	C		2"/6"	33.3			17:56
		---------------------------- -abundant very coarse-grained sand			43	C		3.5'/5'	62.0			18:14
		-some rock fragments begining										
205												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-10	Sheet 15 of 17

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		SAND; yellowish brown (10YR 5/4), abundant rock fragments	SP	Qal	44	C		54"/54"	100.0			18:35 08:32
		SAND TO SILTY SAND; yellowish brown (10YR 5/4), slightly moist, medium dense, coarse- to very coarse-grained angular sand with angular to subangular gravel sized clasts (volcanics, plutonics-mafic, intermediate)	SP/SM									
210					45	C		38"/42"	91.4			08:50 09:06
		SILTY TO CLAYEY SAND; brown (7.5YR 4/3), paleosol sharp contact	SM/SC									
		Coarse SAND grading to SILTY TO CLAYEY SAND; difuse banding inclined 35 degeees, sharp planar feature, inclined approximately 32 degrees	SP SM/SC		46	C		6'/6'	100.0			09:20 09:30
215												
		GRAVELLY SAND TO SANDY GRAVEL; plutonic clast, subrounded, 3-inch in size, mostly angular plutonics and volcanics clats and scattered rounded quartzite clasts	GM/SM									
220												10:00

Project Name:	Metro Rail - Los Angeles
Project Number:	92-2038
Boring Number:	B-10
Sheet	16 of 17

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		SAND TO SILTY SAND; brown (7.5YR 4/3), slightly moist, medium dense, coarse- to very coarse-grained sand with gravel, mostly angular plutonic and volcanic clasts and scattered rounded quartzite clats	SP/SM	Qal	47	C		3.6'/4'	90.0			10:15
		-cobble-sized plutonic clasts										
												10:34
					48	C		5'/5'	100.0			11:28
225												
		-6-inch thick sandy gravel, angular to subrounded (volcanic, plutonic and clastic) clasts to 1/2-inch in size, soft at 226 feet, very coarse clean sand below										
		vague contact inclined 37 degrees										
		SILTY SAND; brown (7.5YR 4/3)	SM									
												11:59
					49	C		5'/5'	100.0			12:10
230		SAND TO SILTY SAND; yellowish brown (10YR 5/4), very coarse-grained sand, angular grains with scattered rounded clasts generally less than 1/4-inch in size	SP/SM									
												12:44
		rounded quartzite and mica schist clasts, clay-lined planar feature inclined 50 degrees			50	C		6'/6'	100.0			
235												

Project Name:	Metro Rail - Los Angeles			
Project Number:	92-2038	Boring Number:	B-10	Sheet 17 of 17

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		SAND TO SILTY SAND; yellowish brown (10YR 5/4)	SP/SM	Qal								
		-plutonic clast, 3-inch in size										
		clay-lined planar features inclined 38 to 40 degrees, possibly slicked										
		bedding inclined approximately 45 degrees										13:40
240		Boring terminated at 240 feet.										
		Free groundwater encountered at 43 feet.										
245												
250												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-11		Sheet 1 of 7
Boring Location:	1822 Camino Palmero	Elevation and Datum(feet):	502.0
Health and Safety: -	Date Started: 6/30/92		Date Finished: 6/30/92
Drilling Equipment: Mobile B61	Total Depth (feet): 90.5		Depth to Bedrock(feet): -
Drilling Method: Hollow Stem Auger	Number of Samples: 57		Depth to Water (feet): -
Boring Diameter: 7-inch	Completion Information: Grouted to Surface		
Hammer Information: Downhole Hammer:140-lb and 30-inch drop.	Logged By: Grant Miller		Checked By: Paul Guptill

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content(%)	Begin/End Time(hr)
0		SILTY SAND; yellowish brown (10YR 5/4), slightly moist, medium dense, angular coarse-grained sand consisting of plutonic rock fragments, trace very coarse-grained sand, most angular, trace rounded, non plastic fines	SM	Qal								
5					1	D	6/8/9	13"/18"				
					2	D	6/6/7	15"/18"				
					3	D	8/13/12	12"/18"				
					4	D	11/14/14	12"/18"				
10												

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Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-11	Sheet 2 of 7

Depth (feet)	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
10	SILTY SAND; yellowish brown (10YR 5/4), abundant very coarse-grained sand consisting of angular plutonic fragments, trace weathered plutonic clasts to 1/4-inch in size	SM	Qal								
				5	D	8/11/14	13"/18"				
				6	D	9/15/17	14"/18"				
				7	D	13/14/15	16"/18"				
15											
	-3-inch thick fine-grained sandy silt layer			8	D	7/11/19	10"/18"				
	CLAYEY SAND; brown (7.5YR 4/3), slightly moist, medium dense, medium- to coarse-grained sand, medium plastic clay, trace plutonic gravel to 1/4-inch in size, scattered plutonic, volcanic, clastic rock fragments	SC		9	D	8/10/12	14"/18"				
				10	D	8/10/10	8"/18"				
20				11	D	5/11/11	11"/18"				
	grading to dark brown (7.5YR 3/2), increasing clay content, paleosol										
				12	D	7/15/16	16"/18"				
				13	D	13/14/16	16"/18"				
	subangular clasts to 1-inch in size										
				14	D	13/17/17	10"/18"				
25											

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Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-11	Sheet 3 of 7

Depth (feet)	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
	CLAYEY SAND; dark brown (7.5YR 3/2); slightly moist, dense, medium- to coarse-grained sand, medium plastic clay, trace gravel	SC	Qal								
				15	D	11/23/32	16"/18"				
	grading to brown (7.5YR 4/3) and yellowish brown (10YR 5/4), less clay										
				16	D	13/26/55	18"/18"				
	mostly yellowish brown (10YR 5/4)										
				17	D	15/29/45	10"/18"				
30											
	grading to brown (7.5YR 4/3), very coarse-grained sand			18	D	15/25/30	18"/18"				
	-highly weathered plutonic clasts to 1-inch in size										
				19	D	11/20/31	15"/18"				
	grading to yellowish brown (10YR 5/4), very coarse-grained sand.			20	D	15/30/38	18"/18"				
35	grading to dark reddish brown (5YR 3/3), increasing clay content, less very coarse-grained sand, trace fine-gravel sized plutonic rock fragments; paleosol			21	D	7/13/29	12"/18"				
				22	D	16/19/24	16"/18"				
	CLAYEY SAND TO SILTY CLAY; dark reddish brown (5YR 3/2), high clay content, medium plastic; paleosol	SC/CL									
				23	D	18/39/55	16"/18"				
	CLAYEY SAND; brown (7.5YR 4/3)	SC									
				24	D	11/29/50	16"/18"				
40											

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-11	Sheet 4 of 7	

Depth (feet)	Description	USCS Classification	Geologic Unit	Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
	CLAYEY SAND; brown (7.5YR 4/3)	SC	Qal								
				25	D	20/52/79	16"/18"				
	---------------------------- grading to yellowish brown (10YR 5/4), some gravel sized rock fragments, decreasing clay content			26	D	21/48/58	18"/18"				
	-weathered angular volcanic clasts to 1-inch in size			27	D	27/40/56	15"/18"				
45	-rounded clasts to 1.5-inch in size, weathered clastics and plutonics										
	SILTY SAND TO SAND; yellowish brown (10YR 5/4), slightly moist to moist, medium dense, coarse-grained sand, non-plastic fines, abundant angular fine-gravel sized clasts (quartzite, plutonics, volcanics)	SP/SM		28	D	23/44/51	15"/18"				
				29	D	32/50/59	12"/18"				
				30	D	55/79/40	15"/18"				
	------------- clayey interval, brown (7.5YR 4/3)										
50	SILTY SAND; yellowish brown (10YR 5/4), slightly moist, medium dense to dense, coarse- to very coarse-grained sand, some fine-gravel, some medium plastic clay; less silt at 51.5 feet	SM		31	D	12/23/44	9"/18"				
				32	D	69/120/50	13"/18"				
	-rounded quartzite clasts to 1.5-inch in size			33	D	30/44/50	11"/18"				
	-with silty and clayey intervals at 54 feet										
55				34	D	29/36/49	18"/18"				

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-11	Sheet 5 of 7

Depth (feet)	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
	CLAYEY SAND; brown (7.5YR 4/3), slightly moist, medium dense to dense, medium- to coarse-grained sand, some very coarse-grained sand, trace fine-gravel (plutonics, sandstone), medium plastic fines, massive	SC	Qal								
				35	D	34/35/55	18"/18"				
	---------------------------- grading to yellowish brown (10YR 5/4) with thin intervals of brown (7.5YR 4/3), increasing gravel content										
				36	D	42/56/60	12"/18"				
	SILTY SAND; yellowish brown (10YR 5/4)	SM		37	D	35/59/70	12"/18"				
60	-6-inch thick interval of brown (5YR 4/3) clayey sand										
				38	D	39/62/70	16"/18"				
	SAND TO SILTY SAND; yellowish brown (10YR 5/4), dry to slightly moist, medium dense, coarse- to very coarse-grained sand, trace to some fine-gravel to 1/2-inch in size, some rounded hard plutonics and quartzite	SP/SM		39	D	27/55/72	14"/18"				
				40	D	27/35/40	12"/18"				
65	SILTY SAND TO CLAYEY SAND; yellowish brown (10YR 5/4); as above	SM/SC		41	D	37/45/55	16"/18"				
	SAND TO SILTY SAND; yellowish brown (10YR 5/4) as above, dry, trace to some gravel-sized clasts to 1-inch in size	SP/SM		42	D	55/79/105	18"/18"				
				43	D	57/98/120	16"/18"				
	-clayey sand interval			44	D	22/27/40	12"/18"				
70											

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-11		Sheet 6 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		SAND TO SILTY SAND; see above	SP/SM	Qal								
		SILTY SAND TO CLAYEY SAND; brown (7.5YR 4/3) to moderate yellowish brown (10YR 5/4), dry to slightly moist, medium dense, some clay, rounded clasts to 1.5-inch in size, some highly weathered plutonics	SM/SC		45	D	36/30/40	17"/18"				
		-12-inch thick clean sand interval										
					46	D	17/25/20	17"/18"				
		-well-rounded quartzite clasts to 1/2-inch in size										
					47	D	21/27/32	13"/18"				
75												
		reddish brown (5YR 4/3), approximately 6-inch thick			48	D	21/31/35	12"/18"				
		CLAYEY TO SILTY SAND; reddish brown (5YR 4/3), with weathered plutonic clasts	SC/SM		49	D	20/27/30	17"/18"				
					50	D	27/39/40	18"/18"				
80		SILTY TO CLAYEY SAND; brown (7.5YR 4/3)	SM/SC		51	D	27/40/51	13"/18"				
		---------------------------- grades to yellowish brown (10YR 5/4) with weathered plutonic clasts to several inches in size										
					52	D	29/37/40	17"/18"				
					53	D	27/28/38	16"/18"				
		---------------------------- grades to brown (7.5YR 4/3), angular schist fragments										
					54	D	17/24/40	10"/18"				
85												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-11	Sheet 7 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		SILTY TO CLAYEY SAND; brown (7.5YR 4/3) --------------- increasing clay content, weathered rounded plutonic clast to 1-inch in size	SM/SC	Qal	55	D	32/69/79	17"/18"				
		CLAYEY SAND; brown (7.5YR 4/3), dry to slightly moist, medium dense to dense, medium- to very coarse-grained sand, medium plastic fines, trace gravel sized clasts	SC		56	D	54/65/81	17"/18"				
					57	D	35/50/62	11"/18"				
90												
		Boring terminated at 90.5 feet. No free groundwater observed.										
95												
100												

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Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-12		Sheet 1 of 7
Boring Location:	1822 Camino Palmero	Elevation and Datum(feet):	512.0
Health and Safety: -		Date Started: 7/1/92	Date Finished: 7/2/92
Drilling Equipment:	Mobile B61	Total Depth (feet): 96.5	Depth to Bedrock(feet): -
Drilling Method:	Hollow Stem Auger	Number of Samples: 60	Depth to Water (feet): 90.0
Boring Diameter:	7-inch	Completion Information:	Grouted to Surface
Hammer Information: Downhole Hammer:140-lb and 30-inch drop.		Logged By: Grant Miller	Checked By: Paul Guptill

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
0		SILTY SAND; dark yellowish brown (10YR 4/4), dry, medium dense, medium-grained sand, some coarse- to very coarse-grained sand, massive	SM	Qal								
5					1		6/9/9	14"/18"				
					2		8/7/7	9"/18"				
		CLAYEY SAND TO SILTY SAND; yellowish brown (10YR 5/4), dry to slightly moist, medium dense, medium- to coarse-grained sand, some very coarse-grained sand, trace gravel, low plastic fines, massive, angular plutonic clasts to 1/2-inch in size with intervals of silty sand	SC/SM		3		8/11/14	15"/18"				
					4		11/12/20	15"/18"				
10												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-12	Sheet 2 of 7

Depth (feet)	Description	USCS Classification	Geologic Unit
10	CLAYEY SAND TO SILTY SAND; yellowish brown (10YR 5/4), dry to slightly moist, medium dense, medium- to coarse-grained sand, some very coarse-grained sand, trace gravel, low plastic fines, massive, angular plutonic clasts to 1/2-inch in size with intervals of silty sand ------------- some sub-angular, gravel-sized plutonics clasts to >2-inch in size	SC/SM	Qal
15	CLAYEY SAND; yellowish brown (10YR 5/4) to brown (7.5YR 4/3), dry to slightly moist, medium dense, very coarse-grained angular sand, some-fine gravel to 1/4-inch in size, massive -silty sand interval at 16 to 16.5 feet	SC	
20			
	CLAYEY SAND TO SANDY CLAY; dark brown (7.5YR 3/2), increasing clay content, medium plastic fines, trace angular gravel to 1-inch in size, trace highly weathered plutonic clasts; paleosol	SC/CL	
25			

Samples

Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
5		12/14/26	14"/18"				
6		13/16/26	18"/16"				
7		8/14/22	12"/18"				
8		14/18/23	14"/18"				
9		10/16/28	16"/18"				
10		11/20/24	9"/18"				
11		6/7/10	5"/18"				
12		11/15/21	14"/18"				
13		13/19/26	10"/18"				
14		11/20/30	13"/18"				

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-12		Sheet 3 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND TO SANDY CLAY; dark brown (7.5YR 3/2), increasing clay content, medium plastic fines, trace angular gravel to 1-inch in size, trace highly weathered plutonic clasts; paleosol	SC/CL	Qal								
					15		12/19/27	11"/18"				
					16		9/22/29	13"/18"				
		CLAYEY SAND; dark reddish brown (5YR 3/3), angular quartzite clasts to 3/4-inch in size, increasing lithic fragments below	SC		17		12/23/39	14"/18"				
30												
		grading to dark yellowish brown (10YR 4/4), some very coarse-grained sand, some angular fine-gravel, less clay			18		6/33/43	17"/18"				
					19		20/49/56	15"/18"				
		-gravelly to cobbly, angular weathered plutonic clasts to >2-inch in size			20		23/46/55	12"/18"				
		grading to moderate brown (7.5YR 4/3)										
35					21		21/35/50	18"/18"				
		CLAYEY SAND TO SANDY CLAY; dark reddish brown (5YR 3/2), increasing clay content, less gravel, very coarse-grained sand-sized rock fragments; paleosol	SC/CL									
					22		27/40/55	18"/18"				
					23		21/30/49	18"/18"				
		CLAYEY SAND; dark yellowish brown (10YR 4/4) to yellowish brown (10YR 5/4), increasing fine gravel-sized rock fragments; paleosol	SC		24		17/29/35	18"/18"				
40												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-12	Sheet 4 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND; dark reddish brown (5YR 3/3) with olive gray (5Y 5/2) mottling; paleosol	SC	Qal								
					25		25/32/45	18"/18"				
		CLAYEY TO SILTY SAND; yellowish brown (10YR 5/4) with olive gray (5Y 5/2), trace rounded clasts to 1/4-inch in size, some angular gravel to 1/2-inch in size, weathered plutonics (light olive gray areas)	SC/SM		26		19/26/35	14"/18"				
					27		20/30/34	18"/18"				
45		-dark reddish brown (5YR 3/3) mottling			28		21/29/38	16"/18"				
					29		25/30/39	18"/18"				
		-weathered volcanic clasts to 1/4-inch in size										
		SILTY TO CLAYEY SAND; mottled yellowish brown (10YR 5/4) and olive gray (5Y 5/2), moist, medium dense to dense, coarse- to very coarse-grained sand, some angular gravel upto 3/4-inch in size, quartzite clasts, non plastic to low plastic fines, some clay, massive	SM/SC		30		29/30/39	18"/18"				
50					31		25/40/33	18"/18"				
		-moderate brown mottling			32		33/33/50	18"/18"				
					33		25/32/40	12"/18"				
		-weathered rounded sandstone clasts to 1-inch in size			34		30/35/42	18"/18"				
55												

Project Name:	Metro Rail - Los Angeles
Project Number:	92-2038
Boring Number:	B-12
Sheet	5 of 7

Depth (feet)	Description	USCS Classification	Geologic Unit
	SILTY TO CLAYEY SAND; yellowish brown (10YR 5/4) with olive gray (5Y 5/2) patches, moist, medium dense to dense, coarse- to very coarse-grained sand, some angular gravel upto 3/4-inch in size, quartzite clasts, non plastic to low plastic fines, some clay, massive	SM/SC	Qal
	-weathered rounded plutonic clast to 2-inch in size; blackish discoloration as streaks and patches		
60	SILTY SAND; yellowish brown (10YR 5/4) with light olive gray (5Y 5/2) mottling, angular to subangular coarse-grained sand, trace to some fines, increasing weathered plutonics and clastics clasts below (highly weathered, friable, some are hard and competent up to 1.5" in size)	SM	
	---------------------------- grades to brown (7.5YR 4/3) with moderate yellowish brown and light olive gray mottling		
	-rounded gravel to 1/2-inch in size		
65	CLAYEY SAND; brown (7.5YR 4/3), with olive gray (5Y 5/2) mottling, medium- to coarse-grained sand, trace gravel to 1/4-inch in size, medium plastic fines, reddish	SC	
	-less clay, increasing weathered plutonic clasts to 1-inch in size		
70	---------------------------- plutonic clasts, slightly moist, increasing coarse-grained sand content		

Samples

Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
35		20/40/59	18"/18"				
36		35/79/130	12"/18"				
37		60/112/125	18"/18"				
38		70/70/115	13"/18"				
39		24/80/85	14"/18"				
40		25/40/36	18"/18"				
41		29/60/75	18"/18"				
42		30/39/38	18"/18"				
43		14/30/35	18"/18"				
44		34/55/112	16"/18"				

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-12		Sheet 6 of 7

Depth (feet)	Description	USCS Classification	Geologic Unit	Sample Number	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
	CLAYEY SAND; brown (7.5YR 4/3), with olive gray (5Y 5/2) mottling, medium- to coarse-grained sand, some very coarse-grained sand, trace gravel	SC	Qal							
	brown (7.5YR 4/3) to pale brown (5YR 5/2), micaceous, weathered sub-angular sandstone and plutonic clasts to 2-inch in size			45	39/81/105	18"/18"				
				46	61/76/102	12"/18"				
	-weathered plutonic clast to 2-inch in size			47	42/85/100	15"/18"				
75										
	CLAYEY SAND TO SILTY SAND; brown (7.5YR 4/3), increasing very coarse-grained sand content and fine-gravel (1/2-3/4-inch in size)	SC/SM		48	37/70/80	17"/18"				
				49	40/61/86	14"/18"				
	grading to brown (7.5YR 4/3) and yellowish brown (10YR 5/4)			50	25/47/88	14"/18"				
	-subrounded, weathered plutonic clasts to 1.5-inch in size									
80				51	30/47/61	18"/18"				
				52		18"/18"				
				53	37/52/100	18"/18"				
85										

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-12		Sheet 7 of 7

Depth (feet)	Description	USCS Classification	Geologic Unit	Sample Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
	-highly weathered plutonic clasts to 2-inch in size, appears rounded	SC/SM	Qal								
				54		50/68/87	18"/18"				
				55		27/43/70	15"/18"				
				56		32/51/66	13"/18"				
90	SAND TO SILTY SAND; brown (7.5YR 4/3) to yellowish brown (10YR 5/4); wet, dense, very coarse-grained sand, trace to some fines	SP/SM									
				57		38/57/88	17"/18"				
	CLAYEY SAND TO SILTY SAND; brown (7.5YR 4/3), slightly moist, very dense, coarse-grained sand, trace gravel	SC/SM									
				58		31/39/63	15"/19"				
				59		27/55/79	15"/19"				
95				60		28/53/65	8"/18"				
	Boring terminated at 96.5 feet. Free groundwater encountered at 90 feet.										
100											

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-13		Sheet 1 of 11
Boring Location:	1840 Camino Palmero	Elevation and Datum(feet):	532.5
Health and Safety: -	Date Started: 7/3/92		Date Finished: 7/3/92
Drilling Equipment: Failing F-10	Total Depth (feet): 155.0		Depth to Bedrock(feet): 18.0
Drilling Method: HSA/Rotary Core	Number of Samples: 64		Depth to Water (feet): 47.0
Boring Diameter: 8"-HSA/4"R	Completion Information:		Grouted to Surface
Hammer Information: Downhole Hammer:140-lb and 30-inch drop.	Logged By: Grant Miller		Checked By: Paul Guptill

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time(hr)
0		SILTY SAND TO SAND; dark yellowish brown (10YR 4/4), slightly moist to moist, medium dense, coarse-grained sand, trace to some non plastic fines, angular to rounded cobbles to 4-inch in size, massive	SM/SP	Qal								
5					1	D	5/8/8	9.5"/18"				
		CLAYEY TO SILTY SAND; brown (7.5YR 4/3), slightly moist to moist, medium dense, medium- to coarse-grained sand, low to medium plastic fines, trace gravel, scattered rounded clasts, micaceous, massive	SC/SM									
					2	D	5/7/8	8"/18"				
					3	D	5/7/8	16"/18"				
					4	D	7/10/11	8.5"/18"				
10												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-13	Sheet 2 of 11

Depth (feet)	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
10	CLAYEY TO SILTY SAND; brown (7.5YR 4/3), slightly moist to moist, medium dense, medium- to coarse-grained sand, low to medium plastic fines, trace gravel, scattered rounded clasts, massive, micaceous	SC/SM	Qal								
	CLAYEY SAND; brown to dark brown (7.5YR 4/3 to 3/2), increasing red tones	SC		5	D	6/8/15	15"/18"				
	-dark brown (7.5YR 3/2), weathered rounded plutonic clasts to 1/2-inch in size; paleosol			6	D	7/12/16	14"/18"				
	grades to yellowish red (5YR 5/6), some cobble sized, highly weathered plutonic clasts to 3-4 inches in size, friable			7	D	17/20/28	18"/18"				
15				8	D	21/28/43	18"/18"				
				9	D	21/38/45	15"/18"				
	SILTY SAND (DECOMPOSED QUARTZ DIORITE); moderate yellowish brown (10YR 5/4)		qd								
				10	D	30/48/50	14"/18"				
	-highly weathered plutonic clast										
20	dark yellowish orange (10YR 6/6) to light brown (5YR 5/6), weathered to silty sand with clay			11	D	21/21/25	18"/18"				
	moderate yellowish brown (10YR 5/4) to dark yellowish orange (10YR 6/6) moist, very weak, completely weathered with intervals that are highly weathered, coarsely crystalline, irregular zones/fractures filled with silt/clay			12	D	18/35/23	12"/18"				
				13	D	23/25/28	18"/18"				
				14	D	45/53/68	18"/18"				
25											

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-13	Sheet 3 of 11

Depth (feet)	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
	QUARTZ DIORITE; moist, very weak, completely weathered with intervals that are highly weathered, coarsely crystalline, irregular zones/fractures filled with silt/clay		qd								
	-clay lined fractures inclined 45 degrees, approximately 1/4" wide, extremely closely spaced, narrow			15	D	45/60/65	18"/18"				
	----------------------------										
	light gray (N8) to light olive gray (5Y 6/6), very closely spaced fractures, clay lined, narrow to very narrow			16	D	16/25/37	18"/18"				
	-several closely spaced shears, clay lined, inclined approximately 55 degrees			17	D	40/75/75	18"/18"				
30	-foliation, inclined approximately 50 degrees										
	-clay gouge			18	D	53/78/105	18"/18"				
	thin interval of clayey										

	-light olive brown (5YR 5/6), finely crystalline below			19	D	35/38/65	18"/18"				
	-light olive gray (5Y 5/2) to dusky yellow (5Y 6/4), thin clay, inclined 50 degrees, occasional shearing										
				20	D	45/88/90	18"/18"				

35	-clay seam, coarsely crystalline below			21	D	35/45/45	18"/18"				
	-foliation, inclined 30 degrees										
				22	D	18/30/40	18"/18"				
	-irregularly sheared pale red purple (5RP 6/2) clay										
				23	D	23/25/60	18"/18"				

	-dark yellowish orange (10YR 6/6) clay seam, inclined approximately 70 degrees, coarsely crystalline below			24	D	42/50/58	13"/18"				
40											

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-13	Sheet 4 of 11	

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		QUARTZ DIORITE; moist, very weak, completely weathered with intervals that are highly weathered, coarsely crystalline, irregular zones/fractures filled with silt/clay		qd								
		-irregularly sheared clay			25	D	25/45/56	18"/18"				
		-light brown (5YR 5/6) discoloration, generally olive gray (5Y 6/1) to olive gray (5YR 4/1)										
					26	D	30/40/45	18"/18"				
		-very thin clay seam, unsheared										
					27	D	50/52/100	17"/18"				
45												
					28	D	39/62/110	15"/18"				
		-narrow, clay-lined fracture										
		-sampler is wet			29	D	50/70/88	18"/18"				
		-very coarsely crystalline, dark brown staining, very moist										
					30	D	40/80/125	16"/18"				
		-dark yellowish orange stained fractures, closely spaced										
50					31	D	50/175/200/2.5"	14"/14.5				
		Hollow Stem Auger drilling terminated @ 51 feet. Switched to Rotary Core drilling with diamond set bit										
		white and black, moist, very weak, slightly weathered, very close to closely spaced, stained and filled narrow irregular fractures, light brown partial alteration of biotite			1	C		0"/24"	0.0			14:27
												14:32
					2	C		16"/24"	0.0			14:50
55												

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Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-13		Sheet 5 of 11

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		QUARTZ DIORITE; white and black, moist, very weak, slightly weathered, very close to closely spaced, stained and filled narrow irregular fractures, light brown partial alteration of biotite		qd								
		sheared and contorted clay seam, light olive brown (5YR 5/6) to olive gray (5Y 3/2), with plutonic intraclasts, inclined 60 degrees			3	C		16"/60"	15.0			14:55 15:08
60												
		rock mass stained olive black to brownish black, sheared clayey intervals, extremely closely sheared, inclined 65 degrees			4	C		22"/24"	91.7			15:18 15:29
		using tungsten carbide bit										
					5	C		0"/12"	0.0			15:44 16:01
					6	C		36"/36"	100.0			16:12 17:10
65		clay with plutonic intraclasts, dark yellowish orange to light olive brown, vertically sheared										
		irregular, clay-filled fractures			7	C		18"/54"	0.0			17:32 17:43
70												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-13		Sheet 6 of 11

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		QUARTZ DIORITE; white and black, moist, very weak, slightly weathered, very close to closely spaced, stained and filled narrow irregular fractures		qd								7:55
					8	C		0"/24"	0.0			17:55 8:27
		-Driller indicates very soft, cuttings return as angular coarse-grained sand with quartz and feldspar; using cris set bit (tungsten carbide-diamond combination)			9	C		0"/24"	0.0			8:34 8:53
75												
					10	C		0"/12"	0.0			8:57 9:10
					11	C		0"/12"	0.0			9:13 9:19
	+ + +	CLAY; dark yellowish brown (10YR 4/2), some silt, low plastic clay, plutonic intraclasts			1	S		8"/12"	66.7			-9:25
	+ + +				12	C		6"/9"	0.0			11:04
	+ + +	-sheared, inclined 45 to 90 degrees										11:13
	+ + +				13	C		6"/18"	0.0			11:45
80		---------------------------										
		dark yellowish orange (10YR 6/6), moderately strong earthy (kaolinite) material to weak calcareous material, sheared clay with hard plutonic fragments, calcite-filled veins			14	C		0"/36"	0.0			11:52 12:10
					15	C		3"/3"	100.0			12:20 12:59
	+ + +	moderate yellowish brown (10YR 5/4) with dark yellowish orange (10YR 6/6) discoloration, slightly moist, very			16	C		27"/30"	90.0			14:06
85												

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Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-13		Sheet 7 of 11

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		weak, moderately weathered, massive, coarsely crystalline, closely spaced smooth shears/fractures, approximately inclined 65 degrees, possibly slickensided		qd								
					17	C		36"/36"	100.0			14:23 14:35
		-gneissic foliation inclined 30 to 40 degrees										
90					18	C		48"/48"	91.7			14:48 15:00
		-CLAY; light brown (5YR 5/6), smooth to slightly rough shear, inclined 80 degrees										
		-crushed material, extremely closely sheared, brittle, fine grained, shear surfaces are smooth										
					19	C		36"/39"	89.7			15:38 15:57
95		-very close to closely spaced random smooth shears, clay filled, narrow										
		CLAY GOUGE/BRECCIA; light olive brown (5Y 5/6), clayey matrix, gravel-sized clasts to 1/4-inch in size, appear subangular, fine to coarsely crystalline, plutonic, brecciated in places, individual rx fragments are strong to very strong but rock is intensely fractured and sheared and crumbles readily, very close to closely randomly oriented spaced smooth shears, clay filled, narrow										
					20	C		51"/57"	21.1			16:35 8:16
		-randomly oriented, extremely closely spaced shears, some slickensides, rough and oriented 45 deg. across vertical shear										
100												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-13		Sheet 8 of 11

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		BRECCIA; light olive brown (5Y 5/6), clayey matrix, gravel-sized clasts to 1/4-inch in size, appear subangular, fine to coarsely crystalline, plutonic, brecciated in places, individual rx fragments are strong to very strong but rock is intensely fractured and sheared and crumbles readily, very close to closely spaced randomly oriented smooth shears, clay filled, narrow		qd	21	C		48"/48"	30.8			8:58 9:12
		-core crumbles easily										
105		fine-grained, well cemented, noncalcareous breccia and shears, smooth, clay-lined, inclined approximately 20 to 45 degrees										
		parallel shears inclined 68 to 45 degrees, very close to closely spaced sheared fractures, smooth to slightly rough, clay lined, narrow; core crumbles easily			22	C		48"/48"	50.0			9:55 10:11
		-dark yellowish orange (10YR 6/6), sheared clay, fine-grained, cemented; fragments to <1/4-inch										
110		------------------------------			23	C		18"/18"	66.7			10:44 12:05
		-gneissic, very close to extemely closely sheared										
		generally gneissic that is closely fractured with intervals that are extremely closely fractures resulting in hard fragments from 1/8 to 2-inch in size, fractures are smooth, clay coated and inclined approximately 40 degrees			24	C		66"/66"	10.6			12:25 15:28
		-foliation, inclined approximately 40 degrees; extremely closely fractured below										
115												

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Project Name:	Metro Rail - Los Angeles			
Project Number:	92-2038	Boring Number:	B-13	Sheet 9 of 11

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Samples: Type	Samples: Blow Count	Samples: Recovery	Samples: RQD (%)	Samples: Dry Density (pcf)	Samples: Moisture Content (%)	Begin/End Time (hr)
		QUARTZ DIORITE; gnessic, white and olive gray crystals, moderately strong, slightly to moderately weathered, coarse-grained, breaks to very coarse-grained sand with some clasts to 1/2-inch in size, closely fractured, some sheared, clay lined, smooth, narrow		qd								
		-extremely closely spaced fractures										
					25	C		48"/48"	0.0			16:07 16:20
		-white, noncalcareous, coarsely crystalline with extremely closely spaced fractures										
		-gouge, shear zone, inclined 20 degrees										
120												
		-clay gouge, abundant plutonic intraclasts			26	C		60"/66"	45.4			16:53 17:07
		-closely to very closely fracture										
		-clay gouge										
125												
		-sheared fracture, clay lined, smooth, narrow to wide, inclined 68 degrees										
		-clayey gouge										
		-gnessic, very weak, weakly foliated, inclined 50 degrees, closely fractured			27	C		34"/42"	52.4			17:49 18:02
130												18:29

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-13		Sheet 10 of 11

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		QUARTZ DIORITE; medium gray to medium dark gray, slightly weathered to unweathered, coarsely crystalline, very friable to coarse-grained sand and gravel up to 3-inch in size, calcareous, gneissic, parts along gneissic foliation, closely fractured and sheared, smooth, very narrow to narrow, randomly oriented, clay-lined		qd	28	C		48"/60"	40.0			13:55
												14:18
135		CLAY; medium gray (N5) to brownish gray (5YR 4/1), moist, firm to stiff in uncemented zone, weak in cemented zone with inclusions of foliated and strong quartz diorite upto 5-inch in size, shears are clay lined, smooth to medium rough, extremely closely spaced, inclined 80 degrees			29	C		48"/48"	12.5			14:34
												15:04
		-slightly calcareous, weakly cemented, some fractures lined with crystalline calcium carbonate			30	C		48"/48"	56.3			15:20
140		QUARTZ DIORITE; medium gray (N5) to medium dark gray (N4), strong to very strong, unweathered to slightly weathered, coarsely crystalline, massive, smooth shear inclined 35 degrees, closely spaced fractures, calcite filled										
		-clay gouge, inclined 20 degrees										
												16:11
					31	C		60"/60"	28.3			16:33
		-close to very closely fracture with intervals that are very close to extremely fractured										
145												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-13		Sheet 11 of 11

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		QUARTZ DIORITE; medium gray (N5) to medium dark gray (N4), strong to very strong, unweathered to slightly weathered, coarsely crystalline, massive, smooth shear inclined 35 degrees, closely spaced fractures, calcite filled		qd								
		-gouge, very close to extremely close fractures										
		-fractures, inclined 70 degrees										
		-closely fracture overall, rough, inclined 30 degrees			32	C		64"/64"	48.4			18:14 8:34
150		-very wide, quartz filled, inclined 60 degrees										
		-unweathered, sheared and fracture, extremely closely spaced, calcium carbonate filled, inclined 60 degrees										
		-shear and fracture, clay lined, narrow, extremely closely spaced, inclined 40 degrees										10:11 10:36
					33	C		20"/20"	37.5			
		-dike										
155												11:00
		Boring terminated at 155 feet. Free groundwater encountered at 47 feet.										
160												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-14	Sheet 1 of 9	
Boring Location:	1822 Camino Palmero	Elevation and Datum(feet):	523.5
Health and Safety: -	Date Started: 7/29/92	Date Finished: 7/31/92	
Drilling Equipment: Mobile B53	Total Depth (feet): 120.5	Depth to Bedrock(feet): 40.0	
Drilling Method: HSA/Mud Rotary Core	Number of Samples: 61	Depth to Water (feet): -	
Boring Diameter: 7-inch	Completion Information: Grouted to Surface		
Hammer Information: Downhole Hammer:140-lb and 30-inch drop.	Logged By: Grant Miller	Checked By: Paul Guptill	

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
0		SAND TO SILTY SAND; yellowish brown (10YR 5/4), dry to slightly moist, medium dense, fine- to very coarse-grained sand, non plastic fines, angular plutonic clasts to 3/4-inch in size, massive, friable	SP/SM	Qal								
5					1	D	7/7/6	18"/18"				
					2	D	5/7/7	18"/18"				
		-clayey interval			3	D	4/4/8	18"/18"				
					4	D	10/5/4	11"/18"				
10												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-14		Sheet 2 of 9

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
10		SAND TO SILTY SAND; yellowish brown (10YR 5/4), dry to slightly moist, medium dense, fine- to very coarse-grained sand, non plastic fines, angular plutonic clasts to 3/4-inch in size, massive, friable	SP/SM	Qal								
		-moderate brown (5YR 3/4), clayey silty sand interval			5	D	9/9/9	10"/18"				
					6	D	9/8/6	17"/18"				
		-some angular gravel										
		-------------- slightly moist			7	D	8/9/10	14"/18"				
15												
					8	D	10/6/8	13"/18"				
		CLAYEY SAND; brown (7.5YR 4/3), moist, medium dense, medium- to coarse-grained sand, slightly to medium plastic fines, slightly micaceous, some angular plutonic clasts to 1/2-inch in size, massive	SC		9	D	7/7/9	11"/18"				
					10	D	4/6/9	15"/18"				
		---------------------------- grades to dark brown (7.5YR 3/2), porous										
20		moderate brown (5YR 3/4), dry to slightly moist, fine- to coarse-grained sand, some fine gravel to 1/4-inch in size, massive; paleosol			11	D	16/18/20	18"/18"				
					12	D	22/32/35	18"/18"				
		CLAYEY SAND TO SILTY CLAY; dark reddish brown (5YR 3/2), very clayey, medium plastic fines; paleosol	SC/CL									
					13	D	18/38/40	17"/18"				
		CLAYEY SAND; brown (7.5YR 4/3) and then yellowish brown (10YR 5/4), less clay than above, well rounded, smooth quartzite clast to 1-inch in size	SC									
					14	D	25/28/33	18"/18"				
25												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-14		Sheet 3 of 9

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND; brown (7.5YR 4/3) and then yellowish brown (10YR 5/4), less clay than above, well rounded, smooth quartzite clast to 1-inch in size	SC	Qal								
					15	D	28/30/35	14"/18"				
		-some quartzite and highly weathered plutonic clasts to 1-inch in size										
		------------------------------ grading to brown (7.5YR 4/3)			16	D	23/28/34	18"/18"				
					17	D	27/40/57	16"/18"				
30		CLAYEY TO SILTY SAND; brown (7.5YR 4/3)	SC/SM									
					18	D	30/32/40	15"/18"				
					19	D	35/45/60	10"/18"				
		SILTY SAND; yellowish brown (10YR 5/4), dry to slightly moist, very dense, some angular to rounded gravel to 1/2-inch in size, highly weathered plutonics to > 2.5-inch in size	SM									
					20	D	37/43/50	16"/18"				
35					21	D	75/62	8"/12"				
		Switched to Rotary Core drilling with spring retract using 2-inch split spoon sampler			1	C		6"/48"	0.0			8:03
		------------------------------ slightly moist, dense to very dense, fine- to coarse-grained sand, silt, some clay, smooth rounded clasts to 1/2-inch in size										
40												8:07

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Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-14		Sheet 4 of 9

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		SILTY SAND; yellowish brown (10YR 5/4), slightly moist, dense to very dense, fine- to coarse-grained sand, silt, some clay, smooth rounded clasts to 1/2-inch in size	SM	Qal	2	C		2"/24"	0.0			8:15
		-decomposed plutonic clasts										
					3	C		0"/36"	0.0			8:19 8:52
45		QUARTZ DIORITE; dark yellowish orange (10YR 6/6), completely weathered to highly weathered, very friable		qd	4	C		2"/24"	0.0			9:04
		-change to diamond set bit/core barrel; no longer using spring retract-split spoon			5	C		0"/24"	0.0			10:12
					6	C		6"/24"	0.0			10:19 10:29
50		highly micaceous, coarsely crystalline, very clayey zones										
					7	C		2"/36"	0.0			10:34 10:45
					8	C		5"/18"	27.8			10:56 11:04
55												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-14		Sheet 5 of 9

Depth (feet)	Description	USCS Classification	Geologic Unit	Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
	QUARTZ DIORITE; moderate yellowish brown (10YR 5/4) with intervals of dark yellowish orange (10YR 6/6), moist, very weak to very friable, highly weathered to completely weathered, coarsely crystalline, highly micaceous, stained, inclined 70 to 80 degrees		qd	9	C		8"/18"	44.4			11:08 11:26
				10	C		5"/18"	27.8			11:31 11:42
				11	C		0"/18"	0.0			11:48 11:59
60				12	C		8"/18"	0.0			12:01 12:13
	-fracture inclined 65 degrees, sheared, stained, clay-lined, narrow -rig chatter at 62 feet			13	C		8"/18"	0.0			12:16 12:24
				14	C		6"/18"	0.0			12:28 12:35
	-extremely closely spaced fractures, irregular, narrow, clay-filled			15	C		16"/18"	66.7			12:38 12:46
65	-hard zone approximately 6-inch thick										
				16	C		15"/18"	83.3			12:50 13:07
	-Driller indicates firmer drilling with occasional soft zones			17	C		5"/48"	0.0			13:10 13:18
70											

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-14		Sheet 6 of 9

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		QUARTZ DIORITE; moderate yellowish brown (10YR 5/4) with intervals of dark yellowish orange (10YR 6/6), moist, very weak to very friable, highly weathered to completely weathered, coarsely crystalline, highly micaceous		qd								
		-rig chatter from 71.5 to 72 feet			18	C		2"/18"	0.0			13:26 13:41
		shear, inclined approximately 20 to 30 degrees			19	C		2"/18"	0.0			13:47 14:00
					20	C		0"/18"	0.0			14:02 14:30
75												
					21	C		12"/18"	55.6			14:34
					22	C		16"/24"	29.2			14:50 14:58
					23	C		0"/24"	0.0			15:05 15:15
80												
		-intermittent rig chatter										
					24	C		0"/24"	0.0			15:20 15:28
					25	C		9"/15"	60.0			15:36 15:50
		-shear, inclined 40 degree, narrow, clay-lined										15:55
85					26	C		0"/22"	0.0			16:04

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-14	Sheet 7 of 9	

Depth (feet)	Description	USCS Classification	Geologic Unit	Sample Number	Type	Recovery	RQD (%)	Begin/End Time (hr)
	QUARTZ DIORITE; moderate yellowish brown (10YR 5/4) with intervals of dark yellowish orange (10YR 6/6), moist, very weak to very friable, highly weathered to completely weathered, coarsely crystalline, highly micaceous		qd					
				27	C	4"/18"	0.0	16:06 16:29
	dark yellowish orange (10YR 6/6), clayey zones with rock fragments embedded in clay; wide, clay-lined, inclined 90 degrees			28	C	12"/18"	0.0	16:33 16:50
				29	C	0"/18"	0.0	16:55 17:07
90	-gouge, rig chatter from 90 to 91 feet							
	gouge; dusky yellow (5Y 6/4), increasing clay content, wide, clay-lined shear, inclined 90 degrees			30	C	0"/18"	0.0	17:10 17:19
				31	C	6"/16"	0.0	17:21 8:18
	dark yellowish orange (10YR 6/6), weak to moderately strong, well cemented, calcareous with plutonic rock fragments upto 1-inch in size embedded in clay, randomly sheared			32	C	12"/12"	100.0	8:21 8:39
95	CLAY GOUGE/BRECCIA; dark yellowish orange (10YR 6/6), dry, medium strong, clay with plutonic rock fragments and crystals embedded, clasts upto 1/4-inch in size, mostly coarse-grained sand size; shears/fractures are extremely closely spaced, randomly oriented; Driller indicates hole taking much water			33	C	1"/24"	0.0	8:56
				34	C	0"/18"	0.0	9:01 9:15 9:18
	-rig chatter at 97.5 feet							
	QUARTZ DIORITE; dark yellowish brown (10YR 4/2), strong to very strong, zones weakly cemented with calcium carbonate, fine-grained, extremely closely fractured and sheared, randomly oriented, some fractures filled with calcite crystals			35	C	24"/60"	0.0	9:45
100								

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-14	Sheet 8 of 9

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		QUARTZ DIORITE; dark yellowish brown (10YR 4/2), strong to very strong, zones weakly cemented with calcium carbonate, fine-grained, extremely closely fractured and sheared, randomly oriented, some fractures filled with calcite crystals		qd								
		-Driller indicates softer material at 103 feet										
		-------------------------------- completely weathered, with clayey intervals, extremely closely sheared, random, clay lined			36	C		12"/42"	0.0			10:06 10:24
105												
					37	C		12"/48"	0.0			10:33 11:04
		clay lined vertical shear, narrow to wide, random irregular, calcite filled										
110												
		extremely closely fractures and sheared, random			38	C		34"/36"	0.0			11:15 11:27
		-slight rig chatter			39	C		29"/36"	0.0			11:38 11:48
115												

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Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-14		Sheet 9 of 9

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
	+	QUARTZ DIORITE; dark yellowish brown (10YR 4/2), strong to very strong, highly weathered with intervals having weak calcareous cementation, very closely to closely spaced clay lined fracture, sheared		qd								
	+											11:57
	+				40	C		39"/42"	11.9			12:17
	+	Brecciated with incompetent zones, weakly to moderately well cemented zone with calcium carbonate, fractures, inclined 70 degrees, very closely fractured and randomly sheared										
120	+											12:34
		Boring terminated at 120.5 feet. No free groundwater observed.										
125												
130												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-15		Sheet 1 of 4
Boring Location: 1822 Camino Palmero		Elevation and Datum(feet): 519.0	
Health and Safety: -	Date Started: 8/4/92		Date Finished: 8/5/92
Drilling Equipment: EZ Bore	Total Depth (feet): 50.0		Depth to Bedrock(feet): -
Drilling Method: Bucket Auger	Number of Samples:		Depth to Water (feet): 45.0
Boring Diameter: 24-inch	Completion Information: Grouted to Surface		
Hammer Information: Downhole Hammer:140-lb and 30-inch drop.	Logged By: Grant Miller		Checked By: Paul Guptill

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time(hr)
0		SILTY SAND; yellowish brown (10YR 5/4) to dark yellowish brown (10YR 4/4), slightly moist, loose to medium dense, fine- to coarse-grained sand, trace very coarse-grained sand, trace gravel consisting of angular to rounded plutonic and quartzite clasts, massive, micaceous	SM	Qal								
5		some gravel to 1-inch in size, rounded quartzite clasts, weathered plutonics, pockets/lenses of clean sand at lower contact										
		SILTY SAND TO CLAYEY SAND; yellowish brown (10YR 5/4), slightly moist, medium dense, fine- to medium-grained sand, some coarse-grained sand, trace gravel to 1/4-inch in size, micaceous	SM/SC									
10												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-15		Sheet 2 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
10		SILTY SAND TO CLAYEY SAND; yellowish brown (10YR 5/4), slightly moist, medium dense, fine- to medium-grained sand, some coarse-grained sand, trace gravel to 1/4-inch in size, micaceous	SM/SC	Qal								
		-sandy sand lens										
15		GRAVELLY SAND; yellowish brown (10YR 5/4), slightly moist, loose to medium dense, fine- to medium-grained sand, lenses of clean coarse-grained sand, trace silt, trace clay, plutonic and quartzite gravel to 2 to 3-inch in size, massive	SM/GM									
		CLAYEY SAND TO SILTY SAND; yellowish brown (10YR 5/4), moist, medium dense, fine- to medium-grained sand, trace coarse-grained sand, low plasticy fines, trace gravel to 1/4 to 1-inch in size, massive, highly micaceous	SC/SM									
20		----------------										
		some coarse-grained sand, trace very coarse, trace gravel, massive with difuse intervals that are finer grained, becomes porous downward										
		-gradational contact										
25												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-15	Sheet 3 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Samples: Type	Samples: Blow Count	Samples: Recovery	Samples: RQD (%)	Samples: Dry Density (pcf)	Samples: Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND; dark brown (7.5YR 3/2), moist, medium dense to dense, fine- to medium-grained sand, some coarse-grained sand, trace very coarse-grained sand and fine-gravel to 1/4-inch in size, massive, micaceous, highly porous, some moderately weathered plutonic clasts to 2-inch in size at 26.5 feet, paleosol	SC	Qal								
		------------------------------ dense, very clayey, poorly developed clay coatings (polished) on soil ped surfaces, less porous, abundant weathered white feldspar grains; paleosol										
30												
		------------------------------ medium dense to dense, black flecks scattered in matrix locally, absence of clay coatings on soil ped surfaces, decreasing clay content, increasing coarse-grained sand, some gravel to 3-inch in size, weathered plutonics, quartzite										
35		gravelly to cobbly interval, weathered plutonics, rounded quartzite to 3-inch in size										
		CLAYEY TO SILTY SAND; brown (7.5YR 4/3), with olive gray (5Y 5/2) mottling, as above	SC/SM									
40												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-15	Sheet 4 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY TO SILTY SAND; brown (7.5YR 4/3), slightly moist, medium dense to dense, coarse- to very coarse-grained sand, some gravel, trace cobbles to 3 inches in size (weathered plutonics and quartzite)	SC/SM	Qal								
		-------------- -moist to wet										
45		-groundwater at 45 feet										
		--------------------------- yellowish brown (10YR 5/4)										
		-Driller indicates hard drilling, cuttings consist of some weathered plutonic clasts to several inches in size and quartzite										
50		Boring terminated at 50 feet. Free groundwater encountered at 45 feet. Visually logged to 40 feet.										
55												

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Project Name:	Metro Rail - Los Angeles				
Project Number:	92-2038	Boring Number:	B-16	Sheet 1 of 8	
Boring Location:	1822 Camino Palmero	Elevation and Datum(feet):	519.0		
Health and Safety:	-	Date Started:	8/6/92	Date Finished:	8/6/92
Drilling Equipment:	Failing-10	Total Depth (feet):	102.5	Depth to Bedrock(feet):	75.0
Drilling Method:	Hollow Stem Auger	Number of Samples:	65	Depth to Water (feet):	47.0
Boring Diameter:	7-inch	Completion Information:	Grouted to Surface		
Hammer Information: Downhole Hammer:140-lb and 30-inch drop.		Logged By: Grant Miller		Checked By: Paul Guptill	

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time(hr)
0		SILTY SAND; yellowish brown (10YR 5/4), dry, medium dense, fine- to coarse-grained sand, trace gravel to 1/2-inch in size, trace clay, massive, friable	SM	Qal								
5					1	D	9/7/9	18"/18"				
					2	D	9/10/11	18"/18"				
					3	D	10/12/8	18"/18"				
		grades to brown (7.5YR 4/3)										
					4	D	9/12/14	18"/18"				
10												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-16	Sheet 2 of 8	

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
10		SILTY SAND; yellowish brown (10YR 5/4), dry, medium dense, fine- to coarse-grained sand, trace gravel to 1/2-inch in size, trace clay, massive, friable	SM	Qal								
		-hard plutonic clasts to > 2.5-inch in size			5	D	5/8/15	18"/18"				
					6	D	6/8/13	12"/18"				
					7	D	8/12/17	18"/18"				
15												
					8	D	10/10/15	18"/18"				
		SILTY SAND TO CLAYEY SAND; brown (7.5YR 4/3) to moderate yellowish brown (10YR 5/4), slightly moist, medium dense, fine- to coarse-grained sand, some angular fine gravel to 1/4-inch in size	SM/SC		9	D	10/9/11	16"/18"				
					10	D	4/6/12	10"/18"				
20					11	D	7/13/15	18"/18"				
					12	D	7/14/24	13"/18"				
		CLAYEY SAND TO SILTY SAND; brown (7.5YR 4/3), increasing clay content, decreasing coarse fraction below	SC/SM									
					13	D	11/13/19	18"/18"				
					14	D	11/13/14	15"/18"				
25												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-16	Sheet 3 of 8

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND TO SILTY SAND; brown (7.5YR 4/3)	SC/SM	Qal								
		CLAYEY SAND; brown to dark brown (7.5YR 4/3 to 3/2), slightly moist, medium dense, trace gravel to 1-inch in size	SC		15	D	5/10/11	14"/18"				
		brown (7.5YR 3/2), paleosol			16	D	9/11/15	18"/18"				
					17	D	8/10/6	15"/18"				
30		-weathered plutonic clast										
		increasing coarse fraction, trace to some coarse-grained sand, scattered fine gravel to 1/4-inch in size			18	D	8/14/28	18"/18"				
					19	D	10/50/29	18"/18"				
					20	D	12/24/31	18"/18"				
35					21	D	11/17/23	18"/18"				
		grades to brown (7.5YR 4/3) to yellowish brown (10YR 5/4)			22	D	15/12/19	18"/18"				
	O	-hard plutonic clast to 1/2-inch in size										
		grades to yellowish brown (10YR 5/4)			23	D	13/18/25	18"/18"				
					24	D	11/14/17	18"/18"				
40												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-16		Sheet 4 of 8

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND; yellowish brown (10YR 5/4)	SC	Qal								
		------------------------------ moist, moisture content increasing downward with light olive gray mottling along root lines			25	D	6/16/20	18"/18"				
					26	D	5/9/10	18"/18"				
					27	D	7/11/17	18"/18"				
45		-discolored light olive gray, irregular fracture, locally filled with wet medium- to coarse-grained sand										
		------------------------------ grades to brown (7.5YR 4/3) -gravelly zone approximately 2 to 3 inches thick, material moist below			28	D	11/19/29	18"/18"				
					29	D	7/17/20	17"/18"				
		-weathered plutonic clast >2.5 inch in size										
		SILTY SAND TO CLAYEY SAND; yellowish brown (10YR 5/4), moist to very moist , medium dense to dense, fine- to coarse-grained sand, trace to some gravel and cobbles to > 2.5-inch in size, mostly weathered plutonics, rare volcanics plus quartzite, massive to crudely stratified - channel sands(?)	SM/SC		30	D	9/11/19	18"/18"				
50					31	D	6/17/24	11"/16"				
					32	D	9/12/20	17"/18"				
					33	D	12/48/67	18"/18"				
					34	D	20/23/31	14"/18"				
55												

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Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-16		Sheet 5 of 8

Depth (feet)	Description	USCS Classification	Geologic Unit	Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
	SILTY SAND TO CLAYEY SAND; yellowish brown (10YR 5/4), moist to very moist, medium dense to dense, fine- to coarse-grained sand, trace to some gravel and cobbles to > 2.5-inch in size, mostly weathered plutonics, rare volcanics plus quartzite, massive to crudely stratified - channel sands(?)	SM/SC	Qal								
				35	D	8/12/26	11"/18"				
				36	D	16/20/33	17"/18"				
	SAND; dark yellowish brown (10YR 4/4) to olive (5Y 5/6), moist to wet, medium dense to dense, medium- to coarse-grained sand with intervals of sandy silt/sandy clay, trace gravel	SP		37	D	10/14/21	16"/18"				
60											
				38	D		18"/18"				
				39	D		11"/18"				
	SILTY SAND TO CLAYEY SAND; brown (7.5YR 4/3) with olive gray (5Y 5/2) mottling locally, very moist, medium dense to dense, scattered plutonics up to 1/4-inch in size, massive	SM/SC		40	D		14"/18"				
65				41	D		16"/18"				
				42	D		14"/18"				
				43	D		18"/18"				
	CLAYEY SAND TO SANDY CLAY; brown to dark brown (7.5YR 4/3 to 3/2), slightly moist to dry, dense to very dense, paleosol	SC/CL									
	------------------------------ grades to yellowish red (5YR 5/6) with light olive gray			44	D		18"/18"				
70											

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-16	Sheet 6 of 8

Depth (feet)	Description	USCS Classification	Geologic Unit	Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
	mottling and seams, discolored unsheared seam, inclined 60 degrees at 69.5 feet	SC/CL	Qal								
				45	D		12"/18"				
	------------------------------ grades to brownish yellow (10YR 6/6), pale olive (5Y 6/4) and olive (5Y 5/6)			46	D		18"/18"				
	QUARTZ DIORITE; dusky yellow to light olive brown (5YR 6/4 to 5YR 5/6), moist, very weak, completely weathered, highly micaceous		qd	47	D		18"/18"				
75											
				48	D		18"/18"				
	------------------------------ shear- inclined approximately 55 degrees, coarsely crystalline with white quartz and feldspar, moderately to slightly weathered, massive below			49	D		11"/18"				
				50	D		12"/18"				
80	extremely closely sheared, crushed, surfaces slicensided			51	D	29/37/50	9"/18"				
				52	D	12/23/46	18"/18"				
	irregular fracture, calcium carbonate filled, inclined approximately 55 degrees										
				53	D	16/27/43	18"/18"				
	parallel fractures, calcium carbonate filled, inclined 55 to 60 degrees										
				54	D	17/30/47	17"/18"				
85											

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-16		Sheet 7 of 8

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		1.25 inch thick powdery calcium carbonate filled fracture inclined 75 degrees		qd								
					55	D	25/51/73	11"/18"				
					56	D	27/48/63	9"/18"				
		------------------------------										
		extremely closely sheared and fracture, crushed, random, dark yellowish orange (10YR 6/6) mottling										
					57	D	46/80/102	6"/18"				
90												
					58	D	57/100/145	4"/18"				
		-brecciated			59	D	53/86/115	6"/18"				
					60	D		4"/18"				
95					61	D		2"/18"				
		-crushed zone, extremely closely fractured and sheared										
					62	D		6"/18"				
					63	D		15"/18"				
					64	D		9"/18"				
100												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-16		Sheet 8 of 8

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
	+ + +	QUARTZ DIORITE; dusky yellow to light olive brown (5Y 6/4 to 5Y 5/6), moist, very weak, completely weathered, highly micaceous		qd								
					65	D		0"/18"				
		Boring terminated at 102.5 feet. Free groundwater encountered at 47 feet.										
105												
110												
115												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-17	Sheet 1 of 7
Boring Location:	1822 Camino Palmero	Elevation and Datum(feet):	514.5
Health and Safety:	-	Date Started: 8/8/92	Date Finished: 8/8/92
Drilling Equipment:	Failing-10	Total Depth (feet): 99.5	Depth to Bedrock(feet): -
Drilling Method:	Hollow Stem Auger	Number of Samples: 63	Depth to Water (feet): 55.0
Boring Diameter:	7-inch	Completion Information:	Grouted to Surface
Hammer Information: Downhole Hammer:140-lb and 30-inch drop.		Logged By: Grant Miller	Checked By: Paul Guptill

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
0		SILTY SAND; yellowish brown (10YR 5/4), dry, medium dense, fine- to coarse-grained sand, trace gravel, massive, friable	SM	Qal								
5					1	D	8/10/18	18"/18"				
					2	D	5/12/16	13"/18"				
					3	D	8/12/12	12"/18"				
10					4	D	11/11/14	18"/18"				

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-17	Sheet 2 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
10		SILTY SAND; yellowish brown (10YR 5/4), dry, medium dense, fine- to coarse-grained sand, trace gravel, massive, friable	SM	Qal								
		---------------------------- grading to dark yellowish brown (10YR 4/4) to yellowish brown (10YR 5/4)			5	D	8/12/12	16"/18"				
					6	D	8/10/12	16"/18"				
					7	D	8/11/14	18"/18"				
15		-weathered, plutonic clast to >2.5-inch in size										
					8	D	11/14/18	14"/18"				
		-weathered, plutonic clast >2.5-inch in size										
					9	D	8/12/12	17"/18"				
					10	D	10/10/10	15"/18"				
20		---------------------------- slightly moist, some very coarse-grained sand, trace gravel, massive, slightly micaceous			11	D	10/10/11	18"/18"				
					12	D	8/10/10	18"/18"				
					13	D	8/8/8	16"/18"				
		---------------------------- clay content increasing										
					14	D	8/12/13	16"/18"				
25												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-17	Sheet 3 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		SILTY SAND; yellowish brown (10YR 5/4), slightly moist, medium dense, fine- to coarse-grained sand, some very coarse-grained sand, some clay, trace gravel, massive, slightly micaceous	SM	Qal								
					15	D	8/12/12	18"/18"				
		CLAYEY SAND; yellowish brown (10YR 5/4) to brown (7.5YR 4/3) slightly moist, medium dense, fine- to coarse-grained sand, trace to some gravel (plutonics)	SC		16	D	8/10/16	18"/18"				
					17	D	11/12/12	17"/18"				
30												
		CLAYEY SAND TO SANDY CLAY; dark brown (7.5YR 3/2), very clayey, paleosol	SC/CL		18	D	7/8/14	18"/18"				
					19	D	12/17/13	18"/18"				
		-charcoal fragments			20	D	7/9/11	18"/18"				
35					21	D	7/10/19	18"/18"				
		CLAYEY TO SILTY SAND; yellowish brown (10YR 5/4), moist to very moist, with less clay	SC/SM									
					22	D	8/10/10	18"/18"				
					23	D	12/12/15	18"/18"				
		CLAYEY SAND; dark brown to dark reddish brown (7.5YR 3/2 to 5YR 3/2), slightly moist, with high clay,	SC		24	D	12/21/35	18"/18"				
40												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-17	Sheet 4 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		paleosol CLAYEY SAND; dark brown to dark reddish brown (7.5YR 3/2 to 5YR 3/2), slightly moist, very clayey, paleosol	SC	Qal								
					25	D	29/30/32	18"/18"				
					26	D	14/23/30	18"/18"				
					27	D	42/30/33	18"/18"				
45												
					28	D	25/30/56	18"/18"				
		grades to yellowish brown (10YR 5/4) to brown (7.5YR 4/3) with some olive gray (5Y 5/2) mottling										
					29	D	18/27/32	18"/18"				
					30	D	25/26/26	18"				
50		moist to very moist, fine- to very coarse-grained sand, trace to some gravel up to 1/2-inch in size, massive			31	D	18/18/20	18"				
					32	D	18/27/40	18"				
					33	D	18/30/32	18"/18"				
					34	D	22/25/40	18"/18"				
55		grading to brown (7.5YR 4/3), dry to slightly moist										

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-17		Sheet 5 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND; brown (7.5YR 4/3), dry to slightly moist, medium dense to dense, fine- to very coarse-grained sand, trace to some gravel to 1/2 inch in size, massive	SC	Qal								
					35	D	14/15/35	18"/18"				
					36	D	15/15/30	18"/18"				
					37	D	25/?/34	16"/18"				
60												
		CLAYEY TO SILTY SAND; yellowish brown (10YR 5/4) with olive gray (5Y 5/2) zones, trace to some weathered plutonic clasts to 1/2-inch in size	SC/SM		38	D	42/32/40	18"/18"				
					39	D	15/30/42	17.5"/18				
					40	D	15/32/40	16"/18"				
65					41	D	40/47/50	18"/18"				
					42	D	44/50/55	18"/18"				
		-weathered, friable rounded plutonic clast up to 5-inch in size										
		SILTY SAND; yellowish brown (10YR 5/4), very moist, medium dense to dense, fine- to coarse-grained sand, trace fine gravel up to 1/4-inch in size, trace to some clay, massive	SM		43	D	34/47/50	16"/18"				
					44	D	15/18/31	11"/18"				
70												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-17		Sheet 6 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		SILTY SAND; yellowish brown (10YR 5/4), very moist, medium dense to dense, fine- to coarse-grained sand, trace fine gravel up to 1/4-inch in size, trace to some clay, massive	SM	Qal								
					45	D	18/24/38	20"/20"				
		grades to olive (5Y 5/6) and yellowish brown (10YR 5/4)										
					46	D	32/36	12"/12"				
		SILTY SAND TO CLAYEY SAND; yellowish brown (10YR 5/4) to brown (7.5YR 4/3), moist, dense to very dense, fine- to coarse-grained sand, some fine gravel upto 1/4-inch in size	SM/SC									
					47	D	28/29/43	14"/18"				
75												
					48	D	55/75	12"/12"				
		contact inclined 30 degrees										
		SILTY SAND; yellowish brown (10YR 5/4), slightly moist, very dense, fine- to coarse-grained sand, some gravel	SM									
					49	D	68/175/5"	11"/11"				
		-fracture inclined 60 degrees, moderate brown discoloration										
		very coarse-grained sand, some gravel to 1/2 to 3/4-inch in size			50	D	72/180/3"	9"/9"				
80					51	D	58/100	12"/12"				
					52	D	250/6"	4"/6"				
		CLAYEY SAND; brown (7.5YR 4/3), slightly moist, very dense	SC		53	D	82/100/4"	18"/18"				
					54	D	150/6"	13.5"/18				
85												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-17	Sheet 7 of 7

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND; brown (7.5YR 4/3)	SC	Qal								
		------------------------------ grading to yellowish brown (10YR 5/4) and brown (7.5YR 4/3)			55	D	47/100	12"/12"				
		--------------------------- grading to brown (7.5YR 4/3)			56	D	21/70/104	18"/18"				
					57	D	47/98/75	6"/18"				
90		---------------------------- dark brown (7.5YR 3/2) to dark reddish brown (5YR 3/2)										
					58	D	30/31/40	18"/18"				
		CLAYEY SAND TO SANDY CLAY; brown (7.5YR 4/3) to moderate reddish brown (10YR 4/6), slightly moist, dense, fine- to coarse-grained sand	SC/CL									
					59	D	30/38/60	18"/18"				
					60	D	28/38/40	18"/18"				
95		------------------------------ grading to brown (7.5YR 4/3) and yellowish brown (10YR 5/4)			61	D	25/30/33	18"/18"				
		------------------------------- with light olive gray mottling, irregular patches and streaks			62	D	20/35/42	18"/18"				
					63	D	20/41/52	18"/18"				
100		Boring terminated at 99.5 feet. Free groundwater encountered at 55 feet.										

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Project Name:	Metro Rail - Los Angeles				
Project Number:	92-2038	Boring Number:	B-18	Sheet 1 of 4	
Boring Location:	1829 Camino Palmero	Elevation and Datum(feet):	514.0		
Health and Safety:	-	Date Started:	9/3/92	Date Finished:	9/3/92
Drilling Equipment:	Failing-10	Total Depth (feet):	50.0	Depth to Bedrock(feet):	-
Drilling Method:	Hollow Stem Auger	Number of Samples:	30	Depth to Water (feet):	48.5
Boring Diameter:	7-inch	Completion Information:	Grouted to Surface		
Hammer Information: Downhole Hammer:140-lb and 30-inch drop.		Logged By: Grant Miller		Checked By: Paul Guptill	

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
0		SILTY SAND; brown (7.5 YR 3/2)	SM	Qal								
5		yellowish brown (10YR 5/4); dry, medium dense, fine- to very coarse-grained sand, trace fine gravel, non plastic fines, massive, very friable, micaceous			1	D	9/10/12	16"/18"				
					2	D	10/11/11	12"/18"				
					3	D	12/15/11	11"/18"				
					4	D	10/10/10	16"/18"				
10		SILTY TO CLAYEY SAND; see below	SM/SC									

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-18		Sheet 2 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
10		SILTY TO CLAYEY SAND; brown (7.5YR 4/3); moist, medium dense, as above and friable	SM/SC	Qal								
					5	D	12/12/12	15"/18"				
		grades to yellowish brown (10YR 5/4)										
					6	D	12/13/14	15"/18"				
		SILTY SAND; yellowish brown (10YR 5/4), dry, medium dense, fine- to coarse-grained sand, trace very coarse-grained sand, trace to some non plastic fines, massive, very friable	SM		7	D	22/24/25	16"/18"				
15												
					8	D	13/15/15	16"/18"				
		SILTY TO CLAYEY SAND; yellowish brown (10YR 5/4); slightly moist to moist, medium dense, fine- to coarse-grained sand, trace very coarse-grained sand, trace gravel, non to low plastic fines, massive, friable, micaceous	SM/SC									
					9	D	15/18/21	15"/18"				
					10	D	14/20/24	14"/18"				
20					11	D	25/18/30	15"/18"				
		-quartzite clast, rounded										
					12	D	8/17/15	12"/18"				
		increasing clay content, less friable	SC/SM		13	D	15/20/25	17"/18"				
					14	D	12/16/18	14"/18"				
25												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-18	Sheet 3 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		SILTY TO CLAYEY SAND; reddish brown (5YR 4/4), slightly moist to moist, medium dense, fine- to coarse-grained sand, trace very coarse-grained sand, trace gravel, non to low plastic fines, massive, friable, micaceous	SM/SC	Qal								
		-(darkens downward)			15	D	12/15/18	10"/18"				
					16	D	17/16/23	16"/18"				
					17	D	17/21/17	14"/18"				
30		with dark brown (7.5YR 3/2) mottling										
					18	D	12/12/12	18"/18"				
		grades to dark brown (7.5YR 3/2), moist, paleosol										
					19	D	10/10/15	16"/18"				
					20	D	5/8/13	15"/18"				
35		SILTY TO CLAYEY SAND; yellowish brown (10YR 5/4) with moderate brown mottling, moist to very moist, medium dense, trace to some gravel to 1-inch in size	SM/SC		21	D	13/18/20	16"/18"				
					22	D	25/25/20	18"/18"				
					23	D	18/30/30	22"/22"				
		CLAYEY SAND TO SANDY CLAY; dark reddish brown (5YR 3/2); slightly moist, dense to very dense, fine- to medium-grained sand, trace coarse- to very coarse-grained sand, medium plastic fines, massive, micaceous; paleosol	SC/CL									
40												

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Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-18		Sheet 4 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND TO SANDY CLAY; dark reddish brown (5YR 3/2); slightly moist, dense to very dense, fine- to medium-grained sand, trace coarse- to very coarse-grained sand, medium plastic fines, massive, micaceous; paleosol	SC/CL	Qal	24	D	30/40/55	23"/23"				
		-------------- less clay			25	D	25/50/35	18"/18"				
					26	D	27/50/60	18"/18"				
		CLAYEY TO SILTY SAND; brown (7.5YR 4/3) to yellowish brown (10YR 5/4)	SC/SM		27	D	15/22	11"/12"				
45					28	D	14/25/25	18"/18"				
		---------------------------- with light to olive gray mottling										
		-weathered plutonic clast			29	D	14/24/25	18"/18"				
		---------------------------- grading to yellowish brown (10YR 5/4) with light olive gray mottling			30	D	15/18/30	18"/18"				
50		Boring terminated at 50 feet. Free groundwater encountered at 48.5 feet.										
55												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-19		Sheet 1 of 4
Boring Location:	1829 Camino Palmero	Elevation and Datum(feet):	512.0
Health and Safety: -		Date Started: 9/10/92	Date Finished: 9/10/92
Drilling Equipment:	Failing-10	Total Depth (feet): 50.0	Depth to Bedrock(feet): -
Drilling Method:	Hollow Stem Auger	Number of Samples: 30	Depth to Water (feet): -
Boring Diameter:	7-inch	Completion Information:	Grouted to Surface
Hammer Information: Downhole Hammer:140-lb and 30-inch drop.		Logged By: Grant Miller	Checked By: Paul Guptill

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time(hr)
0		SILTY SAND; yellowish brown (10YR 5/4); dry, medium dense, fine- to very coarse-grained sand, trace gravel, non plastic fines, massive, very friable	SM	Qal								
5					1	D	8/9/9/	13"/18"				
					2	D	10/10/10	16"/18"				
					3	D	10/12/13	17"/18"				
10		brown (7.5YR 4/3) to yellowish brown (10YR 5/4), increasing fines, cohesive, less friable	SM/SC		4	D	12/10/11	14"/18"				

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Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-19	Sheet 2 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
10		SILTY SAND; yellowish brown (10YR 5/4); dry, medium dense, fine- to very coarse-grained sand, trace gravel, non plastic fines, massive, very friable	SM	Qal								
		---------------------------- friable			5	D	10/11/11	16"/18"				
		---------------------------- very friable, less fines (trace to some)			6	D	12/12/16	13"/18"				
					7	D	15/15/17	14"/18"				
15												
					8	D	11/12/15	14"/18"				
		---------------------------- more fines, somewhat cohesive, less friable			9	D	15/16/18	16"/18"				
		CLAYEY SAND TO SILTY SAND; yellowish brown (10YR 5/4); slightly moist to moist, medium dense to dense, fine- to coarse-grained sand, trace to some very coarse-grained sand, trace gravel, slightly plastic fines, massive, weakly to non friable	SC/SM		10	D	13/14/16	17"/18"				
20					11	D	11/12/15	10"/18"				
					12	D	12/13/12	17"/18"				
					13	D	13/13/15	18"/18"				
					14	D	12/16/20	15"/18"				
25												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-19		Sheet 3 of 4

Depth (feet)	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
	CLAYEY SAND TO SILTY SAND; yellowish brown (10YR 5/4); slightly moist to moist, medium dense to dense, fine- to coarse-grained sand, trace to some very coarse-grained sand, trace gravel, slightly plastic fines, massive, weakly to non friable	SC/SM	Qal								
	CLAYEY SAND; brown (7.5YR 4/3)	SC		15	D	10/12/22	15"/18"				
	----------------------------- grades to dark reddish brown (5YR 3/2), slightly moist, dense, fine- to coarse- grained sand, trace very coarse-grained sand, medium plastic fines, massive, porous; paleosol			16	D	10/12/20	18"/18"				
				17	D	15/20/30	18"/18"				
30											
	----------------------------- lightening in color			18	D	27/30/25	18"/18"				
				19	D	17/30/25	17"/18"				
	----------------------------- grades to dark yellowish brown (10YR 4/4), some very coarse sand, trace gravel										
				20	D	14/18/18	18"/18"				
	CLAYEY SAND TO SANDY CLAY; dark reddish brown (5YR 3/2), very clayey, trace gravel; paleosol	SC/CL									
35				21	D	13/25/31	18"/18"				
	-darker (5YR 3/2) interval			22	D	15/31/32	18"/18"				
				23	D	12/22/27	17"/18"				
	----------------------------- grades to dark reddish brown (5YR 2.5/2 to 5YR 3/2), paleosol			24	D	10/18/30	18"/18"				
40											

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-19	Sheet 4 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND TO SANDY CLAY; dark reddish brown (5YR 2.5/2) to grayish brown (5YR 3/2); paleosol	SC/CL	Qal								
					25	D	10/25/36	18"/18"				
		grades to dark reddish brown (5YR 3/2)										
					26	D	15/28/30	18"/18"				
		CLAYEY SAND; olive gray streaks and patches, overall grades to brown (7.5YR 4/3), trace weathered plutonic clasts, some coarse-grained sand, massive	SC									
					27	D	20/30/50	18"/18"				
45												
					28	D	22/26/28	18"/18"				
		CLAYEY SAND TO SILTY SAND; yellowish brown (10YR 5/4)	SC/SM		29	D	16/25/42	18"/18"				
					30	D	16/25/36	18"/18"				
50		Boring terminated at 50 feet. No free groundwater observed.										
55												

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Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-20	Sheet 1 of 4
Boring Location:	Camino Palmero	Elevation and Datum(feet):	509.5
Health and Safety:	-	Date Started: 10/7/92	Date Finished: 10/7/92
Drilling Equipment:	Failing F-10	Total Depth (feet): 50.0	Depth to Bedrock(feet):
Drilling Method:	HSA	Number of Samples: 30	Depth to Water (feet):
Boring Diameter:	8"	Completion Information:	Grouted to Surface
Hammer Information: Downhole Hammer:140-lb and 30-inch drop.		Logged By: Grant Miller	Checked By: Paul Guptill

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
0		SILTY SAND; dark yellowish brown (10YR 4/4), dry, medium dense, fine- to coarse-grained sand with some very coarse-grained sand, trace gravel, trace cobbles (plutonics), non plastic fines,micaceous, massive, very friable	SM	Qal								
5					1	D	9/12/12	17"/18"				7:49
					2	D	10/15/11	15"/18"				
		CLAYEY SAND; dark yellowish brown (10YR 4/4), dry, medium dense, fine- to coarse-grained sand with very coarse-grained sand, low plasticity clay	SC		3	D	8/10/12	12"/18"				
		SILTY TO CLAYEY SAND; see below	SM/SC		4	D	9/9/12	14"/18"				7:59
10												

Project Name:	Metro Rail - Los Angeles
Project Number:	92-2038
Boring Number:	B-20
Sheet	2 of 4

Depth (feet)	Description	USCS Classification	Geologic Unit	Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
10	SILTY TO CLAYEY SAND; dark yellowish brown (10YR 4/4), dry, medium dense, fine- to coarse-grained sand with very coarse-grained sand, with thin, cohesive, less friable intervals	SM/SC	Qal								
				5	D	9/10/15	15"/18"				
	cohesive interval			6	D	10/12/12	18"/18"				
				7	D	11/13/15	14"/18"				8:10
15	cohesive interval			8	D	9/9/9	13"/18"				
				9	D	8/8/14	15"/18"				
	dark yellowish brown (10YR 4/4), slightly porous, increasing clay content, trace gravel, less friable			10	D	7/8/10	14"/18"				
20				11	D	8/11/10	14"/18"				8:30
	grading to brown (7.5YR 4/4), increasing clay content			12	D	10/12/12	16"/18"				
	CLAYEY SAND; brown (7.5YR 4/4), slightly moist, dense, fine to very course sand, trace gravel, porous, clayey	SC		13	D	6/8/11	13"/18"				
				14	D	9/8/16	18"/18"				
25											

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Project Name:	Metro Rail - Los Angeles			
Project Number:	92-2038	Boring Number:	B-20	Sheet 3 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND, grades to dark reddish brown (5YR 3/2) at 2.5', increasing clay content, trace roots, paleosol	SC	Qal								
					15	D	9/16/16	14"/18"				8:45
					16	D	6/12/17	18"/18"				
		-- grades to dark brown (7.5YR 3/2), increasing sand content, abundant roots			17	D	11/18/24	17"/18"				
30		dark brown to brown (7.5YR 3/2 to 4/3), dense to very dense, fine- to medium-grained sand, some very coarse-grained sand, trace angular gravel (up to 1" diam.), medium plastic clay, trace roots; brown below 30.5, increasing gravel content			18	D	11/18/25	18"/18"				8:57
		-- grades to dark reddish brown (5YR 3/2), decreasing coarse-grained sand, increasing clay content, paleosol			19	D	19/25/28	18"/18"				
					20	D	8/18/23	18"/18"				
35					21	D	17/27/39	18"/18"				
		-- grades to brown (7.5YR 4/3), scattered weathered plutonic clasts to small cobble size			22	D	20/30/45	18"/18"				9:20
					23	D	13/25/40	17"/18"				
					24	D	23/35/50	18"/18"				
40												

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Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-20	Sheet 4 of 4	

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND; brown (7.5 YR 4/3), slightly moist, dense to very dense, fine to medium sand, trace to some very coarse sand, scattered, weathered plutonic clasts to small cobble size	SC	Qal								
					25	D	25/33/50	18"/18"				9:37
		-- grades to brown (7.5YR 4/4), increasing coarse-grained sand and gravel content										
					26	D	30/35/40	17"/18"				
					27	D	25/50/60	15"/18"				
45												
					28	D	35/43/32	18"/18"				10:03
		-friable interval										
		SILTY SAND; yellowish brown (10YR 5/4), dry, dense, fine- to medium-grained sand, trace coarse-grained sand, trace to some gravel, trace cobble, friable	SM		29	D	25/30/47	14"/18"			--	
					30	D	25/28/33	15"/18"				
50		Boring terminated at 50 feet No free groundwater encountered.										10:17
55												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-22		Sheet 1 of 5
Boring Location:	Camino Palmero on Franklin Ave	Elevation and Datum(feet):	490.0
Health and Safety: -	Date Started: 9/9/92		Date Finished: 9/9/92
Drilling Equipment: Failing-10	Total Depth (feet): 60.5		Depth to Bedrock(feet): -
Drilling Method: Hollow Stem Auger	Number of Samples: 37		Depth to Water (feet): -
Boring Diameter: 7-inch	Completion Information: Grouted to Surface		
Hammer Information: Downhole Hammer:140-lb and 30-inch drop.	Logged By: Grant Miller		Checked By: Paul Guptill

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time(hr)
0		asphalt base Course										
		SILTY SAND; dark yellowish brown (10YR 4/4); dry, medium dense, fine- to very coarse-grained sand, trace gravel, non plastic fines, massive, very friable	SM	Qal								
5					1	D	7/7/9	14"/18"				
					2	D	8/8/9	15"/18"				
					3	D	8/9/12	14"/18"				
					4	D	10/12/12	16"/18"				
10												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-22		Sheet 2 of 5

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
10		SILTY SAND; dark yellowish brown (10YR 4/4); dry, medium dense, fine- to very coarse-grained sand, trace gravel, non plastic fines, massive, very friable	SM	Qal								
					5	D	7/10/13	14"/18"				
					6	D	7/7/10	16"/18"				
					7	D	6/6/8	16"/18"				
		SILTY TO CLAYEY SAND; brown (7.5YR 4/3), friable	SM/SC									
15												
					8	D	5/6/6	12"/18"				
		grades to dark brown (7.5YR 3/2), friable, paleosol										
					9	D	8/8/9	17"/18"				
		lightening with depth, becoming brown to yellowish brown (7.5YR 3/2 to 10YR 5/4)										
					10	D	7/14/14	17"/18"				
20		gravelly interval			11	D	15/15/23	13"/18"				
		brown (7.5YR 4/3), becoming very friable			12	D	30/30/17	14"/18"				
		CLAYEY TO SILTY SAND; brown (7.5YR 4/3) to dark brown (7.5YR 3/3), somewhat friable, paleosol	SC/SM		13	D	12/13/13	16"/18"				
					14	D	11/12/12	17"/18"				
25												

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Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-22		Sheet 3 of 5

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY TO SILTY SAND; brown (7.5YR 4/3) to dark brown (7.5YR 3/3), somewhat friable, paleosol	SC/SM	Qal								
		charcoal flecks at 26 feet										
		very coarse, relatively clean SAND, trace to some fines, trace gravel, very friable	SP/SM		15	D	12/12/12	12"/18"				
		-clayey interval, SILTY SAND below										
			SM		16	D	13/13/15	13"/18"				
		-clayey interval										
					17	D	15/15/22	14"/18"				
30												
		SAND TO SILTY SAND; brown (7.5YR 4/3) to dark brown (5YR 3/4), medium- to coarse-grained relatively clean sand, trace to some fines, trace gravel (mostly weathered plutonics and rare quartzite), very friable	SP/SM		18	D	24/20/25	15"/18"				
					19	D	17/22/23	18"/18"				
		-clayey interval										
		-very coarse sand interval										
		-clayey interval			20	D	18/21/25	14"/18"				
		-clayey interval										
35					21	D	25/33/30	16"/18"				
					22	D	20/25/25	16"/18"				
		-clayey interval										
					23	D	21/25/25	16"/18"				
					24	D	27/28/30	13"/18"				
40												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-22	Sheet 4 of 5	

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		SAND TO SILTY SAND; moderate yellowish brown (10YR 5/4), very friable	SP/SM	Qal								
		-fine to medium sand interval, silty										
					25	D	20/25/21	16"/18"				
		-weathered plutonic clast										
					26	D	22/35/30	17"/18"				
					27	D	22/26/35	14"/18"				
45		-weathered plutonic clasts										
					28	D	40/40/30	16"/18"				
		-weathered plutonic clast										
					29	D	18/28/45	14"/18"				
		-weathered plutonic clast			30	D	28/25/30	18"/18"				
50					31	D	15/25/20	15"/18"				
		-clayey/silty interval										
					32	D	18/32/80	14"/18"				
					33	D	200	6"/6"				
		-gravelly zone										
		CLAYEY SAND; moderate yellowish brown to moderate brown (10YR 5/4 - 5YR 4/4)	SC		34	D	17/35/40	18"/18"				
55												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-22	Sheet 5 of 5

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND; brown to dark brown (7.5YR 4/3 - 7.5YR 3/4)	SC	Qal								
					35	D	17/28/28	16"/18"				
		SILTY SAND; dark yellowish brown (10YR 4/4), dry to slightly moist, dense, fine- to very coarse-grained sand, trace to some gravel	SM									
					36	D	20/28/35	15"/18"				
		CLAYEY SAND WITH GRAVEL; brown (7.5YR 4/4)	SC									
					37	D	20/70/75	14"/18"				
60		SILTY SAND with GRAVEL; friable	SM									
		Boring terminated at 60.5 feet. No free groundwater observed.										
65												
70												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-24	Sheet 1 of 5
Boring Location:	1745 Camino Palmero	Elevation and Datum(feet):	486.0
Health and Safety:	-	Date Started: 9/10/92	Date Finished: 9/10/92
Drilling Equipment:	Failing-10	Total Depth (feet): 57.0	Depth to Bedrock(feet): -
Drilling Method:	Hollow Stem Auger	Number of Samples: 35	Depth to Water (feet): -
Boring Diameter:	7-inch	Completion Information:	Grouted to Surface
Hammer Information: Downhole Hammer:140-lb and 30-inch drop.		Logged By: Grant Miller	Checked By: Paul Guptill

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time(hr)
0		SILTY TO CLAYEY SAND; dark brown (7.5YR 3/2); dry, medium dense, fine- to very coarse-grained sand, trace to some very coarse-grained sand, trace gravel, non plastic fines, massive	SM/SC	Qal								
5					1	D	10/15/20	17"/18"				
		SILTY SAND; brown (10YR 4/3), very friable	SM		2	D	10/14/16	14"/18"				
					3	D	9/10/13	16"/18"				
10					4	D	10/10/14	17"/18"				

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-24	Sheet 2 of 5

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
10		SILTY SAND; brown (10YR 4/3), very friable	SM	Qal								
					5	D	12/12/14	15"/18"				
					6	D	10/10/12	16"/18"				
					7	D	15/15/15	13"/18"				
15												
		-clean sand			8	D	8/8/10	18"/18"				
		SILTY SAND TO CLAYEY SAND; dark brown (7.5YR 3/2), slightly moist, medium dense to dense, fine- to coarse-grained sand, trace very coarse, trace gravel, massive, friable, paleosol	SM/SC									
					9	D	8/10/10	18"/18"				
					10	D	8/10/14	13"/18"				
		SILTY SAND; brown (7.5YR 4/3), friable	SM									
20					11	D	22/18/10	18"/18"				
		SILTY TO CLAYEY SAND; dark yellowish brown to brown (10YR 4/4 to 7.5YR 4/4)	SM/SC									
					12	D	15/25/30	15"/18"				
		-scattered gravel										
					13	D	15/27/13	15"/18"				
		-weathered plutonic clast > 2.5-inch in size										
					14	D	17/17/15	15"/18"				
25												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-24	Sheet 3 of 5

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY TO SILTY SAND; dark brown (7.5YR 3/3), porous, paleosol	SC/SM	Qal								
					15	D	20/20/21	18"/18"				
		------------------------------ grades to brown (7.5YR 4/3), some very coarse-grained sand, scattered gravel, porous										
					16	D	20/32/22	18"/18"				
					17	D	17/17/25	15"/18"				
30												
					18	D	17/17/22	18"/18"				
		-gradational										
		SILTY SAND; brown (10YR 4/3), slightly moist, dense, fine- to very coarse-grained sand, trace gravel, non plastic fines, massive, porous, somewhat friable	SM									
					19	D	16/17/20	13"/18"				
					20	D	18/20/25	16"/18"				
35					21	D	20/20/20	17"/18"				
					22	D	10/16/16	14"/18"				
		CLAYEY TO SILTY SAND; brown (7.5YR 4/3), slightly moist, very dense, trace coarse- to very coarse-grained sand, trace gravel, medium plastic fines, massive, paleosol	SC/SM									
					23	D	10/17/20	18"/18"				
					24	D	16/24/40	17"/18"				
40												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-24	Sheet 4 of 5

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY TO SILTY SAND; brown (7.5YR 4/3), slightly moist, very dense, trace coarse- to very coarse-grained sand, trace gravel, medium plastic fines, massive, paleosol	SC/SM	Qal								
					25	D	32/50/50	18"/18"				
		-plutonic clast										
		CLAYEY SAND; dark reddish brown (5YR 3/2) to moderate brown (5YR 4/4), paleosol	SC		26	D	35/40/50	17"/18"				
		----------------------------			27	D	17/20/37	18"/18"				
		grades to brown (7.5YR 4/3), some coarse- to very coarse-grained sand below										
45												
					28	D	38/50/67	18"/18"				
		SILTY TO CLAYEY SAND; brown (7.5YR 4/4) with friable interval	SM/SC		29	D	35/45/60	15"/18"				
					30	D	32/35/38	13"/18"				
		-clayey interval										
50					31	D	25/35/43	15"/18"				
					32	D	28/36/45	12"/18"				
					33	D	30/35/30	?"/18"				
		-friable										
		CLAYEY TO SILTY SAND; reddish brown (5YR 4/3)	SC/SM									
					34	D	28/30/35	15"/18"				
55												

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Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-24	Sheet 5 of 5

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY TO SILTY SAND; reddish brown (5YR 4/3)	SM/SC	Qal								
		------------------------------ grades to brown (7.5YR 4/4)			35	D	21/23	11"/12"				
		Boring terminated at 57 feet. No free groundwater observed.										
60												
65												
70												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-27	Sheet 1 of 4
Boring Location:	1745 Camino Palmero	Elevation and Datum(feet):	474.5
Health and Safety: -	Date Started: 9/3/92	Date Finished: 9/3/92	
Drilling Equipment: Failing-10	Total Depth (feet): 54.5	Depth to Bedrock(feet): -	
Drilling Method: Hollow Stem Auger	Number of Samples: 33	Depth to Water (feet): -	
Boring Diameter: 7-inch	Completion Information: Grouted to Surface		
Hammer Information: Downhole Hammer:140-lb and 30-inch drop.	Logged By: Grant Miller	Checked By: Paul Guptill	

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time(hr)
0		SILTY SAND; dark brown (10YR 3/3); dry, medium dense, fine- to very coarse-grained sand, trace gravel, non plastic fines, massive, roots, friable	SM	Qal								
5					1	D	40/18/13	8"/18"				
					2	D	5/10/10	17"/18"				
					3	D	10/16/13	14"/18"				
		brown (10YR 4/3) to dark yellowish brown (10YR 4/4), very friable										
					4	D	8/15/17	15"/18"				
10												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-27		Sheet 2 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
10		SILTY SAND; moderate yellowish brown (10YR 5/4); dry, medium dense, fine- to very coarse-grained sand, trace gravel, non plastic fines, massive, roots, friable	SM	Qal								
					5	D	8/13/14	17"/18"				
		-plutonic clast			6	D	7/8/15	15"/18"				
					7	D	12/12/10	17"/18"				
15												
		SILTY SAND TO CLAYEY SAND; moderate brown (5YR 3/4) to moderate yellowish brown (10YR 5/4), increasing clay content, paleosol	SM/SC		8	D	10/11/17	16"/18"				
					9	D	12/12/16	16"/18"				
					10	D	17/23/25	15"/18"				
		-scattered gravel										
20					11	D	20/27/30	18"/18"				
		-scattered gravel			12	D	25/30/38	16"/18"				
					13	D	20/27/35	18"/18"				
		CLAYEY SAND; moderate brown (5YR 3/4), lightens downward, paleosol	SC		14	D	20/37/40	14"/18"				
25												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-27		Sheet 3 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND; moderate brown (5YR 3/4), lightens downward, paleosol	SC	Qal								
					15	D	30/30/40	18"/18"				
		---------------------------- grades to moderate yellowish brown (10YR 5/4) to dark yellowish brown (10YR 4/2)										
					16	D	17/24/30	14"/18"				
		SILTY SAND TO CLAYEY SAND; moderate yellowish brown (10YR 5/4), intermittently friable	SM/SC		17	D	18/30/33	18"/18"				
30												
					18	D	15/17/25	12"/18"				
		-cohesive interval										
					19	D	15/25/25	14"/18"				
		-gravelly interval, friable										
					20	D	27/23/25	16"/18"				
		-friable interval, medium- to very coarse-grained clean sand										
35												
					21	D	27/18/50	14"/18"				
		-cohesive interval										
		-gravelly interval			22	D	28/30/38	14"/18"				
		-very friable, very coarse-grained clean sand										
		-cohesive interval			23	D	20/45/37	18"/18"				
		CLAYEY SAND; moderate brown (5YR 4/4 - 3/4); dry to slightly moist, very dense, fine- to coarse-grained sand, trace to some very coarse-grained sand, low to medium plastic fines, massive, paleosol	SC									
			SC									
					24	D	35/63/80	18"/18"				
40												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-27	Sheet 4 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND; dark reddish brown (7.5YR 3/3); dry to slightly moist, very dense, fine- to coarse-grained sand, trace to some very coarse-grained sand, low to medium plastic fines, massive, paleosol	SC	Qal								
					25	D	42/65/70	18"/18"				
					26	D	50/85/100	18"/18"				
		CLAYEY TO SILTY SAND; dark brown (7.5YR 3/4)	SC/SM		27	D	25/40/60	18"/18"				
45												
		brown (7.5YR 4/4) below 45.5 feet -gravelly			28	D	30/55/75	16"/18"				
					29	D	32/42/50	15"/18"				
					30	D	17/30/55	13"/18"				
50					31	D	40/50/30	16"/18"				
		-gravelly interval										
					32	D	35/30/45	17"/18"				
					33	D	35/50/25	17"/18"				
		grades to dark brown (7.5YR 3/4) to brown (7.5YR 4/4)										
		Boring terminated at 54.5 feet. No free groundwater observed.										
55												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-31	Sheet 1 of 4
Boring Location:	1745 Camino Palmero	Elevation and Datum(feet):	464.0
Health and Safety:	-	Date Started: 9/8/92	Date Finished: 9/8/92
Drilling Equipment:	Failing-10	Total Depth (feet): 54.5	Depth to Bedrock(feet): -
Drilling Method:	Hollow Stem Auger	Number of Samples: 33	Depth to Water (feet): -
Boring Diameter:	7-inch	Completion Information:	Grouted to Surface
Hammer Information: Downhole Hammer:140-lb and 30-inch drop.		Logged By: Grant Miller	Checked By: Paul Guptill

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time(hr)
0		CLAYEY SAND; dark grayish brown (10YR 4/2)	SC	Qal								
5					1	D	18/13/12	18"/18"				
		SILTY SAND; dark yellowish brown (10YR 4/4); dry, medium dense, fine- to very coarse-grained sand, trace to some very coarse-grained, trace gravel to 1/4-inch in size, massive, friable	SM									
					2	D	6/8/10	12"/18"				
					3	D	5/10/15	13"/18"				
		-carbonate streaks			4	D	7/7/7	14"/18"				
10												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-31	Sheet 2 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
10		SILTY SAND; dark yellowish brown (10YR 4/4); dry, medium dense, fine- to very coarse-grained sand, trace to some very coarse-grained, trace gravel to 1/4-inch in size, massive, friable	SM	Qal								
					5	D	7/11/9	18"/18"				
		CLAYEY TO SILTY SAND; brown (7.5YR 4/3), paleosol	SC/SM		6	D	9/9/11	8"/18"				
					7	D	8/8/11	13"/18"				
15												
					8	D	8/10/17	14"/18"				
		grading to brown (7.5YR 4/3 to 7.5YR 4/2) -charcoal flecks at 17 feet			9	D	11/25/27	15"/18"				
					10	D	11/13/28	13"/18"				
20			SC/SM		11	D	20/23/35	16"/18"				
		grading to brown (7.5YR 4/2), weak paleosol			12	D	17/35/50	16"/18"				
		-porous										
					13	D	25/60/80	15"/18"				
		SILTY TO CLAYEY SAND; brown (10YR 4/3); gravelly interval, weathered plutonics, abundant very coarse-grained sand below	SM/SC		14	D	40/45/30	15"/18"				
25												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-31	Sheet 3 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		SILTY TO CLAYEY SAND; brown (10YR 4/3); gravelly interval, weathered plutonics, abundant very coarse-grained sand below	SM/SC	Qal								
					15	D	18/35/30	17"/18"				
		SILTY SAND; yellowish brown (10YR 5/4), friable with cohesive intervals	SM		16	D	12/17/19	16"/18"				
					17	D	18/21/20	17"/18"				
30		SILTY TO CLAYEY SAND; yellowish brown (10YR 5/4), somewhat friable	SM/SC									
					18	D	15/20/25	14"/18"				
					19	D	18/18/22	16"/18"				
		CLAYEY TO SILTY SAND; dark reddish brown (5YR 3/3); slightly moist, dense, fine- to very coarse-grained sand, medium plastic fines, porous, paleosol	SC/SM									
					20	D	10/15/28	16"/18"				
35		grades to dark reddish brown (5YR 3/3) to brown (7.5YR 4/3)			21	D	20/30/45	17"/18"				
					22	D	10/30/45	16"/18"				
					23	D	20/35/60	18"/18"				
		grades to dark reddish brown (5YR 3/3), paleosol			24	D	22/40/55	18"/18"				
40												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-31		Sheet 4 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time(hr)
		CLAYEY TO SILTY SAND; dark reddish brown (5YR 3/3), paleosol	SC/SM	Qal	25	D	25/30/35	18"/18"				
		SILTY TO CLAYEY SAND; brown (7.5YR 4/3)	SM/SC									
		-gravelly at 42 feet			26	D	35/45/40	18"/18"				
		CLAYEY TO SILTY SAND; reddish brown (5YR 4/3)	SC/SM		27	D	25/40/50	17"/18"				
45												
		SILTY SAND; brown (7.5YR 4/4), somewhat friable	SM		28	D	40/50/30	15"/18"				
					29	D	22/25/38	14"/18"				
					30	D	200/5"	3"/5"				
50		-very friable			31	D	25/30/35	15"/18"				
					32	D	10/12/19	14"/18"				
		SILTY SAND TO CLAYEY SAND; reddish brown (5YR 4/3)	SM/SC		33	D	10/28/30	17"/18"				
		------------------------------ grades to brown (7.5YR 4/4)										
55		Boring terminated at 54.5 feet. No free groundwater observed.										

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-34	Sheet 1 of 5
Boring Location:	1725 Camino Palmero	Elevation and Datum(feet): 453.0	
Health and Safety:	-	Date Started: 9/4/92	Date Finished: 9/4/92
Drilling Equipment:	Failing-10	Total Depth (feet): 56.0	Depth to Bedrock(feet): -
Drilling Method:	Hollow Stem Auger	Number of Samples: 34	Depth to Water (feet): -
Boring Diameter:	7-inch	Completion Information: Grouted to Surface	
Hammer Information: Downhole Hammer:140-lb and 30-inch drop.		Logged By: Grant Miller	Checked By: Paul Guptill

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
0		CLAYEY TO SILTY SAND; dark brown (10YR 3/3)	SC/SM	Qal								
5					1	D	5/9/10	18"/18"				
		SILTY TO CLAYEY SAND; brown (10YR 4/3); slightly moist, medium dense, fine- to very coarse-grained sand, trace to some very coarse-grained sand, trace fine gravel, non plastic fines, massive, friable intervals	SM/SC		2	D	10/11/11	12"/18"				
					3	D	7/8/10	9"/18"				
					4	D	13/8/6	10"/18"				
10												

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Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-34	Sheet 2 of 5	

Depth (feet)	Description	USCS Classification	Geologic Unit	Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
10	SILTY TO CLAYEY SAND; moderate yellowish brown (10YR 5/4); slightly moist, medium dense, fine- to very coarse-grained sand, trace to some very coarse-grained sand, trace fine gravel, non plastic fines, massive, friable intervals	SM/SC	Qal								
				5	D	12/12/9	10"/18"				
	grades to moderate yellowish brown (10YR 5/4) to moderate brown (5YR 3/4), paleosol										
				6	D	11/13/15	16"/18"				
	-charcoal flakes										
				7	D	24/29/60	16"/18"				
15											
	-gravelly interval, increasing clay			8	D	23/25/25	14"/18"				
				9	D	14/20/30	17"/18"				
	CLAYEY SAND TO SILTY SAND; moderate yellowish brown (10YR 5/4) to moderate brown (5YR 3/4), paleosol	SC/SM		10	D	14/35/35	18"/18"				
20				11	D	18/30/35	17"/18"				
	grading to moderate yellowish brown (10YR 5/4)			12	D	20/33/40	18"/18"				
	SILTY TO CLAYEY SAND; moderate yellowish brown (10YR 5/4) with gravel	SM/SC									
				13	D	25/30/30	16"/18"				
				14	D	18/25/22	17"/18"				
25											

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-34	Sheet 3 of 5

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		SILTY TO CLAYEY SAND; moderate yellowish brown (10YR 5/4)	SC/SM	Qal								
					15	D	14/28/35	16"/18"				
					16	D	17/25/40	14"/18"				
		SILTY SAND; moderate yellowish brown (10YR 5/4), friable	SM									
		-weathered plutonic clast >4-inch in size			17	D	18/20/20	14"/18"				
30												
		CLAYEY SAND; moderate brown (5YR 3/4), paleosol	SC		18	D	23/18/24	16"/18"				
					19	D	15/25/45	17"/18"				
		grades to moderate yellowish brown (10YR 5/4)										
					20	D	25/25/45	18"/18"				
35					21	D	41/60/70	18"/18"				
		grades to moderate brown (5YR 3/4 - 4/4), paleosol										
					22	D	35/50/65	18"/18"				
					23	D	32/38/40	18"/18"				
		grades to moderate brown (5YR 4/4) to moderate yellowish brown (10YR 5/4)										
					24	D	18/30/38	18"/18"				
40												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-34		Sheet 4 of 5

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND; moderate yellowish brown (10YR 5/4) to moderate brown (10YR 4/4)	SC	Qal								
					25	D	25/40/37	17"/18"				
					26	D	26/25/32	17"/18"				
		grades to moderate brown (5YR 4/4), paleosol										
					27	D	23/31/35	16"/18"				
45												
		CLAYEY TO SILTY SAND; moderate brown (5YR 4/4) to moderate yellowish brown (10YR 5/4), slightly moist, dense, fine- to coarse-grained sand, trace to some very coarse-grained, low plastic fines, massive	SC/SM		28	D	20/25/25	17"/18"				
					29	D	20/22/20	14"/18"				
					30	D	21/30/25	16"/18"				
50					31	D	30/30/28	16"/18"				
					32	D	25/30/25	16"/18"				
					33	D	28/35/40	17"/18"				
					34		30/35/38	16"/18"				
55												

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Project Name:	Metro Rail - Los Angeles				
Project Number:	92-2038	Boring Number:	B-34	Sheet 5 of 5	

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Samples: Type	Samples: Blow Count	Samples: Recovery	Samples: RQD (%)	Samples: Dry Density (pcf)	Samples: Moisture Content (%)	Samples: Begin/End Time (hr)
		CLAYEY TO SILTY SAND; brown (7.5YR 5/3), slightly moist, dense, fine- to coarse-grained sand, trace to some very coarse-grained, low plastic fines, massive	SC/SM	Qal								
		Boring terminated at 56 feet. No free groundwater observed.										
60												
65												
70												

Project Name:	**Metro Rail - Los Angeles**		
Project Number:	**92-2038**	Boring Number: **B-38**	Sheet 1 of 4
Boring Location:	**1725 Camino Palmero**	Elevation and Datum(feet):	**440.0**
Health and Safety:	-	Date Started: **9/9/92**	Date Finished: **9/9/92**
Drilling Equipment:	**Failing-10**	Total Depth (feet): **54.5**	Depth to Bedrock(feet): –
Drilling Method:	**Hollow Stem Auger**	Number of Samples: **33**	Depth to Water (feet): –
Boring Diameter:	**7-inch**	Completion Information:	**Grouted to Surface**
Hammer Information: **Downhole Hammer:140-lb and 30-inch drop.**		Logged By: **Grant Miller**	Checked By: **Paul Guptill**

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time(hr)
0		CLAYEY TO SILTY SAND; dark brown (10YR 3/3)	SC/SM	Qal								
5					1	D	6/7/7	15"/18"				
		SILTY TO CLAYEY SAND; brown (10YR 4/3), slightly moist, medium dense, fine- to coarse-grained sand, low plastic fines, trace gravel, massive, somewhat friable	SM/SC									
					2	D	5/5/5	14"/18"				
					3	D	5/9/17	12"/18"				
		dry			4	D	12/12/25	15"/18"				
10												

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Project Name:	Metro Rail - Los Angeles				
Project Number:	92-2038	Boring Number:	B-38	Sheet 2 of 4	

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
10		SILTY TO CLAYEY SAND; moderate yellowish brown (10YR 5/4) to moderate brown (5YR 4/4), slightly moist, medium dense, fine- to coarse-grained sand, low plastic fines, trace gravel, massive, somewhat friable	SM/SC	Qal	5	D	14/17/25	14"/18"				
		grades to moderate yellowish brown (10YR 5/4), trace to some gravel			6	D	16/15/18	14"/18"				
		abundant coarse- to very coarse-grained sand (SP/SM)			7	D	12/21/23	15"/18"				
15		CLAYEY SAND; moderate brown (5YR 3/4), dry, dense, fine- to coarse-grained sand, trace very coarse-grained sand, trace gravel, medium plastic fines, massive, paleosol	SC									
		grades to moderate brown (5YR 3/4) to moderate yellowish brown (10YR 5/4) at 15.5 feet			8	D	18/22/25	18"/18"				
					9	D	15/22/27	18"/18"				
					10	D	12/30/30	15"/18"				
		-plutonic clast > 2.5-inch in size										
20		SILTY SAND; moderate yellowish brown (10YR 5/4), fine- to coarse-grained sand, some very coarse-grained sand, trace gravel, massive, somewhat friable	SM		11	D	17/25/17	17"/18"				
		very friable			12	D	15/15/17	11"/18"				
					13	D	20/25/20	17"/18"				
25		extremely friable			14	D	15/17/30	14"/18"				

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-38	Sheet 3 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		SILTY SAND; moderately yellowish brown (10Yr 5/4), fine- to coarse-grained sand, some very coarse-grained sand, trace gravel, massive, extremely friable	SM	Qal								
					15	D	30/25/20	17"/18"				
		CLAYEY TO SILTY SAND; moderate yellowish brown (10YR 5/4) with moderate brown (5YR 3/4) diffuse mottling, dry, very dense, fine- to coarse-grained sand, trace gravel, massive	SC/SM		16	D	11/11/15	16"/18"				
					17	D	15/15/22	16"/18"				
30		CLAYEY SAND; moderate brown (5YR 3/4), paleosol	SC									
					18	D	17/25/35	18"/18"				
		grades to moderate yellowish brown (10YR 5/4) to moderate brown (5YR 4/4)										
					19	D	25/35/16	18"/18"				
					20	D	18/40/40	18"/18"				
35		grades to moderate brown (5YR 4/4 to 3/4), paleosol										
					21	D	25/35/45	18"/18"				
					22	D	20/28/35	17"/18"				
		grades to moderate brown (5YR 4/4)										
					23	D	25/25/30	17"/18"				
		CLAYEY TO SILTY SAND; moderate yellowish brown (10YR 5/4), trace to some gravel	SC/SM									
40					24	D	25/28/30	17"/18"				

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-38	Sheet 4 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY TO SILTY SAND; brown (7.5YR 5/3), trace to some gravel	SC/SM	Qal								
					25	D	22/75/32	17"/18"				
		grades to brown (7.5YR 4/3), paleosol										
					26	D	25/37/45	17"/18"				
					27	D	20/30/27	18"/18"				
45												
		grades to brown (7.5YR 5/3) -weathered plutonic clast > 3-inch in size			28	D	25/37/40	16"/18"				
					29	D	25/35/35	18"/18"				
		SILTY TO CLAYEY SAND; brown (7.5YR 5/3), slightly friable	SM/SC									
		CLAYEY TO SILTY SAND; brown (7.5YR 4/3)	SC/SM		30	D	17/30/55	14"/18"				
50					31	D	25/35/45	16"/18"				
		SILTY TO CLAYEY SAND; brown (7.5YR 5/3), friable, very gravelly intervals	SM/SC									
					32	D	35/50/45	16"/18"				
					33	D	25/28/32	13"/18"				
55		Boring terminated at 54.5 feet. No free groundwater observed.										

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-41		Sheet 1 of 4
Boring Location:	1649 Camino Palmero	Elevation and Datum(feet):	429.5
Health and Safety: -		Date Started: 9/1/92	Date Finished: 9/1/92
Drilling Equipment:	Failing-10	Total Depth (feet): 54.5	Depth to Bedrock(feet): -
Drilling Method:	Hollow Stem Auger	Number of Samples: 33	Depth to Water (feet): -
Boring Diameter:	7-inch	Completion Information:	Grouted to Surface
Hammer Information: Downhole Hammer:140-lb and 30-inch drop.		Logged By: Grant Miller	Checked By: Paul Guptill

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
0		SILTY TO CLAYEY SAND; dark brown (10YR 3/3), slightly moist, medium dense, fine- to medium-grained sand, trace to some coarse- to very coarse-grained sand, low plastic fines, massive, scattered gravel to 1-inch in size (plutonics), friable	SM/SC	Qal								
5					1	D	5/6/6	14"/18"				
		grades to brown (7.5YR 4/3)			2	D	8/9/13	13"/18"				
					3	D	9/10/12	11"/18"				
		grades to brown (10YR 4/3)			4	D	15/16/25	16"/18"				
10												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-41		Sheet 2 of 4

Depth (feet)	Description	USCS Classification	Geologic Unit	Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
10	SILTY TO CLAYEY SAND; moderate yellowish brown (10YR 5/4), friable	SM/SC	Qal								
	trace to some fine gravel, scattered clasts to 1-inch in size (plutonics)			5	D	13/15/15	13"/18"				
				6	D	15/18/30	12"/18"				
	CLAYEY SAND; moderate brown (5YR 3/4), dry to slightly moist, dense, fine- to coarse-grained sand, medium to low plastic clay fines, trace to some very coarse-grained sand, massive, porous to 16 feet, paleosol	SC		7	D	13/18/30	18"/18"				
15				8	D	15/20/30	18"/18"				
				9	D	15/25/30	16"/18"				
	grades to moderate yellowish brown (10YR 5/4), trace gravel clasts (plutonic) to 1-inch in size			10	D	10/24/28	16"/18"				
20	very dense, low to medium plastic clay fines, rare gravel			11	D	20/28/23	14"/18"				
				12	D	20/23/25	18"/18"				
				13	D	16/24/30	15"/18"				
25				14	D	20/25/32	16"/18"				

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-41		Sheet 3 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND; moderate yellowish brown (10YR 5/4), dry to slightly moist, dense to very dense, fine- to coarse-grained sand, low to medium plastic clay fines, trace to some very coarse-grained sand, rare gravel	SC	Qal								
		SILTY SAND WITH CLAY; moderate yellowish brown (10YR 5/4), dry to slightly moist, dense, fine- to coarse-grained sand, trace gravel, low plastic fines, massive, friable	SM		15	D	22/19/20	14"/18"				
					16	D	15/30/30	16"/18"				
					17	D	16/16/19	12"/18"				
30												
					18	D	15/24/26	18"/18"				
		CLAYEY SAND; moderate brown (5YR 3/4), dry to slightly moist, dense, fine- to coarse-grained sand, trace gravel, low plastic fines, massive, paleosol	SC									
					19	D	20/28/94	16"/18"				
		----------------------------- grades to moderate brown (5YR 4/4)										
					20	D	28/40/45	16"/18"				
		----------------------------- grades to moderate yellowish brown (10YR 5/4)										
35		----------------------------- grades to moderate brown (5YR 4/4), paleosol			21	D	45/105/95	18"/18"				
		----------------------------- grades to moderate brown (5YR 3/4 to 4/4), paleosol			22	D	90/105/105	18"/18"				
					23	D	40/90/95	15"/18"				
		SILTY TO CLAYEY SAND; moderate yellowish brown (10YR 5/4) and becoming very coarse-grained sand with trace to some gravel to 1-inch in size	SM/SC									
					24	D	32/40/120	15"/18"				
40												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-41	Sheet 4 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		SILTY TO CLAYEY SAND; dark yellowish brown (10YR 4/4) and becoming very coarse-grained sand with trace to some gravel to 1-inch in size	SM/SC	Qal								
					25	D	70/95/110	16"/18"				
					26	D	55/120/100	15"/18"				
					27	D	20/40/50	17"/18"				
		CLAYEY SAND; brown (7.5YR 4/4)	SC									
45					28	D	22/50/60	17"/18"				
					29	D	23/25/45	16"/18"				
					30	D	45/65/70	18"/18"				
50		CLAYEY TO SILTY SAND; brown (7.5YR 4/4)	SC/SM		31	D	14/22/44	17"/18"				
		very coarse-grained sand										
					32	D	30/65/135	18"/18"				
		SILTY SAND; yellowish brown (10YR 5/4), abundant gravel (plutonics, quartzite) to several inches in size, friable	SM									
					33	D	55/55/40	/18"				
55		Boring terminated at 54.5 feet. No free groundwater observed.										

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Project Name:	Metro Rail - Los Angeles				
Project Number:	92-2038	Boring Number:	B-42	Sheet 1 of 4	
Boring Location:	1643 Martel			Elevation and Datum(feet):	418.5
Health and Safety:	-	Date Started:	8/31/92	Date Finished:	8/31/92
Drilling Equipment:	Failing-10	Total Depth (feet):	54.5	Depth to Bedrock(feet):	–
Drilling Method:	Hollow Stem Auger	Number of Samples:	33	Depth to Water (feet):	–
Boring Diameter:	7-inch	Completion Information:	Grouted to Surface		
Hammer Information: Downhole Hammer:140-lb and 30-inch drop.		Logged By: Grant Miller		Checked By: Paul Guptill	

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content(%)	Begin/End Time(hr)
0		CLAYEY TO SILTY SAND; dark brown (10YR 3/3), dry to slightly moist, medium dense, fine- to very coarse-grained sand, low plastic fines, trace gravel (weathered and plutonics), massive, porous, friable	SC/SM	Qal								
5					1	D	8/8/8	17"/18"				
					2	D	4/8/10	16"/18"				
					3	D	5/10/14	15"/18"				
					4	D	11/15/20	18"/18"				
10												

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Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-42		Sheet 2 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
10		CLAYEY TO SILTY SAND; as above	SC/SM	Qal								
		CLAYEY SAND; moderate brown (5YR 3/4), very clayey, fine- to medium-grained sand along ped surfaces, porous, paleosol	SC		5	D	11/19/21	16"/18"				
		CLAYEY TO SILTY SAND; dark yellowish brown (10YR 4/2)	SC/SM		6	D	11/21/25	18"/18"				
					7	D	15/30/35	18"/18"				
15		grades to moderate yellowish brown (10YR 5/4), coarse gravel (plutonics), less clay			8	D	17/23/30	18"/18"				
		grades to dark yellowish brown (10YR 4/2)			9	D	18/15/25	16"/18"				
					10	D	15/20/22	16"/18"				
		-quartzite clast to 2-inch in size										
20		SILTY TO CLAYEY SAND; moderate yellowish brown (10YR 5/4)	SM/SC		11	D	14/18/15	18"/18"				
		-dark yellowish brown (10YR 4/2) interval, friable below			12	D	12/12/12	15"/18"				
		SILTY SAND; less fines, friable	SM		13	D	10/13/13	11"/18"				
		SILTY TO CLAYEY SAND; moderate yellowish brown (10YR 5/4), gravelly interval, plutonics, friable	SM/SC		14	D	10/12/18	14"/18"				
25												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-42	Sheet 3 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		SILTY TO CLAYEY SAND; moderate yellowish brown (10YR 5/4), gravelly interval, plutonics, friable	SM/SC	Qal								
					15	D	13/15/17	17"/18"				
		-pockets and stringers of medium sand			16	D	10/18/20	12"/18"				
		-grades to moderate brown (5YR 3/4), increasing clay fines, paleosol from 18.5 to 19.5 feet, less friable below			17	D	17/15/17	16"/18"				
30												
					18	D	15/32/30	18"/18"				
		-plutonic clast										
					19	D	19/35/25	16"/18"				
					20	D	27/30/40	18"/18"				
		CLAYEY SAND; moderate brown (5YR 3/4), increasing clay content, porous, paleosol	SC									
35					21	D	30/40/50	17"/18"				
					22	D	30/30/34	18"/18"				
					23	D	27/50/35	15"/18"				
		----------------------------- grading to moderate yellowish brown (10YR 5/4)										
		-mafic plutonic clast, angular to 2-inch in size			24	D	21/30/33	18"/18"				
40												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-42		Sheet 4 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND; brown (7.5YR 4/3) to dark brown (7.5YR 3/4), increasing clay content, porous, paleosol	SC	Qal								
					25	D	15/31/37	17"/18"				
					26	D	13/25/30	15"/18"				
		grading to brown (7.5YR 4/3)			27	D	15/20/20	16"/18"				
45												
					28	D	20/20/18	18"/18"				
					29	D	10/18/20	14"/18"				
		SILTY TO CLAYEY SAND; dark yellowish brown (10YR 4/4), decreasing clay content, increasing coarse sand, gravel (mostly weathered plutonics)	SM/SC		30	D	11/14/25	17"/18"				
50		SILTY SAND; yellowish brown (10YR 5/4), less clay, fine- to coarse-grained sand, friable	SM		31	D	20/30/37	12"/18"				
		-clayey interval			32	D	40/35/32	17"/18"				
		-clayey interval			33	D	24/30/30	17"/18"				
55		Boring terminated at 54.5 feet. No free groundwater observed.										

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Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-43		Sheet 1 of 5
Boring Location: 1633 Martel		Elevation and Datum(feet): 410.0	
Health and Safety: -		Date Started: 8/31/92	Date Finished: 8/31/92
Drilling Equipment: Failing-10		Total Depth (feet): 60.5	Depth to Bedrock(feet): -
Drilling Method: Hollow Stem Auger		Number of Samples: 37	Depth to Water (feet): -
Boring Diameter: 8-inch		Completion Information: Grouted to Surface	
Hammer Information: Downhole Hammer:140-lb and 30-inch drop.		Logged By: Grant Miller	Checked By: Paul Guptill

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time(hr)
0		SILTY TO CLAYEY SAND; brown (7.5YR 4/3), dry to slightly moist, dense, fine- to medium-grained sand, some coarse and very coarse-grained sand, trace gravel, massive, friable	SM/SC	Qal								
5					1	D	6/9/15	15"/18"				
					2	D	14/19/23	15"/18"				
					3	D	14/19/20	18"/18"				
		------------- increasing clay content			4	D	25/32/36	16"/18"				
10												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-43	Sheet 2 of 5

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
10		SILTY TO CLAYEY SAND; moderate yellowish brown (10YR 5/4), increasing clay content	SM/SC	Qal								
		CLAYEY SAND; moderate yellowish brown to dark yellowish brown (10YR 3/4 to 4/2), dry, dense, fine to coarse-grained sand, low plastic fines, trace gravel (plutonics), massive, paleosol(?)	SC		5	D	27/30/42	16"/18"				
					6	D	25/50/60	18"/18"				
		---------------------------- friable										
					7	D	28/36/34	17"/18"				
15					8	D	25/33/34	16"/18"				
					9	D	22/24/20	14"/18"				
					10	D	18/20/21	15"/18"				
20		SILTY TO CLAYEY SAND; moderate yellowish brown (10YR 5/4), dry, dense, friable	SC/SM		11	D	17/15/20	16"/18"				
					12	D	18/20/20	13"/18"				
		SILTY SAND; moderate yellowish brown (10YR 5/4), dry, loose, coarse- to very coarse-grained sand, trace to some gravel, friable	SM		13	D	20/26/20	18"/18"				
25		SILTY TO CLAYEY SAND; moderate yellowish brown (10YR 5/4), friable	SM/SC		14	D	17/25/21	16"/18"				

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-43	Sheet 3 of 5

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		SILTY TO CLAYEY SAND; moderate yellowish brown (10YR 5/4), friable	SM/SC	Qal								
		------------- moderate brown (5YR 4/4) to moderate yellowish brown (10YR 5/4), friable -------------			15	D	13/15/20	15"/18"				
					16	D	20/23/25	14"/18"				
					17	D	25/32/33	15"/18"				
30		CLAYEY SAND; moderate brown (5YR 4/4 to 3/4), paleosol, somewhat friable	SC									
					18	D	40/52/53	14"/18"				
		---------------------------- increased clay content, less friable, paleosol(?)			19	D	50/55/55	18"/18"				
					20	D	30/45/50	13"/18"				
35		------------------------------ grades to moderate brown (5YR 3/4), paleosol			21	D	32/48/60	15"/18"				
					22	D	40/60/55	15"/18"				
		CLAYEY TO SILTY SAND; moderate yellowish brown (10YR 5/4), less clay, more silt, somewhat friable	SC/SM		23	D	40/35/33	17"/18"				
40					24	D	40/27/40	18"/18"				

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

Project Number: **92-2038** Boring Number: **B-43** Sheet **4** of **5**

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY TO SILTY SAND; moderate yellowish brown (10YR 5/4), less clay, more silt, somewhat friable	SC/SM	Qal								
					25	D	15/15/30	13"/18"				
		CLAYEY TO SILTY SAND; moderate brown (5YR 4/4), paleosol	SC/SM		26	D	24/30/30	16"/18"				
					27	D	27/33/47	15"/18"				
45												
					28	D	36/35/40	16"/18"				
		CLAYEY TO SILTY SAND; moderate yellowish brown (10YR 5/4), friable	SC/SM		29	D	50/47/38	17"/18"				
					30	D	50/40/50	17"/18"				
50		SILTY SAND; moderate yellowish brown (10YR 5/4), dry, very dense, fine- to coarse-grained sand, non plastic fines, trace to some gravel (mostly plutonics), trace to some clay, very friable from 52 - 53.5 feet, interval consists of fine to coarse-grained sand with trace fines, massive	SM		31	D	35/60/80	14"/18"				
					32	D	50/55/75	18"/18"				
		becomes dark yellowish orange (10YR 6/6)			33	D	30/60/60	17"/18"				
		- powdery calcium carbonate infilling at 54.5 feet			34	D	35/45/70	16"/18"				
55												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-43	Sheet 5 of 5

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		SILTY SAND; yellowish brown (10YR 5/4), dry, very dense, fine- to coarse-grained sand, non plastic fines, trace to some gravel (mostly plutonics), trace to some clay, interval consists of fine to coarse-grained sand with trace fines, massive	SM	Qal								
					35	D	95/45/45	18"/18"				
		-decomposed granitic clast >3-inch										
		-clayey sand interval										
					36	D	33/60/65	16"/18"				
					37	D	30/50/50	15"/18"				
60												
		Boring terminated at 60.5 feet. No free groundwater observed.										
65												
70												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-44	Sheet 1 of 4	
Boring Location:	1635 Martel	Elevation and Datum(feet):	400.5
Health and Safety: -	Date Started: 9/1/92	Date Finished: 9/1/92	
Drilling Equipment: Failing-10	Total Depth (feet): 54.5	Depth to Bedrock(feet): -	
Drilling Method: Hollow Stem Auger	Number of Samples: 32	Depth to Water (feet): -	
Boring Diameter: 7-inch	Completion Information: Grouted to Surface		
Hammer Information: Downhole Hammer:140-lb and 30-inch drop.	Logged By: Grant Miller	Checked By: Paul Guptill	

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time(hr)
0		CLAYEY SAND; brown (7.5YR 4/2), dry, dense, fine- to very coarse-grained sand, low plastic fines, trace to some gravel to 1/2-inch	SC	Qal								
5					1	D	12/18/23	16"/18"				
		paleosol										
					2	D	11/18/22	14"/18"				
		SILTY TO CLAYEY SAND; yellowish brown (10YR 4/4), less clay, abundant very coarse-grained sand; very friable from 8 to 9 feet	SM/SC									
					3	D	25/25/25	16"/18"				
		CLAYEY SAND; dark brown (7.5YR 3/2), very clayey, paleosol, grades to brown (7.5YR 4/3) at 9.5 feet	SC									
					4	D	21/24/29	13"/18"				
10												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-44		Sheet 2 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
10		CLAYEY SAND; brown (7.5YR 4/3), very clayey, paleosol	SC	Qal								
					5	D	17/35/38	15"/18"				
		grades to dark yellowish brown (10YR 4/4), friable										
					6	D	24/24/35	18"/18"				
					7	D	21/31/38	13"/18"				
15												
					8	D	24/28/28	15"/18"				
		-weathered plutonic clast										
					9	D	20/21/21	14"/18"				
		-plutonic clast, friable; friable zone from 18.5 to 19 feet; appears to be slightly darker in color below			10	D	21/23/23	16"/18"				
20		SILTY TO CLAYEY SAND; brown (7.5YR 4/3), dry to slightly moist, very dense, fine- to coarse-grained sand, trace to some very coarse-grained sand, low plastic fines, massive; mostly friable silty sand below 21.5 feet	SM/SC		11	D	12/17/25	12"/18"				
					12	D	23/23/25	15"/18"				
					13	D	18/20/20	15"/18"				
		grading to brown (7.5YR 4/3) to dark reddish brown(5YR 3/2), paleosol			14	D	15/30/33	16"/18"				
25												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number:	B-44	Sheet 3 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		SILTY TO CLAYEY SAND; brown (7.5YR 4/3), dry to slightly moist, very dense, fine- to coarse-grained sand, trace to some very coarse-grained sand, low plastic fines, massive, friable	SM/SC	Qal								
					15	D	18/24/38	18"/18"				
		CLAYEY SAND; dark reddish brown (5YR 3/2), paleosol	SC									
					16	D	38/45/50	18"/18"				
					17	D	43/48/52	17"/18"				
30												
		---------------------------- plutonic clasts; grades to dark yellowish brown (10YR 4/4) with indistinct brown (7.5YR 4/4) intervals, paleosol(?)			18	D	46/50/63	18"/18"				
					19	D	37/40/50	18"/18"				
					20	D		18"/18"				
		---------------------------- grades to brown (7.5YR 4/4)										
35												
		SILTY TO CLAYEY SAND; brown (7.5YR 4/4), becoming very coarse-grained sand	SM/SC		21	D	26/38	9"/12"				
					22	D	14/28/30	13"/18"				
					23	D	27/30/35	14"/18"				
40												

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-44	Sheet 4 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		SILTY TO CLAYEY SAND; brown (7.5YR 4/4), becoming very coarse-grained sand	SM/SC	Qal								
					24	D	30/34/46	16"/18"				
		CLAYEY SAND; dark brown (7.5YR 3/4) to dark reddish brown (5YR 3/3), paleosol	SC									
					25	D	30/37/44	17"/18"				
					26	D	25/28/33	16"/18"				
45		----------------------------- grades to brown (7.5YR 4/4)										
					27	D	25/25/34	14"/18"				
		SILTY SAND; dark yellowish brown (10YR 4/4), very friable	SM									
					28	D	25/26/42	14"/18"				
					29	D	26/28/30	15"/18"				
		-rounded basalt clast										
50		-very friable silty sand			30	D	28/32/35	14"/18"				
		-clayey interval			31	D	26/26/30	14"/18"				
		-clean sand interval (SP/SM)			32	D	34/36/42	13"/18"				
55		Boring terminated at 54.5 feet No free groundwater observed.										

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Project Name:	Metro Rail - Los Angeles				
Project Number:	92-2038	Boring Number:	B-45	Sheet 1 of 4	
Boring Location:	1615 Martel	Elevation and Datum(feet):	396.5		
Health and Safety:	-	Date Started:	9/2/92	Date Finished:	9/2/92
Drilling Equipment:	Failing-10	Total Depth (feet):	54.5	Depth to Bedrock(feet):	-
Drilling Method:	Hollow Stem Auger	Number of Samples:	33	Depth to Water (feet):	-
Boring Diameter:	7-inch	Completion Information:	Grouted to Surface		
Hammer Information: Downhole Hammer:140-lb and 30-inch drop.		Logged By: Grant Miller		Checked By: Paul Guptill	

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
0		CLAYEY SAND; brown (7.5YR 4/2), slightly moist, medium dense, fine- to very coarse-grained sand, low plastic fines, massive, trace gravel to 1/4-inch (weathered plutonics)	SC	Qal								
		grades to yellowish brown (10YR 5/4)										
5					1	D	6/11/14	18"/18"				
		grades to dark brown (7.5YR 3/2), very porous, paleosol			2	D	12/15/19	18"/18"				
		grades to brown (10YR 4/3)										
		-weathered plutonic clast to 2-inch			3	D	19/22/29	18"/18"				
		coarse to very coarse sand, trace to some gravel, angular			4	D	18/26/35	17"/18"				
10												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-45		Sheet 2 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
10		CLAYEY SAND; brown (7.5YR 4/3), slightly moist, medium dense, fine- to very coarse-grained sand, low plastic fines, massive, trace gravel to 1/4-inch (weathered plutonics)	SC	Qal								
		---------------------------- mostly dark yellowish brown (10YR 4/4)			5	D	22/25/29	17"/18"				
					6	D	18/25/18	17"/18"				
		------------- very friable interval, abundant very coarse-grained sand and gravel			7	D	18/23/18	17"/18"				
15		CLAYEY TO SILTY SAND; dark yellowish brown (10YR 4/4), friable	SC/SM									
					8	D	13/15/20	14"/18"				
		------------- very friable interval, mostly coarse-grained sand, some very coarse sand (SM)			9	D	16/21/20	17"/18"				
		---------------------------- dark yellowish brown (10YR 4/4) to brown (7.5YR 4/3)										
					10	D	15/18/25	/18"				
20		SILTY SAND; brown (7.5YR 4/3), dry to slightly moist, very dense, fine- to coarse-grained sand, some very coarse, trace to some gravel (angular), non plastic fines, massive, friable zones	SM		11	D	13/20/20	16"/18"				
					12	D	25/20/22	17"/18"				
					13	D	20/18/20	14"/18"				
					14	D	20/18/18	16"/18"				
25												

Project Name:	Metro Rail - Los Angeles				
Project Number:	92-2038	Boring Number:	B-45	Sheet 3	of 4

Depth (feet)	Description	USCS Classification	Geologic Unit
	SILTY SAND; brown (7.5YR 4/3), dry to slightly moist, very dense, fine- to coarse-grained sand, some very coarse, trace to some gravel (angular), non plastic fines, massive, friable zones	SM	Qal
	gradational contact		
	CLAYEY SAND; dark reddish brown (5YR 3/2), dry to slightly moist, very dense, fine- to coarse-grained sand, trace very coarse-grained sand, medium plastic fines, massive, paleosol	SC	
	-charcoal fragments		
	------------------------------		
	grades to brown (7.5YR 4/3), some very coarse-grained sand, scattered gravel		
30			
	------------------------------		
	grades to dark yellowish brown (10YR 4/4) to brown (7.5YR 4/3)		
35			
	------------------------------		
	grades to dark brown (7.5YR 3/4), paleosol		
	CLAYEY TO SILTY SAND; brown (7.5YR 4/4)	SC/SM	
	-rounded quartzite clast		
40			

Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
15	D	20/20/37	16"/18"				
16	D	19/33/40	18"/18"				
17	D	19/24/40	18"/18"				
18	D	19/27/50	18"/18"				
19	D	26/30/45	18"/18"				
20	D	30/43/35	18"/18"				
21	D	45/35/50	17"/18"				
22	D	30/40/40	16"/18"				
23	D	33/35/40	14"/18"				
24	D	35/40/55	15"/18"				

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Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-45	Sheet 4 of 4

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY TO SILTY SAND; brown (7.5YR 4/4)	SC/SM	Qal								
		-plutonic clast > 2.5-inch in size			25	D	30/40/55	18"/18"				
		CLAYEY SAND; dark brown (7.5YR 3/4) to dark reddish brown (5YR 3/3), paleosol	SC									
					26	D	17/35/35	18"/18"				
		grades to brown (7.5YR 4/3)										
					27	D	30/45/55	15"/18"				
45		SILTY SAND; brown (7.5YR 4/3); dry to slightly moist, very dense, fine- to coarse-grained sand, non plastic fines, very friable below 45.5 feet	SM									
					28	D	25/35/45	18"/18"				
					29	D	23/35/22	18"/18"				
		-clayey interval			30	D	20/25/30	18"/18"				
		-weathered plutonic clast to 1.5-inch in size										
50		SILTY TO CLAYEY SAND; yellowish brown (10YR 4/4); dry to slightly moist, very dense, fine- to coarse-grained sand, very friable below 51.5 feet with clayey intervals	SM/SC		31	D	20/33/40	18"/18"				
					32	D	7/22/35	14"/18"				
					33	D	12/25/40	/18"				
55		Boring terminated at 54.5 feet No free groundwater observed.										

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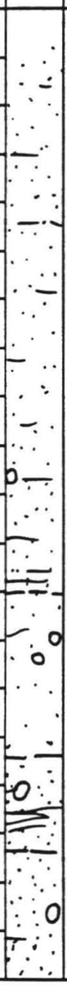
Project Name:	**Metro Rail - Los Angeles**		
Project Number: **92-2038**	Boring Number: **B-46**		Sheet 1 of 5
Boring Location: **1605 Martel Ave**		Elevation and Datum(feet): **385.5**	
Health and Safety: **-**	Date Started: **9/2/92**		Date Finished: **9/2/92**
Drilling Equipment: **Failing-10**	Total Depth (feet): **56.0**		Depth to Bedrock(feet): **-**
Drilling Method: **Hollow Stem Auger**	Number of Samples: **33**		Depth to Water (feet): **-**
Boring Diameter: **7-inch**	Completion Information: **Grouted to Surface**		
Hammer Information: **Downhole Hammer:140-lb and 30-inch drop.**	Logged By: **Grant Miller**		Checked By: **Paul Guptill**



Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
0		CLAYEY TO SILTY SAND; brown (7.5YR 4/2), dry, dense, fine- to very coarse-grained sand, trace fine gravel, low plastic fines, massive	SC/SM									
5					1	D	16/23/28	17"/18"				
					2	D	19/27/40	17"/18"				
					3	D	20/30/33	18"/18"				
		grades to brown (7.5YR 4/3)										
					4	D	20/25/35	15"/18"				
10												

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Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-46		Sheet 2 of 5

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
10		CLAYEY TO SILTY SAND; brown (7.5YR 4/3), dry, dense, fine- to very coarse-grained sand, trace fine gravel, low plastic fines, massive	SC/SM									
					5	D	18/24/28	16"/18"				
		---------------------------- grades to brown (7.5YR 4/3), paleosol										
		---------------------------- grades to dark yellowish brown (10YR 4/4)			6	D	13/19/24	17"/18"				
		-charcoal fragments			7	D	15/24/27	18"/18"				
15												
					8	D	15/15/15	16"/18"				
		SILTY SAND; brown (7.5YR 4/3); friable at 17.5 to 18 feet	SM		9	D	17/23/25	17"/18"				
		-plutonic clast to several inches in size			10	D	20/20/14	16"/18"				
20		SILTY TO CLAYEY SAND; brown (7.5YR 4/3)	SM/SC		11	D	22/23/25	15"/18"				
					12	D	25/25/25	17"/18"				
					13	D	22/30/37	12"/18"				
		------------- very friable										
		-relatively clean coarse- to very coarse- grained sand (SP/SM) below 24.5 feet			14	D	20/27/20	18"/18"				
25												

Project Name:	Metro Rail - Los Angeles		
Project Number: 92-2038	Boring Number: B-46		Sheet 3 of 5

Depth (feet)	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
	SILTY TO CLAYEY SAND; brown (7.5YR 4/3) -clayey interval	SP/SM									
	CLAYEY SAND; dark reddish brown (5YR 3/2), porous, paleosol	SC		15	D	30/38/50	18"/18"				
	---------------------------- grades to dark yellowish brown (10YR 4/4) to brown (7.5YR 4/3), coarse to very coarse sand, scattered gravel			16	D	28/25/38	17"/18"				
				17	D	25/35/60	18"/18"				
30											
	---------------------------- grades to dark yellowish brown (10YR 4/4), as above			18	D	28/32/45	18"/18"				
				19	D	20/45/23	14"/18"				
	-gravelly interval			20	D	21/25/20	17"/18"				
	---------------------------- dark brown (7.5YR 3/4), paleosol										
35				21	D	30/30/33	17"/18"				
	CLAYEY TO SILTY SAND; brown (7.5YR 4/4)	SC/SM		22	D	20/25/25	13"/18"				
				23	D	20/30/30	18"/18"				
	-friable coarse sand and fine gravel interval										
	CLAYEY SAND; dark brown (7.5YR 3/4) to dark reddish brown (5YR 3/3), paleosol	SC		24	D	20/35/60	18"/18"				
40											

Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-46	Sheet 4 of 5

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND; dark brown (7.5YR 3/4) to dark reddish brown(5YR 3/3), paleosol	SC									
		------------------------------- grades to dark yellowish brown (10YR 4/4)			25	D	25/25/32	17"/18"				
					26	D	15/27/35	18"/18"				
		SILTY SAND; brown (7.5YR 4/3), dry, very dense, fine- to coarse-grained sand, some very coarse-grained sand, trace gravel to 2-inch in size, with friable intervals, clayey intervals	SM									
					27	D	18/35/55	15"/18"				
45												
					28	D	20/28/45	15"/18"				
		-plutonic clast										
					29	D	17/30/42	15"/18"				
		-friable										
		-clayey interval			30	D	15/30/30	17"/18"				
		-very friable interval										
50		-clayey interval			31	D	29/70/100	18"/18"				
		-very friable interval, coarse- to very coarse-grained sand (SP-SM)										
					32	D	29/55/44	16"/18"				
		-clayey interval										
					33	D	23/32/35	16"/18"				
		-very friable interval										
		CLAYEY SAND; dark yellowish brown (10YR 4/4)	SC		34	D	30/65/55	14"/18"				
55												

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Project Name:	Metro Rail - Los Angeles		
Project Number:	92-2038	Boring Number: B-46	Sheet 5 of 5

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	RQD (%)	Dry Density (pcf)	Moisture Content (%)	Begin/End Time (hr)
		CLAYEY SAND; dark yellowish brown (10YR 4/4)	SC									
		Boring terminated at 56 feet. No free groundwater observed.										
60												
65												
70												

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FIGURE A-4 LOG OF BORING B-4

Project Name:	METRO RAIL - Hollywood/La Brea				
Project Number:	91-8005	Borehole Number:	B-4	Sheet 1 of 10	
Borehole Location:	Hillside/La Brea	Elevation and Datum(feet): 492.0			
Health and Safety:	Level D	Date Started: 2/12/91		Date Finished: 2/13/91	
Drilling Equipment:	Mayhew 1000	Total Depth (feet): 260.0		Depth to Bedrock(feet): -	
Drilling Method:	Rotary Wash	Number of Samples: 23		Depth to Water (feet): -	
Borehole Diameter:	5-inch	Completion Information: Hole grouted.			
Hammer Information: SPT Hammer: 140-lb and 30-inch drop.		Logged By: Paul Dunstar		Checked By: Mahi Galagoda	

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	OVA (ppm)	Dry Density (pcf)	Moisture Content (%)	Background OVA(ppm)
		1.5 feet thick ASPHALT-CONCRETE.										
5		SILTY GRAVEL; Dark yellowish brown to moderately brown, fine-grained gravel, low plasticity silt with fine- to medium-grained sand.	GM									--
10		SILTY SAND; Dark yellowish brown to moderately brown, fine- to coarse-grained sand, low plasticity silt, trace fine gravel; angular to sub-rounded, granitic-highly weathered.	SM									
15		CLAYEY SILT; Moderately brown, high plasticity, with some sand.	MH									
		SILTY CLAY; Moderately brown, highly plastic fines, trace very fine- to medium-grained sand.	CH									

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FIGURE A-4 LOG OF BORING B-4

Project Name:	METRO RAIL - Hollywood/La Brea		
Project Number:	91-8005	Borehole Number: B-4	Sheet 2 of 10

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	OVA (ppm)	Dry Density (pcf)	Moisture Content (%)	Background OVA (ppm)
		SILTY CLAY; Moderately brown, highly plastic fines, some fine- to medium-grained sand.	CH									
25												
		SILT; Light brown, low- to medium plasticity, some fine- to medium-grained sand.	ML									
30												
35												
40		SILT; Moderately brown, high plasticity, some clay, trace fine- to medium-grained sand.	MH									
45												
		SILTY SAND-SANDY SILT; Moderately brown, fine- to coarse-grained sand, non plastic silt.	SM-ML									

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FIGURE A-4 LOG OF BORING B-4

Project Name:	METRO RAIL - Hollywood/La Brea		
Project Number: 91-8005	Borehole Number: B-4		Sheet 3 of 10

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Samples Type	Samples Blow Count	Samples Recovery	Samples OVA (ppm)	Samples Dry Density (pcf)	Samples Moisture Content (%)	Background OVA (ppm)
		SILTY SAND; Light yellowish brown, dry, very dense, fine-grained sand, trace gravel.	SM		1	D	30 50	10"/12"		122	13	
55												
60		SILTY SAND-CLAYEY SAND; Moderately brown, moist to dry, soft to medium stiff, low plasticity fines, fine-grained sand.	SM-SC		2	S	18 26 30	13"/18"				
65												
		SILTY SAND-SANDY SILT; Moderately brown, fine- to medium-grained sand, low plasticity silt.	SM-ML									
70		SILTY SAND; Moderately yellowish brown, dry, dense, fine- to medium-grained sand, non plastic fines, trace rounded coarse-grained gravel; granitic, highly weathered.	SM		3	D	50	2"/6"		117	14	
75												

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FIGURE A-4 LOG OF BORING B-4

Project Name:	METRO RAIL - Hollywood/La Brea											
Project Number:	91-8005	Borehole Number: B-4							Sheet 4 of 10			

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	OVA (ppm)	Dry Density (pcf)	Moisture Content (%)	Background OVA (ppm)
		SILTY SAND; Dusky yellow to moderately yellowish brown, dry, dense, fine- to medium-grained sand, trace coarse-grained sand, non plastic fines, some gravel.	SM		4	S	50	3"/6"				
85		Same as above with increasing sand content.										
90		(Consistency and percent sand change at 89.5'.) SAND-SILTY SAND; Moderately yellowish brown, dry, dense to very dense, fine- to medium-grained sand, non-elastic silt, carbonated white strip in the middle of sample.	SP-SM		5	D	33 50	12"/12"				
95												
100		SANDY CLAY-SANDY SILT; Light brown, hard, highly plastic fines, trace some fine-grained sand, trace fine- to coarse-grained rounded gravel.	CL-ML		6	S	16 26 46	18"/18"				
105		SAND-SILTY SAND; Moderately brown to moderately reddish brown, dense, fine- to coarse-grained sand, non-elastic silt, some fine- to coarse-grained gravel; rounded siltstone and granitic clasts.	SP-SM		7	D	50	3"/6"		124	14	

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FIGURE A-4 LOG OF BORING B-4

Project Name: METRO RAIL - Hollywood/La Brea

Project Number: 91-8005 | Borehole Number: B-4 | Sheet 5 of 10

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	OVA (ppm)	Dry Density (pcf)	Moisture Content (%)	Background OVA (ppm)
		CLAYEY SAND-SANDY CLAY; Moderately reddish brown to moderately brown, dry, stiff, low plasticity silt, trace rounded black coarse-grained gravel and some sand.	SC-CL		8	S	23 32 36	16" /18"				
		SAND-SILTY SAND; Angular, fine to medium-grained sand, angular, non-elastic silt.	SP-SM									
115		SILTY SAND; Reddish brown to brown, dry, dense, slickensided rock piece inside the sample, low plasticity silt, some fine-grained sand.	SM		9	D	36 50					
120		SILTY SAND-CLAYEY SAND; Dark reddish brown, moist, very stiff, low plasticity fines, with some fine- to medium-grained sand.	SM-SC		10	S	30 50	11" /12"				
125		SILTY SAND; Dark reddish brown, dry, dense to very dense, medium- to coarse-grained sand, trace fine sand.	SM		11	D	40 50	7" /12"		129	10	
130		CLAYEY SAND; Moderately brown, dry, medium dense, medium- to coarse-grained sand, low plasticity fines, trace gravel.	SC		12	S	29 50	11" /12"				
135		SILTY SAND-SANDY SILT; Moderately brown, dry, dense, non plastic fines, fine- to coarse-grained sand, trace fine gravel.	SM-ML		13	D	45 50	9" /12"		127	12	
140												

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FIGURE A-4 LOG OF BORING B-4

Project Name: **METRO RAIL - Hollywood/La Brea**

Project Number: 91-8005 | Borehole Number: B-4 |

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples Number	Type	Blow Count	Recovery	OVA (ppm)	Dry Density (pcf)	Moisture Content (%)	Background OVA (ppm)
		SILTY SAND; Moderately brown, dry, dense, low plasticity fines, medium-grained sand, trace fine gravel.	SM		14	S	52	6"/6"				
145		SILTY SAND; Moderately brown, dry, dense, fine- to coarse-grained sand, low plasticity fines, trace fine gravel.	SM		15	D	50	4"/6"				
150		Same as above with no gravel, medium plasticity fines.	SM		16	S	32 50	12"/12"				
155		SILTY SAND; Moderately brown, moist, dense, fine- to medium-grained sand, non plastic fines.	SM		17	D	20 30	8"/12"				
160		SILTY SAND; Light brown to moderately brown, dry to moist, dense, low to medium plasticity fines.	SM		18	S	40 50	10"/12"				
165		SILTY SAND; Moderately brown, dry to moist, dense, very fine-grained sand, trace coarse sand, very low plasticity fines.	SM		19	D	25 40	9"/12"				
170												

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FIGURE A-4 LOG OF BORING B-4

Project Name:	METRO RAIL - Hollywood/La Brea		
Project Number:	91-8005	Borehole Number: B-4	Sheet 7 of 10

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	OVA (ppm)	Dry Density (pcf)	Moisture Content (%)	Background OVA (ppm)
		SILTY SAND; Moderately brown, dry to moist, dense, fine- to medium-grained sand, very low plasticity fines, micaceous.	SM		20	S	50 50/4"	9"/10"				
175		SILTY SAND; Moderately brown, moist, dense, fine- to medium-grained sand, low plasticity fines, micaceous, trace fine gravel, trace coarse sand.	SM		21	D	28 50	7"/12"		127	12	
180		SILTY SAND; Moderately brown, dry to moist, dense, fine- to medium-grained sand, very low plasticity fines, trace quartz.	SM		22	S	50/6"	6"/6"				
185												
		Drill cuttings show increasing sand content.										
190												
195												
		Drill cuttings show increasing sand content. Sand becomes coarser.										
200												

FIGURE A-4 LOG OF BORING B-4

Project Name:	METRO RAIL - Hollywood/La Brea		
Project Number:	91-8005	Borehole Number: B-4	Sheet 8 of 10

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	OVA (ppm)	Dry Density (pcf)	Moisture Content (%)	Background OVA (ppm)
205		SANDY SILT/CLAYEY SILT; Low plasticity fines, medium- to coarse-grained, rounded to sub-angular sand.	ML									
210		Same as above.										
215												
220		Same as above.										
225		Same as above.										
230												

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FIGURE A-4 LOG OF BORING B-4

Project Name: METRO RAIL - Hollywood/La Brea

Project Number: 91-8005 | Borehole Number: B-4 | Sheet 9 of 10

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	OVA (ppm)	Dry Density (pcf)	Moisture Content (%)	Background OVA (ppm)
		SANDY SILT; Medium- to coarse-grained sand.										
235		Same as above. Sand becoming coarser.										
240		Same as above.										
245		(Driller reports "harder" drilling.) SILTY SAND; Fine- to medium-grained sand, trace gravel.										
250												
255		SILTY SAND; Moderately brown, dry, medium dense, medium- to coarse-grained sand, pieces of granite (1/10"-1/5" in size), very low plasticity fines.	SM		23	D	70/6"	3"/6"		133	10	
260												

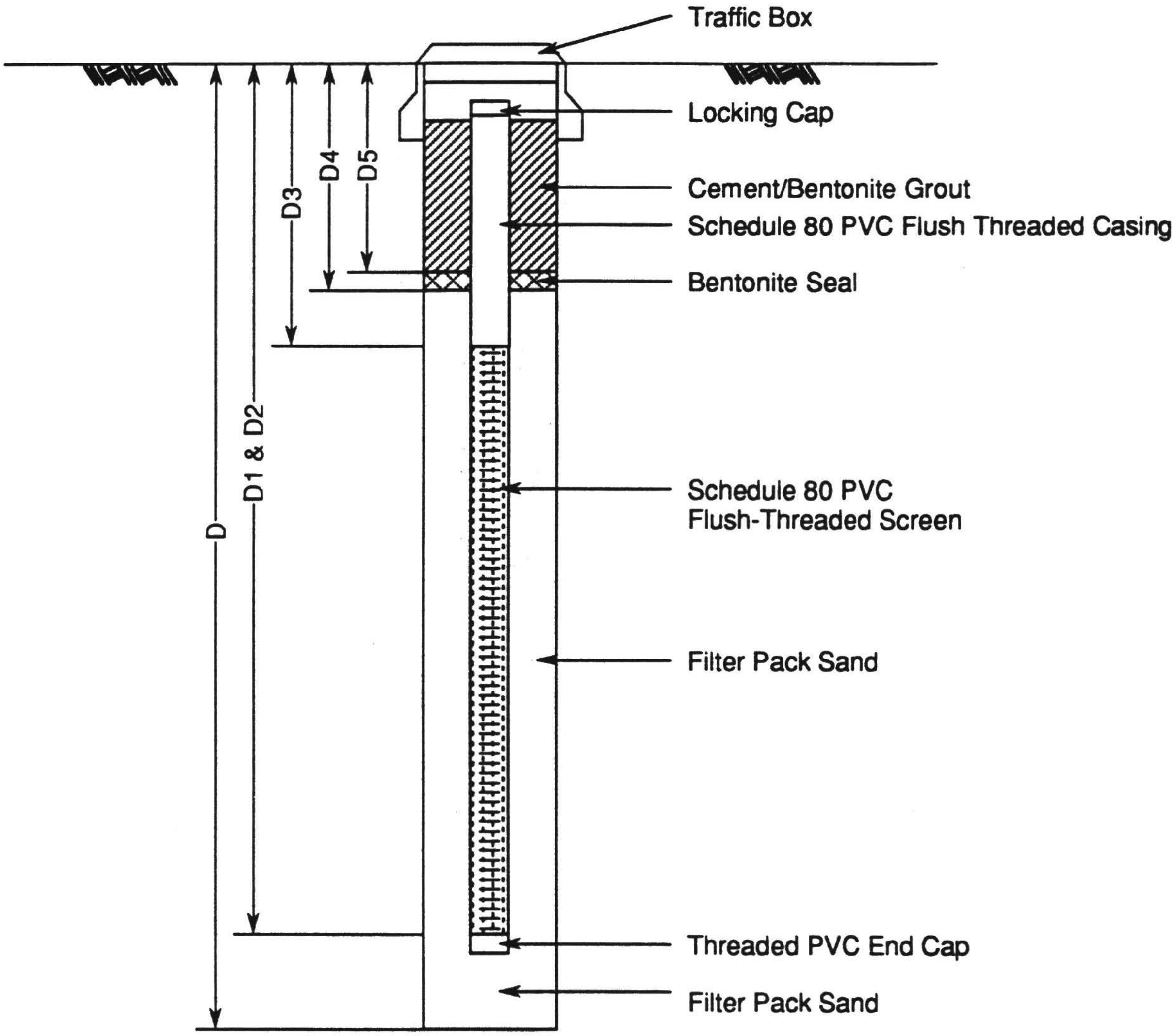
FIGURE A-4 LOG OF BORING B-4

Project Name:	METRO RAIL - Hollywood/La Brea		
Project Number: 91-8005	Borehole Number: B-4		Sheet 10 of 10

Depth (feet)	Lithology	Description	USCS Classification	Geologic Unit	Samples: Number	Type	Blow Count	Recovery	OVA (ppm)	Dry Density (pcf)	Moisture Content (%)	Background OVA (ppm)
		Boring terminated at 260 feet.										
265		NOTE: This borehole log is based on field classification and visual soil description and is further modified to include results of laboratory classification tests, where available. This summary applies only at the location of this boring and at the time of drilling. Subsurface conditions may differ at other locations and may change at this location with passage of time. The data presented is simplification of actual conditions encountered. The stratification lines represent the approximate boundary between subsurface material types and the transition may be gradual.										
270												
275												
280												
285												
290												

APPENDIX B

WELL CONSTRUCTION LOGS



Total Depth (D)	= 199 Feet
Total Depth of Casing (D1)	= 195 Feet
Depth to Bottom of Well Screen (D2)	= 195 Feet
Depth to Top of Well Screen (D3)	= 125 Feet
Depth to Bottom of Top Seal (D4)	= 112 Feet
Depth to Top of Top Seal (D5)	= 103.3 Feet
Well Casing Diameter	= 2 Inch
Well Screen Slot Size	= 0.01 Inch
Filter Pack Sand Type	= 2/12 Monterey
Bentonite Seal Type	= 1/4 Inch Pellets and Chips

The Earth Technology Corporation

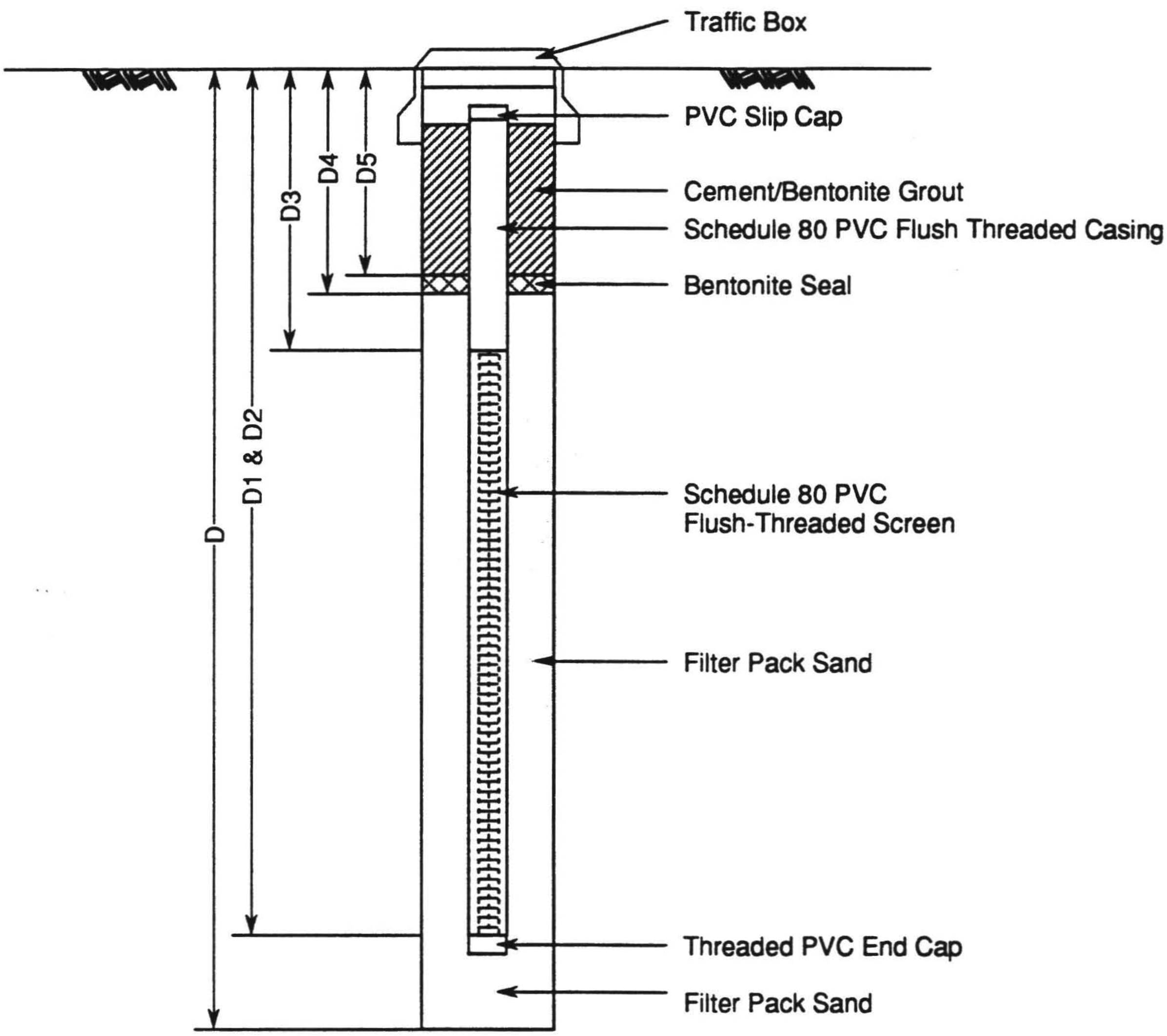
Project No. 92-2038

Hollywood Fault Study
Metro Red Line

Well Number SM-1

1-93

Figure B-1



Total Depth (D)	= 180 Feet (Sloughed to 150 feet)
Total Depth of Casing (D1)	= 150 Feet
Depth to Bottom of Well Screen (D2)	= 150 Feet
Depth to Top of Well Screen (D3)	= 10 Feet
Depth to Bottom of Top Seal (D4)	= 9 Feet
Depth to Top of Top Seal (D5)	= 3 Feet
Well Casing Diameter	= 1 Inch
Well Screen Slot Size	= 0.01 Inch
Filter Pack Sand Type	= 2/12 Monterey
Bentonite Seal Type	= 1/4 Inch Pellets

The Earth Technology Corporation

Project No. 92-2038

Hollywood Fault Study
Metro Red Line

Well Number SM-1A

1-93

Figure B-2

APPENDIX C

PALEONTOLOGIC DATA

MICROPALEO
CONSULTANTS, INC.

December 8, 1992

Mr. Dennis Burke
The Earth Technology Corporation
13900 Alton Parkway, Suite 120
Irvine, California 92718

Dear Dennis:

Enclosed is our report on the two samples you recently sent us. We examined sample B-8 for Foraminifera and palynology; only Foraminifera were done on sample SM-1.

Sample B-8 contains no definite fossils and, therefore, is age indeterminate. The lithology appears to be some sort of muddy sandstone containing abundant plutonic fragments. It is possible, however, the sample is 100% fault gouge.

Sample SM-1 is certainly sedimentary. We believe it represents Modelo deposition, but it could be as old as Topanga.

Our invoice is also enclosed. If you have any questions about either the bill or the report, give me a call.

Sincerely,

Rick Boettcher

Richard S. Boettcher
MICROPALEO CONSULTANTS, INC.

RSB:be

Enclosures

681 Encinitas Blvd. • Suite 312 • Encinitas, California 92024 • (619) 942-6082 • FAX (619) 942-9623
Laboratory: 4569 Mission Gorge Place • Suite K • San Diego, California 92120 • (619) 284-7703

MICROPALEO CONSULTANTS, INC.

SAMPLE B-8

FORAMINIFERA

Age:	Indeterminate
Environment:	Indeterminate
Fossils:	Arenaceous spp.? (R)
Remarks:	The lithology consists of a light gray muddy sandstone?, with abundant plutonic fragments. There are no definite Foraminifera in this sample. The arenaceous spp.? recorded may well be some inorganic occurrences that in a general way mimic crushed arenaceous Foraminifera. In view of this uncertainty, we prefer to categorize both the age and environment as indeterminate.

PALYNOLOGY

Age:	Indeterminate
Environment:	Indeterminate
Remarks:	Barren of organics.

681 Encinitas Blvd. • Suite 312 • Encinitas, California 92024 • (619) 942-6082 • FAX (619) 942-9623
Laboratory: 4569 Mission Gorge Place • Suite K • San Diego, California 92120 • (619) 284-7703

SAMPLE SM-1

FORAMINIFERA

Age: Middle to Late Miocene, Probable Luisian to "Delmontian" Equivalent. Topanga/Modelo Formation(s).

Environment: Open Marine

Fossils: Arenaceous spp. (C), *Haplophragmoides* spp. (F), *Globigerina bulloides* (C), *G. quadrilatera*? (C), *G.* spp. (A), Fish remains (R), Radiolaria (F)

Remarks: The lithology of this sample is a light brown/gray shale/mudstone, plus some white tuff. The fossils are not highly age restrictive except to say middle to late Miocene (roughly Luisian to "Delmontian"). There is possibly slightly more evidence to suggest assignment to the younger part of this age range, say Mohnian to "Delmontian", although this is speculative. The maximum range of formational assignment would be from the Topanga to the Modelo (= Puente). Again, if we are correct in our speculation that the fauna implies a Mohnian/"Delmontian" age, then the Modelo would be preferable to the Topanga. The arenaceous species do not provide much paleodepth information; the abundant planktonics indicate an open marine setting.

Interpreted by:

Richard S. Boettcher
MICROPALEO CONSULTANTS, INC.

Hideyo Haga by RSB
MICROPALEO CONSULTANTS, INC.

APPENDIX D

FEBRUARY 1, 1993 LETTER TO ENGINEERING MANAGEMENT CONSULTANT, CHIEF TUNNEL ENGINEER

Kerry Sieh
Post Office Box 3148
Blue Jay, CA 92317

February 1, 1993

Mr. Timothy Smirnoff
Chief Tunnel Engineer
Parsons Brinckerhoff/DMJM
707 Wilshire Boulevard, Suite 2900
Los Angeles, CA 90017

Dear Mr. Smirnoff:

By this letter I am transmitting to you my evaluation of the potential for fault movements along the proposed route of the MetroRail Red Line. This letter augments the recent report of The Earth Technology Corporation, with respect to the Hollywood fault. Furthermore, I discuss other possibly active geological structures that lie close to other portions of the MetroRail route.

Scientific Background

Within the past five years, a number of scientists have come to believe that an active system of thrust faults exists within the Los Angeles metropolitan region. In order to provide a context for the discussion of those specific elements of this system that directly affect the MetroRail Red Line, I will first give a brief, general description of the fault system, as it is currently known.

The damaging Whittier Narrows earthquake of 1987 (M_L 5.9) marks the initiation of widespread concern about active reverse faults within the metropolitan region. Prior to this earthquake, concern had been focussed primarily on the effects of earthquakes generated by the San Andreas fault, 55 kilometers northeast of Los Angeles. Other lesser, but nearer strike-slip faults, such as the Whittier and Newport-Inglewood faults, were also known at that time to pose significant earthquake hazards within the region[1].

---

[1] Ziony, J., 1985, Evaluating Earthquake Hazards in the Los Angeles Region -- An Earth-Science Perspective: U. S. Geological Survey Profess. Pap 1360, 505 p.

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(714) 337-0827 (home)

However, none of these faults cross the alignment of the Red Line and, therefore, none were believed to pose fault-rupture hazards along the alignment.

Seismologic and geodetic analysis of the 1987 earthquake revealed that it was generated by about a meter of slip on a 5-by-5-kilometer patch of a shallowly north-dipping fault, buried about 12 kilometers beneath the Whittier Narrows, just off of the eastern edge of Figure 1[2, 3]. Geodetic data showed that hills above the fault rose about 5 centimeters during the earthquake[3]. Geologists found no evidence for fault rupture at the ground surface, but geological maps indicated young folding in the region. Thus the seismologic, geodetic and geologic evidence pointed to seismic slip on a "blind" thrust fault, that is, a fault which causes folding of the ground surface, but which does not, itself, break the ground surface.

It is now recognized that the small fault that caused the Whittier Narrows earthquake and its small surficial fold are merely two elements in a system of thrust faults that underlie the metropolitan region between Whittier Narrows and the Pacific Ocean[4]. During the past three million years, movement on this system of faults and folds has accomodated several kilometers of north-south contraction of the Los Angeles region[5]. The detailed geometry of these blind thrust faults and their surficial manifestations are not yet perfectly known. However, the Santa Monica Mountains, Hollywood Hills, Elysian Park Hills, Bunker Hill and the hills of East Los Angeles are the more obvious manifestations of this long-term, north-south shortening of the crust.

The most recent few thousand years of activity on this system manifests itself as smaller irregularities on or near these larger hills. It is these smaller, more youthful and more subtle features that are

---

[2] Hauksson, E., and others, 1988, The 1987 Whittier Narrows earthquake in the Los Angeles metropolitan area, California: *Science*, **239**, 1409-1412.

[3] Lin, J., and R. Stein, 1989, Coseismic folding, earthquake recurrence, and the 1987 source mechanism at Whittier Narrows, Los Angeles basin, California: *J. Geophys. Res.*, **94**, 9614-9632.

[4] Dolan, J., and K. Sieh, 1992, Paleoseismology and geomorphology of the northern Los Angeles basin: Evidence for Holocene activity on the Santa Monica fault and identification of new strike-slip faults through Downtown Los Angeles: in **EOS, Trans. Amer. Geophys. U., 73,** 589; Bullard, T., and W. Lettis, in press, Quaternary fold deformation associated with blind thrust faulting, Los Angeles Bassin, California, *J. Geophysical Res* .

[5] Wright, T., 1991, Structural geology and tectonic evolution of the Los Angeles basin, California; Davis, T., and J. Namson, 1989, A cross section of the Los Angeles area: Seismically active fold and thrust belt, the 1987 Whittier Narrows earthquake, and Earthquake Hazard: *J. Geophysical Res.* **94**, 9644-9664.

of most concern to me, with respect to MetroRail, because the youngest elements are the ones most likely to be active during the lifetime of MetroRail.

The subtle surficial expressions of several small faults and folds of the thrust system are depicted in Figure 1. The figure is based principally on work performed under my supervision by Dr. James Dolan. For reference, the figure also shows the approximate MetroRail Red Line alignment and other cultural features. The alignment crosses two and perhaps three young faults and also a feature that may be a fold. The faults are the MacArthur Park, Echo Park and Hollywood.

These faults are expressed at the surface as gentle, linear south-facing slopes. Figure 1 depicts these slopes as lines of irregular width. Dashes indicate where we infer that these structures could exist, but where surficial expression is non-existent. At this time, we believe these short, relatively minor structures dip rather steeply northward and root in a larger, shallowly north-dipping thrust fault buried several kilometers beneath the region, similar in nature to the structure associated with the 1987 earthquake.

The Echo Park, Coyote Pass and MacArthur Park faults

East of the Downtown area, the scarps of the **Coyote Pass fault** suggest a predominance of right-lateral slip and minor dip slip, south side down (Figure 1). To the best of my knowledge, this fault was first noted in a State report thirty years ago[6]. Bullard and Lettis[7] also display a portion of the feature on one of their maps, but neither discuss it in any detail nor mention it by name.

On trend with the Coyote Pass fault, northwest of Downtown Los Angeles, is an alignment of bedrock hills that suggests another young fault. This speculative fault we have named the **Echo Park fault** (Figure 1). If this structure exists, and if it is contiguous with the Coyote Pass fault, the combined structure would pass through the MetroRail tunnel near the Hollywood (101) freeway. Geological cross sections of the MetroRail tunnel excavation, shown to us by Mr. Richard Radwanski, do not indicate any faults in the Puente

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6 California Department of Water Resources, June 1961, Bulletin 104 (see Areal Geology Map and Geologic Sections K-K' and L-L').

7 Bullard, T., and W. Lettis, in press, Quaternary fold deformation associated with blind thrust faulting, Los Angeles Bassin, California, *J. Geophysical Res.*

Formation at the Downtown crossing of the postulated fault. This means that the structures, though aligned, are not connected and that neither the Coyote Pass nor the Echo Park fault pose a fault-rupture hazard to the tunnel north of Downtown.

At and west of Vermont Avenue, we see no topographic indication of our postulated Echo Park fault. It is quite plausible that the structure does not continue across the MetroRail alignment. Nevertheless, special care should be taken to examine the tunnel walls for evidence of faulting near the intersection of Vermont Avenue and the northwestward projection of the Echo Park feature.

The **MacArthur Park fault** exhibits clear scarps just north of the MetroRail route between Downtown and Vermont Avenue. There it also displays clear evidence of predominantly right-lateral slip, with a minor component of dip slip, south-side down. As Figures 1 and 1a show, the landforms associated with this fault are located north of the tunnel along Wilshire Blvd. Furthermore, Mr. Richard Radwanski's mapping of the tunnel excavations confirm that this fault does not intersect the tunnel along Wilshire Blvd.

I anticipate, however, that the MetroRail tunnel will cross the MacArthur Park fault along Vermont Avenue, north of Wilshire Boulevard (Figure 1a).

Slippage along the MacArthur Park fault during an earthquake would probably be a combination of right-lateral and vertical (north-side-up). I can not accurately predict how much slip would occur. But, given its much shorter length, it would probably be much less than that which I postulate below for the Hollywood fault.

West of Vermont Avenue, at the Normandie station, the station excavation crosses a linear, gently southwest-sloping hillside that appears to be the surficial expression of a young fold. For the sake of this discussion, I will call this feature the **Normandie Fold.**

Prior to excavation of the Normandie station, your exploratory borings there suggested to me that the late Quaternary San Pedro Sand had indeed been warped down to the south, perhaps as much as 80 feet. This 80-foot-high slope was suspicious, because one would have expected the shallow-water San Pedro sands to have been laid down on a much more gently inclined sea floor. The San Pedro Sand may be about a half-million years old, so this warping would have taken place sometime during the past half-million years.

I and Dr. Dolan tested the fold hypothesis by inspecting the excavation as it progressed. We expected to find minor, secondary faults and fissures at the contact of the San Pedro Sand and underlying bedrock (Puente Formation). Such structures are common on the limbs of active folds, and their presence would have been an independent indication of youthful tectonic activity. To my surprise, inspections by myself and Dr. Dolan during occasional visits to the excavation revealed no secondary faulting. Irregularities in the contact and less than optimal viewing conditions leave us with some uncertainty about the lack of faulting, but our judgement is that, for the portions of the excavation that we inspected, offsets of the contact greater than about 25 cm would have been visible to us. Mr. Radwanski concurs with this opinion. He is currently completing his cross-section of the entire exposure. I would like to inspect his cross section before I make a final judgement about the lack of faulting.

The apparent lack of secondary faults or fissures reduces my concern about the possibility of minor faulting and reduces my concern about tectonic tilting of the Normandie station. Nevertheless, the most plausible explanation of the feature is that it is a young fold, but with secondary structures too small to have been seen in excavation.

The Hollywood fault

The largest fault along the Red Line alignment is the Hollywood fault. During 1992, this fault was the subject of intensive geotechnical investigation, which is described in detail in the report of The Earth Technology Corporation (ETC). I and Dr. Dolan participated in that investigation and reviewed the report prior to its submission to you.

The ETC report describes the numerous borings that were made in 1992 to locate more precisely the Hollywood fault zone in the vicinity of the Red Line. There is no need for me to re-iterate most of the findings and conclusions of that report. I will, however, in the paragraphs that follow, present a small amount of additional data and discuss the following matters:

1) The possibility of a trace of the Hollywood fault, immediately south of and parallel to Hollywood Blvd, has been eliminated by the set of borings made in September and October of 1992.

2) A recent exposure of a young fault in a sewer excavation on Fuller Avenue suggests minor young faulting slightly north of the principal zone of faulting.

3) Radiocarbon dates that we received in early December indicate that the Hollywood fault has moved in the past 17,000 years.

4) Future dislocations of features crossing the Hollywood fault may have an appreciable left-lateral component.

5) Determination of the slip rate and average recurrence interval for the fault zone remain problematic, but I do suggest reasonable values for your consideration.

POSSIBLE FAULT ALONG HOLLYWOOD BOULEVARD

In one of our meetings in early 1992, I expressed concern that a southern branch of the Hollywood fault system might be responsible for topographic irregularities immediately south of Hollywood Boulevard. These irregularities appear in the contours of the Hollywood and Burbank 1:24,000-scale topographic quadrangles made by the US Geological Survey in the 1920s. For reference, I include as Figure 2 our map of this linear zone of steeper topography. The topographic contours on the old map suggested that we would see vertical dislocations of at least 10 feet between Hollywood Blvd and Hawthorn.

Although our inspection of the area with Dr. Allen in early 1992 had led us to doubt that the old topographic map had been drawn correctly, I recommended that additional borings be made in order to completely address the possibility of additional active faulting along Hollywood Blvd.

The borings made along Martel Avenue, between Hawthorn and Franklin Avenues in late 1992, allowed us to eliminate the possibility that the zone of odd topography along Hollywood Blvd. is related to active faulting. The pedogenic soils and alluvial layers encountered in the borings appear to be tectonically undisturbed between B-12 and B-46. This lack of disturbance is shown in the ETC report's Plate 1. Our most recent interpretation of the borings differs slightly from that shown on Plate 1, but only between B-34 and B-12, that is, north of Hollywood Blvd. Figure 3 is a rough draft of our interpretation of that portion of the cross-section. As you can see, in neither our latest interpretation nor ETC's is there any indication of disturbance of the soils or sedimentary layers.

SEWER TRENCH ALONG FULLER AVENUE

Figure 4 is a map of the Hollywood fault zone in the vicinity of the MetroRail crossing. The location of the principal fault zone on this map reflects constraints from the ETC borings along Camino Palmero and La Brea Avenue and from a shallow sewer trench dug in November along Fuller Avenue.

Figure 5 is a sketch of the western wall of the sewer trench, made by Dr. Dolan. The excavation revealed loose alluvial sediment (yellow), underlain by massive clayey alluvium or colluvium (light brown), which is underlain by crystalline bedrock (dark orange). At its southernmost exposure, the bedrock is faulted against the clayey alluvial or colluvial unit. The borings along La Brea Avenue and Camino Palmero indicate that the main zone of faulting is south of this exposure, but, because of the speed with which excavation and backfilling occurred, we were unable to view that portion of the sewer excavation.

The presence of a small, young fault north of the main fault zone is a tangible indication that the borings should be interpreted with this cautionary note: minor faults, with up to a foot or two of vertical separation should be expected outside of the main zone.

MOST RECENT ACTIVITY OF THE HOLLYWOOD FAULT

You have asked me to assess the recency of activity of the Hollywood fault. Based upon radiocarbon analyses of several samples of carbon from the Camino Palmero borings, Dr. Dolan and I conclude that the most recent movements of the fault have occurred in the past 17,000 years. I infer that at least one event occurred between 17,000 and about 8,000 years ago. Movement along the fault during the past 8,000 years can be neither demonstrated nor disproved from any of the data now available.

A radiocarbon age of 16,760 years, determined for sample B-31 HFZ 21' (Appendix 1), provides a maximum age for the most recent fault movements. This sample came from 21 feet below Martel Avenue in boring B-31, between Hollywood Boulevard and Franklin Avenue. Figure 3 shows that this location is stratigraphically between two pedogenic soils that are faulted farther upslope, between borings B-12 and B-17. The top of these soils have a vertical separation of about 8 feet across the fault between B-12 and B-17. This separation is almost certainly the result of fault rupture. We have considered the possibility that the vertical separation is due to channelization into the fan. The geometry of the top of the soil renders this alternative very unlikely. Borings B-17, 10, 15 and 16 show that no appreciable channel wall exists on what would be the northern wall of this channel. The smoothness of this slope and its elevation make channelization a very improbable explanation.

Figure 6 is is a 3-dimensional structure-contour map of the top of the soil in the vicinity of the fault. Borings 18,19 and 20 provided enough control to allow Mr. Miller at ETC to construct this map. The map is quite instructive: It shows that south of the fault the surface of the soil slopes southwestward, away from the mouth of Runyon Canyon. This is consistent with our interpretation that the sediments south of the fault came from Runyon Canyon. North of the fault, the soil slopes southward, away from the mountainfront. This is precisely what one would expect for sediment derived not from Runyon Canyon, but, rather, from the slope north of Camino Palmero. The structure-contour map shows that these two surfaces of differing orientations meet at the fault zone.

If the crease between the two surfaces were not faulted, the contours through B-9, 12 and 20 would merge with the contours drawn through B-10, 17 and 18 without turning to the northeast. The northeastward deflection of the contours between B-20/B-12 and B-18/17/10 probably indicates faulting, north-side down. The borings constrain the orientation of the fault to be within the range N50E to about East-West. This range of orientations is nearly parallel to or slightly more northerly than the orientation of the principal zone of faulting (Figure 4).

Figure 6 indicates that the magnitude of dip-slip separation across the fault is about 5 feet. The actual orientation and magnitude of the slip vector cannot be determined uniquely from the available data, however. The observed separation could be the result of pure dip slip or a combination of dip and strike slip. In the following paragraph, I consider the possibilities.

Because the separation is down to the north and the dip of the fault is northward (Figure 3), the dip-separation is normal, not reverse. A normal fault with this angle to the main zone would most easily be interpreted as a Riedel shear in a left-lateral fault zone. If we assume the slip vector across the fault is either pure normal slip, then the magnitude of the dip-slip would equal the vertical separation, about 5 feet. If, however, the slip vector has a component of left-lateral slip, then the dip slip would be greater than 5 feet. For example, if the component of left-lateral slip were 20 feet, dip-slip would be about 7 feet.

Regardless of the exact slip vector, this fault slip probably antedates deposition of the clayey "orange" alluvium on Figure 3, because the tops of that unit south and north of the fault are coplanar. Thus, the events responsible for the 5 feet of vertical separation on the underlying soils displaced the underlying soils before deposition of the top of the "orange" alluvium.

Although one cannot be certain, a vertical separation of this magnitude is close to the maximum value one would expect for slippage in only one earthquake[8]. I suspect, therefore, that at least two large earthquakes, or possibly several smaller earthquakes were associated with rupture of the Hollywood fault between about 17,000 years ago and deposition of the top of the clayey alluvium, colored orange in Figure 3. In the following paragraph, I estimate an age for the top of this clayey alluvium.

Sample B-15 HFZ 7', recovered from loose alluvium at a depth of 7' in boring B-15, has a radiocarbon age of about 3400 years (Figure 3 and Appendix 1). The base of the loose alluvium is at a depth of about 16 feet in this boring and rests immediately upon the orange layer in Figure 3. Using this 3,400 year age, a linear extrapolation of age as a function of depth yields an age of about 8,000 years for the base of the loose alluvium and top of the clayey underlying unit. This provides a reasonable constraint upon the event or events that produced the 5-foot separation -- they occurred between about 17,000 and about 8,000 years.

From the data now in hand, we cannot determine whether the Hollywood fault has ruptured within the past 8,000 years. The following stratigraphic relationship between borings B-12 and B-15 suggests the possibility, but does not prove it: The contact between loose post-8,000-year-old alluvium and clayey underlying alluvium is clearly traceable from boring B-12 southward and from boring B-10 northward, but is not clear in boring B-17. The absence of the stratum in B-17 could be due to channelized erosion near the fault scarp. It could also be a stratigraphic complication due to faulting subsequent to creation of the contact. If this latter alternative is the correct one, then the fault has ruptured in the past 8,000 years or so.

The latest movement on the Hollywood fault may have occurred prior to about 1,200 years ago. This is suggested, but not proven, by the structural relationships in the Fuller Avenue sewer excavation (Figure 5). In that excavation, the fault plane that juxtaposes bedrock (dark orange) and clayey alluvium or colluvium does not appear to break the youngest (yellow) alluvial unit. The yellow, youngest alluvial unit corresponds to the loose, upper 16 feet of alluvium in the Camino Palmero borings, and we believe that the

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[8] I am aware of no historical California earthquake, for example, associated with a scarp greater than about 5 feet in height.

underlying clayey alluvium corresponds to the clayey alluvium on Camino Palmero. Samples C-2 and C-3, which were taken from the younger unit, indicate that this unbroken unit is about 1,200 years old. Thus we infer that this fault plane has not slipped in at least 1,200 years[9]. This conclusion is speculative, because the 1,200-year-old stratum may, actually, be faulted. The contact between the two youngest units in the excavation is obscured by man-made fill at the place where the fault would intersect the contact. Thus, although we believe it to be unlikely, the possibility that the base of the young unit is faulted cannot be dismissed.

SENSE OF DISLOCATION AND RATE OF SLIP ALONG THE HOLLYWOOD FAULT

You also requested me to evaluate the amount and type of dislocations that are likely to occur during the next rupture of the Hollywood fault. With respect to this question, the data we collected in 1992 yielded some surprises.

The location of the Hollywood fault, at the southern base of the Santa Monica Mountains, and the geological structure of the mountains suggest that slip on the Hollywood fault has been dominantly vertical. Even recent interpretations show the fault dipping moderately northward under the mountains and show the mountains moving up, over the sediment of the Hollywood plain[10]. The borings along Camino Palmero and La Brea Avenues support this view, inasmuch as they show bedrock north of the faults over-riding alluvium south of the faults.

Three pieces of evidence collected in 1992, however, indicate that the fault may have a significant component of left-lateral slip. First, the dip of the fault planes encountered in and inferred between borings B-12, 17, 10 and 16 are unexpectedly steep. Such steep dips (75° and higher) are not commonly associated with dip-slip faults. They are commonly associated with strike-slip structures. Second,

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9 Sample C-4, which was collected from the unit beneath the young (yellow) alluvium, yielded a radiocarbon age of only 300 years. This is inconsistent with the 1200-year ages determined for C-2 and C-3. The most satisfactory resolution of this discrepancy is that the necessarily rapid mapping of the trench wall precluded recognition of burrows or other disturbances that emplaced younger material within the older unit.

10 Davis, T., and J. Namson, , 1989, A cross section of the Los Angeles area: Seismically active fold and thrust belt, the 1987 Whittier Narrows earthquake, and Earthquake Hazard: *J. Geophysical Res.* **94**, 9644-9664.

the sense of vertical separation of the latest Pleistocene soil, between B-12 and B-17 is opposite that which one would expect for a reverse fault. The soils above and below the 17,000-year-old sample appear to have dropped down on the north, relative to their elevations south of the fault. If the fault were bringing the mountains up, relative to the Hollywood plain, then the sense of vertical separation of this bed would be up-on-the-north. The observed sense of vertical separation -- down on the north -- would not be uncommon for a Reidel shear within a left-lateral fault zone. The third piece of evidence that suggests strike-slip motion is the linearity of the fault zone between Vista and La Brea Avenues. Faults of such linearity are more commonly associated with strike-slip or oblique-slip rather than pure dip-slip motion.

The odd sense of vertical separation across the fault makes me very reticent to use the separation across the fault to calculate a rate of vertical or lateral slip for the Hollywood fault zone. In lieu of a firm conclusion, however, let me offer a speculative analysis.

The lack of a prominent fault scarp across Camino Palmero is an indication that sedimentation has been occurring at a rate that is greater than the rate of relative vertical displacement. This allows me to place a constraint on the rate of vertical displacement across the fault zone. At the fault zone, the 17,000-year-old stratum occurs at a depth (on the southern side of the fault) of about 25 feet. From this one can calculate an average rate of deposition of about 0.4 mm/yr. If the average rate of vertical slip on the fault had exceeded this value, a scarp would have been visible on the ground surface and deposition would have occurred only on one side of the fault zone. From this analysis, then, I conclude that the rate of vertical slip, either north- or south-side-up, along the Hollywood fault is substantially less than 0.4 mm/yr. If we use the 5 feet, south-side-up, to calculate a vertical slip rate, we calculate a rate of 0.1 mm/yr, mountain-side down.

The rate of left-lateral slip is more difficult to assess, but some constraints can be estimated. From the topographic map of Figure 2, one can see that the geomorphic expression of the alluvial fan emanating from Runyon Canyon would disappear if sediments were removed to a depth of about 100 feet in the vicinity of the Camino Palmero crossing of the Hollywood fault. A linear extrapolation with depth of the 17,000-year-old sample yields an approximate age of 80,000 years for the base of the alluvial fan.

What minimum average rate of left-lateral slip on the Hollywood fault would be required to create a visible asymetry in the alluvial fan? The shape of the fan is complicated by the presence of two lesser canyons west of Runyon Canyon. Even so, it appears to me that the bulk of the sediment on the fan originated from Runyon Canyon. The apex of the fan appears to be very near the mouth of Runyon Canyon. More than about 100 meters of left-lateral slip on the fault would probably have left a topographically visible remant of the fan east of Runyon canyon. If I assume that 100 meters or less of left-lateral slip has occurred in the past 80,000 years, I calculate a maximum rate of about 1.2 mm/yr.

In the section below I will use a vertical slip rate of 0.1 mm/yr and a maximum left-lateral slip rate of 1.2 mm/yr to estimate minimum average recurrence intervals for the Hollywood fault.

AVERAGE RECURRENCE INTERVALS FOR THE HOLLYWOOD FAULT

In the text above, I have concluded that at least one, and probably more, ruptures of the Hollywood fault occurred between 17,000 and 8,000 years ago. If we assume that only one rupture occurred during that period, and that no ruptures have occurred subsequently, we have an average recurrence of slip along the fault of at least 8,000 years. If we use the 0.1 and 1.2 mm/yr vertical and horizontal slip rates, we calculate that at least about 0.8 m of vertical and 10 m of horizontal slip would have built up during the 8,000-year or greater period between earthquakes. Such a large horizontal dislocation is unreasonable -- the largest offset associated with historical earthquakes along the San Andreas fault, a much larger fault, capable of much larger earthquakes, is about 10 meters. From this I conclude that either I have chosen an unreasonably long recurrence interval or an unreasonably high rate of horizontal slip. In the next paragraph, I assume that the average recurrence interval is much shorter than 8,000 years.

Let us consider two simple and speculative scenarios. First, I assume that the Hollywood fault, in concert with other reverse and strike-slip faults of the metropolitan region, produces large (magnitude 7.5) earthquakes. Slip during earthquakes of this size is commonly as great as 3 to 6 meters[11] . At an accumulation rate of 1.2 mm/yr, about 2,500 to 5,000 years would be required to store

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[11] This range of values is consistent with those found in the most recent compilation of values, which is in Wells, D., and K. Coppersmith, Updated empirical relationships among magnitude, rupture length, rupture area and surface displacement: *Seismol. Soc. America Bull*, in preparation.

this amount of strain between earthquakes. Since 1.2 mm/yr was a maximum estimated rate, 2,500 years would be a minimum average recurrence interval. Repetition of such a large dislocation along the Hollywood fault would probably be a few thousand years. With such a long interval between events, the recurrence of a large event in the lifetime of the MetroRail tunnel would be extremely small.[11]

Alternatively, if we assume that the Hollywood fault breaks during smaller (magnitude 6.5) earthquakes, then I would expect events to be much more frequent, but each would relieve less strain. If we use the 1.2 mm/yr rate and adopt a typical scenario for a magnitude 6.5 earthquake -- one-half meter of lateral slip[11] -- , events along the Hollywood fault would occur, on average, every 400 years As in the calculation for a larger-magnitude earthquake, this is a minimum average interval, because the 1.2 mm/yr rate is a maximum estimated rate. A more likely average interval might be as high as one thousand years.

EARTHQUAKE SCENARIOS FOR THE HOLLYWOOD FAULT

In this final section of my report, I offer two scenarios for the displacement across the Hollywood fault at the MetroRail Red Line crossing: First, I assume the occurrence of a magnitude 6.5 earthquake. Then, I assume occurrence of a magnitude 7.5 event.

If the Hollywood fault ruptures during an earthquake of magnitude 6.5, major fault rupture would likely be confined to the Hollywood fault zone -- that is, the principal faults and their subsidiary traces, along the southern flank of the Santa Monica mountains and Hollywood Hills. At the MetroRail crossing, most of the slip would occur on discrete faults within the zone identified on Figure 4. The amount of slip would be on the order of one-half to one meter, and there would be components of both vertical and left-lateral slip.

If the Hollywood fault ruptures during an earthquake of magnitude 7.5, major fault rupture would likely occur on other faults as well as the Hollywood fault zone. It is not inconceivable that other faults on Figure 1 could rupture in concert with the Hollywood Fault. At the tunnel crossing, offsets of several meters could occur within the principal zone of faulting.

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[11] As a caution, however, let me say that the faults of the Landers earthquake had similarly long periods of repose prior to the magnitude 7.4 earthquake in 1992.

I hope that this rather lengthy analysis of the seismic rupture hazards along the MetroRail Red Line route is of use to you. If you wish me to discuss these matters further with you, your staff, or your geotechnical consultants, I would be happy do so. I will be in town most of February, March and early April.

Sincerely yours,

Kerry Sieh
Registered Geologist 5057

FIGURE CAPTIONS

Figure 1. Map of possibly active faults and folds in the vicinity of the MetroRail Red Line. Prominent lines of variable thickness represent south- to southwest-facing slopes that indicate youthful faulting of the ground surface. Dashed lines represent speculative interpolations of these features where topographic indicators were not present. Lines with opposing double arrows are crests of youthful folds on the ground surface. The features that are relevant to the MetroRail Red Line are the MacArthur Park, Echo Park and Hollywood faults and a nearby fold.

Figure 1a. Map of the MacArthur Park fault in the vicinity of Wilshire Boulevard. and Vermont Avenue. The red color represents slopes that we interpret as fault scarps. The yellow color indicates outcroppings of bedrock (from other published mapping). The red lines with opposing arrows indicate the crest of the Normandie fold. Topography is from the USGS Hollywood and Los Angeles topographic maps of the 1920s. Contour intervals are 5 and 25 feet.

Figure 2. The topography along Hollywood Boulevard, mapped by the USGS in the 1920s, suggests the presence of a southern strand of the Hollywood fault. Borings made in late 1992 indicate that this zone of irregular topography is not the product of faulting.

Figure 3. Our most recent interpretation of the borings along Martel Avenue, north of Hollywood Avenue, differs slightly from that in the October 1992 report. Both interpretations, however, suggest that no young faulting exists south of Franklin Avenue.

Figure 4. The cross-hatched zone on this map includes the location of the principal traces of the Hollywood fault zone, which are well-constrained by borings along Camino Palmero and La Brea Avenues. The two short, heavy lines across Fuller and Camino Palmero Avenues are individual faults, which are discussed in the text.

Figure 5. A sewer excavation on Fuller Avenue exposed a young fault north of the principal zone of faulting.

Figure 6. This structure-contour map shows, in plan view, the elevation of the top of the uppermost "brown" soil encountered in the borings along Camino Palmero. From this map, I infer the nature of youngest slip along the Hollywood fault.

Figure 2

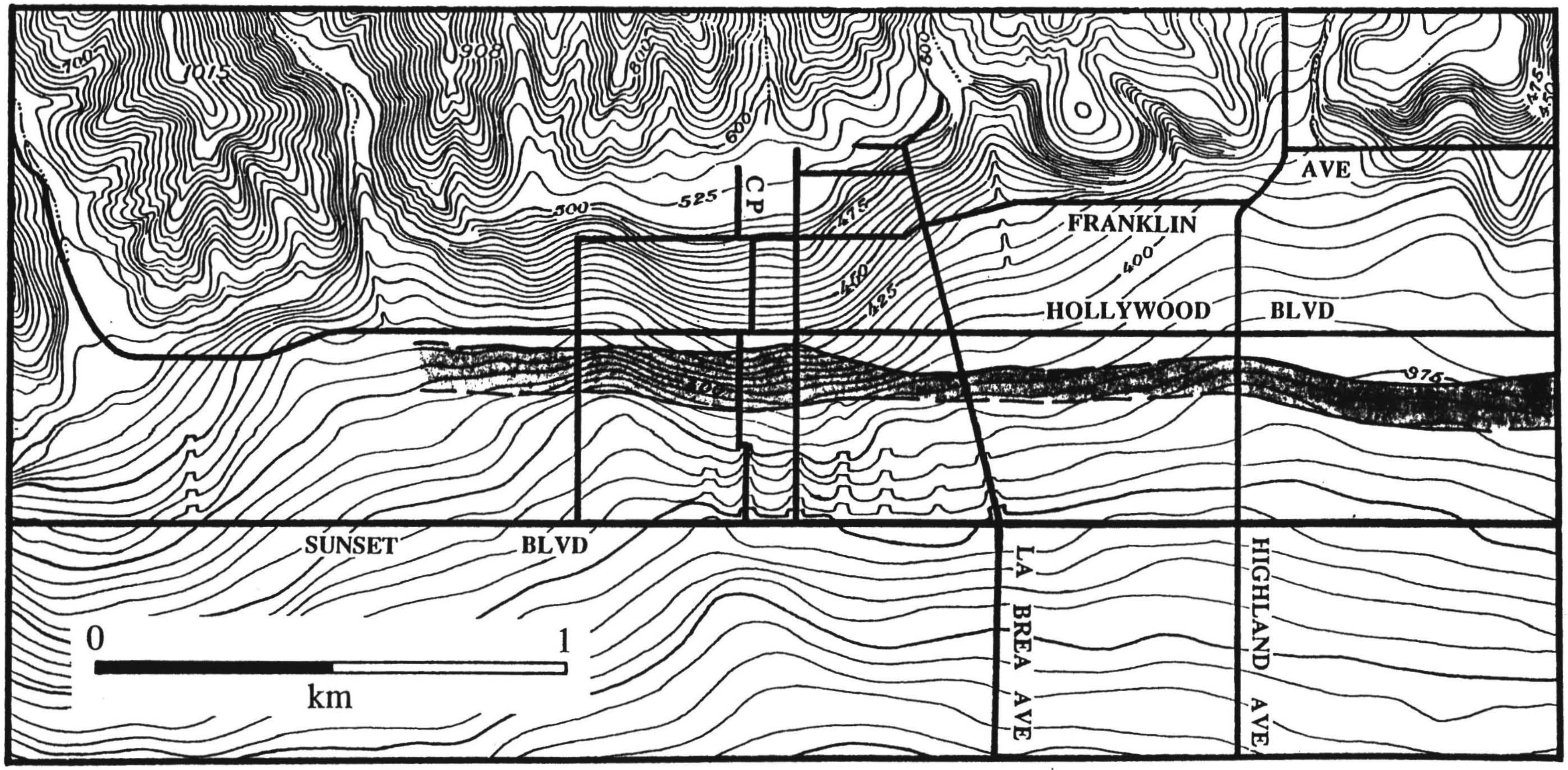
AVE
FRANKLIN
HOLLYWOOD BLVD
SUNSET BLVD
LA BREA AVE
HIGHLAND AVE
CP
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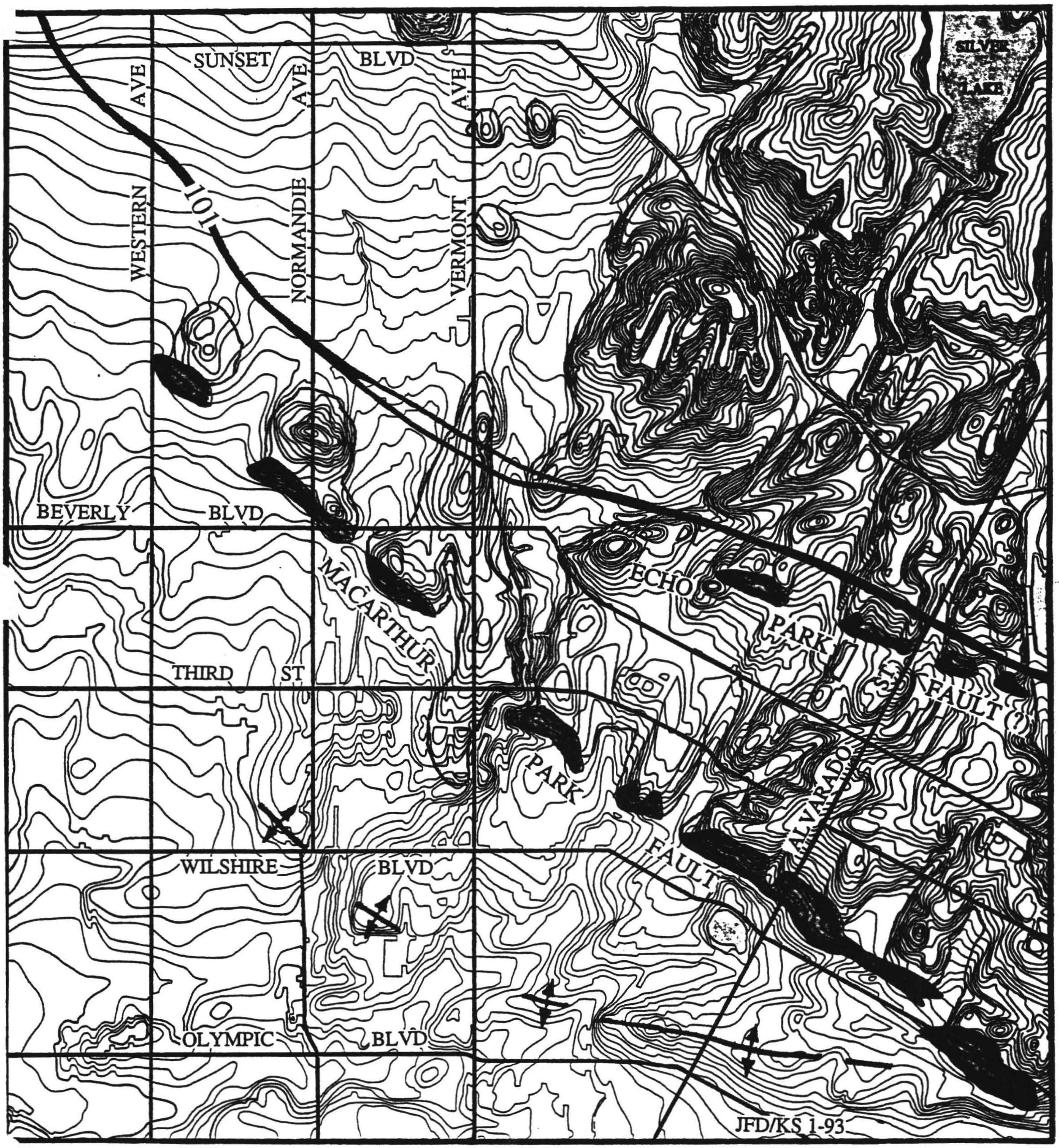
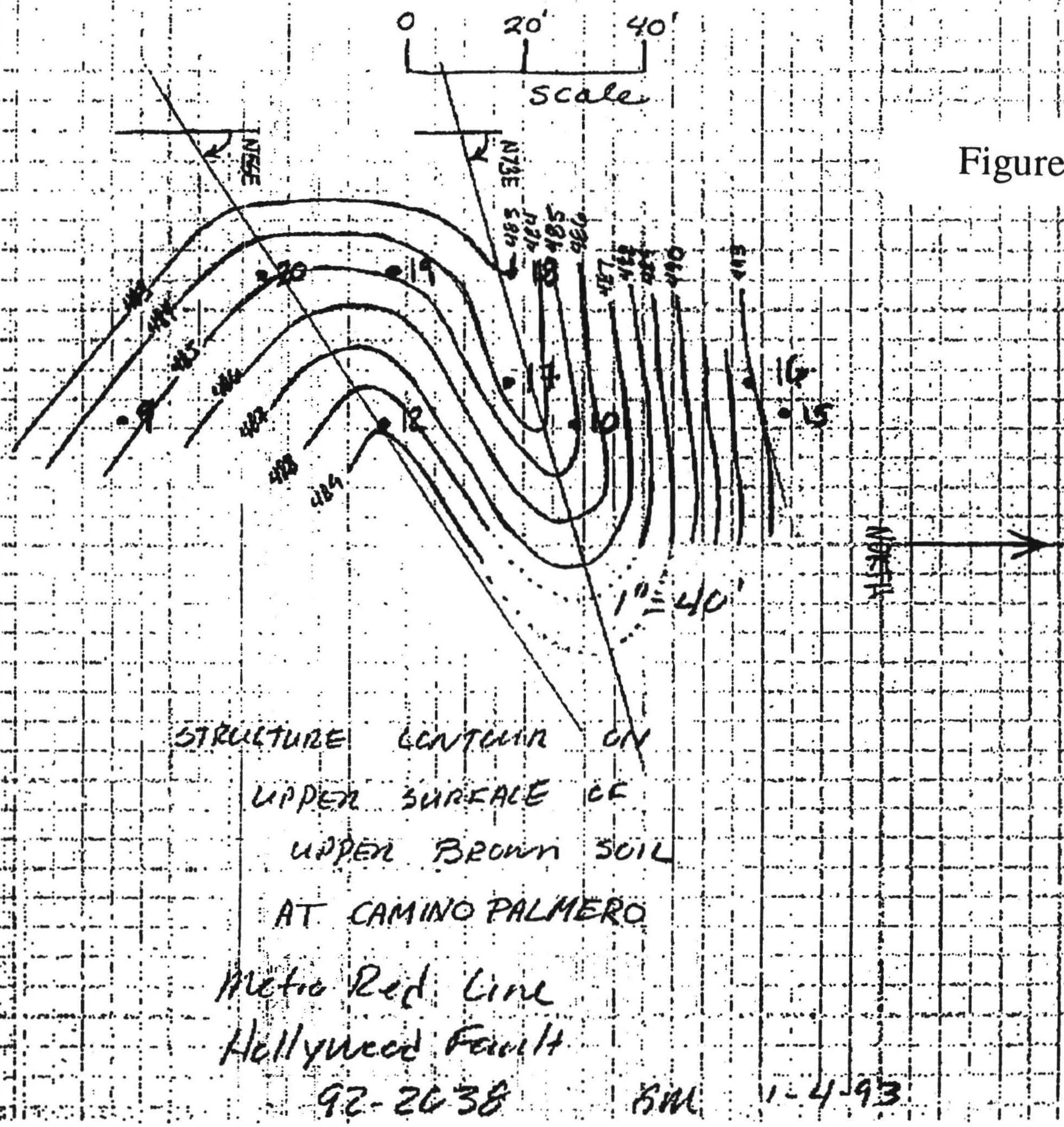
Figure 1a



SUNSET
BLVD
SILVER LAKE
WESTERN AVE
NORMANDIE AVE
VERMONT AVE
101
BEVERLY
BLVD
MACARTHUR
ECHO
PARK
S.L.
FAULT (?)
THIRD
ST
PARK
FAULT
ALVARADO
WILSHIRE
BLVD
OLYMPIC
BLVD
JFD/KS 1-93

Figure 6


0
20'
40'
scale
N56E
N73E
NORTH
1" = 40'
STRUCTURE CONTOUR ON
UPPER SURFACE OF
UPPER BROWN SOIL
AT CAMINO PALMERO
Metro Red Line
Hollywood Fault
92-2638
KM 1-4-93

Appendix One

BETA ANALYTIC INC.

JERRY J. STIPP, PH.D.
MURRY A. TAMERS, PH.D.
CO-DIRECTORS

4985 S.W. 74 COURT
MIAMI, FLORIDA
33155 U.S.A.

REPORT OF RADIOCARBON DATING ANALYSES

FOR: James F. Dolan
California Institute of Technology

DATE RECEIVED: November 3, 1992
DATE REPORTED: November 25, 1992
SUBMITTER'S PURCHASE ORDER #

OUR LAB NUMBER	YOUR SAMPLE NUMBER	C-14 AGE YEARS B.P. ± 1σ	
Beta-57674 CAMS-4148	HF C-2	1230 +/- 70 BP	(charcoal)
Beta-57675 CAMS-4149	HF C-3	1230 +/- 70 BP	(charcoal)
Beta-57676 CAMS-4150	HF C-4	300 +/- 70 BP	(charcoal)
Beta-57677 CAMS-4151	B-16 HFZ 7'	3170 +/- 70 BP	(charcoal)
Beta-57681 CAMS-4152	B-31 HFZ 21'	16760 +/- 90 BP	(charcoal)

Note: these samples were done using the AMS technique. The reported dates have been adjusted by carbon 13.

These dates are reported as RCYBP (radiocarbon years before 1950 A.D.). By international convention, the half-life of radiocarbon is taken as 5568 years and 95% of the activity of the National Bureau of Standards Oxalic Acid (original batch) used as the modern standard. The quoted errors are from the counting of the modern standard, background, and ... analyzed. They represent one standard deviation statistics (68% probability), based on the random nature

... These dates are reported as RCYBP (radiocarbon years before 1950 A.D.). By international convention, the half-life of radiocarbon is taken as 5568 years and 95% of the activity of the National Bureau of Standards Oxalic Acid (original batch) used as the modern standard. The quoted errors are from the counting of the modern standard, background, and sample being analyzed. They represent one standard deviation statistics (68% probability), based on the random nature of the radioactive disintegration process. Also by international convention, no corrections are made for DeVries effect, reservoir effect, or isotope fractionation in nature, unless specifically noted above. Stable carbon ratios are measured on request and are calculated relative to the PDB-1 international standard; the adjusted ages are normalized to -25 per mil carbon 13.

BETA ANALYTIC INC.

MURRY A. TAMERS, PH.D.
JERRY J. STIPP, PH.D.
CO-DIRECTORS

4985 S.W. 74 COURT
MIAMI, FLORIDA
33155 U.S.A

November 25, 1992

Dr. James F. Dolan
California Institute of Technology
Seismological Laboratory
Pasadena, CA 91125

Dear Dr. Dolan:

Please find enclosed the results on five very small charcoal samples recently submitted for radiocarbon dating analyses using the AMS (Accelerator Mass Spectrometry) technique. The other seven samples from this group were canceled.

Your charcoals were pretreated by first examining for rootlets. The samples were then given a hot acid wash to eliminate carbonates. They were repeatedly rinsed to neutrality and subsequently given a hot alkali soaking to take out humic acids. After rinsing to neutrality, another acid wash followed and another rinsing to neutrality. The samples were combusted in an enclosed system. The carbon dioxides collected were purified and reacted with hydrogen on cobalt catalysts to produce graphite. The AMS measurements were made in the Lawrence Livermore National Laboratory in California (CAMS). The chemical pretreatments and target material conversions were done at Beta Analytic. In discussing the dates in reports or papers, both the Beta- and CAMS- numbers should be cited.

We are enclosing our invoice. Would you forward this to the appropriate office for payment. We had originally sent an advance invoice for all thirteen AMS samples in this group, but, since seven of them were canceled, we thought you might want another invoice.

Sincerely yours,

Murry Tamers

Murry Tamers, Ph.D.
Co-director

P.S. We are sending this letter and the date report sheet by fax in addition to regular air mail.

APPENDIX E

MAY 21, 1993 LETTER TO LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS

CALIFORNIA INSTITUTE OF TECHNOLOGY

DIVISION OF GEOLOGICAL AND PLANETARY SCIENCES 170-25

June 3, 1993

Mr. Paul Guptill
Earth Technology Corporation
13900 Alton Parkway
Suite 120
Irvine, CA 92718

Dear Paul,

Here is a copy of the letter that I recently sent to Los Angeles County explaining the rationale for our research in their storm drain trenches. It includes all of the basic data and conclusions from our trench studies. Kerry Sieh will use these data to formulate his final report to MetroRail when he returns on July 10.

As I mentioned to you on the phone this afternoon, the basic conclusion from the Vista Street trench, which I believe crossed directly over the main strand of the Hollywood fault, is that the fault has not experienced a surface-rupturing earthquake in at least one-to-two thousand years. Age constraints are based on preliminary soil age determinations conducted in the trench by Professor Tom Rockwell of San Diego State. While the data are not definitive concerning the recent seismic history of the Hollywood fault, they suggest that the fault has very long recurrence intervals measurable in terms of thousands, rather than hundreds, of years. If I can provide any additional information or answer any questions please call me at (818) 356-6984.

Please note that Figure 2 in the letter is labeled Figure 3 (map); Figure 3 in the letter is labeled Figure 5 (Vista Street log); Figure 4 in the letter is labeled Figure 3. Figure 1 in the letter is labeled Figure 1. This is a compilation map that I just put together about two weeks ago. It represents a synthesis of recent mapping by SCEC researchers of active surficial structures. Slip rates are from Rockwell's work. Note that reference 'Yerkes and Jones, 1989' should read 'Ziony and Jones, 1989'.

Sincerely,

James F. Dolan
Post-Doctoral Research Fellow
Seismological Laboratory
Caltech 252-21
Pasadena, CA 91125

PASADENA, CALIFORNIA 91125
TELEPHONE (818) 356-6109; TELEX 188192 OR 675425; TELEFAX (818) 568-0935

CALIFORNIA INSTITUTE OF TECHNOLOGY

SEISMOLOGICAL LABORATORY 252-21

May 21, 1993

Mr. Gary Johnson
Los Angeles County
Department of Public Works
900 South Fremont Avenue, 8th Floor
Alhambra, CA 91803-1331

Dear Mr. Johnson,

First of all, I would like to thank the Los Angeles County Department of Public Works for allowing me access to your storm drain excavation on Vista Street in Hollywood. I would also like to thank you personally for facilitating my research in the trench. This letter details the results of this research and explains in detail why we requested deepening and partial re-excavation of a portion of the trench on April 4, 1993.

As you know, Caltech professor Kerry Sieh and I have been studying the seismic hazard potential of the Hollywood fault for the past two years. Very little is known about the earthquake potential of this fault, which runs E-W along the base of the Hollywood Hills, from northern Beverly Hills through downtown Hollywood to the Los Angeles River. Our previous studies have focused on an examination of evidence of past earthquake activity preserved in abnormal contours in the ground surface--the seismic 'signature' of the fault, if you will. These ground surface studies (known as geomorphology), in conjunction with collaborative work we have done as consultants for the MetroRail Red Line project, have allowed us to map out the location of the Hollywood fault in unprecedented detail (Figure 1). Our mapping indicated to us that the main trace of the Hollywood fault crosses perpendicular to Vista Street about halfway between Franklin and Hillside Avenues (Figure 2).

One of the principal means by which geologists assess the seismic hazard potential of a fault is by studying its past earthquake history, with the assumption that past earthquake behavior will provide important insights into the future behavoir of the fault. These so-called 'paleoseismologic' studies focus on extremely detailed mapping of trench exposures, typically 15-18 feet deep, cut across the fault. Based on our knowledge of where the Hollywood fault crossed your proposed excavation, we requested permission from Los Angeles County to examine the walls of the Vista Street trench.

Although we are confident that the Hollywood fault crosses your trench route well north of Franklin Avenue, I logged the entire 1225' trench length from Hollywood Boulavard north in order to provide a wider perspective of any potential seismic deformation (e.g.,warping or folding of sedimentary layers) as well as to collect as many datable charcoal samples as possible (Figure 2). To state our conclusions at the outset, the trench appears to have passed directly over the Hollywood fault without revealing any paleo-earthquake deformation. In other words, because of high alluvial fan sedimentation rates in the area, the trench only exposed sediments that have been deposited since the most recent earthquake on the Hollywood fault; it was not deep enough to see evidence of the most recent earthquake. While this may seem at first to be a disappointing result, the absence of any earthquake-related features in the 10-13 foot-deep trench tells us that a significant period of time has elapsed since the most recent earthquake. Judging by preliminary soil age analyses by Dr. Thomas Rockwell of San Diego State University, at least one to two thousand years have elapsed since the last event. Although the age of the last event is not well constrained by the trench results, this minimum age for the last event has extremely important implications for our understanding of the seismic hazards affecting the Los Angeles metropolitan area. This is because the Hollywood fault does not represent the only seismic hazard in the northern Los Angeles basin. The Hollywood fault, by itself, is probably capable of producing a M=6-6.5 earthquake. Although an earthquake of this size would cause significant damage in the Hollywood-Los Angeles area, it is by no means the most important hazard affecting the area. In fact, we believe that a major fault buried several miles beneath Hollywood represents the most important seismic hazard in the area.

PASADENA, CALIFORNIA 91125 TELEPHONE (818) 356-6912

The 1987 M=5.9 Whittier Narrows earthquake revealed the existance of an entirely new class of active faults beneath Los Angeles. The fault that broke in this earthquake, which dips shallowly to the north several miles below the Whittier Narrows-Montebello Hills area east of downtown Los Angeles, does not reach the surface. Instead, earthquake deformation is manifested at the surface by the growth of large folds, seen today as the East LA-Montebello Hills. The southern part of the Montebello Hills grew about two inches during the 1987 earthquake. Subsequent studies have shown that this buried thrust fault extends at least as far west as Century City, and probably even farther west beneath the Malibu Coast. The great length of this fault(s) suggest that it may be capable of producing at least a M=7 earthquake directly beneath Los Angeles. As yet, virtually nothing is known about the earthquake behavior of these buried thrust faults (also called blind thrust faults). Obviously, understanding how (and when) these faults are likely to break represents a high priority in our research. Unfortunately, because of their inaccessibility these buried faults are very difficult to study, and we are required to search out indirect methods of studying their sesimic hazard potential.

One of the most promising methods that we have been pursuing involves the study of surface faults that we believe are mechanically linked to the buried thrust faults, based on the assumption that these faults rupture co-seismically with the larger buried fault during major thrust fault earthquakes. The Hollywood fault represents one such related surface fault. The earthquake history of surface faults like the Hollywood fault (or the San Andreas fault) is relatively easy to study in trenches. Obviously, we cannot use these methods to study the earthquake history of the buried thrust faults, which stop several miles below the surface. We believe, however, that the Hollywood fault may break co-seismically with the main buried thrust fault. The earthquake history of the Hollywood fault may therefore be used as a 'proxy' for the earthquake history of the main buried fault.

Placed in this context, our data concerning the minimum elapsed time since the most recent Hollywood fault earthquake has important implications concerning the earthquake behavior of the buried fault. If our assumption that the Hollywood and buried faults are mechanically linked is correct, then our initial estimate of at least one to two thousand years since the most recent surface rupture suggests that the buried fault may break very infrequently. This is both good news and bad news. It is good news because with repeat times of several thousand years the likelihood of a major event occurring within our lifetime or the lifetime of any structures that we might construct is very small. However, let me remind you that some of the faults that ruptured in last summer's M=7.4 Landers event appear not to have ruptured for several thousand years. Our result is bad news when one considers that the longer the time between earthquakes on a fault, the more strain is built up and the larger the earthquake is likely to be. In summary, our results suggest the possibility of extremely rare, but possibly very large, earthquakes on the buried thrust fault beneath Los Angeles.

Having explained why we wished to study the Vista Street trench, I would now like to explain the specifics of our request to deepen and partially re-excavate a portion of the trench north of Franklin Avenue on April 4, 1993. I have reproduced a portion of the trench log covering the presumed crossing of the Hollywood fault trace, which we estimated was between 820' N and 960' N (Figure 3). All distances are in feet north of the northern edge of the sidewalk along the northern side of Hollywood Boulavard. I logged the trench at a scale of 1:48, assisted during the presumed crossing of the fault by Dr. Kerry Sieh, Dr. Thomas Rockwell, and Mr. Grant Miller of the Earth Technology Corporation.

As you can see from the log, we exposed two distinct buried soil horizons beneath the very weakly developed surface soil. Soil development requires time, and the degree of development provides a first-order age for the soil. The surface soil and the uppermost buried soil (soil 2 in Figure 3) have a combined age of only a few thousand years, possibly only two thousand years. They overlie a much better developed reddish-brown soil (soil 3 in Figure 3) that probably required at least 5,000 years to develop (Note: All soil age determinations are provided by Dr. Thomas Rockwell and all are preliminary, being based solely on his examination of the soils at the exposure). Unfortunately, because of the shallowness of the trench, soil 3 was not exposed continuously across the fault zone. I would also like to note that differences between the soils were difficult to recognize at times, due to the similarity in soil parent materials and the speed with which we were logging the trench walls.

The top of buried soil 2 is somewhat irregular due to channelization, but the original ground surface can still be discerned. Both north and south of the portion of the trench shown in Figure 3 this soil has a rather flat upper surface roughly parallel to the ground surface. The most pronounced change in the surface of this soil occurs at 895' N, where the soil surface exhibits an inflection point between a southern segment dipping slightly more steeply than the ground surface and a northern segment dipping more shallowly than the ground surface. We noticed the southern segment while in the trench and postulated that we were just south of the main fault trace. When the next section of trench was excavated to the north (905' N to 928'

N), it appeared to us that the top of soil 2, projected from the slope of the soil 2 surface between 867' N and 895' N, was approximately six feet lower than expected at 915' N to 920' N. This suggested to us a 6-foot, down-to-the-north displacement along a fault. This is exactly the relationship we would have expected, based on the results of work that we conducted with MetroRail and the Earth Technology Corporation on Camino Palmero (one block east of Vista Street). By the time we realized this, the Bubalo Construction crew had already laid two lengths of pipe and backfilled the critical area of trench that we needed to examine. We therefore requested that the already laid pipe length between 900' N and 908' N be removed, and that the trench be deepened several feet below grade, both of which you kindly allowed us to do. The results were interesting, and although we did not find evidence of the fault, we did resolve the ambiguity in the data. First of all, the soil at 915' N to 920' N, which we were corellating with the top of soil 2, is in fact soil 3, which up to that point had only been recognized in a deep man-hole pit at 820' N to 825' N. With the removal of the pipe and deepening of the trench we were able to determine that soil 3 extended continuously beneath soil 2 at least as far south as 870' N. Soil 2 is apprently not cut by any faults, suggesting that it has formed since the most recent surface faulting on the Hollywood fault. However, soil-forming processes could have obliterated any evidence of faulting within soil 2 in only one to two thousand years. Similarly, although soil 3 did not reveal any evidence of surface faulting, soil-forming processes may have obliterated any evidence. The only potentially fault-related feature that we observed inthe trench was one carbonate-filled vein at 918' N, 12-13' depth. This vein was highly irregular in plan view and may be a soil-related feature. The top of soil 3, though not continuously exposed across the fault zone due to its depth, does not appear to be offset vertically. In summary, we were unable to detect any evidence of faulting in the buried soils exposed across our estimated Hollywood fault crossing. This statement could not have been made had we not gone back and re-excavated the trench from 895' N to 925' N. While not definitive, because of discontinuous exposure of the deepest units, we did rule out the possibility of very recent earthquake rupture, based on the absence of faulting in buried soil 2. Based on the data we were able to collect, we can say that it appears to have been at least one to two thousand years since the most recent ground-rupturing earthquake on the Hollywood fault.

In addition to the data from the Vista Street trench, I have also included a copy of the trench log I made last fall in the northern half of the Fuller Street trench. Although we learned of your trenching program too late to examine the southern half of the Fuller Street trench, which we believe included the crossing of the main strand of the Hollywood fault, we were able to log the northern half of the trench. This trench exposed a secondary northern strand of the Hollywood fault north of Hillside Avenue (see Figure 2 for trench location). This 1 m-wide fault zone juxtaposed basal granodiorite with brown, massive, clayey alluvium, which was in turn overlain by friable, yellow-brown, well-bedded alluvium. The fault extended at least one meter into the brown alluvium, but its upward termination could not be determined because of time constraints. The young channel that is incised into the brown alluvium just south of the fault trends S50E and does not appear to be offset by the fault, which strikes N59E and dips 70^{o}NW. We collected three charcoal samples from the base of channel in the youngest alluvium, and one sample from the upper part of the brown alluvial unit (Figure 4). Of these, two samples (C-2 and C-3) from the base of the channel yielded 1200 year-old C^{14} ages. Because the channel deposit does not appear to be offset by the fault, these age data suggest that this strand of the Hollywood fault has not slipped in at least 1200 years. Unfortunately, the charcoal sample from within the faulted brown alluvial unit yielded an anomalous 300 year-old age, suggesting that it was collected from a burrow that remained unrecognized during our rapid mapping of the trench. Thus, we have no direct age control on the faulted brown alluvium, and the 1200 year age represents a minimum age for the most recent ground-rupturing earthquake on this strand of the Hollywood fault zone.

I hope this letter explains our motivations and results to your satisfaction. If I can answer any questions please call me at (818) 356-6984. Thank you again for all you assistance with the trench logistics.

Sincerely,

James F. Dolan
Post-Doctoral Research Fellow in Geology
Seismological Laboratory
Caltech 252-21
Pasadena, CA 91125

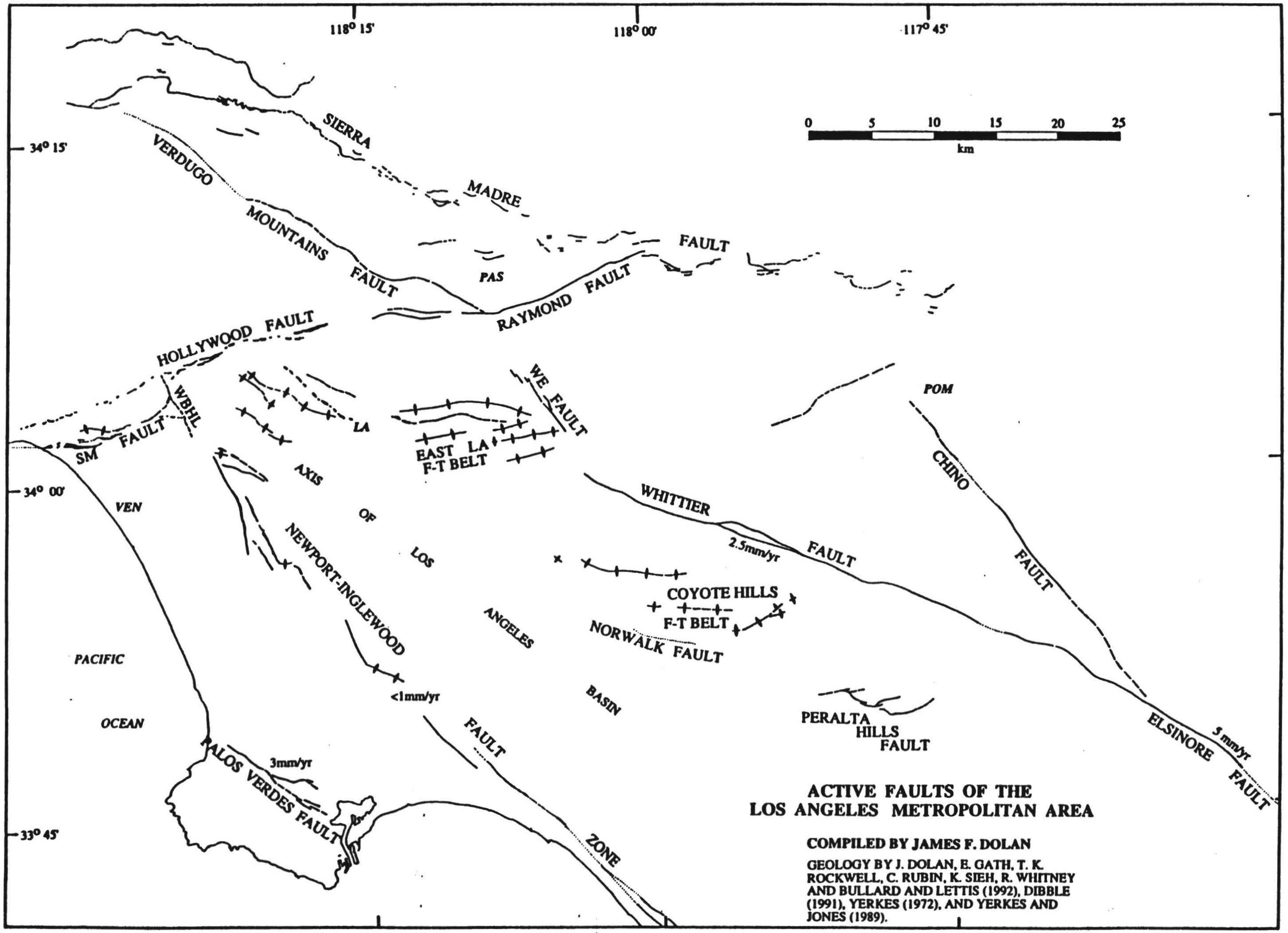
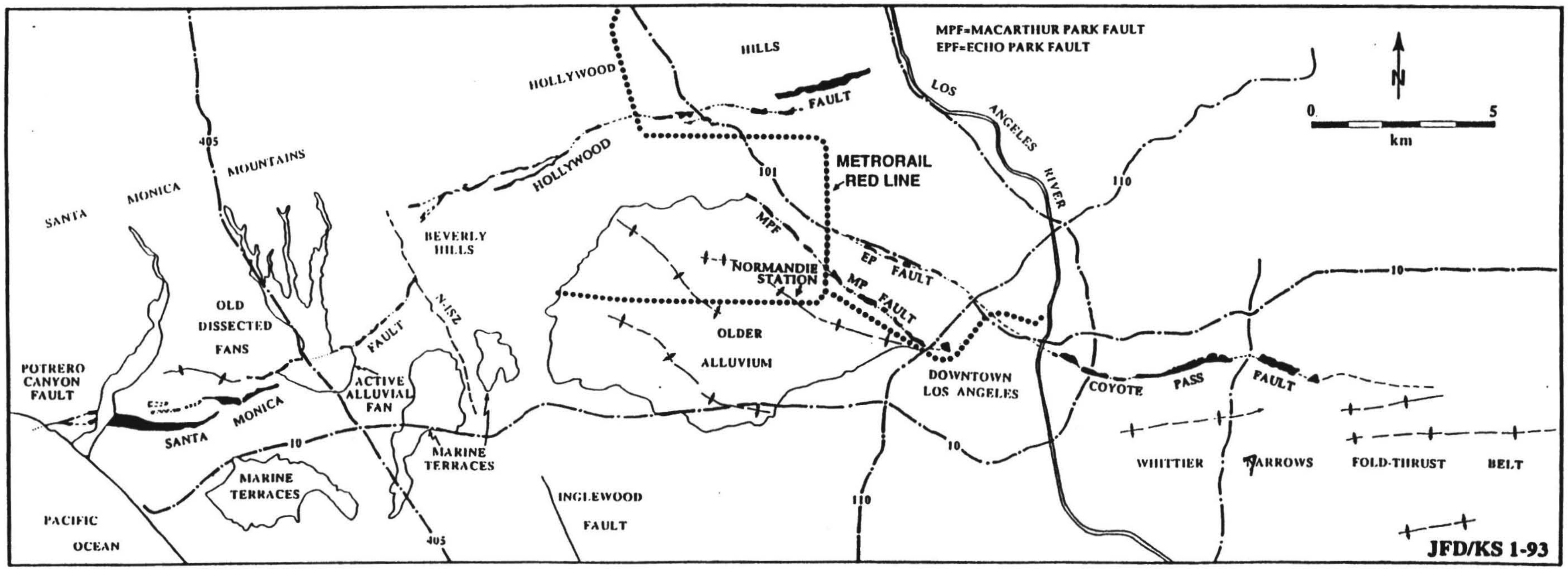

118° 15'
118° 00'
117° 45'
34° 15'
34° 00'
33° 45'
0 5 10 15 20 25
km
SIERRA
MADRE
FAULT
VERDUGO
MOUNTAINS
FAULT
PAS
RAYMOND FAULT
HOLLYWOOD FAULT
WBHL
SM FAULT
LA
EAST LA
F-T BELT
WE FAULT
POM
CHINO
FAULT
AXIS
OF
LOS
ANGELES
BASIN
WHITTIER
2.5mm/yr
FAULT
VEN
NEWPORT-INGLEWOOD
COYOTE HILLS
F-T BELT
NORWALK FAULT
PACIFIC
OCEAN
<1mm/yr
FAULT
ZONE
PALOS VERDES FAULT
3mm/yr
PERALTA
HILLS
FAULT
ELSINORE
5 mm/yr
FAULT
ACTIVE FAULTS OF THE
LOS ANGELES METROPOLITAN AREA
COMPILED BY JAMES F. DOLAN
GEOLOGY BY J. DOLAN, E. GATH, T. K. ROCKWELL, C. RUBIN, K. SIEH, R. WHITNEY AND BULLARD AND LETTIS (1992), DIBBLE (1991), YERKES (1972), AND YERKES AND JONES (1989).

Figure 1

Figure 1


MPF=MACARTHUR PARK FAULT
EPF=ECHO PARK FAULT
HILLS
HOLLYWOOD
FAULT
HOLLYWOOD
METRORAIL
RED LINE
LOS ANGELES RIVER
0
5
km
SANTA MONICA MOUNTAINS
405
101
110
BEVERLY HILLS
MPF
EP FAULT
NORMANDIE STATION
MP FAULT
OLD DISSECTED FANS
FAULT
N-ISZ
OLDER ALLUVIUM
10
POTRERO CANYON FAULT
ACTIVE ALLUVIAL FAN
DOWNTOWN LOS ANGELES
COYOTE PASS FAULT
SANTA MONICA
MARINE TERRACES
MARINE TERRACES
WHITTIER NARROWS FOLD-THRUST BELT
INGLEWOOD FAULT
PACIFIC OCEAN
JFD/KS 1-93

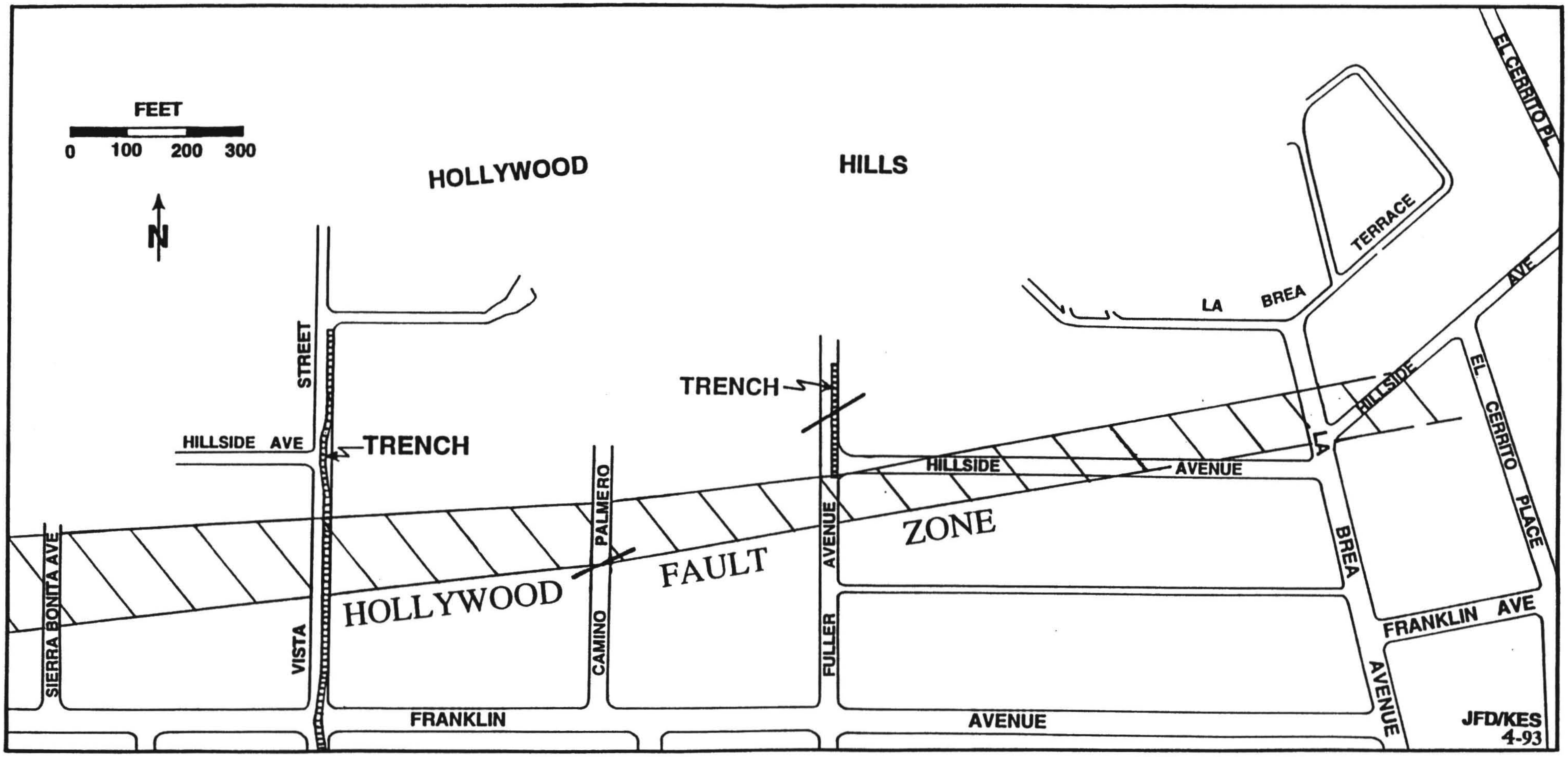
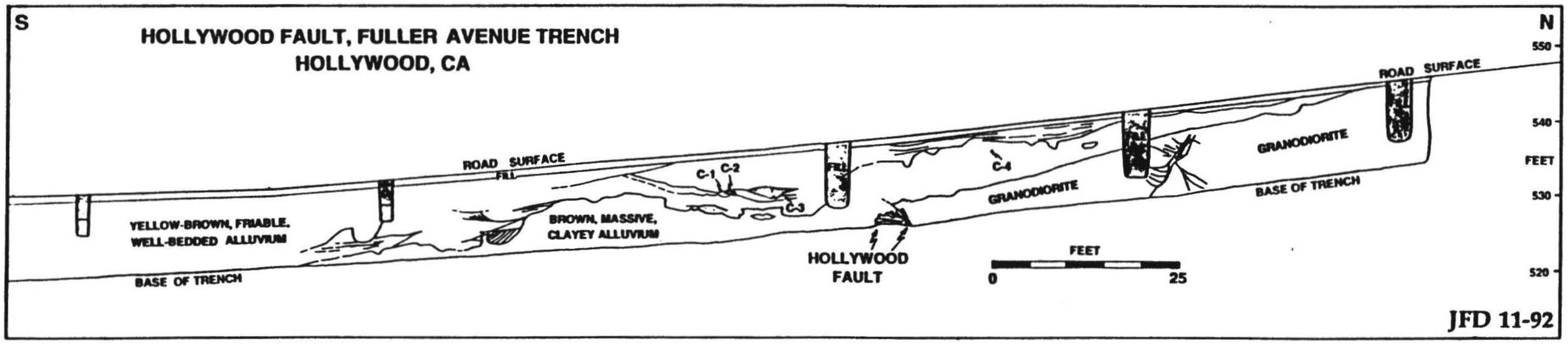

FEET
0
100
200
300
N
HOLLYWOOD
HILLS
TERRACE
EL CERRITO PL.
LA BREA
AVE
STREET
TRENCH
HILLSIDE AVE
TRENCH
PALMERO
HILLSIDE
AVENUE
HILLSIDE
LA
EL CERRITO PLACE
SIERRA BONITA AVE
AVENUE
ZONE
FAULT
HOLLYWOOD
BREA
FRANKLIN AVE
VISTA
CAMINO
FULLER
AVENUE
FRANKLIN
AVENUE
JFD/KES
4-93

Figure 3



S
N
HOLLYWOOD FAULT, FULLER AVENUE TRENCH
HOLLYWOOD, CA
550
540
530
520
FEET
ROAD SURFACE
FILL
ROAD SURFACE
C-1
C-2
C-3
C-4
YELLOW-BROWN, FRIABLE, WELL-BEDDED ALLUVIUM
BROWN, MASSIVE, CLAYEY ALLUVIUM
GRANODIORITE
GRANODIORITE
BASE OF TRENCH
BASE OF TRENCH
HOLLYWOOD FAULT
FEET
0
25
JFD 11-92

Figure 4

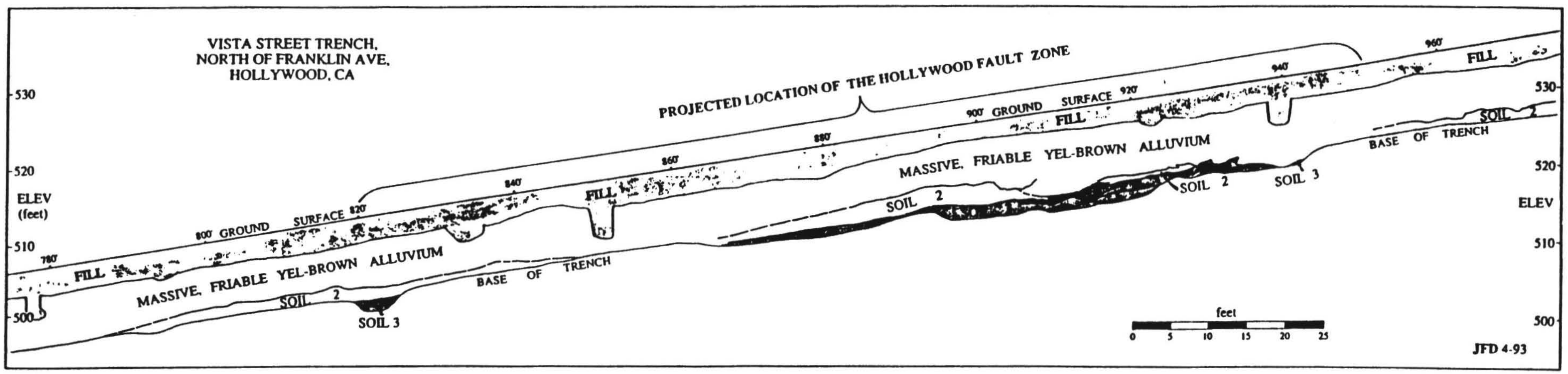
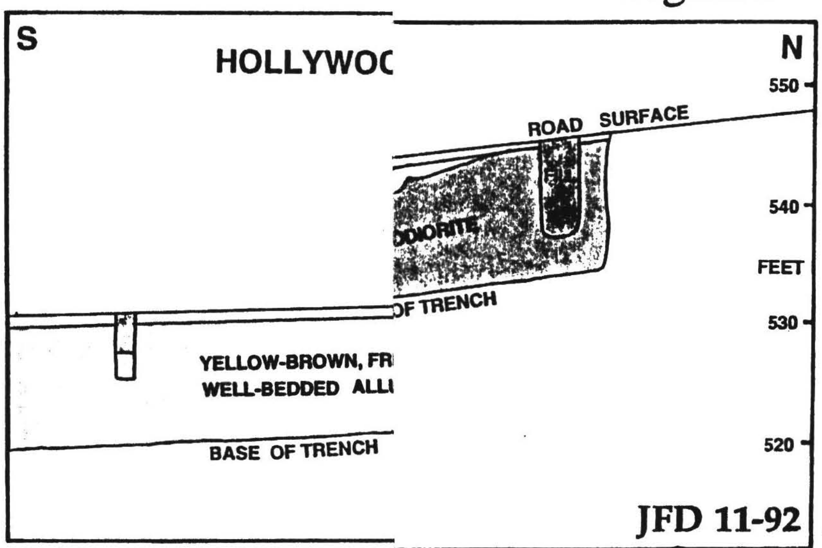

VISTA STREET TRENCH,
NORTH OF FRANKLIN AVE,
HOLLYWOOD, CA
PROJECTED LOCATION OF THE HOLLYWOOD FAULT ZONE
530
520
510
500
ELEV
(feet)
780'
800' GROUND SURFACE 820'
840'
860'
880'
900' GROUND SURFACE 920'
940'
960'
FILL
MASSIVE, FRIABLE YEL-BROWN ALLUVIUM
BASE OF TRENCH
SOIL 2
SOIL 3
feet
0 5 10 15 20 25
JFD 4-93

Figure 5

Figure 5


S
HOLLYWOO
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ROAD SURFACE
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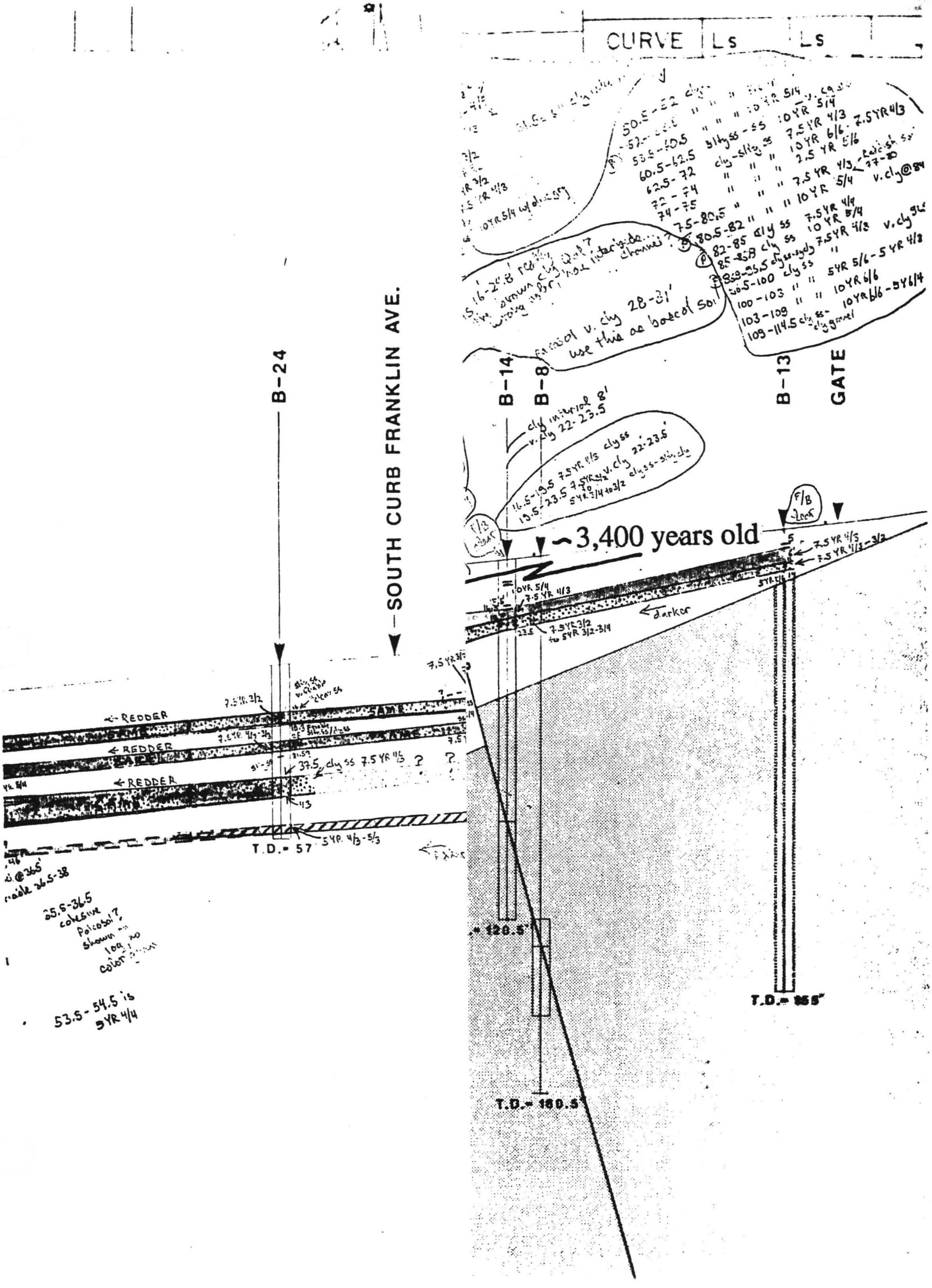
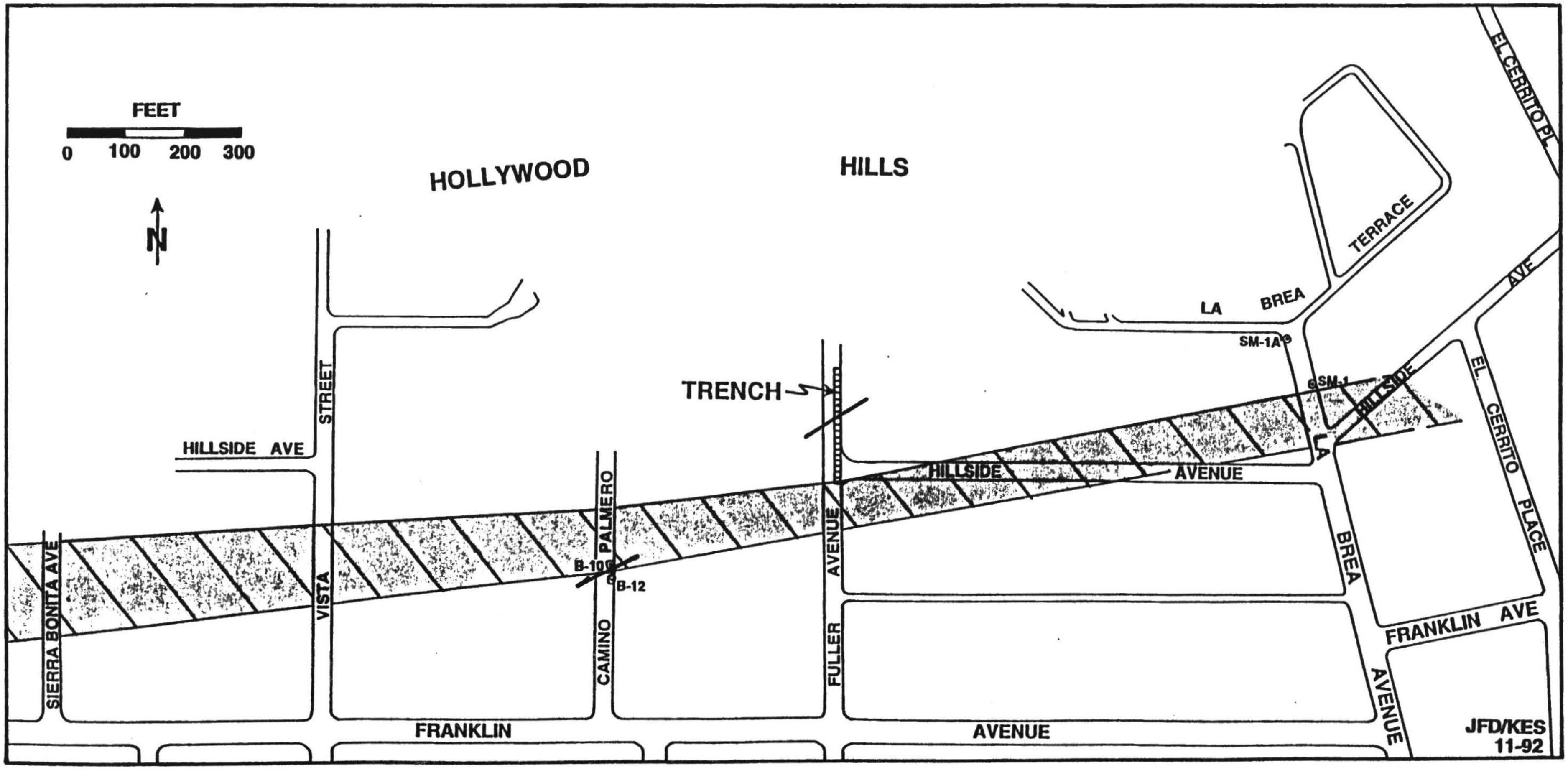
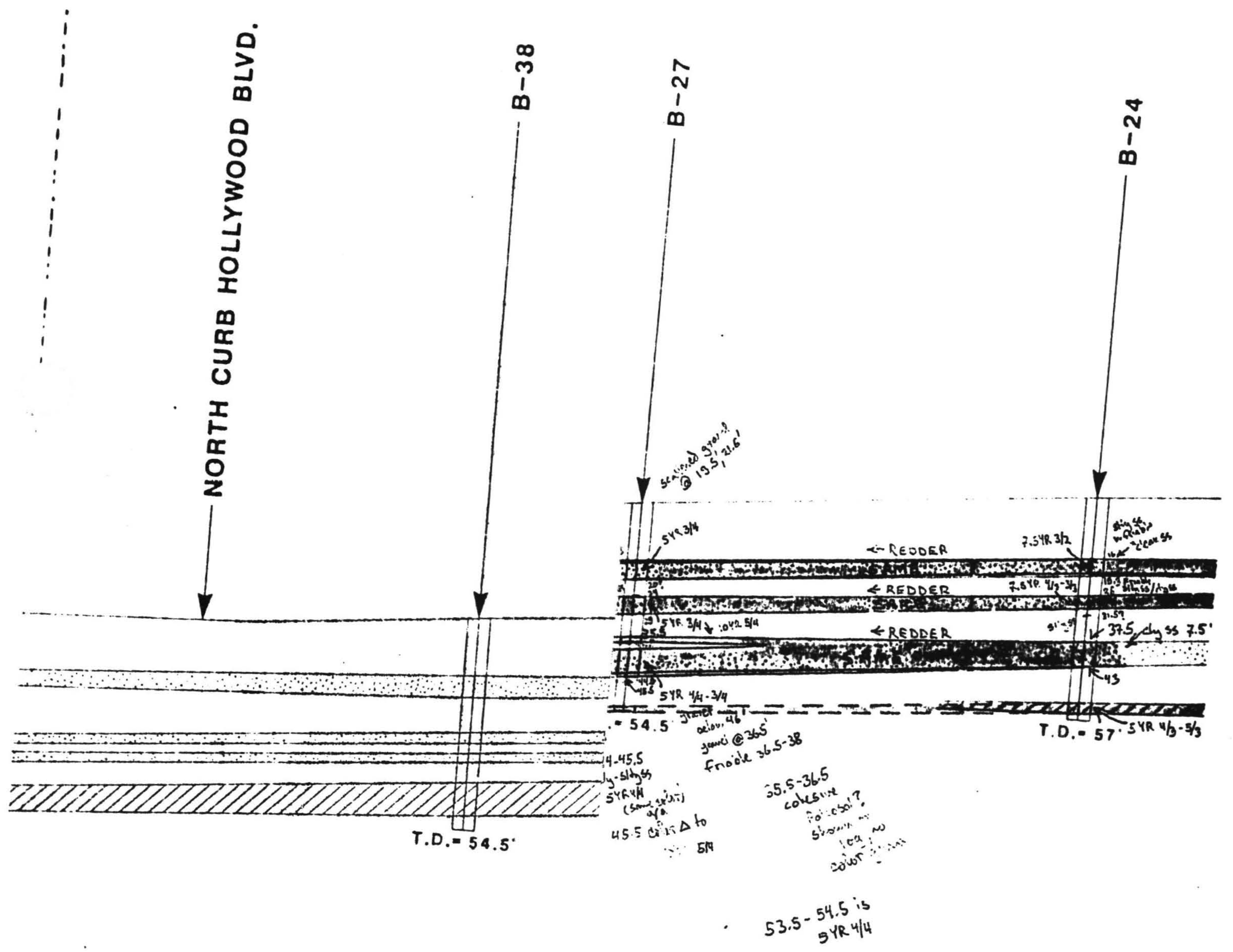
OF TRENCH
YELLOW-BROWN, FR
WELL-BEDDED ALL
BASE OF TRENCH
JFD 11-92



CURVE
Ls
Ls
B-24
SOUTH CURB FRANKLIN AVE.
B-14
B-8
B-13
GATE
~3,400 years old
REDDER
REDDER
REDDER
darker
T.D.= 57
T.D.= 120.5'
T.D.= 180.5'
use this as basal soil
53.5 - 54.5 is 5YR 4/4

Figure 4


FEET
0 100 200 300
N
HOLLYWOOD
HILLS
HILLSIDE AVE
VISTA STREET
CAMINO PALMERO
B-10
B-12
TRENCH
FULLER AVENUE
HILLSIDE AVENUE
LA BREA
SM-1A
SM-1
TERRACE
EL CERRITO PL.
HILLSIDE AVE
LA BREA AVENUE
EL CERRITO PLACE
FRANKLIN AVE
SIERRA BONITA AVE
FRANKLIN AVENUE
JFD/KES
11-92



NORTH CURB HOLLYWOOD BLVD.
B-38
B-27
B-24
← REDDER
← REDDER
← REDDER
5YR 3/4
7.5YR 3/2
5YR 4/4 - 3/4
T.D. = 54.5'
T.D. = 57'
5YR 4/3 - 5/3
54.5
53.5 - 54.5 is
5YR 4/4

DUE DATE	DUE DATE