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To: **Mr. Gary Woods**
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Subject: **Preliminary geomorphic, structural, and stratigraphic evaluation of the eastern Santa Monica Fault Zone, and West Beverly Hills Lineament, Century City/Cheviot Hills area, California.**

1.0 EXECUTIVE SUMMARY

Kenney GeoScience (KGS) was retained by the Beverly Hills Unified School District (BHUSD) to provide a geologic evaluation of the Century City/Cheviot Hills area. Numerous recent site-specific geologic studies have been completed or are underway by various parties within the Century City/Cheviot Hills area including the Los Angeles County Metropolitan Transportation Authority (Metro). Metro has completed a study that included potential subway station sites and the Beverly Hills High School (BHHS). The BHUSD has completed a study of the BHHS. The BHUSD has an ongoing study of the El Rodeo Elementary School (north of the proposed eastern Santa Monica subway station site) and private parties have ongoing studies of properties at 10000 Santa Monica (between the BHHS and the proposed eastern Santa Monica subway station site) and at the Westfield Mall (between the proposed western Santa Monica subway station site and the proposed Constellation subway station site). The purpose of this analysis is to establish a regional geologic context in which to evaluate the site specific data being generated by all parties using standard geomorphic, structural and stratigraphic methods of analysis and evaluation.

KGS has completed its analysis and is preparing a final report including a formal peer review process. That report is anticipated to be complete within two weeks. This letter is intended to provide preliminary observations and conclusions.

2.0 PURPOSE AND SCOPE OF STUDY

2.1 The Century City Question

The Century City/Cheviot Hills area has long been a subject of great geologic interest because of its location near the Santa Monica, Hollywood, and Newport-Inglewood Fault Zones and specific local topographical features including the West Beverly Hills Lineament (WBHL). Prior to 2011, the closest

paleoseismic fault study conducted on the Santa Monica Fault was at the Veterans Administration Hospital site located approximately 2 miles west of Century City by Dolan et al. (2000) that determined that the Santa Monica fault zone is active. There are a series of particularly visible scarps along Santa Monica Boulevard between the present Mormon Temple and the Los Angeles Country Club on the northern edge of Century City that have survived urban development (Dolan and Sieh, 1992). Fault evaluation studies conducted by MACTEC (2010) and Parsons (2011) have identified several faults in the vicinity of Santa Monica Boulevard that support that the topographic lineament along Santa Monica Boulevard resulted from faulting and subsequent erosion along the fault zone. Parsons (2011) without any sediment age data to evaluate the age of faulting presumed that the faults along Santa Monica boulevard were active due to their mapped correlation to the identified active Santa Monica fault zone at the Veterans Administration Hospital site by Dolan et al. (2000).

The WBHL represents an north-northwest trending east-sloping escarpment located on the western edge of the City of Beverly Hills. Based on the existing literature it is unclear what processes produced the WBHL. There is by no means a unanimous opinion regarding what geologic process produced the WBHL. However, recently, the California Geological Survey (CGS) has posted a fault map (their website) showing a single fault in the area of the WBHL. The placement of the WBHL on the official maps did not follow the normal CGS procedure that includes the publishing of a very detailed Fault Evaluation Report: there has been no published Fault Evaluation Report of the WBHL by the CGS. It should also be noted that until the present time, there has not been a single fault study or presentation of other hard evidence of the actual presence of a fault zone existing along the WBHL. Regardless, the WBHL was listed on the CGS maps as an active fault. Some published explanations for creation of the topographic WBHL include:

- Uplift above a deep-seated northerly extension of the Newport-Inglewood fault zone (NIFZ; see Wright, 1991 and this study). This model therefore indicates that uplift, folding, and erosion are the dominant processes producing the WBHL.

- Faults associated with the northern extension of the NIFZ (Dolan and Sieh, 1992). This model suggests that faults associated with the NIFZ extend to the surface or very close to the surface within the WBHL. Tsutsumi et al. (2001) are essentially in agreement with this model.

- The surface manifestation of a northern extension of the gently east-dipping Compton blind thrust fault (Shaw and Suppe, 1996). This model suggests that uplift, folding and erosion led to the development of the WBHL.

- An east dipping normal fault associated with extension along the left step between the Hollywood and Santa Monica fault zones (Dolan et al., 1997). Presumably this model suggests that a shallow northwest trending normal fault zone produced the WBHL escarpment.

- Lang and Dreeson (1975) propose that the NIFZ turns westward south of the Cheviot Hills and cuts the SMFZ west Century City. This model therefore indicates that faults associated with the NIFZ do not extend northward in the vicinity of the WBHL.

- Hummon et al., (1994) indicate that the broad west-plunging anticline produced by the Wilshire fault, the axis of which is parallel to Wilshire Boulevard east of the Cheviot Hills terminates westward at the WBHL. Our interpretation of this model suggests that Hummon et al. (1994) indicate that a structural "break" occurs across the WBHL that is likely associated with faulting.

- Lang (1994) disagrees with the Hummon et al. (1994) findings and indicates that the Wilshire fault does not intersect their mapped trace of the West Beverly Hills Lineament-Newport-Inglewood fault (WBHL-NIFZ). Lang (1994) indicates that subsurface mapping, constrained by dense subsurface control from nearly 300 wells in the Cheviot Hills precludes the existence of any fault with the trace that Hummon et al. (1994) showed for the WBHL-NIFZ.

- Based on boring data located approximately one mile southeast of Beverly Hills High School in the Baldwin Hills, Tsutsumi et al. (2001) suggested that the WBHL is underlain by a steeply east dipping normal-separation fault that could be a northern continuation of the Inglewood fault. They also indicate that they were unable to locate the subsurface continuation of the lineament farther north because of the structural complexity north of the southern strand of the Santa Monica Fault and that right slip across the Inglewood fault is absorbed by growth of the Cheviot Hills anticline and Sawtelle syncline as originally proposed by Wright (1991).

- Dolan et al. (1997) suggest numerous tectonic models for the creation of the WBHL. These include an east dipping normal fault associated with extension along the left step between the Hollywood and Santa Monica Fault Zones, a fold scarp along the northern extension of the back limb of the Compton blind thrust anticline and right-lateral strike-slip faulting associated with the northern NIFZ.

- It should be pointed out that Shaw and Suppe (1993) indicate that the slip rate on the northern NIFZ south of the Cheviot Hills is estimated to be <0.1 mm/yr and Tsutsumi et al. (2001) suggest that the slip rate of the NIFZ should decrease toward the north. This is consistent with Wrights (1991) proposal that the NIFZ has propagated northward during the late Quaternary.

Based on all these different models it is clear that the WBHL is an important late Quaternary structural feature within a complex tectonic region of converging folds and various fault zones but remains poorly understood. The models are consistent in regards to indicating that faulting or folding were the primary structural processes involved in the creation of the WBHL.

If the WBHL is indeed attributed to faulting, and if the Santa Monica Fault Zone actually extends to Century City along Santa Monica Boulevard, then there is a logical temptation to simply extend and "connect the dots" and conclude that the WBHL is actually an extension of the Newport-Inglewood Fault Zone, that the Newport-Inglewood Fault Zone probably connects to western terminus of the Hollywood Fault, and that Century City sits at the confluence of the Santa Monica Fault and the WBHL/Newport-Inglewood Fault Zone. The lack of any detailed subsurface data in the immediate area prevented resolution of the underlying questions. As discussed previously, it is clear that the WBHL is indeed a topographic lineament (escarpment), but it is unclear what natural processes created it - faulting, folding, uplift, erosion or a combination of these processes. In addition, if the WBHL primarily resulted from faulting then are these faults active as defined by the State of California?

The lack of resolution has not prevented urban development. Century City itself is now heavily developed with high-rise buildings, and the surrounding areas that may overly the various suspected faults are completely developed and urbanized.

2.2 The Westside Subway Extension Studies

During the past year and a half, the first fault investigations providing subsurface data in the Century City area were conducted as part of the design studies for the Los Angeles County Metro Westside Extension subway project. Both the MACTEC (2010) and Parsons (2011) investigations for Metro provided subsurface data to evaluate potential fault locations associated with the generally northwest to southeast trending West Beverly Hills Lineament (WBHL) and the generally southwest to northeast trending Santa Monica Fault Zone (SMFZ). The Parsons (2011) investigation and public testimony by experts who participated in the investigation made numerous and significant conclusions regarding the presence of faulting in the Century City area:

- the Santa Monica Fault Zone extends across the northern edge of Century City,
- the WBHL is actually the northern part of the Newport-Inglewood Fault Zone extending from Century City to possibly further north where it intersects the western terminus of the Hollywood Fault near the base of the Santa Monica Mountains,
- the data supported a map of numerous fault strands of both the Santa Monica and WBHL faults systems which intersect along Santa Monica Boulevard,
- the data supported the mapping of a broad swath of active faulting (fault zone) with the potential for surface disruption within the State of California definition of an active fault (younger than 11,000 years)
- because of the presence of active faulting as mapped by Parsons (2011) two of the three potential station locations in Century City were unsafe and should not be considered, and
- the existing Beverly Hills High School overlays numerous active faults.

Although the purpose of the Metro studies was to assist in subway design, the conclusions and public pronouncements made by Parsons (2011) have public implications that go well beyond the immediate questions of subway planning and design. **These conclusions are not supported by the data or by rigorous analysis and are not consistent with emerging data and analysis from other sources.**

There are certain obvious limitations in the scope of the Metro field investigations. Some of these include the disproportionate reliance on widely spaced CPT data with relatively few continuous core borings or other method of result confirmation, and a lack of any fault trenching or age dating of the local sediments. The MACTEC (2010) and Parsons (2011) fault investigation reports provided absolutely no data regarding fault activity because neither study provided any quantitative sediment age data. There was no trenching or positive identification at the surface of any fault within the study area. Their studies also did not provide any fault strike data with the exception of attempting to connect certain faults identified on local transects which by its nature is speculative. Despite the lack of data, several faults within each zone were identified as “Active” on the published Parsons (2011) maps.

KGS disagrees with many of the Parsons (2011) interpretations and believes that the findings within the Parsons (2011) report should have been considered preliminary and followed up with additional studies both to better resolve the actual locations and existence of faults and their activity level in the study area.

In addition, it is clear that more subsurface data needs to be collected for the proposed subway station locations.

2.3 The Beverly Hills High School Studies

After the release of the Parsons (2011) report, Leighton Consulting Inc. (LCI) conducted an extensive fault investigation within the Beverly Hills High School property. The LCI (2012) investigation is significant because it is the only field investigation in the immediate Century City area to have conducted large scale trenching directly across the Parsons (2011) proposed faults within the WBHL – Newport Inglewood fault zone (WBHL-NIFZ).

The LCI (2012) fault investigation focused on whether or not the proposed northwest to southeast trending faults associated with the WBHL exist. The study also provided considerable age data for the near surface sediments to evaluate whether or not any faults that may exist in the area should be considered as "active" under State of California definitions. Simply put, LCI (2012) determined that no active near surface faults exist in the Beverly Hills High School property associated with the WBHL. This conclusion diverges significantly from the Parsons (2011) conclusion.

The LCI (2012) investigation is also significant because it attempted to replicate a series of Parsons (2012) CPT tests along Transect 4 with closely spaced continuous core borings and CPT tests. This confirmation testing revealed certain discrepancies in the Parsons (2011) CPT data when compared against the LCI continuous core borings and CPT tests.

The most recent publication to emerge regarding potential subsurface faulting is Parsons (2012) entitled "Response to Leighton Consulting Report" dated May 14, 2012. This report provided adjusted locations for Parsons (2011) proposed WBHL faults, which were either stopped where these faults were trending toward an LCI (2012) fault trench showing they do not exist in the near surface, or moved slightly to just slide between a small gap between LCI trench locations. The Parsons (2012) response report also provided new data consisting of a subsurface structure contour map of the upper San Pedro Formation surface. Parsons (2012) interpreted deformation evaluated in this surface as evidence that a northwest-southeast trending fault within their WBHL fault zone exhibits approximately 350 feet of right-lateral displacement.

2.4 Scope of Kenney GeoScience Study

The Parsons (2011 and 2012) analysis of the WBHL and mapping of active faults across the Beverly Hills High School remains sharply at odds with the LCI (2012) findings and data. This contradiction in actual LCI (2012) findings versus Parsons (2011) predictions, the apparent issues with the Parsons (2011) CPT data and its repercussions, the lack of soil dating, and other analytical limitations in the Parsons (2011) study raise serious questions regarding the overall Metro study methodology and conclusions regarding the overall Century City area. Again, the MACTECH (2010) and Parsons (2011) fault studies are considered good preliminary fault investigations especially taking into account the density of urban development. These studies essentially provided a model for the potential location of faults but provided no data regarding weather or not the faults really exist and if so their activity. Their preliminary data

should have been utilized for developing a more refined subsurface study in the area of their identified faults to determine weather or not the faults exist and their activity as defined by the State of California.

It is also clear that accurate interpretation of this data cannot be done out of context: it requires interpretation consistent with all of the known geologic facts and attributes of the overall Century City area. Even after the MACTEC (2010), Parsons (2011 and 2012), and LCI (2012) reports and the many preceding papers on the subject, many questions remain regarding potential deformation associated with the Santa Monica and proposed WBHL-NIFZ within the Century City area. Some of these include:

- What was the geologic history of the Century City area since the late Pleistocene?
- What is the tectonic role of local folding in the Cheviot Hills? What did cause the uplift and erosion in the Cheviot Hills to produce the WBHL?
- Are the faults along Santa Monica Boulevard active?
- Do faults associated with the West Beverly Hills Lineament exist in the near surface in the Century City and Beverly Hills area?
- Could blind active faults exist in the southern Cheviot Hills area?
- Why do the identified faults along Santa Monica Boulevard dip approximately 20 to 30 degrees at the Veterans Hospital property (Pratt et al., 1998; Catchings et al., 2008) located approximately 2 miles west of Century City, and then dip approximately 50 to 85 degrees in the Century City area? What does this imply?
- Are the faults identified along Santa Monica Blvd actually the primary Santa Monica Fault Zone?
- Why do many of the faults identified in the Parsons (2011) report along Santa Monica Boulevard show apparent normal and reverse dip-slip separation?
- Does a releasing bend occur in the SMFZ locally in the Century City area along Santa Monica Boulevard?
- Are the faults identified along Santa Monica Boulevard actually secondary faults to the basal reverse fault of the SMFZ?
- Has the primary basal reverse fault to the SMFZ not yet been identified locally?

Kenney GeoScience (KGS) was requested to perform a geomorphic, structural and stratigraphic evaluation of the eastern Santa Monica Fault Zone and the West Beverly Hills Lineament in the Cheviot Hills area of Century City and Beverly Hills, California based on an integrated review of older published maps and data and the recently completed investigations for Metro and BHHS. While the immediate purpose of this study is to better understand potential fault surface rupture hazard in the Century City area, and particularly in regard to how it might affect local schools (El Rodeo K-12, Beverly Hills High School), the proposed Metro Station sites along Santa Monica Boulevard and the proposed Metro Station site on Constellation Boulevard (Plate ES-1a), the implications of this work for the existing and future urban development of the surrounding area is fully recognized.

The KGS analysis provides a preliminary geologic and tectonic history regarding the age and history of sedimentation, erosion, uplift, folding and faulting in the Century City area. The KGS analysis has intentionally sought out multiple lines of overlapping inquiry.

3 Report Conclusions

KGS has made the following conclusions based on all the reviewed and existing data regarding potential locations and activity of seismic deformation (faulting, folding, etc.) in the Century City area.

- A late Quaternary geologic history has been developed for the Cheviot Hills based on all the provided data that greatly assists in our understanding of the timing and scale of local deformational structures and sedimentary units in the Cheviot Hills.

- A detailed geomorphic analysis of the Cheviot Hills is presented that provides improvements in our understanding of the style, age, and location of faults in the Cheviot Hills region.

- No conclusive evidence has been published that any faults in the Cheviot Hills (Century City area) are active. Based on published geologic mapping, age dating of near surface sediments, geomorphology, evaluation of the geologic history of the local area, and revised interpretation of the Parsons (2011) transect cross sections, there is a possibility that none of the faults along Santa Monica Blvd, referred herein as the Santa Monica Boulevard Fault Zone (SMBFZ) are active. The data suggest that activity on various individual faults within the fault zone likely ceased at different times. Based on the existing data, the SMBFZ was active approximately 150,000 years ago, offsets a soil profile dated at approximately 134,000 years old, and may have ceased prior to approximately 40,000 to 50,000 years ago. Therefore, faults within this zone should not be considered active until a more detailed subsurface fault investigation is conducted and they are determined to be active by direct evidence.

- It is probable that active folding is occurring in the Cheviot Hills and thus may potentially affect proposed stations on either Santa Monica or Constellation. The rate of folding is considered low to very low (i.e. per major earthquake event) but this aspect of the local geology should be more fully evaluated by professional geologists and engineers. KGS has concluded that the WBHL was produced by folding, and not near surface faulting. For strain budgets, it is clear that fault displacement estimates should consider local folding as a slip sink.

- Faults associated with the proposed WBHL-NIFZ likely do not exist in the study area along the WBHL. The WBHL resulted from concurrent folding (uplift of Century City) and erosion by the Benedict Canyon Wash that produced a fold-scarp as proposed by Dolan et al. (1997).

- Parsons (2011) presumed that many soil layers were essentially horizontal which partly led to their identification of numerous faults within their WBHL-NIFZ.

- The Benedict Canyon Wash has had a significant defining role in the Cheviot Hills region since the late Quaternary. Today, it is a northwest-southeast trending drainage that has contributed significantly to the erosional and depositional patterns that in addition to local uplift contributed to the creation the WBHL. In the past, the Benedict Canyon Wash flowed southwest across the northern edge of Century City and through the Cheviot Hills. Parsons (2011) did not identify the older Benedict Canyon Wash Deposits (BCWD) in terms of their geologic significance.

- A regional tectonic kinematic model is proposed for the creation of the WBHL that is associated with the Newport-Inglewood Fault Zone (NIFZ); however, these faults are not required to reach the surface in the eastern Cheviot Hills. Essentially the model proposes that the NIFZ extends under the eastern Cheviot Hills and underneath the Santa Monica Fault Zone similar to a model proposed by Wright (1991). Thus, as the Santa Monica tectonic block, defined as west of the NIFZ and south of the SMFZ, moves toward the north along the NIFZ, it simply deforms the basal SMFZ and causes uplift in the Cheviot Hills in a region parallel to and above the subsurface NIFZ. This uplift caused the development of a northwest-southeast striking, east dipping monocline in the general area of the WBHL. As the uplift continued, erosion occurred along the strike of the uplift thus creating the east facing, northwest-southeast striking escarpment referred to as the WBHL. This model allows for the NIFZ to be the causative agent for the development of the WBHL, but does not require faults associated with the NIFZ to exist at the near surface (above the underlying SMFZ).

- Parsons (2011) concluded that northwest to southeast trending active faults associated with the West Beverly Hills Lineament-Newport-Inglewood Fault Zone (WBHL-NIFZ) extended to and cross the Beverly Hills High School and the eastern Santa Monica subway station site. The proposed northwest to southeast trending active faults associated with the WBHL-NIFZ simply do not exist in the near surface in the study area (i.e. the maximum depths of all currently published investigations). One fault was identified by LCI in the BHHS property (Fault Trench 3) but was determined to be inactive, did not exhibit a thick gouge zone, and the total apparent offset across the fault was likely in the range of a few feet. Thus, it appears likely based on the existing that a relatively major strike-slip fault system associated with the WBHL-NIFZ does not exist in the near surface at least in the area where sufficient subsurface data has been collected (i.e. region of the LCI, 2012 and Parsons, 2011 studies).

- The primary fault zone in the study area occur in the general vicinity of Santa Monica Boulevard, and are referred herein as the Santa Monica Boulevard Fault Zone (SMBFZ). The SMBFZ is defined as a series of faults that trend parallel to Santa Monica Boulevard between the Mormon Temple through Century City and into western Beverly Hills. Faults within the SMBFZ predominantly dip steeply toward the north and likely exhibit primarily right-lateral displacement with local secondary reverse and normal displacement dependent on their strike within the zone (i.e. local restraining and releasing orientations). Our findings regarding the general location of these faults are in close agreement with Parsons (2011), however we are in disagreement regarding the kinematic role of the SMBFZ and its potential age.

- The SMBFZ splays outwards towards the east in the study area, and thus, the faulting at various scales is likely complex and exhibits numerous relatively smaller scale faults that would prove difficult to identify based on the resolution of the existing data.

- Based on the evaluated data, many if not all of the faults within the SMBFZ are inactive. The presumption that this fault zone is active is not supported by any local data. A number of individual faults within this zone are shown to be inactive by Parsons (2011) and additional analysis provided herein indicates the possibility that the majority if not all of the faults in the SMBFZ are not active in terms of rupturing the surface during the past 11,000 years as defined

by the State of California (Bryant and Hart, 2007). Further investigations to analyze fault activity within this zone are strongly warranted and should be conducted of mapped older Benedict Canyon Wash Deposits.

- Based on evaluation of the geophysical seismic reflection data provided in the Parsons (2011) report, some relatively deep and likely inactive faults may occur south of the identified SMBL fault zone as shown by Parsons (2011). These faults are poorly understood but may provide some insights on the tectonic and structural evolution of the region in addition to potential seismic hazards. For example, have faults similar to the SMBFZ migrated toward the north over time, and thus suggest a possible bend in the underlying primary basal reverse Santa Monica Fault? Could these faults be active and are simply blind and thus producing local near surface folding?

- Numerous lines of evidence suggest that the SMBFZ is a secondary upper plate fault zone associated with the basal oblique left-lateral reverse SMBZ. This conclusion infers that the basal SMFZ has not yet been identified in the Cheviot Hills and if it does exist would likely occur in the southern Cheviot Hills.

- This hypothesis therefore suggests that the basal SMFZ reverse fault exists in the southern Cheviot Hills, that all the sediments of the Cheviot Hills are in the upper plate and thus could exhibit active folding and relatively small scale faulting. In addition, based on this hypothesis, it is conceivable that the SMBFZ could actually be inactive even if the basal SMFZ reverse fault remained active in the area. All of these factors greatly affect estimates regarding how fault displacements would be partitioned in the area during a major earthquake in addition to a lack of understanding regarding the western reaches of the Hollywood fault zone.

- One, and possibly two fault strands identified by Parsons Brinckerhoff (Parsons, 2011) as part of their proposed WBHL fault zone are actually extensions of fault strands that exist along the SMBFZ.

The conclusions of this report regarding the proposed Metro Westside Subway Extension Project include:

- Several strands of the SMBFZ cross the western proposed Santa Monica subway station site (but not the eastern site proposed by Metro or the central site proposed by BHUSD). The evidence is that most if not all of these strands are inactive. Additional field investigation would be required to confirm that the shallowest faults are or are not active.

- Based on the existing data, no faults were identified that transect or trend toward the proposed central or eastern Santa Monica subway station sites.

- A series of northeast-southwest tending, relatively deep faults may extend across the site just north or possibly through the proposed Constellation Station. The primary evidence of these faults is provided by evaluation of Parsons (2011) seismic reflection data and Parsons (2012) structure contour map. Insufficient data exists in the region of the proposed Constellation Station to evaluate whether or not relatively major faults occur in this area, and thus warrants additional investigation.

- Late Quaternary folding occurs in the Cheviot Hills that should be evaluated by geotechnical engineers in terms of potential impacts to proposed and possibly existing structures.

It should be noted that additional investigations are currently underway by private parties that have been negatively affected by the Metro studies. The approved high-rise project at 10000 Santa Monica (immediately between the eastern proposed Santa Monica subway station and the Beverly Hills High School) has excavated geologic trenching to provide further confirmation of the absence of north-south WBHL-NIFZ active faulting. The trenches were excavated last week and are currently being scraped and logged, a process that will require less than a week to complete. This project may also be required to conduct north-south trenching to establish dating of the known east-west SMBFZ faults that cross the site (identified but strongly suspected to be older and inactive). Similarly, the Westfield Mall that has already obtained zoning permits for a $1 billion redevelopment is beginning a geologic exploration plan that will address the presence and age of predicted SMBZ faults – the same faults that were predicted by Metro to cross the western Santa Monica subway station site. Unlike the Metro studies, these investigations are subject to regulatory oversight and review: these investigations must specifically address the presence or absence of active SMBZ faulting to the satisfaction of the City of Los Angeles Building and Safety Department as part of the standard permitting process. The emerging data stream is consistent with the conclusions of the KGA analysis and the conclusions presented herein.

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