WESTSIDE SUBWAY EXTENSION PROJECT

Contract No. PS-4350-2000

Response to Leighton Consulting Report

Prepared for:

Metro

Prepared by:

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May 14, 2012

1.0 INTRODUCTION

Leighton Consulting, Inc., was retained by the Beverly Hills Unified School District to *"complete an assessment of possible fault presence and activity at Beverly Hills High School (BHHS) campus located in western Beverly Hills, California."* As authorized by the Beverly Hills School District (BHUSD), Leighton states they undertook a several-phase investigation to *"critically assess"* the possible presence of active faults associated with the West Beverly Hills Lineament (WBHL). In particular, Leighton states their investigation was designed *"to confirm or reject the Parsons (2011b) [Westside Subway Extension Fault Report] fault interpretation."* Leighton's results were presented in a report titled *"Fault Hazard Assessment of the West Beverly Hills Lineament, Beverly Hills High School, 241 South Moreno Drive, Beverly Hills, California,"* hereafter referred to as the "Leighton report."

Metro has received and reviewed the Leighton report. The Leighton investigation provides welcome new data to help constrain the locations of identified faults within the WBHL, beneath and adjacent to BHHS. However, **there is nothing in the Leighton report data that contradict Metro's conclusion that there is no safe location to site a station on Santa Monica Boulevard in Century City**.

Leighton's investigation included the excavation of 4 trenches, 21 continuous core borings, and 12 cone penetrometer tests (CPT). The locations are shown on Figure 1 along with Metro's borings, CPTs, and geophysical transect locations. In addition to reviewing Leighton's report, Metro's team and the Leighton team had the opportunity to study each other's recovered cores from their respective borings and share some of the raw data. The Leighton team reviewed Metro's cores on January 25 and February 22, 2012. The Metro team reviewed Leighton's cores on April 30, May 1, and May 10, 2012. However, although Metro received copies of trench wall photographs and Leighton's interpretation of the trench sidewall geology, Metro's team was denied access to the trenches for an independent evaluation.

Metro compiled and correlated the new Leighton data with its prior data. It is noted that: (1) Metro's Lakewood formation and San Pedro formation were combined into one unit, called the San Pedro formation in this report, for the purpose of facilitating consistent correlation between the two groups, and (2) lines depicting faults on Metro's maps represented approximate locations. The data points constraining the fault locations are far enough apart that actual fault locations may be tens of feet different, laterally, than the lines shown on the maps. As additional data are acquired (e.g., those provided by Leighton), these fault locations have been more accurately constrained, as shown on Figure 1.

The following summarizes Metro's response to the Leighton Report in which Metro takes issue with a number of Leighton's comments and conclusions. A more detailed response follows this section:

- Metro's compilation of the Leighton data, Metro data, and older geotechnical borehole data confirm that the WBHL is a NNW-trending zone of right lateral strike slip faults. This is consistent with the strike of small faults exposed in the Leighton trenches (e.g., trench T-3), which also exhibited evidence for strike-slip.
- Leighton appears to confuse the generally east-facing topographic escarpment that defines the eastern edge of the WBHL with the actual strike slip fault strands of the Northern Newport-Inglewood Fault Zone (NIFZ) in the Century City area. As with most of the topographic uplifts along the NIFZ, the strike-slip fault strands in the Century City area lie within the uplifted region to the west of the topographic scarp.

- Metro's compilation of all available borehole and CPT data from the Century City area reveals strong evidence for a major NNW-trending strike-slip fault along or just west of the Beverly Hills city limit with approximately 350 to 400 feet of right-lateral offset across the top of the underlying San Pedro formation. The fault is located along one of the main strands identified in the original Metro fault report (2011).
- Leighton's statement on the absence of active faults within BHHS cannot be substantiated because they did not excavate trenches continuously across the entire zone of faulting associated with the WBHL and across several of the strands identified by Metro within BHHS.
- Metro's previous reports have made no recommendations regarding the State's Alquist-Priolo Act. This issue is under the purview of the California Geological Survey and the California Alfred E. Alquist Seismic Safety Commission. However, the WBHL is shown on State of California fault maps as a Holocene active fault.
- Leighton conducted 12 CPT soundings to depths of 91 feet. However, no discussion on the implications of the CPT data or Metro CPT data is provided. The addition of the Leighton CPT data to those collected earlier by Metro strengthens evidence for several faults extending through the BHHS campus.
- As stated in the introduction, there is no new information in the Leighton report that contradicts the conclusion that there is no safe location to site a station on Santa Monica Boulevard in Century City.

More detailed commentary is provided below.

2.0 LEIGHTON COMMENTS AND METRO RESPONSES

Leighton: ***"Although the WBHL has been recognized since early 1990, it was not clear if its origin related to faults or to other geologic processes."***

Metro Response: Here and elsewhere in their report (e.g., Section 3.1.2), Leighton confuses the generally east-facing topographic escarpment that defines the eastern edge of the WBHL with the actual strike-slip fault strands of the Northern NIFZ in the Century City area. This is incorrect and represents a misunderstanding of the significance of this topographic feature. The West Beverly Hills Lineament separates the higher, more dissected topography to the west from the lower-lying, gently south-sloping alluvial plain to the east. As with most of the topographic uplifts along the NIFZ between Long Beach and the Baldwin Hills (e.g., Baldwin Hills, Rosecrans Hills, Dominguez Hills), the strike-slip fault strands that comprise the Northern NIFZ in the Century City area lie to the west of the topographic scarp (Barrows 1974). The fact that the broader topographic uplift has been eroded by fluvial processes along its eastern margin in no way obviates Metro's identification of active faulting within the region west of the current topographic scarp.

As shown in Figure 2A, a compilation of all available borehole and CPT data from the Century City area reveals strong evidence for a major NNW-trending strike-slip fault with approximately 350 feet of right-lateral offset across the top of the San Pedro formation at the approximate location of one of the main strands identified in Metro's original report—approximately along or just east of the western Beverly Hills-City of Los Angeles boundary.. Note this fault passes through the proposed Santa Monica Boulevard Station. Figure 2B projects the contours to their pre-faulting position, to indicate over 300 feet of offset. Moreover, as shown in Figure 3, there are numerous clear-cut features in the topography (linear, slope-

parallel drainages, triangular facets, and aligned topographic saddles) that indicate the presence of a major strike-slip fault extending southward for more than 1.5 miles along the WBHL. In addition, as discussed below, there is abundant evidence from the subsurface data for several NNW-trending faults in the several hundred feet to the east of this main strand along and south of Santa Monica Boulevard. The fact that the major south-flowing Benedict Canyon drainage and the strike-slip faults of the NIFZ in the Century City area is not a coincidence—drainage is localized along the fault zone, especially near the southern end of the Cheviot Hills, as it eroded into the broader uplifted region through which the NIFZ extends (Figure 3).

Leighton: ***"The State Mining and Geology Board (in accordance with the Alquist-Priolo Earthquake Fault Zoning Act) defines an active fault as one that has had surface displacement within Holocene time (Bryant and Hart, 2007). However, no site-specific age determination of the soils encountered during their study and no evidence of surface displacement from WBHL faults was documented by Parsons. Based on the absence of this [sic] data it is our opinion that Parsons significantly overstates the hazard from faulting associated with the WBHL."***

Metro Response: Metro's previous reports have made no recommendations regarding the State's Alquist-Priolo Act. This issue is under the purview of the California Geological Survey and the Alfred E. Alquist Seismic Safety Commission. It is noted, however, that the WBHL is shown on State fault maps (Bryant 2005) as a Holocene active fault as defined by the California Geological Survey (fault movement within the past 11,700 years). As noted above, the new Leighton data, combined with previously collected data, provide a more comprehensive data set that confirms the presence of a zone of right-lateral strike-slip faulting along the WBHL through the Century City area. Given the urban infrastructure and logistical constraints, especially the presence of subsurface infrastructure (e.g., storm drains, water mains, gas, sewer, and electric lines), it will be impossible to confirm that all of the faults that Metro has identified along the WBHL are inactive, particularly in the area of Santa Monica Boulevard.

Metro again notes that trenching is not the single most definitive tool to determine the activity or inactivity of faults. One must integrate all lines of evidence (geomorphic, seismicity, geophysical, borings, CPT and trenching) to judge fault activity. The effectiveness of trenching to investigate faults on Santa Monica Boulevard was also discussed in Metro's April 2012 Response to Shannon and Wilson.

Leighton: ***"3.0 OBSERVATIONS AND DISCUSSION"***

Metro Response: Cross-section B-B' (Plate 4) notes 12 CPT soundings to depths of 91 feet were conducted. However, no discussion of the implications of the CPT data is provided. Cross-section B-B' is essentially the same as Transect 4 of the Metro October 19 Century City Area Fault Investigation Report. The approximate location of fault traces on Transect 4, defined in the Metro Report, is also noted on Figure 1. These trace locations were established and constrained by an evaluation of both boring and CPT data.

With respect to Leighton's Plate 4, we find it surprising that no comment is made regarding the significance of either the Leighton or Metro CPT data in relation to the appropriate fault traces. Differences in CPT end-tip and side-friction signatures (including soil behavior characteristics) between adjacent CPTs together with vertical offsets in signatures clearly define several faults. Leighton's Plate 4, however, implies the absence of faults, given the near-horizontal or slightly sloping stratigraphy they suggest. This interpretation is contradicted by the CPT data. For example, significant differences in signatures between Leighton's CPT 6 and CPT 11 slightly west of Moreno Drive clearly define the fault

mapped on the basis of Metro CPT data at this location. Similarly, differences in the signatures between Leighton's CPT 10 and CPT 8 east of Moreno Drive, clearly define the fault location defined by Metro data between the above CPT data. When all of the CPT data are combined, they provide a sufficiently dense set of data to more precisely locate these faults.

3.0 LEIGHTON CONCLUSIONS

Leighton: ***"We find direct geologic evidence that there has been no faulting associated with the WBHL at BHHS for at least 70,000 to 100,000 years ago and perhaps more than 500,000 years. We find direct geologic evidence to refute the north-south faults mapped by Parsons through BHHS. Fault trenches specifically excavated across the surface traces of these faults did not encounter evidence of active faulting."***

Metro Response: Leighton overstates their ability to confirm that these faults are inactive or do not exist. There is clear evidence from CPT, geophysical, and borehole data for several faults that extend into the BHHS property. The basic problem with Leighton's statements is that they did not excavate trenches continuously across the entire zone of faulting associated with the WBHL. Specifically, they had a 210-foot-wide gap between their FT-1 and FT-2 trenches along the approximate trend of one of the fault zones Metro identified in the subsurface data (i.e., extending southward from near the intersection of Moreno Drive and Santa Monica Boulevard approximately to the intersection of Moreno Drive and Heath Road (Figure 1)). Moreover, they had a 15-foot-wide gap in their trench FT-2 adjacent to where they found *"clay filled fractures"* in their trench. Farther south, Leighton had a 70-foot-wide gap between their FT-3 and FT-4 trenches. This gap is located along the approximate trend of the fault that extends southward from near the intersection of Moreno Drive and Santa Monica Boulevard and through the gap between their FT-1 and FT-2 trenches. Similarly, Leighton's trench FT-4 did not extend far enough to the east to intersect the surface projection of the eastern fault strand that projects to the surface near the gap within their FT-2 trench adjacent to the soil fractures. Thus, Leighton did not have continuous trench exposure across several of the strands Metro identified at the northern end of the BHHS property. In the absence of continuous trench exposure showing unbroken deposits or soils of known age, it is not possible to prove that any particular fault strand that Metro identified within the WBHL is active or inactive. Such data can only be gleaned from trenches that provide continuous exposure of the entire width of the potential fault zone. Gaps of even a few feet between adjacent trenches can result in surface faults being missed, especially when strike-slip is the primary motion.

Leighton did encounter minor faults within their trench FT-3. They suggest that these features are inactive because they are overlain by a gravel unit that appears not to be faulted, although they concede that the base of the gravel unit above one of their faults may be offset with minor slip. They also suggest that an alternative interpretation of their data is that the ***"faults"*** [Leighton's quotation marks] are ***"…the near-surface manifestation of a seismically induced liquefaction event…"*** Although Metro was not allowed to view the trench exposures, this interpretation cannot explain the observed mismatch in the thickness of the same sedimentary unit across the fault strand encountered at trench Station 0+74. Such differences in the thickness of a single stratigraphic unit across a sub-vertical fault strand require strike-slip motion. Thus, these ***"faults"*** are actually real strike-slip faults, albeit likely with small cumulative displacements, and the faults exposed in Leighton trench T-3 may in fact be inactive. This does not, however, preclude the possible presence and recent activity of faults in the areas that are not covered by the trenches.

In conclusion, **t**he Leighton data do not refute the north-south WBHL faults mapped by Metro. Their CPT, trench, and boring data support, and help refine, the locations of the mapped faults, as discussed above. The Leighton trenches may not have encountered evidence of active faulting. However the trenches are not continuous and do not extend outside of the BHHS campus.

Leighton: ***"We find direct geologic evidence that the escarpment below WBHL was created by lateral erosion from Benedict Canyon Wash more than 100,000 years ago and no evidence to suggest an active fault origin for this escarpment."***

Metro Response: As noted above, the WBHL has clearly been eroded by south-flowing drainages emanating from Benedict Canyon. This observation (made by Metro in the Metro Century City Fault Investigation Report) in no way obviates Metro's conclusions concerning the presence of a zone of NNW-trending right-lateral strike-slip faults that extend through the Century City area along the WBHL. Leighton seems to be mistaking the eroded edge of the broad uplift associated with the WBHL with the faults of the Northern NIFZ in this area. This is not correct. The strike-slip faults of the NIFZ extend through the zone of broader uplift.

4.0 CONCLUSION

In conclusion, the new Leighton data, combined with previously collected data, provide a more comprehensive data set that confirms the presence of a zone of right-lateral strike-slip faulting along the WBHL through the Century City area and through the Santa Monica Boulevard station location. Given the urban infrastructure and logistical constraints, especially the presence of subsurface infrastructure (e.g., storm drains, water mains, gas, sewer, and electric lines), it will be impossible to confirm that all of the faults that Metro has identified along the WBHL are inactive, particularly in the area of Santa Monica Boulevard. There is nothing in the Leighton report data that contradict Metro's conclusion that there is no safe location to site a station on Santa Monica Boulevard in Century City.

5.0 REFERENCES

Barrows, A. G., 1974, *A Review of the Geology and Earthquake History of the Newport-Inglewood Structural Zone, Southern California,* California Division of Mines and Geology Special Report 114.

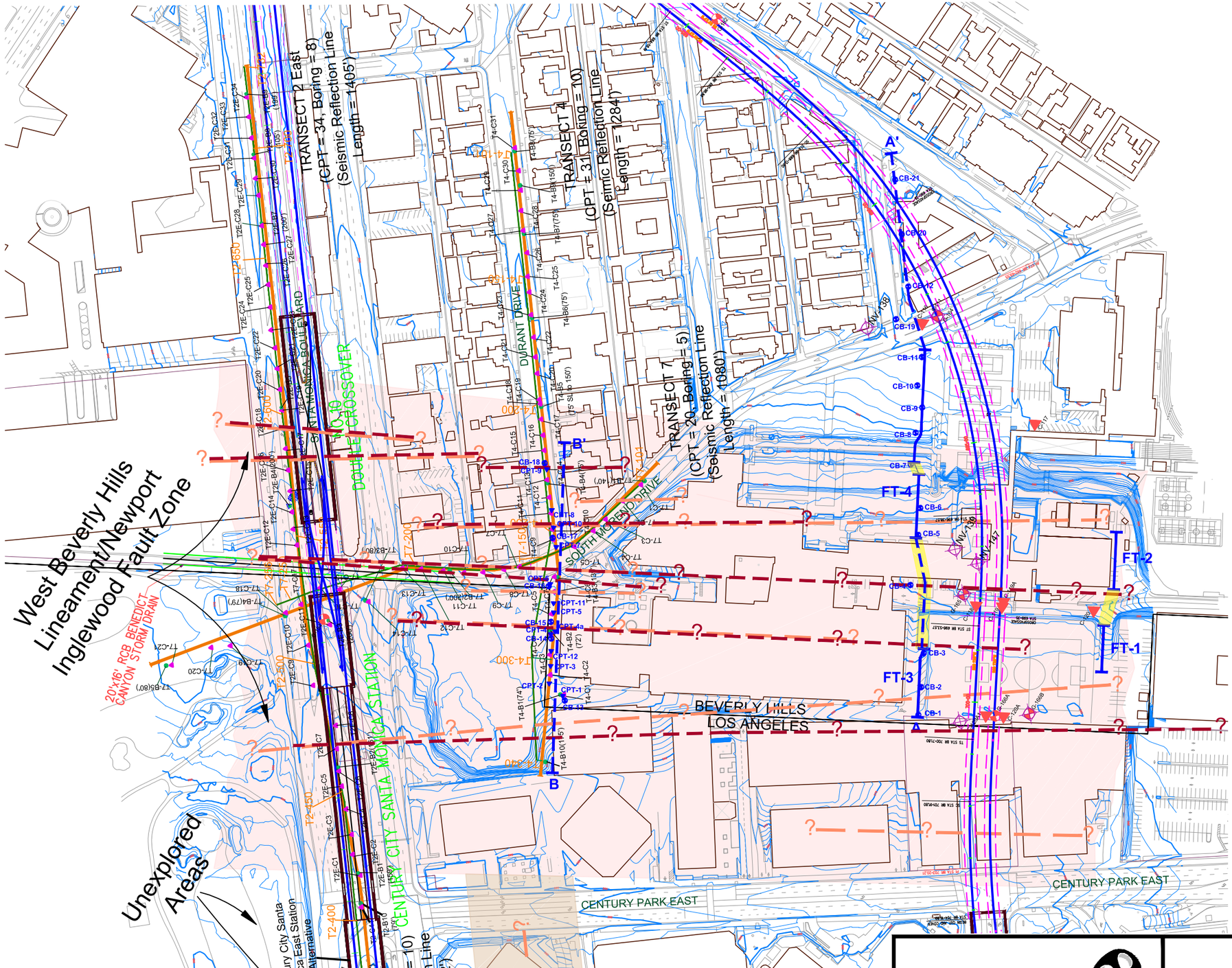
Bryant, W. A. (compiler), 2005, *Digital Database of Quaternary and Younger Faults from the Fault Activity Map of California, Version 2.0,* California Geological Survey.

Bryant, W. A., and E. W. Hart, 2007, *Fault-Rupture Hazard Zones in California: Alquist-Priolo Earthquake Fault Zoning Act with Index to Earthquake Fault Zones Maps.*

Los Angeles County Metropolitan Transportation Authority, 2011, *Westside Subway Extension Century City Area Fault Investigation Report.*

Los Angeles County Metropolitan Transportation Authority, April 17, 2012, *Response to Preliminary Review Comments of Century City Area Fault Investigation Report by Shannon and Wilson.*

FIGURES



0 100' 200' 400'

SCALE: 1" = 200'

EXPLANATION

Fault Investigation:

- Transect Profile Line
- T7-101 — P-Wave Seismic Reflection Line with Shot Point Number (Shown every 50 feet)
- T8-C15 — CPT Sounding Location
- T8-B5 (80') — Continuous Core Boring Location and Total Depth Drilled
- Approximate Zone of Faulting
- ? — Fault Location, Queried Where Uncertain, Oct. 14, 2011 Metro Report
- ? — Fault Location, Queried Where Uncertain, Refined based on New Leighton Data, current Report

Geotechnical Soil Gas Investigation:

- G-206 — Trotary-Wash Boring Location
- C-127 — CPT Sounding Location
- S-115 — Sonic Core Location
- 71-A711174 (1) — Boring Location (LeRoy Crandall, 1964; 1967; 1969; 1971; 1984)

Leighton Fault Investigation:

- CB-21 — Continuous Core Boring Location
- CPT-19 — CPT Sounding Location
- Trench Location
- Cross-Section Location
- Gap between Leighton Trenches

Fault Investigation:

- Centerline of Tracks
- Cross Passages (Approximate)
- Alternative Station and Cross-Over Outline

Note: Missing CPT's and Borings on all Transects were not drilled.

Base Map:
PB Topo Base Delivered 3/10/2011

Revised removed proposed borings 11/16/2011
Revised : Added Leighton Data, Revised Fault Location 5/11/12

LOS ANGELES COUNTY
METROPOLITAN TRANSPORTATION AUTHORITY

Metro

PB

GEP Imagery Date: Oct. 8, 2007
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amec

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MTA Westside Extension

JOB:	4953-11-1421
LT.LNG:	34.069,-118.403
SCALE:	1" = 200'
DRAWN:	V. Nguyen
CHKD:	R. Munro
PM:	R. Munro
DATE:	5/11/2012

Updated Fault Exploration Plan

Beverly Hills / Century City Area

FIGURE NO. 1

PROJECT NO. 4953-11-1421

Path: G:\4953_Geotech\2011\111421_MetroWestside\CAD\Fault-Profiles\4953-11-1421_Figure-1(2012-05-11).dwg [Scale-200]
Date: May 14, 2012 - 12:35pm By: vo.nguyen

West Beverly Hills
Lineament/Newport
Inglewood Fault Zone

Unexplored
Areas

Santa Monica
Fault Zone

Santa Monica Fault Zone
Holocene Activity Undetermined

TRANSECT 1
(CPT = 29, Boring = 8)
(Seismic Reflection Line
Length = 2252')

TRANSECT 2
(CPT = 23, Boring = 10)
(Seismic Reflection Line
Length = 1492')

TRANSECT 2 East
(CPT = 34, Boring = 5)
(Seismic Reflection Line
Length = 1405')

TRANSECT 3
(CPT = 38, Boring = 8)
(Seismic Reflection Line
Length = 1144')

TRANSECT 4
(CPT = 31, Boring = 10)
(Seismic Reflection Line
Length = 1264')

TRANSECT 7
(CPT = 30, Boring = 5)
(Seismic Reflection Line
Length = 1080')

TRANSECT 8
(CPT = 15, Boring = 6)

EXPLANATION

Project Core Data

Other Geotechnical Data

Base Map:
PB Topo Base Delivered 3/10/2011

Revised removed proposed borings 7/11/2011

MTA Westside Extension

Top of San Pedro
Contour Map Showing
Displacement Along WBHL

2A

West Beverly Hills
Lineament/Newport
Inglewood Fault Zone

Unexplored
Areas

Santa Monica
Fault Zone

Santa Monica Fault Zone
Holocene Activity Undetermined

TRANSECT 1
(CPT = 29, Boring = 8)
(Seismic Reflection Line
Length = 2252')

TRANSECT 2
(CPT = 23, Boring = 10)
(Seismic Reflection Line
Length = 1492')

TRANSECT 3
(CPT = 38, Boring = 8)
(Seismic Reflection Line
Length = 1144')

TRANSECT 4
(CPT = 31, Boring = 10)
(Seismic Reflection Line
Length = 1264')

TRANSECT 7
(CPT = 21, Boring = 9)
(Seismic Reflection Line
Length = 1080')

TRANSECT 8
(CPT = 15, Boring = 6)

EXPLANATION

Project Core Data

Other Geotechnical Data

Base Map:
PB Topo Base Delivered 3/10/2011

Revised removed proposed borings 11/10/2011

MTA Westside Extension

Reconstructed Top of San Pedro
Contour Map Showing
Displacement Along WBHL

2B

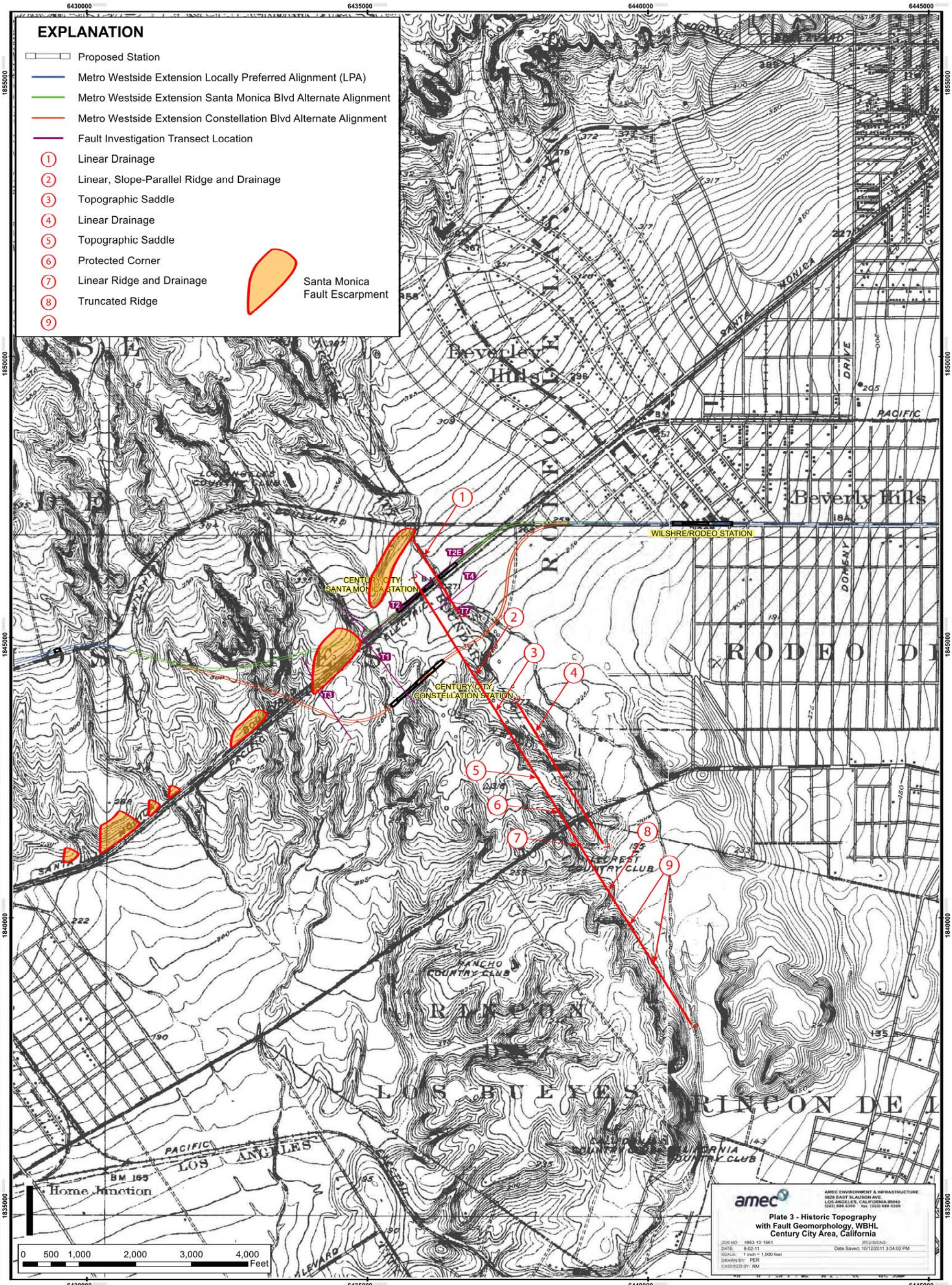

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Plate 3 - Historic Topography with Fault Geomorphology, WBHL Century City Area, California

JOB NO:	4953-10-1561
DATE:	8-02-11
SCALE:	1 inch = 1,000 feet
DRAWN BY:	PER
CHECKED BY:	RM
REVISIONS:	Date Saved: 10/12/2011 3:04:02 PM

Path: G:\4953_Geotech\2010\101561_Metro_Westside_Extension\GIS\Figures\Fault_inv_deliverable\Final\101561_SMF_Plate_1_Hist_topo.mxd Author: P. Romo

BASE: USGS 1926 Hollywood 6 minute quadrangle
USGS 1925 Sawtelle 6 minute quadrangle