Earth Consultants International

Project No. 3425
June 3, 2015

To: **Millennium Hollywood Development LLC**
1680 N. Vine Street
Los Angeles, California 90028

Attention: **Mr. Philip E. Aarons, VP**

Subject: **Response to Request from the City of Los Angeles Reviewer**
East and West Millennium Sites
1733-1741 Argyle Avenue; 6236 and 6334 West Yucca Street; 1720-1730, 1740, 1745-1760, and 1762-1770 North Vine Street; 1746, 1748-1754, 1760, 1764, and 1770 North Ivar Avenue, in the Hollywood Area of the City of Los Angeles

Dear Mr. Aarons,

At your request, Earth Consultants International, Inc. (ECI) has conducted an additional detailed analysis of the cone penetration test (CPT) and borehole data collected by Group Delta Consultants (GDC) for the East and West Millennium sites. Our review was prompted by a request from the City's geologist, Mr. Dan Schneidereit, to revisit the data to address concerns raised by geologists from the California Geological Survey (CGS) who have reportedly interpreted a zone of faulting along portions of these sites. Copies of the cross-sections annotated by the CGS geologists were provided to us on April 7, 2015 by Mr. Jerold Neuman.

Specific tasks and the methodology that we used to complete our analysis are described below:

1. We reviewed several of the cores housed at GDC's laboratory in Torrance to obtain data on the depth to the top and bottom of the "Mud Flow" unit and other geologic deposits and layers exposed in these borings. We conducted this review together with Mr. Steven Kolthoff of GDC. The borings that we reviewed include B-7 through B-13, B-15, B-16 and B-18 for the East Millennium site.

2. We re-plotted the CPT data for cross-sections N-N′ and the southern end of M-M′ using the elevation data obtained by Psomas and submitted to us by GDC on March 23rd. Only the southern approximately 100 feet of Section M-M′ were revisited, an area that was not effectively and conclusively shadowed by the trenches previously excavated at the East Millennium site, and where CGS geologists interpreted a possible zone of faulting. Specifically, the borings and CPTs along Section N-N′ were emplaced to evaluate whether or not the Argyle strand of the Hollywood fault occurs in the area where CGS mapped it in the official Alquist-Priolo Earthquake Fault Zoning map issued

in November 2014 (based in part on their interpretation of Section M-M′). The Argyle fault strand was re-located southward to this area after the trenches in the East Millennium site showed that there were no active faults in the area where the preliminary Alquist-Priolo map (dated January 8, 2014) showed the Argyle strand.

Our cross-sections include both the tip resistance (qc) and sleeve friction (fs) recorded in these areas. Please note that the raw data do not include inclination measurements, so possible errors in the depth to the various layers, if the soundings wandered from vertical, have not been corrected. Uncorrected deviations from vertical can result in stratigraphic mismatches that increase with depth, mimicking the expression of a fault that has had recurrent movement over time, and thus giving a "false positive." Because the geologic units underlying the area are known to vary in dip and thickness, and the cross-section lines extend obliquely across the axes of the alluvial fans, variations in the depth to individual units can be expected in the cross-sections. Undulations in these contacts are normal, as observed in the trenches previously excavated in the East Millennium and 6230 Yucca Street sites, where steps 2 to 3 feet deep, caused by channel incision rather than faulting, were common at the base of the Mud Flow unit. For the purposes of this study, we have taken a conservative approach and have inferred possible faults in those portions of the cross-sections where a step-down (or step-up) in the stratigraphy occurs across several layers or the entire section at depth.

3. We re-plotted the CPT data for cross-sections O-O′ and P-P′ on the West Millennium site using elevation data that we extracted from the 2006 10-foot LiDAR (Light Distance and Ranging) –derived Digital Elevation Model (DEM) acquired by the Los Angeles Regional Imagery Acquisition Consortium in partnership with the U.S. Geological Survey (available for free at http://egis3.lacounty.gov/dataportal/2011/01/26/2006-10-foot-digital-elevation-model-dem-public-domain/). The vertical resolution of these data is reportedly of ±9 cm (3.54 inches or 0.3 feet), which, while not ideal, is better than the differences noted locally between the original and surveyed elevations for line N-N′, as discussed further below.

4. We correlated the CPT data from one sounding to the next, and included the borehole data described above to prepare each of the cross-sections included herein.

5. We prepared this report and accompanying illustrations.

CROSS-SECTION INTERPRETATIONS

Discussions with GDC personnel about topographic elevation control revealed that the elevations and spatial locations of the borings and CPTs emplaced as part of these fault studies were approximated from generalized topographic maps of the properties, rather than being surveyed. This is typically adequate for resolving gross offset stratigraphy, but is inadequate for the resolution of small-scale displacements such as those that CGS geologists have interpreted at various locations from various generations of drafts and finalized cross-sections issued both informally and formally by GDC. To better place the CPTs and borings on the cross-section lines along the southern portion of the East Millennium site, GDC retained Psomas, a licensed surveying contractor, to complete a survey of the borings and CPTs that comprise Section N-N′. Psomas also conducted an elevation survey for the southern portion of Section M-M′, as described further below.

The differences between the locations used by GDC in their original cross-sections and the new Psomas-surveyed locations of the borings and CPTs along Section N-N′ are shown on Figure 1. In most cases there is about a 10-foot difference between the original estimated locations and the surveyed locations, which were measured from the actual painted labels and asphalt patches still visible in the parking lot. The differences in elevations between the original GDC locations and the new Psomas-surveyed data are shown in red on Plate 1, atop each of the CPT or borehole notations. While there is good agreement on some of the N-N′ borings and CPT elevations, most show differences ranging from -0.8 to +1.1 feet (the plus elevation differences mean that the surveyed locations are higher than the original elevations used by GDC; similarly, the minus elevation differences mean the surveyed elevations are lower).

It was impossible to survey the exact locations of the CPTs and borings along Section M-M′ because the markings and patches left on the parking lot surface after the soundings were backfilled are no longer visible, the result of the lot having been repaved since the original exploration work was conducted in August 2012. Absent the markings on the ground, Psomas surveyed the elevations along GDC's best-estimated location of Section M-M′ using five-foot horizontal spacings (see Figure 1). This provided us with a topographic line onto which we projected the CPTs and borings using GDC's approximate locations, and from there we interpreted their elevations. However, as discussed in more detail below, the locations of the CPTs and borings are still approximate. As a result, for this cross-section, there are lateral and vertical spacing errors that are unresolvable. Since the CPTs and borings along Sections O-O′ and P-P′ were also not surveyed, lateral and spacing errors on these sections are also possible. (We extracted elevation data for the borings and CPTs along Section M-M′ from the 2006 DEM obtained from the County, but the elevations estimated in this manner did not resolve the issues associated with the locations of the borings, so we did not pursue this further).

The differences in elevation between the original CPT and borehole locations in the southern portion of Section M-M′ and the estimated new elevations based on the surveyed line are shown on Plate 1. In this area, the elevation differences vary from +0.2 to -1.2 feet, but given that the actual locations of the CPTs and borings are unknown, these elevation differences are estimates only. Furthermore, given the almost 2-foot spread in elevation difference along line N-N′, we assume that the actual elevation differences along section M-M′ are at least similar, but could be larger. For these reasons, we consider the revised Section N-N′ to be of much higher accuracy, and therefore validity, than the revised Section M-M′. Despite the issues above, we processed the new survey data, and re-plotted and completely reinterpreted both sections as shown on Plates 3 and 4. Since we trust more the data used to create Section N-N′, we present and discuss this section first (see Plate 3).

Sections O-O′ and P-P′ were also analyzed, with our interpretations shown on Plates 5 and 6. The differences between the LiDAR-derived elevations and the elevations used by GDC for their original sections are shown graphically on Plate 2. For Section O-O′, these elevation differences range from +1.1 feet at its northern end (with the LiDAR-derived elevation being 1.1-foot higher than the elevation used by GDC in their original cross-section), to -1.1 feet in the central portion of the section, near CPTs C-16 and C-17. In most other areas, the differences range from -0.4 to -0.8 feet. In the northern portion of Section P-P′, the LiDAR-derived elevations agree with the elevations used by GDC. Starting at about the area of CPT C-111, the LiDAR-derived elevations are consistently lower than the elevations originally used by GDC, with the difference between the two sets of elevations generally increasing southward. The largest difference, in the order of -1.2 feet, was noted in the area of CPT C-102 (see Plate 2).

Section N-N′: This section shows that a possible minor high-angle fault can be interpreted between boring B-11 and CPT-36. We have chosen to show this fault as north dipping, with a reverse sense of motion, but it could also dip to the south with a normal sense of motion. At depth, based on our review of the borings in this area, the fault places Older Alluvium (Qoa) overlain by strongly developed paleosols formed in what we refer to as Older Mud Flow deposits (Qom) on the south against a thick section of strongly developed paleosols in Older Mud Flow deposits on the north. The interpreted fault can be traced upward about 4.5 feet into the bottom of the Mud Flow unit, vertically offsetting the base of the unit approximately 1.7 feet. Differences in the thicknesses of the layers at the bottom of the Mud Flow unit across the interpreted fault suggest some lateral component of movement on the fault. The data show that the channel filled in with the Mud Flow deposits falls gently to the west in the area between sections M-M′ and N-N′. Thus, and assuming that the horizontal component of slip on this interpreted fault is left-lateral, as it is generally assumed for the Hollywood fault zone, the horizontal movement would actually enhance the vertical separation of the base of the Mud Flow channel. This means that the 1.7-foot vertical offset measured in section N-N′ most likely over-estimates the true vertical displacement of the base of the Mud Flow unit across this possible fault.

Higher up in the stratigraphic section, several layers within the Mud Flow unit extend unbroken across the interpreted fault, indicating that the most recent event on this feature, if real, occurred early in the depositional history of the Mud Flow unit. The Mud Flow unit is interpreted to have been deposited during a previous major interglacial period, and its degree of soil development suggests it was exposed at the surface for many tens of thousands of years (see ECI, 2015). Combined, these data strongly suggest that this unit was deposited between 80,000 and 120,000 years ago, although it could be older. Given that the interpreted fault is confined to the lower section of the Mud Flow unit, the fault likely last moved more than 80,000 years ago, and is thus no longer active.

Please note that the interpretations discussed above are based solely on the CPT signatures and stratigraphic layers interpreted from the CPT data. Our review of the borings, on the other hand, suggests that the base of the Mud Flow unit extends unbroken across the area, as illustrated by the thick orange dashed line on Plate 3, suggesting that if there is a minor fault in this area, it either does not impact the base of the Mud Flow unit (making it more than 150,000 years old), or it has been obscured by pedogenic alteration of the bottom part of the Mud Flow unit, similar to the observations made in the East Trench on the 6230 Yucca Street site (see ECI, 2015).

At the southern end of Section N-N′, both the surface topography and stratigraphic layers interpreted in the subsurface appear to level out, and possibly even start to rise a bit. This behavior is characteristic of alluvial fan bodies, and is also consistent with the fact that the cross-sections that are the subject of this report are oriented slightly obliquely to the alluvial fan axes (see Figure 2). A fault farther south is not required to explain this part of the cross-section.

Section M-M′: The CPT data show that the stratigraphy along the southern portion of cross-section Section M-M′ is more complex, and no borings were drilled in the immediate vicinity of these CPTs to provide additional information on the geologic units underlying this area. This complexity, combined with the uncertainties in the locations and elevations of the CPTs, yields a cross-section that allows for multiple interpretations.

The most conservative interpretation (see Plate 3, Interpretation A, on the left side) places a pair of high-angle, south-dipping faults between CPTs 26 and 30. The more northerly of these two possible faults is interpreted to extend about 8 feet into the bottom part of the Mud Flow unit, but dies out and is capped by unfaulted strata within this unit, making the fault not active. The more southerly of these two possible faults can be interpreted to offset the base of the Mud Flow unit by ~3 feet, offset the base of the Argyle Sand deposits by a similar ~2 to 3 feet, and extend upwards to within 10 feet of the current ground surface. However, the validity of this interpretation is heavily dependent upon the accuracy of CPT-29′s location and vertical positioning, a significant issue as described below.

GDC personnel revisited the area of the parking lot where CPT-29 was emplaced and found that there is a low spot in this area that was not captured in the survey conducted by Psomas. (See red dot to the right of center on the photograph in Figure 3; the white dots in the bottom left and front center of the photo show two of the points recently surveyed by Psomas for line M-M′. The photo shows that the surveyed line is a few feet to the east of the boring and CPT locations, consistent with the data shown on Figure 1.) The vertical drop was not quantified, so appropriate corrections to the elevation of CPT-29 in section M-M′ cannot be made, and a review of the DEM did not help resolve this issue. The four CPTs that constrain the locations of the interpreted faults have the largest vertical elevation differentials (-0.8 to -1.2 feet) based on the newest, post-repaving survey, and the photograph in Figure 3 suggests that these differentials may be even larger in some spots. If these uncertainties could be resolved, and the true elevation of the CPTs were known, it is possible that the drops currently being interpreted in the stratigraphy as fault-controlled would go away, showing essentially parallel, unbroken stratigraphy under this area.

To illustrate the impact that this presumably incorrectly surveyed or emplaced CPT has on the interpretation of the sedimentary section in this area of the East Millennium site, we have prepared two additional permissible interpretations for cross-section M-M′, also included on Plate 3. Interpretation B, in the center, shows Cross-Section M-M′ without CPT-29 (deleting the questionable data point). Interpretation C, on the right, shows what happens when the “offset” at the base of the Holocene section is corrected by splicing the section along the inferred southern fault, and then restoring one half relative to the other so that the contact between the Argyle Sand and Mud Flow unit extends unbroken across that portion of the line. Each of these interpretations is discussed further next.

Interpretation B shows that when the data from CPT-29, which, as we have argued above, is incorrectly plotted, is omitted from the section, the stratigraphic layers between CPT-30 on the left and CPT-28 on the right can be projected unbroken across the 20-foot wide span in the transect.

Given that there are no stratigraphic disruptions near that span of the section that would suggest secondary deformation associated with a possible fault in that area, the idea that CPT-29 is incorrectly plotted appears reasonable. When CPT-29 is omitted, the dips of the stratigraphic layers that can be correlated across do not change in this area, whereas in other cross-sections included in this report where possible faults are interpreted, there is often a change in the dip and thickness of the layers. Finally, and significantly, the sediments in this portion of Section M-M′ are, based on the CPT curves, similar, even at depth. This contrasts with the other cross-sections analyzed for this study, including the southern ends of Sections N-N′, O-O′ and P-P′, where the units near the bottom of the sections are dissimilar across the the potential faults interpreted therein, typically placing Older Alluvium against Older Colluvium. All of these observations strongly suggest that this inferred break is not real, but rather an artifact of the data.

In Interpretation C we retain the data from CPT-29, but have spliced the cross-section along the inferred southern fault shown on Interpretation A, and moved the eastern half down so as to align the contact between the Argyle Sand (Qs) and underlying Mud Flow unit (Qm). When doing this, other stratigraphic layers and contacts at depth can be correlated unbroken across that portion of the cross-section. This shows that the amount of vertical displacement across this inferred fault is the same across the entire section, which at depth includes sediments that are many hundreds of thousands of years old. This indicates that if this feature it is indeed a fault, it has seen only one earthquake, as repeated earthquakes would result in increasing separation of the sedimentary layers with increasing depth. Furthermore, given that the inferred displacement in the layers can be taken to the top of the Argyle Sand, this last earthquake would have occurred less than 4,000 years ago, when the upper portion of the Argyle Sand was most likely deposited, based on both soil development and radiocarbon dating of these deposits in the East Trench of the East Millennium site (ECI, 2015; GDC, 2015). Published and consulting studies of the Hollywood fault that provide data on its earthquake history indicate that the last earthquake on this fault occurred between about 7,000 and 10,000 years ago (Dolan et al. 2000; Law/Crandall, 2001; WLA, 2004), with preferred ages in the 8,000 to 9,500 years range. Thus, the possible interpretation of an earthquake less than 4,000 years ago based on one sole CPT is contrary to other studies where the fault has actually been observed in downhole-logged borings. Interpretation C strongly supports our opinion challenging the validity of CPT-29.

Considering the locational uncertainties inherent and unresolvable for the Section M-M′ data, and the discussions above, it is our opinion that the interpretation of section N-N′ (and to some extent O-O′ and P-P′), should carry more weight towards the presence or absence of faults interpreted solely from the CPT and boring correlations. But, even assuming that the faults interpreted in Section M-M′ are real, the northernmost of these is clearly overlain by unbroken layers that are Pleistocene in age, indicating that this fault is not active. Assuming a westerly trend, the more southerly feature would project westward onto a portion of Section N-N′ where the base of the Mud Flow unit and multiple other internal layers are demonstrably not affected by fault deformation. To miss Section N-N′, this southerly feature, if it is a fault, would have to trend either northwesterly, or northeasterly. A northwesterly trend would project this fault onto the southern halves of Sections P-P′ and O-O′. Both of these cross-sections are described further below. A northeasterly trend would project this fault into the area previously trenched by GDC, where no active faults were found.

A stepping (en echelon) style of faulting, whereby this southern fault would be discontinuous in the near-surface, and thus potentially missed in one or more cross-sections could be considered. The expected surface and sub-surface expression of en echelon faults and folds in a left-lateral strike-slip environment is illustrated in Figure 4, Panels A and B. Assuming a westerly strike for the main zone of faulting (a reasonable orientation for the Hollywood fault in this area), the near-surface faults would step right, but strike southwesterly. Thus, a fault exposed along the southern portion of Section M-M′ should be exposed in Section N-N′ because this western transect effectively shadows the area where the principal, master fault at depth would extend through, and also extends farther south, imaging the area where the next near-surface fault to the west would project. Thus, if the southern feature in Section M-M′ were a fault (and we have discussed several reasons why we don't believe that is the case), then, if it were part of an en echelon system, the fault would step right at the surface, but the master fault at depth would extend through Section N-N′, and would be noticeable especially in the more consolidated sediments of the Mud Flow unit and the older sediments below it (see Figure 4, Panel B). Secondary deformation of the sediments, including tilting and folding should be expected, especially in the area where the fault steps, where the sediments are under compression, with down-to-the-north movement (see Panel C). Stepping of the fault northwesterly, to the north of Cross-section N-N′, is inconsistent with the expected left-lateral displacement on the Hollywood fault and the down-to-the-south expression inferred in the cross sections (see Panel C in Figure 4). En echelon faults to the east of Line M-M′ should have been observed in the southern half of the East Trench on the East Millennium site, but were not. Given that neither Cross-Section N-N′ nor the East Trench exposed a zone of deformation characteristic of an en echelon fault system further suggests that the step in the stratigraphy forced by the inclusion of CPT-29 is not real, and caused by problems with the CPT-29 data.

Section O-O′: This section shows south-dipping Older Alluvium (Qoa) overlain by a southward-thickening section of predominantly fine-grained deposits with moderately to strongly developed paleosols with 7.5YR to 5YR hues. The fine-grained section, which, given its degree of reddening and soil development is interpreted to be Pleistocene in age, is likely regionally correlative to the Mud Flow unit (Qm) exposed in the borings drilled to the east, in the East Millennium site. The overlying sand and gravelly sand packages are interpreted to be correlative to the Argyle Sand of the East Millennium site, although in this area these deposits would be sourced from the next canyon to the west, the Cahuenga Canyon. For this reason, GDC refers to these deposits as the Cahuenga Sand (Qc). At the north end of the cross-section, the Older Alluvium overlies bedrock of the Topanga Formation (not shown in our Plate 5).

A possible fault can be interpreted near the southern end of the section, in the area between CPTs C-6 and C-4 (see Plate 5). At depth, the inferred fault appears to place moderately dipping sand and gravelly sand beds of Older Alluvium (Qoa) on the north against more gently dipping, finer-grained sediments on the south. These finer-grained deposits appear to be similar to the fine-grained, pedogenically altered sediments observed along Section N-N′, which we assigned to an Older Mud Flow (Qom) unit. The base of the Mud Flow unit and a layer internal to this unit are both vertically offset about 0.5 to 0.8 feet, up to the north. The inferred fault may extend upwards at least 8 feet into the late Pleistocene-aged Mud Flow (Qm) unit, but does not offset a layer near the top of the unit, nor the contact between the Mud Flow unit and the overlying Cahuenga Sand. A lack of correlation of the lowermost sediments across this inferred fault suggests an undetermined amount of lateral displacement in addition to the vertical offsets described above. Since the inferred fault near the southern end of Section O-O′ is intra-formational (can be traced only into the bottom part of the Mud Flow unit), it last moved before the upper portion of the Mud Flow unit was deposited, and is thus more than 80,000 years old. As a result, this fault, if present, is not active.

A possible fault that impacts the lower layers of the Older Alluvium can also be interpreted between CPTs C-20 and C-19. This possible fault appears to displace beds in the Older Alluvium up to 2 feet vertically, north-side up, but does not extend upwards into the upper section of the Older Alluvium where several beds extend unbroken across the upward projection of the fault. Similar to the other fault interpreted in this cross-section, changes in the thickness of the units across this feature suggest certain amount of lateral displacement. Since the Older Alluvium is interpreted to be several hundred thousands years old, and the fault does not deform the upper at least 25 feet of the Older Alluvial section, this possible fault, if present, is not active.

Section P-P′: This section shadows approximately the southern two-thirds of Section O-O′, and like Section O-O′, at depth it shows south-dipping beds of Older Alluvium (Plate 6). This unit is overlain by a thin sequence of generally finer-grained sediments with a CPT-signature similar to that of the Mud Flow unit exposed in the other transects on both the East and West Millennium sites. The Mud Flow unit is in turn overlain by sand and silty sand layers here assigned to the Cahuenga Sand (Qc). Because there were no borings drilled in the immediate vicinity of this transect, the picks between geologic units are based entirely on the CPT signatures and comparison with other cross-sections where these contacts were observed in the cores recovered.

Changes in the sediment type, thickness and/or dip of the stratigraphic layers permit the interpretation of three possible faults in this section. The northernmost of these occurs at the north end of the section, where the CPT signatures of C-116 and C-115 suggest that the beds in the Older Alluvium step up to the north between the two soundings, with the vertical offset of the beds ranging between about 5 and 7 feet. Because there are no data north of C-116, the thickness and character of the beds in the Older Alluvium to the north of this location are approximate, but the data available suggest that the bed thicknesses change across this inferred fault, an indication of some component of lateral movement. The base of the Mud Flow unit and possibly one or two beds near the top of the Older Alluvium extend unbroken across this feature, indicating that this inferred fault, if present, is Pleistocene in age (and more than 150,000 years old, given that the channel upon which the Mud Flow unit was deposited is thought to be at least 150,000 years old). Thus, this fault, if present, is not active.

The second area where changes in the dip and character of the beds in the Older Alluvium could be related to faulting occurs between CPTs C-112 and C-111. Robust correlations of stratigraphic beds across this feature cannot be made, so the vertical displacement across this inferred fault cannot be determined. This possible break extends upward to but does not offset the base of the Mud Flow unit. Since this contact is erosional, it appears that the last displacement on this possible fault occurred many thousands of years before the erosional event that carved out the channel that was then backfilled by the Mud Flow deposits. However, the data available only permit us to conclude that the last event on this possible fault occurred no later than about 150,000 years ago, when the channel incision is thought to have occurred (ECI, 2015). Thus, like the fault discussed in the previous paragraph, this possible fault is not active.

The third and southernmost of the possible faults interpreted in Section O-O′ occurs in the area between CPTs C-105 and C-103. This fault zone appears to place coarse-grained beds characteristic of the Older Alluvium on the north against finer-grained beds characteristic of the pedogenically altered Older Mud Flow deposit on the south. Individual beds cannot be matched across this feature, so its sense of movement is unclear, but is likely to include both a lateral component, and a vertical, north-side up component. As with the previous faults, this possible fault does not extend upward into, nor does it offset the circa 150,000-year-old base of the Mud Flow unit, and is thus not active.

DISPLACEMENT MAGNITUDES

As described above, in cross-section N-N′, which we re-plotted using the new survey data, it is possible to interpret the basal contact of the Mud Flow (Qm) unit as being vertically offset approximately 1.7 feet. If there is indeed a fault in this area, and the fault is assumed to have a left-lateral component of movement, the true vertical displacement due to faulting may be less than the 1.7 feet measured in the cross-section (a similar feature that also extends into the bottom portion of the Mud Flow unit can be interpreted in Section O-O′, but here the vertical displacement at the base of the Mud Flow is 0.5 to 0.8 feet). For simplicity, and to use the most conservative scenario, we assume that the base of the Mud Flow unit is truly offset by 1.7 feet. Based on our previous analysis (ECI, 2015), the erosional contact at the base of the Mud Flow unit is estimated to have been formed about 150,000 years ago, but it could be older.

An offset of 1.7 feet (~520 mm) in 150,000 years yields a negligible slip rate of 0.003 mm/yr, which itself implies the fault is no longer active. But, assuming an ~10,000-year recurrence interval for earthquakes on the Hollywood fault in the 150,000 years since this unconformable contact was formed as a result of incision, the contact should have experienced at least 15 Hollywood fault earthquakes. It is unlikely that the total offset at the base of the Mud Flow unit was generated in 1.3-inch increments over the span of 15 earthquakes. It is more reasonable to assume that this offset, if real, occurred during a single earthquake event that occurred soon after the channel form was cut, and that there have been no surface-rupturing earthquakes on this fault since. This finding is similar to the possible fault exposed in GDC's East Trench on the 6230 Yucca Street site (Figure 2a of ECI's March 9, 2015 report), where about 1+ foot of vertical offset of the base of the Mud Flow unit could be interpreted. This trench exposure conclusively demonstrated that this possible offset (a point that could be argued), is more than 100,000 years old because the soil developed within the mudflow sediments is not sheared and has completely obscured any evidence of faulting. If the feature in the East Trench and the displacement interpreted in Section N-N′ are both faults, and part of the same zone, these observations independently indicate that the most recent earthquake on this fault strand occurred sometime between about 100,000 and 150,000 years ago.

If the faults interpreted in the southern portions of Sections M-M′, N-N′, O-O′ and P-P′ are part of the Hollywood fault, as depicted by the CGS in its official Alquist-Priolo Map, then one would expect that surface rupturing offsets for this 15- to 20-km long strike slip fault would be in the order of 0.4 – 1.0 meters (1.3 – 3 feet) per event, using the average and maximum fault displacement regression equations by Wells and Coppersmith (1994; see Figure 5, and Table 1 below). In 15 events (we assume that since the 150,000-year old basal contact formed, the fault has had 15 surface-rupturing earthquakes using a recurrence interval of about 10,000 years), this amounts to 20 – 50 feet of cumulative offset. Even if the fault displacement is partitioned equally between the Argyle and Yucca fault strands, total offset on this strand would be in the order of 10 to 25 feet, rather than the maximum 1.7 feet measured at the base of the Mud Flow unit in Section N-N′. This analysis suggests that this interpreted break is: 1) not a fault, or 2) if a fault, it is minor, not active, and has not been active for more than 100,000 years.

Table 1: Average and Maximum Displacement Values for a
17-km Long Fault such as the Hollywood Fault,
for strike-slip and reverse faulting mechanisms using Wells and Coppersmith (1994)
(A longer fault would result in larger displacement values.
For additional information, refer to Figure 5.)

	Strike-Slip Fault	Reverse Fault
Average Displacement Per Event	0.4 m (1.3 ft)	0.6 m (2 ft)
Maximum Displacement Per Event	0.5 m (1.6 ft)	1.0 m (3.3 ft)
Cumulative Displacement (Over 15 Events)	6 - 7.5 m 20 - 24 ft	9 - 15 m 30 - 50 ft

With the exception of the faults interpreted near the southern ends of Sections N-N′ and O-O′, and the northernmost of the possible faults in Section M-M′, the other possible faults interpreted from the cross-sections reviewed for this study are all confined to the Older Alluvium, a geologic unit that was deposited many hundreds of thousands of years ago, and that was significantly deformed before it was incised by the channel upon which the Mud Flow sediments were deposited (that incision is thought to have occurred about 150,000 years ago, but could be older). Trench exposures to the northeast of the East Millennium site, in the Green and Champion sites (GDC, 2015), have shown that the Older Alluvium is folded and faulted; the inferred faults discussed above are consistent with that deformation. Furthermore, these cross-sections show that most of these faults are overlain by unbroken, undeformed beds in the Older Alluvium, indicating that most of these faults, if present, are intra-formational, and thus very old (at least 150,000 years old, and most likely more than 400,000 years old). Where a possible fault could be traced upward to the top of the Older Alluvium, the erosional contact defining the base of the Mud Flow unit was found to extend unbroken across the potential fault, indicating that the fault is not active.

LATERAL EXTENT OF INFERRED FAULTS

The possible lateral extent of some of the faults that can be interpreted from the cross-sections reviewed are shown in map view on Figure 6. This figure shows that two of the possible faults interpreted in Cross-Sections O-O′ and P-P′ may be correlated across the two sections, defining a westerly trend (N81-85W). Projection of the northernmost of these inferred faults eastward onto the East Millennium site coincides almost exactly with the location where a bedding-plane fault was observed in the East Trench of the 6230 Yucca Street site.

Projection of the southern inferred fault eastward assuming that it maintains the same trend as in between Sections O-O′ and P-P′ places it in the same area where the CGS had originally mapped the Argyle strand of the Hollywood fault, and in the area cleared of active faults by GDC's East Trench. Projection of this line farther eastward coincides with Carlos Avenue, at the break in slope that has been previously interpreted as a significant trace of the Hollywood fault in this area (Hernandez and Treiman, 2014; LCI, 2014; Hernandez, 2014). However, the cross-section and trench data compiled by GDC for the East and West Millennium sites clearly show that this trace has not moved in the Holocene and is therefore not active.

The trend of the possible faults interpreted in Sections M-M′ and N-N′ cannot be definitely deduced from the data available (at least two points are needed to define a line). The dotted green lines on Figure 6 show how these inferred faults, if real, could be interpreted to connect with the southernmost fault interpreted in Sections P-P′ and O-O′ to the west, and the break in slope along Carlos Avenue on the east. Although this configuration could be possible with a shallow-dipping reverse fault, the high-angle dips inferred from the cross-sections make this interpretation highly unlikely. Thus, if these faults are indeed present, and they are somewhat regionally extensive, we would expect that they would have strikes similar to the orange dashed lines on Figure 6. However, given that both of these features, if they are indeed faults, are not active, defining their lateral extent is not critical.

SUMMARY

The following bullet points summarize our interpretations and conclusions:

1. We have a much higher degree of confidence in the data presented in cross-section N-N′ (Plate 3) given the uncertainties in the locations and elevations of the CPTs and borings used to construct and interpret sections M-M′, O-O′ and P-P′. The borings and CPTs along Section N-N′ were emplaced to evaluate the area where CGS re-located the Argyle strand of the Hollywood fault after the trenches in the East Millennium site showed that no active faults underlie the trenched portion of the property.

2. A conservative interpretation of Section M-M′ suggests the presence of two possible faults. The northernmost of these does not impact sediments that are thought to be at least 80,000 years old, and thus, if a fault, this feature is not active. The southern feature, based on CPT-29, is most likely an artifact of the data. Analysis of the CPT curves in this region shows that if this suspect point is removed, there is no longer a step in the sedimentary section. If we "correct" for the perceived displacement at the contact between the Argyle Sand and the underlying Mud Flow unit, all the underlying layers extend unbroken across the area. This indicates that if this feature were indeed a fault, it has experienced only one surface-rupturing event, with this event occurring in the late Holocene, after the Argyle Sand was deposited, and thus within the past about 4,000 years. Since the most recent event on the Hollywood fault reportedly occurred between about 8,000 and 9,500 years ago, this rupture is inconsistent with the earthquake history of the Hollywood fault, and further suggests that this interpretation is the result of flawed data. A westward stepping of this feature in an en echelon manner would project it through Section N-N′, where active faults were not observed. Stepping the Section

M-M′ "fault" north of Section N-N′ is inconsistent with a left-lateral strike-slip fault mechanism. To the east, this interpreted offset would extend through the East Trench, where no active faults were observed. Based on these arguments, it is our opinion that the "fault" interpreted solely due to CPT-29 is a result of a flawed elevation for CPT-29 and is not real.

3. The data permit the interpretation of a minor, high-angle fault through the area covered by Section N-N′, between Boring B-11 and CPT-36. This interpreted fault appears to vertically displace the bottom of the Mud Flow unit approximately 1.7 feet, and to extend upward into the base of the Mud Flow unit approximately 4.5 feet. The inferred fault is overlain by unbroken layers in the upper part of the Mud Flow unit, indicating that this fault, if indeed present, has not moved in the past at least 80,000 years (and most likely more than 100,000 years), and is thus not active.

4. Differences in the thickness of the basal layers across this inferred feature in Section N-N′ suggest some component of horizontal movement. The amount or direction of this movement cannot be determined from the data available, but we have assumed it to be left-lateral. Given that the base of the Mud Flow unit falls gently toward the west between Sections M-M′ and N-N′, left-lateral slip would enhance the vertical offset, so the 1.7 feet of displacement measured represents a maximum value for the true tectonic-induced separation of the contact. This amount of separation suggests that this break, if even a fault, is a very minor structure within the Hollywood fault zone, as it does not have the 10 to 50 feet of displacement expected on the Hollywood fault in the past 150,000 years.

5. The base of the Mud Flow unit is estimated to be at a minimum 150,000 years old, based on the degree of soil development of the paleosols that occur internally within the Mud Flow deposits, and correlations with the glacial and interglacial periods in the late Pleistocene based on sea level curves (see ECI, 2015). The 1.7 feet (~520 mm) of displacement in 150,000 years yields a very slow slip rate of 0.003 mm/yr, which itself strongly implies that the fault is no longer active. However, it is most likely that the 1.7 feet of offset occurred in one earthquake event that occurred sometime between about 80,000 and 150,000 years ago.

6. Faults with similar amounts of vertical displacement and impacting similar units can be interpreted in the southern portions of Sections P-P′ and O-O′, although the locations and elevations of the CPTs and borings used to construct these sections were not surveyed and are thus less certain. In the southern portion of Section O-O′ we find that the data permit the interpretation of a fault that extends upward into the Mud Flow unit, vertically displacing the base of the unit and at least one bed within it between about 0.5 and 0.8 feet. This fault does not offset the younger beds in the Mud Flow unit, and is thus also not active. Given that the Mud Flow unit thickens westward in this area, left-lateral movement on a fault here would enhance the vertical separation of the beds. Thus, the 0.5 to 0.8 feet of offset is considered a maximum value. As with the possible fault interpreted in Section N-N′, the possible fault interpreted in Sections P-P′ and O-O′ is a very minor structure.

7. Given that the main trace of the Hollywood fault should have experienced at least 15 earthquake events in the past 150,000 years, with total displacements in that time frame of between about 10 and 50 feet, the 0.8-foot and 1.7-foot offsets interpreted from sections O-O′

and N-N′, respectively, suggest that these faults are only minor structures, probably reflecting a single rupture event more than 100,000 years ago.

8. While our conservative re-analysis of the CPT and boring data collected near the southern portion of the East Millennium site and the West Millennium site permits the interpretation of a zone of faulting in the same general area where the CGS has reportedly inferred faults, the faults that we can interpret are minor, and are overlain by demonstrably unbroken late Pleistocene sediments, meaning these faults are not active.

We hope that the information provided above provides you with the data you need at this time. If you have any questions or comments regarding the analysis presented above, please do not hesitate to contact either of the undersigned.

Respectfully submitted,
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Attachments:

Figure 1:	Site Location Map Showing CPTs and Borings Used in This Analysis
Figure 2:	Geomorphic Characteristics of Alluvial Fan Sequences
Figure 3:	Photograph of Area Where CPT-29 was Reportedly Emplaced, Showing a Divet
Figure 4:	Surface and Sub-Surface Expression of En-Echelon Folds and Faults
Figure 5:	Wells and Coppersmith (1994) Regression Equations for Displacement per Event
Figure 6:	Map View of Faults Interpreted from the CPT and Borehole Transects
Plate 1:	Elevation Differentials Between Original and Final Surveyed Locations
Plate 2:	Elevation Differentials Between Original and Final Surveyed Locations
Plate 3:	Cross-Section N-N′
Plate 4:	Cross-Section M-M′
Plate 5:	Cross-Section O-O′
Plate 6:	Cross-Section P-P′

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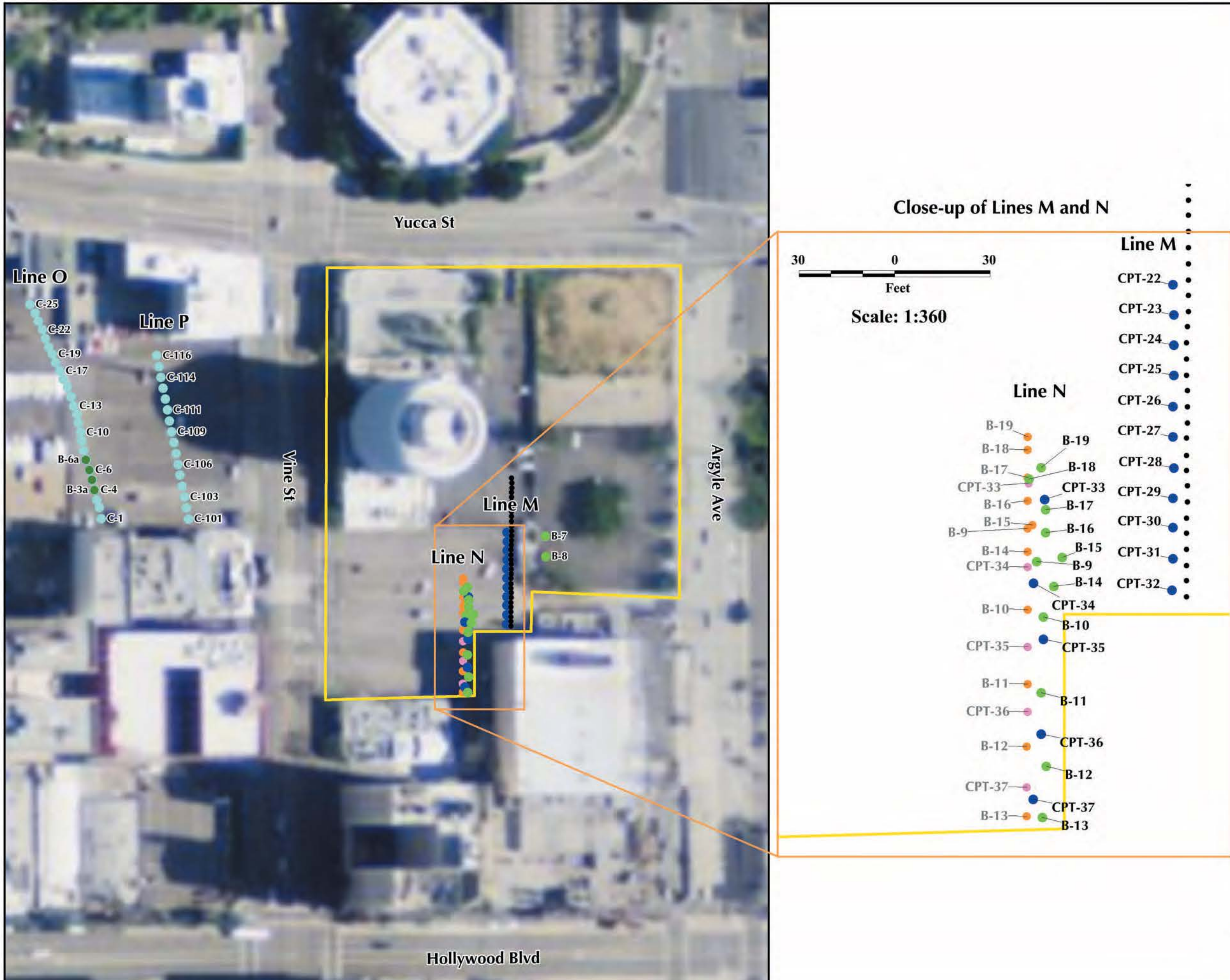

Site Location Map Showing CPTs and Borings Used in This Analysis

Explanation

- CPT-37 ● CPT location used by ECI (This Study).
- B-19 ● Boring location used by ECI (This Study).
- ● Survey data used for elevation of CPTs 22 through 32 (This Study).
- CPT-37 ● CPT location East Millennium Site used by GDC (2015).
- B-19 ● Boring location East Millennium Site used by GDC (2015).
- C-116 ● CPT location West Millennium Site used by GDC (2015).
- B-6a ● Boring location West Millennium Site used by GDC (2015).
- Site Boundary.

N W E S

100 0 100

Feet

Scale: 1:1,200

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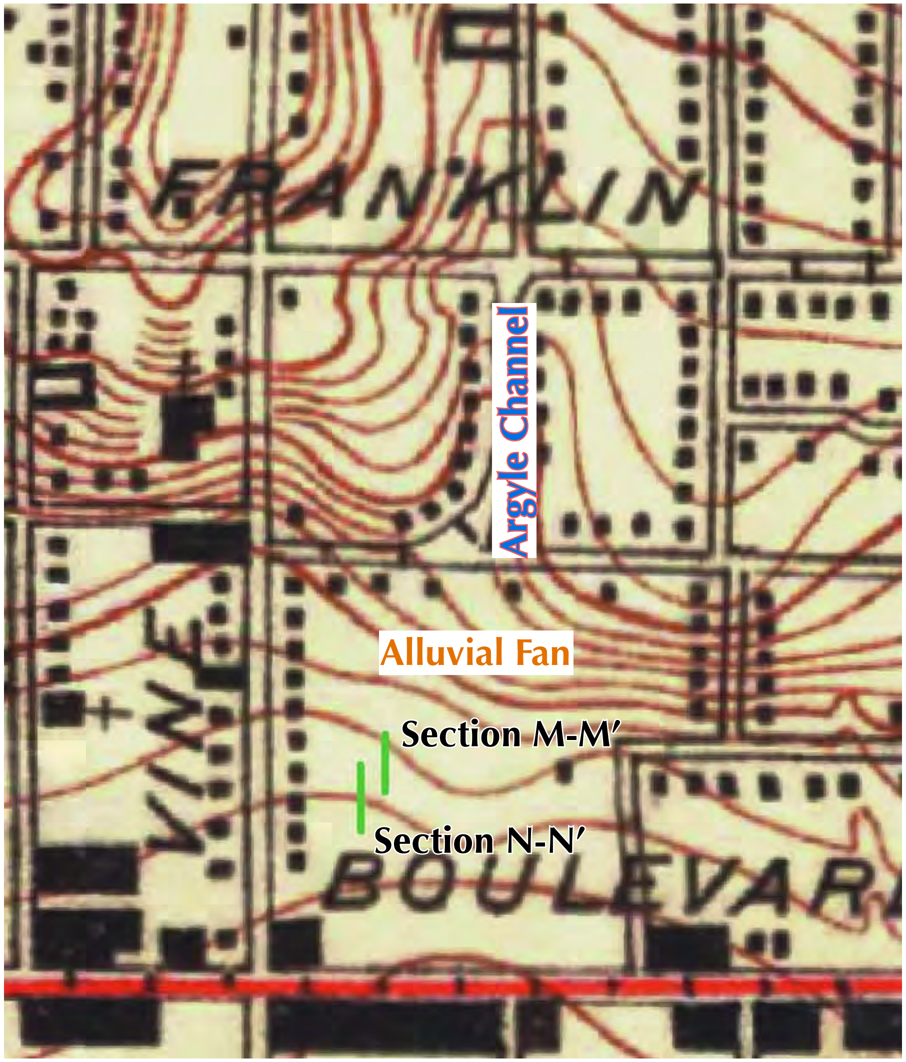
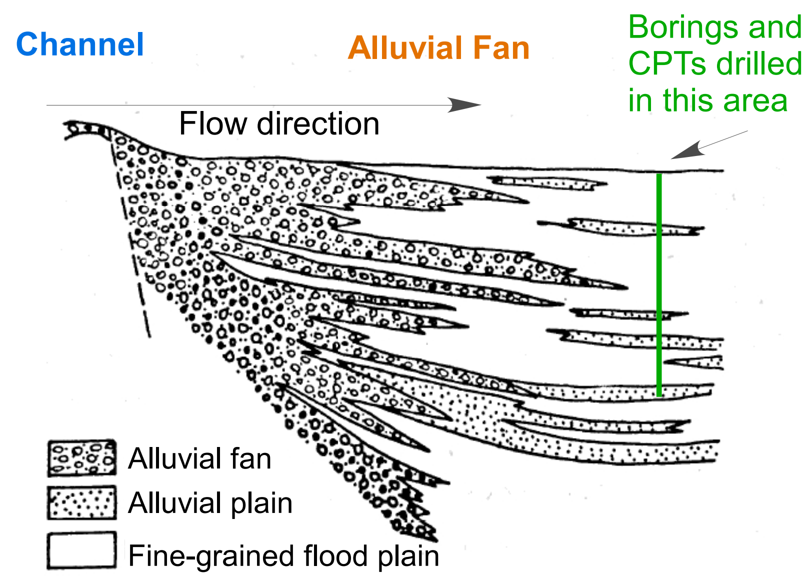
Date: 2015

Figure 1



Location of Sections M-M′ and N-N′ relative to the Argyle Fan. Note that the sections are somewhat oblique to gradient of the fan. Base map is c. 1926 topography from Hoots and Kew (1931).



Longitudinal Profile of an Alluvial Fan and Alluvial Plain showing the flattening of the geologic units in the distal portion of the fan, in the approximate area where Sections M-M′ and N-N′ are located. Alluvial fan diagram modified from Fraser and Suttner (1986).

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Geomorphic Characteristics of Alluvial Fan Sequences

Figure 2

Photograph taken and annotated by Steven Kolthoff on March 31, 2015.
View is to the north-northwest.

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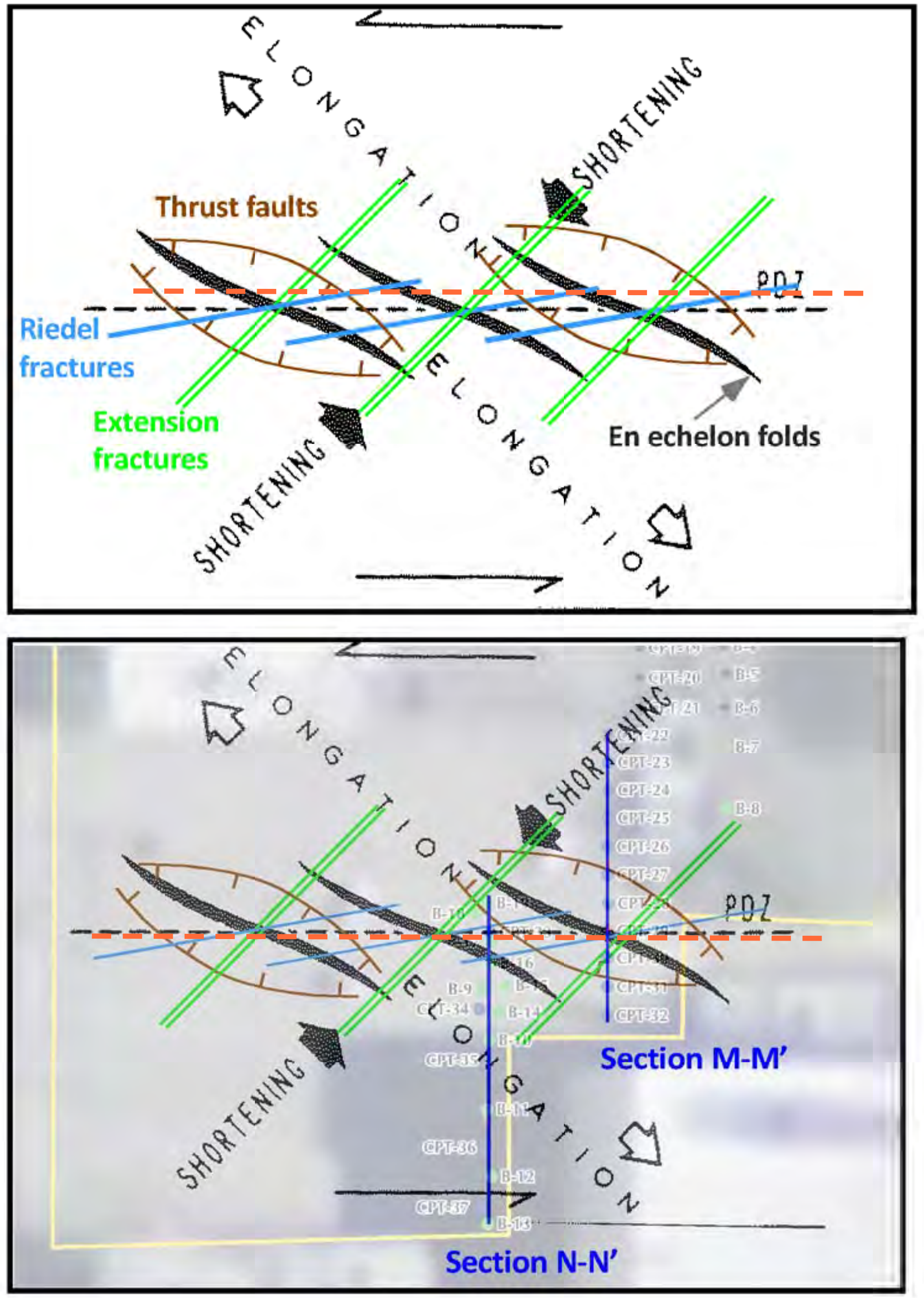
Photograph of the Area where CPT-29 was Reportedly Emplaced, Showing a Divet in the Parking Lot

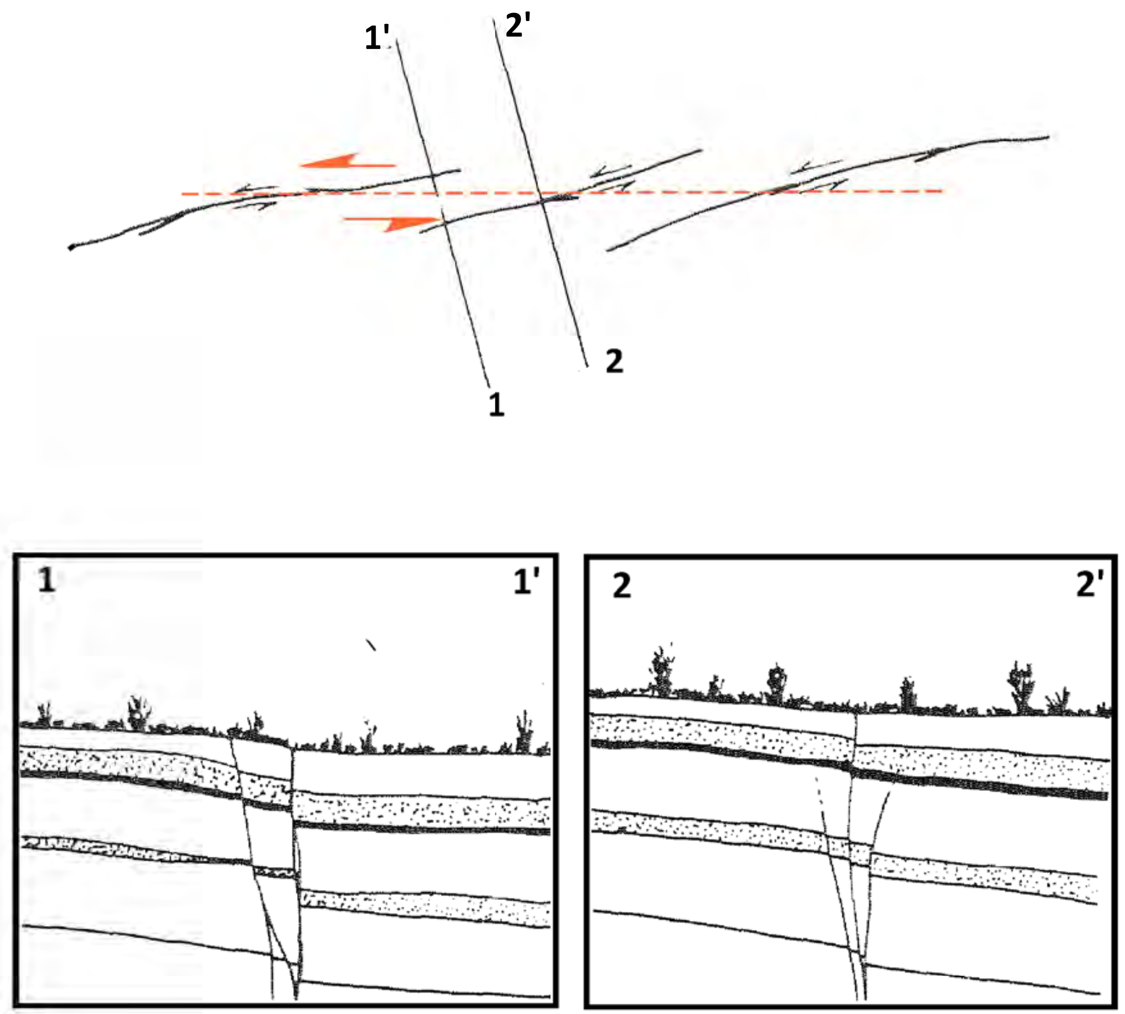
Figure 3

A



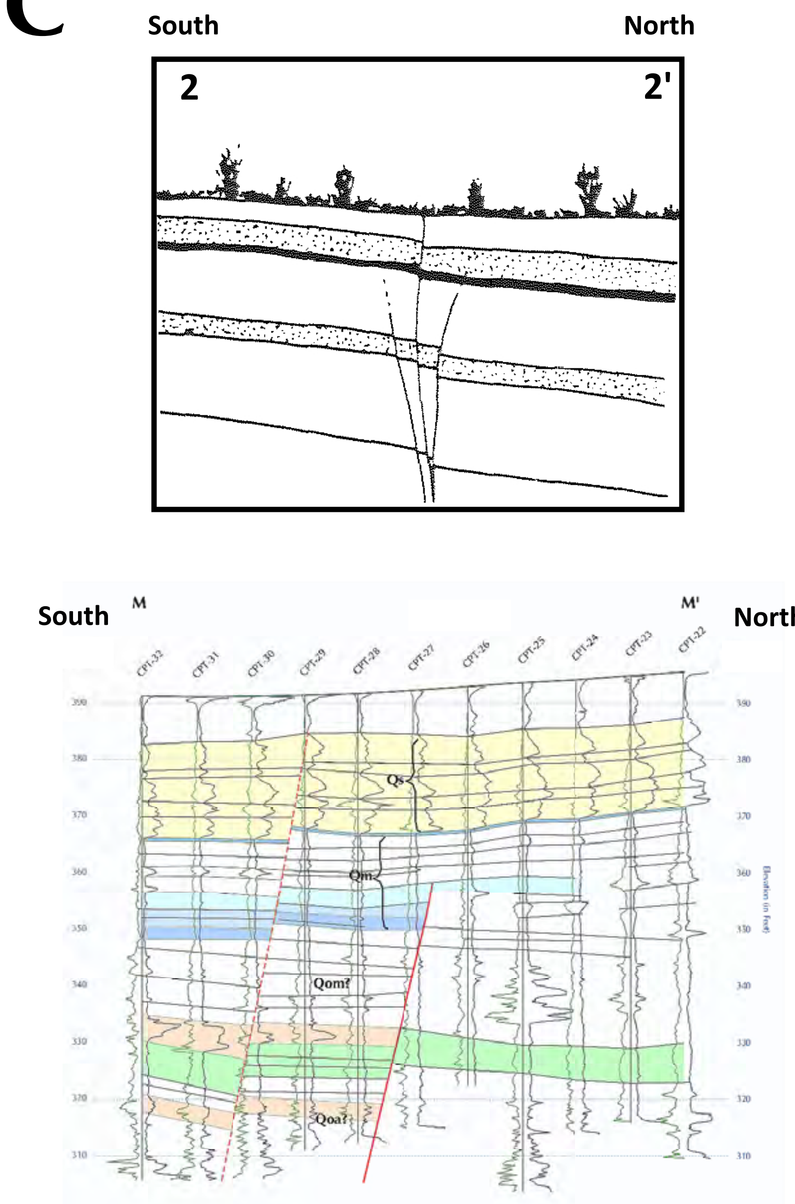
A (above): Orientation of en echelon folds and faults in left simple shear, such as those anticipated along the left-lateral Hollywood fault. PDZ = principal displacement zone. (Modified from Sylvester, 1988). Bottom diagram shows how these features would project across a section of the East Millennium site assuming that the southern feature in Section M-M′ is real, and part of a left-lateral zone of slip with a predominantly east-to-west strike.

B



B (above): Schematic map and cross-sections of a typical en echelon left-lateral zone of faulting that extends to the surface. The orange line on the map view shows the predominant direction of movement (the principal displacement zone). The cross-sections show plausible patterns of faults that would be observed in exposures along the fault zone. Note that both exposures would show at least one fault rupturing to the surface, and the sense of offset is opposite to that inferred from Section M-M′ (see C to the right). All of the ruptures in the cross-sections above would have formed at the same time due to transfer of fault slip across the step. (Modified from Rockwell, 1987).

C



C (above): Comparison between the expected geometry in a left-lateral strike-slip en echelon fault system with the characteristics interpreted in Section M-M′ (for a larger view of this section refer to Plate 4, Interpretation A). Note that if the possible faults in Section M-M′ were part of an en echelon system, the faults should be north-dipping, and converging at depth, rather than south-dipping. Apparent vertical sense of movement should be north-side down; in Section M-M′, the apparent vertical movement is south-side down, contrary to the expected sense of motion.

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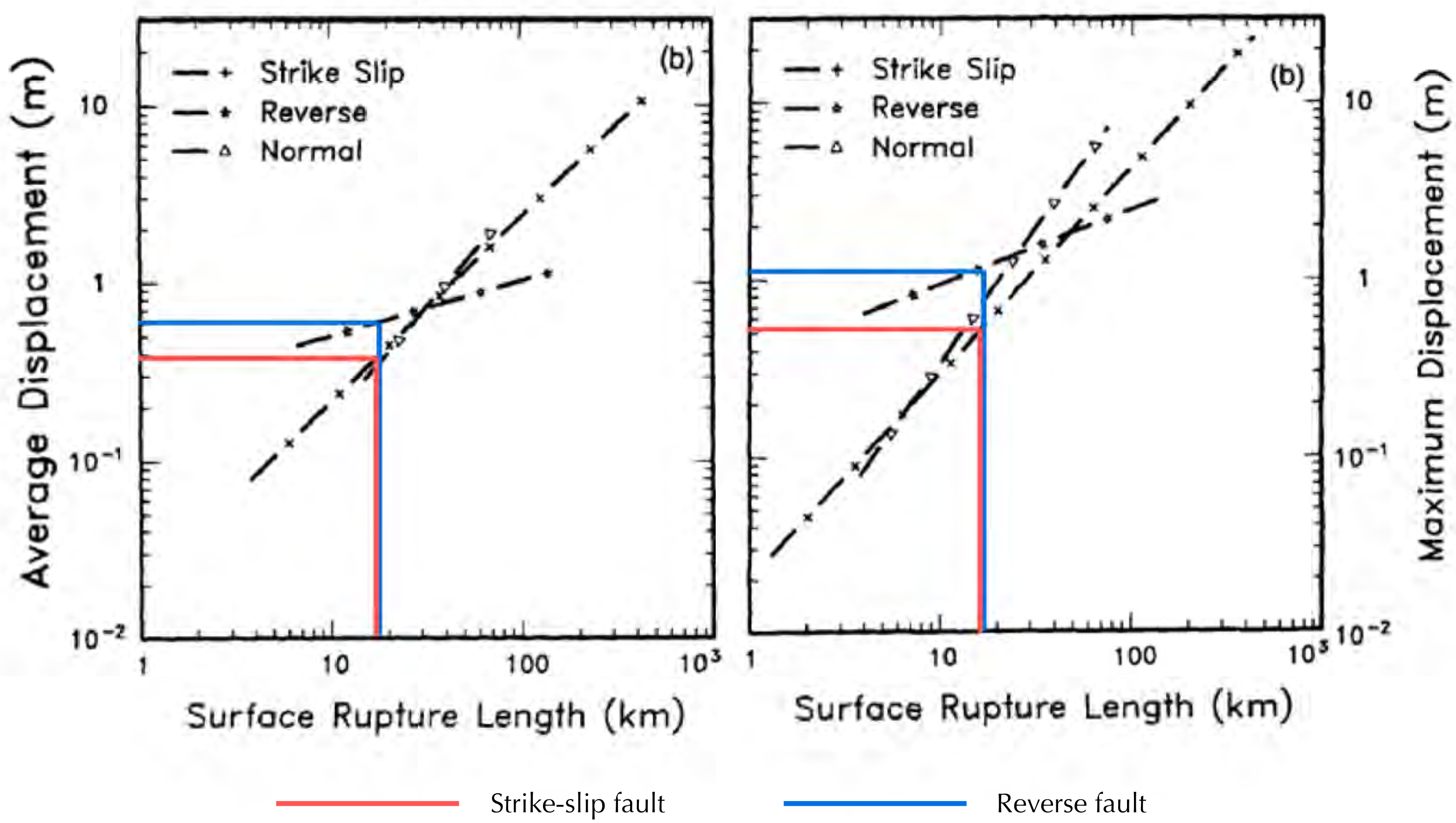
Expected Surface and Sub-Surface Expression of En-Echelon Folds and Faults in a Left-Lateral Strike-Slip Environment and Comparison with Interpretation A in Section M-M′

Figure 4



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Date: 2015

Wells and Coppersmith (1994) Regression Equations for Average (Left) and Maximum (Right) Displacement Per Event for Different Fault Types

Figure 5

Map View of Faults Interpreted from the CPT and Borehole Transects

Explanation

- CPT location used by ECI (this Study).
- Boring location used by ECI (this Study).
- CPT location used by ECI (this Study).
- Boring location used by ECI (this Study).
- CPT and boring locations used by GDC (2015).
- Possible trend of faults interpreted in Cross-Sections O-O′ and P-P′. Red dots show the approximate projection of the fault to the ground surface. Small green dots show the fault location at depth.
- Highly speculative regional trend of faults interpreted in Cross-Sections M-M′ and N-N′. Refer to text for additional discussion.
- Trench outlines per GDC (2015).

50 0 50

Feet

Scale: 1:600

N W E S

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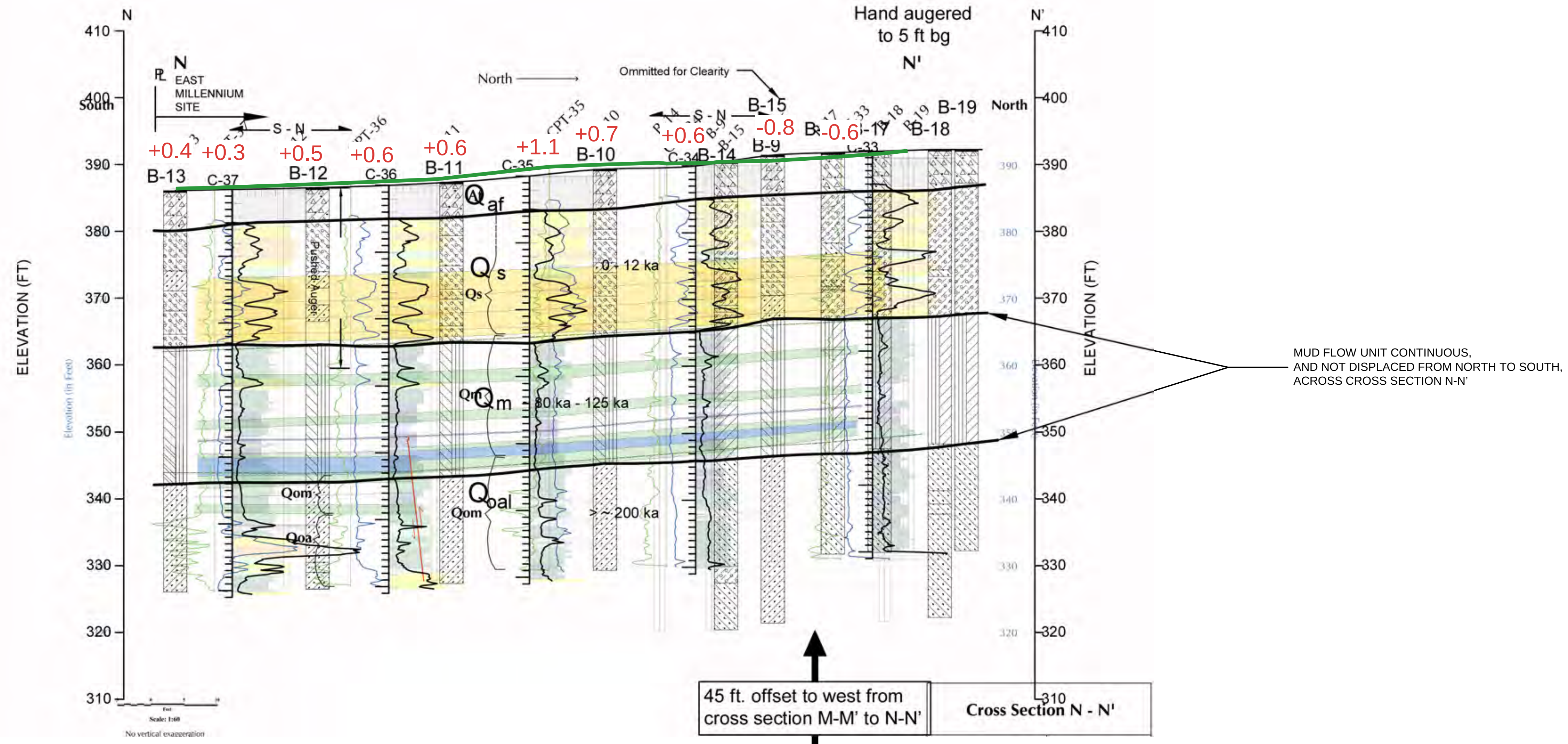
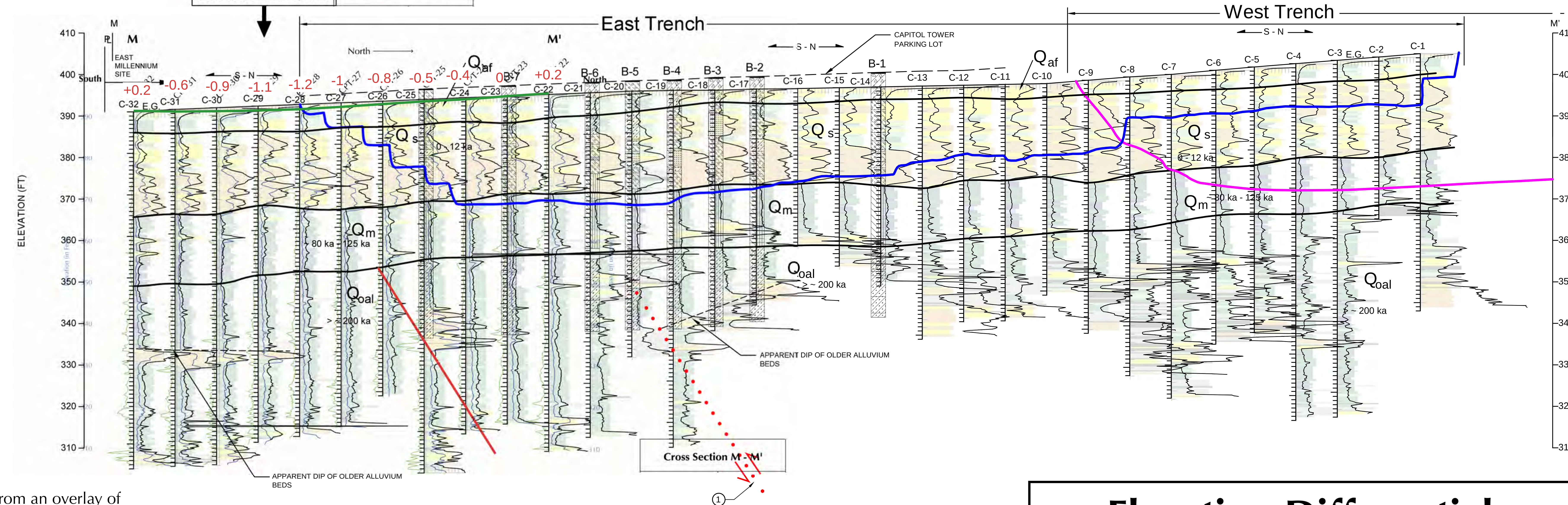
Project Number: 3425
Date: 2015

Figure 6

DATE: 9/12/2014	DRAWN BY: KM	GROUP DELTA	GROUP DELTA CONSULTANTS, INC	CROSS SECTION M-M' AND N-N' (CPT/SOIL CORE)	PROJECT NUMBER: LA1191A
REVISION: 10/31/2014	APPROVED BY: SK		370 Amapola Ave. Suite 212		SCALE: AS SHOWN
REVISION: 1/28/2015		DELTA	Torrance, CA. 90501	EAST MILLENNIUM SITE	PLATE NUMBER: 7





Elevation differences measured from an overlay of ECI's cross-section onto GDC's cross-sections

LEGEND:

- +1.1 — Difference in Elevation between original and final surveyed locations
- Surveyed Existing Grade
- E.G. — Existing Grade used in GDC's cross-sections
- C-32 — CPT Location and Number
- B-8 — Boring Location and Number
- Bedding Contact
- Unit Contact
- West Trench Projected onto M-M'
- East Trench Projected onto M-M'
- ① — (Sense of Motion Uncertain)
- Approximate Location of Inferred Fault (ECI, 2015)
- Approximate Location of Inferred Fault (GDC, 2015)

BORING LEGEND:

HOLOCENE	Artificial Fill	Q_{af}	
	Argyle Sand	Q_s	0 - 12 ka
			> 50 ka (see text for discussion)
PLEISTOCENE	Argyle Mud Flow	Q_m	~ 80 ka - 125 ka
	Older Alluvium	Q_{oal}	> ~ 200 ka

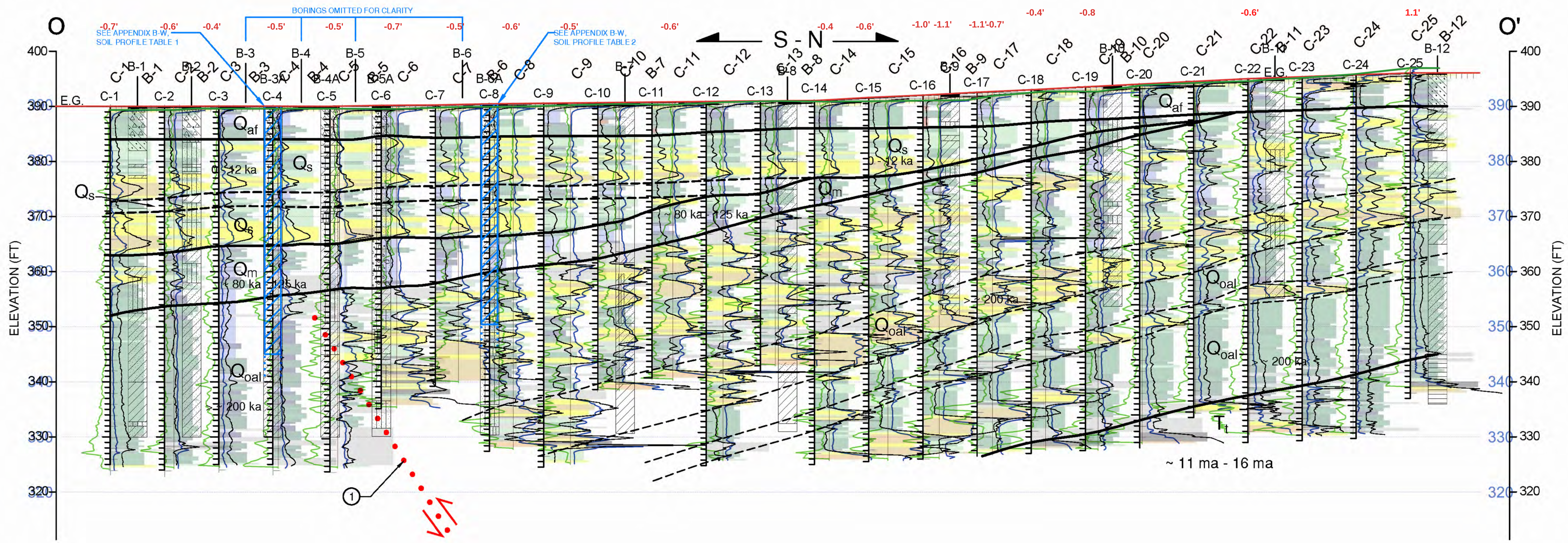
SCALE (FT): V 20' 10' ; H 0' 10' 20'

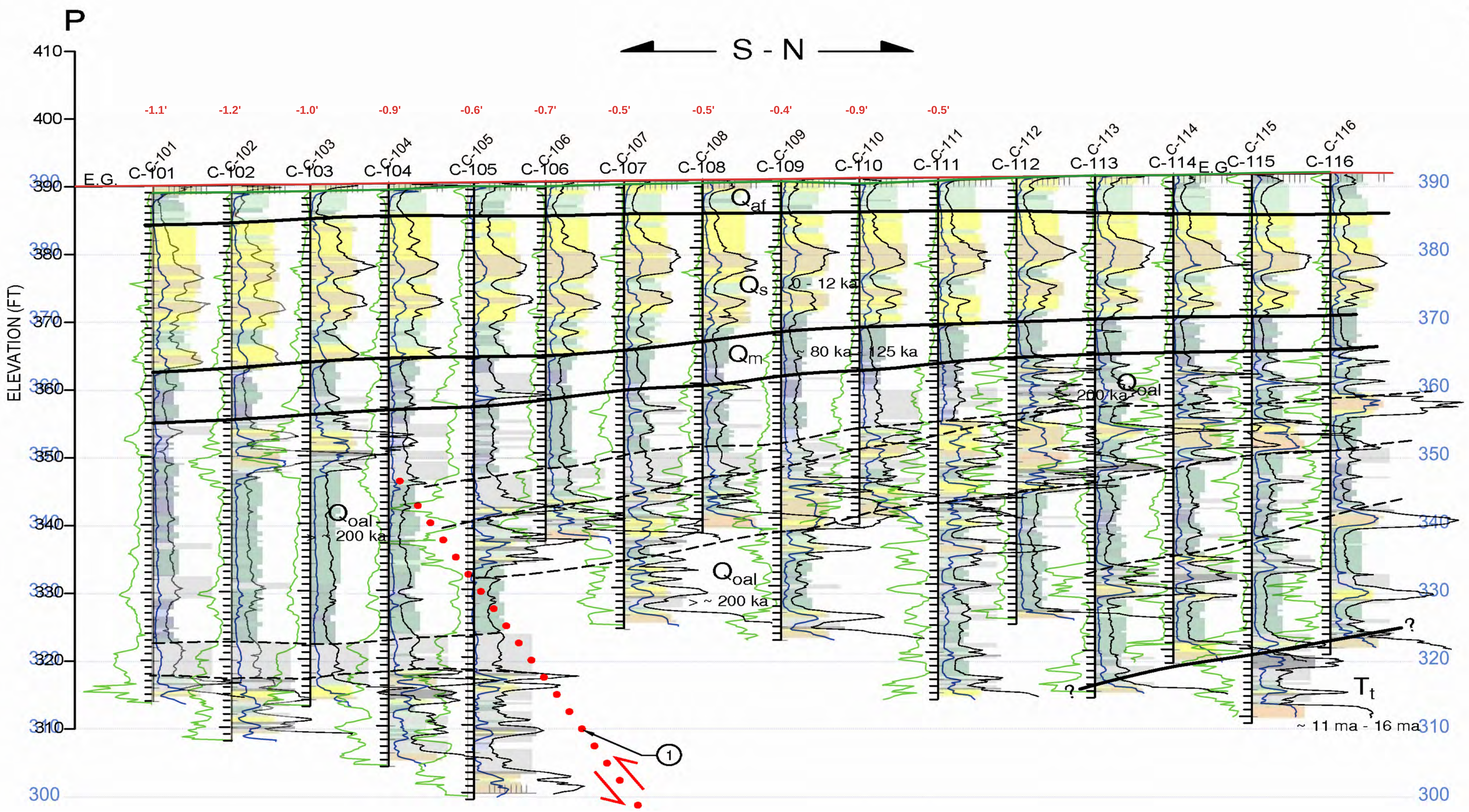
Elevation Differentials Between Original and Final Surveyed Locations

Earth Consultants International

Project Number: 3425
Date: 2015

Plate 1





BORING LEGEND:

HOLOCENE	Artificial Fill	Q_{af}	
HOLOCENE	Argyle Sand	Q_s	0 - 12 ka
PLEISTOCENE	Argyle Mud Flow	Q_m	~ 80 ka - 125 ka
PLEISTOCENE	Older Alluvium	Q_{oal}	> ~ 200 ka

10 0 10 20
Feet

Scale: 1:120

No Vertical Exaggeration

Elevation differences measured from an overlay of ECI's cross-section onto GDC's cross-sections

LEGEND:

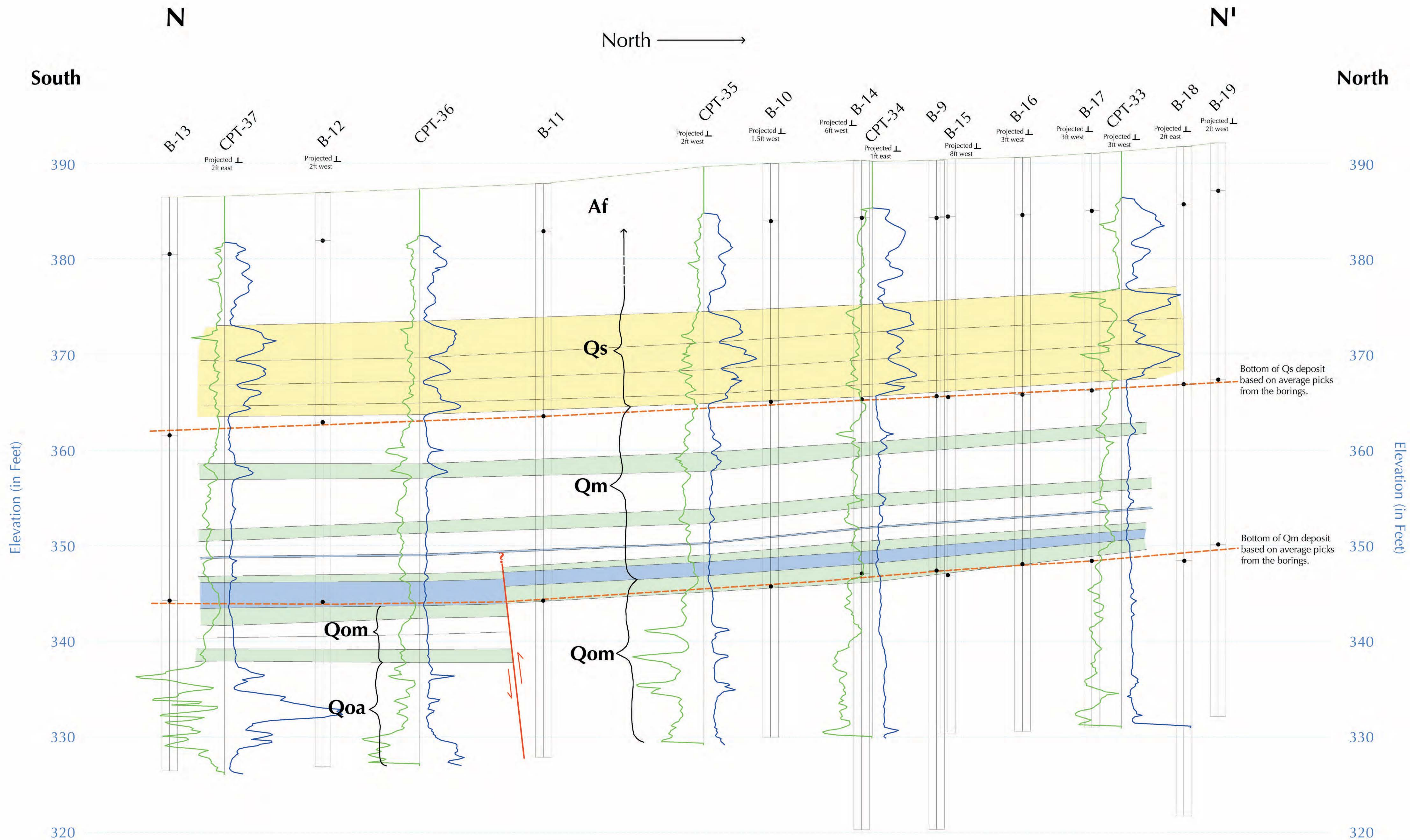
+1.1	Difference in Elevation between original and final surveyed locations
	Surveyed Existing Grade
E.G.	Existing Grade used in GDC's cross-sections
C-32	CPT Location and Number
B-8	Boring Location and Number
— — —	Bedding Contact
———	Unit Contact
	West Trench Projected onto M-M'
	East Trench Projected onto M-M'
1	(Sense of Motion Uncertain)
	Approximate Location of Inferred Fault (ECI, 2015)
	Approximate Location of Inferred Fault (GDC, 2015)

Elevation Differentials Between Original and Final Surveyed Locations

Earth Consultants International

Project Number: 3425
Date: 2015

Plate 2



Geologic Units

Qs: Argyle Sand.
Qm: "Mud flow" unit.
Qom: Older mud flow deposits with strongly developed paleosols.
Qoa: Older Alluvium.

5 0 5 10
Feet
Scale: 1:60
No vertical exaggeration

Symbols

Boring Log. Black dots show actual picks made during visual inspection of the cores.

Location of interpreted fault.

Bottom of deposit based on average picks from the borings.

CPT Log. Blue line is Cone Resistance (qc in tsf). Green line is Sleeve Friction (fs in tsf).

Cross Section N - N'

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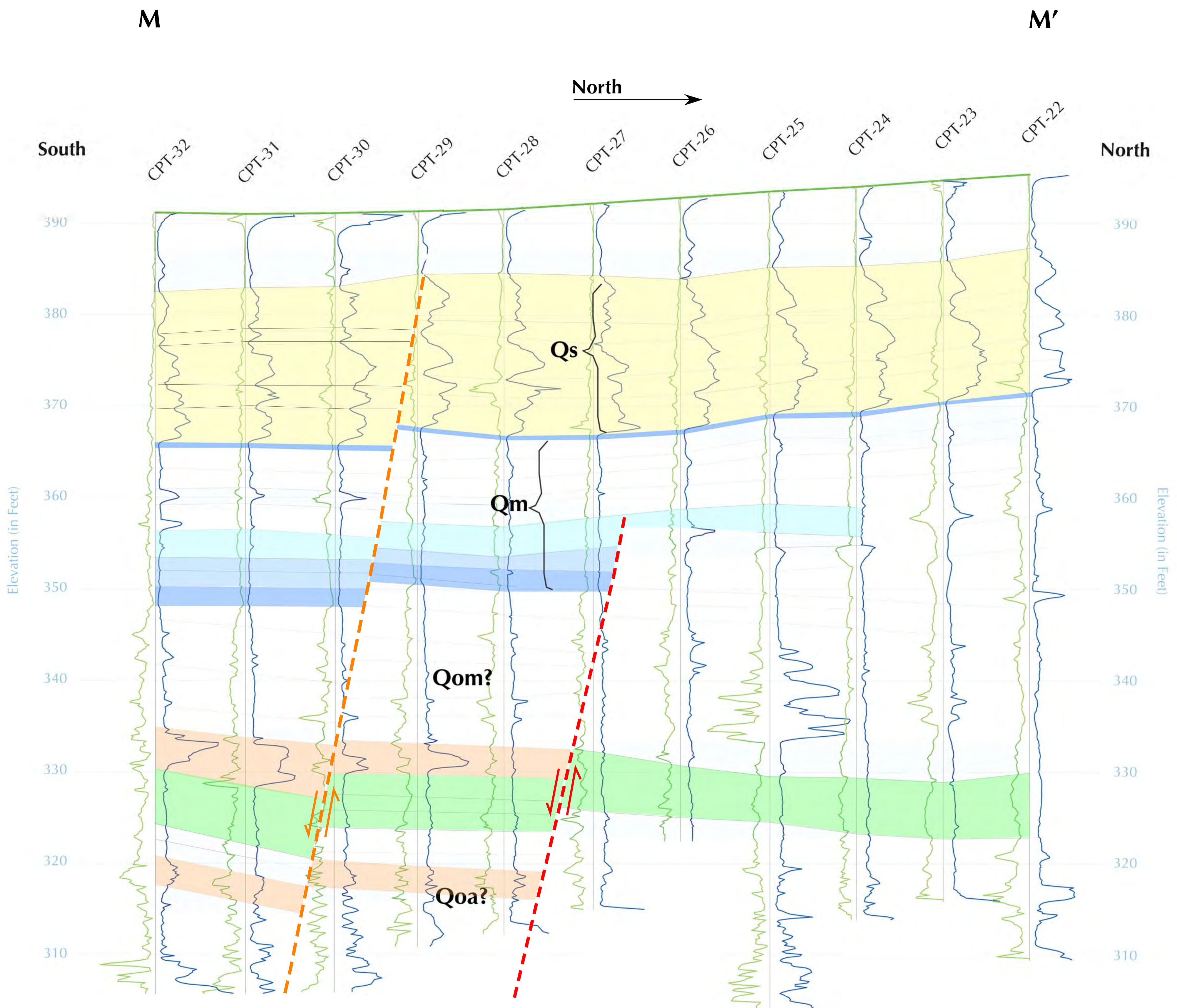
Date: 2015

Plate 3

Interpretation A: Most conservative interpretation; covers area of concern identified in sections interpreted by CGS geologists. This portion of Section M-M' is shadowed to the west by Section N-N'. The first possible fault on the right (north) is overlain by unbroken layers within the Mud Flow unit, making this possible fault not active. The second feature, shown with dashed orange line, is most likely an artifact of the data, based on CPT-29, which we believe plots incorrectly due to a surveying error. For additional information refer to text.

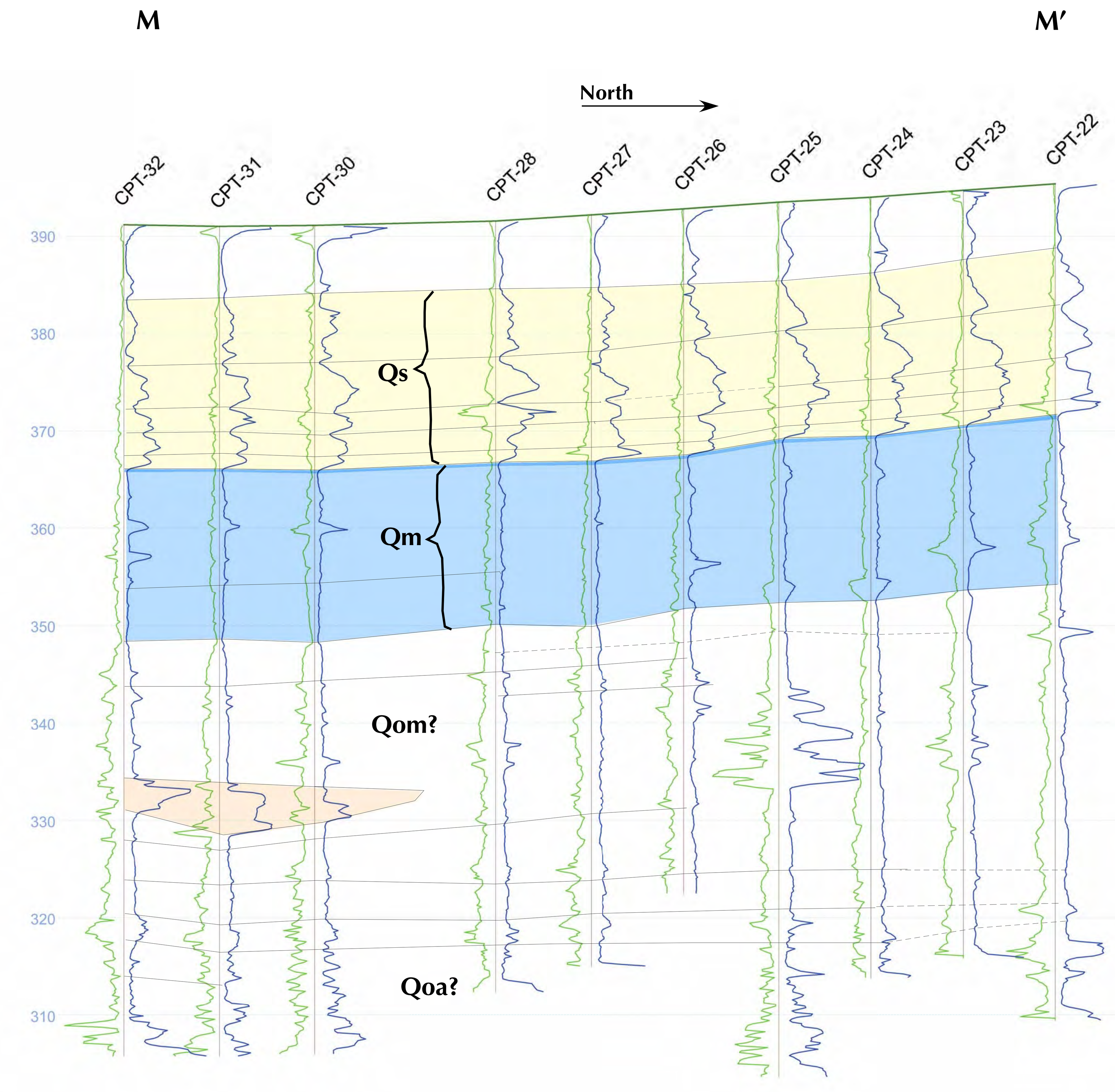


Inferred break, with apparent down-to-the-south vertical displacement required by inclusion of CPT-29. Panel B shows this feature goes away if CPT-29 is not included.

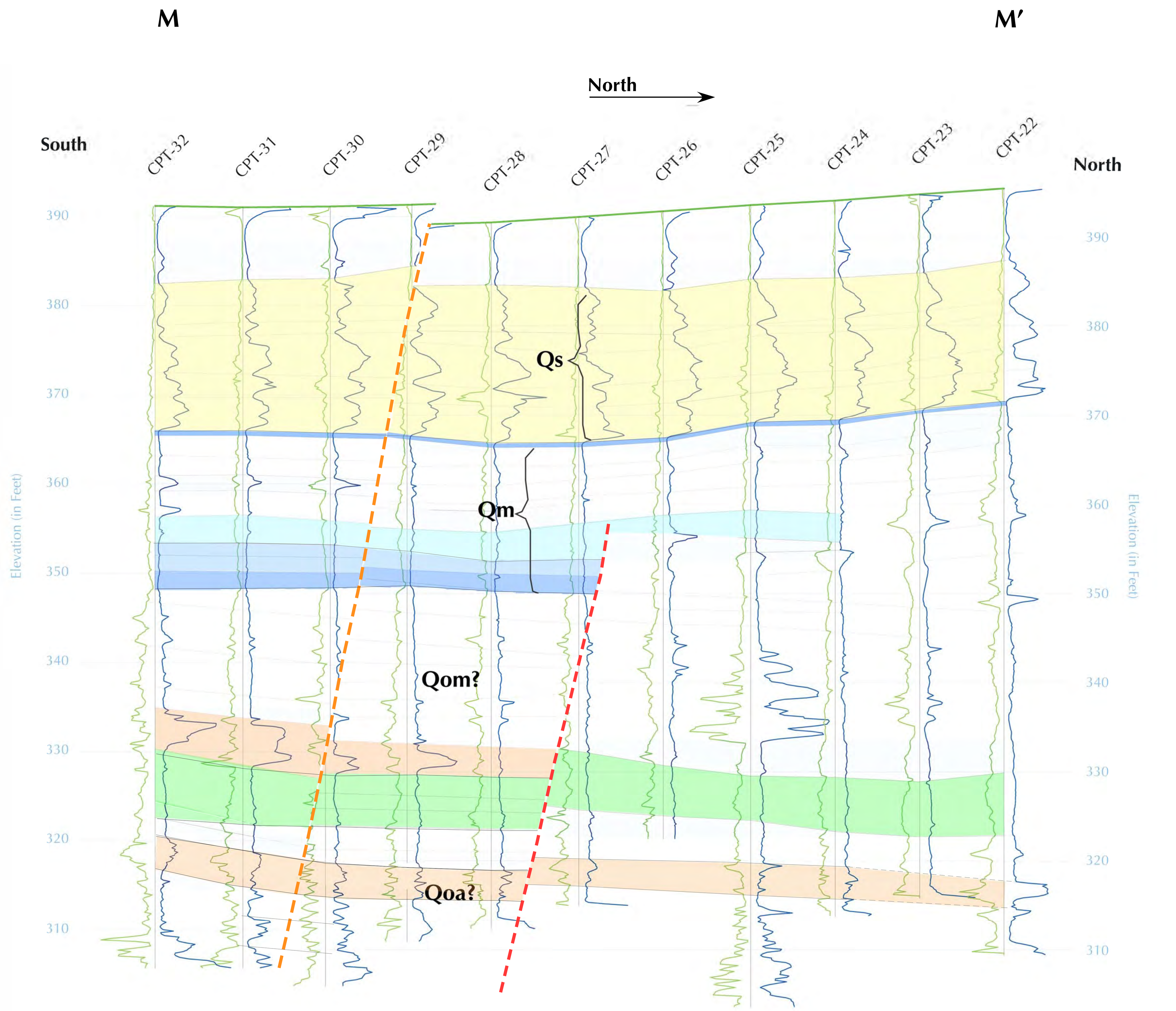
Possible fault suggested by changes in soil type at the depth of the Qm and Qom? units. An equally plausible interpretation that does not require a fault in this area is presented in Panel B.

Designation of the geologic units is based on a comparison of the CPT curves from this section with those of other sections where cores provide direct evidence of the geologic sediments along the transect. Uncertainties in the unit designations are indicated by the question (?) marks.

Interpretation B: Interpretation after removing CPT-29. Note that many layers can now be extended unbroken across the span between CPT-30 and CPT-28. This strongly suggests that CPT-29 plots incorrectly, possibly due to surveying error, and should not be used to assess whether this area is underlain by faults.

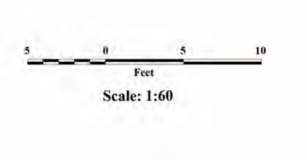


Interpretation C: In this interpretation, the section has been cut along the orange dashed line, and the right-hand side of the section has been moved down along the cut so that the contact between the Qs and Qm unit extends unbroken across the area between CPTs 30 and 28. When doing this, all other discrete beds at depth can now be correlated across the break that we had to infer in Interpretation A. This indicates that the amount of vertical separation of the units does not increase with depth. If the feature defined by the orange dashed line were a fault, the layers at depth should not match across, even after the "correction" is made.

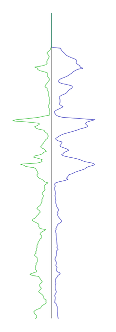


Geologic Units

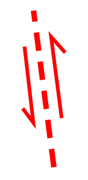
Qs: Argyle Sand
Qm: "Mud flow" unit
Qom: Older mud flow deposits with strongly developed paleosols
Qoa: Older Alluvium



Symbols



CPT Log. Blue line is Cone Resistance (qc in tsf). Green line is Sleeve Friction (fs in tsf).



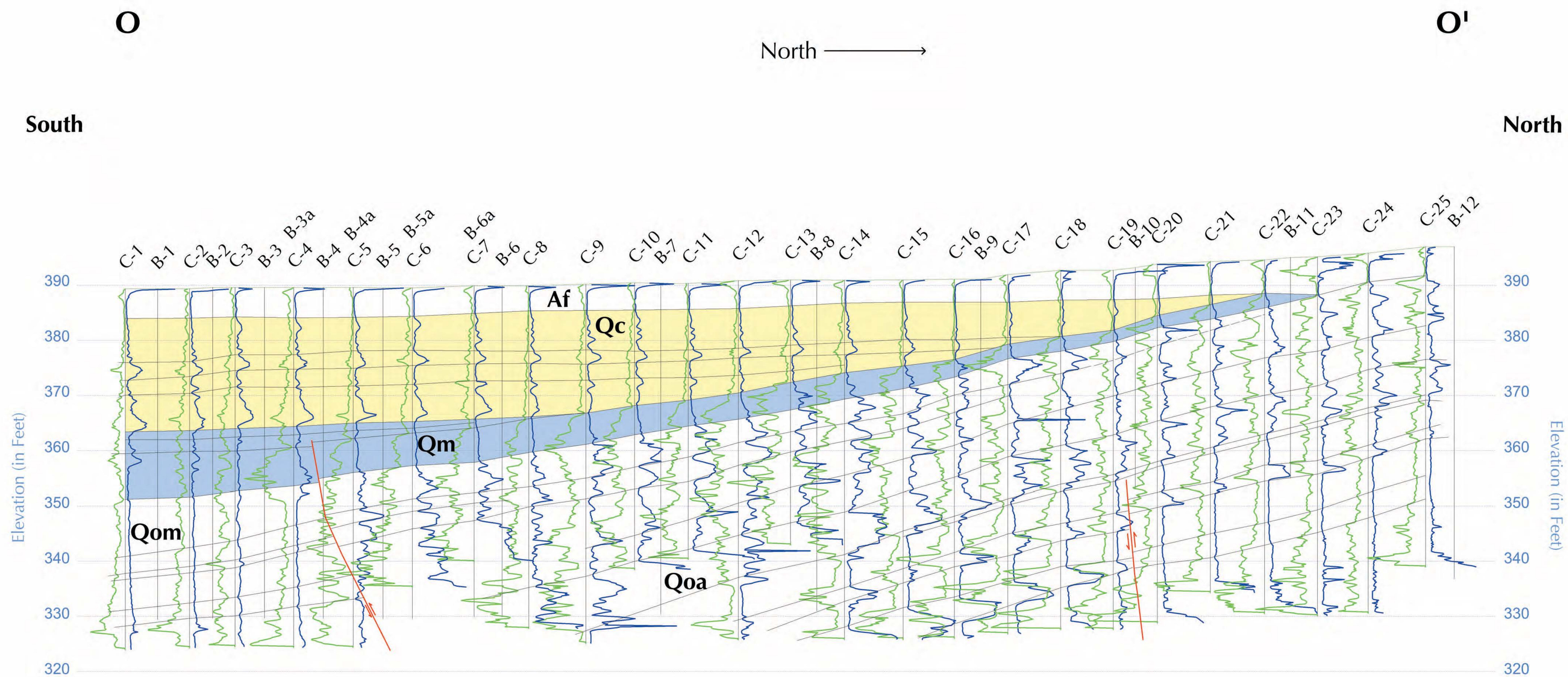
Location of inferred fault

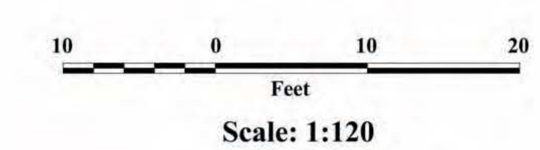
Cross Section M - M'

Earth Consultants International

Project Number: 3425
Date: 2015

Plate 4





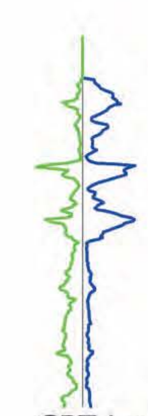
No vertical exaggeration

Geologic Units

Qs: Cahuenga Sand
Qm: "Mud flow" unit
Qom: Older mud flow deposits with strongly developed paleosols
Qoa: Older Alluvium

Symbols

Location of interpreted fault



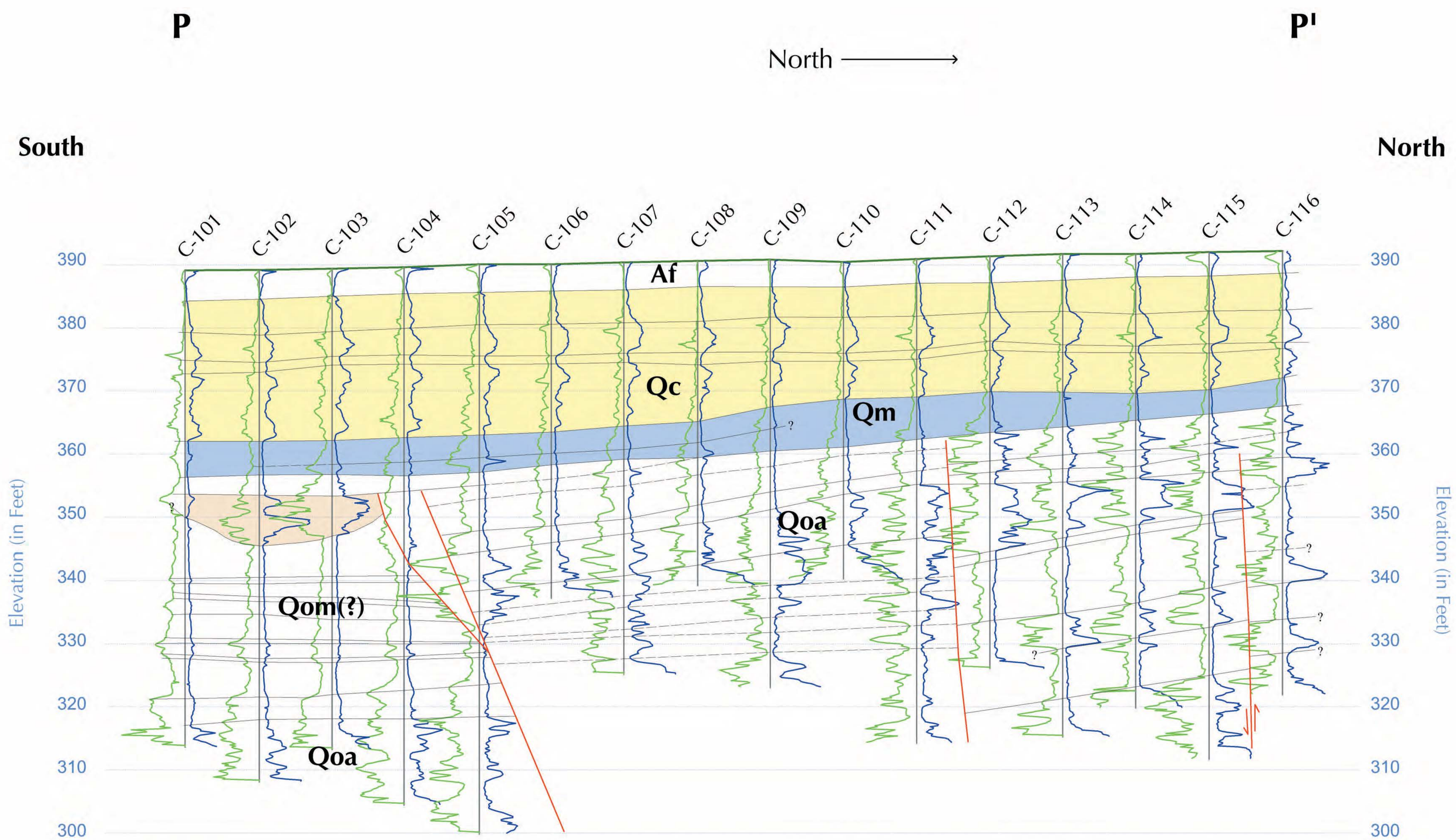
CPT Log. Blue line is Cone Resistance (qc in tsf). Green line is Sleeve Friction (fs in tsf).

Cross Section O - O'

Earth Consultants International

Project Number: 3425
Date: 2015

Plate 5



10 0 10 20
Feet
Scale: 1:120

No vertical exaggeration

Geologic Units

Qs: Cahuenga Sand
Qm: "Mud flow" unit
Qom: Older mud flow deposits with strongly developed paleosols
Qoa: Older Alluvium

Symbols

Location of interpreted fault.

CPT Log. Blue line is Cone Resistance (qc in tsf). Green line is Sleeve Friction (fs in tsf).

Cross Section P - P'

Earth Consultants International
Project Number: 3425
Date: 2015

Plate 6