DRAFT SCREENING-LEVEL FAULT RUPTURE INVESTIGATION
APNs 4342-015-038 and 4342-015-040; Lot 12
Beverly Hills, California

Prepared For:
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16 July 2021  
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Langan Engineering and Environmental Services Inc. is pleased to submit the results of the screening-level fault investigation prepared for the site referred to as Lot 12, Beverly Hills, California (Figure 1, Project Site). A screening-level fault investigation was also performed on Lot 13, located just northeast of Lot 12, concurrent with this investigation. References made to Lot 13 within this report are for reference only due to the proximity of and shared history between the two lots. It is our understanding that the Beverly Hills Land Company is proposing to convey Lot 13 to the City of Beverly Hills for use as a public park. The results of the Lot 13 screening-level fault investigation are reported separately.

The project site (Lot 12) is located southwest of the intersection of N. Santa Monica Boulevard and Beverly Boulevard, immediately southeast of Santa Monica Boulevard and northwest of Civic Center Drive. The site is approximately 1,500 feet long by 80 feet wide and currently vacant with shrubs and tall grass. Paved parking and street occupies approximately 30 feet of the width along the southeastern edge of the lot (Figure 2).

The site is located outside the current Alquist-Priolo (AP) Earthquake Fault Zones (EFZs), but lies between two of them, the Santa Monica EFZ and the Hollywood EFZ (CGS, 2018a; Figure 3). Prior to new construction or development of a property, the potential for surface fault rupture must be reviewed for any site located within an EFZ, or where it is required by the regulatory agency. As the lead agency, the City of Beverly Hills (CBH) requires standard-of-practice site-specific seismic fault investigations to assess the potential for surface rupture at the site for all fault zones that intersect or are proximal. For the project site, the proximal faults are the Santa Monica, Hollywood, and the Newport-Inglewood (West Pico strand) faults (CBH, 2018 & 2019a & 2019b; Figure 4).

1.0 PROJECT DESCRIPTION

We understand that the planned development will consist of 11 three- and four-story office buildings. We understand a one- to two-level basement is planned to underlie the entire footprint of the site.

We have incorporated relevant information from the following reports submitted for this project:

- **Limited Geotechnical Investigation, Lot 12, Beverly Hills, CA 90210** (12 July 2021), report by Langan Engineering and Environmental Services, Inc.

Based on a review of the Final Soil Management Plan (FSMP) for the site from the Department of Toxic Substances Control, the site was previously occupied by a railroad right-of-way operated by the Pacific Electric Railway Company (PERC) from 1928 until between 1971 and 1979. Union
Pacific Railroad (UPRR), the successor in interest to PERC reportedly transferred the site to the Beverly Hills Land Company in 1998. The FSMP indicates that high levels of arsenic have been detected at the site. The highest concentrations were found within the upper 5 feet of soil along the center of the former railroad right-of-way at concentrations between 16 and 996 mg/kg. Groundwater was reportedly encountered at depths of 45 to 52 feet below the ground surface (bgs). In addition to other criteria, the FSMP stipulated that soil from the restricted area shall be stockpiled separately from other soil located at the site and shall not be reused at the site, but shall be stockpiled until it can be tested for disposal/reuse onsite.

2.0 SCOPE OF SERVICES

The initial scope of services for our fault investigation was outlined in our Proposal for Preliminary Geotechnical Services and Screening-Level Fault Rupture Investigation of 2 March 2021.

The purpose of our investigation was to evaluate subsurface geologic age and lateral continuity of deposits in order to assess the potential for surface fault rupture through the site. The screening-level fault rupture hazard investigation consisted of the following tasks:

- Reviewing published and unpublished geologic, geophysical, geotechnical, and historic data at and near the site;
- Reviewing topographic maps of the site vicinity to identify possible geomorphic features indicative of recent faulting;
- Reviewing aerial stereo-paired photographs and oblique historical photographs of the site vicinity to identify possible fault-controlled morphologies and to assess the possible impact of historical land use on surface and near surface sediment continuity;
- Developing and submitting a fault study work plan to the City of Beverly Hills, which was subsequently accepted by the City of Beverly Hills Department of Community Development based on the recommendation of their fault study technical peer reviewer. The approval letter was dated 1 April 2021.
- Developing and conducting a subsurface exploration program consisting of 3 continuous core hollow stem auger (HSA) borings, 4 geotechnical HSA borings, and 3 cone penetration tests (CPTs);
- Analyzing continuous core samples to identify buried soil horizons and to visually compare and correlate identified subsurface units and marker beds;
- Collecting and submitting samples for bulk and carbon age dating;
- Using collected field data to develop two geologic cross sections that shadow the project site;
- Conducting periodic meetings with the project team;
- Discussing the project scope and work plan with the CBH fault investigation peer reviewer; and
- Preparation of this report.

Core review and data analyses were performed in collaboration with John Helms, CEG, who performed soil stratigraphy analyses and relative age dating of the collected cores.
Langan Senior Project Geologist, Shaun Wilkins, CEG, supervised all tasks of this investigation.

### 3.0 ALQUIST-PRIOLO ACT BACKGROUND AND AGENCY REQUIREMENTS

The Alquist-Priolo Earthquake Fault Zoning Act (AP) was enacted in 1972. The purpose of the Act is to prevent construction of buildings for human occupancy across the surface trace of an active fault. The law requires that the State Geologist delineate and establish regulatory Earthquake Fault Zones (EFZs) around the surface traces of known active faults, and publish maps accordingly for use by local agencies in regulating development within EFZs.

In 2018, the California Geological Survey (CGS) published Fault Evaluation Report (FER) 259 (Olson, 2018) for the Hollywood, Santa Monica and Newport-Inglewood faults in the Beverly Hills and Topanga 7.5' Quadrangles, updated from FER 51 (Smith, 1978). The site is mapped between the Santa Monica Fault Zone (SMFZ) and the Hollywood Fault Zone (HFZ) (Figure 3). CBH has incorporated fault maps included in FER 259 into their GIS website and created its own city reference fault map, which depicts each parcel with an address with respect to the CGS fault traces (Figure 4).

The CGS portrays the centerline of the Santa Monica Earthquake Fault Zone (SMEFZ) approximately 1100 feet southeast of Lot 12, running roughly parallel to the long axis of the site (Figure 4). The northeastern edge of the SMEFZ is approximately 525 to 750 feet from the southern edge of Lot 12. The trace of the Santa Monica fault in the project vicinity is poorly constrained and is mapped as inferred and approximately located across a series of discontinuous, highly degraded, and wide fault scarps (Dolan et al., 2000a; Olson, 2018).

The nearest extent of the Hollywood EFZ is 0.6 mile north of the northeast corner of Lot 12.

The Newport-Inglewood (West Pico strand) EFZ generally trends north to northeast of the site but ends approximately 1.4 miles southeast of the site.

#### 3.1 CGS Investigation Guidelines (Special Publication 42)

For this investigation, we used the CGS guidelines for the AP Earthquake Fault Zoning Program (CGS, 2018b). The CGS defines an active fault as one that has had surface displacement within Holocene time (about the last 11,700 years). A fault is deemed “sufficiently active” if there is evidence of Holocene surface displacement along one or more of its segments or branches. A fault can be considered inactive if there is conclusive evidence that shows it has not ruptured in the last 11,700 years.

In general, the age of fault activity is determined by establishing the age of the youngest materials displaced by the fault. If datable material is present, a numerical age can roughly be established by using carbon dating or other means. If no datable material exists, then only a relative age can be assigned to movement on the fault based on qualitative interpretation.

For faults that have evidence of movement in the last 11,700 years to be included in an AP EFZ, they must also be “well-defined.” A fault is considered well defined if its trace is clearly detectable by a trained geologist as a physical feature at or just below the ground surface. The fault may be identified by direct observation or by indirect method. The critical consideration is that the fault or some part of it can be located with sufficient precision and confidence in the field.
3.2 City of Beverly Hills Fault Investigation Guidelines

The City of Beverly Hills (CBH) revised their Guidelines for Evaluating Potential Surface-Fault Rupture within the City of Beverly Hills, California (Guidelines) and The City Policy for Site-Specific Seismic Fault Investigations (Policy, both revised September 2019). The CBH refers to the California Geological Survey (CGS) in their definition of an active fault and the mapped Earthquake Fault Zones (EFZs) for locations where site-specific fault investigations are required. Further, the CBH directs geologic consultants to be familiar with CGS Note 49 (Guidelines for Evaluating the Hazard of Surface Fault Rupture) and CGS Publication 42 (A Guide for Assessing Fault Rupture Hazards in California). In addition to other criteria, these guides provide fault investigation techniques.

The site is depicted on the City of Beverly Hills Final Earthquake Fault Zone Map (CBH, 2018) and falls between the Santa Monica Fault Zone (SMFZ) and the Hollywood Fault Zone (HFZ) (Figures 3 and 4). The CBH has stated that properties located between the Santa Monica and Hollywood EFZs must be evaluated for active faulting and the potential for surface fault rupture. Additionally, CBH may impose fault investigation requirements for developments of four or more ‘units’ whether in or out of an EFZ. The Policy states ‘The likely connection between the Santa Monica and the Hollywood EFZs is currently unknown and hence projects between them may similarly require geological evaluation.’

Requirements specific to performing and reporting on fault investigations are specified in Guidelines for Evaluating Potential Surface-Fault Rupture within the City of Beverly Hills, California (CBH, 2019b). They include:

- Compliance with CGS guidelines as published in SP-42 (CGS, 2018b) and Note 49 (CGS, 2002);
- Evaluation of the potential impact of the Santa Monica fault zone, Hollywood, Newport-Inglenook fault zones, and any other unnamed fault zones that may reasonably project into the site;
- Subsurface investigations including continuous core, hollow stem auger borings, CPTs, fault trenching, and large diameter borings. Well-documented trenches of sufficient length and depth are currently regarded by the City as the “standard,” most useful indicator of potential fault activity, but are not required for projects outside present, CGS-designated EFZs. The Consultants-of-Record are required to prepare a suitable investigation plan to be approved by CBH’s peer reviewer;
- Regular review and consultation with the CBH fault investigation peer reviewer, including observing field conditions to identify any possible technical issues;
- Submitting a draft report to the CBH peer reviewer for review and comment. Once all comments have been addressed to the satisfaction of the peer reviewer, the final report is submitted and may receive the “Recommendation for Acceptance” by the peer reviewer.

4.0 SITE CONDITIONS

The site is relatively flat with a very gentle northeasterly gradient. Site elevations range from approximately 256 feet at the southwest end to 244 feet at the northeast end. Elevations referenced herein are in feet and with respect to the North American Vertical Datum of 1988.
Lot 12 is the former railroad right-of-way adjacent to Santa Monica Boulevard between Alpine Drive and North Doheny Drive. The lot is currently vacant with tall grasses and occasional shrubs. A row of parking spaces is present within the site boundaries on the southeast side of the vacant lot. It is our understanding that these spaces are currently in the City right-of-way but the project will vacate the right-of-way. The surrounding area is entirely developed and paved with asphalt or concrete hardscape.

5.0 BACKGROUND REVIEW

5.1 Investigations by Others

We reviewed reports from numerous fault investigations performed in and near Beverly Hills as part of our assessment of potential active fault rupture at the project site. The reports reviewed are listed in Table 1.

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Property Address</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Geotechniques, 2013</td>
<td>935 North San Vicente Boulevard, West Hollywood, California</td>
<td>Fault Rupture Hazard Investigation, 935 North San Vicente Boulevard, West Hollywood, California</td>
</tr>
<tr>
<td>AES, 2015b</td>
<td>1749 and 1751 Malcolm Avenue and Glendon Avenue, Los Angeles CA</td>
<td>Supplement No. 1, Dated November 30, 2015. Response to City comments.</td>
</tr>
<tr>
<td>Earth Consultants International (ECI), 2018</td>
<td>332 N. Foothill Road, City of Beverly Hills, CA</td>
<td>Fault Investigation for 332 N. Foothill Road, City of Beverly Hills, CA</td>
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<tr>
<td>ECI, 2019</td>
<td>420 Lasky Drive, Beverly Hills, CA</td>
<td>Seismic Investigation</td>
</tr>
<tr>
<td>Feffer Geologic Consulting (Feffer) &amp; GeoCon West, 2012</td>
<td>10000 Santa Monica Boulevard, Los Angeles, CA</td>
<td>Report of Fault Rupture Hazard Investigation, Proposed Development 10000 Santa Monica Boulevard, Century City district Los Angeles. Prepared for Crescent Heights</td>
</tr>
<tr>
<td>Feffer Geologic Consulting (Feffer), 2018a</td>
<td>468 North Rodeo Drive, Beverly Hills, CA</td>
<td>Evaluation of Potential Faulting</td>
</tr>
<tr>
<td>Feffer Geologic Consulting (Feffer), 2018b</td>
<td>461 North Beverly Drive, Beverly Hills, CA</td>
<td>Evaluation of Potential Faulting</td>
</tr>
<tr>
<td>Author, Year</td>
<td>Property Address</td>
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<tr>
<td>Feffer Geologic Consulting(Feffer), 2018c</td>
<td>456 North Beverly Drive, Beverly Hills, CA</td>
<td>Evaluation of Potential Faulting</td>
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<tr>
<td>Feffer Geologic Consulting(Feffer), 2019</td>
<td>420 North Rodeo Drive, Beverly Hills, CA</td>
<td>Evaluation of Potential Faulting</td>
</tr>
<tr>
<td>GeoCon West, 2013</td>
<td>1801 Avenue of the Stars, 10250 Santa Monica Boulevard &amp; 1930 Century Park West, Los Angeles, CA</td>
<td>Fault Rupture Hazard Investigation, Consultant report prepared for Westfield, Project No. A8929-06-02</td>
</tr>
<tr>
<td>GeoCon West, 2014a, b, and 2015</td>
<td>9900 Wilshire Boulevard, Beverly Hills, California</td>
<td>Report of Phase II Site-Specific Fault Rupture Investigation</td>
</tr>
<tr>
<td>GeoCon West, 2020</td>
<td>125 and 129 S Linden Drive, Beverly Hills, California</td>
<td>Fault Rupture Hazard Investigation</td>
</tr>
<tr>
<td>GeoKinetics, 2014</td>
<td>10131 Constellation Boulevard, Century City, CA</td>
<td>Summary of Fault Trench Study</td>
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<tr>
<td>Kenney GeoScience (KGS), 2011</td>
<td>Proposed LA Metro Stations in Century City</td>
<td>Preliminary Literature and Geomorphic Evaluation of The Eastern Santa Monica Fault Zone, And Potential Impacts Associated with Fault Surface Rupture</td>
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<tr>
<td>KGS, 2012</td>
<td>The Century City/Cheviot Hills Area</td>
<td>Geomorphic, Structural and Stratigraphic Evaluation of The Eastern Santa Monica Fault Zone, And West Beverly Hills Lineament</td>
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<td>KGS, 2013</td>
<td>The Century City/Cheviot Hills Area</td>
<td>Preliminary Revised Fault Map Based on Geomorphic, Structural and Stratigraphic Evaluation</td>
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<td>KGS, 2014</td>
<td>The Century City-Cheviot Hills Area.</td>
<td>Structural and Stratigraphic Evaluation</td>
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<td>Langan, 2020</td>
<td>400 and 408 N. Rodeo Drive, Beverly Hills, CA</td>
<td>Fault Rupture Hazard Investigation for 400 and 408 N. Rodeo Drive, Beverly Hills, CA</td>
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<tr>
<td>Leighton Consulting, 2015</td>
<td>605 Whittier Drive, Beverly Hills, CA</td>
<td>Geohazard Report, El Rodeo K-8 School</td>
</tr>
<tr>
<td>Author, Year</td>
<td>Property Address</td>
<td>Title</td>
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<tr>
<td>Leighton Consulting, 2016</td>
<td>605 Whittier Drive, Beverly Hills, CA</td>
<td>Updated Fault Hazard Assessment and Response to CGS Review Letter, El Rodeo K-8 School</td>
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<tr>
<td>MACTEC, 2008</td>
<td>9900 Wilshire Boulevard, Beverly Hills, CA</td>
<td>Report of Geotechnical Investigation, Project Lotus Development. (included discussion of faulting)</td>
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<tr>
<td>Metro, 2012b</td>
<td>Westside Subway Extension Century City Area *</td>
<td>Los Angeles County Metropolitan Transportation Authority (Metro). 2012. Reply to Exponent Responses.</td>
</tr>
<tr>
<td>Metro, 2012c</td>
<td>Westside Subway Extension Century City Area *</td>
<td>Los Angeles County Metropolitan Transportation Authority (Metro). 2012. Response to Hazard Assessment Study by Exponent.</td>
</tr>
<tr>
<td>Metro, 2017b</td>
<td>Westside Purple Line Extension Section 2*</td>
<td>Los Angeles County Metropolitan Transportation Authority (Metro). 2016. Geotechnical Fault Investigation Summary Memorandum- Revision 1</td>
</tr>
<tr>
<td>Metro, 2017c</td>
<td>Westside Purple Line Extension - Tunnel Reach 6*</td>
<td>Los Angeles County Metropolitan Transportation Authority (Metro). 2017., Santa Monica Fault Investigation</td>
</tr>
<tr>
<td>Stoney-Miller Consultants, Inc. (SMC), 2018</td>
<td>425, 427 and 429 N. Palm Drive</td>
<td>Site Specific Surface Rupture Evaluation Multi-Story Residential Building 425, 427 and 429 N. Palm Drive</td>
</tr>
</tbody>
</table>
Summaries of the eleven consultant reports that provided relevant information and their findings are presented below. The locations of these reports and several others that provided instructive fault data are depicted on Figure 5, Previous Investigations in the Beverly Hills Area.

1. **Fault Investigation Report for 420 N. Rodeo Drive, in the City of Beverly Hills, CA, prepared for 420 N. Rodeo Drive LLC, by Feffer Geologic Consulting, recommended for conditional approval in April, 2019 (Feffer, 2019).** This study assessed the potential for surface fault rupture and fault activity of the SMFZ. The site of the study lies approximately 0.36 mile southwest of the southwest end of Lot 12 and within the AP EFZ for the Santa Monica fault trace. Two borings and three CPTs were completed for the study. The borings and interpreted CPT data show no offset in the exposed materials. The sediments were determined to be in place, continuous, and of Holocene- to latest Pleistocene-age per a Soil Development Index (SDI) assessment. The investigation concluded that no faults traverse the property.

2. **Fault Investigation Report for 468 N. Rodeo Drive, in the City of Beverly Hills, CA, prepared for 468 N. Rodeo Drive LLC, prepared by Feffer Geologic Consulting, recommended for approval on 28 August, 2018 (Feffer, 2018a).** This study similarly assessed the potential for surface fault rupture. The study site is approximately 0.35 mile southwest of the southwest end of Lot 12 and outside the AP EFZ for the Santa Monica Fault trace. Four borings and 11 CPTs were completed for the study. The borings and interpreted corollary CPT data show no offset of exposed sediments. The materials were determined to be in place, continuous, and of Holocene- to latest Pleistocene-age according to a SDI assessment. The investigation concluded that no faults traverse the property.

3. **Fault Investigation Report for 461 N. Beverly Drive, in the City of Beverly Hills, CA, prepared for 461 N. Beverly Drive LLC, prepared by Feffer Geologic Consulting, recommended for approval on 8 October 2018 (Feffer, 2018b).** This study also assessed the potential for surface fault rupture. The study site is about 0.31 mile southwest of the southwest end of Lot 12 and outside of the AP SMFZ. This report relied on the field data from Feffer, 2018a, and no original data were collected for this project. As the findings match that of the previous Feffer report, the fundamental conclusion was that no faults impact the property.

4. **Fault Investigation for the Property at 332 N. Foothill Road, in the City of Beverly Hills, CA, prepared for Magen David of Beverly Hills, prepared by Earth Science Consultants, dated 19 July 2018 (ECI, 2018).** This study assessed the potential for surface fault rupture and fault activity of the SMFZ. The site is about 950 feet southeast of the southeast edge of Lot 12 and near the end point of the AP EFZ. Four borings, six CPTs with geoprobe sampling, and a 30-foot trench exposure were completed for this study. The trench and interpreted correlated CPT and boring data show continuous unbroken stratigraphy across this site that is estimated to be Holocene, with basal sediment ages estimated at latest Pleistocene in age.

5. **Evaluation of Regional and Local Seismic Issues within the Beverly Hills Unified School District and their Public and Scientific Issues, prepared by Kenny Geoscience, dated 30 March 2016 (KGS, 2016).** This study was prepared to provide the tectonic setting for the School District region. Reports by other consultants were compiled by KGS and shown to contain site-specific interpretations that contradict the Metro Studies.
This study suggests the integration of this data to the Metro Study in order to refine fault characterizations, location, and activity status for the SMFZ and Newport-Inglewood (NIFZ) fault zones.

KGS reinterprets the two active traces of the Santa Monica fault zone to extend further northeast than previously mapped. The first active trace KGS interprets as splay or step-over to the southeast, and occurs east of the Cheviot Hills. This trace is referred to as the North Salt Lake fault and it bounds the Salt Lake oil fields to the south and the Hollywood Basin to the north (Hummon et al., 1994). The second inferred splay is oriented more northerly (tangential to the easterly trend of the Western Transverse Ranges) and hard-links the Santa Monica fault in the Cheviot Hills to the Hollywood fault zone. This splay is one of two northeast-trending tangential, or cross faults, that connect the Santa Monica and Hollywood faults. The cross fault is designated potentially active and passes 150 feet southeast of the site. The other mapped cross fault is designated inactive. This study was not peer reviewed.

7. *Westside Purple Line Extension Final Supplemental EIS & Section 4(f) Evaluation, prepared for the Westside Purple Line Extension, by USDT Federal Administration & Los Angeles Country Metropolitan Transportation Authority, dated 22 November 2017 (Metro, 2017).* The studies for the Metro’s Westside Purple Line extension include multiple reports and revisions of those reports from 2010 through November of 2017. These reports were prepared to characterize site conditions and potential fault-related hazards for the planned Metro extension. The Wilshire/Rodeo Station is located roughly 1 mile northeast of the planned Century City Station, and is approximately 0.5 mile south of the southwest end of Lot 12. The Metro studies reviewed for the site are presented in the Appendix B-Geotechnical Studies, of the Metro 2017 report. A summary memorandum was compiled by Metro of studies that had occurred since the 2011 draft EIS, including responses to comments from the BHUSD and CGS. Reinterpretations were shown as a result of these studies and all mapped active and inactive fault traces for each author’s observations are shown.

In summary, the Metro Transect 9 study (depicted as yellow line on Figure 5) interpreted a Holocene active surface trace of the Santa Monica fault intersecting South Lasky Drive between Young and Robbins Drive and extending into CBH. The location of this assumed fault is based upon the near surface presence and juxtaposition of varved deposits (dated at 9,000-16,500 years old) and alluvial materials. The contact between these materials was not directly observed, but inferred from boring data. The authors have assumed the varved deposits accumulated in sag ponds along an active fault trace and therefore consider these deposits to be a fault trace marker (Metro, 2017c).

8. *Fault Rupture Hazard Investigation for 400 and 408 N. Rodeo Drive, Beverly Hills, CA, prepared for CHANEL, Inc., prepared by Langan Engineering and Environmental Services, Inc., dated 27 March 2020 (Langan, 2020).* This study assessed the potential for surface fault rupture and fault activity of the SMFZ. The site of the study lies approximately 0.37 mile southwest of the southwest end of Lot 12 and within the AP EFZ for the Santa Monica fault trace. Twenty-one continuous borings, 28 CPTs, 2 seismic reflection geophysical surveys, 1 downhole geophysical survey, 1 trench, and 39 large diameter bucket auger borings were completed for this study. Additionally, two
monitoring wells were installed. The continuous borings, interpreted CPT data, trench, and large diameter bucket auger borings show no offset in the exposed materials. The sediments were determined to be in place, continuous, and of Holocene- to Pleistocene-age per a Soil Development Index (SDI) assessment. The investigation concluded that no faults traverse the property. Two faults were interpreted from the seismic reflection surveys, one 380 feet southwest of Rodeo drive intersecting Brighton Way at approximately 750 feet below ground surface (bgs) and one 150 to 300 feet southeast of Brighton way intersecting Rodeo Drive at approximately 165 feet bgs.

9. Fault Rupture Hazard Investigation, 935 North San Vicente Boulevard, West Hollywood, California, prepared for 5to9 Group, prepared by Advanced Geotechniques (Advanced Geotechniques, 2013). This study assessed the potential for surface fault rupture and fault activity of the Hollywood Fault Zone. The site of the study lies approximately 0.92 mile northeast of the northeast end of Lot 12, approximately 350 feet south of the mapped trace of the Hollywood Fault and inside the AP EFZ for the fault. Two continuous hollow stem auger borings and five CPTs were completed for the study. From the subsurface investigations, the study determined the stratigraphy across the site to be continuous and unfaulted. Additionally, no abrupt steps in the groundwater surface and no topographic features suggesting faulting were observed at the site. The investigation concluded that no faults traverse the property.

10. Site Specific Surface Rupture Evaluation Multi-Story Residential Building 425, 427 and 429 N. Palm Drive, prepared for ETCO Homes, Inc., prepared by Stoney-Miller Consultants, Inc. (SMC, 2018). This study assessed the potential for surface fault rupture and fault activity at a site 750 feet east of Lot 12 outside designated AP Earthquake Fault Zones. Four CPTs were completed for the study in addition to two previous borings and two previous CPTs. The investigation concluded that no faults traverse the property.

11. Fault Rupture Hazard Investigation, 125 South Linden Drive (aka 9744 Wilshire Boulevard) and 129 South Linden Drive, Beverly Hills, California, prepared for 9300 Wilshire, LLC, prepared by GeoCon West, Inc. (GeoCon West, Inc., 2020). This report evaluated the potential for surface fault rupture on the subject properties. GeoCon advanced 30 CPTs along two exploration transects, drilled and logged three 30-inch diameter borings, and excavated and logged two 30- and 40-foot-long, 30-foot-deep, exploratory trenches. The investigation concluded that active faults existed on the property and recommended 25-foot structural setback zones from the observed 20-foot-wide fault zone.

5.2 Aerial Photography Review

We reviewed stereo-paired aerial photos from between 1928 and 2007 to obtain a history of area land use and grading, and to characterize and review early-development land surfaces for fault-related geomorphic features. The aerial photographs reviewed are listed in Table 2.
TABLE 2 - Aerial Photographs Reviewed for this Study

<table>
<thead>
<tr>
<th>Collection</th>
<th>Date</th>
<th>Flight ID</th>
<th>Scale</th>
<th>Frames</th>
</tr>
</thead>
<tbody>
<tr>
<td>UCSB*</td>
<td>1/1/1928</td>
<td>C_300</td>
<td>K-21, K-22</td>
<td>18,000</td>
</tr>
<tr>
<td>UCSB</td>
<td>5/1/1937</td>
<td>C_4686</td>
<td>25, 26, 27</td>
<td>8,400</td>
</tr>
<tr>
<td>UCSB</td>
<td>5/1/1937</td>
<td>C_4686</td>
<td>39, 40, 41</td>
<td>8,400</td>
</tr>
<tr>
<td>UCSB</td>
<td>1/1/1947</td>
<td>GS_EM</td>
<td>2-1, 2-2</td>
<td>24,000</td>
</tr>
<tr>
<td>UCSB</td>
<td>5/1/1947</td>
<td>C_11351</td>
<td>9-8, 9-9</td>
<td>24,000</td>
</tr>
<tr>
<td>UCSB</td>
<td>11/3/1952</td>
<td>AXJ_1952</td>
<td>14K-61, 14K-62</td>
<td>20,000</td>
</tr>
<tr>
<td>UCSB</td>
<td>7/1/1956</td>
<td>C_22555</td>
<td>13-22, 13-23</td>
<td>14,400</td>
</tr>
<tr>
<td>UCSB</td>
<td>5/1/1960</td>
<td>C_23870</td>
<td>1596, 1597</td>
<td>14,400</td>
</tr>
<tr>
<td>UCSB</td>
<td>10/1/1962</td>
<td>C_24400</td>
<td>13-142, 13-143</td>
<td>12,000</td>
</tr>
<tr>
<td>UCSB</td>
<td>3/1/1968</td>
<td>TG_2400</td>
<td>1-211, 1-212</td>
<td>28,800</td>
</tr>
<tr>
<td>UCSB</td>
<td>2/1/1976</td>
<td>TG_7600</td>
<td>11-36, 11-37</td>
<td>24,000</td>
</tr>
<tr>
<td>UCSB</td>
<td>7/1/1979</td>
<td>TG_3800</td>
<td>14-31, 14-32</td>
<td>24,000</td>
</tr>
<tr>
<td>UCSB</td>
<td>5/31/1994</td>
<td>NAPP_2C</td>
<td>6858-13, 6858-14</td>
<td>40,000</td>
</tr>
<tr>
<td>UCSB</td>
<td>6/10/2002</td>
<td>NAPP_3C</td>
<td>12465-116, 12465-118</td>
<td>40,000</td>
</tr>
<tr>
<td>UCSB</td>
<td>3/1/2007</td>
<td>EAG_05</td>
<td>4487, 4488</td>
<td>23,000</td>
</tr>
</tbody>
</table>

*University of California, Santa Barbara

In the earliest photographs of the site area (1928) indicate that nearly all of the nearby streets in the Beverly Hills area had already been established and the vast majority of the lots had been developed. Other historical records indicate that the area was generally utilized for agricultural purposes until the early 20th century. Scattered vacant lots were in extant and grades near the site did not appear to have been modified substantially but very few virgin ground surfaces remained. Lots 12 and 13 already existed in their near-present configuration and appeared to contain railroad tracks. A row of trees/shrubs existed between the lots and Santa Monica Boulevard to the north. Other than development of the remaining vacant parcels and
redevelopment of many of the (especially commercial and municipal) structures, the area has remained largely unchanged since 1928.

As stated above, the site was previously occupied by a railroad right-of-way operated by the Pacific Electric Railway Company (PERC) from 1928 until between 1971 and 1979. Union Pacific Railroad (UPRR), the successor in interest to PERC reportedly transferred the site to the Beverly Hills Land Company in 1998.

We performed an analysis of stereo-paired historical aerial photographs by means of a stereoscope. This tool, when viewing two photographs of the same area taken at slightly different angles, creates an exaggerated 3-dimensional image, which is useful in identifying potential geologically related linear feature (lineaments). These lineaments can be an indication of geologically recent ground deformation, including the presence of potentially active faulting.

The results of our aerial photo lineament analysis are presented on Figure 6.

5.3 Topographic Review

We reviewed previous geomorphic assessments of the area (Dolan et al., 2000a & b), the 5-foot contour Hollywood topographic map (USGS, 1926), and the 2015-2016 LARIAC Lidar DEM dataset. The topographic maps show that the surrounding area is largely influenced by alluvial fan deposition, and at the site location, the grading of the trolley line and railroad that ran subparallel to projected traces of the SMFZ (Dolan et al., 2000a). The site is located within a broad open hillslope, feeding into the larger Hollywood Basin (Elevation Profiles, Figures 7A, 7B, 7C, and 7D). These figures have a vertical scale that has been exaggerated 10 times to help illuminate surface profile changes potentially associated with active faulting.

The surface profile includes the location of the project site where it crosses, or projects to the profile location and also includes the locations or projections of nearby landmarks, fault zones, and faults (projected along strike in some cases).

The elevation profiles depict a potential 11-foot scarp approximately 360 feet southeast of the site (Figure 7B) that continues to the northeast (Figure 7A). A potential 2-foot-high, northwest dipping scarp less than 100 feet northwest of the site is apparent in Figure 7C, but may be attributed to noise in the topographic data.

The site gently slopes to the northeast and does not exhibit any topographic irregularities or fault scarps parallel its long axis (Figure 7D). The immediate subsurface and general morphology of the site is estimated as Holocene- and Pleistocene-aged (11,700 years ago to present) (Dolan et al., 2000b). The principal surface expression of the SMFZ is southwest of the project site as a slight topographic break that trends approximately parallel to the historic railroad that occupied both lots (Dolan et al., 2000a). This topographic scarp dies out to the west and was not identified east of the Cheviot Hills.

5.4 Hydrologic Review

Subsurface groundwater barriers have often been cited as potential evidence for subsurface faulting or offset of Pleistocene and Holocene geologic units along the SMFZ (Hill, 1979; Hill et al., 1978; Dolan et al, 2000a; Olson, 2018). Groundwater barriers, or abrupt changes in the elevation of the top of groundwater, were first utilized by Hill (1979) to define the westernmost traces of the SMFZ, which were extended through to the east, between the Beverly Hills and
Hollywood region based on oil well data and historic records. The Fault Evaluation Report for the SMFZ (FER 259) by Olson (2018) cites personal communication data that suggest multiple steps in groundwater across CBH parallel to and used to define the near-surface eastward strike of the SMFZ.

For this study, we collected publicly available groundwater data for the site vicinity to identify any potential alignments on the ground water surface (Figure 8). The review of this data shows that the groundwater elevation jumps 35 vertical feet over a horizontal distance of approximately 300 feet west of Lot 12 and North Santa Monica Boulevard (Figure 8). This suggests a northeast-trending groundwater barrier that projects approximately 300 feet southwest of Lot 12 (Olson, 2018).

This is an incomplete compilation of groundwater data, without a detailed analysis of the source data (e.g. seasonal and year-to-year variations, temporal differences in measurement times, and confirmed ground surface elevations). FER 259 included a brief summary of the groundwater data reviewed as part of their report but did not include details as noted above. Therefore, the hydrologic review of the site vicinity should not be considered comprehensive. Groundwater data at and near the site appears to indicate no large changes in elevation, i.e., suggestive of barriers, and thus was not analyzed further.

6.0 FIELD INVESTIGATIONS

The project area is not located within a mapped EFZ, but is located between the Santa Monica and Hollywood Earthquake Fault Zones. The City of Beverly Hills places increased scrutiny in this area beyond a typical site outside of an EFZ. The City ‘standard’ when it comes to fault rupture investigations involves trenching. However, due to the long, narrow layout of the lot, the anticipated trend of the nearest fault being near-parallel to its long-axis, the anticipated 20 to 25 feet depth to the H-P boundary, and arsenic in the soil (DTSC, 2017), trenching of the site would be difficult. The City makes an allowance for other subsurface exploration methods. Given the site constraints we have performed continuous core borings and CPT soundings, supplemented with ‘standard’ hollow stem auger borings advanced for geotechnical purposes, to evaluate the potential for surface fault rupture at the site.

Prior to drilling, we obtained the necessary well/boring permit(s) from the County of Los Angeles, Environmental Health, Drinking Water Program and updated the DTSC work plan. We submitted a work plan, dated 19 March 2021, for the fault investigation to CBH, which was subsequently approved. A Langan field geologist located and marked the boring and CPT locations and contacted Underground Service Alert of Southern California (DigAlert) to locate and mark known public underground utilities present within the public rights-of-way. In addition, we retained the services of a private utility-locating subcontractor to scan each investigation location for utility conflicts.

6.1 Exploratory Borings

Three continuous core borings were drilled on 10 and 11 May 2021 by 2R Drilling under the full-time observation of a Langan field geologist. The continuous core borings are identified as B-1, B-4, and B-7 and were drilled to a depth of 40 feet below ground surface (bgs). The borings were drilled with a truck-mounted CME-75 drill rig equipped with 8-inch continuous core hollow stem augers. Due to the limitations of the continuous core sampling equipment, the upper 5 feet of each boring was not sampled.
During drilling, our field geologist placed the cores into wax-treated cardboard core boxes, where they were measured for recovery, photographed, and logged. The percentage of core recovery for each 5-foot section of sample is noted on the logs. The continuous core boring logs are presented in Appendix A. The soil encountered in the borings was classified in accordance with the Unified Soil Classification System (USCS). Photographs of the continuous core samples are presented in Appendix B.

Our subsurface investigation of Lot 12 also included four (4) HSA borings drilled for geotechnical purposes, identified as B-2, B-3, B-5, and B-6, drilled to a depth of 16.5 to 26.5 feet below ground surface (bgs). A truck-mounted drill rig with hollow-stem augers was used to advance the boreholes using conventional soil drilling techniques. The borings were performed by 2R Drilling on 10 May 2021. The geotechnical boring logs are presented in Appendix A.

Bulk samples were collected from the geotechnical borings from the ground surface to about 5 feet below ground surface. Standard Penetration Tests (SPT)\(^1\) and split spoon sampling were typically performed at 5-feet intervals until the boring termination depth. SPT N-Values were recorded to identify the relative density and stiffness of the cohesionless and cohesive soils. California ring samples were also collected at select locations using a 3.0-inch-outer-diameter split-barrel California sampler lined with 2.42-inch-inner-diameter brass or stainless steel rings. The augers were decontaminated between each boring. SPT sampler and California Ring sampler were decontaminated between each sampling interval. Borings were observed and logged on a full-time basis by a LANGAN field engineer. Soil samples were visually examined and classified in the field in accordance with the Unified Soil Classification System (USCS).

Other details associated with the geotechnical borings including laboratory test results are presented in a separate report.

Upon completion, the borings were backfilled via tremie methods with grout to the ground surface. Excess soil cuttings generated during drilling were temporarily stored on-site in 55-gallon drums for subsequent characterization and disposal.

The location of borings B-1 through B-7 are presented on Figure 2. The results of our continuous core exploratory borings are discussed in Sections 10.0 through 10.2 and 11.

### 6.2 Cone Penetrometer Tests (CPT)

Three CPTs were advanced to 50 feet bgs by Kehoe Testing and Engineering using a truck-mounted 30-ton cone penetrometer rig. The CPTs were performed by hydraulically pushing a 1.7-inch-diameter cone-tipped probe with a projected area of 2.3 square inches into the ground. The cone tip measures tip resistance, and the friction sleeve behind the cone tip measures frictional resistance. Electrical strain gauges or load cells within the cone continuously measure the cone tip resistance and frictional resistance during the entire depth of each probing. Accumulated data were processed by computer to provide engineering information, such as the types and approximate strength characteristics of the soil encountered. The CPT logs, showing tip

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\(^1\) The Standard Penetration Test is a measure of the soil density and consistency. The SPT N-value is defined as the number of blows required to drive a 2-inch outer diameter split-barrel sampler 12-inches, after an initial penetration of 6 inches, using a 140-pound automatic hammer free falling from a height of 30-inches (ASTM D1586).
resistance and friction ratio by depth, and interpreted SPT N-values, friction angle, soil strength parameters, and interpreted soil behavior type are presented in Appendix C.

After completion, the CPTs were backfilled with grout in accordance with Los Angeles County permit requirements.

The results of our CPT data, are discussed in Sections 10.0 through 10.2 and 11.

7.0 LABORATORY TESTING – RADIOMETRIC DATING

Three samples of buried detrital charcoal and disseminated micro charcoal were collected from the small-diameter boring continuous core samples and submitted for bulk radiocarbon age determinations using the Accelerator Mass Spectrometry (AMS) technique. Samples were collected from borings B-1 and B-7. The samples were submitted to the Keck Carbon Cycle AMS Facility at the University of California, Irvine (UCI) Earth System Science Department. The ages provided are in years before present (BP). A detailed description of the methodologies employed and results of the analysis and reported age-dates are provided in Appendix D. The results of the age dating by UCI for these samples are summarized in Table 3.

<table>
<thead>
<tr>
<th>Boring</th>
<th>Depth (feet)</th>
<th>Ground Surface Elevation (feet)</th>
<th>Geologic Unit Classification</th>
<th>$^{14}$C Age (years BP) and Uncertainty</th>
<th>Relative Soil Unit and Elevation in boring (feet, NAVD 88)</th>
<th>Sample notes (UCIAMS #)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1</td>
<td>16-A</td>
<td>256.7</td>
<td>Qoa1</td>
<td>10,730 ± 120</td>
<td>Top of 4BT2b unit, elev. 240.6</td>
<td>Reworked carbon in soil, 0.056 mg C, (247453)</td>
</tr>
<tr>
<td>B-1</td>
<td>16-B</td>
<td>256.7</td>
<td>Qoa1</td>
<td>11,210 ± 25</td>
<td>Top of 4BT2b unit, elev. 240.6</td>
<td>Bulk soil (247449)</td>
</tr>
<tr>
<td>B-7</td>
<td>33.5</td>
<td>247.5</td>
<td>Qoa2</td>
<td>30,990 ± 400</td>
<td>Top of 7Bwb unit, elev. 314.0</td>
<td>Reworked carbon in soil, 0.18 mg C, (247454)</td>
</tr>
</tbody>
</table>

The results of our radiocarbon age dating are discussed further in Sections 7.1, 10.2, and 11.

7.1 Radiocarbon Interpretation & Potential Error/Inversion

We carried out radiometric age dating for the project for the purpose of calibrating the Soil Development Index (SDI) analyses and testing our interpreted unit ages. However, a number of constraints within the collection, distribution, and analysis of the available collected samples limit how we use the data within this report and our associated analyses.

The charcoal collected for this project was present as small flakes of charcoal or as organic rich horizons, with no depositional orientation or notable correlation with bedding fabrics. No pockets, lenses, or large deposits of charcoal were encountered, and therefore, no samples were collected. Charcoal encountered was small in size (at or below the required volume for analyses). In spite of the small sample size, which contributes to potential age uncertainty, the radiometric age dating correlated relatively well with the Soil Development Index (SDI) analyses. However, due to the small and relatively poor carbon samples available for testing we are relying more heavily on the soil ages based on the SDI analyses.
8.0 REGIONAL AND LOCAL GEOLOGY

8.1 Geologic Setting

The Santa Monica and Hollywood fault zones generally mark the boundary between the Peninsular Ranges geomorphic province to the south and the Transverse Ranges Geomorphic Province to the north. This boundary is expressed as the convergence of the Hollywood Basin, Wilshire Arc, West Beverly Hills lineament, and Los Angeles Basin against the Santa Monica Mountains range front (Dolan et al., 2000a; Figure 9). The Peninsular Ranges geomorphic province consists of mountain ranges separated by northwest-trending valleys subparallel to faults branching from the San Andreas Fault. The Transverse Ranges Geomorphic province forms a relatively youthful physiographic feature in response to accelerated uplift that accommodates concentrated north-south crustal shortening in a region of compression. The section of the Santa Monica Mountains north of the project area owe their height to vertical displacement on north-dipping reverse faults, such as the Santa Monica and Hollywood fault zones (Yerkes, et al, 1965; Cooke and Marshall, 2006; and Campbell et al., 2014).

Regional geologic mapping depicts the site as situated in the northwestern portion of the Hollywood basin, approximately 0.9 mile southeast of the Santa Monica Mountain foothills and 1.3 miles northeast of the Cheviot Hills. Surface deposits present within and around the project site are mapped as dissected early Holocene age alluvial deposits, underlain by latest Pleistocene alluvial and fluvial sediments, which are in turn underlain by interbedded terrestrial fan and marine deposits identified as Lakewood Formation in earlier publications and unnamed in later publications (Yerkes and Campbell, 1965; DWR, 1961; and Dibblee, 1991). Regional maps indicate that the project area is underlain by young alluvial fan deposits of late Pleistocene and Holocene age (Campbell et al, 2014, Figure 10). The deposits consist of alluvial gravel, sand, and silty clay, derived mostly from the Santa Monica Mountains, including gravel and sand of stream channels. Note that Campbell et al. (2014) incorporate the earlier mapping of Yerkes & Campbell (2005), Dibblee (1991), and Hoots and Kew (1931). The site location is presented on the 1931 map by Hoots and Kew for historical reference on Figure 11.

8.2 Active Tectonic Setting

Three broad fault zones identified by the USGS Quaternary Fault and Fold Database and used in the 2014 National Seismic Hazard Map (NSHM) (Field et al., 2015, also cited as: Jennings, 2010; SCEC, 2014) are mapped within the site vicinity. These zones are the Santa Monica, Hollywood, and Newport-Inglewood faults of the Transverse Range southerly bounding fault system (Figure 9). The Santa Monica, Newport-Inglewood (West Pico strand), and Hollywood faults have been studied under the Alquist-Priolo act for site specific assessments, which have designated portions of these faults to be Holocene active (Jones et al., 1990; Weaver and Dolan, 2000; Dolan et al., 2000a & b).

8.2.1 Santa Monica Fault Zone (SMFZ)

The SMFZ is characterized as a north-dipping, reverse-left-oblique fault that trends roughly northeast. The section of the Santa Monica fault related to the AP zone just southwest of the site extends for approximately 25 miles, from the Pacific Palisades at the Santa Monica coastline to the West Hollywood area along the southern base of the Santa Monica Mountains, and strikes between N75° to 50° E (Dolan et al., 2000a and Olson, 2018). The SMFZ is part of a regional fault system that extends along the southern boundary of Transverse Ranges (Figure 9).
This study has divided the discussion of the SMFZ assumed characteristics and data into two main portions, the heavily investigated and data-rich southwestern portion of this fault segment, and the newer and less defined northeastern portion of this segment of the SMFZ. Lot 12 lies northwest of the eastern terminus of the mapped SMFZ segment (Figures 4 and 5).

The northeastern strand of the SMFZ is projected to the surface between the Cheviot Hills and the West Hollywood termination of the mapped fault trace, as shown on Figure 12. This segment was originally mapped as buried and projecting to the surface in two strands south of the project area by KGS (2016). The January 2018 updated Alquist-Priolo Earthquake Zone of Required Investigation Map (EZRIM) (Figure 3) defined the active fault trace by utilizing the median location of these two surface trace interpretations of KGS (2016), linking a drainage deflection point in the Cheviot Hills to the west of the site, and groundwater barrier lineaments within 0.2 and 0.45 miles of the site (Olson, 2018).

The northeastern SMFZ segment is generally based on the eastward projection of a fault zone interpreted east of the Beverly Hills High School (Metro, 2017n and 2017j), an analysis of groundwater well data obtained from various sources, and topographic survey data collected by Los Angeles between 1985 and 2000 (the analyses were conducted by Petra Geosciences and reported by Olson, 2018). These data were reportedly collected and reviewed to investigate the area for “potential shallow subsurface faulting” (Olson, 2018). The groundwater data reportedly show a 30-foot drop in groundwater elevation over a horizontal distance of 250 feet, and the leveling data shows a zone of differential subsidence (Olson, 2018). Because these interpreted anomalies roughly align with the trend of the Santa Monica fault, they were considered suggestive of the presence of a fault in the shallow subsurface, although “no faults were specifically interpreted from these data” (Olson, 2018).

The northeastern portion of the SMFZ is not well defined. The surface expression, geomorphic evidence, recurrence interval, and slip rate are not specified by the CGS FER 259 for this portion of the fault. The activity status for this portion of the fault is currently defined by studies on the southwestern portion of this segment.

The southwestern portion of the eastern segment of the SMFZ is roughly confined between the Pacific Palisades and the Cheviot Hills, and has slip rates estimated between 0.27 to 1.0 mm/yr: 0.27 to 0.39 mm/yr at the low end of the estimated range, based on geomorphic offset (Peterson and Wesnousky, 1994); to the moderate dip-slip values of 0.5 to 0.6 mm/year. These are based on subsurface unit offsets (Dolan et al., 1997; Dolan et al., 2000a); and 1.0 mm/yr at the high end of the range, derived from mechanical models (Cooke and Marshall, 2006). The most recent ground surface rupture for this portion of the eastern segment is seven to eight thousand years ago, based on scarp exposed in trenches underlying the Veterans Memorial Hospital, preserved fault scarps paralleling the present-day mapped trace and offset soil development ages of alluvial fans along the segment (Dolan et al., 2000a and Olson, 2018).

The location and character of the individual traces characterizing this fault zone varies between available publications. Past research places the main fault at the mountain front (Hoots and Kew, 1931; Dibbler, 1991), while more recent studies have sited the fault underlying the outwash plain to the south (Wright, 1991 and Tsutsumi et al., 2001), and have inferred faults through or connecting the mountain front and the outwash plains (Hill et al., 1978; and Hill1979; Crook and Proctor, 1992; Dolan et al., 1992, 1997; KGS, 2014, 2016). As another example, the mapped fault trace in Figure 10 (Campbell, et. al, 2014) is further north, does not extend as far northwest as
the more recently mapped trace in Figure 3, and stops before crossing the Cheviot Hills (Olson, 2018). Wright (1991) shows the Santa Monica fault terminating approximately 3,000 feet below the ground surface, at or just below the contact between the Pico and Repetto formations of Pliocene age (approximately two to five million years old). Given the locational uncertainties, the location of the Santa Monica fault at or near the ground surface is approximated as a center line to the mapped AP zone (Olson, 2018). The lack of specific evidence indicating Holocene activity led Smith (1978) to exclude the Santa Monica fault from zoning under the criteria of the AP Act when initially reviewed by the state.

Between the 1980s and early 2000s, Crook et al. (1983, 1992), Dolan et al. (1992, 1997a, 2000), Pratt et al. (1998), and Catchings et al. (2001, 2008) published various geomorphic, geophysical, and paleoseismic studies that show the SMFZ consists of a series of north-dipping, high-angle left-lateral reverse faults expressed at the surface by several stepping, broad folds that stretch across the northern part of the basin, outward from the mountain front (mapped scarps highlighted in dark gray on Figure 5). Geophysical studies confirmed that the zone consists of two main north-dipping branches (referred to as the North and South branches) that merge at a depth of approximately 1.4 miles (Catchings, et. al., 2001 and 2008; GEOVision, 2012; and Metro, 2017c). The North Branch (which the CGS refers to as the Santa Monica fault) has been investigated at a few locations, including the Veterans Administration property (Crook et al., 1983, Dolan et al., 2000), and at University High School (MACTEC, 2004a, 2004b, 2007), where a series of steeply dipping to subvertical faults that offset late Quaternary deposits were exposed in trenches. These studies at the VA property (Pratt et al., 1998; Dolan et al., 2000; Meigs, 2008; Catchings et al., 2001) and the University High School match the SMFZ associated topographic scarps and connect to correlate with a zone of subvertical faults offsetting late Quaternary deposits. Although the faults exposed by Dolan et al. (2000) and MACTEC (2004a) are probably upper-plate features rather than the main fault zone, the findings of these studies were the first to suggest that the Santa Monica fault has ruptured in the Holocene and should therefore be considered active. About two miles to the west of the project site, a study adjacent to the Mormon Temple also found evidence of Holocene activity, presumably along the same strand (AES, 2015a, 2015b, and 2016).

8.2.2 Newport-Inglewood Faults Zone (NIFZ)

The north- to northwest-trending Newport-Inglewood fault zone (NIFZ) has been mapped across the western part of the Los Angeles basin, with the onshore section of this fault forming the elevated surfaces that stretch from Newport Mesa in the south to the Cheviot and Beverly Hills to the north. Given the project site location, only the northern reach of the NIFZ is pertinent, and thus discussed in this section (Figures 4 and 5).

The location of the northern part of the NIFZ has been mapped in multiple locations and orientations, with some research supporting bending the fault zone westward as it approaches the Santa Monica fault (Lang and Dreesen, 1975; Hill et al., 1978, 1979). Other research places it near the eastern base of the Cheviot Hills or along the geomorphic break referred to as the West Beverly Hills Lineament (Dolan et al., 1992, 1997, as adopted by the U.S. Geological Survey and the CGS in 2006. Still others have mapped it farther east (Poland et al., 1959; Erickson and Spaulding, 1975; Wright, 1991; Metro, 2017n and j; Olson, 2018). A fault investigation of the West Beverly Hills Lineament (see Area B on Figure 5) at Beverly Hills High School determined that this geomorphic break is not a fault, but rather it is the expression of channel incision during
the most recent low sea-level stands (Leighton, 2012a, 2012b, 2012c, 2015, and 2016; ECI, 2012a, 2012b). In short, the uplifted region and lineament are commonly accepted geomorphic features with multiple proposed tectonic drivers, none of which have been incorporated as a state-accepted active tectonic feature at this time (Olson et al, 2018).

Poland et al. (1959) used differences in the depth to groundwater to postulate a trace of the Newport-Inglewood fault. Erickson and Spaulding (1975) inferred two other north-trending faults farther east. From west to east, these were referred to as the Inglewood and West Pico faults. The West Pico fault was interpreted from oil well records at a depth of about 3,000 feet, with differences in depth to groundwater suggesting that it extends upward, close to the ground surface. Consequently, the CGS (2018) placed the West Pico fault within an AP EFZ (Figures 4 and 5). The West Pico fault is identified by the CGS as the easternmost lineament mapped for the Newport-Inglewood strands per Erickson and Spaulding (1975) and has been reintroduced, linking the NIFZ to the Beverly Hills lineament per previous interpretations (Olson, 2018). At its closest approach, this EFZ is approximately 1.5 miles to the southeast of the project site, and, given its northerly trend, its northward surface projection would pass about 0.8 mile east of and would not impact the project site.

8.2.3 Hollywood Fault (HFZ)

The Hollywood Fault Zone (HFZ) is a north-dipping, left-reverse fault trending approximately northeast-southwest for about nine miles from the western edge of West Hollywood to the Elysian Valley, along the southern base of the Santa Monica Mountains (CBH, 2018 and Olson, 2018). The HFZ is part of a regional fault system that extends for nearly 125 miles along the southern boundary of Transverse Ranges (Figure 9).

The HFZ has slip rates estimated between 0.33 and 0.75mm/yr (Petersen and Wesnousky, 1994); with a higher estimated value of 1.0mm/yr derived from mechanical models (Cooke and Marshall, 2006). The most recent surface ground rupture for this segment is mid-Holocene, based on bifurcated stream incisions and trench and boring transects, within the AP EFZ (Dolan et al., 2000b and Olson, 2018). The Hollywood fault is mapped with the closest surface projection located approximately 0.5 mile to the north of the site (Olson, 2018 and CBH, 2018).

9.0 REGIONAL SEISMICITY

According to the USGS 2014 California Seismic Source Model (Field, 2015), the closest known active faults capable of producing the strongest ground shaking at the site are the Santa Monica fault, approximately 0.4 miles (0.7 km); the Hollywood fault, approximately 0.7 mile (1.2 km) north of the site; and the Newport-Inglewood fault, approximately 2.3 mile (3.7 km) southeast of the site (Figure 3, 4, 11, and Table 4). The distance to faults within about 62 miles (100 km), mean characteristic moment magnitude, mean slip rate and fault length are shown in Table 4.
### TABLE 4 - Seismic Source Characterization Within 100 Kilometers (62 Miles) of the Site

<table>
<thead>
<tr>
<th>Fault Name</th>
<th>Distance (km)</th>
<th>Faulting Mechanism</th>
<th>Direction from Fault to Site</th>
<th>Mean Characteristic Moment Magnitude</th>
<th>Mean Slip Rate (mm/yr)</th>
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</thead>
<tbody>
<tr>
<td>San Vicente</td>
<td>0.9</td>
<td>thrust</td>
<td>N</td>
<td>NA</td>
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<tr>
<td>Hollywood</td>
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<td>6.7</td>
<td>1.6</td>
</tr>
<tr>
<td>Santa Monica alt 1</td>
<td>1.7</td>
<td>strike slip</td>
<td>NE</td>
<td>6.6</td>
<td>1.2</td>
</tr>
<tr>
<td>Newport-Inglewood alt 1</td>
<td>3.7</td>
<td>strike slip</td>
<td>N</td>
<td>7.2</td>
<td>1.3</td>
</tr>
<tr>
<td>Newport-Inglewood alt 2</td>
<td>3.7</td>
<td>strike slip</td>
<td>N</td>
<td>7.2</td>
<td>1.0</td>
</tr>
<tr>
<td>North Salt Lake</td>
<td>4.1</td>
<td>thrust</td>
<td>SW</td>
<td>NA</td>
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<tr>
<td>Elysian Park (Lower CFM)</td>
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<td>thrust</td>
<td>NW</td>
<td>NA</td>
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</tr>
<tr>
<td>Puente Hills (LA)</td>
<td>7.4</td>
<td>thrust</td>
<td>NW</td>
<td>7.0</td>
<td>.8</td>
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<tr>
<td>Puente Hills</td>
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<td>thrust</td>
<td>W</td>
<td>7.1</td>
<td>1.0</td>
</tr>
<tr>
<td>Elysian Park (Upper)</td>
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<td>thrust</td>
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<td>6.7</td>
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<tr>
<td>Malibu Coast alt 2</td>
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<td>Malibu Coast alt 1</td>
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<tr>
<td>Anacapa-Dume alt 2</td>
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<td>Verdugo</td>
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<td>SW</td>
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</tr>
<tr>
<td>Raymond</td>
<td>16.7</td>
<td>strike slip</td>
<td>SW</td>
<td>6.7</td>
<td>1.7</td>
</tr>
<tr>
<td>Northridge Hills</td>
<td>17.7</td>
<td>thrust</td>
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</tr>
<tr>
<td>Palos Verdes</td>
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<td>2.7</td>
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<td>Mission Hills 2011</td>
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<td>S</td>
<td>6.5</td>
<td>0.9</td>
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<tr>
<td>Sierra Madre (San Fernando)</td>
<td>22.7</td>
<td>thrust</td>
<td>SW</td>
<td>6.7</td>
<td>1.7</td>
</tr>
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<td>Sierra Madre</td>
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<td>7.2</td>
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<td>Compton</td>
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<td>0.9</td>
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<tr>
<td>Santa Susana East (connector)</td>
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<td>S</td>
<td>6.4</td>
<td>3.7</td>
</tr>
<tr>
<td>Northridge</td>
<td>25.9</td>
<td>thrust</td>
<td>S</td>
<td>6.9</td>
<td>1.4</td>
</tr>
<tr>
<td>Santa Susana alt 2</td>
<td>26.7</td>
<td>thrust</td>
<td>S</td>
<td>6.9</td>
<td>4.6</td>
</tr>
<tr>
<td>Santa Susana alt 1</td>
<td>28.0</td>
<td>thrust</td>
<td>SW</td>
<td>6.9</td>
<td>4.6</td>
</tr>
<tr>
<td>San Gabriel (Extension)</td>
<td>28.0</td>
<td>strike slip</td>
<td>SW</td>
<td>NA</td>
<td>0.6</td>
</tr>
<tr>
<td>San Gabriel</td>
<td>28.8</td>
<td>strike slip</td>
<td>SW</td>
<td>7.2</td>
<td>0.7</td>
</tr>
<tr>
<td>Redondo Canyon alt 1</td>
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<td>S</td>
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<tr>
<td>Anacapa-Dume alt 1</td>
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<td>thrust</td>
<td>NE</td>
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<td>0.7</td>
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<tr>
<td>Puente Hills (Santa Fe Springs)</td>
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<td>Redondo Canyon alt 2</td>
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<td>Whittier alt 2</td>
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<td>3.4</td>
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<td>Whittier alt 1</td>
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<td>W</td>
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<td>San Pedro Escarpment</td>
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<td>San Pedro Basin</td>
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<tr>
<td>Anaheim</td>
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<tr>
<td>Holser alt 1</td>
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<td>thrust</td>
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<td>6.9</td>
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<tr>
<td>Clamshell-Sawpit</td>
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<td>thrust</td>
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<td>0.3</td>
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<tr>
<td>Puente Hills (Coyote Hills)</td>
<td>38.4</td>
<td>thrust</td>
<td>NW</td>
<td>6.8</td>
<td>0.9</td>
</tr>
</tbody>
</table>
### TABLE 4 - Seismic Source Characterization Within 100 Kilometers (62 Miles) of the Site

<table>
<thead>
<tr>
<th>Fault Name</th>
<th>Distance (km)</th>
<th>Faulting Mechanism</th>
<th>Direction from Fault to Site</th>
<th>Mean Characteristic Moment Magnitude</th>
<th>Mean Slip Rate (mm/yr)</th>
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</thead>
<tbody>
<tr>
<td>Holser alt 2</td>
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<td>unassigned</td>
<td>SE</td>
<td>6.7</td>
<td>0.6</td>
</tr>
<tr>
<td>Del Valle</td>
<td>44.4</td>
<td>thrust</td>
<td>SE</td>
<td>6.4</td>
<td>1.5</td>
</tr>
<tr>
<td>Oak Ridge (Onshore)</td>
<td>46.7</td>
<td>thrust</td>
<td>SE</td>
<td>7.2</td>
<td>4.1</td>
</tr>
<tr>
<td>San Jose</td>
<td>47.9</td>
<td>strike slip</td>
<td>W</td>
<td>6.7</td>
<td>0.4</td>
</tr>
<tr>
<td>Malibu Coast (Extension) alt 1</td>
<td>49.7</td>
<td>strike slip</td>
<td>E</td>
<td>6.6</td>
<td>0.4</td>
</tr>
<tr>
<td>Malibu Coast (Extension) alt 2</td>
<td>49.7</td>
<td>unassigned</td>
<td>E</td>
<td>6.9</td>
<td>0.5</td>
</tr>
<tr>
<td>Santa Monica Bay</td>
<td>49.8</td>
<td>thrust</td>
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</tr>
<tr>
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<td>52.3</td>
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<td>5.7</td>
</tr>
<tr>
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<tr>
<td>San Andreas (Mojave S)</td>
<td>58.7</td>
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<tr>
<td>San Joaquin Hills</td>
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<td>NW</td>
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<td>0.6</td>
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<tr>
<td>Chino alt 2</td>
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<td>W</td>
<td>6.8</td>
<td>0.9</td>
</tr>
<tr>
<td>Chino alt 1</td>
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<td>strike slip</td>
<td>W</td>
<td>6.6</td>
<td>1</td>
</tr>
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<td>Cucamonga</td>
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<td>thrust</td>
<td>W</td>
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<td>1.9</td>
</tr>
<tr>
<td>Ventura-Pitas Point</td>
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<td>1.7</td>
</tr>
<tr>
<td>San Andreas (Mojave N)</td>
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<td>strike slip</td>
<td>S</td>
<td>7.0</td>
<td>24.2</td>
</tr>
<tr>
<td>Newport-Inglewood (Offshore)</td>
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<td>strike slip</td>
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</tr>
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<tr>
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<tr>
<td>Santa Cruz Catalina Ridge alt2</td>
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<tr>
<td>San Diego Trough north alt1</td>
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<td>1.7</td>
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<td>Santa Ynez (East)</td>
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<td>strike slip</td>
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<td>7.1</td>
<td>1.7</td>
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<td>Sisar</td>
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<td>Fontana (Seismicity)</td>
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<td>Channel Islands Thrust</td>
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<td>6.9</td>
<td>14.2</td>
</tr>
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<td>Oceanside alt1</td>
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<td>thrust</td>
<td>NW</td>
<td>7.2</td>
<td>0.7</td>
</tr>
<tr>
<td>Oak Ridge (Offshore)</td>
<td>83.2</td>
<td>thrust</td>
<td>E</td>
<td>6.9</td>
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<tr>
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<td>thrust</td>
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<td>1.1</td>
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<tr>
<td>San Jacinto (San Bernardino)</td>
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<td>strike slip</td>
<td>W</td>
<td>7.0</td>
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<td>Red Mountain</td>
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<td>Cleghorn</td>
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<td>San Andreas (Big Bend)</td>
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<td>strike slip</td>
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<td>23.1</td>
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</table>
**TABLE 4 - Seismic Source Characterization Within 100 Kilometers (62 Miles) of the Site**

<table>
<thead>
<tr>
<th>Fault Name</th>
<th>Distance (km)</th>
<th>Faulting Mechanism</th>
<th>Direction from Fault to Site</th>
<th>Mean Characteristic Moment Magnitude</th>
<th>Mean Slip Rate (mm/yr)</th>
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</thead>
<tbody>
<tr>
<td>Channel Islands Western Deep Ramp</td>
<td>93.3</td>
<td>thrust</td>
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<td>NA</td>
<td>0.6</td>
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<tr>
<td>Garlock (West)</td>
<td>94.2</td>
<td>strike slip</td>
<td>SE</td>
<td>7.4</td>
<td>4.3</td>
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<tr>
<td>San Clemente</td>
<td>95.3</td>
<td>strike slip</td>
<td>NE</td>
<td>7.4</td>
<td>1.9</td>
</tr>
<tr>
<td>Big Pine (Central)</td>
<td>97.1</td>
<td>thrust</td>
<td>SE</td>
<td>NA</td>
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</tr>
<tr>
<td>North Channel</td>
<td>98.6</td>
<td>thrust</td>
<td>E</td>
<td>NA</td>
<td>0.9</td>
</tr>
<tr>
<td>Big Pine (East)</td>
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<td>strike slip</td>
<td>SE</td>
<td>6.7</td>
<td>0.5</td>
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<tr>
<td>San Diego Trough north alt2</td>
<td>99.5</td>
<td>unassigned</td>
<td>N</td>
<td>7.2</td>
<td>1.8</td>
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<td>Pitas Point (Lower)- Montalvo</td>
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<td>thrust</td>
<td>E</td>
<td>7.3</td>
<td>1.6</td>
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</tbody>
</table>

**Notes:**
1. Seismic source characterization based on information provided by SCEC/USGS UCERF 3 (Field, 2015).
2. Characterization of faults with multiple segments and geometry uses a distribution of magnitudes, slip rates, and fault segment rupture scenarios; best estimates provided above. Refer to SCEC/USGS UCERF 3 (Field, 2015), 2014 NSHM (Petersen et al., 2014).
3. Magnitude referenced from USGS BSSC 2014 (Scenario Catalog).
4. NA – Magnitude is not available and not provided by BSSC 2014 (Scenario Catalog).

A search of the USGS ANSS Comprehensive Earthquake Catalog (ComCat) using a web-based Earthquake Archive Search and URL builder tool, found that as of 16 July 2021, 50 earthquakes with magnitudes 5.0 or greater have occurred within a 62 mile (100-km) radius of the site since 1 January 1800.

Earthquakes of all magnitudes occurring within roughly 7 km of the site since 1 January 1800 are presented on Figure 12. No earthquakes over magnitude 4.9 have been recorded based on this criteria.

The 2014 Working Group for California Earthquake Probabilities (WGCEP) at the U.S. Geologic Survey (USGS) predicted a 60 percent chance of a magnitude 6.7 or greater earthquake occurring in the Los Angeles Area in 30 years (Field, 2015-UCERF 3).

**10.0 SUBSURFACE CONDITIONS**

The geologic materials encountered beneath the site during our field investigation program included artificial fill, Holocene alluvium, and two packages of older alluvium that consists of distal alluvial fan and stream channel deposits of Pleistocene age. Each of these deposits are described from youngest to oldest in more detail in the sub-sections below.

The geotechnical descriptions in the boring logs (Appendix A) identify the primary or alluvial stratigraphic contacts while the soil stratigraphic descriptions (Appendix E) identify both the primary and secondary (or pedogenic) contacts. Secondary contacts are most often subtle material differences related to diagenetic changes in materials after deposition. Most alluvial packages geotechnically identified on site are punctuated with different degrees of soil
development. Each soil package contains either sharp or gradational contacts from which relative age estimates are made.

The soil stratigraphic report is included in Appendix E.

### 10.1 Geologic Units

The continuity of soil horizons and primary stratigraphic contacts provides essential data to evaluate the presence or absence of faulting. Four conformable distinct soil stratigraphic units within the alluvium were encountered in the borings and CPTs. For more detailed descriptions of these units, refer to the boring logs in Appendix A and the soil descriptions in Appendix E. Relative ages of each stratigraphic unit encountered based on the Soil Development Index (SDI), as well as corresponding carbon date ages, where available, are presented in Table 5. The lateral extent of these deposits under the site is illustrated in the cross-sections A-A’ and B-B’ (Figure 13) and described below.

<table>
<thead>
<tr>
<th>Stratigraphic Unit</th>
<th>Location</th>
<th>Depth (ft)</th>
<th>Section Age Estimate (ka)</th>
<th>14C Age (years BP), Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qal1</td>
<td>B-4</td>
<td>5.0 - 10.8</td>
<td>4 – 8</td>
<td>N/A</td>
</tr>
<tr>
<td>Qal2</td>
<td>B-4</td>
<td>10.8 - 17.0</td>
<td>12 – 23</td>
<td>11,210 +/- 25, B-1 at 16’</td>
</tr>
<tr>
<td>Qoa1</td>
<td>B-4</td>
<td>17.0 - 35.9</td>
<td>20 – 50</td>
<td>N/A</td>
</tr>
<tr>
<td>Qoa2</td>
<td>B-4</td>
<td>35.9 - 40.0+</td>
<td>33 – 65</td>
<td>35,130 +/- 340, B-7 at 33.5’</td>
</tr>
</tbody>
</table>

#### 10.1.1 Artificial Fill (af)

Four to nine and a half feet of artificial fill was encountered above the native soil at every boring location advanced within the study area. Fill was generally characterized as fine to medium grained, brown to gray silty sand.

#### 10.1.2 Holocene Alluvial Fan Deposit (Qal1)

The uppermost unit beneath the artificial fill in sections A-A’ and B-B’ (Figure 13) is composed of silty sand, sandy clay, and sandy silt with varying gravel content. Sand is generally fine- to medium-grained and gravel is generally fine to medium and subangular to subrounded. Soil matrix hues are in the 10YR to 7.5YR range (brown). Soil stiffness ranges from slightly hard to hard from the top to bottom of the unit. We interpret this unit as a Holocene-aged alluvial deposit that has developed into three soil horizons, a truncated weak soil at the top, a cambic horizon in the middle, and a truncated weak argillic horizon at the base.

Stratigraphic unit Qal1 is characterized by low CPT sleeve friction values (less than 2 tons per square foot, tsf) and by low CPT tip resistance values (less than 50 tsf) that represent the truncated and weakly developed argillic diagnostic subsurface horizons. The basal contact of the Qal1 unit with the underlying Qal2 unit is a clear scour and characterized by a slight increase in CPT tip resistance.

No carbon was observed or collected for dating from this unit; however, soil relative age dating indicates this sequence of alluvial deposits started in the middle Holocene (Table 5, Appendix E).
10.1.3 Earliest Holocene Alluvial Fan Deposit (Qal2)

The earliest Holocene unit on sections A-A’ and B-B’ (Figure 13) is composed of fine-grained sandy clay, clay, and clay with silt. Soil matrix hues are in the 10YR to 7.5YR range (brown). The soil is hard to very hard, massive, and slightly to moderately well oxidized. We interpret this unit as an early Holocene- to latest Pleistocene-aged alluvial deposit that is weakly developed into argillic soil horizons. The uppermost horizon in this unit is stacked and truncated by overlying scour deposits.

Stratigraphic unit Qal2 is also characterized by low CPT sleeve friction (primarily between 1 and 4 tsf) and low CPT tip resistance (primarily between 50 and 100 tsf) values that represent the weakly developed argillic subsurface horizons. The basal contact of the Qal2 unit with the underlying Qoa1 unit is characterized by a gradational increase in CPT sleeve friction and tip resistance values.

One sample of carbon acquired near the boundary between unit Qal2 and the underlying Qoa1 indicated that soil deposition in this zone occurred close to the Holocene-Pleistocene boundary, usually taken to be approximately 11,700 years ago.

10.1.4 Latest Pleistocene Alluvial Fan Deposit (Qoa1)

The latest Pleistocene unit on sections A-A’ and B-B’ (Figure 13) is composed of sandy clay that grades to silty or clayey sand that grades to gravelly sand or sand. Fine- to coarse-grained sand content varies throughout the unit. Fine to medium, sub-angular to sub-rounded slate gravel is common throughout the unit and increases with depth. Soil matrix hues are in the 7.5YR to 10YR to 2.5Y range (brown to olive brown). Qoa1 grades from very hard and moderately well oxidized at the top to soft/loose and slightly oxidized at the base. We interpret this unit as a sequence of late Pleistocene age alluvial fan deposits and braided stream channels.

The top of unit Qoa1 consists of a stacked, truncated, moderately strong argillic soil horizon that grades to one to two weaker argillic soil horizons below. At the northeast end of the project site, two additional scour deposits are present below the two scour deposits continuous across the site. These four scour deposits are locally punctuated by three discontinuous, weakly developed, truncated cambic soil horizons.

Stratigraphic unit Qoa1 is characterized by higher CPT tip resistance peaks (greater than 100 tsf) and higher CPT sleeve friction values (with peaks up to 10 tsf) that decrease with depth (to around 2 tsf). This represents the very hard to hard stacked, truncated soil remnant that grades to a medium dense scour deposit.

No carbon was observed or collected for dating from this unit; however, soil relative age dating indicates that the basal coarse-grained alluvium was deposited in the late Pleistocene (Table 5, Appendix E).

10.1.5 Pleistocene Alluvial Fan Deposit (Qoa2)

Beneath unit Qoa1, we encountered a unit composed of clay and fine- to coarse-grained sandy clay (Figure 13). The unit is massive, slightly to moderately well oxidized, and hard to very hard. Soil matrix hues are in the 7.5YR to 10YR range (brown) with some localized 2.5Y olive brown gleyed zones. Fine to medium, sub-rounded slate gravel is rare at the top of the unit and more common towards the base of the unit. This unit is interpreted as a Pleistocene alluvial fan deposit.
that contains one to two truncated, moderately strong argillic soil horizons. Unit Qoa2 is observed across the project site with very little variation in depth bgs (between 33.3 and 36.8 feet in borings B-1, B-4, and B-7).

Stratigraphic unit Qoa2 is characterized by relatively moderately low tip resistance values (less than 100 tsf) and low CPT sleeve friction values (around 2 tsf) that represent a moderately well-developed argillic horizon. Both of these measurements increase with depth with tip resistance peaks around 200 to 500 tsf and sleeve friction values between 4 and 6 tsf.

Carbon dating indicates these clay-rich and highly weathered alluvial deposits are Pleistocene in age (Table 5, Appendix D). Soil relative age dating similarly indicates that the age of this deposit is late Pleistocene (Table 5, Appendix E).

10.1.6 Discontinuities

Both Holocene units, Qal1 and Qal2, are laterally continuous across the site and dip gently to the northeast subparallel to surficial topography. The upper stratigraphic correlations within the latest Pleistocene unit, Qoa1, are laterally continuous across the site. Unit Qoa1 gradationally thin s to the northeast along cross section A-A’ and exhibits two discontinuous scour deposits. This gradational thinning along strike of the cross section is attributed to normal sedimentary processes and defines a broad drainage with a W-E axis of deposition (paleo flow direction) visible on Figure 11. The earliest Pleistocene unit observed, Qoa2, is laterally continuous across the site, the surface of which is subparallel to surficial topography (Figure 13).

10.2 Relative Soil Profile Development

For the Quaternary geologist, a soil is defined as a natural body that consists of horizons of organic and/or mineral constituents, which differ from its parent material in some way (Birkland, 1984). This study is concerned with a section of alluvial soils derived from the southern range front of the Santa Monica Mountains. The borings lie across a graded (or stripped) and artificially filled surface that is geomorphically inactive due to urban development. The soil profile in each boring consists of a truncated sequence of multiple stacked and truncated soils (Qal1, Qal2, Qoa1, and Qoa2). The entire section is capped by 4 to 9½ feet of artificial fill. Parent materials for these soils are chiefly slate-rich debris flow and/or stream channel deposits that have most likely shed from alluvial aprons upslope and deposited along distributary fans from Benedict Canyon.

Additional details of the soil profile development are provided in Appendix E.

10.3 Groundwater Indicators

A potential indicator for the presence of a fault is the sudden change in the depth to groundwater. Past studies have shown that both inactive and active fault strands along the Santa Monica fault zone act as groundwater barriers and produce abrupt steps in the groundwater surface (Olson, 2018).

Groundwater was not encountered in any of the borings or CPTs advanced at the project site to a depth of 50 feet. This is consistent with groundwater levels reported by the CGS in the site vicinity (Olson, 2018; Figure 8). According to FER 259 Figure 21, two northeast-trending groundwater barriers are mapped approximately 250 feet northwest and 1100 feet southeast of the site, respectively. If the barrier northwest of the site was extended towards the site, it would not cross the site, but would project approximately 400 feet southwest of the site. Our
explorations indicate a groundwater level deeper than 50 feet bgs across the site, which is consistent with the groundwater level southeast of the mapped barrier and suggests the barrier does not cross the site. The groundwater barrier southeast of the site was partially incorporated into the mapped trace of the Santa Monica Fault in the January 2018 updated Alquist-Priolo EZRIM (Figure 3), but a fault study on that barrier found unbroken stratigraphy and an absence of active faulting (ECI, 2018).

### 11.0 DISCUSSION AND CONCLUSIONS

To assess the potential for fault rupture at the site, we reviewed several regional and site-specific investigations and analyses, and compared them with the results of our own field investigation and analyses.

The CGS has updated and defined the new AP EFZs and traces of active faults in this region (Olson, 2018). Our report, while including a review of raw data and the interpretations developed by others (Table 1), relies more heavily upon the site-specific data collected for our study and the updated summary provided by the CGS for interpretations of fault activity and trace location (Olson, 2018; Campbell, 2014). The Metro (2017j) studies interpret active faulting in the Beverly Hills area based on the presence of truncated soil sequences, Holocene strata thickening within the fault zone and localized sag pond deposits; it is noted that the shears and faults were only directly observed in alluvium of Pleistocene age. No such features were encountered at the Lot 12 site.

An investigation by Stoney-Miller Consultants, Inc. (2018) at 425 N. Palm Drive encountered un-faulted alluvial sediments similar to those encountered below Lot 12. An investigation by ECI (2018) at 322 Foothill Road encountered laterally continuous Holocene and late Pleistocene sediments similar to those encountered below Lot 12. This study concluded that no active faults traverse the property at the northeast end of the Santa Monica EFZ, 950 feet southeast of Lot 12. An investigation by Advanced Geotechniques (2013) at 935 N San Vicente Blvd encountered un-faulted Holocene and late Pleistocene sediments that suggest that the Hollywood Fault trace lies north of the site.

Lot 12 lies in the convergent zone between the Santa Monica, Hollywood, and Newport-Inglewood faults. The relationship between these faults has been studied, but is still poorly understood. KGS (2016) mapped two approximately located to inferred fault traces that connect the Santa Monica and Hollywood fault zones, but definitive evidence for Holocene fault activity on these traces has not been found. The SMFZ passes 950 feet southeast of the site while the HFZ passes 3,500 feet northeast of the site and is consistent with fault scarps mapped by Dolan et al. (2000a). The Newport-Inglewood Fault Zone has been extended north along the topographic escarpment called the West Beverly Hills lineament, but Holocene fault activity along this lineament has not been proven (Olson, 2018). Though the site exists in a tectonically active area, no Holocene active faults are mapped across the site and the property is not located within any previous or current Earthquake Zones of Required Investigation (CGS, 2018a).

As noted by others (e.g., Dolan et al., 2000a), the pronounced geomorphic expression of the SMFZ further to the west, which includes left-laterally offset and/or deflected landforms and en echelon fold scarps, generally does not persist east of the Cheviot Hills. Based on our independent assessment of topographic data of the area (Figures 7A, B, C, and D), we do not
see geomorphic evidence suggestive of surface faulting at or in the vicinity of the site. Explanations for the absence of tectonic geomorphic features in the vicinity of the site include:

- activity on the fault dies out to the east,
- left-lateral shear is transferred north onto the Hollywood fault,
- the preservation potential of scarps is low because of erosion on the Benedict Canyon alluvial fan, or
- any subtle tectonic geomorphic features indicative of active faulting have been destroyed by urbanization.

Analyses of historical information on the early 20th century development of the area suggests that urbanization likely exploited—and therefore altered—the pre-existing topographic relief (e.g., the trolley line noted by Dolan and others [2000a]). West of the intersection of Santa Monica Blvd and Avenue of the Stars, this topographic break associated with the trolley line is likely controlled in part by the SMFZ. East of the intersection, the topographic break bends north and the historic trolley line continues northeast through the project site.

Based on Soil Development Indices (SDIs), the bottom of the Holocene/top of the Pleistocene-aged materials (HP) boundary was established at approximately 14 to 16 feet bgs across the area investigated. The two units above this depth, Qal1 and Qal2, are laterally continuous across the site. The first unit below the HP boundary, Qo1, is an alluvial unit with a scoured base conservatively interpreted to be a stage 2 gravel equivalent. Figure 14 shows the evidence for regional, early Holocene, incipient soil formation in Mediterranean climates and the stage 2 climatic change and general channel incision. This figure also shows that stage 3 is associated with general landscape stability and moderate relative soil development. Finally, the figure shows relative sea levels, proxy records for regional (mid latitude) climatic change and landscape stability that roughly correspond to the reported soil relative age date estimates on site.

11.1 Evidence for Absence of Faulting

Several subsurface geologic relationships at Lot 12 provide direct evidence that precludes Holocene faulting beneath the site. Topographic and groundwater analyses, when considered with subsurface mapping, provide compelling evidence for lack of surface rupture potential at the site. Evidence that supports the interpretation that no active faults traverse the site is listed below:

- The site stratigraphy is characterized by continuous, un-faulted soil horizons and unit contacts. The boring and CPT transect conducted across the long axis of the site exhibits multiple, laterally-continuous and unbroken stratigraphic and pedogenic horizons. All deposits encountered correlate well across the project site. If faults with a vertical component of slip were active in this area, they would have produced recognizable, vertical separations or displacements of the Holocene and Pleistocene units. Similarly, recurrent active strike-slip faulting would have produced an apparent dip-slip component or truncation of units due to the juxtaposition of different Holocene and Pleistocene strata or pedogenic horizons.
- No fault planes, shear surfaces or anomalous high-angle unit contacts were observed in the in the recovered continuously-cored samples. While these samples and exposures only preclude the presence of faulting at the locations of the explorations, they are consistent with and corroborate the other lines of evidence.
• The Metro studies (2017) state that varved (repetitive and layered) sediments and sag pond (a depression formed between two strike-slip faults) deposits provide evidence for faulting. Neither were encountered in the subsurface across the project site.

• There is no evidence suggestive of any large groundwater barrier at the project site. Groundwater level across the site is deeper than 50 feet below ground surface. Though not compelling enough to preclude the presence of faulting, it is consistent with and corroborates other lines of evidence.

• No topographic scarps, lateral deflections/offsets of linear geomorphic features, or sag-ponds were observed in historical photos or the topographic profiles (Figures 7A-7D) at the project site.

12.0 LIMITATIONS

Our services have been performed in accordance with generally accepted principles and practices of the geological and geotechnical profession. In addition, the conclusions presented in this report are professional opinions based on the indicated project criteria and data described in this report. They are intended only for the purpose, site location and project indicated.

This report has been prepared for the exclusive use of Beverly Hills Land Company, LLC and applies only to the proposed development located at Lot 12 (APNs 4342-015-038 and 4342-015-040) in the City of Beverly Hills, California. In the event that significant changes in the construction plans should occur, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed by Langan, and the conclusions and recommendations of this report are verified in writing.
REFERENCES


CGS, 2018a, Earthquake Zones of Required Investigation Beverly Hills 7.5 Minute Quadrangle: Department of Conservation, revised official map released January 11, 2018, scale 1:24,000.


City of Beverly Hills (CBH), 2019b. Guidelines for Evaluating Potential Surface-Fault Rupture within the City of Beverly Hills, California. Released 1 January 2014; Revised 3 September.


Earth Consultants International (ECI), 2019, Seismic Investigation for the Property at 420 Lasky Drive, in the City of Beverly Hills, California: Consultant report prepared for Magen David of Beverly Hills, 162 p.


GeoCon West, Inc., 2020, Fault Rupture Hazard Investigation, 125 South Linden Drive (AKA 9744 Wilshire Boulevard) and 129 South Linden Drive, Beverly Hills, California, Tract: #6648; Lots 38, 39 & 40, Assessor ID No. 4328-009-07 & -021, dated October 7.

_____, 2015, Response to geology report correction letter, fault rupture hazard investigation, Buerge mixed-use development, 11800-11842 Santa Monica Boulevard, Los Angeles, California, dated January 9.
_____ 2014a, Report of fault rupture hazard investigation, Buerge mixed-use development, 11800-11842 Santa Monica Boulevard, Los Angeles, California, dated October 17.

_____ 2014b, Phase II site-specific fault rupture investigation, 9900 Wilshire Boulevard, Beverly Hills, California, dated May 6.

_____ 2013, Fault rupture hazard investigation, 1801 Avenue of the Stars, 10250 Santa Monica Boulevard, 1930 Century Park West, Century City-Los Angeles, California, dated October 18.

GeoKinetics, 2014, Summary of Fault Trench Study at 10131 Constellation Boulevard, Century City, CA.


Hoots, H.W., and Kew, W.S.W., 1931, Geology of the eastern part of the Santa Monica Mountains, Los Angeles County, California: U.S. Geological Survey, Professional Paper 165, scale 1:24,000.


Lang, H. R., and Dreesen, R. W., 1975, Subsurface structure of the northwestern Los Angeles basin, in California Division of Oil and Gas Technical Papers, Report No. TP01, 33 p.


Leighton Consulting, Inc., 2015, Fault hazard assessment, El Rodeo K8 School, 655 Whittier Drive, Beverly Hills, California, dated February 27.


1. Site located in the Beverly Hills USGS Quadrangle.
2. USGS topographic basemap is provided through Langan's Esri ArcGIS software licensing and ArcGIS online, National Geographic Society, i-cubed.
3. All features shown are approximate.
Notes:
1. Aerial imagery provided by Langan's subscription to Nearmap.com.
2. All features shown are approximate.
LOT 12 & 13  
BEVERLY HILLS

EARTHQUAKE ZONES OF REQUIRED INVESTIGATION MAP

Legend

Property Boundary

Earthquake Fault Zones
Zone boundaries are delineated by straight-line segments: the boundaries define the zone encompassing active faults that constitute a potential hazard to structures from surface faulting or fault creep such that assistance as described in Public Resources Code Section 29215.5(a) would be required.

Liquefaction Zones
Areas where historical occurrence of liquefaction, or local geologic conditions such as overlying soft clay and/or historic water levels indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 29215.5(c) would be required.

Overlap of Earthquake Fault Zone and Liquefaction Zone
Areas that are covered by both Earthquake Fault Zone and Liquefaction Zone.

Notes:
1. Basemap provided by the Earthquake Zones of Required Investigation for the Beverly Hills Quadrangle, California Geological Survey.
Notes:
2. All features shown are approximate.

Legend
- Property Boundary

Project: LOT 12 & 13
BEVERLY HILLS
LOS ANGELES COUNTY, CALIFORNIA

Figure Title: CITY OF BEVERLY HILLS FINAL EARTHQUAKE FAULT ZONE MAP (JANUARY 2018)

Project No.: 721018701
Date: JULY 2021
Scale: 1" = 2,000'
Drawn By: OG
Fault Investigation Abbreviations
A) GeoKinetics, 2014
C) GeoCon West, 2014a and b
E) AMEC, 2014a, 2014b
F) ECI, 2019
G) Feffer, 2018a
H) Feffer, 2018b
I) Feffer, 2018c
J) Feffer, 2019
K) ECI, 2018
L) Langan, 2020
M) GeoCon West, 2020
N) Advanced Geotechniques, 2013
O) SMC, 2018
NA) Not available

Legend
- Observed Fault (Langan, 2020)
- Surface projection of seismic reflection lineament (Langan, 2020)
- Fault Location (Metro-Fugro, 2017c)
- Preferred Fault Location (Metro-Fugro, 2017c)
- Seismic Survey (USGS, 2020)
- MTA, Purple Line Transect 9 (Metro, 2017c)
- MTA, Transect 10 (Metro-Fugro, 2019)

Fault Investigations within City of Beverly Hills:
- Completed studies
- Active studies
- Other studies, cleared for construction outside City of Beverly Hills
- Fold scars (Dolan et al., 2000a)
- Fault zones
- Property Boundary

Fault Traces
- Accurately Located
- Approximately Located
- Approximately Located, Queried
- Inferred
- Inferred, Queried
- Concealed
- Concealed, Queried
- Aerial Photo Lineament

Notes:
1. Topographic basemap is provided through Langan's Esri ArcGIS software licensing and ArcGIS online, National Geographic Society, i-cubed.
2. All features shown are approximate.

LOT 12 & 13
BEVERLY HILLS
LOS ANGELES COUNTY
CALIFORNIA

PRIOR FAULT INVESTIGATIONS IN THE BEVERLY HILLS AREA

Project No. 721018701
Figure Title: PRIOR FAULT INVESTIGATIONS IN THE BEVERLY HILLS AREA

Date: JULY 2021
Scale: 1"=3,000'

Drawn By: OG

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Path:\langan.com\data\SFO\other\GIS\Projects\Lot 12 & 13\MXD\GeoTech_Figures\2021-06 Site Plan and Sections\Figure 5 - Previous Investigations by Others.mxd Date: 7/23/2021 User: ogodfrey Time: 2:38:45 PM
Figure Title: LINEAMENT ANALYSIS

LOT 12 & 13
BEVERLY HILLS
LOS ANGELES COUNTY
CALIFORNIA

Project: LOT 12 & 13

Project No.: 721018701

Figure: 6

Date: JULY 2021

Scale: 1" = 3,000'

Drawn By: OG

Notes:
1. Topographic basemap is provided through Langan’s Esri ArcGIS software licensing and ArcGIS online, National Geographic Society, i-cubed.
2. All features shown are approximate.

Legend:
- Weak to Moderate Lineament - Accurately Located
- Strong Lineament - Accurately Located
- Fault Zones
- Property Boundary

Fault Traces:
- Accurately Located
- Approximately Located
- Inferred
- Inferred, Queried
- Concealed
- Concealed, Queried
- Aerial Photo Lineament

Notes:
1. Topographic basemap is provided through Langan’s Esri ArcGIS software licensing and ArcGIS online, National Geographic Society, i-cubed.
2. All features shown are approximate.
Hollywood Fault Zone

Lot 12
Lot 13

Projection of the Hollywood Fault, Along Strike

Projection of the Santa Monica Fault, Along Strike

Sunset Boulevard
Elevado Avenue

Elevation (feet, NAVD88)

5,000
4,000
3,000
2,000
1,000
0

0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200

-100
-200
-300
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200

Notes:
2. Ground surface based on the 2015-2016 LARIAC Lidar DEM dataset, estimated accuracy of 1 meter, NAVD88.
3. Aerial basemap is provided through Langan's Esri ArcGIS software licensing and ArcGIS online, National Geographic Society, i-cubed.
4. All features shown are approximate.

EOUTH EARTu QUEIVAL ZONE
Lot 13
(Projected 585 Ft. NE)

ELEVATION PROFILE
SECTION 1

Distance Along Section (feet)

0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000

-1000
-2000
-3000
0
100
200
300
400
500
600
700
800
900
1000
1100
1200

Notes:
2. Ground surface based on the 2015-2016 LARIAC Lidar DEM dataset, estimated accuracy of 1 meter, NAVD88.
3. Aerial basemap is provided through Langan's Esri ArcGIS software licensing and ArcGIS online, National Geographic Society, i-cubed.
4. All features shown are approximate.

Distance Along Section (feet)

0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000

-1000
-2000
-3000
0
100
200
300
400
500
600
700
800
900
1000
1100
1200

Notes:
2. Ground surface based on the 2015-2016 LARIAC Lidar DEM dataset, estimated accuracy of 1 meter, NAVD88.
3. Aerial basemap is provided through Langan's Esri ArcGIS software licensing and ArcGIS online, National Geographic Society, i-cubed.
4. All features shown are approximate.

ELEVATION PROFILE
SECTION 1

Distance Along Section (feet)

0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000

-1000
-2000
-3000
0
100
200
300
400
500
600
700
800
900
1000
1100
1200

Notes:
2. Ground surface based on the 2015-2016 LARIAC Lidar DEM dataset, estimated accuracy of 1 meter, NAVD88.
3. Aerial basemap is provided through Langan's Esri ArcGIS software licensing and ArcGIS online, National Geographic Society, i-cubed.
4. All features shown are approximate.

ELEVATION PROFILE
SECTION 1

Distance Along Section (feet)

0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000

-1000
-2000
-3000
0
100
200
300
400
500
600
700
800
900
1000
1100
1200

Notes:
2. Ground surface based on the 2015-2016 LARIAC Lidar DEM dataset, estimated accuracy of 1 meter, NAVD88.
3. Aerial basemap is provided through Langan's Esri ArcGIS software licensing and ArcGIS online, National Geographic Society, i-cubed.
4. All features shown are approximate.
Projection of the Hollywood Fault, Along Strike

Projection of Santa Monica Fault, Along Strike

Sunset Boulevard
Elevado Avenue
Lot 12/Lot 13
Burton Way

Elevation (feet, NAVD88)

Distance Along Section (feet)

Site Plan Legend
- Surface profiles
- Property boundary
- Fault Zones
- Fault Traces
- Accurately Located
- Approximately Located, Queried
- Inferred
- Inferred, Queried
- Concealed
- Concealed, Queried
- Aerial Photo Lineament

Notes:
2. Ground surface based on the 2015-2016 LARIAC Lidar DEM dataset, estimated accuracy of 1 meter, NAVD88.
3. Aerial basemap is provided through Langan's Esri ArcGIS software licensing and ArcGIS online, National Geographic Society, i-cubed.
4. All features shown are approximate.
Cross Section Legend

- Existing ground surface

Site Plan Legend
- Surface profiles
- Property boundary
- Fault Zones
- Fault Traces
- Accurately Located
- Approximately Located, Queried
- Concealed
- Concealed, Queried
- Aerial Photo Lineament

Notes:
2. Ground surface based on the 2015-2016 LARIAC Lidar DEM dataset, estimated accuracy of 1 meter, NAVD88.
3. Aerial basemap is provided through Langan's Esri ArcGIS software licensing and ArcGIS Online, National Geographic Society, Inc.
4. All features shown are approximate.
**Legend**

- Site Location
- Relative slip rate vectors of tectonic blocks
- Santa Monica Mountains Anticlinorium of Davis et al. (1989)
- QFFDB Source (USGS QFDDB, 2006) (refer to fault table for fault names)
- Inferred Fault

- Fault
- Darker orange region (A) is approximate area of the rapid convergence from (Argus et. al., 1999; Argus et al. 2005), moderate orange area (B) – (Camarillo Fold & Thrust Belt – exhibits moderate convergence rates lower than area A, and faster than area C (KGS, 2016).
- Area B: Approximate region exhibiting compressional and strike-slip deformation associated with the transition zone between the Western Transverse Ranges and the Peninsular Ranges. (KGS, 2016).
- Area C:

**Notes:**

1. Terrain topographic map provided by Esri®.
Notes:
2. All features shown are approximate.
LEGEND:

HOLOCENE-AGE ALLUVIUM: COARSE UNCONSOLIDATED DEPOSITS IN VALLEYS AND PRESENT STREAM CHANNELS.

UPPER PLEISTOCENE-AGE ALLUVIAL PLAIN, STREAM, AND MARINE TERRACE DEPOSITS.

MIocene-AGE MODELO FORMATION, MARINE: CONSISTS OF INTERBEDDED HARD PLATY SILICEOUS SHALE

TRIASSIC-AGE SANTA MONICA SLATE: DARK-GRAY TO BLACK SLATE, REMARKABLE SPOTTED OWING TO CONTACT METAMORPHISM.

TRIASSIC-AGE SANTA MONICA SLATE: DARK-GRAY MICA SCHIST AND PHyllITE CUT BY VEINS OF WHITE QUARTZ.

JURASSIC-AGE IGNEOUS GRANITE AND GRANODIORITE

Notes:
1. Fault trace and zone from:FER 259 Plate 3 by CGS (Olson, 2018)
2. Terrain topographic map provided by Esri®.
3. Earthquakes queried within 7 km of site location from 01/01/1800 to present, from the ANSS Comprehensive Earthquake Catalog (ComCat), downloaded 07/06/2021. No earthquake over a magnitude of 4.9 shown in the current map extent.
NOTES:
1. GROUND SURFACE PROFILE BASED ON THE 2015-2016 LARIAC LIDAR DEM DATASET, ESTIMATED ACCURACY OF 1 METER, NAVD88.
3. REFER TO APPENDIX C FOR A SUMMARY OF CPT DATA AND AN EXPLANATION OF SOIL BEHAVIOUR TYPE (SBT).

LEGEND:
- ARTIFICIAL FILL (af)
- TEMPORAL SOIL PACKAGE BOUNDARIES
- YOUNG ALLUVIUM (Qal1)
- SUB-UNIT GEOLOGIC CONTACT
- YOUNG ALLUVIUM (Qal2)
- HOLOCENE/PLEISTOCENE BOUNDARY
- OLD ALLUVIUM (Qoa1)
- RELATIVE SOIL PROFILE I.D.
- OLD ALLUVIUM (Qoa2)
- 13C AGE (BP) AND MARGIN OF ERROR

CPT LEGEND:
- CONE TIP RESISTANCE
- SLEEVE FRICTION

Vertical Scale in Feet
Horizontal Scale in Feet

LOT 12 PROPERTY LIMITS
LOT 12 PROPERTY LIMITS

LEGEND:
- TEMPORAL SOIL PACKAGE BOUNDARIES
- SUB-UNIT GEOLOGIC CONTACT
- HOLOCENE/PLEISTOCENE BOUNDARY
- RELATIVE SOIL PROFILE I.D.
- 13C AGE (BP) AND MARGIN OF ERROR

CPT LEGEND:
- CONE TIP RESISTANCE
- SLEEVE FRICTION

Vertical Scale in Feet
Horizontal Scale in Feet

LOT 12 PROPERTY LIMITS

NOTES:
1. GROUND SURFACE PROFILE BASED ON THE 2015-2016 LARIAC LIDAR DEM DATASET, ESTIMATED ACCURACY OF 1 METER, NAVD88.
3. REFER TO APPENDIX C FOR A SUMMARY OF CPT DATA AND AN EXPLANATION OF SOIL BEHAVIOUR TYPE (SBT).
OXYGEN ISOTOPE RECORD OF GLOBAL ICE VOLUME AND SEA LEVEL FOR THE PAST 200,000 YEARS SHOWING THE MAJOR GLACIAL AND INTERGLACIAL EPISODES (DATA FROM MARTINSON ET AL., 1987). DASHED LINES ABOVE THE CURVE INDICATE HIGHSTAND DEPOSITS IN THE MID-ATLANTIC REGION ASSOCIATED WITH THE GLOBAL PERIODS OF REDUCED ICE VOLUMES.

REFERENCE: MODIFIED FROM FIGURES FOR THE GEOLOGY OF THE VIRGINIA COAST.
APPENDIX A
HOLLOW STEM AUGER (HSA) BORING LOGS
**UNIFIED SOIL CLASSIFICATION SYSTEM**

<table>
<thead>
<tr>
<th>Major Divisions</th>
<th>Symbols</th>
<th>Typical Names</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravels (more than half of coarse fraction is retained/ &gt; no. 4 sieve size)</td>
<td>GW</td>
<td>Well-graded GRAVELS with less than 5% fines or gravel-sand mixtures</td>
</tr>
<tr>
<td></td>
<td>GP</td>
<td>Poorly-graded GRAVELS with less than 5% fines or gravel-sand mixtures</td>
</tr>
<tr>
<td></td>
<td>GM</td>
<td>Silty gravels, gravel-sand-silt mixtures; GRAVELS with greater than 12% ML or MH fines</td>
</tr>
<tr>
<td></td>
<td>GC</td>
<td>Clayey gravels, gravel-sand-clay mixtures; GRAVELS with greater than 12% CL or CH</td>
</tr>
<tr>
<td>Sands (more than half of coarse fraction passes/ &lt; no. 4 sieve size)</td>
<td>SW</td>
<td>Well-graded sands with less than 5% fines or gravelly sands, little or no fines</td>
</tr>
<tr>
<td></td>
<td>SP</td>
<td>Poorly-graded sands with less than 5% fines or gravelly sands, little or no fines</td>
</tr>
<tr>
<td></td>
<td>SM</td>
<td>Silty sands, sand-silt mixtures; SANDS with greater than 12% ML or MH fines</td>
</tr>
<tr>
<td></td>
<td>SC</td>
<td>Clayey sands, sand-clay mixtures; SANDS with greater than 12% CL or CH fines</td>
</tr>
<tr>
<td>Silts and Clays LL = &lt; 50</td>
<td>ML</td>
<td>Inorganic silts and clayey silts of low plasticity, sandy non-plastic SILT, gravelly SILT</td>
</tr>
<tr>
<td></td>
<td>CL</td>
<td>Inorganic clays of low to medium plasticity, silty CLAY, trace fines, sand</td>
</tr>
<tr>
<td></td>
<td>OL</td>
<td>Organic silts and organic silt-clays of non-plastic to medium plasticity</td>
</tr>
<tr>
<td></td>
<td>MH</td>
<td>Inorganic medium plastic silts, medium plastic to very plastic clayey silts.</td>
</tr>
<tr>
<td></td>
<td>CH</td>
<td>Inorganic plastic to very plastic CLAYS, sandy plastic CLAY</td>
</tr>
<tr>
<td></td>
<td>OH</td>
<td>Organic medium plastic to plastic silty CLAYS, and very plastic CLAYS</td>
</tr>
</tbody>
</table>

**SOIL DESCRIPTIONS/SYMBOLS**

- Well-graded GRAVEL (GW)
- Poorly-graded GRAVEL (GP)
- Silty GRAVEL (GM)
- Clayey GRAVEL (GC)
- Well-graded SAND (SW)
- Poorly-graded SAND (SP)
- Silty SAND (SM)
- Clayey SAND (SC)
- AGGREGATE BASE
- Low-Plasticity SILT (ML)
- High-Plasticity SILT (MH)
- Low-Plasticity CLAY (CL)
- High-Plasticity CLAY (CH)
- SANDSTONE
- CLAYSTONE
- Siltstone
- FILL
- Asphalt

**GRAIN SIZE CHART**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Range of Grain Sizes</th>
<th>Grain Size in Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulders</td>
<td>Above 12&quot;</td>
<td>Above 305</td>
</tr>
<tr>
<td>Cobble</td>
<td>12&quot; to 3&quot;</td>
<td>305 to 76.2</td>
</tr>
<tr>
<td>Gravel coarse fine</td>
<td>3&quot; to 3/4&quot;</td>
<td>76.2 to 4.75</td>
</tr>
<tr>
<td>Gravel fine</td>
<td>3/4&quot; to No. 4</td>
<td>76.2 to 19.1</td>
</tr>
<tr>
<td>Gravel fine</td>
<td>No. 4 to No. 200</td>
<td>4.76 to 0.075</td>
</tr>
<tr>
<td>Gravel fine</td>
<td>No. 4 to No. 10</td>
<td>4.76 to 2.00</td>
</tr>
<tr>
<td>Gravel fine</td>
<td>No. 10 to No. 40</td>
<td>2.00 to 0.420</td>
</tr>
<tr>
<td>Gravel fine</td>
<td>No. 40 to No. 200</td>
<td>0.240 to 0.075</td>
</tr>
<tr>
<td>Silt and Clay</td>
<td>Below No. 200</td>
<td>Below 0.075</td>
</tr>
</tbody>
</table>

**GROUNDWATER READING**

- Groundwater encountered during drilling
- Groundwater at completion
- Groundwater at 24 hours

**SAMPLER TYPE**

- CR - Modified California (CR) split-barrel ring sampler with a 3.0-inch outside diameter and a 2.5-inch inside diameter.
- SPT - Standard Penetration Test (SPT) split-barrel sampler with a 2.00-inch outside diameter with a 1.5-inch inside diameter
- ST - Shelby Tube (3.0-inch outside diameter, thin-walled tube) advanced with hydraulic pressure

**APPENDIX A**

**BORING LOG LEGEND**

- CR - Modified California (CR) split-barrel ring sampler with a 3.0-inch outside diameter and a 2.5-inch inside diameter.
- SPT - Standard Penetration Test (SPT) split-barrel sampler with a 2.00-inch outside diameter with a 1.5-inch inside diameter
- ST - Shelby Tube (3.0-inch outside diameter, thin-walled tube) advanced with hydraulic pressure

**LANGAN**

Langan Engineering & Environmental Services, Inc.

515 South Flower Street, Suite 2860
Los Angeles, CA 90071

Tel: 213.943.1310  Fax: 213.943.1301  www.langan.com

© 2002 Langan
<table>
<thead>
<tr>
<th>Elev. (ft)</th>
<th>Sample Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>256.7</td>
<td>Artificial Fill (af)</td>
</tr>
<tr>
<td>Silty SAND (SM), olive gray, dry, some clay, trace gravel.</td>
<td></td>
</tr>
<tr>
<td>Moist.</td>
<td></td>
</tr>
<tr>
<td>252.7</td>
<td>Young Alluvium (Qa)</td>
</tr>
<tr>
<td>Sandy CLAY (CL), dark grayish brown to very dark grayish brown 10YR 4/2-3/2, slightly moist, fine sand.</td>
<td></td>
</tr>
<tr>
<td>250.7</td>
<td>Sandy Silt (ML), yellowish brown to dark yellowish brown 10YR 5/4-4/4, moist, fine sand.</td>
</tr>
<tr>
<td>248.7</td>
<td>Sandy CLAY (CL), brown 10YR 4/3, moist, fine sand.</td>
</tr>
<tr>
<td>242.7</td>
<td>Older Alluvium (Qoa)</td>
</tr>
<tr>
<td>CLAY (CL), brown to dark yellowish brown 10YR 4/3-4/4, slightly moist, few fine sand, some silt, trace gravel.</td>
<td></td>
</tr>
<tr>
<td>Sandy CLAY (CL), brown 10YR 4/3, slightly moist, fine to medium sand.</td>
<td></td>
</tr>
<tr>
<td>238.7</td>
<td>Silty SAND (SM), brown 7.5YR 4/4, slightly moist, fine to coarse sand.</td>
</tr>
<tr>
<td>Sandy CLAY (CL), brown to dark brown 10YR 4/3-3/2, moist, fine to coarse sand.</td>
<td></td>
</tr>
</tbody>
</table>

| % Core Recovery | 92 |
| % Core Recovery | 100 |
| % Core Recovery | 74 |

C14 sample collected at 16 feet.

% Core Recovery = 74
<table>
<thead>
<tr>
<th>Elev. (ft)</th>
<th>Sample Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>235.7</td>
<td>Silty SAND (SM), brown 7.5YR 4/4, slightly moist, fine to coarse sand, trace gravel.</td>
</tr>
<tr>
<td>231.7</td>
<td>Sandy CLAY (CL), brown to dark brown 10YR 4/3-3/3, moist, fine to coarse sand, trace gravel.</td>
</tr>
<tr>
<td>225.7</td>
<td>Gravelly SAND (SP), yellowish brown to dark yellowish brown 10YR 5/4-4/4, slightly moist. Olive brown 2.5Y 4/3, fine to coarse sand and gravel, few silt.</td>
</tr>
<tr>
<td>219.7</td>
<td>Silty SAND (SM), yellowish brown to dark yellowish brown 10YR 5/4-4/4, slightly moist, fine to medium sand.</td>
</tr>
<tr>
<td>216.7</td>
<td>Decreasing grain size, gradation contact.</td>
</tr>
<tr>
<td>216.7</td>
<td>CLAY (CL), dark yellowish brown 10YR 4/4, moist, few fine sand, some silt.</td>
</tr>
<tr>
<td>216.7</td>
<td>Trace gravel.</td>
</tr>
<tr>
<td>216.7</td>
<td>End of boring at 40 feet. Groundwater not encountered. Boring backfilled with bentonite grout.</td>
</tr>
</tbody>
</table>

**% Core Recovery**
- % Core Recovery = 92
- % Core Recovery = 70
- % Core Recovery = 58
- % Core Recovery = 86
### Artificial Fill (af)

- Sandy SILT (ML), dark brown, moist, fine to medium sand. 
  
*Field Notes:* 6-inch grass and roots

### Young Alluvium (Qal)

- Silty SAND (SM), brown, loose, moist, fine to medium sand.
- Silty SAND (SM), brown, medium dense, moist, fine to medium sand.

### Older Alluvium (Qoa)

- Sandy CLAY (CL), brown, stiff, to course sand, fine gravel.

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample Data</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>250.8</td>
<td></td>
<td>6-inch grass and roots</td>
</tr>
<tr>
<td>245.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>241.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>238.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>235.6</td>
<td></td>
<td>Air pinholes observed.</td>
</tr>
<tr>
<td>233.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth</td>
<td>Sample Description</td>
<td>Remarks</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>----------------------------------------------</td>
</tr>
<tr>
<td>20.00</td>
<td>Sandy SILT (ML), brown, very stiff, moist, fine to medium sand.</td>
<td></td>
</tr>
<tr>
<td>21.00</td>
<td>Silty SAND (SM), brown, medium dense, moist, fine to medium sand.</td>
<td></td>
</tr>
<tr>
<td>22.00</td>
<td>Silty SAND (SM), brown, very dense, moist, fine to medium sand, trace clay.</td>
<td></td>
</tr>
<tr>
<td>25.00</td>
<td>End of boring at 26.5 feet. Groundwater not encountered. Boring backfilled with bentonite grout.</td>
<td>Air pinholes observed.</td>
</tr>
</tbody>
</table>

**Log of Boring**

**Project**

Lots 12 and 13 - Beverly Hills

**Location**

SEC of Santa Monica Blvd and Beverly Blvd

**Elevation and Datum**

250.8 feet (NAVD88)
Artificial Fill (af)
Silty SAND (SM), brown, moist, trace fine to coarse gravel. [FILL]

Sandy SILT (ML), dark brown, stiff, moist, fine to course sand. [FILL]

Sandy SILT (ML), dark brown, stiff, moist, fine to medium sand. [FILL]

Young Alluvium (Gal)
Sandy SILT (ML), brown, very stiff, moist, fine to course sand.

Sandy CLAY (CL), brown, stiff, moist, fine to medium sandy clay.


Air pinholes observed.
### Artificial Fill (af)
- Silty SAND (SM), grayish brown, slightly moist, fine to medium sand. [FILL]
- Trace gravel.

### Young Alluvium (Qal)
- Silty SAND (SM), brown to yellowish brown 10YR 5/3-5/4, dry, fine to medium sand.

### Sandy CLAY (CL), brown 10YR 5/3, dry, fine to medium sand.
- Few fine to coarse gravel.
- Organics.

### CLAY with Silt (CL-ML), dark yellowish brown 10YR 4/4, moist.

### Older Alluvium (Qoa)
- Sandy CLAY (CL), dark yellowish brown, slightly moist, fine to coarse sand, few gravel, slightly porous.

**Remarks:**
- Poor core sample recovery (rock in tip).
- % Core Recovery = 22
- % Core Recovery = 80
- % Core Recovery = 86
### Sample Description

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>235.5</td>
<td>Increased sand content, gradational contact.</td>
</tr>
<tr>
<td>234.5</td>
<td>Clayey SAND (SC), brown 10YR 5/3, slightly moist, fine to coarse sand.</td>
</tr>
<tr>
<td>233.5</td>
<td>Gravelly SAND with some Clay (SP), dark grayish brown 2.5Y 4/2, dry to slightly moist, fine to coarse sand and gravel.</td>
</tr>
<tr>
<td>223.5</td>
<td>Clayey SAND (SC), olive brown 2.5Y 4/3, slightly moist, fine to coarse sand, trace gravel.</td>
</tr>
<tr>
<td>220.5</td>
<td>CLAY with Silt (CL-ML) to SILT with Clay (ML-CL), olive brown 2.5Y 4/3 and light gray 2.5Y 7/2 mottled, moist.</td>
</tr>
<tr>
<td>218.5</td>
<td>Sandy CLAY (CL), yellowish brown 10YR 5/4, slightly moist, fine to coarse sand, few gravel.</td>
</tr>
<tr>
<td>End of boring at 40 feet. Groundwater not encountered. Boring backfilled with bentonite grout.</td>
<td></td>
</tr>
</tbody>
</table>

### Remarks

- % Core Recovery = 84
- % Core Recovery = 84
- % Core Recovery = 86
- % Core Recovery = 94
**Sample Description**

**Artificial Fill (af)**
Silty SAND (ML), dark brown, moist, fine to medium sand, trace fine gravel. [FILL]

**Young Alluvium (Qal)**
Sandy CLAY (CL), brown, stiff, moist, fine to medium sand, trace silt.

Sandy CLAY (CL), brown, stiff, moist, fine to medium sand, trace silt.

Sandy CLAY (CL), brown, stiff, moist, fine to course sand.

**Older Alluvium (Qoa)**
Air pinholes observed.
Air pinholes observed.
Clayey SAND (SC), brown, very dense, moist, fine to coarse sand, trace fine gravel.

Sandy SILT (ML), brown, stiff, moist, fine to course sand, trace fine gravel.

End of boring at 26.5 feet.
Groundwater not encountered.
Boring backfilled with bentonite grout.
**Sample Description**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample Data</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>S-1</td>
<td>Water Content 2%</td>
</tr>
<tr>
<td>5</td>
<td>S-2</td>
<td>Water Content 2%</td>
</tr>
<tr>
<td>6</td>
<td>S-3</td>
<td>Water Content 2%</td>
</tr>
<tr>
<td>7</td>
<td>S-4</td>
<td>Water Content 2%</td>
</tr>
</tbody>
</table>

**Remarks**

Air pinholes observed.

**Groundwater**
- Not encountered

**Boring**
- Backfilled with bentonite grout

**Additional Notes**
- Drilling Fluid, Depth of Casing, Fluid Loss, Drilling Resistance, etc.
Asphalt Concrete: 3.0 inches thick.
Aggregate Base: 9.0 inches thick.

Artificial Fill (af)
Silty SAND (SM), grayish brown moist, fine to coarse sand, trace gravel. [FILL]

Young Alluvium (Qal)
Silty SAND (SM), brown 10YR 4/3, dry, fine to coarse sand, trace gravel.

Sandy CLAY (CL), brown 7.5YR 4/3, moist, fine to coarse sand, trace gravel.

CLAY (CL), dark brown 7.5YR 3/4, moist, few fine to coarse sand, some silt.

Sandy CLAY (CL), brown 7.5YR 4/4, slightly moist, fine to coarse sand.

Older Alluvium (Qoa)
Sandy CLAY (CL), dark brown 7.5YR 3/3, slightly moist, fine to coarse grained.

With some fine to coarse gravel.

% Core Recovery = 56
% Core Recovery = 78
% Core Recovery = 68
Clayey SAND (SC), dark yellowish brown 10YR 4/4, slightly moist, fine to medium sand. Silty SAND (SM), yellowish brown 10YR 5/4, slightly moist, fine to medium sand, with lenses of Sandy Silt (ML). Decreasing silt content, gradational contact. SAND with Silt (SP-SM), dark yellowish brown 10YR 4/4, slightly moist, fine to coarse sand. Lenses of CLAY with Silt (CL-ML), moist. Sandy CLAY (CL), dark brown 10YR 3/3, moist, fine to coarse sand. SAND with Silt (SP-SM), dark yellowish brown 10YR 4/4, slightly moist, fine to coarse sand, trace gravel. End of boring at 40 feet. Groundwater not encountered. Boring backfilled with bentonite grout.

% Core Recovery = 100

% Core Recovery = 96

% Core Recovery = 100

C14 sample collected at 33.5 feet.

% Core Recovery = 90
BORING B-1
BORING B-4
BORING B-7
Depth: 10 to 15
Langan PN: 72-11870
Boring #: 8-7
Depth: 20 to 25 ft
Depth: 30 to 35
Depth: 35 to 40
APPENDIX C
SUMMARY OF CONE PENETRATION TEST DATA
REPORT BY KEHOE
SUMMARY
OF
CONE PENETRATION TEST DATA

Project:
Lots 12 & 13
Beverly Hills, CA
May 10, 2021

Prepared for:
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Langan Eng. & Environmental Services
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www.kehoetesting.com
TABLE OF CONTENTS

1. INTRODUCTION
2. SUMMARY OF FIELD WORK
3. FIELD EQUIPMENT & PROCEDURES
4. CONE PENETRATION TEST DATA & INTERPRETATION

APPENDIX

- CPT Plots
- CPT Classification/Soil Behavior Chart
- Summary of Shear Wave Velocities
- CPT Data Files (sent via email)
SUMMARY OF Cone Penetration Test DATA

1. INTRODUCTION

This report presents the results of a Cone Penetration Test (CPT) program carried out for the Lots 12 & 13 project located in Beverly Hills, California. The work was performed by Kehoe Testing & Engineering (KTE) on May 10, 2021. The scope of work was performed as directed by Langan Eng. & Environmental Services personnel.

2. SUMMARY OF FIELD WORK

The fieldwork consisted of performing CPT soundings at six locations to determine the soil lithology. A summary is provided in TABLE 2.1.

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>DEPTH OF CPT (ft)</th>
<th>COMMENTS/NOTES:</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPT-1</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>CPT-2</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>CPT-3</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>CPT-4</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>CPT-5</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>CPT-6</td>
<td>50</td>
<td></td>
</tr>
</tbody>
</table>

TABLE 2.1 - Summary of CPT Soundings

3. FIELD EQUIPMENT & PROCEDURES

The CPT soundings were carried out by KTE using an integrated electronic cone system manufactured by Vertek. The CPT soundings were performed in accordance with ASTM standards (D5778). The cone penetrometers were pushed using a 30-ton CPT rig. The cone used during the program was a 15 cm^2 cone and recorded the following parameters at approximately 2.5 cm depth intervals:

- Cone Resistance (qc)
- Sleeve Friction (fs)
- Dynamic Pore Pressure (u)
- Inclination
- Penetration Speed
At location CPT-2, shear wave measurements were obtained at approximately 5-foot intervals. The shear wave is generated using an air-actuated hammer, which is located inside the front jack of the CPT rig. The cone has a triaxial geophone, which recorded the shear wave signal generated by the air hammer.

The above parameters were recorded and viewed in real time using a laptop computer. Data is stored at the KTE office for up to 2 years for future analysis and reference. A complete set of baseline readings was taken prior to each sounding to determine temperature shifts and any zero load offsets. Monitoring baseline readings ensures that the cone electronics are operating properly.

4. CONE PENETRATION TEST DATA & INTERPRETATION

The Cone Penetration Test data is presented in graphical form in the attached Appendix. These plots were generated using the CPeT-IT program. Penetration depths are referenced to ground surface. The soil behavior type on the CPT plots is derived from the attached CPT SBT plot (Robertson, “Interpretation of Cone Penetration Test...”, 2009) and presents major soil lithologic changes. The stratigraphic interpretation is based on relationships between cone resistance (qc), sleeve friction (fs), and penetration pore pressure (u). The friction ratio (Rf), which is sleeve friction divided by cone resistance, is a calculated parameter that is used along with cone resistance to infer soil behavior type. Generally, cohesive soils (clays) have high friction ratios, low cone resistance and generate excess pore water pressures. Cohesionless soils (sands) have lower friction ratios, high cone bearing and generate little (or negative) excess pore water pressures.

The CPT data files have also been provided. These files can be imported in CPeT-IT (software by GeoLogismiki) and other programs to calculate various geotechnical parameters.

It should be noted that it is not always possible to clearly identify a soil type based on qc, fs and u. In these situations, experience, judgement and an assessment of the pore pressure data should be used to infer the soil behavior type.

If you have any questions regarding this information, please do not hesitate to call our office at (714) 901-7270.

Sincerely,

KEHOE TESTING & ENGINEERING

Steven P. Kehoe
President

05/17/21-wt-2845
APPENDIX
Seismic Shear Wave Velocities

Langan Eng & Env Services
Lots 12 & 13
Beverly Hills, CA

CPT Shear Wave Measurements

<table>
<thead>
<tr>
<th>Location</th>
<th>Tip Depth (ft)</th>
<th>Geophone Depth (ft)</th>
<th>Travel Distance (ft)</th>
<th>S-Wave Arrival from Surface (msec)</th>
<th>S-Wave Velocity from Surface (ft/sec)</th>
<th>Interval S-Wave Velocity (ft/sec)</th>
</tr>
</thead>
<tbody>
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Shear Wave Source Offset - 2 ft

S-Wave Velocity from Surface = Travel Distance/S-Wave Arrival
Interval S-Wave Velocity = (Travel Dist2-Travel Dist1)/(Time2-Time1)
APPENDIX D
RADIOCARBON AND AMS RELATIVE AGE DATES
Radiocarbon concentrations are given as fractions of the Modern standard, D\(^{14}\)C, and conventional radiocarbon age, following the conventions of Stuiver and Polach (Radiocarbon, v. 19, p.355, 1977).

Sample preparation backgrounds have been subtracted, based on measurements of \(^{14}\)C-free coal (bulk sediment) and wood (organics).

All results have been corrected for isotopic fractionation according to the conventions of Stuiver and Polach (1977), with \(d\(^{13}\)C\) values measured on prepared graphite using the AMS spectrometer. These can differ from \(d\(^{13}\)C\) of the original material, and are not shown.

Comments:
Bulk sediment samples were decalcified prior to combustion.
Other organic samples were treated with acid-base-acid (1N HCl and 1N NaOH, 75°C) prior to combustion.

The large uncertainties for several samples are due to a combination of small sample size and age.

None of these samples contained any material with texture resembling charcoal, but UCIAMS-247453 - 247456 were processed soil clasts with black material that appeared to be reworked carbon. This material mostly disappeared during the alkali pretreatment but the residue formed a darker brown layer of fines over the remaining silt, and this finer layer was sampled for dating.
Radiocarbon concentrations are given as fractions of the Modern standard, D\textsuperscript{14}C, and conventional radiocarbon age, following the conventions of Stuiver and Polach (Radiocarbon, v. 19, p.355, 1977).

Sample preparation backgrounds have been subtracted, based on measurements of \textsuperscript{14}C-free wood.

All results have been corrected for isotopic fractionation according to the conventions of Stuiver and Polach (1977), with d\textsuperscript{13}C values measured on prepared graphite using the AMS spectrometer. These can differ from d\textsuperscript{13}C of the original material, and are not shown.

Comments:
This sample was treated with acid-base-acid (1N HCl and 1N NaOH, 75°C) prior to combustion.

This date was measured on processed soil clasts with black material that appeared to be reworked carbon. The black material mostly disappeared during the alkali pretreatment but the residue formed a darker brown layer of fines over the remaining silt, and this finer layer was sampled for dating.
APPENDIX E
SOIL DEVELOPMENT INDEX (SDI)
REPORT BY J. HELMS
Soil Stratigraphy Study and Relative Age Estimates
Fault Rupture Hazard Investigation
Lot 12 North Santa Monica Boulevard
and Civic Center Drive
Beverly Hills, California

Prepared for: Langan, Inc.
18575 Jamboree Road, Suite 150
Irvine, California 92612

Prepared by: Tetra Tech BAS
21700 Copley Drive, Suite #200
Diamond Bar, California 91765

July 30, 2021
Project No. GEN 21-39E
Mr. Shaun Wilkins, CEG  
Langan  
18575 Jamboree Road, Suite 150  
Irvine, California 92612  

Subject: **SOIL STRATIGRAPHY STUDY AND RELATIVE AGE DATING ESTIMATES**  
**FAULT RUPTURE HAZARD INVESTIGATION**  
Lot 12 – North Santa Monica Boulevard and Civic Center Drive  
Beverly Hills, California  

Dear Mr. Wilkins;

Tetra Tech is pleased to present to you this soil stratigraphic study and relative-age determinations to be used with your fault rupture hazard assessment of the proposed development along Lot 12 located in-between North Santa Monica Boulevard and Civic Center Drive, in the City of Beverly Hills, California.

Langan, Inc. retained Tetra Tech to describe and assist in correlations of the soil stratigraphy from continuously cored borehole samples and to assign relative age dates for the deposits identified across the site. The continuously cored bore hole samples were obtained from a single transect of borings and CPTs, Transect A. One borehole, B-4 from transect A was described in detail and has been reviewed and summarized. Two additional boreholes, B-1 and B-7 have also been reviewed and summarized. The detailed descriptions are used to calculate various soil development indices (or SDIs). The SDI values are compared to the SDI values from similar described soils with known ages to estimate age ranges for the soils understudy.

The attached report classifies the described soil profiles, identifies stratigraphic relationships, defines soil chronosequences, and estimates the relative ages for the soil profile described in detail. Calculated SDI’s show strong correlations to the SDI values of other published, described, and dated soil profiles with similar parent materials.

Age estimates range from 33 to 65 thousand year before present (ka) for the stratigraphic section studied along transect A in boring B-4. There are several distinctive soil units that can be correlated across transect A. One distinctive buried soil (buried soil 3 in transect A) is designated as the top of stratigraphic unit Qoa1. Unit Qoa1 consists of a sequence of two stacked and truncated and weakly-to-moderately well-developed Alfisol soils that overlies a crudely stratified
scour deposit, and ranges in relative age from 20 – 50 ka. Please see Table 6 in the attached report for a summary listing of all of the determined relative ages at the study site.

Thank you for this opportunity to be of service. Should you have any questions or require additional information, please do not hesitate to contact the undersigned.

Respectfully submitted,
Tetra Tech BAS, Inc.

John Helms, CEG
Engineering Geologist

David M. Luka, CEG
Supervising Geologist

Distribution: Addressee (pdf by email swilkins@langan.com)
Filename: 2021-07-30 Langan - GRPT Lot 12 Beverly Hills.docx
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- Table 2.1 - Transect A Boring B-1 Soil Summary Sheet
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- Table 4 - Summary of Comparative Data
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- Table 6 - Cross Sectional Unit Relative Ages

### Figure

- Figure 1 - Oxygen Isotope Record with Sea Level Fluctuations
1. INTRODUCTION

One soil profile has been studied for geomorphic characteristics and relative degrees of weathering to estimate deposit relative age. The relative age estimates are based on index value comparisons with other published and dated soil profile descriptions. The comparative soils are from areas with a similar climate and similar parent material to this study area. The estimated relative ages in this report will be used by Langan, Inc. to assess the recency and recurrence of faulting across the study area. Alluvial units are assessed chronostratigraphically across a single borehole location from a single transect of borings and CPT’s that shadow the area proposed for development. In this study, the soil stratigraphy is defined with field description data, and no laboratory analyses. This study identifies the stratigraphy across the area under study and estimates the relative age of one soil profile. Continuously cored and sampled borehole B-4 has been described in detail along transect A. Transect A is located along a graded and stripped alluvial surface.

For the Quaternary geologist, a soil can be defined as a natural body that consists of horizons of organic and/or mineral constituents which differ from its parent material in some way (Birkland, 1984). A chronosequence is a group of soils for which all soil forming factors (such as topography, parent material, vegetation, and climate) except time is relatively equal (Jenny, 1941). Past geologic studies in the coastal region of southern California provide age constraints for several deposits and geomorphic surfaces ranging in age from middle Pleistocene to recent (McFadden, 1982; Rockwell, 1988; and WLA, 1998). Often it has proven difficult to date older deposits due to changes in past climatic regimes. Studies on the impacts of glacial to interglacial climatic changes on soil development in specific regions (McFadden, 1982; Birkland, 1984; McFadden, 1988) indicate that soil development has occurred throughout the Quaternary.

This study specifically characterizes a section of alluvium derived from the southern range front of the Santa Monica Mountains, which is within the Transverse Ranges Geomorphic Province. A series of stacked and truncated cambic and argillic soil subsurface horizons within the stratigraphic section studied indicates that the stratigraphy across the entire study area correlates well and is older than 30 ka at a minimum. Age estimates range from 33 to 65 ka for the stratigraphic section studied across transect A in boring B-4.

Soil relative age estimates have broad ranges, dependent upon the pool of comparative data used. Most of the buried soils across the study area fall into the Entisol and Alfisol soil orders (Soil Conservation Service, 2000). Entisols are a soil order in USDA soil classification. They form relatively quickly through alteration of alluvium, and have no accumulation of clays, iron oxide, or aluminum oxide. Alfisols are soils that have relatively high native fertility. These soils are well developed and contain a subsurface horizon in which clays have accumulated. Alfisols form in loamy parent materials and generally, under forest vegetation.
2. MATERIAL AND METHODS

Continuous core samples collected from boring B-4 by Langan, Inc. were described in detail as part of this study. The soils were described using guidelines set by the Soil Survey Staff (1999a and 1999b). Specific soil properties such as structure and horizon boundaries could not be accurately described from the core sample exposures. These soil qualifiers have not been described and do not factor into the estimated soil relative age comparisons.

Soil profile field description values are used to quantify physical properties to develop a soil development index (SDI) value as outlined by Harden (1982). Points are assigned to descriptive data for each of several observed physical properties (i.e. dry color, moist color, texture, dry and wet consistence, and clay film content) for each horizon in a soil profile relative to the horizon’s thickness, and normalized to a common depth. The maturity of a soil profile is gauged through data collected from unaltered or unweathered alluvium.

Table 1.1 lists the detailed soil description for the studied boring in longhand format. Table 1.2 lists the soil descriptions using soil conservation service notation and shows the SDI calculations. Table 1.2 shows the calculated SDI values, the soil profile descriptions, and the normalization values for raw alluvium. SDI values are calculated by assigning point values to each described soil property. The points are summed for each soil horizon and divided by the total number of descriptive properties used. This equals the mean horizon index value (HI). HI values are multiplied by the corresponding soil horizon thickness. The SDI value equals the sum of the thickness normalized horizon indices. The maximum horizon index (MHI) is the value of the horizon with the largest summed descriptive value. MHI is independent of horizon thickness, and is usually the diagnostic subsurface horizon for most soil profiles. Table 1.2 lists the determined HI, SDI, and MHI values for the soil profile under study.

SDI and MHI values have shown significant correlations to soil age in many previous research (Harden, 1981; Rockwell et al., 1985; Reheis et al., 1990; Rockwell et al., 1994). The soils described in this study are compared to soils described and dated by McFadden (1982 and 1987) in San Bernardino County near Mission Creek, by Rockwell (1988) in the Ventura River basin, and by William Lettis and Associates, Inc. (1998) in West Hollywood. SDI values have all been calibrated to a common depth of 3 feet.

Describing and measuring changes described as subsurface pedogenic properties within a soil profile allow for relative age determinations by emphasizing specific physical properties (such as color and clay film content) that are most diagnostic. The properties that express themselves well through time are most often used in the assessment of relative ages through a specific soil property index such as the color or clay film index. The color index is used to quantify observed colors (in Munsell notation) of each soil profile to compare relative degrees of reddening (Rockwell et al., 1985, 1994). The color index is simply the summation of an entire soil profile’s horizon index values for dry and moist colors. The clay film index is used to quantify field descriptions of this property to compare relative soil profile maturity (Rockwell et al., 1985, 1994). The clay film index is the summation of an entire soil profile’s horizon index values for clay films. MHI is a comparison of a soil profile’s master (or diagnostic) subsurface horizon (typically an argillic or
cambic horizon). Independent of horizon thickness, the MHI directly compares the properties of the soil profiles strongest soil horizon.
3. **SOIL RELATIVE AGE METHODS**

Relative ages are calculated and compared independently for each soil profile described. The soil profile described in detail has a surface age that is implied by estimating the time of inception for the exposed surficial soil. The soil profile described in detail for this study also contains a series of stacked and or buried soil profiles. In this case, deposit age assessments are obtained by identifying and isolating the different parent materials (or deposits). Then, by comparing a set of abridged calculated indices to an additional suite of similar soils that have been radiometrically dated, a buried surface age is estimated. Such burial relationships are common along the southern Santa Monica Mountains range front; especially where paleosols overprint alluvial fan deposits which commonly bury or locally truncate older well-developed alluvial deposits. A cumulic soil profile estimated age can assess landform age, and has potential to assess rates of erosion, rates of landform evolution, and rates of tectonic activity across the study area.

An SDI value is calculated based on the described soil profiles and used to estimate the relative age. Cumulic relative age estimates for stacked and buried soil profiles are specifically referred to as “deposit ages.” The relative age estimate for the surface profile or modern soil is referred to as the “surface age.” All relative age estimates given are minimum ages due to the uncertainties that result from unknowns such as previous amounts and rates of erosion and rates of sedimentation or burial.
4. DISCUSSION AND RESULTS

The soil profiles described for this study are located across several buried alluvial surfaces that differ in relative age, facies of deposition, and degrees of preservation. A series of stacked, buried, and truncated soil horizons with illuvial clays characterize a majority of the soil profiles described on this project site.

This section describes and measures the continuously cored boring described in SCS guidelines with designated tables for the soil profile. The attached Table 1.1 presents the soil profile description in longhand format. Table 1.2 presents the results of the calculated SDI values. Table 3 is a summary of the soil relative age estimates for the profiles under study. Table 4 is a compilation of the comparative data in a format that compares to the data generated for this study. Table 5 is a soil abbreviation key to be used in conjunction with the SDI calculation sheets. Table 6 lists the relative ages for each designated stratigraphic unit that is shown on the geologic cross section in the fault rupture hazard report.

Soil descriptions, SDI calculations, and relative age determinations follow for the soil profile studied.

4.1. Transect A

One soil profile was described in detail out of core samples from boring B-4 in transect A. Age estimates range from 33 to 65 ka for the stratigraphic section studied across the site along transect A in boring B-4. Two soil profiles were summarized out of core samples from borings B-1 and B-7 in transect A. This study encountered truncated, continuous beds and strong correlations for most of the deposits in the stratigraphic section studied across transect A.

4.2. Boring B-4

The core samples from transect A, boring B-4 were reviewed at the project site on June 2, 2021. Boring B-4 is located in the center portion of transect A. This alluvial section is characterized by a sequence of truncated argillic soil horizons interbedded with massive and crudely stratified scour deposits. See Table 1.1 for a complete soil description of the continuously sampled boring, Table 1.2 for the SDI index value calculations and relative age estimates, and Langan Inc.’s cross section and geologic map for both the borehole and transect locations.

The youngest stratigraphic unit (Qal1) in boring B-4 consists of the surface soil. This unit is composed of an organic-rich weakly developed Alfisol that is characterized by a moderately thick, truncated, and weakly developed argillic horizon and has an estimated relative age of 4 to 8 ka. The surface soil from transect A, boring B-4 can be correlated across the entire length of transect A.

Stratigraphic unit Qal2 consists of the first buried soil encountered boring B-4. Unit Qal2 is composed of a stacked and truncated and moderately well-developed Alfisol soil and has an estimated relative age value of 12 to 23 ka. Unit Qal2 can be correlated across the entire area.
investigated and is identified as the base of the Holocene in this stratigraphic section. Unit Qal2 consists of a well horinzonated (i.e., more than one describable soil unit) and moderately thick soil.

Stratigraphic unit Qoa1 consists of the second, third, and forth buried soils encountered in boring B-4. Unit Qoa1 is composed of two stacked and truncated and weakly to moderately well-developed Alfisol soils over a basal Entisol soil that consists of a crudely stratified and coarse-grained scour deposit and has an estimated relative age value of 20 to 50 ka. The top of unit Qoa1 can be correlated across the entire area investigated, and is identified as the top of the Pleistocene in this stratigraphic section. The base of unit Qoa1 consists of a crudely stratified scour deposit that thickens to the northwest across Transect A. Unit Qoa1 consists of a moderately well-developed truncated and thin soil that lies over a weakly developed stacked and moderately thick soil over a crudely stratified scour deposit that can be traced across the study area. The scour deposit is interpreted as representing a regional climatic change during the Wisconsin glacial period that lowered global sea levels and initiated general channel incisions and deposited the observed stage 2 gravel (Figure 1).

Figure 1: Oxygen isotope record of global ice volume and sea level for the past 200,000 years illustrating major glacial and interglacial episodes (Martinson et al. 1987).

Stratigraphic unit Qoa2 consists of the fifth buried soil encountered in boring B-4. Unit Qoa2 is composed of a truncated and stacked moderately well-developed Alfisol soil. The soil is characterized as a truncated, moderately well oxidized, moderately well-developed, and fine grained argillic horizon. This lowest stratigraphic unit (Qoa2) is scoured out to the northwest and is not present in bring B-7 in transect A. Unit Qoa2 provides a relative age date for the entire stratigraphic section studied, and has an estimated relative age value of 33 to 65 ka.
Differences in the number of soils, burial depth, and unit thicknesses due to differential erosion and truncation may cause minor variances in relative age estimates between the individual borings. However, borings B-4, B-1, and B-7 are in general agreement with the number of soils present and the depths of burial and unit thicknesses.

### 4.3. Soil Summary Description

The key properties from two soil profiles are summarized out of core samples from borings B-1, and B-7 in this study. The summary descriptions record the diagnostic pedogenic features for each soil horizon identified. This was done in order to assist with establishing stratigraphic correlations across the site. Relative age estimates were not generated for the listed soil summary descriptions. The soil summary descriptions are listed in Tables 2.1 and 2.2.
5. **CONCLUSIONS**

The soils observed across the study area are Entisols and Alfisols that have developed in alluvial environments. All of the soil profiles across Transect A consist of a series of stacked, truncated, and buried argillic horizons that are separated by scour deposits. The truncated and buried soils with argillic subsurface horizons are weakly to moderately well developed. The Holocene aged soils typically have 10YR soil color hues with trace amounts of secondary (pedogenic) clay in a series of juvenile argillic (Bt) or cambic (Bw) diagnostic subsurface horizons. The Pleistocene aged soils typically have 7.5YR and 5YR soil color hues with sparse to moderate amounts of secondary (pedogenic) clay in a series of argillic (Bt) diagnostic subsurface horizons.

The surface and most buried soil profiles across the area investigated are laterally continuous across transect A. The minimal lateral variability that is observed in the soils across the site is due to localized erosion or scouring. In this sedimentological environment, surfaces that have been stable long enough to form a soil can suddenly be buried by a new deposit, or scoured out (truncated) and possibly in-filled with younger material. The amount of erosion that has occurred with each truncated soil under study is unknown. Thus, the relative age estimates given in this study are minimum ages.

These relative age determinations are consistent with the general geologic and pedogenic observations of soils in southern California. Strongly developed, well horizonated, thick, and oxidized Alfisols can be as much as 200 ka in age. Erosion tends to act as a rejuvenating aspect in soil development, by decreasing the strength of the soil development properties and the consequent age estimates are younger. In that past magnitudes and rates of erosion are difficult to assess, the soil relative age estimates are utilized as minimum ages.

The soils observed along transect A on Lot 12 are Holocene and Pleistocene in age. The buried and stacked soils display multiple buried horizons that have weak to moderately strong argillic development. Age estimates range from 33 to 65 ka for the entire alluvial stratigraphic section studied along transect A. Stratigraphic unit Qoa1 can be correlated across the entire area investigated and is capped by a moderately well-developed argillic soil profile and ranges in relative age from 20 – 50 ka along the length of Transect A. Stratigraphic unit Qoa2 can be correlated across the area investigated and consists of a truncated moderately well oxidized, moderately well-developed argillic soil profile that range in relative age from 33 to 65 ka along the length of Transect A.
6. LIMITATIONS

The conclusions and recommendations presented herein are the results of an inherently limited scope. Specifically, the scope of services consisted of an assessment of relative age from core samples and did not participate in any drilling activities at the site. The conclusions and recommendations contained in this report are professional opinions derived in accordance with current standards of professional practice. No other warranty is expressed or implied.

This report has been prepared for the exclusive use of Langan, Inc. and applies only to the Fault Rupture Hazard Study located along Lot 12 between North Santa Monica Boulevard and Civic Center Drive in the City of Beverly Hills. In the event that significant changes in the interpretations of this study are made, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed by Tetra Tech, and the conclusions and recommendations of this report are verified in writing.

Site conditions can change with time as a result of natural processes or the activities of man. Changes to the applicable laws, regulations, codes, and standards of practice may occur as a result of government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which Tetra Tech has no control. Therefore, this report should be reviewed and recertified by Tetra Tech if it were to be used for a project design commencing more than one year after the date of issuance of this report.
7. REFERENCES


Martinson, Douglas G; Pisias, Nicklas G; Hays, James D; Imbrie, John D; Moore, Theodore C; Shackleton, Nicholas J, 1987, Age Dating and the orbital theory of the ice ages: development of a high-resolution 0- to 300,000-year chronostratigraphy. Quaternary Research, v. 27, p. 1-29.


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<td>20.0 - 22.0</td>
<td>4Bl2b</td>
<td>Brown (7.5YR 5/4 d, 7.5YR 4/3 m), loam, moderately well oxidized, slightly hard to hard, very friable, moderately sticky, slightly plastic, coarse-grained poorly sorted sand with common fine slate-rich sub angular gravel, brown (7.5YR 4/4 d, 7.5YR 3/3 m) clay films very few thin on ped faces and few thin coating clasts, and few to common clay stains on ped faces and few coating clasts, massive to crudely stratified, gradational lower boundary to;</td>
<td>Qoa1</td>
</tr>
<tr>
<td>22.0 - 33.0</td>
<td>4BcB</td>
<td>Brown (10YR 5/3d, 10YR 4/2 m) sandy loam and Light Brown (7.5YR 6/3d, 7.5YR 5/2m) loamy sand, crudely stratified, with slightly oxidized beds, loose to soft, very friable, non- to slightly sticky, non-plastic, coarse-grained poorly sorted sand with few to common fine and medium sub rounded gravel, moderately thick scour deposit, clear lower boundary to;</td>
<td></td>
</tr>
<tr>
<td>33.0 - 35.9</td>
<td>5Bc lam b</td>
<td>Light Brown (7.5YR 6/3d, 7.5YR 5/2 m) loamy sand matrix and Brown (7.5YR 5/4d, 7.5YR 4/3m) loam laminae, matrix is slightly oxidized, loose, very friable, non-sticky, non-plastic, coarse-grained poorly sorted sand with beds of few to common fine and medium sub rounded gravel, crudely stratified with 0.2 to 0.4' thick randomly spaced laminae that are hard, friable, slightly sticky, slightly plastic, medium- to coarse-grained poorly sorted sand, brown (7.5YR 4/4 d, 7.5YR 3/3 m) clay stains very few thin on ped faces, crudely stratified scour deposit, clear lower boundary to;</td>
<td></td>
</tr>
<tr>
<td>35.9 - 39.0</td>
<td>6Bt1b</td>
<td>Brown (7.5YR 5/4 d, 7.5YR 4/3 m), loam to clay loam, moderately strong redox with common gray (2.5Y 6/1d, 2.5Y 5/1m) gleyed patches and few fine strong brown (7.5YR 5/6d, 7.5YR 4/4) mottles, hard, friable, moderately sticky, moderately plastic, fine- to medium-grained moderately well sorted sand with few fine and medium sub rounded gravel, brown (7.5YR 4/4 d, 7.5YR 3/3 m) clay films few thin on ped faces, and common clay stains on ped faces and coating clasts, truncated argillic horizon, gradational lower boundary to;</td>
<td>Qoa2</td>
</tr>
<tr>
<td>39.0 - 40.0+</td>
<td>6Bt2b</td>
<td>Brown (7.5YR 5/4d, 7.5YR 4/3m), sandy clay loam, moderately well oxidized, hard to very hard, friable, moderately to very sticky, moderately plastic, coarse-grained poorly sorted sand with common fine and medium slate rich sub rounded gravel, brown (7.5YR 4/4 d, 7.5YR 3/3 m) clay films few thin on ped faces and common thin coating clasts, and common clay stains on ped faces; undetermined lower boundary to;</td>
<td></td>
</tr>
<tr>
<td>Unit</td>
<td>Thickness (Feet)</td>
<td>Color</td>
<td>Texture</td>
</tr>
<tr>
<td>--------------</td>
<td>------------------</td>
<td>--------</td>
<td>-----------</td>
</tr>
<tr>
<td>Raw Alluvium</td>
<td>3</td>
<td>2.5Y 7/3</td>
<td>X/10</td>
</tr>
<tr>
<td>Transect A; Boring LB 4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AB</td>
<td>1.6</td>
<td>7.5YR 3/2</td>
<td>0.2</td>
</tr>
<tr>
<td>Bt</td>
<td>1.8</td>
<td>7.5YR 5/4</td>
<td>0.3</td>
</tr>
<tr>
<td>2Bt1b</td>
<td>1.6</td>
<td>7.5YR 5/4</td>
<td>0.3</td>
</tr>
<tr>
<td>2Bt2b</td>
<td>1.2</td>
<td>7.5YR 5/4</td>
<td>0.3</td>
</tr>
<tr>
<td>3Bb</td>
<td>2.0</td>
<td>7.5YR 5/4</td>
<td>0.3</td>
</tr>
<tr>
<td>4Bt1b</td>
<td>0.6</td>
<td>5YR 5/4</td>
<td>0.4</td>
</tr>
<tr>
<td>4Bt2b</td>
<td>2.4</td>
<td>7.5YR 5/4</td>
<td>0.3</td>
</tr>
<tr>
<td>4BCb</td>
<td>1.1</td>
<td>7.5YR 5/3</td>
<td>0.2</td>
</tr>
<tr>
<td>5BC lam b</td>
<td>0.8</td>
<td>7.5YR 6/3</td>
<td>0.2</td>
</tr>
<tr>
<td>6Bt1b</td>
<td>4.1</td>
<td>7.5YR 5/4</td>
<td>0.3</td>
</tr>
<tr>
<td>6Bt2b</td>
<td>1.9</td>
<td>7.5YR 5/4</td>
<td>0.3</td>
</tr>
</tbody>
</table>

### INDEX VALUES AND DETERMINED AGES (ka)

<table>
<thead>
<tr>
<th>Soil Member</th>
<th>MHI</th>
<th>Mean Soil Index</th>
<th>SDI @ 7 feet</th>
<th>Color Index</th>
<th>Clay Film Index</th>
<th>Soil Age Estimate ka</th>
<th>Section Age Estimate ka</th>
<th>Stratigraphic Unit</th>
<th>Depth (Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Soil</td>
<td>0.30</td>
<td>1.43</td>
<td>2.94</td>
<td>0.80</td>
<td>0.80</td>
<td>4 - 8</td>
<td>4 - 8</td>
<td>Qal1</td>
<td>5.0 - 10.8</td>
</tr>
<tr>
<td>Buried Soil 1</td>
<td>0.54</td>
<td>1.42</td>
<td>3.56</td>
<td>1.00</td>
<td>0.58</td>
<td>8 - 15</td>
<td>12 - 23</td>
<td>Qal2</td>
<td>10.8 - 14.0</td>
</tr>
<tr>
<td>Buried Soil 2</td>
<td>0.56</td>
<td>1.11</td>
<td>3.89</td>
<td>0.50</td>
<td>0.20</td>
<td>8 - 15</td>
<td>20 - 38</td>
<td>Qoa1</td>
<td>15.0 - 17.0</td>
</tr>
<tr>
<td>Buried Soil 3</td>
<td>0.59</td>
<td>1.38</td>
<td>2.36</td>
<td>1.50</td>
<td>0.65</td>
<td>4 - 8</td>
<td>24 - 46</td>
<td>Qoa2</td>
<td>17.0 - 33.0</td>
</tr>
<tr>
<td>Buried Soil 4</td>
<td>0.11</td>
<td>0.08</td>
<td>0.74</td>
<td>0.30</td>
<td>0.17</td>
<td>1 - 4</td>
<td>25 - 50</td>
<td>Qoa2</td>
<td>33.0 - 35.9</td>
</tr>
<tr>
<td>Buried Soil 5</td>
<td>0.51</td>
<td>2.77</td>
<td>3.24</td>
<td>1.00</td>
<td>0.65</td>
<td>8 - 15</td>
<td>33 - 65</td>
<td>Qoa2</td>
<td>35.9 - 40.0+</td>
</tr>
</tbody>
</table>

### Table 1.2

**Soil Development Index Calculation Sheet**

Lot 12 North Santa Monica Boulevard and Civic Center Drive - Transect A; Boring LB 4
<table>
<thead>
<tr>
<th>Depth (Ft)</th>
<th>Horizon</th>
<th>Summary Description of Transect A; Boring LB-1</th>
<th>Stratigraphic Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 5.0</td>
<td>NR &amp; Af</td>
<td>No Recovery and Artificial Fill</td>
<td></td>
</tr>
<tr>
<td>5.0 - 6.2</td>
<td>AB</td>
<td>Truncated weak soil, dark brown, loam, massive, slightly hard, slight organics, medium-grained with few fine and medium sub rounded gravel, few clay stains, gradational lower boundary to;</td>
<td></td>
</tr>
<tr>
<td>6.2 - 7.3</td>
<td>Bw</td>
<td>Cambic horizon, light brown, loam, massive, slightly well oxidized, soft to slightly hard, fine-grained with very few fine sub rounded gravel, scour deposit, clear boundary to;</td>
<td>Qal1</td>
</tr>
<tr>
<td>7.3 - 10.9</td>
<td>2Btb</td>
<td>Truncated weak argillic horizon, brown, sandy clay loam, massive, hard, slightly well oxidized, fine-grained, with common fine and medium sub angular gravel, few to common thin clay films, clear lower boundary to;</td>
<td></td>
</tr>
<tr>
<td>10.9 - 11.6</td>
<td>3Bt1b</td>
<td>Stacked and truncated weak argillic horizon, brown, silty clay loam, massive, hard, slightly well oxidized, fine-grained, very few thin clay films, gradational lower boundary to;</td>
<td>Qal2</td>
</tr>
<tr>
<td>11.6 - 13.9</td>
<td>3Bt2b</td>
<td>Subsurface argillic horizon, brown, sandy clay loam, massive, very hard, slightly well oxidized, fine-grained, few thin clay films, gradational lower boundary to;</td>
<td></td>
</tr>
<tr>
<td>13.9 - 15.6</td>
<td>4Bt1b</td>
<td>Stacked and truncated moderately strong argillic horizon, reddish brown, clay loam, massive, moderately well oxidized, very hard, medium to coarse-grained, few moderately thick and common thin clay films and common clay stains, gradational lower boundary to;</td>
<td></td>
</tr>
<tr>
<td>15.6 - 20.0</td>
<td>4Bt2b</td>
<td>Subsurface weak to moderately strong argillic horizon, brown, loam, massive, moderately well oxidized, hard, coarse-grained, common fine and medium sub angular gravel, few thin clay films and common clay stains, gradational lower boundary to;</td>
<td></td>
</tr>
<tr>
<td>20.0 - 22.0</td>
<td>5Btb</td>
<td>Stacked and truncated weak argillic horizon, brown, loam, massive, hard, slightly well oxidized, coarse-grained, common fine and medium sub angular gravel, few to common thin clay films, gradational lower boundary to;</td>
<td>Ooa1</td>
</tr>
<tr>
<td>Depth (Ft)</td>
<td>Horizon</td>
<td>Summary Description of Transect A: Boring LB-1</td>
<td>Stratigraphic Unit</td>
</tr>
<tr>
<td>-----------</td>
<td>---------</td>
<td>-----------------------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>22.0 - 31.0</td>
<td>5BCb</td>
<td>Transitional horizon, light brown, sandy loam, massive to crudely stratified, soft, medium to coarse-grained with few to common fine and medium sub rounded gravel, slightly oxidized, scour deposit, clear lower boundary to;</td>
<td></td>
</tr>
<tr>
<td>31.0 - 36.8</td>
<td>6BC lamb</td>
<td>Stacked and truncated transitional horizon, light brown, sandy loam to loam, crudely stratified, fine to medium-grained and coarse-grained beds with common fine and medium sub rounded gravel, slightly oxidized, scour deposit, clear lower boundary to;</td>
<td></td>
</tr>
<tr>
<td>36.8 - 40.0+</td>
<td>7Btb</td>
<td>Truncated moderately strong argillic horizon, brown, clay loam, massive, slightly well oxidized, hard, coarse-grained few fine and medium sub rounded slate rich gravel, few moderately thick and common thin clay films and common clay stains, gradational lower boundary to;</td>
<td>Qoa2</td>
</tr>
</tbody>
</table>
### Table 2.1 - Soil Summary Sheet
Lot 12 North Santa Monica Boulevard and Civic Center Drive - Transect A - Boring B-7

<table>
<thead>
<tr>
<th>Depth (Ft)</th>
<th>Horizon</th>
<th>Summary Description of Transect A; Boring B-7</th>
<th>Stratigraphic Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 5.0</td>
<td>NR &amp; Af</td>
<td>No Recovery and Artificial Fill</td>
<td></td>
</tr>
<tr>
<td>5.0 - 6.0</td>
<td>AB</td>
<td>Truncated weak soil, dark brown, loam, massive, slightly hard, slight organics, medium-grained with few fine and medium sub rounded gravel, few clay stains, gradational lower boundary to;</td>
<td></td>
</tr>
<tr>
<td>6.0 - 10.4</td>
<td>Bw</td>
<td>Cambic horizon, light brown, loam, massive, slightly well oxidized, soft to slightly hard, fine-grained with very few fine sub rounded gravel, scour deposit, clear boundary to;</td>
<td>Qal1</td>
</tr>
<tr>
<td>10.4 - 12.0</td>
<td>2Btb</td>
<td>Truncated weak argillic horizon, brown, sandy clay loam, massive, hard, slightly well oxidized, fine-grained, with common fine and medium sub angular gravel, few to common thin clay films, clear lower boundary to;</td>
<td></td>
</tr>
<tr>
<td>12.0 - 14.0</td>
<td>3Bt1b</td>
<td>Stacked and truncated weak argillic horizon, brown, silty clay loam, massive, hard, slightly well oxidized, fine-grained, very few thin clay films, gradational lower boundary to;</td>
<td></td>
</tr>
<tr>
<td>14.0 - 15.5</td>
<td>3Bt2b</td>
<td>Subsurface argillic horizon, brown, sandy clay loam, massive, very hard, slightly well oxidized, fine-grained, few thin clay films, gradational lower boundary to;</td>
<td>Qal2</td>
</tr>
<tr>
<td>15.5 - 16.1</td>
<td>4Btb</td>
<td>Stacked and truncated weak argillic horizon, brown, silty clay loam, massive, hard, slightly well oxidized, fine-grained, very few thin clay films, gradational lower boundary to;</td>
<td></td>
</tr>
<tr>
<td>16.1 - 21.1</td>
<td>5Bt1b</td>
<td>Stacked and truncated moderately strong argillic horizon, reddish brown, clay loam, massive, moderately well oxidized, very hard, medium to coarse-grained, few moderately thick and common thin clay films and common clay stains, gradational lower boundary to;</td>
<td></td>
</tr>
<tr>
<td>21.1 - 23.1</td>
<td>5Bt2b</td>
<td>Subsurface weak to moderately strong argillic horizon, brown, loam, massive, moderately well oxidized, hard, medium- to coarse-grained, few fine and medium sub angular gravel, few thin clay films and common clay stains, gradational lower boundary to;</td>
<td></td>
</tr>
<tr>
<td>Depth (Ft)</td>
<td>Horizon</td>
<td>Summary Description of Transect A; Boring B-7</td>
<td>Stratigraphic Unit</td>
</tr>
<tr>
<td>-----------</td>
<td>---------</td>
<td>--------------------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>23.1 - 27.0</td>
<td>5Bl3b</td>
<td>Subsurface weak argillic horizon, brown, loam to sandy loam, massive, moderately well oxidized, slightly hard, coarse-grained, common fine and medium sub angular gravel, very few thin clay films and common clay stains, gradational lower boundary to;</td>
<td></td>
</tr>
<tr>
<td>27.0 - 29.5</td>
<td>5BCb</td>
<td>Transitional horizon, light brown, sandy loam, massive to crudely stratified, soft, medium to coarse-grained with few to common fine and medium sub rounded gravel, slightly oxidized, scour deposit, clear lower boundary to;</td>
<td>Ooa1</td>
</tr>
<tr>
<td>29.5 - 32.0</td>
<td>6Bwb</td>
<td>Truncated inset weakly developed soil, cambic horizon, brown, loam, massive, slightly well oxidized, soft to slightly hard, fine-grained with very few fine sub rounded gravel, gradational boundary to;</td>
<td></td>
</tr>
<tr>
<td>32.0 - 33.3</td>
<td>6BCb</td>
<td>Transitional horizon, light brown, sandy loam to loam, crudely stratified, fine to medium-grained and coarse-grained beds with common fine and medium sub rounded gravel, slightly oxidized, scour deposit, clear lower boundary to;</td>
<td></td>
</tr>
<tr>
<td>33.3 - 34.0</td>
<td>7Bwb</td>
<td>Truncated inset weakly developed soil, cambic horizon, brown, loam, massive, slightly well oxidized, soft to slightly hard, fine-grained with very few fine sub rounded gravel, gradational boundary to;</td>
<td></td>
</tr>
<tr>
<td>34.0 - 34.2</td>
<td>7BCb</td>
<td>Transitional horizon, light brown, sandy loam to loam, crudely stratified, fine to medium-grained and coarse-grained beds with common fine and medium sub rounded gravel, slightly oxidized, scour deposit, clear lower boundary to;</td>
<td></td>
</tr>
<tr>
<td>34.2 - 35.6</td>
<td>8Bwb</td>
<td>Truncated inset weakly developed soil, cambic horizon, brown, loam, massive, slightly well oxidized, soft to slightly hard, fine-grained with very few fine sub rounded gravel, gradational boundary to;</td>
<td></td>
</tr>
<tr>
<td>35.6 - 40.0+</td>
<td>8BCb</td>
<td>Transitional horizon, light brown, sandy loam, massive to crudely stratified, soft, medium to coarse-grained with few to common fine and medium sub rounded gravel, slightly oxidized, scour deposit, clear lower boundary to;</td>
<td>Ooa2</td>
</tr>
<tr>
<td>Profile Number</td>
<td>Soil Member</td>
<td>Stratigraphic Unit</td>
<td>MHI Value</td>
</tr>
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<td>-----------</td>
</tr>
<tr>
<td>Transect A Boring LB 4</td>
<td>Surface Soil</td>
<td>Qal1</td>
<td>0.30</td>
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<tr>
<td></td>
<td>Buried Soil 1</td>
<td>Qal2</td>
<td>0.54</td>
</tr>
<tr>
<td></td>
<td>Buried Soil 2</td>
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<td>0.56</td>
</tr>
<tr>
<td></td>
<td>Buried Soil 3</td>
<td>Qoa1</td>
<td>0.59</td>
</tr>
<tr>
<td></td>
<td>Buried Soil 4</td>
<td></td>
<td>0.11</td>
</tr>
<tr>
<td></td>
<td>Buried Soil 5</td>
<td>Qoa2</td>
<td>0.51</td>
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</table>
### Table 4. Comparison Soil Data Indices Value Summary

<table>
<thead>
<tr>
<th>(McFadden) Mission Creek Soils</th>
<th>SDI At 7'</th>
<th>MHI</th>
<th>Reddening Index</th>
<th>Clay Film Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>S7 0-1000 yrbp</td>
<td>0.59</td>
<td>0.12</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>S5 4-13 ka</td>
<td>1.02</td>
<td>0.3</td>
<td>0.1</td>
<td>0</td>
</tr>
<tr>
<td>S4 13-70 ka</td>
<td>3.14</td>
<td>0.37</td>
<td>3.94</td>
<td>7.37</td>
</tr>
<tr>
<td>S2 70-250 ka</td>
<td>5.61</td>
<td>0.61</td>
<td>4.80</td>
<td>6.24</td>
</tr>
<tr>
<td>S2 250-700 ka</td>
<td>2.57</td>
<td>0.39</td>
<td>6.20</td>
<td>10.31</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(Rockwell) Ventura River Basin Soils</th>
<th>SDI At 7'</th>
<th>MHI</th>
<th>Reddening Index</th>
<th>Clay Film Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qt3 4 - 8 ka</td>
<td>1.7</td>
<td>0.17</td>
<td>0.5</td>
<td>0</td>
</tr>
<tr>
<td>Qt4 10 -15 ka</td>
<td>2.7</td>
<td>0.43</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Qt5a 15 – 20 ka</td>
<td>2.8</td>
<td>0.37</td>
<td>3.5</td>
<td>4.2</td>
</tr>
<tr>
<td>Qt5b 30 ka</td>
<td>3.2</td>
<td>0.46</td>
<td>5</td>
<td>7</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>(WLA) West Hollywood Buried Soils</th>
<th>SDI At 7'</th>
<th>MHI</th>
<th>Reddening Index</th>
<th>Clay Film Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qol1 100 ka</td>
<td>2.1</td>
<td>0.42</td>
<td>1.05</td>
<td>1.99</td>
</tr>
<tr>
<td>Qol2 100-300 ka</td>
<td>7.3</td>
<td>0.8</td>
<td>8.2</td>
<td>13.2</td>
</tr>
<tr>
<td>Texture</td>
<td>Structure</td>
<td>Consistence</td>
<td>Clay Films</td>
<td>Calcium Carbonate (Pedogenic CaCO3)</td>
</tr>
<tr>
<td>---------</td>
<td>-----------</td>
<td>-------------</td>
<td>------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>S - sand</td>
<td>m - massive</td>
<td>l - loose</td>
<td>vfr - very friable</td>
<td>so non sticky</td>
</tr>
<tr>
<td>LS - loamy sand</td>
<td>sg - single grained</td>
<td>so - soft</td>
<td>fr - friable</td>
<td>ss slightly sticky</td>
</tr>
<tr>
<td>SL - sandy loam</td>
<td>OR</td>
<td>sh - slightly hard</td>
<td>fi - firm</td>
<td>s moderately sticky</td>
</tr>
<tr>
<td>L - loam</td>
<td>1 - weak</td>
<td>h - hard</td>
<td>vfi - very firm</td>
<td>vs very sticky</td>
</tr>
<tr>
<td>CL - clay loam</td>
<td>2 - moderate</td>
<td>vh - very hard</td>
<td>AND</td>
<td>AND</td>
</tr>
<tr>
<td>SCL - sandy clay loam</td>
<td>3 - strong</td>
<td>eh - extremely hard</td>
<td>po non plastic</td>
<td>vn stains</td>
</tr>
<tr>
<td>C - clay</td>
<td>AND</td>
<td>ps slightly plastic</td>
<td>n thin</td>
<td>V+ many thick coatings on clast bottoms, many coarse pendants, many clasts completely enveloped, completely disseminated in matrix - petrocalcic</td>
</tr>
<tr>
<td>Si - silt</td>
<td>vf - very fine</td>
<td>p moderately plastic</td>
<td>mk moderately thick</td>
<td></td>
</tr>
<tr>
<td>SIL - silt loam</td>
<td>f - fine</td>
<td>vp very plastic</td>
<td>k thick</td>
<td></td>
</tr>
<tr>
<td>SiCL - silt clay loam</td>
<td>m - medium</td>
<td>AND</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SiC - silty clay</td>
<td>c - coarse</td>
<td>cl coating clasts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>vc - very coarse</td>
<td>pf ped faces</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AND</td>
<td>br bridging sand grains</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>gr - granular</td>
<td>po lining pores</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pl - platy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pr - prismatic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>abk - angular blocky</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sbk - sub angular blocky</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
### Table 6. Geological Cross Section Unit Age
Lot 12 Santa Monica Boulevard

<table>
<thead>
<tr>
<th>Cross Sec. Unit</th>
<th>Description</th>
<th>Age (ka)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qal1</td>
<td>Surficial organic rich and weakly developed Alfisol soil (Surface Soil)</td>
<td>4 - 8</td>
</tr>
<tr>
<td>Qoa1</td>
<td>Stacked and truncated moderately thick and moderately well developed Alfisol soils (Buried Soil 1)</td>
<td>12 - 23</td>
</tr>
<tr>
<td>Qoa2</td>
<td>Stacked and truncated thin and moderately well developed Alfisol soil over a truncated weakly developed Alfisol soil and moderately thick scour deposit (Buried Soil 2, 3, and 4)</td>
<td>20 - 50</td>
</tr>
<tr>
<td>Qoa3</td>
<td>Truncated and moderately well developed Alfisol soil (Buried Soil 5)</td>
<td>33 - 65</td>
</tr>
</tbody>
</table>