GEOTECHNICAL INVESTIGATION REPORT
TAHQUITZ CREEK LEVEE SYSTEM

FEMA Levee Certification
Palm Springs, California

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This report was prepared by the staff of AMEC Geomatrix, Inc., under the supervision of the Engineer and/or Geologist whose signature appears hereon.

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1.0 INTRODUCTION

AMEC Geomatrix, Inc. (AMEC) is pleased to present the results of our geotechnical investigation for the Tahquitz Creek Levee System located in Palm Springs, California. This investigation was performed on behalf of the City of Palm Springs and Nolte Associates, Inc. (Nolte) to evaluate the ability of the levee structure to contain the base flood[1] from a geotechnical standpoint. This study is part of a broader effort to evaluate the levee using the criteria set forth in 44 CFR Section 65.10 of the National Flood Insurance Program (NFIP) in order for the levee to remain accredited by FEMA as providing flood protection. This report strictly addresses the geotechnical aspects of the FEMA levee certification process; other engineering evaluations (i.e., hydrologic and hydraulic) to satisfy the FEMA criteria were performed by Nolte. However, the results of Nolte's hydrologic and hydraulic studies were used as a basis for our geotechnical analysis.

The salient objectives of this investigation were to: (1) evaluate the nature and engineering properties of the levee embankment and underlying foundation materials; (2) evaluate potential seismic hazards; (3) evaluate groundwater and seepage conditions during the base flood event; (4) perform static and seismic slope stability analyses; (5) identify potential deficiencies that might exist in the levee and if necessary, provide recommendations for remediation measures for each deficiency; and (6) provide recommendations for maintenance tasks. The scope of the authorized investigation included researching, compiling and reviewing all available pertinent geotechnical data, conducting initial field inspections, performing engineering analyses, and preparing this report as outlined in our letter dated October 17, 2008.

2.0 PROJECT DESCRIPTION

The Tahquitz Creek Levee is located in Palm Springs, California as shown in Figure 1. The subject levee consists of an earthen embankment located along the northern bank of Tahquitz Creek. The levee provides flood protection to Demuth Park, a wastewater treatment plant (WWTP) and private residences north of Tahquitz Creek as depicted in Figure 2.

[1] The base flood as defined by 44 CFR Section 65.10 is a 1% annual chance of exceedance or the 100-year event.

2.1 LEVEE ALIGNMENT

As shown in Figure 2, the alignment of the levee begins at the northwest corner of Demuth Park, extends south about 300 feet, and extends east to southeast about 4,600 feet, where it terminates at Gene Autry Bridge (formerly Bogie Road Bridge).

2.2 PROJECT BACKGROUND

In performing this investigation, AMEC researched, compiled, and reviewed pertinent data. Table 1 presents a summary of documents reviewed as part of this investigation. These documents were provided by Nolte and the City of Palm Springs.

Based on our review of the available information, we understand that the Tahquitz Creek Levee is comprised of undocumented fill (old fill) overlain by up to 8 feet of engineered fill (new fill). It is not clear from our review of the available historical documents when the old fill was placed. The new fill was placed in 1981 during the levee upgrade project associated with the construction of the Bogie Road Bridge. The design drawings for the upgrade were prepared by S&T Western dated March 12, 1981, and construction commenced in June 1981. A geotechnical investigation of the old embankment fill was performed shortly after commencement of construction as described below.

The typical levee cross section on the S&T Western design drawings (Sheet 39, 1981) shows riverside and landside slope gradients of 1.5:1 and 3:1, respectively. The design drawings specify 4-inch thick reinforced concrete lining along the riverside slopes, extending from the crest to about 6 feet below the creek invert. Furthermore, the design drawings indicate approximately 3 feet of new fill was placed at the crest, with modest amounts (less than one foot) placed along the riverside and landside slopes.

Leighton and Associates (Leighton) performed compaction testing of the old fill in September 1981 as requested by the Riverside County Flood Control and Water Conservation District (the District). The relative compactions (RCs) of the old fill were found to be significantly less than 90 percent (i.e., 77.0 < RC < 87.5%). The City of Palm Springs subsequently stopped construction, and retained Leighton to conduct a geotechnical investigation. The main objectives of the Leighton investigation were to evaluate the subsurface conditions of the old embankment fill, and the stability of the levee slopes during a flood event. According to the Leighton geotechnical investigation report, up to 8 feet of new fill was placed between July 15 and August 20, 1981. Hence, Leighton potholed along the levee alignment and performed compaction testing at 4 feet and 7 feet below ground surface (bgs). Leighton found that the new fill was generally well compacted with RC values ranging between 77 and 92 percent with a mean of 87 percent. Leighton further concluded that the old fill was loose (i.e., RC values between 74 and 91 percent with a mean value of 79 percent), and susceptible to static

consolidation settlement. Furthermore, Leighton found that the foundation alluvial soils are susceptible to hydro-collapse. The results of Leighton's slope stability analyses indicate that the riverside slopes are marginally stable under normal seepage conditions (i.e., Factor of Safety (FS) =1.15), and unstable during rapid drawdown (i.e., FS = 0.75). Leighton provided the following remedial recommendations for reducing the potential of levee settlement and sliding: a) removal and replacement of the loose soil with well compacted fill; b) consolidation of the loose soils by water jetting, trench flooding, vibratory compaction or a combination of these; and c) placement of additional compacted fill in a manner to flatten the levee side slopes. It is not clear if any of these recommendations were ever implemented.

Additional problems relating to the construction of the upgraded levee were discovered by the City of Palm Springs in April 1983. Following a localized failure of the concrete liner at one location, the City of Palm Springs measured the concrete thickness of the failed section and found that it was less than the design specification of 4 inches. Leighton was subsequently commissioned by the City of Palm Springs to investigate the concrete liner thickness at various locations along the riverside slopes. Leighton cored 77 concrete liner samples and found that 30 of the average sample thicknesses were less than 4 inches. In a letter addressed to the General Contractor dated April 6, 1983, the City of Palm Springs wrote that "failed areas (cracked or less than 4" thick) will require replacement with limits to be determined in the field by the City and the resident engineer." Based on the documents provided, it is not clear if the repair work was completed.

Significant modifications to river channel and riverside levee slopes were made during construction of the Tahquitz Creek Golf Course. The construction of the Tahquitz Creek Golf Course, which now encompasses the river channel, was completed in 1994 and opened to the public in 1995. The golf course construction has resulted in most of the concrete liner along the riverside slopes being buried, as well as encroachments associated with the golf course landscaping and irrigation system.

3.0 FIELD EXPLORATION AND LABORATORY TESTING

The geotechnical investigation included field inspections, a field exploration program, and a laboratory testing program. The field inspection, field exploration and laboratory testing programs are briefly described below. A more detailed description of the field inspection, field exploration and laboratory testing programs are provided in Appendices A, B and C, respectively.

3.1 FIELD INSPECTIONS

AMEC conducted visual inspections along the entire length of the levee on December 29, 2008 and June 17, 2009 to investigate the conditions of the levees and identify potential issues. The field inspections were performed using the criteria and rating system of the "Levee Embankments" excerpt contained in the United States Army Corp (USACE) Flood Damage Reduction System Inspection report. Potential issues are summarized in Table A-1 and photographs from our inspections are provided in Appendix A. For the rated items listed which are not applicable to the Tahquitz levee inspection, a rating of "N/A" was assigned. Stationing of our field observations is depicted in Figure 2, and begins at the west end of the levee and increases towards the east. The stationing does not include the section of levee which is located along the west side of Demuth Park. A discussion of the potential issues noted during our inspection is provided in Section 4.2 of this report.

3.2 SUBSURFACE EXPLORATION

A subsurface exploration program was performed by GeoTek, Inc. (GeoTek) of Riverside, California using a truck mounted drill rig (CME 75) equipped with continuous hollow-stem augers (HSA). The exploration program consisted of drilling 10 borings (B-1 through B-10) and four hand-auger borings (HA-1 through HA-4). All of the HSA borings with the exception of B-6 were drilled along the top of the levee. Boring B-6 was drilled at the base of the landside slope near a WWTP pond to investigate the potential for perched groundwater. The purpose of the other borings was to evaluate the subsurface conditions and obtain both relatively undisturbed and bulk soil samples for laboratory testing. Four hand-auger borings were also advanced in areas along the Tahquitz Creek Golf Course to obtain samples in the riverside slopes. The approximate locations of the HSA and hand-auger borings are shown in Figure 2. Logs of subsurface conditions encountered in the test pits were prepared by GeoTek, and are presented in Appendix B.

Borings B-1 through B-6 were drilled on January 29, 2009, and borings B-7 through B-10 on January 30, 2009. All of the borings, except for B-6, were advanced to a depth of approximately 31.5 feet below the ground surface (bgs). Boring B-6 was drilled to a depth of approximately 51.5 feet bgs. All four hand-auger borings were advanced to a depth of approximately 4.0 feet bgs.

Standard Penetration Tests (SPTs) were performed in the borings at selected depths. The SPT consists of driving a standard sampler, as described in the ASTM D1586-84 Standard Method, using a 140-pound automatic-trip hammer falling 30 inches. The SPT sampler allowed for liners inside the barrel, but no liners were used. Relatively undisturbed samples were obtained by driving a modified California ring sampler. The same hammer used in the SPTs was dropped 30 inches to drive the modified California sampler.

The number of blows required to drive the SPT and modified California samplers every six inches of the sampling interval is recorded on the GeoTek boring logs provided in Appendix B. It should be noted that the reported blows for the entire depth of B-1, and between 0 and 20 feet for B-2, are for every seven inches.

3.3 LABORATORY TESTING

Relatively undisturbed and bulk soil samples were tested in the laboratory to evaluate engineering properties of materials retrieved from the HSA and hand-auger borings. Tests performed include moisture content and dry density (ASTM D2216 and D2937), sieve analysis (ASTM D422), compaction (ASTM D1557), direct shear (ASTM D3080), Atterberg Limits, (ASTM D4318), and flexible wall hydraulic conductivity test (ASTM D5084). All laboratory tests, except for the hydraulic conductivity tests, were performed by GeoTek. The hydraulic conductivity tests were performed by AP Engineering and Testing, Inc., of Pomona, California. A summary of the laboratory test results is presented on Table 2, and the individual results are provided in Appendix C. The soil classifications and descriptions presented on Table 2 are in accordance with the visual/manual procedures described in ASTM D2488-06 "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)". They are based on the GeoTek field log descriptions as well as the results of the GeoTek laboratory test results.

4.0 SITE CONDITIONS

The following discussion of findings for the site is based on the results of data review, field inspections, field exploration and laboratory tests.

4.1 GEOLOGIC SETTING

The Tahquitz Creek levee is located along the southern margin of a relatively broad, easterly draining, alluviated drainage that lies near the northeastern edge of the Santa Rosa Mountains, within an area known as the Salton Trough. The Santa Rosa Mountains are represented by an elevated, north-south-trending sliver of presumably Paleozoic to Mesozoic metasedimentary rocks which have been intruded by partially metamorphosed and cataclastically deformed Cretaceous-age igneous rocks, which lie along the eastern margin of the more extensive San Jacinto Mountains massif (see Dibblee,1982; Brown, 1981,and CDMG,1965). Aside from a number of moderate to high angle faults that have been mapped in the area, there are no documented active or potentially active faults within or projecting toward the levee.

4.2 SURFACE CONDITIONS

The top of the levee generally consists of an approximately 15-foot wide unpaved gravel road surface. The levee is bounded by the Tahquitz Creek Golf Course on the south side and Demuth Park and the WWTP on the north side. Several unlined ponds are located adjacent to the landside levee slopes on the south side of the WWTP. Water was observed in these ponds during the initial inspection in December 2008; however, the ponds were dry during our subsequent inspection in June 2009. There is a chain link steel fence which extends the entire section along the top of the levee.

The geometry and surface conditions of the landside and riverside slopes vary considerably across the length of the levee. The levee is generally 6 to 12 feet high with landside gradients between 4:1 and 2:1 (Horizontal: Vertical), and riverside slope gradients that range from approximately 10:1 to 2:1. As discussed, the river channel and riverside slopes are now part of the existing golf course, and except for the section of levee on the west side of Demuth Park, most of the concrete liner along the riverside slopes has been buried. In the golf course areas where the concrete liner is partially exposed, signs of distress were observed including a 5-inch wide gap near Station 5+51 (Photo 1), and cracking at Station 38+83 (Photo 2).

The existing embankment fill is highly susceptible to erosion, and significant erosion features, as well as animal burrows were identified during our inspections. Erosion along the landside slopes near the crest of the levee was noted at Stations 24+20 (Photo 3) and 33+42 (Photo 4) as well as in several areas on the south side of Demuth Park (Photos 5 and 6). Erosion of the riverside slopes near the crest of the levee was noted at Stations 4+25 (Photo 7), and Station 25+97 (Photo 8). As seen from the photographs, the dimensions of some of these erosion features are in the order of 1 to 2 feet or more. Animal burrows (Photos 9 and 10) were observed near the crest of the levee on the south side of Demuth Park. In addition, an area of depression and ponded water along the top of the levee was observed at Station 22+61 (Photo 11).

There is currently a significant amount of unwanted vegetation along the levee slopes. The thickest vegetation was observed along the landside slopes near the pond areas on the south side of the WWTP (Photos 12 and 13). There are trees (Photo 14) and other vegetation at various locations along the riverside slopes near the golf course.

Several encroachments were noted during our inspection. The encroachments observed include the golf course irrigation system (Photo 15), and light poles near the toe of the landside slopes in Demuth Park (Photo 16). During our most recent site visit, we observed grading activities associated with the installation of a storm drain on the adjacent north

property from the east section of the levee (Photo 17 and 18). The grading has impacted the landside slope geometry in this area.

4.3 SUBSURFACE CONDITIONS

The Tahquitz Levee is comprised of an earthen embankment founded on alluvium. Earthen embankment fill was encountered in all of the borings at depths ranging from about 7.5 to 10 feet below the top of the levee. Based on the results of the field exploration and laboratory tests, the embankment fill generally consists of poorly graded sand with varying amounts of silt. The embankment fill encountered during the subsurface exploration is generally loose to medium dense.

The new embankment fill was indistinguishable from the old fill based on visual soil classification during drilling. However, significant differences in SPT blowcounts (i.e., N_{60}) and dry densities with depth were found. Average N_{60} values were computed at 2.5, 5.0 and 7.5 feet bgs and found to be 31, 19, and 14, respectively. Furthermore, dry densities in the upper 4 feet are generally between 112 and 119 pounds per cubic foot (pcf), while the dry densities below 4 feet are generally between 102 and 108 pcf. The relative compaction of the embankment fill was evaluated based on laboratory test results of the dry densities and a modified Proctor compaction test obtained from a bulk sample in Boring B-7 (ASTM D1557). The relative compaction in the upper 4 feet was found to vary between 91.2 and 96.9 percent with a mean value of 93.6 percent, while the relative compaction below 4 feet varied between 72.8 and 90.4 percent with a mean value of 84.4 percent. The observed trends are generally consistent with Leighton (1981) as described in Section 2.2, wherein they found that the new fill was generally well compacted but the old fill was loose. The moisture contents of both the old and new embankment fills generally fall between 2.0 and 5.5 percent.

The results of the GeoTek direct shear tests on the old embankment fill indicate that the residual friction angles and cohesion values range from approximately 24 to 31 degrees, and 130 to 380 pounds per square foot (psf), respectively. The results of the direct shear tests performed by Leighton (1981) on remolded samples of the embankment fill at a depth of 7 feet indicate friction angles of 29 and 36 degrees for relative compaction values of 74 and 88 percent, respectively.

The upper alluvium is generally comprised of poorly graded sand with varying amounts of silt. Based on the SPT blowcounts, the alluvial sand is generally loose to medium dense between 7.5 and 15 feet ($7 < N_{60} < 20$), and medium dense to dense between 20 and 30 feet ($27 < N_{60} < 32$). The moisture content and dry density of the alluvial sand is generally between 2 and 6 percent, and 100 to 112 pcf, respectively. The results of the GeoTek direct shear

tests on the alluvial sand indicate that the residual friction angles and cohesion values range from 33 to 36 degrees, and 0 to 160 psf, respectively.

A layer of stiff to very stiff silt/sandy silt was encountered at a depth of approximately 30 feet in Borings B-1 through B-3, and B-6. Boring B-6 was drilled at the base of the landside slope near a WWTP pond. The silt layer in Boring B-6 is approximately 10 to 15 feet thick, and is underlain by dense to very dense silty sand.

Moisture contents, dry densities and overburden corrected SPT blowcounts $(N_1)_{60}$ for all soil samples from the subsurface exploration and laboratory testing programs were plotted versus depth (Figure 3). Estimates of friction angles obtained using the Peck et al. (1974) empirical correlation with N_{60} blowcounts are also plotted. Estimates of friction angle using the Peck et al. (1974) correlation were found to correlate reasonably well with the measured friction angles from the GeoTek and Leighton (1981) direct shear test results.

Figure 4 shows plots of relative compaction and friction angle versus depth for the embankment fill soils. The relative compaction of the embankment fills was evaluated from GeoTek laboratory test results and Leighton (1981) compaction test results. The friction angle was evaluated from empirical correlations with N_{60}, and laboratory test results from GeoTek and Leighton (1981).

4.4 GROUNDWATER CONDITIONS

Groundwater was not encountered in any of the exploratory borings during the subsurface exploration program, including Boring B-6 located near the WWTP pond. However, groundwater level can fluctuate with seasonal rainfalls and dry weather. Hence, we reviewed historical regional groundwater level data for the subject site. Based on groundwater level data from the State of California Department of Water Resources (DWR, 2008), historical high groundwater in the area is believed to be approximately 150 feet bgs.

5.0 SEISMIC HAZARDS

The project site is located in the Southern California region, one of the more seismically active regions in the world. Available literature indicates that the site area has experienced significant ground shaking as a result of numerous previous prominent earthquakes occurred within the Riverside County area. Potential seismic hazards for the subject site include fault rupture, strong ground shaking, seismic slope stability, liquefaction and seismically-induced ground settlement.

5.1 REGIONAL TECTONIC SETTING

As indicated above, the levee lies within an area known as the Salton Trough, the name given to the northernmost extension of the Gulf of California into Southern California. It is a low lying, fault-bounded geologic depression extending approximately 120 miles from the Mexican border on the south to the northern end of the San Jacinto Mountains in the San Gorgonio Pass; the central portion of which is occupied by the Salton Sea (Sheehan, 1986). The tectonic setting of this region (Figure 5) is mostly controlled by the San Andreas Fault, which represents the juncture between the North American and Pacific tectonic plates. In the Salton Trough area, the northward motion of the Pacific plate relative to the American plate has produced what is referred to as the Elsinore/Agua Caliente-San Jacinto-San Andreas transform fault series. These Holocene-active faults, as well as numerous other active faults in the region, produce considerable ongoing seismicity in the region. However, there are no documented active or potentially active faults within or projecting toward the levee.

The closest active faults to the levee are the San Andreas and San Jacinto faults, located approximately 4.5 and 10 miles to the northeast and southwest, respectively. The Burnt Mountainn and the Eureka Peak faults are located approximately 11 and 14 miles, respectively, to the northeast. At its closest approach, the Agua Caliente/Elsinore fault zone is located about 38 miles to the southwest.

5.2 SURFACE FAULT RUPTURE HAZARD

As there are no active or potentially active faults transecting or projecting toward the levee, the risk of surface fault rupture is considered remote.

5.3 PROBABILISTIC SEISMIC HAZARD ANALYSIS

A peak ground acceleration of 0.54 g was estimated for the levee alignment for a 475 year return period (10% probability of exceedance in 50 years) utilizing the United States Geologic Survey (USGS) Probabilistic Seismic Hazard Assessment (PSHA) model (USGS, 2008). De-aggregation of the earthquake magnitudes and distances from the USGS model indicate that this peak acceleration is associated with a modal moment magnitude of 7.4 at a modal hypocentral distance of 7.1 km. The major contributing fault to the probabilistic model is the San Andreas Fault.

5.4 LIQUEFACTION ASSESSMENT

Liquefaction is a phenomenon in which saturated granular soil materials transform from a solid to a liquefied state when subjected to large, rapid loadings such as strong ground shaking during an earthquake. The transformation to a liquid state occurs due to the tendency of granular materials to compact, which consequently results in increased pore water pressure accompanied by a significant reduction in the effective stress. The change of state occurs

most readily in recently deposited (i.e., geologically young) loose to moderately dense granular soils. The liquefaction susceptibility is highly dependent on the density of the soil, wherein looser soils are generally more susceptible. Furthermore, the consequences of liquefaction are also density dependent. In loose materials, soil liquefaction can result in a significant loss of shear strength, which is often accompanied by large shear deformations. In moderately dense to dense materials, liquefaction may temporarily induce high excess pore water pressures, but the tendency to dilate during shear inhibits major strength loss and large ground deformations.

It is widely understood that clayey soils are generally less susceptible to soil liquefaction compared to clean sands. Significant new research has developed new liquefaction susceptibility criteria for fine-grained soils. Bray et al. (2004) performed laboratory testing on soils that were and were not observed to have liquefied in Adapazari during the Kocaeli earthquake, and concluded that the amount of clay minerals best indicate a soil's susceptibility to liquefaction. Hence, Bray et al. (2004) recommended that loose soils meeting the following criteria should be considered susceptible to soil liquefaction: (1) the plasticity index is < 12; and (2) the natural moisture content is > 0.8 times the liquid limit. Boulanger and Idriss (2006) also investigated liquefaction characteristics of fine-grained soils and recommended that the term liquefaction be reserved to describe the development of significant strains or strength loss in soils exhibiting a sand-like behavior, while the term cyclic softening be used to describe similar phenomena in soils exhibiting clay-like behavior. Boulanger and Idriss (2006) further recommended that for practical purposes clay-like behavior can be expected for fine-grained soils that have a plasticity index > 7.

As described above, liquefaction susceptibility is highly dependent on the in situ soil density and amount of clay mineral content. Additional factors shown to influence liquefaction susceptibility include soil fabric, ageing effects, overconsolidation, prior seismic history and fines content. Furthermore, each of these factors with the exception of fines content affects field penetration resistance (i.e., SPT blowcounts and CPT tip resistance) in a similar way that it affects liquefaction resistance. For instance, it has been well documented that the effect of overconsolidation increases both soil liquefaction resistance and field penetration resistance. Hence, the "simplified procedure," which uses field penetration resistance to evaluate liquefaction resistance, has evolved as the standard of practice in assessing the liquefaction susceptibility of soils over the past 35 years.

As described in Section 4.3, the levee is underlain mostly by medium dense sands and silty sands. These sands are of the types that are generally susceptible to liquefaction. However, the groundwater is generally deep along the levee alignment except during periods of flooding which may cause the presence of perched groundwater. During these periods, the soils may

be prone to liquefaction if strong ground shaking occurs. Therefore, the potential for liquefaction triggering can be characterized as a conditional probability of strong ground shaking occurring simultaneously with the high-groundwater-level condition induced by flood loading. Since the confluence of a significant flood event coinciding with strong ground shaking is highly unlikely, the potential for liquefaction is judged to be low for the levee.

6.0 GEOTECHNICAL ANALYSES

The subject levee was evaluated from a geotechnical standpoint in general conformance with the guidelines presented in 44 CFR 65.10. The following analyses were performed on critical cross sections thought to represent the adverse sections of the levee alignment:

1. Seepage conditions through and under the levee embankment were evaluated using a finite element computer model. The seepage conditions within the levee and alluvial materials were evaluated using steady-state analysis methods.

2. The stability of the levee slopes was evaluated under the following loading conditions: (i) long-term static stability with steady state seepage; (ii) rapid drawdown; and (iii) 475-year return period earthquake.

3. Long term static settlement and seismically-induced settlement evaluation.

6.1 SELECTION OF CRITICAL CROSS SECTIONS

The critical cross sections were identified based on the following factors: (1) subsurface conditions (i.e., presence of soft or liquefiable soils); (2) surface conditions (i.e., surficial anomalies, areas of scour or erosion, and/or encroachments); (3) geometrical configurations (i.e., steepest slopes, highest slopes, thinnest portions of the levee), and (4) flood loading conditions based on the Nolte hydrologic and hydraulic analysis results (Appendix D).

As described in Section 4.3, the subsurface soil conditions encountered during the subsurface exploration program consist of embankment fill underlain by alluvial sand deposits. Furthermore, it appears that the subsurface conditions are generally uniform with depth along the entire levee alignment. The surface conditions, geometrical configurations, and the flood loading conditions vary significantly along the levee alignment. Hence, four different critical cross sections were selected at locations thought to represent the most adverse conditions based on these factors. Section A-A was selected because Nolte's hydrologic and hydraulic analyses predict ponded water at the base of the landside slopes during the base flood event. Section B-B was selected because it is located in an area with relatively steep and high riverside slopes. Section C-C was selected because it is located in an area with relatively

steep landside slope gradients, and Section D-D was selected because it is located in an area with less than 1.6 feet of freeboard during the base flood.

Section A-A has an existing crest width of 20 feet, a slope gradient of 4:1 on the landside and 8.5:1 (H:V) on the riverside, and an embankment height of about 11 feet. Section B-B does not have a well defined crest width and landside slope gradient; however, the riverside slope height and gradient are 12 feet and 2.1:1, respectively. Section C-C has an existing crest width of 42 feet, a slope gradient of 1.7:1 on the landside and 8.5:1 on the riverside, and an embankment height ranging from 6 to 12 feet. Section D-D has an existing crest width of 49 feet, a slope gradient of about 2:1 on the landside and 7:1 on the riverside, and an embankment height ranging from 6.5 to 11 feet.

6.2 SOIL PROFILES AND MATERIAL PROPERTIES

Material properties required as input for our analyses include total unit weight (γ), friction angle (ϕ), cohesion (c), saturated vertical hydraulic conductivity (k_v) and the hydraulic conductivity anisotropy defined as the ratio of the horizontal to the vertical hydraulic conductivities (k_h/k_v). A summary of the soil layers and engineering properties used in our analyses for each critical cross section are presented in Figures 6 to 9. Values for total unit weight and strength parameters (i.e., friction angle and cohesion) were selected based on the results of our subsurface exploration, previous and current laboratory testing programs, and empirical correlations as summarized in Figures 3 and 4. Based on the subsurface conditions encountered, friction angles and cohesion values used in our analyses are drained strength parameters. The values of saturated vertical hydraulic conductivity obtained from the laboratory tests appear to be low for the soils tested. Therefore, hydraulic conductivities were evaluated using the Kozeny-Carmen (Carrier, 2003) empirical correlations. Lastly, the hydraulic conductivity anisotropy ratio was assumed to be k_h/k_v= 10 in our seepage analyses.

As described in Section 4.3, the levee embankment generally consists of well compacted fill in the upper 4 feet overlying loose old fill down to the alluvium. Hence, the embankment fill was divided into two sections (i.e., upper and lower embankment fill) for the analyses. The upper embankment layer was assumed to be slightly less permeable (k_v = 6.0 x 10^{-5} ft/s) than the lower embankment layer (k_v = 3.0 x 10^{-4} ft/s) due to the higher dry densities. Strength parameters of ϕ = 36 degrees and c = 50 psf were selected for the upper embankment fill soils. The assigned strength parameters for the lower embankment soils are ϕ = 29 degrees and c = 50 psf. The selected friction angles correspond to the values used by Leighton (1981) in their stability analyses, and represent the lower bound of the range of the friction angles evaluated using empirical correlations with SPT blowcounts and GeoTek's laboratory test results. A cohesion of 50 psf was selected for both the upper and lower embankment fill to prevent the computation of surficial instabilities within Slope/W.

The upper alluvium encountered during our subsurface exploration generally consists of medium dense poorly graded sand with varying amounts of silt. Based on the empirical correlations, a friction angle of ϕ = 31 degrees, no cohesion and saturated vertical hydraulic conductivity of $k_v = 3.0 \times 10^{-4}$ ft/s were selected for the upper alluvium. The selected friction generally represented the lower end of the range of values shown in Figure 3.

Based on the results of Boring B-6, we expect that the upper alluvial sand is underlain by a fine grained sandy silt to silt layer at a depth of approximately 30 feet. The thickness of this layer was assumed to be 10 feet. A friction angle of ϕ = 25 degrees was assigned for this layer using empirical correlations with liquid limit by Stark et al. (2005), and a hydraulic conductivity of $k_v = 3.0 \times 10^{-7}$ ft/s was selected based on the same empirical correlations used for the fill and upper alluvial sand. Finally, a silty sand layer with a friction angle of ϕ = 30 degrees, no cohesion and saturated vertical hydraulic conductivity of $k_v = 5.0 \times 10^{-6}$ ft/s was assumed to underlay the sandy silt to silt layer.

6.3 ACCEPTANCE CRITERIA

The USACE Manual EM 1110-2-1913 Design and Construction of Levees does not provide formal acceptance criteria for seepage control. However, it does provide design guidance to mitigate excessive hydrostatic pressures, sand boils and piping resulting from underseepage. Based on our experience with levee embankments, a minimum FS against piping of 2.0 was adopted.

In terms of slope stability, the FS against sliding is defined as the ratio of resisting forces (friction and cohesion along a potential failure surface) to driving forces (gravitational forces pulling downslope). A FS of unity (1.0) indicates a delicate balance between the resisting and driving forces and represents insipient failure. Factors of Safety below unity indicate instability.

The levee slopes must satisfy the minimum FS allowed using the criteria in USACE Manual EM 1110-2-1913 Design and Construction of Levees and are also set forth in 44 CFR Section 65.10 of the National Flood Insurance Program (NFIP) in order for the levees to remain accredited by FEMA as providing flood protection. Per these criteria, the stability criteria used in this report to evaluate the levees are as follows:

FS ≥ 1.4 for long-term static stability with seepage

FS ≥ 1.0 for rapid drawdown for conditions where these water levels are unlikely to persist for a long time

The USACE Manual EM 1110-2-1913 does not explicitly provide acceptance criteria related to the seismic stability of levee embankments. However, based on our experience with levee and dam embankments, the following criterion was adopted:

> FS ≥ 1.0 for earthquake loading (i.e., pseudo-static) using a seismic coefficient (k) calculated based on the screening analysis of Stewart et al (2003).

6.4 SEEPAGE ANALYSIS

Steady state analyses were performed on each of the critical cross sections to evaluate the potential seepage conditions within and beneath the levee embankment during the base flood event. The analyses were performed using a commercially available computer program, Seep/W (GEO-SLOPE, 2004) that can incorporate both saturated and unsaturated flow characteristics of soil and model both steady state and transient flow conditions. Under normal conditions in the Tahquitz Creek, the subject levee does not experience flow against the riverside slope. However, based on the Nolte flood loading diagram and table (Appendix D) the riverside slope may be subjected to flood water loadings up to 1.6 feet below the crest during the base flood. The potential for excessive hydrostatic pressures, sand boils and piping within and beneath the levee embankment during this flood event were evaluated using steady state seepage analyses.

6.4.1 Boundary Conditions

Figures 6 through 9 (Sections A-A through D-D) show the seepage models and boundary conditions used in the analysis. A total head boundary was specified on the riverside of the levee corresponding to the base flood elevations provided by Nolte (Appendix D). A potential seepage face boundary was specified for the ground surface and the levee slope on the landside except for Section A-A. For Section A-A, a total head elevation equal to the landside flood elevation level was specified to account for potential water ponding at Demuth Park.

6.4.2 Seepage Analysis Results

The results of the steady state seepage analyses for the critical geologic cross sections are presented in Appendix E. For each critical cross section, pressure head contours, total head contours intervals, and hydraulic gradients are shown.

The results of the steady state seepage analyses indicate that the seepage will emerge near the toe of the existing landside slopes. A maximum hydraulic gradient of 0.4 during the base flood was computed at Sections C-C and D-D. Critical hydraulic gradients of about 1.0 to 1.1 are required to cause piping in the soils near the base of the levee on the landside. Therefore, the minimum factor of safety against piping for the subject levees was found to be 2.5 at

Sections C-C and D-D. Based on the seepage analysis results, we do not anticipate problems resulting from excessive hydrostatic pressures, sand boils or piping.

Due to the relatively short duration of the flood events at the subject site, it is highly unlikely that steady state conditions within and beneath the levee embankment will develop. Hence, the seepage results reported herein are generally considered conservative for the anticipated short-duration flood events.

6.5 SLOPE STABILITY ANALYSES

Slope stability analyses were performed using the computer program Slope/W (GEO-SLOPE, 2004). Slope/W is a commercially available computer program that uses a limit equilibrium approach to compute factors of safety against sliding. Slope/W can be coupled with the program Seep/W so that the seepage results (i.e., pore water pressures) obtained form Seep/W can be directly imported into Slope/W. Furthermore, the comprehensive formulation of Slope/W makes it possible to select a variety of methods for computing the factor of safety, and analyze complex geometric configurations as well as loading conditions. Spencer's method was used to analyze the static stability of the embankments because it satisfies both force and moment equilibrium, and accounts for inter-slice forces.

6.5.1 Loading Conditions

Slope stability analyses were performed on all of the critical cross-sections for the following loading conditions: (1) long term stability with steady state seepage; (2) rapid drawdown; and (3) seismic loading.

6.5.1.1 Long Term with Steady-State Seepage

The static stability of the levee was evaluated under flood loading conditions (i.e., base flood event) by directly importing the pore water pressures computed during the steady state seepage analyses into our stability models for each cross section. The stability of the levees on both the landside and riverside were analyzed using circular surfaces.

6.5.1.2 Rapid Drawdown

We evaluated the slope stability of the riverside levee slopes during rapid drawdown. Rapid drawdown represents the condition whereby a prolonged flood stage saturates at least the major part of the upstream embankment portion and then falls faster than the soil can drain.

6.5.1.3 Seismic Slope Stability

The seismic slope stability of the levee was evaluated using the pseudo-static analysis method. In this method, the earthquake forces are represented by a pseudo-static representation of seismic demand within a conventional limit-equilibrium slope stability

calculation. The seismic demand is introduced as a static lateral force equal to the product of the horizontal seismic coefficient (k) and the weight of the slide mass. The most commonly used values for the seismic coefficient are based on the recommendations from Seed (1979), which was developed for application to earth dams and for up to 1 meter of displacement. The Seed (1979) procedure recommends values of k = 0.1 and 0.15 for M = 6.25 and 8.25 earthquakes, respectively.

It is our opinion that the Seed (1979) procedure is not the most appropriate approach for the current investigation because seismically-induced displacements on the order of 1 meter may not be acceptable and result in a significant loss of freeboard. Consequently, we derived the seismic coefficient using the Stewart et al. (2003) screen analysis procedure because it is specifically intended for slopes which can tolerate smaller displacements. AMEC estimated the seismic coefficient using the Stewart et al. (2003) procedure for a maximum seismic slope displacement of 15 cm during an earthquake event with a 10% probability of exceedance in 50 years. This procedure takes into account local variations in seismicity as represented by magnitude, distance, significant duration of shaking, peak amplitude of shaking in the slide mass and ratio of slope resistance to peak demand. A seismic coefficient of 0.23 was computed based on the Stewart et al. (2003) procedure and the ground motion parameters from the USGS (see Section 5.3) for a 475-year return period earthquake.

The seismic stability analyses were performed assuming groundwater conditions of 150 feet below the riverbed surface. This assumption is consistent with the guidelines presented in USACE Manual EM 1110-2-1913 which states “earthquake loadings are not normally considered in analyzing the stability of levees because of the low probability of earthquake coinciding with periods of high water.”

6.5.2 Slope Stability Analysis Results

The results of the stability analyses for each loading condition are summarized in Table 3, and the graphical results are shown in Appendix F. The calculated minimum Factors of Safety were compared to stability criteria outlined in Section 6.3.

For the long-term static condition with steady state seepage, the minimum Factors of Safety were found to vary between 1.22 and 3.34. Sections C-C and D-D did not meet the minimal acceptance criterion (i.e., FS < 1.4). For the rapid drawdown loading conditions, the minimum Factors of Safety varied between 0.97 and 3.34. Section D-D did not meet the minimal acceptance criterion of 1.0. Lastly, minimum factors of safety on the landside and riverside slopes varied from 1.18 to 1.98 for the seismic loading condition. Based on the results of the seismic slope stability analyses, we expect that the amount of displacement during the design earthquake will be minimal (i.e., < 6 inches) and not result in the loss of significant freeboard.

6.6 SETTLEMENT EVALUATION

Settlement was evaluated for static conditions and seismically-induced conditions. The results of the static and seismically-induced settlement are discussed below.

6.6.1 Static Settlement

Based on the granular and pervious nature of the alluvial soils, it is highly likely that the majority of the settlement from embankment fill placement occurred during and/or immediately after construction. Given that the upgrades to the original levee were performed more than 28 years ago, additional static settlement resulting in substantial loss of freeboard is not anticipated.

6.6.2 Seismic Settlement

The potential for seismically-induced settlement was evaluated for the subject levee assuming a 475-year return period earthquake event and normal groundwater conditions (i.e., groundwater level 150 feet bgs). The seismically-induced settlement is associated with the accumulation of volumetric strains in unsaturated soils due to strong ground shaking, a phenomena termed seismic compression (i.e., Whang et al, 2004). This analysis was performed according to criteria outlined by Stewart and Whang (2003) and Duku et al. (2008). The seismic compression analysis was performed using the SPT data obtained during the subsurface investigation. The peak acceleration of 0.54g for 10% probability of exceedance in 50 years obtained based on the USGS Probabilistic Seismic Hazards Assessment (PSHA) Model, 2008, and an earthquake magnitude of 7.4 were used in the analysis. The results of this evaluation indicate that a maximum estimated settlement of the dry sandy soils due to the design seismic event at this site is about 1 ½ inches. Therefore, the potential seismic settlement that may occur is not expected to result in a significant loss of freeboard.

7.0 FINDINGS

Based on the results of our geotechnical investigation, it is our opinion that the Tahquitz Creek Levee does not meet the geotechnical criteria set forth in 44 CFR Section 65.10 of the National Flood Insurance Program for the loading conditions described in USACE Design Manual EM 1110-2-1913. A discussion of each of the geotechnical criteria is provided below.

<u>Erosion of Levee Embankment During Base Flood</u>

The surface soils along the levee are highly erodible. As described in Section 4.2, evidence of significant erosion and animal burrows was observed at various locations along the levee during our inspections. We expect that existing areas will continue to erode over time, and other sections of the levee, which are currently unaffected, could erode if mitigation measures

are not implemented. Existing and future erosion will reduce the integrity, and thus, increase the potential for slope instability.

Revetment Protection

Several deficiencies in the original concrete liner thickness were noted in the Leighton coring study (1983), and most of the concrete liner has since been buried from the construction of the golf course. In the exposed sections of the liner, we observed cracking and even separation at one location. Furthermore, the existing revetment does not provide slope protection to the fill buttress on the riverside slopes that was placed during construction of the Tahquitz Creek Golf Course. Hence, based on the results of our review and observations during the inspections, the existing revetment is judged to be inadequate to provide protection for the riverside slopes during the base flood.

Levee Embankment Stability

Detailed analyses were performed to evaluate the embankment stability for various loading conditions. The loading conditions considered during this study included: (1) steady-state seepage from the base flood event, (2) rapid drawdown, and (3) earthquake loading from a 475-year event. For the static loading conditions on the landside, the calculated minimum Factors of Safety for Sections C-C and D-D did not meet the stability criteria outlined in the USACE Manual EM 1110-2-1913 Design and Construction of Levees and also set forth in 44 CFR Section 65.10 of the National Flood Insurance Program (NFIP). For the rapid drawdown condition, Section D-D did not meet the adopted stability criteria. Additionally, the flood loading elevation levels by Nolte indicate several sections of the levee do not have adequate freeboard (Appendix D). The lack of adequate freeboard may result in floodwater overtopping the embankment, which in turn will cause instability of the embankment.

Levee Foundation Stability

We expect that the vast majority of any static settlement has already likely occurred. In addition, we estimate approximately 1.5 inches of seismic compression could occur during a 475-year earthquake event. During our field inspections, we did not observe any evidence of settlement. Therefore, it is our opinion that the levee foundations are stable and potential future settlement will not create a significant loss of freeboard.

Encroachments/Unwanted Vegetation/Maintenance

During our field inspections, we observed several encroachments associated with the landscaping and irrigation system of the golf course. We observed grading activities along the landside slopes in the east section of the levee at the WWTP, and areas of thick vegetation along the landside slopes. Erosion may be accelerated if irrigation is not properly controlled

and/or if an irrigation line ruptures. The grading activities along the landside slopes could increase the potential for instability if the slopes are not properly restored. Furthermore, the thick vegetation could inhibit maintenance and/or emergency operations as well as reduce the integrity of the levee from decaying root systems and/or other organic matter.

8.0 RECOMMENDATIONS

As described in Section 1.0, the scope of this investigation included identifying potential deficiencies that might exist in the levee per 44 CFR Section 65.10 and providing recommendations for remediation measures for each deficiency. To wit, AMEC was tasked with identifying and evaluating potential remedial conceptual design for each of the deficiencies identified in the preceding section. In the following sections we describe the required mitigation measures which must be implemented in order for the levee to be certifiable.

8.1 MAINTENANCE PROGRAM IMPLEMENTATION

In order to mitigate issues related to erosion, animal burrows and unwanted vegetation, we recommend performing regularly scheduled inspections of the subject levees accompanied by appropriate remedial actions.

8.2 REVETMENT PROTECTION

The existing concrete liner revetment was placed during on 1.5:1 riverside slopes in 1981 during the original construction of the subject levee. As described in Section 2, the construction of the Tahquitz Creek Golf Course in 1994 resulted in substantial re-grading of the riverside slopes and burial of the concrete liner. Hence, the existing concrete liner does not provide adequate revetment protection to the fill buttress on the riverside slopes subsequent to the original levee construction. Therefore, additional revetment protection is required to provide slope protection to the re-graded riverside slopes.

8.3 MITIGATION OF EXISTING SLOPES

Many remedial measures are available to mitigate the levee slopes. To select the most appropriate alternative, it is important to establish a set of criteria for evaluating the proposed alternatives based on the site conditions and project constraints. Our understanding of the site conditions was described in the preceding sections of this report. We understand that the project constraints include: (1) a minimum of 3 feet of freeboard against flood elevations computed by Nolte during the 100-year flood; and (2) the existing golf course and WWTP.

8.3.1 Selection Criteria

Based upon our understanding of the project demands, we evaluated potential conceptual designs using the set of criteria described below.

1. Reliability and Effectiveness – Mitigation approaches should have a proven track record for effectively and reliably stabilizing similar slopes and conditions to those at the site.

2. Cost Control – Mitigation measures with lower construction costs are favorable over those with higher costs.

3. Site Constraints Compatibility – Mitigation measures should be able to be constructed within the boundary and use constraints that exist for the levee.

4. Constructability – Mitigation measures that are relatively easy to construct successfully and for which contractors are readily available are favorable over those that are difficult to construct successfully or for which experienced contractors are not readily available.

5. Aesthetic Appeal – Mitigation measures that are aesthetically pleasing and will blend with the natural environmental are preferable.

6. Low Long-Term Maintenance – Mitigation measures with little to no maintenance are preferable over those with moderate to high maintenance

There are many mitigation measures that are effective in stabilizing slopes. In general, these mitigation measures either reduce the forces tending to cause slope movement or increase the forces resisting movement. The most appropriate measures for a specific slope can depend on many factors. Some of these can include the size and depth of the potentially sliding mass, the intended use of the land area after mitigation, construction costs, physical site constraints, and subsurface conditions. In some cases, a combination of these stabilization measures is needed to obtain an adequate Factor of Safety against movement. A brief overview of these approaches and their relevance to the subject levee is provided below.

8.3.1.1 Slope Grading

Removal or flattening of unstable slope materials is typically effective in stabilizing slopes. At the subject site, we expect that this slope grading would be relatively inexpensive and easy to construct. For the present study, flattening the existing slopes would be a viable option

provided that there is cooperation with the WWTP and golf course with respect to access and slope grading on their property.

8.3.1.2 Structural Stabilization

Structural elements, although effective, are commonly an expensive approach to stabilize slopes. However, structural elements enable construction of steeper slopes and do not require significant quantities of soil for import or export. Of the structural elements commonly used for slope stabilization, a reinforced earth slope is likely to be very effective. However, in addition to being costly, this approach would also involve a substantial amount of slope grading.

8.3.1.3 Material Strengthening

A material-strengthening approach, such as soil cement is appropriate for strengthening the embankment fill along the landside slope. However, such methods often require large staging areas to mix the soil with cement, and would involve significant slope grading. Hence, material strengthening is not likely to be cost-effective to remediate the subject slopes.

8.3.2 Selected Remedial Alternative

We consider the slope grading option to be the most appropriate mitigation option since it is the most cost-effective and satisfies all of the general criteria outlined in Section 8.1.1 as well as the site-specific project constraints identified in Section 8.3.1.

8.3.3 Analysis of Remedial Conceptual Design

The proposed slope grading in the areas of Sections C-C and D-D should initially consist of engineered fill placement along the top of the levee up to an elevation of at least 3 feet above the design flood elevation. The riverside slope gradients for the new fill may remain the same as the existing gradients. Following the fill placement, the landside slope should be re-graded to a gradient no steeper than 2.7:1 (H:V). The riverside slope gradient should remain the same as the existing gradient. The remedial conceptual design for Sections C-C and D-D are shown in Figures 10 and 11, respectively. Seepage analyses were performed on the remedial sections, and the results are presented in Appendix E.

The results of the stability analyses for each loading condition of Sections C-C and D-D are summarized in Table 4, and the graphical results are shown in Appendix F. The calculated minimum Factors of Safety were compared to stability criteria outlined in Section 6.3.

Based on the results of the analyses, the conceptual remedial design for Sections C-C and D-D meet the long-term steady state seepage minimal acceptance criterion (i.e., FS ≥ 1.4), and the rapid drawdown acceptance criterion (FS ≥ 1.0). Lastly, minimum factors of safety on

the landside and riverside slopes varied from 1.27 to 1.92 for the seismic loading condition. Based on the results of the seismic slope stability analyses, we expect that the amount of displacement during the design earthquake will be less than six inches.

9.0 LIMITATIONS

In the performance of its professional services, AMEC, its employees, and its agents comply with the standards of care and skill ordinarily exercised by members of our profession practicing in the same or similar localities. This report may not provide all the subsurface information that may be needed by other parties for evaluation or construction of any particular project. No warranty, either express or implied, is made or intended in connection with the work performed by us, or by the proposal for consulting or other services, or by the furnishing of oral or written reports or findings. In the event that conclusions or recommendations based on data in this report are made by others, such conclusions and recommendations are not our responsibility unless we have been given an opportunity to review, and we concur in writing with, such conclusions or recommendations.

In presenting data generated or collected by others, AMEC does not warrant or in any other way attest to the accuracy or applicability of the data. Locations of previous explorations by others have been approximated based upon figures provided in reproduced reports, and in many cases do not provide sufficient information or detail for accurate or precise locating of the explorations. As such, locations should be considered approximate. Additionally, the locations are approximated from reports prepared by others; AMEC does not warrant or in any other way attest to the accuracy of the locations.

The scope of work for this study did not include an environmental assessment or investigation for the presence of natural or man-made contaminants in the soil, bedrock, or groundwater. No inference of such conditions should be made from information contained in this report.

10.0 REFERENCES

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TABLES

TABLE 1

DOCUMENTS REVIEWED
Geotechnical Investigation Report
Tahquitz Creek Levee System
Palm Springs, California

Date	Author	Document	Description
03/28/1979	Riverside County Flood Control and Water Conservation District	Letter to City of Palm Springs	Initial Review of Bogie Road Bridge Design
07/05/1979	Riverside County Flood Control and Water Conservation District	Letter to S&T Western	Request for Additional Information
02/14/1980	Riverside County Flood Control and Water Conservation District	Letter to City of Palm Springs	Comments Regarding Bogie Road Bridge and North Creek Levee Design
07/02/1980	S&T Western, Inc.	Excerpt from Letter to City of Palm Springs	Bridge and Levee Costs
12/09/1980	City of Palm Springs	Letter to Riverside County Flood Control and Water Conservation District	Request for Design Review
03/11/1981	Riverside County Flood Control and Water Conservation District	Encroachment Permit	Levee Construction Details
03/12/1981	S&T Western, Inc.	Gene Autry Trail Bridge Levee Construction Sheets 37 through 41	Design Drawings
08/12/1981	City of Palm Springs	Letter to Riverside County Flood Control and Water Conservation District	Levee Design
09/21/1981	Leighton and Associates	Geotechnical Investigation Report	City Project 76-47, Bogie Road Bridge Project, North Levee, Palm Springs
09/23/1981	Leighton and Associates	Letter to City of Palm Springs	Summary of Geotechnical Investigation
09/23/1981	S&T Western, Inc.	Letter to City of Palm Springs	Response to Geotechnical Investigation
09/24/1981	City of Palm Springs	Letter to General Contractor	Resume Work
09/25/1981	City of Palm Springs	Letter to Riverside County Flood Control and Water Conservation District	Rejection of Remedial Work
09/28/1981	City of Palm Springs	Memorandum	History of events according to City employee
09/28/1981	City of Palm Springs	Letter to General Contractor	Explanation of Stop Work order and compaction related issues
10/19/1981	S&T Western, Inc.	Letter to Leighton and Associates	Comments on Concrete Compression Test Results
02/12/1982	City of Palm Springs	Letter to Dames and Moore	Clarification of Rip-rap flood protection along east side of Demuth Park
11/10/1982	City of Palm Springs	Letter to S&T Western	Dispute resolution meeting
03/31/1983	City of Palm Springs	Letter to S&T Western	Response to Request for Additional Change Order Approval
04/06/1983	City of Palm Springs	Letter to General Contractor	Concrete liner As-Built Construction Deficiencies
04/15/1983	Leighton and Associates	Summary Letter	Bogie Road Bridge - North Channel Lining Coring
04/22/1983	S&T Western, Inc.	Letter to City of Palm Springs	Notice of Intent to Terminate Services
05/04/1983	City of Palm Springs	Letter to S&T Western	Response to S&T's letter dated April 22, 1983
07/18/2008	DMC Design Group	Final Storm Drain Report	Design Drawings and Report
04/22/2009	Nolte Associates, Inc.	Design Spreadsheet and Cross Section Location Plan (via email)	Nolte Cross Sections, Flood Loading Elevations and Rock Sizing

TABLE 2

SUMMARY OF LABORATORY TESTING PROGRAM (GEOTEK)

Geotechnical Investigation Report
Tahquitz Creek Levee System
Palm Springs, California

Boring No.	Sample No.	Sample Depth (feet)	Sample type[1]	Unified Soil Classification System (USCS)		Moisture Content (ASTM[2] D2216) (%)	Dry Density (ASTM D2216) (pcf)	Sieve Analysis (ASTM D422)			Hydrometer (ASTM D422)	Atterberg Limits (ASTM D4318)		Modified Compaction (ASTM D1557)		Direct Shear (ASTM D3080)			
				Group Name	Group Symbol			% Gravel	% Sand	% Fines		LL:PL:PI	Group Symble of Fines	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	c (peak) (psf)	ϕ (peak) (degrees)	c (Ultimate) (psf)	ϕ (Ultimate) (degrees)
B-1	1	3.0-3.5	Mod-Cal	POORLY GRADED SAND with SILT	SP-SM	4.4	112.3												
	2	5.5-6.0	SPT	POORLY GRADED SAND with SILT	SP-SM			8	83	9									
	3	8.0-8.5	Mod-Cal	POORLY GRADED SAND with SILT	SP-SM	1.7	105.7												
	4	10.5-11.0	SPT	POORLY GRADED SAND	SP			2	95	3									
	5	13.0-13.5	Mod-Cal	POORLY GRADED SAND	SP	2.0	103.1												
	6	15.5-16.0	SPT	POORLY GRADED SAND with SILT	SP-SM	3.5		1	89	10									
	7	20.5-21.0	Mod-Cal	POORLY GRADED SAND with SILT	SP-SM	3.0	103.2												
	9	30.5-31.0	Mod-Cal	SILT	ML	34.1	89.0					38:31:7	ML						
B-2	2	5.5-6.0	Mod-Cal	POORLY GRADED SAND	SP	2.0	104.8												
	3	8.0-8.5	SPT	POORLY GRADED SAND	SP			3	95	2									
	4	10.5-11.0	Mod-Cal	SILTY SAND	SM	3.9	101.4												
	6	15.5-16.0	Mod-Cal	SILTY SAND	SM	2.9	105.0												
	8	25.5-26.0	Mod-Cal	SILTY SAND	SM	2.3	103.7												
	9	30.5-31.0	SPT	SILT	ML				15	85	23% Silt, 62% Clay	31:25:6	ML						
B-3	1	3.0-3.5	Mod-Cal	SILTY SAND	SM	5.4		5	78	16									
	3	8.0-8.5	Mod-Cal	SILTY SAND	SM	5.4	89.6												
	4	10.5-11.0	SPT	POORLY GRADED SAND	SP			1	95	4									
		10.0-15.0	BULK	SILTY SAND	SM									117.0	13.5				
	5	13.0-13.5	Mod-Cal	SILTY SAND	SM	3.8	106.0											160	33
	7	20.5-21.0	Mod-Cal	SILTY SAND	SM	5.6	109.0												
	9	30.5-31.0	Mod-Cal	SILTY SAND	SM	31.4	91.0		59	41	28% Silt, 12% Clay								
B-4	1	2.5-3.0	SPT	WELL GRADED SAND with SILT	SW-SM			7	86	7									
	2	5.5-6.0	Mod-Cal	WELL GRADED SAND with SILT	SW-SM	3.3	102.5												
	3	8.0-8.5	SPT	POORLY GRADED SAND	SP			3	93	4									
	4	10.5-11.0	Mod-Cal	SILTY SAND	SM	4.8	97.8												
	5	13.0-13.5	SPT	POORLY GRADED SAND	SP			4	93	3									
	6	15.5-16.0	Mod-Cal	SILTY SAND	SM	4.3	104.2												
	8	25.5-26.0	Mod-Cal	SILTY SAND	SM	2.5	111.0												
B-5	1	3.0-3.5	Mod-Cal	POORLY GRADED SAND with SILT	SP-SM	4.9	112.2												
	2	5.5-6.0	SPT	POORLY GRADED SAND with SILT	SP-SM			5	90	5									
	3	8.0-8.5	Mod-Cal	POORLY GRADED SAND	SP	5.8	111.2												
	4	10.5-11.0	SPT	POORLY GRADED SAND with SILT	SP-SM			1	93	6									
	5	13.0-13.5	Mod-Cal	POORLY GRADED SAND with SILT	SP-SM	6.3	104.0												
	7	20.5-21.0	Mod-Cal	SILTY SAND	SM	4.1	104.4											0	36
	9	30.5-31.0	Mod-Cal	SILTY SAND	SM	4.5	104.1												
B-6	3	8.0-8.5	Mod-Cal	SILTY SAND	SM	3.1	103.6												
	5	13.0-13.5	Mod-Cal	SILTY SAND	SM	3.9	99.2												
	7	20.5-21.0	Mod-Cal	SILTY SAND	SM	2.0	111.8												
	9	30.5-31.0	Mod-Cal	LEAN CLAY with SAND / SILT with SAND	ML-CL	21.7	104.1	3	18	79	21% Silt, 60% Clay	25:21:4	ML-CL						
B-7	1	3.0-3.5	Mod-Cal	SILTY SAND	SM	5.5	119.2												
	2	5.5-6.0	SPT	POORLY GRADED SAND with SILT	SP-SM			6	87	7									
	3	8.0-8.5	Mod-Cal	POORLY GRADED SAND	SP	4.1	99.6											130	31
	4	10.5-11.0	SPT	POORLY GRADED SAND	SP			1	98	2									
	5	13.0-13.5	Mod-Cal	POORLY GRADED SAND	SP	2.9	102.3												
	7	20.5-21.0	Mod-Cal	SILTY SAND	SM	2.3	114.4												
	9	30.5-31.0	Mod-Cal	SILTY SAND	SM	3.2	124.3												

TABLE 2

SUMMARY OF LABORATORY TESTING PROGRAM (GEOTEK)

Geotechnical Investigation Report
Tahquitz Creek Levee System
Palm Springs, California

Boring No.	Sample No.	Sample Depth (feet)	Sample type[1]	Unified Soil Classification System (USCS)		Moisture Content (ASTM[2] D2216) (%)	Dry Density (ASTM D2216) (pcf)	Sieve Analysis (ASTM D422)			Hydrometer (ASTM D422)	Atterberg Limits (ASTM D4318)		Modified Compaction (ASTM D1557)		Direct Shear (ASTM D3080)			
				Group Name	Group Symbol			% Gravel	% Sand	% Fines		LL:PL:PI	Group Symble of Fines	Maximum Dry Density (pcf)	Optimum Moisture Content (%)	c (peak) (psf)	ϕ (peak) (degrees)	c (Ultimate) (psf)	ϕ (Ultimate) (degrees)
B-8	1	3.0-3.5	SPT	POORLY GRADED SAND with SILT	SP-SM			1	89	10									
	2	5.5-6.0	Mod-Cal	SILTY SAND	SM	5.7	108.1											380	24
	3	8.0-8.5	SPT	POORLY GRADED SAND With SILT	SP-SM			3	92	5									
	4	10.5-11.0	Mod-Cal	POORLY GRADED SAND With SILT	SP-SM	7.5	104.6												
	6	15.5-16.0	Mod-Cal	SILTY SAND	SM	3.5	97.3												
	8	25.5-26.0	Mod-Cal	SILTY SAND	SM	18.7	104.9												
B-9	1	3.0-3.5	Mod-Cal	SILTY SAND	SM	5.1	116.9												
	2	5.5-6.0	SPT	POORLY GRADED SAND	SP			4	91	5									
	3	8.0-8.5	Mod-Cal	SILTY SAND	SM	3.7	100.3												
	4	10.5-11.0	SPT	POORLY GRADED SAND	SP			1	96	3									
	5	13.0-13.5	Mod-Cal	SILTY SAND	SM	2.7	101.1												
	7	20.5-21.0	Mod-Cal	SILTY SAND	SM	3.5	119.9												
	8	25.5-26.0	Mod-Cal	SILTY SAND	SM			8	80	12									
	9	30.5-31.0	Mod-Cal	SILTY SAND	SM	6.0	107.1												
B-10	2	5.5-6.0	Mod-Cal	SILTY SAND	SM	1.5	105.3												
	6	15.5-16.0	Mod-Cal	SILTY SAND	SM	2.3	103.0												
	8	25.5-26.0	Mod-Cal	SILTY SAND	SM	4.4	109.4												
	9	30.5-31.0	Mod-Cal	SILTY SAND	SM	3.6	121.5												
HA-1		1.0-4.0	BULK	POORLY GRADED SAND with SILT	SP-SM			1	93	6									
HA-2		1.0-4.0	BULK	POORLY GRADED SAND with GRAVEL	SP			16	80	4									
HA-3		1.0-4.0	BULK	SILTY SAND	SM			2	85	13									
HA-4		1.0-4.0	BULK	POORLY GRADED SAND with SILT	SP-SM			1	87	12									

Notes:

1. Mod Cal - Modified California sampler - 2.5-inch inside diameter, 3-inch outside diameter.
   SPT - Standard Penetration Test sampler - 1.4-inch inside diameter, 2-inch outside diameter.
   Bulk - Bulk sample.

2. ASTM - ASTM International Standard.

TABLE 4
SUMMARY OF SLOPE STABILITY RESULTS (REMEDIAL CONCEPTUAL DESIGN)
Geotechnical Investigation Report
Tahquitz Creek Levee System
Palm Springs, California

CROSS SECTION	FACTORS OF SAFETY				
	Static			Seismic[1]	
	Long Term with Seepage Landside	Long Term with Seepage Riverside	Rapid Drawdown	Landside	Riverside
C-C'	1.40	5.13	1.81	1.32	1.92
D-D'	1.41	4.22	1.23	1.27	1.72

Note:
1. Based on the Stewart et al screening method (2003) with a calculated "k" coefficient = 0.23.

FIGURES

Basemap modified from Google Earth, aerial photograph dated 2007

Approximate Scale in Feet

0 1000 2000

0 300 600

Approximate Scale in Meters

SITE LOCATION MAP
Tahquitz Creek Levee System
Palm Springs, California

By: kle	Date: 08/25/09	Project No. 13203.001.0
AMEC Geomatrix		Figure 1

Plot Date: 08/25/09 - 1:27pm, Plotted by: pat.herring
Drawing Path: Y:\13203.001.0\ACAD\, Drawing Name: Tahquitz_site_loc_tb.dwg

Basemap modified from Google Earth, aerial photograph dated 2007

Explanation

B-10 ● Approximate boring location and designation

HA-04 ○ Approximate location and designation of hand auger boring

D D' Cross section location

Approximate Scale in Feet
0 250 500
0 75 150
Approximate Scale in Meters

BORING LOCATION MAP
Tahquitz Creek Levee System
Palm Springs, California

By: kle	Date: 08/27/09	Project No. 13203.001.0
AMEC Geomatrix		Figure 2

Plot Date: 08/25/09 - 1:25pm, Plotted by: pat.herring
Drawing Path: Y:\13203.001.0\ACAD\, Drawing Name: Tahquitz_Levee_tb.dwg

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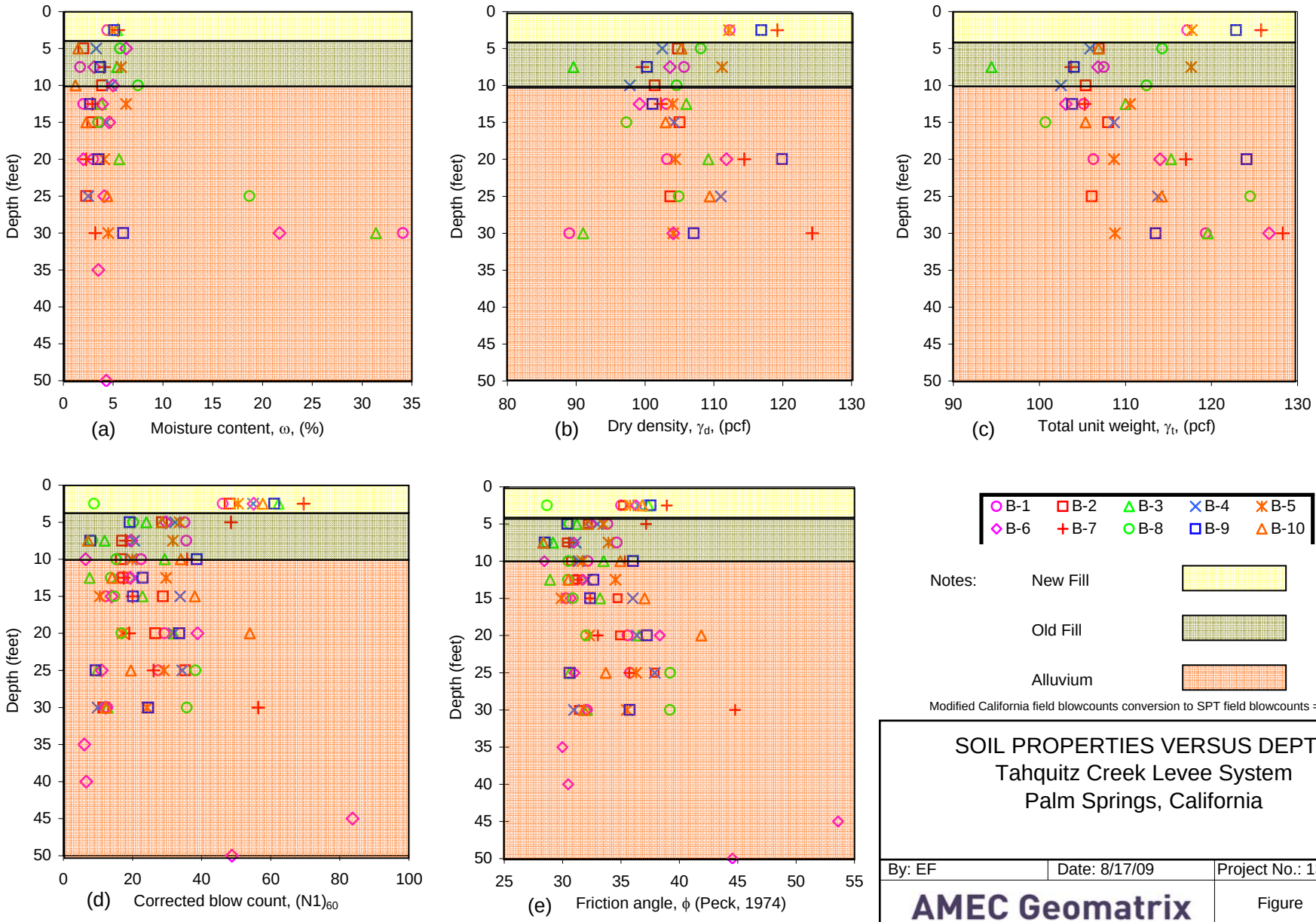
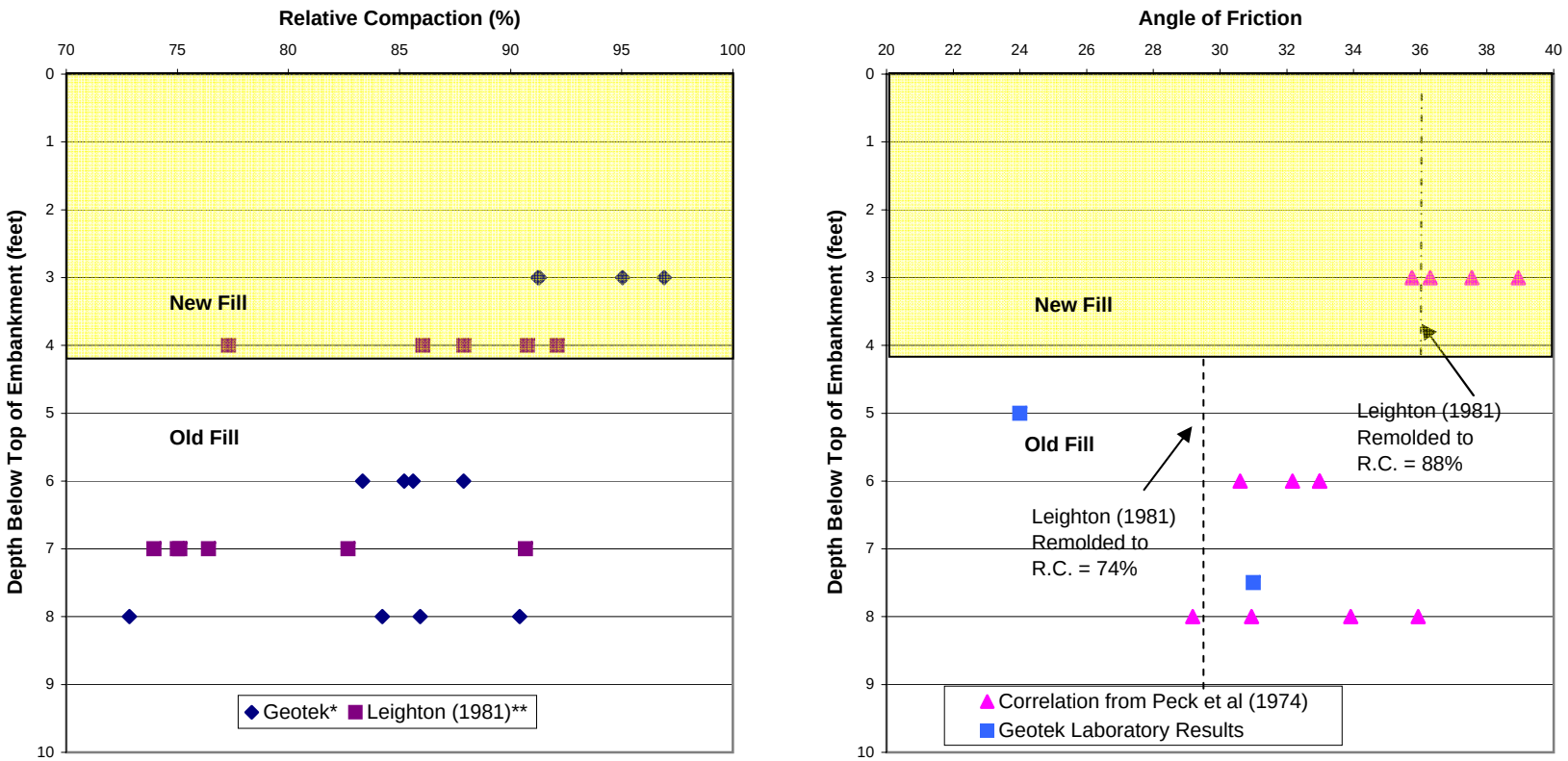


SOIL PROPERTIES VERSUS DEPTH
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure 3

P:\13203.000.0\13203.001\Docs\FINAL Geotechnical Investigation Report\Figures\Figures 3-4.xls



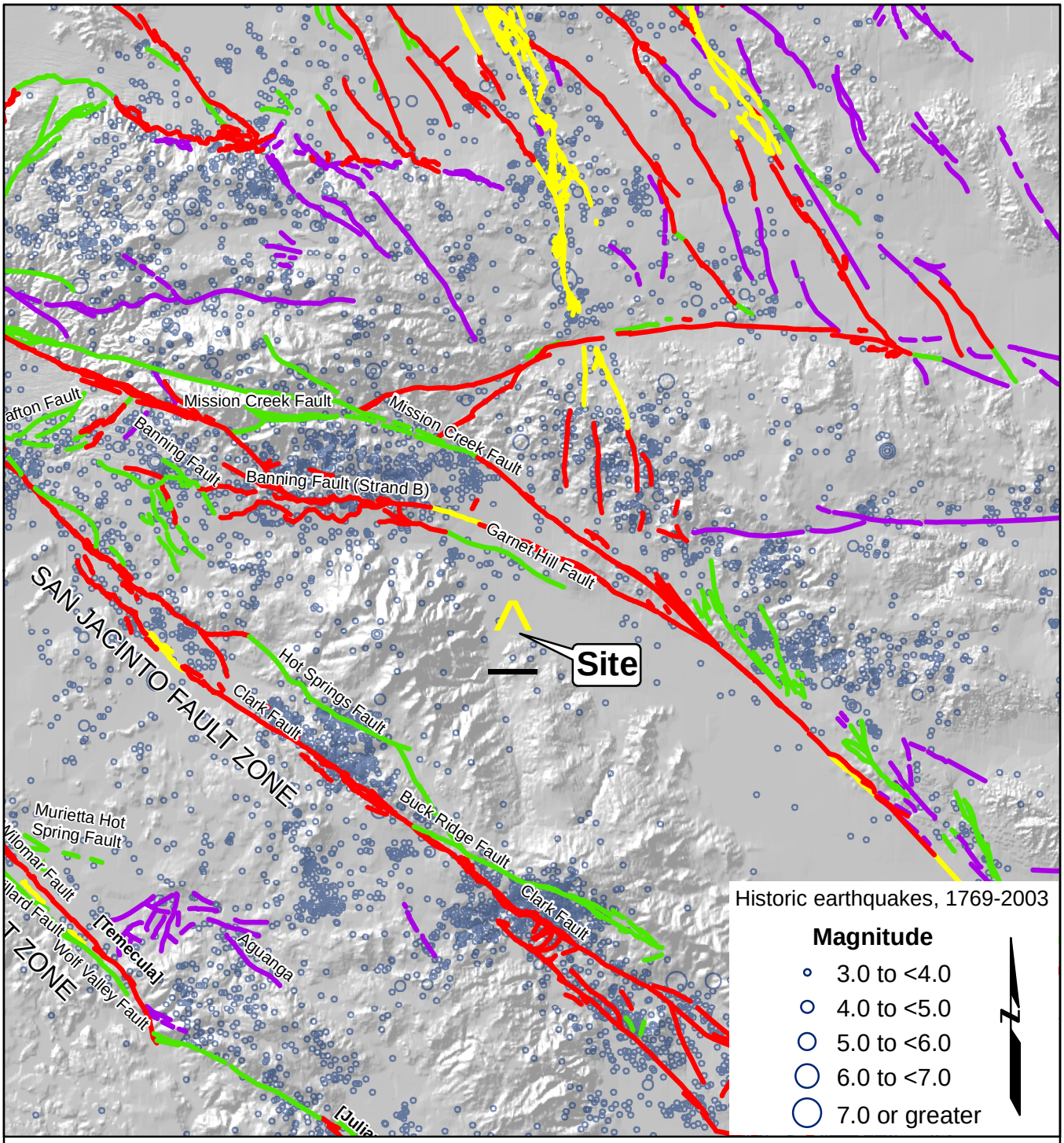
Maximum Dry Density Based on Laboratory Compaction Curves (ASTM D1557)

* Based on Dry Density Laboratory Test Results (ASTM D2216 & 2937)

** Based on Nuclear Gauge and Sand Cone Test Results (ASTM D1556-64)

SOIL PROPERTIES OF EMBANKMENT FILL
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001
AMEC Geomatrix		Figure 4



Explanation

Fault Recency Classification (Jennings, 1994)

- Faults that displace Holocene (~10 ka) deposits or geomorphic surfaces
- Faults with historic surface rupture or creep
- Faults that displace late Quaternary (~700 ka) deposits or geomorphic surfaces
- Quaternary faults; show evidence for displacement within past 1.6 Million years

[Anza] Fault Segments

Note: See text of report for description of seismicity catalog.

0 5 10 15 Kilometers

Surface fault traces from Jennings, 1994

REGIONAL FAULT MAP
Tahquitz Creek Levee System
Palm Springs, California

By: pah	Date: 08/25/09	Project No.13203.001.0
AMEC Geomatrix		Figure 5

Y:\oakland_faults\13203001_fault_map.mxd

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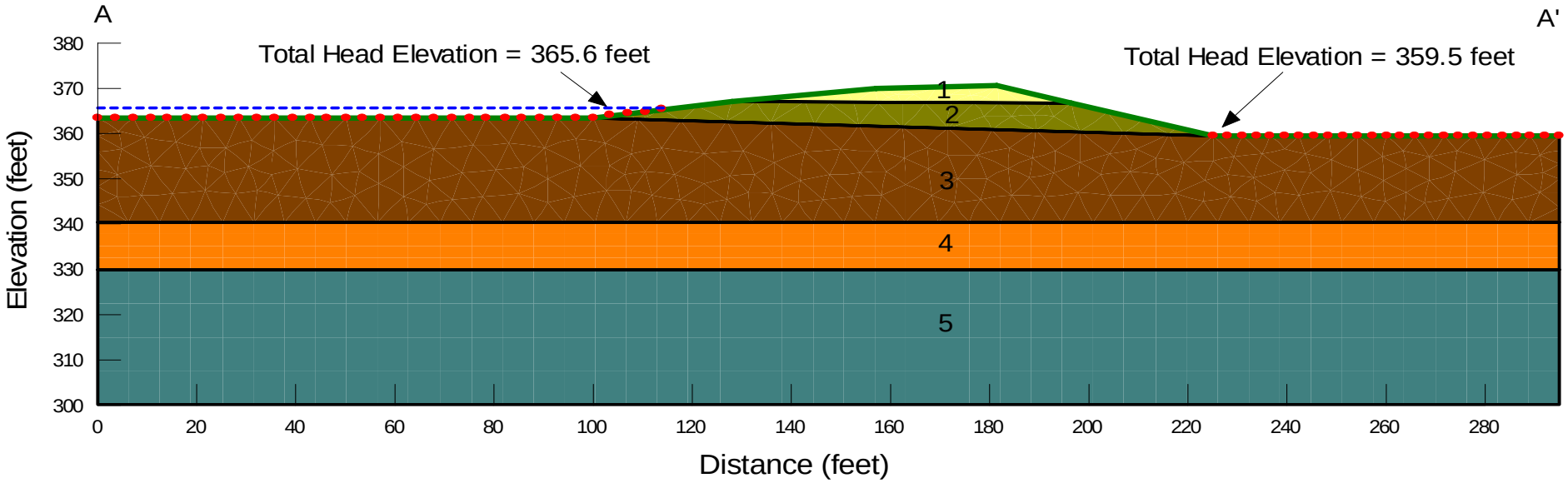
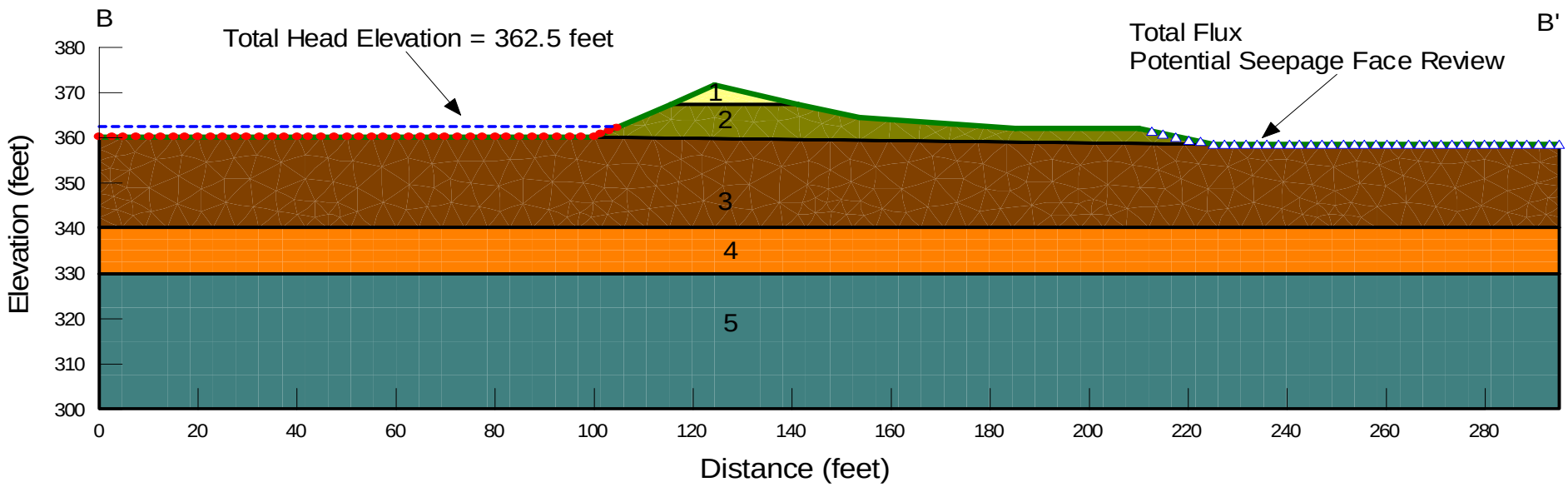


SOIL PROPERTIES						
Material	Soil Description	Soil Type	γ_t (pcf)	ϕ (degrees)	c (psf)	k_v (ft/s)
1	Upper Embankment Fill	SP-SM	120	36	50	6.0E-05
2	Lower Embankment Fill	SP-SM	110	29	50	3.0E-04
3	Alluviual Sand	SP-SM	110	31	0	3.0E-04
4	Alluvial Silt	ML	120	25	0	3.0E-07
5	Alluvial Silty Sand	SM	110	30	50	5.0E-06

● Total head elevation boundary

CRITICAL CROSS SECTION A-A'
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure 6



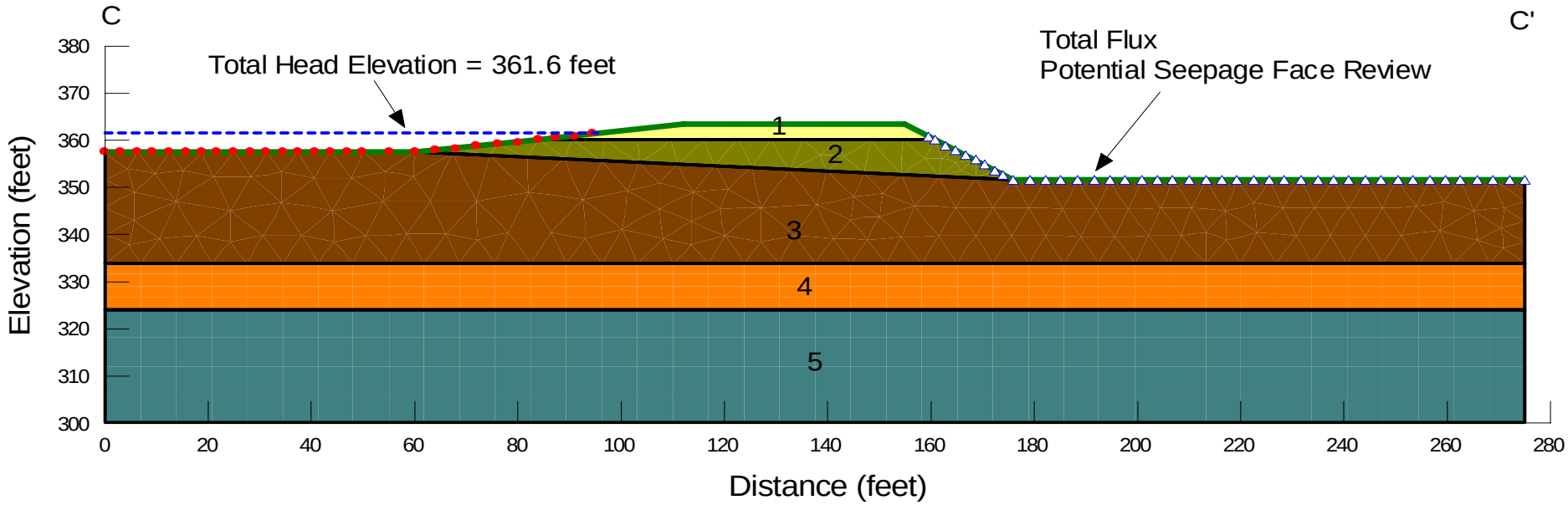
SOIL PROPERTIES						
Material	Soil Description	Soil Type	γ_t (pcf)	ϕ (degrees)	c (psf)	k_v (ft/s)
1	Upper Embankment Fill	SP-SM	120	36	50	6.0E-05
2	Lower Embankment Fill	SP-SM	110	29	50	3.0E-04
3	Alluviual Sand	SP-SM	110	31	0	3.0E-04
4	Alluvial Silt	ML	120	25	0	3.0E-07
5	Alluvial Silty Sand	SM	110	30	50	5.0E-06

● Total head elevation boundary

△ Potential seepage face review boundary

CRITICAL CROSS SECTION B-B'
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure 7



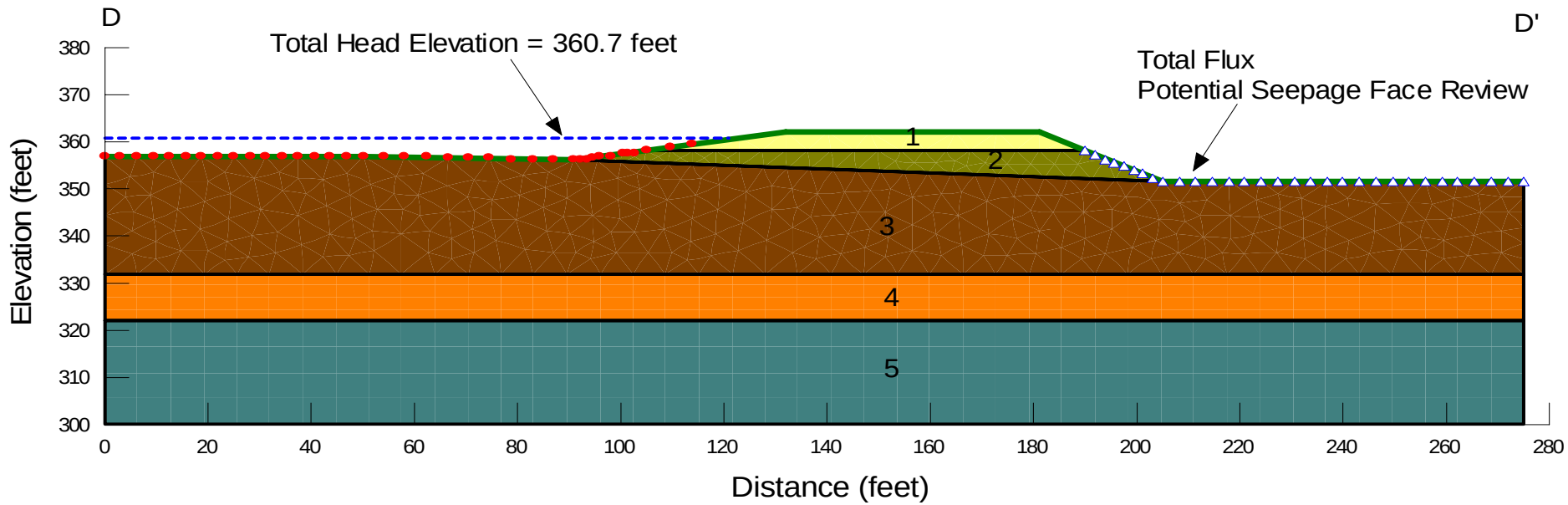
SOIL PROPERTIES						
Material	Soil Description	Soil Type	γ_t (pcf)	ϕ (degrees)	c (psf)	k_v (ft/s)
1	Upper Embankment Fill	SP-SM	120	36	50	6.0E-05
2	Lower Embankment Fill	SP-SM	110	29	50	3.0E-04
3	Alluviual Sand	SP-SM	110	31	0	3.0E-04
4	Alluvial Silt	ML	120	25	0	3.0E-07
5	Alluvial Silty Sand	SM	110	30	50	5.0E-06

● Total head elevation boundary

△ Potential seepage face review boundary

CRITICAL CROSS SECTION C-C'
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure 8



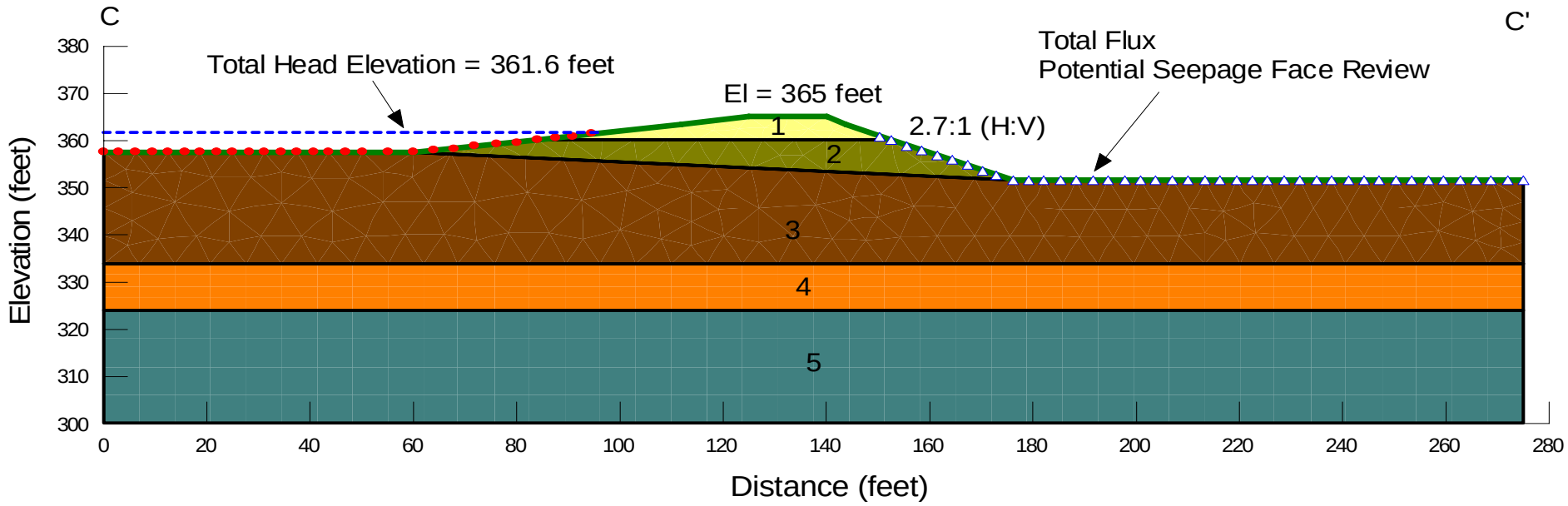
SOIL PROPERTIES						
Material	Soil Description	Soil Type	γ_t (pcf)	ϕ (degrees)	c (psf)	k_v (ft/s)
1	Upper Embankment Fill	SP-SM	120	36	50	6.0E-05
2	Lower Embankment Fill	SP-SM	110	29	50	3.0E-04
3	Alluviual Sand	SP-SM	110	31	0	3.0E-04
4	Alluvial Silt	ML	120	25	0	3.0E-07
5	Alluvial Silty Sand	SM	110	30	50	5.0E-06

● Total head elevation boundary

△ Potential seepage face review boundary

CRITICAL CROSS SECTION D-D'
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure 9



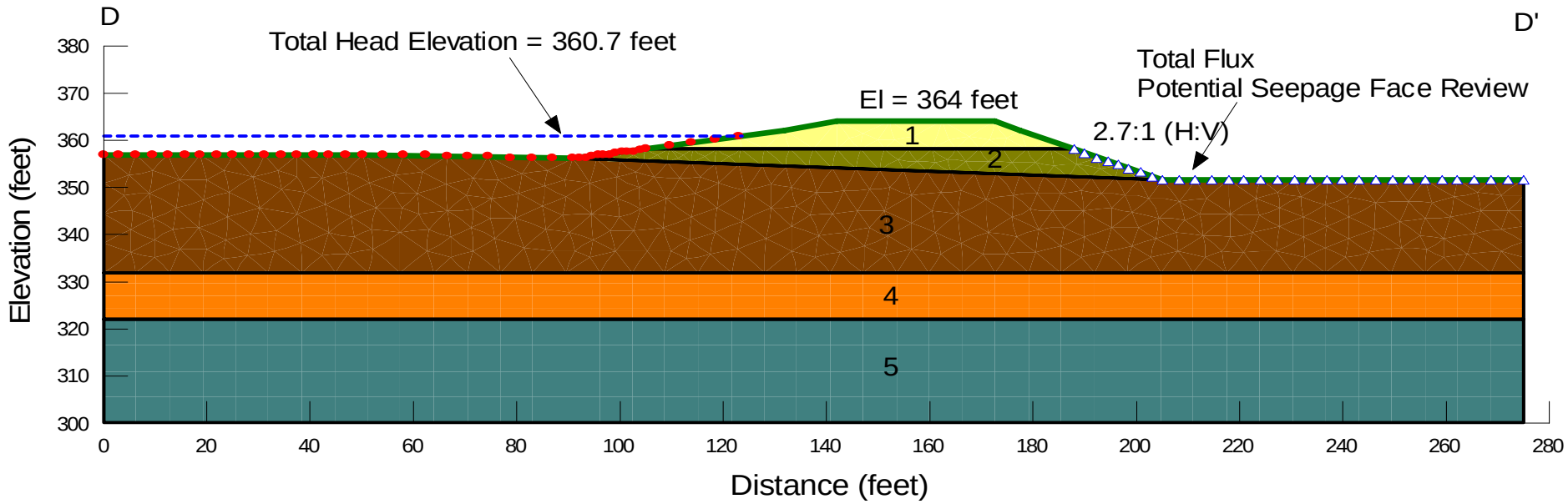
SOIL PROPERTIES						
Material	Soil Description	Soil Type	γ_t (pcf)	ϕ (degrees)	c (psf)	k_v (ft/s)
1	Upper Embankment Fill	SP-SM	120	36	50	6.0E-05
2	Lower Embankment Fill	SP-SM	110	29	50	3.0E-04
3	Alluviual Sand	SP-SM	110	31	0	3.0E-04
4	Alluvial Silt	ML	120	25	0	3.0E-07
5	Alluvial Silty Sand	SM	110	30	50	5.0E-06

● Total head elevation boundary

△ Potential seepage face review boundary

CRITICAL CROSS SECTION C-C'
REMEDIAL CONCEPTUAL DESIGN
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure 10



SOIL PROPERTIES						
Material	Soil Description	Soil Type	γ_t (pcf)	ϕ (degrees)	c (psf)	k_v (ft/s)
1	Upper Embankment Fill	SP-SM	120	36	50	6.0E-05
2	Lower Embankment Fill	SP-SM	110	29	50	3.0E-04
3	Alluviual Sand	SP-SM	110	31	0	3.0E-04
4	Alluvial Silt	ML	120	25	0	3.0E-07
5	Alluvial Silty Sand	SM	110	30	50	5.0E-06

● Total head elevation boundary

△ Potential seepage face review boundary

CRITICAL CROSS SECTION D-D'
REMEDIAL CONCEPTUAL DESIGN
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure 11

APPENDIX A

Summary of Field Inspection and Photographs

TABLE A-1
SUMMARY OF TAHQUITZ CREEK LEVEE FIELD INSPECTION[1]

Geotechnical Investigation Report
Tahquitz Creek Levee System
Palm Springs, California

Rated Item	Rating[2]	Rating Guidelines[3]	Location/Remarks/ Recommendations
1 Unwanted Vegetation Growth[4]	A	The levee has little or no unwanted vegetation (trees, bush, or undesirable weeds), except for vegetation that is properly contained and/or situated on overbuilt sections, such that the mandatory 3-foot root-free zone is preserved around the levee profile. The levee has been recently mowed. The vegetation-free zone extends 15 feet from both the landslide and riverside toes of the levee to the centerline of the tree. If the levee access easement doesn't extend to the described limits, then the vegetation-free zone must be maintained to the easement limits. Reference EM 1110-2-301 or Corps policy for regional vegetation variance.	**RATING: U** Significant amount of brush, weeds, and trees along landside of levee slopes near pond and wastewater treatment facility (Photos 12 and 13) Trees along riverside slopes in west area of levee (Photo 14)
	M	Minimal vegetation growth (brush, weeds, or trees 2 inches in diameter or smaller) is present within the zones described above. This vegetation must be removed but does not currently threaten the operation or integrity of the levee.	
	U	Significant vegetation growth (brush, weeds, or any trees greater than 2 inches in diameter) is present within the zones described above and must to be removed to reestablish or ascertain levee integrity.	
2 Sod Cover	A	There is good coverage of sod over the levee.	**N/A**
	M	Approximately 25% of the sod cover is missing or damaged over a significant portion or over significant portions of the levee embankment. This may be the result of over-grazing or feeding on the levee, unauthorized vehicular traffic, chemical or insect problems, or burning during inappropriate seasons.	
	U	Over 50% of the sod cover is missing or damaged over a significant portion or portions of the levee embankment.	
	N/A	Surface protection is provided by other means.	
3 Encroachments	A	No trash, debris, unauthorized farming activity, structures, excavations, or other obstructions present within the easement area. Encroachments have been determined to not diminish proper functioning of the levee.	**RATING: M** Golf course irrigation lines (Photo 15), Light poles along toe of landside slopes (Photo 16), Grading of landside slopes at SE end associated with storm drain installation (Photos 17 and 18)
	M	Trash, debris, unauthorized farming activity, structures, excavations, or other obstructions present, or inappropriate activities noted that should be corrected but will not inhibit operations and maintenance or emergency operations.	
	U	Unauthorized encroachment or inappropriate activities noted are likely to inhibit operations and maintenance, emergency operations, or negatively impact the integrity of the levee.	
4 Closure Structures (Stop Log, Earthen Closures, Gates, or Sandbag Closures) (A or U only)	A	Closure structure in good repair. Placing equipment, stoplogs, and other materials are readily available at all times. Components are clearly marked and installation instructions/procedures readily available. Trial erections have been accomplished in accordance with the O&M Manual.	**N/A**
	U	Any of the following issues is cause for this rating: Closure structure in poor condition. Parts missing or corroded. Placing equipment may not be available within the anticipated warning time. The storage vaults cannot be opened during the time of inspection. Components of closure are not clearly marked and installation instructions/procedures are not readily available. Trial erections have not been accomplished in accordance with the O&M Manual.	
	N/A	There are no closure structures along this component of the FDR system.	

TABLE A-1
SUMMARY OF TAHQUITZ CREEK LEVEE FIELD INSPECTION[1]

Tahquitz Creek Levee System
Palm Springs, California

Rated Item	Rating[2]	Rating Guidelines[3]	Location/Remarks/ Recommendations
5 Slope Stability	A	No slides, sloughs, tension cracking, slope depressions, or bulges are present.	**RATING: M** Refer to results of Slope Stability Analyses in Geotechnical Report
	M	Minor slope stability problems that do not pose an immediate threat to the levee embankment.	
	U	Major slope stability problems (ex. deep seated sliding) identified that must be repaired to reestablish the integrity of the levee embankment.	
6 Erosion/Bank Caving	A	No erosion or bank caving is observed on the landward or riverward sides of the levee that might endanger its stability.	**RATING: U** Stn 4+25 Riverside slope (Photo 7), Stn 24+20 Landside Slope (Photo 3), Stn 25+97 Riverside Slope (Photo8), Stn 33+42 Fence top of levee (Photo 4), Animal Burrows (erosion?) (Photos 5 and 6)
	M	There are areas where minor erosion is occurring or has occurred on or near the levee embankment, but levee integrity is not threatened.	
	U	Erosion or caving is occuring or has occurred that threatens the stabiliity and integrity of the levee. The erosion or caving has progress into the levee section or into the enxtended footprint of the levee foundation and has compromised the levee foundation stability.	
7 Settlement[5]	A	No observed depressions in crown. Records exist and indicate no unexplained historical changes.	**RATING: A**
	M	Minor irregularities that do not threaten integrity of levee. Records are incomplete or inclusive.	
	U	Obvious variations in elevation over significant reaches. No records exist or records indicate that design elevation is compromised.	
8 Depressions/ Rutting	A	There are scattered, shallow ruts, pot holes, or other depressions on the levee that are unrelated to levee settlement. The levee crown, embankments, and access road crowns are well established and drain proerly without any ponded water.	**RATING: M** Stn 22+61 Evidence of water ponding on top of levee (Photo 11)
	M	There are some infrequent minor depressions less than 6 inches deep in the levee crown, embankment, or access roads that will pond water.	
	U	There are depressions greater than 6 inches deep that will pond water.	
9 Cracking	A	Minor longitudinal, transverse, or desiccation cracks with no vertical movement along the crack. No cracks extend continuously through the levee crest.	**RATING: A**
	M	Longitudinal and/or transverse cracks up to 6 inches in depth with no vertical movement along the crack. No cracks extend continuously through the levee crest. Longitudinal cracks are no longer then the height of the levee.	
	U	Cracks exceed 6 inches in depth. Longitudinal cracks are longer than the height of the levee and/or exhibit vertical movement along the crack. Transverse cracks extend through the entire levee width.	

TABLE A-1
SUMMARY OF TAHQUITZ CREEK LEVEE FIELD INSPECTION[1]

Tahquitz Creek Levee System
Palm Springs, California

Rated Item	Rating[2]	Rating Guidelines[3]	Location/Remarks/ Recommendations
10 Animal Control	A	Continuous animal burrow control program in place that includes the elimination of active burrowing and the filling in of existing burrows.	**RATING: U** Evidence of animal burrows in west area of levee (Photos 9 and 10)
	M	The existing animal burrow control program needs to be improved. Several burrows are present which may lead to seepage or slope stability problems, and they require immediate attention.	
	U	Animal burrow control program is not effective or is nonexistent. Significant maintenance is required to fill existing burrows, and the levee will not provide reliable flood protection until this maintenance is complete.	
11 Culverts/Discharge Pipes[6]	A	There are no breaks, holes, cracks in the discharge pipes/culverts that would result in significant water leakage. The pipe shape is still essentially circular. All joints appear to be closed and the soil tight. Corrugated metal pipes, if present, are in good condition with 100% of the original coating still in place (either asphalt or galvanizing) or have been relined with appropriate material, which is still in good condition. Condition of pipes has been verified using television camera video taping or visual inspection methods within the past 5 years, and the report for every pipe is available for review by the inspector.	**N/A**
	M	There are a small number of corrosion pinholes or cracks that could leak water and need to be repaired, but the entire length of pipe is still structurally sound and is not in danger of collapsing. Pipe shape may be ovalized in some locations but does not appear to be approaching a curvature reversal. A limited number of joints may be opened and soil loss may be beginning. Any open joints should be repaired prior to the next inspection. Corrugated metal pipes, if present, may be showing corrosion and pinholes but there are no areas with total section loss. Condition of pipes has been verified using television camera video taping or visual inspection methods within the past 5 years, and the report for every pipe is available for review by the inspector.	
	U	Culvert has deterioration and/or has significant leakage; it is in danger of collapsing or has already begun to collapse. Corrugated metal pipes have suffered 100% section loss in the invert. HOWEVER: Even if pipes appear to be in good condition, as judged by an external visual inspection, an Unacceptable Rating will be assigned if the condition of pipes has not been verified using television camer video taping or visual inspection methods within the past 5 years, and reports for all pipes are not available for review by the inspector.	
	N/A	There are no discharge pipes/culverts.	

TABLE A-1
SUMMARY OF TAHQUITZ CREEK LEVEE FIELD INSPECTION[1]

Tahquitz Creek Levee System
Palm Springs, California

Rated Item	Rating[2]	Rating Guidelines[3]	Location/Remarks/ Recommendations
12 Riprap Revetments and Bank Protection	A	No riprap displacement or stone degradation that could pose an immediate threat to the integrity of channel bank. Riprap intact with no woody vegetation present.	**N/A**
	M	Minor riprap displacement or stone degradation that could pose an immediate threat to the integrity of the channel bank. Unwanted vegetation must be cleared or sprayed with an appropriate herbicide.	
	U	Significant riprap displacement, exposure of bedding, or stone degradation observed. Scour activity is undercutting banks, eroding emankments, or impairing channel flows by causing turbulence or shoaling. Rock protection is hidden by dense brush, trees, or grasses.	
	N/A	There is no riprap protecting this feature of the system, or riprap is discussed in another section.	
13 Revetments other than Riprap	A	Existing revetment protection is properly maintained, undamaged, and clearly visible.	**RATING: U** (Revetment is Buried) Stn 5+51 Break in concrete liner about 5-inch gap, irrigation line in gap (Photo 1) Stn 38+83 Cracks in concrete liner (Photo 2)
	M	Minor revetment displacement or deterioration that does not pose an immediate threat to the integrity of the levee. Unwanted vegetation must be cleared or sprayed with an appropriate herbicide.	
	U	Significant revetment displacement, deterioration, or exposure of bedding observed. Scour activity is undercutting banks, eroding embankments, or impairing channel flows by causing turbulence or shoaling. Revetment protection is hidden by dense brush and trees.	
	N/A	There are no such revetments protecting this feature of this system.	
14 Underseepage Relief Wells/ Toe Drainage Systems	A	Toe drainage systems and pressure redlief wells necessary for maintaining FDR system stability during high water functioned properly during the last flood event and no sediment is observed in horizontal system (if applicable). Nothing is observed which would indicate that the drainage systems won't function properly during the next flood, and maintenance records indicate regular	**N/A**
	M	Toe drainage systems or pressure relief wells are damaged and may become clogged if they are not repaired. Maintenance records are incomplete or indicate irregular cleaning and pump testing.	
	U	Toe drainage systems or pressure relief wells necessary for maintaining FDR system stability during flood events have fallen into disrepair or have become clogged. No maintenance records. No documentation of the required pump testing.	
	N/A	There are no relief wells/toe drainage systems along this component of the FDR system.	
15 Seepage	A	No evidence or history of unrepaired seepage, saturated areas, or boils.	**RATING: A**
	M	Evidence or history of minor unrepaired seepage or small saturated areas at or beyond the landslide toe but not on the landward slope of levee. No evidence of soil transport.	
	U	Evidence or history of active seepage, extensive saturated areas, or boils.	

1. Levee embankment ratings taken from Flood Damage Reduction System Inspection Report by US Army Corps of Engineers.
2. Ratings: A = acceptable; M = minimally acceptable, maintenance is required; U = unacceptable; N/A = not applicable.
3. FDR = flood damage reduction.
4. If there is significant growth on the levee that inhibits the inspection of animal burrows or other items, the inspection should be ended until this item is corrected.
5. Detailed survey elevations are normally required during periodic inspections, and whenever there are obvious visual settlements.
6. The decision on whether or not USACE inspectors should enter a pipe to perform a detailed inspection must be made at the USACE District level. This decision should be made in conjunction with the District Safety Office, as pipes may be considered confined spaces. This decision should consider the age of the pipe, the diameter of the pipe, the apparent condition of the pipe, and the length of the pipe. If a pipe is entered for the purposes of inspection, the inspector should record observations with a video camera in order that the condition of the entire pipe, including all joints, can later be assessed. Additionally, the video record provides a baseline to which future inspections can be compared.

Photo 1: 5-inch space in concrete liner at Station 5+51

Photo 2: Evidence of concrete liner cracking at Station 38+83

FIELD INSPECTION
PHOTOGRAPHS
Tahquitz Creek Levee System
Palm Springs. California

By: MB	Date: 8/17/09	Project No.:13203.001.0
AMEC Geomatrix		Appendix A

Photo 3: Evidence of erosion along landside slope at Station 24+20

Photo 4: Erosion along landside slope at Station 33+42

FIELD INSPECTION
PHOTOGRAPHS
Tahquitz Creek Levee System
Palm Springs. California

By: MB	Date: 8/17/09	Project No.:13203.001.0
AMEC Geomatrix		Appendix A

Photo 5: Erosion near top of landside slope south of Demuth Park

Photo 6: Erosion near top of landside slope south of Demuth Park

FIELD INSPECTION
PHOTOGRAPHS
Tahquitz Creek Levee System
Palm Springs. California

By: MB	Date: 8/17/09	Project No.:13203.001.0
AMEC Geomatrix		Appendix A

Photo 7: Erosion along riverside slope at Station 4+25

Photo 8: Erosion along riverside slope at Station 25+97

FIELD INSPECTION
PHOTOGRAPHS
Tahquitz Creek Levee System
Palm Springs. California

By: MB	Date: 8/17/09	Project No.:13203.001.0
AMEC Geomatrix		Appendix A

Photo 9: Animal Burrow near top of landside slope south of Demuth Park

Photo 10: Animal burrow/erosion near top of landside slope south of Demuth Park

FIELD INSPECTION
PHOTOGRAPHS
Tahquitz Creek Levee System
Palm Springs. California

By: MB	Date: 8/17/09	Project No.:13203.001.0
AMEC Geomatrix		Appendix A

Photo 11: Depression area filled with ponded water at Station 22+61

Photo 12: Thick vegetation along landside slope near ponds (south of WWTP)

FIELD INSPECTION
PHOTOGRAPHS
Tahquitz Creek Levee System
Palm Springs. California

By: MB	Date: 8/17/09	Project No.:13203.001.0
AMEC Geomatrix		Appendix A

Photo 13: Thick vegetation along landside slopes near ponds (south of WWTP)

Photo 14: Trees and roots along riverside slopes

FIELD INSPECTION
PHOTOGRAPHS
Tahquitz Creek Levee System
Palm Springs. California

By: MB	Date: 8/17/09	Project No.:13203.001.0
AMEC Geomatrix		Appendix A

Photo 15: Golf course related encroachments

Photo 16: Lightpole encroachments along toe of landside slopes in Demuth Park

FIELD INSPECTION
PHOTOGRAPHS
Tahquitz Creek Levee System
Palm Springs. California

By: MB	Date: 8/17/09	Project No.:13203.001.0
AMEC Geomatrix		Appendix A

Photo 17: Storm drain installation area

Photo 18: Grading of landside slopes associated with storm drain installation

FIELD INSPECTION
PHOTOGRAPHS
Tahquitz Creek Levee System
Palm Springs. California

By: MB	Date: 8/17/09	Project No.:13203.001.0
AMEC Geomatrix		Appendix A

APPENDIX B

Field Exploration (Geotek)

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Nolte and Associates	DRILLER:	Layne Drilling	LOGGED BY:	EHL
PROJECT NAME:	Tahquitz Levee	DRILL METHOD:	8" Hollow Stem	OPERATOR:	Chon
PROJECT NO.:	0512-CR3	HAMMER:	Auto 140#/30"	RIG TYPE:	CME 75
LOCATION:	See Boring Location Map			DATE:	1/29/2009

BORING NO. B-1

Boring located roughly 200' north of Station 0+00

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
					Asphaltic Concrete: 0 to 2 inches~			
					Artificial Fill:			
		8 18 30	B1-1	SM	Silty f-m SAND (SM), light brown gray, damp to slightly moist, medium dense	4.4	112.3	
5		7 10 12	B1-2		@5', becomes moist, piece of gravel in sample			SA
		14 23 23	B1-3		Silty fine SAND (SM), light brown gray mottled, slightly moist	1.7	105.7	
10		5 8 8	B1-4	SP	**Alluvium:** f-m SAND (SP) with some silt, light gray mottled, damp, medium dense			SA
		6 9 15	B1-5		@12.5', becomes slightly moist to moist	2.0	103.1	
15		3 4 6	B1-6	SM	Silty f-m SAND (SM) with some gravel, slightly moist, loose to medium dense	3.5		SA
20		5 13 28	B1-7		Silty fine SAND (SM), light to medium gray, damp, medium dense	3.0	103.2	
25		7 11 12	B1-8		Silty f-m SAND (SM), light gray mottled, damp, medium dense			
30								Note: Reported blows were taken at 7-inch intervals for the samples shown on this log.

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Nolte and Associates	DRILLER:	Layne Drilling	LOGGED BY:	EHL
PROJECT NAME:	Tahquitz Levee	DRILL METHOD:	8" Hollow Stem	OPERATOR:	Chon
PROJECT NO.:	0512-CR3	HAMMER:	Auto 140#/30"	RIG TYPE:	CME 75
LOCATION:	See Boring Location Map			DATE:	1/29/2009

BORING NO.: *B-1(continued)*

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
30		6 11 16	B1-9	ML	**continued:** SILT (ML), medium gray, slightly moist to moist, stiff	34.1	89.0	AL
					BORING TERMINATED AT 31.5 FEET No groundwater encountered Boring backfilled with soil cuttings			
35								
40								
45								
50								
55								
60								Note: Reported blows were taken at 7-inch intervals for the samples shown on this log.

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; SR = Sulfate/Resisitivity Test; EI = Expansion Index; SH = Shear Test; SA = Sieve Analysis; HC= Consolidation; RV = R-Value Test; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Nolte and Associates	DRILLER:	Layne Drilling	LOGGED BY:	EHL
PROJECT NAME:	Tahquitz Levee	DRILL METHOD:	8" Hollow Stem	OPERATOR:	Chon
PROJECT NO.:	0512-CR3	HAMMER:	Auto 140#/30"	RIG TYPE:	CME 75
LOCATION:	See Boring Location Map			DATE:	1/29/2009

BORING NO. B-2

Boring located at approximate Station 2+00

Depth (ft)	SAMPLES: Sample Type	Blows/ 6 in	Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Dry Density (pcf)	Others
				SM	**Artificial Fill:** Silty fine SAND (SM), light brown gray, slightly moist, loose to medium dense			
		8 14 13	B2-1		SAME, medium dense			
5		9 14 16	B2-2		SAME	2.0	104.8	
		4 6 6	B2-3	SP	Fine SAND (SP) with some silt and gravel, light brown gray, slightly moist, loose to medium dense			SA
10		4 9 13	B2-4	SM	**Alluvium:** Silty f-m SAND (SM), light gray, damp to slightly moist, medium dense	3.9	101.4	
		3 6 8	B2-5		SAME			
15		5 13 28	B2-6		Silty f-c SAND (SM), light brown gray mottled, slightly moist to damp, medium dense	2.9	105	
20		8 11 10	B2-7		Silty fine SAND (SM), light brown gray, slightly moist, medium dense			
25		8 20 25	B2-8		Silty fine SAND (SM), light brown gray, damp, medium dense	2.3	103.7	
30								Note: Reported blows were taken at 7-inch intervals for the samples shown on this log from 0 to 20 feet. Reported blows below 20 feet were taken at 6-inch intervals.

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Nolte and Associates	**DRILLER:**	Layne Drilling	**LOGGED BY:**	EHL
PROJECT NAME:	Tahquitz Levee	**DRILL METHOD:**	8" Hollow Stem	**OPERATOR:**	Chon
PROJECT NO.:	0512-CR3	**HAMMER:**	Auto 140#/30"	**RIG TYPE:**	CME 75
LOCATION:	See Boring Location Map			**DATE:**	1/29/2009

BORING NO.: *B-2 (continued)*

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
30		2 5 6	B2-9	ML	**continued:** Fine sandy SILT (ML), light gray, slightly moist to moist, stiff to medium dense			SA, AL
					BORING TERMINATED AT 31.5 FEET No groundwater encountered Boring backfilled with soil cuttings			
35								
40								
45								
50								
55								
60								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Nolte and Associates	DRILLER:	Layne Drilling	LOGGED BY:	EHL
PROJECT NAME:	Tahquitz Levee	DRILL METHOD:	8" Holiow Stem	OPERATOR:	Chon
PROJECT NO.:	0512-CR3	HAMMER:	Auto 140#/30"	RIG TYPE:	CME 75
LOCATION:	See Boring Location Map			DATE:	1/29/2009

BORING NO. B-3

Boring located at approximate Station 6+00

Depth (ft)	Sample Type	Blows/ 6 in	Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Water Content (%)	Dry Density (pcf)	Others
					Asphaltic Concrete: 0 to 2 inches~			
				SM	**Artificial Fill:** Silty f-m SAND (SM), light gray brown, damp, loose to medium dense			
		14 23 31	B3-1		Silty fine SAND (SM), light gray brown, slightly moist to moist, medium dense (some gravel in sample)	5.4	159.4	SA
5		4 6 6	B3-2		Silty f-m SAND (SM), light gray brown, slightly moist to moist, medium dense			
		3 6 6	B3-3		SAME, slightly moist, loose to medium dense	5.4	89.6	
10		3 7 10	B3-4	SP	**Alluvium:** f-m SAND (SP) with some silt, light to medium gray brown, slightly moist, medium dense			SA MD
		3 4 6	B3-5	SM	Silty f-m SAND (SM), light to medium gray brown, moist, loose	3.8	106	SH
15		4 7 9	B3-6		SAME, medium dense			
20		5 14 25	B3-7		Silty fine SAND (SM), light gray brown mottled, damp to slightly moist, gravel in tip, medium dense	5.6	109.2	SH
25		5 4 5	B3-8		SAME, loose			
30								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Nolte and Associates	DRILLER:	Layne Drilling	LOGGED BY:	EHL
PROJECT NAME:	Tahquitz Levee	DRILL METHOD:	8" Hollow Stem	OPERATOR:	Chon
PROJECT NO.:	0512-CR3	HAMMER:	Auto 140#/30"	RIG TYPE:	CME 75
LOCATION:	See Boring Location Map			DATE:	1/29/2009

BORING NO.: *B-3(continued)*

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
30		4 7 16	B3-9	ML	**continued:** Fine sandy SILT (ML), light gray mottled, moist, stiff	31.4	91	SA
					BORING TERMINATED AT 31.5 FEET No groundwater encountered Boring backfilled with soil cuttings			
35								
40								
45								
50								
55								
60								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Nolte and Associates	DRILLER:	Layne Drilling	LOGGED BY:	EHL
PROJECT NAME:	Tahquitz Levee	DRILL METHOD:	8" Hollow Stem	OPERATOR:	Chon
PROJECT NO.:	0512-CR3	HAMMER:	Auto 140#/30"	RIG TYPE:	CME 75
LOCATION:	See Boring Location Map			DATE:	1/29/2009

BORING NO. B-4

Boring located at approximate Station 11+00

Depth (ft)	Sample Type	Blows/ 6 in	Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Water Content (%)	Dry Density (pcf)	Others
				SM	**Asphaltic Concrete: 0 to 2 inches~** **Artificial Fill:** Silty f-m SAND (SM), light gray brown, slightly moist, medium dense			
		8 14 13	B4-1		Silty f-m SAND (SM), light gray brown, slightly moist to moist, medium dense			SA
5		9 14 16	B4-2		SAME	3.3	102.5	
		4 6 6	B4-3	SP	f-m SAND (SP) with some silt, light gray brown, slightly moist to moist, medium dense			SA
10		4 9 13	B4-4	SM	**Alluvium:** Silty fine SAND (SM), light brown mottled, moist, medium dense	4.8	97.8	
		3 6 8	B4-5	SP	fine SAND (SP) with some silt, light brown mottled, moist, medium dense			SA
15		5 13 28	B4-6		Silty f-c SAND (SM) with gravel, mottled brown gray, moist, medium dense to dense	4.3	104.2	
20		8 11 10	B4-7		Silty fine SAND (SM), light gray, moist, medium dense			
25		8 20 25	B4-8		SAME	2.5	111.0	
30								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; SR = Sulfate/Resisitivity Test; EI = Expansion Index; SH = Shear Test; SA = Sieve Analysis; HC= Consolidation; RV = R-Value Test; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Nolte and Associates	**DRILLER:**	Layne Drilling	**LOGGED BY:**	EHL
PROJECT NAME	Tahquitz Levee	**DRILL METHOD:**	8" Hollow Stem	**OPERATOR:**	Chon
PROJECT NO.:	0512-CR3	**HAMMER:**	Auto 140#/30"	**RIG TYPE:**	CME 75
LOCATION:	See Boring Location Map			**DATE:**	1/29/2009

BORING NO.: *B-4 (continued)*

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
30		3 5 5	B4-9		**continued:** SAME			
					BORING TERMINATED AT 31.5 FEET No groundwater encountered Boring backfilled with soil cuttings			
35								
40								
45								
50								
55								
60								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; SR = Sulfate/Resisitivity Test; EI = Expansion Index; SH = Shear Test; SA = Sieve Analysis; HC= Consolidation; RV = R-Value Test; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Nolte and Associates	DRILLER:	Layne Drilling	LOGGED BY:	EHL
PROJECT NAME:	Tahquitz Levee	DRILL METHOD:	8" Hollow Stem	OPERATOR:	Chon
PROJECT NO.:	0512-CR3	HAMMER:	Auto 140#/30"	RIG TYPE:	CME 75
LOCATION:	See Boring Location Map			DATE:	1/29/2009

BORING NO. B-5

Boring located at approximate Station 15+00

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
					Asphaltic Concrete: 0 to 2 inches~			
				SM	**Artificial Fill:** Silty f-m SAND (SM), light gray brown, slightly moist, medium dense			
		14 22 23	B5-1		Silty f-m SAND (SM) with occasional gravel, light gray brown mottled, moist, medium dense	4.9	112.2	
5		5 8 10	B5-2	SP-SM	SAME, no gravel			SA
		5 14 21	B5-3		SAME	5.8	111.2	
10		5 6 7	B5-4	SM	**Alluvium:** Silty f-m SAND (SM), light gray brown, moist, medium dense			SA
		12 17 19	B5-5		SAME	6.3	104.0	
15		2 4 4	B5-6		SAME, slightly darker gray, loose			
20		5 9 14	B5-7		Silty f-m SAND (SM), light gray mottled, damp, coarser than above, medium dense	4.1	104.4	
25		6 9 12	B5-8		SAME			
30								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Nolte and Associates	**DRILLER:**	Layne Drilling	**LOGGED BY:**	EHL
PROJECT NAME:	Tahquitz Levee	**DRILL METHOD:**	8" Hollow Stem	**OPERATOR:**	Chon
PROJECT NO.:	0512-CR3	**HAMMER:**	Auto 140#/30"	**RIG TYPE:**	CME 75
LOCATION:	See Boring Location Map			**DATE:**	1/29/2009

BORING NO.: *B-5 (continued)*

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
30		7 15 21	B5-9	SM	**continued:** Silty fine SAND (SM), light gray mottled, damp to slightly moist, medium dense	4.5	104.1	
					BORING TERMINATED AT 31.5 FEET No groundwater encountered Boring backfilled with soil cuttings			
35								
40								
45								
50								
55								
60								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Nolte and Associates	DRILLER:	Layne Drilling	LOGGED BY:	EHL
PROJECT NAME:	Tahquitz Levee	DRILL METHOD:	8" Hollow Stem	OPERATOR:	Chon
PROJECT NO.:	0512-CR3	HAMMER:	Auto 140#/30"	RIG TYPE:	CME 75
LOCATION:	See Boring Location Map			DATE:	1/29/2009

BORING NO. B-6

Boring located approximately 75' north of Sta. 17+00

Depth (ft)	Sample Type	Blows/ 6 in	Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Water Content (%)	Dry Density (pcf)	Others
					Asphaltic Concrete: 0 to 2 inches~			
					Artificial Fill:			
		27 25 23	B6-1		(No recovery of sample)			
5		3 7 8	B6-2	SM	Silty f-m SAND (SM), light gray brown, slightly moist, medium dense	6.3		
		5 8 13	B6-3		Silty f-m SAND (SM), light gray mottled, damp, medium dense	3.1	103.6	
10		3 2 2	B6-4	SM	**Alluvium:** Silty f-c SAND (SM), light gray mottled to medium brown, damp, loose	5.0		
		5 8 16	B6-5		Silty f-m SAND (SM), light gray brown, slightly moist, medium dense	3.9	99.2	
15		3 4 6	B6-6		SAME	4.6		
20		7 18 29	B6-7		Silty f-c SAND (SM), light gray mottled, damp, some gravel, medium dense to dense	2.0	111.8	
25		3 4 6	B6-8		Silty fine SAND (SM), light gray mottled, damp, loose to medium dense	4.1		
30								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Nolte and Associates	DRILLER:	Layne Drilling	LOGGED BY:	EHL
PROJECT NAME:	Tahquitz Levee	DRILL METHOD:	8" Hollow Stem	OPERATOR:	Chon
PROJECT NO.:	0512-CR3	HAMMER:	Auto 140#/30"	RIG TYPE:	CME 75
LOCATION:	See Boring Location Map			DATE:	1/29/2009

BORING NO.: *B-6 (continued)*

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
30		7 10 13	B6-9	ML	**continued:** SILT (ML), light gray, moist, stiff	21.7	104.1	SA, AL
35		2 3 4	B6-10		Fine sandy SILT (ML), light to medium gray, very moist, medium stiff	3.5		
40		2 4 11	B6-11		(No recovery of sample)			
45		16 24 43	B6-12		Silty f-c SAND (SM) with gravel, light to medium gray brown mottled, damp to slightly moist, dense to very dense			
50		9 28 44	B6-13		SAME	4.3		
					BORING TERMINATED AT 51.5 FEET No groundwater encountered Boring backfilled with soil cuttings			
55								
60								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Nolte and Associates	**DRILLER:**	Layne Drilling	**LOGGED BY:**	EHL
PROJECT NAME:	Tahquitz Levee	**DRILL METHOD:**	8" Hollow Stem	**OPERATOR:**	Chon
PROJECT NO.:	0512-CR3	**HAMMER:**	Auto 140#/30"	**RIG TYPE:**	CME 75
LOCATION:	See Boring Location Map			**DATE:**	1/30/2009

BORING NO. B-7

Boring located at approximate Station 22+00

Depth (ft)	Sample Type	Blows/ 6 in	Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Water Content (%)	Dry Density (pcf)	Others
					Asphaltic Concrete: 0 to 2 inches~			
					Artificial Fill:			
				SM	Silty f-m SAND (SM), light yellow brown, moist, medium dense			MD
		13 28 35	B7-1		Silty f-m SAND (SM) with some coarse, light yellow brown, moist, medium dense	5.5	119.2	
5		10 13 16	B7-2		Silty f-m SAND (SM), light brown, moist, medium dense			SA
		5 9 10	B7-3	SP	**Alluvium:** Fine to medium SAND (SP), minor silt, light yellow gray mottled, slightly moist, medium dense	4.1	99.6	SH
10		5 12 10	B7-4		SAME			SA
		5 9 13	B7-5		becomes slightly coarser	2.9	102.3	
15		3 7 7	B7-6	SM	Silty f-m SAND (SM), light yellow brown mottled, slightly moist, gradationally bedded, medium dense			
20		7 14 12	B7-7		Silty fine SAND (SM) to Silty f-c SAND (SM) with gravel, light yellow brown mottled, slightly moist, medium dense	2.3	114.4	
25		5 9 11	B7-8		Silty f-m SAND (SM), light yellow brown mottled, slightly moist, medium dense			
30								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Nolte and Associates	DRILLER:	Layne Drilling	LOGGED BY:	EHL
PROJECT NAME:	Tahquitz Levee	DRILL METHOD:	8" Hollow Stem	OPERATOR:	Chon
PROJECT NO.:	0512-CR3	HAMMER:	Auto 140#/30"	RIG TYPE:	CME 75
LOCATION:	See Boring Location Map			DATE:	1/30/2009

BORING NO.: *B-7 (continued)*

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
30		13 37 41	B7-9	SM	**continued:** SAME	3.2	124.3	
					BORING TERMINATED AT 31.5 FEET No groundwater encountered Boring backfilled with soil cuttings			
35								
40								
45								
50								
55								
60								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; SR = Sulfate/Resisitivity Test; EI = Expansion Index; SH = Shear Test; SA = Sieve Analysis; HC= Consolidation; RV = R-Value Test; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Nolte and Associates	DRILLER:	Layne Drilling	LOGGED BY:	EHL
PROJECT NAME:	Tahquitz Levee	DRILL METHOD:	8" Hollow Stem	OPERATOR:	Chon
PROJECT NO.:	0512-CR3	HAMMER:	Auto 140#/30"	RIG TYPE:	CME 75
LOCATION:	See Boring Location Map			DATE:	1/30/2009

BORING NO. B-8

Boring located at approximate Station 28+00

Depth (ft)	SAMPLES: Sample Type	Blows/ 6 in	Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Dry Density (pcf)	Others
					Asphaltic Concrete: 0 to 2 inches~			
					Artificial Fill:			
				SM	Silty SAND (SM), light yellow brown, moist, medium dense			
		2 2 3	B8-1		Silty f-m SAND (SM), light yellow brown, moist, loose			SA
5		4 7 12	B8-2		SAME, slightly darker, medium dense	5.7	108.1	SH
		2 2 3	B8-3	SM	**Alluvium:** Silty f-m SAND (SM), light yellow brown, slightly moist, loose			SA
10		2 3 15	B8-4		SAME, occasional gravel clast, loose to medium dense	7.5	104.6	
		4 5 5	B8-5		SAME			
15		5 9 10	B8-6		Silty f-c SAND (SM), light yellow brown mottled, slightly moist, medium dense	3.5	97.3	
20		9 6 6	B8-7		Silty f-m SAND (SM), light yellow brown, moist to very moist, medium dense			
25		9 21 30	B8-8		Silty fine SAND (SM) to fine sandy SILT (ML), light medium gray mottled, very moist, medium dense	18.7	104.9	
30								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; SR = Sulfate/Resisitivity Test; EI = Expansion Index; SH = Shear Test; SA = Sieve Analysis; HC= Consolidation; RV = R-Value Test; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Nolte and Associates	**DRILLER:**	Layne Drilling	**LOGGED BY:**	EHL
PROJECT NAME:	Tahquitz Levee	**DRILL METHOD:**	8" Hollow Stem	**OPERATOR:**	Chon
PROJECT NO.:	0512-CR3	**HAMMER:**	Auto 140#/30"	**RIG TYPE:**	CME 75
LOCATION:	See Boring Location Map			**DATE:**	1/30/2009

BORING NO.: *B-8 (continued)*

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
30		7 13 15	B8-9		**continued:** Silty f-m SAND (SM), light gray mottled, moist, medium dense			
					BORING TERMINATED AT 31.5 FEET No groundwater encountered Boring backfilled with soil cuttings			
35								
40								
45								
50								
55								
60								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Nolte and Associates	DRILLER:	Layne Drilling	LOGGED BY:	EHL
PROJECT NAME:	Tahquitz Levee	DRILL METHOD:	8" Hollow Stem	OPERATOR:	Chon
PROJECT NO.:	0512-CR3	HAMMER:	Auto 140#/30"	RIG TYPE:	CME 75
LOCATION:	See Boring Location Map			DATE:	1/30/2009

BORING NO. B-9

Boring located at approximate Station 33+00

Depth (ft)	Sample Type	Blows/ 6 in	Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Water Content (%)	Dry Density (pcf)	Others
					Asphaltic Concrete: 0 to 2 inches~			
				SM	**Artificial Fill:** Silty f-m SAND (SM), light gray brown, moist, medium dense			
		15 26 29	B9-1		Silty f-m SAND (SM), light gray brown mottled, moist, medium dense	5.1	116.9	
5		3 5 5	B9-2	SP-SM	SAME, loose to medium dense			SA
		2 3 5	B9-3	SM	**Alluvium:** Silty f-c SAND (SM), light gray brown mottled, moist, loose	3.7	100.3	
10		5 11 13	B9-4	SP	f-m SAND (SP) with some silt, light gray brown mottled, moist, medium dense			SA
		8 12 16	B9-5	SM	Silty gravelly f-c SAND (SM), light gray brown mottled, moist, medium dense	2.7	101.1	
15		4 7 7	B9-6		SAME			
20		12 20 22	B9-7		SAME	3.5	119.9	
25		3 4 5	B9-8		Silty f-m SAND (SM), light gray mottled, moist, loose to medium dense			SA
30								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Nolte and Associates	DRILLER:	Layne Drilling	LOGGED BY:	EHL
PROJECT NAME:	Tahquitz Levee	DRILL METHOD:	8" Hollow Stem	OPERATOR:	Chon
PROJECT NO.:	0512-CR3	HAMMER:	Auto 140#/30"	RIG TYPE:	CME 75
LOCATION:	See Boring Location Map			DATE:	1/30/2009

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	BORING NO.: *B-9 (continued)* — MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
30		6 16 21	B9-9	SM	**continued:** Silty fine SAND (SM), light gray mottled, moist, medium dense	6.0	107.1	
					BORING TERMINATED AT 31.5 FEET No groundwater encountered Boring backfilled with soil cuttings			
35								
40								
45								
50								
55								
60								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; SR = Sulfate/Resisitivity Test; EI = Expansion Index; SH = Shear Test; SA = Sieve Analysis; HC= Consolidation; RV = R-Value Test; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Nolte and Associates	DRILLER:	Layne Drilling	LOGGED BY:	EHL
PROJECT NAME:	Tahquitz Levee	DRILL METHOD:	8" Hollow Stem	OPERATOR:	Chon
PROJECT NO.:	0512-CR3	HAMMER:	Auto 140#/30"	RIG TYPE:	CME 75
LOCATION:	See Boring Location Map			DATE:	1/30/2009

BORING NO. B-10

Boring located at approximate Station 38+00

Depth (ft)	Sample Type	Blows/ 6 in	Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Water Content (%)	Dry Density (pcf)	Others
				SM	**Artificial Fill:** Silty fine SAND (SM), light gray and brown mottled, slightly moist, medium dense			
		10 16 12	B10-1		SAME			
5		6 13 13	B10-2		Silty f-m SAND (SM), light gray, slightly moist, medium dense	1.5	105.3	
		2 2 2	B10-3		SAME, very uniform (possible alluvium?), loose			
10		4 20 18	B10-4	SP	**Alluvium:** Fine to medium SAND (SP) with some coarse, mottled light gray, damp, medium dense	1.2		
		4 5 5	B10-5		Fine to medium SAND (SP), mottled light gray, damp, loose to medium dense			
15		8 22 24	B10-6	SM	Silty fine SAND (SM), light gray mottled, damp, medium dense	2.3	103	
20		7 15 20	B10-7	SP	Fine to medium SAND (SP) with some coarse and one piece of gravel, light gray mottled, damp, medium dense			
25		5 12 17	B10-8	SM	Silty fine SAND (SM), light gray mottled, moist, medium dense	4.4	109.4	
30								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT:	Nolte and Associates	**DRILLER:**	Layne Drilling	**LOGGED BY:**	EHL
PROJECT NAME:	Tahquitz Levee	**DRILL METHOD:**	8" Hollow Stem	**OPERATOR:**	Chon
PROJECT NO.:	0512-CR3	**HAMMER:**	Auto 140#/30"	**RIG TYPE:**	CME 75
LOCATION:	See Boring Location Map			**DATE:**	1/30/2009

BORING NO.: *B-10 (continued)*

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
30		2 3 9	B10-9		**continued:** SAME	3.6	121.5	
					BORING TERMINATED AT 31.5 FEET No groundwater encountered Boring backfilled with soil cuttings			
35								
40								
45								
50								
55								
60								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT: Nolte and Associates
PROJECT NAME: Tahquitz Levee
PROJECT NO.: 0512-CR3
LOCATION: See Boring Location Map

DRILL METHOD: Hand Auger

LOGGED BY: EHL
DATE: 1/30/2009

BORING NO. HA-1

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
	X			SM	**Artificial Fill:** Silty fine SAND (SM), light gray and brown mottled, slightly moist, medium dense			SA, AL
					BORING TERMINATED AT 4 FEET			
5					No groundwater encountered Boring backfilled with soil cuttings			
10								
15								
20								
25								
30								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT: Nolte and Associates
PROJECT NAME: Tahquitz Levee
PROJECT NO.: 0512-CR3
LOCATION: See Boring Location Map

DRILL METHOD: Hand Auger

LOGGED BY: EHL
DATE: 1/30/2009

BORING NO. HA-2

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
				SM	**Artificial Fill:** Silty f-m SAND (SM), light yellow brown, moist, medium dense			SA, AL
					BORING TERMINATED AT 4 FEET			
5					No groundwater encountered Boring backfilled with soil cuttings			
10								
15								
20								
25								
30								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT: Nolte and Associates
PROJECT NAME: Tahquitz Levee
PROJECT NO.: 0512-CR3
LOCATION: See Boring Location Map

DRILL METHOD: Hand Auger

LOGGED BY: EHL
DATE: 1/30/2009

BORING NO. HA-3

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
				SM	**Artificial Fill:** Silty f-m SAND (SM), light gray brown, damp, loose to medium dense			SA, AL
					BORING TERMINATED AT 4 FEET			
5					No groundwater encountered Boring backfilled with soil cuttings			
10								
15								
20								
25								
30								

LEGEND

Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

GeoTek, Inc.

LOG OF EXPLORATORY BORING

CLIENT: Nolte and Associates
PROJECT NAME: Tahquitz Levee
PROJECT NO.: 0512-CR3
LOCATION: See Boring Location Map

DRILL METHOD: Hand Auger

LOGGED BY: EHL
DATE: 1/30/2009

BORING NO. HA-4

Depth (ft)	SAMPLES: Sample Type	SAMPLES: Blows/ 6 in	SAMPLES: Sample Number	USCS Symbol	MATERIAL DESCRIPTION AND COMMENTS	Laboratory Testing: Water Content (%)	Laboratory Testing: Dry Density (pcf)	Laboratory Testing: Others
				SM	**Artificial Fill:** Silty fine SAND (SM), light brown gray, slightly moist, loose to medium dense			SA, AL
					BORING TERMINATED AT 4 FEET			
5					No groundwater encountered Boring backfilled with soil cuttings			
10								
15								
20								
25								
30								

LEGEND

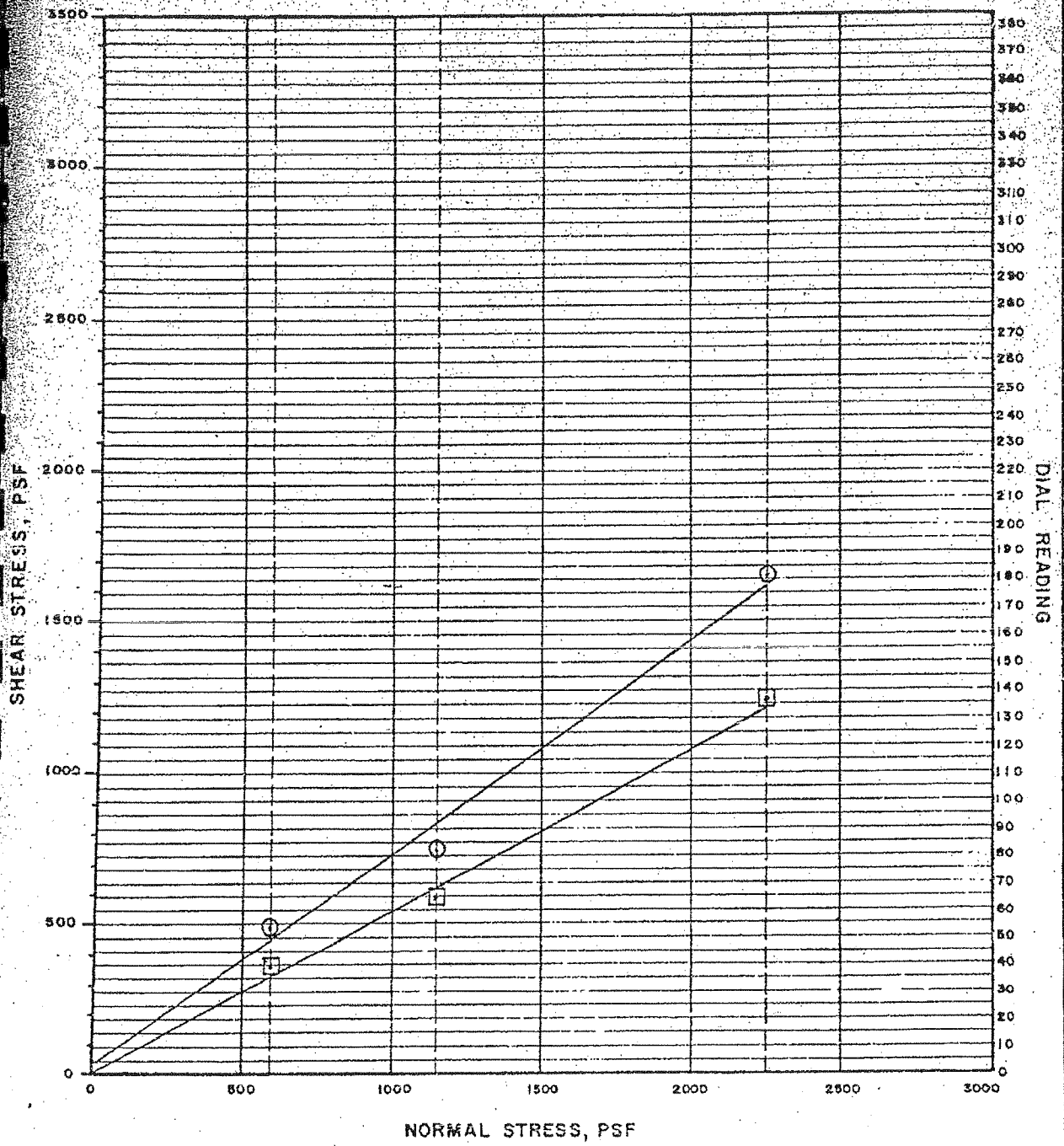
Sample type: ---Ring ---SPT ---Small Bulk ---Large Bulk ---No Recovery ---Water Table

Lab testing: AL = Atterberg Limits; EI = Expansion Index; SA = Sieve Analysis; RV = R-Value Test; SR = Sulfate/Resisitivity Test; SH = Shear Test; HC= Consolidation; MD = Maximum Density

APPENDIX C

Laboratory Test Results (Geotek)

DIRECT SHEAR SUMMARY



Boring	Depth	Symbol	Friction Angle	Cohesion	Remarks
STA. 3+25	7 FT.	⊙	36°	50 PSF	REMOLDED TO 88 % R.C.
STA 3+25	7 FT.	⊡	29°	0	REMOLDED TO 74 % R.C.

Project No.: 679321-04

340 A (8/77)

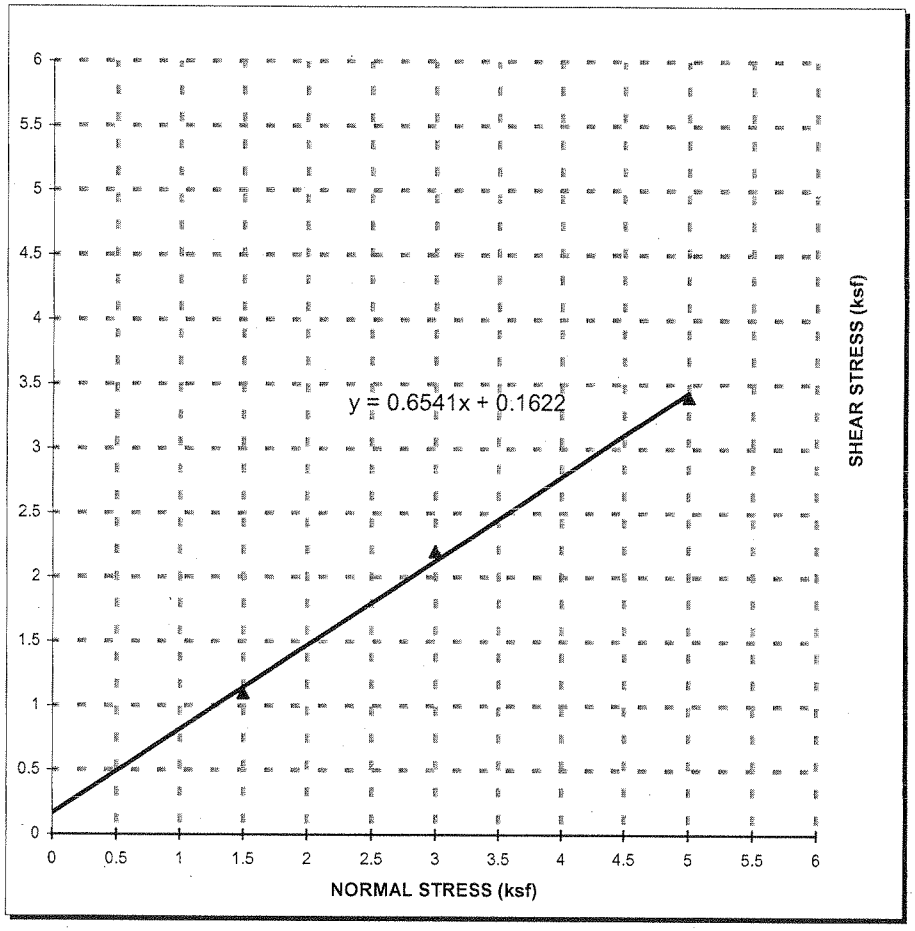
Leighton & Associates

Plate No.: 4

GEOTEK

DIRECT SHEAR TEST

Project Name:	Nolte Associates	***Sample Source:***	B - 3 @ 12.5'
Project Number:	0512-CR3	***Date Tested:***	4/20/2009
Soil Description:	Silty SAND (SM)		



Shear Strength: $\Phi = 33.0^{\circ}$, **C =** 0.16 **ksf**

Test No.	Load (ksf)	Water Content (%)	Dry Density (pcf)
1	1.5	17.9	106.9
2	3.0	20.3	105.7
3	5.0	17.6	106.2

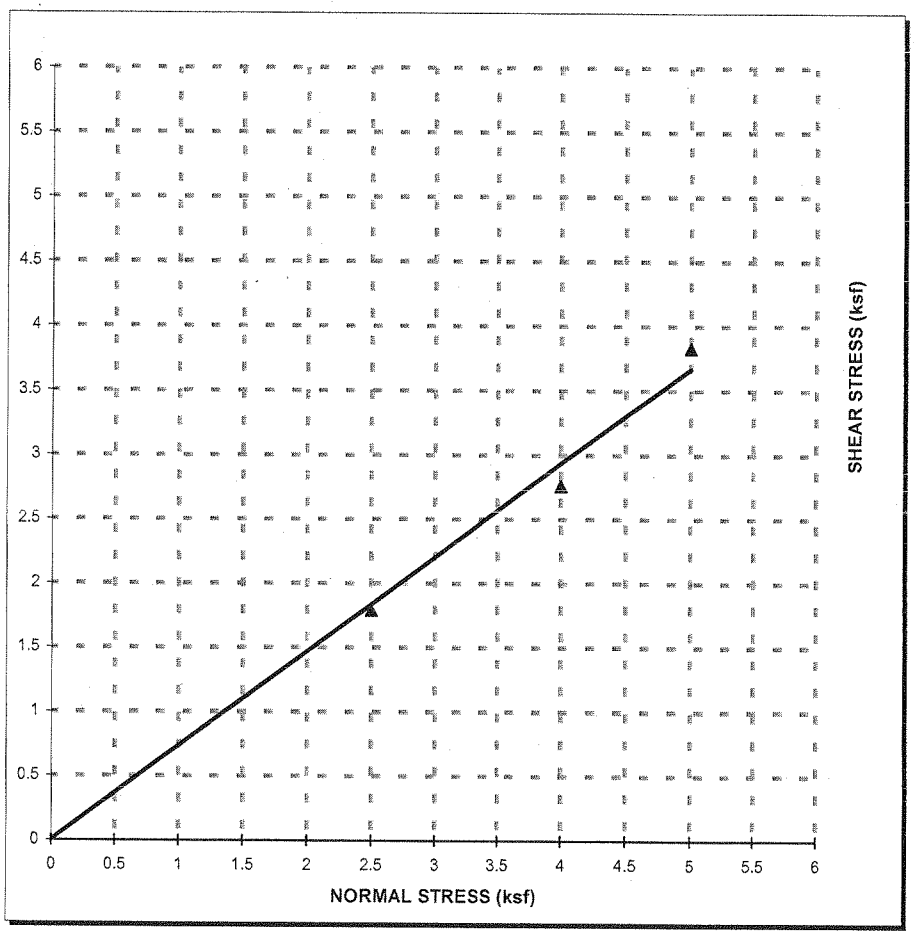
Notes:

1 - The soil specimen used in the shear box was an "undisturbed ring" sample collected during the field investigation.
2 - The above reflect residual shear strength at saturated conditions.
3 - The tests were ran at a shear rate of 0.025 in/min.

GEOTEK

DIRECT SHEAR TEST

Project Name:	Nolte Associates	***Sample Source:***	B - 5 @ 20'
Project Number:	0512-CR3	***Date Tested:***	4/20/2009
Soil Description:	Silty SAND (SM)		



Shear Strength: $\Phi = 36.0^{\circ}$, **C =** 0.00 **ksf**

Test No.	Load (ksf)	Water Content (%)	Dry Density (pcf)
1	2.5	21.3	100.8
2	4.5	20.7	97.0
3	5.0	22.1	102.0

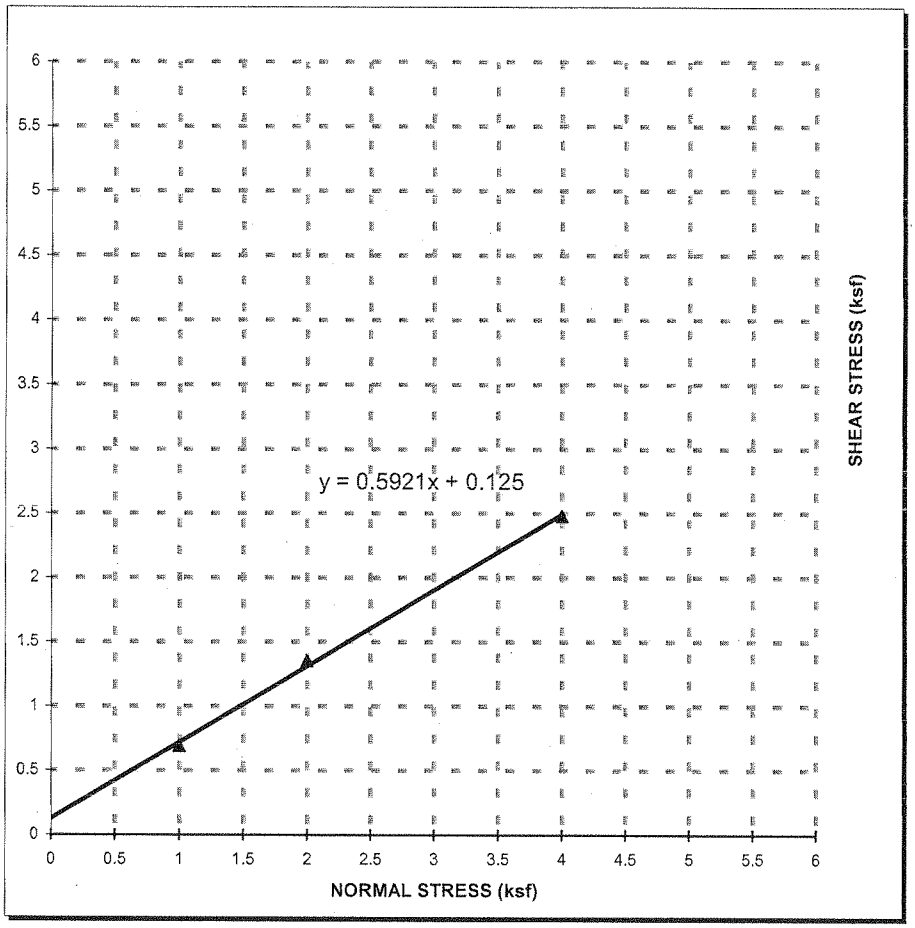
Notes:

1 - The soil specimen used in the shear box was an "undisturbed ring" sample collected during the field investigation.
2 - The above reflect residual shear strength at saturated conditions.
3 - The tests were ran at a shear rate of 0.025 in/min.

GEOTEK

DIRECT SHEAR TEST

Project Name:	Nolte Associates	***Sample Source:***	B - 7 @ 7.5'
Project Number:	0512-CR3	***Date Tested:***	4/20/2009
Soil Description:	SAND (SP)		



Shear Strength: $\Phi = 30.5^{\circ}$, **C =** 0.13 **ksf**

Test No.	Load (ksf)	Water Content (%)	Dry Density (pcf)
1	1.0	24.3	89.6
2	2.0	23.7	94.8
3	4.0	22.6	98.2

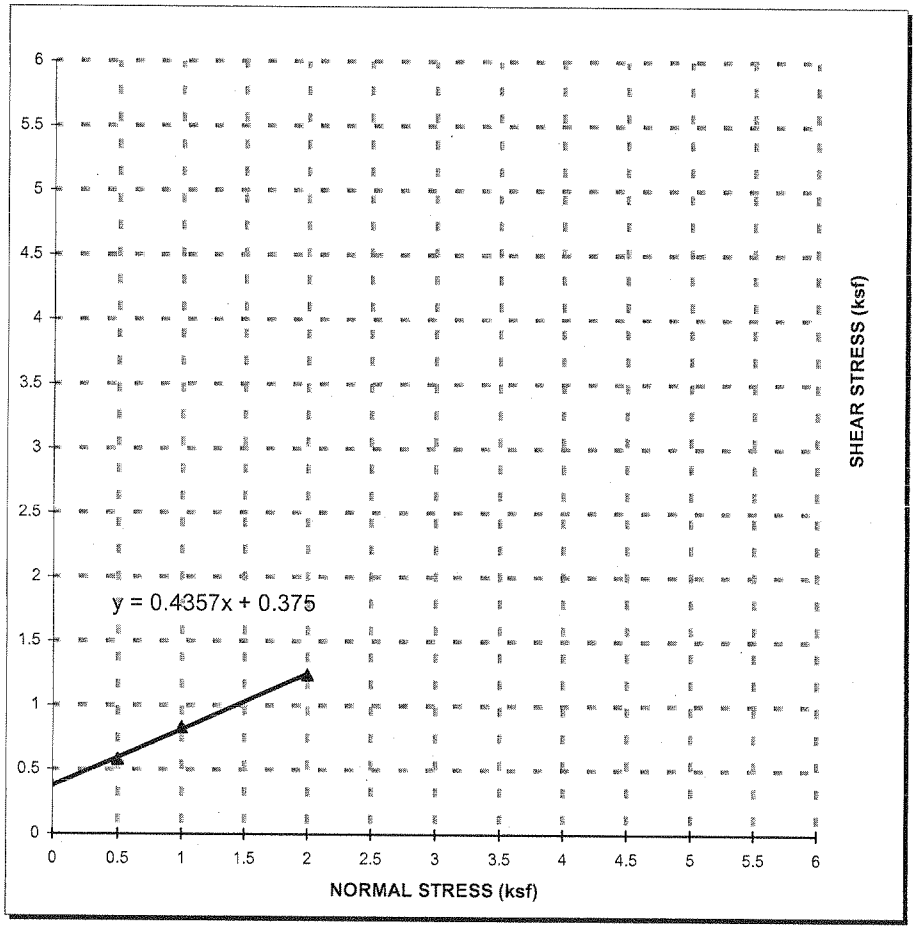
Notes:

1 - The soil specimen used in the shear box was an "undisturbed ring" sample collected during the field investigation.
2 - The above reflect residual shear strength at saturated conditions.
3 - The tests were ran at a shear rate of 0.025 in/min.

GEOTEK

DIRECT SHEAR TEST

Project Name:	Nolte Associates	***Sample Source:***	B - 8 @ 5'
Project Number:	0512-CR3	***Date Tested:***	4/20/2009
Soil Description:	Silty SAND (SM)		



Shear Strength: $\Phi = 23.7^{\circ}$, **C =** 0.38 **ksf**

Test No.	Load (ksf)	Water Content (%)	Dry Density (pcf)
1	0.5	16.4	104.4
2	1.0	20.9	105.3
3	2.0	18.0	105.0

Notes:

1 - The soil specimen used in the shear box was an "undisturbed ring" sample collected during the field investigation.
2 - The above reflect residual shear strength at saturated conditions.
3 - The tests were ran at a shear rate of 0.025 in/min.

GEOTEK
4130 Flat Rock Drive, Suite 140. Riverside, CA. 92505-5864
951-710-1160 Office 951-710-1167 Fax

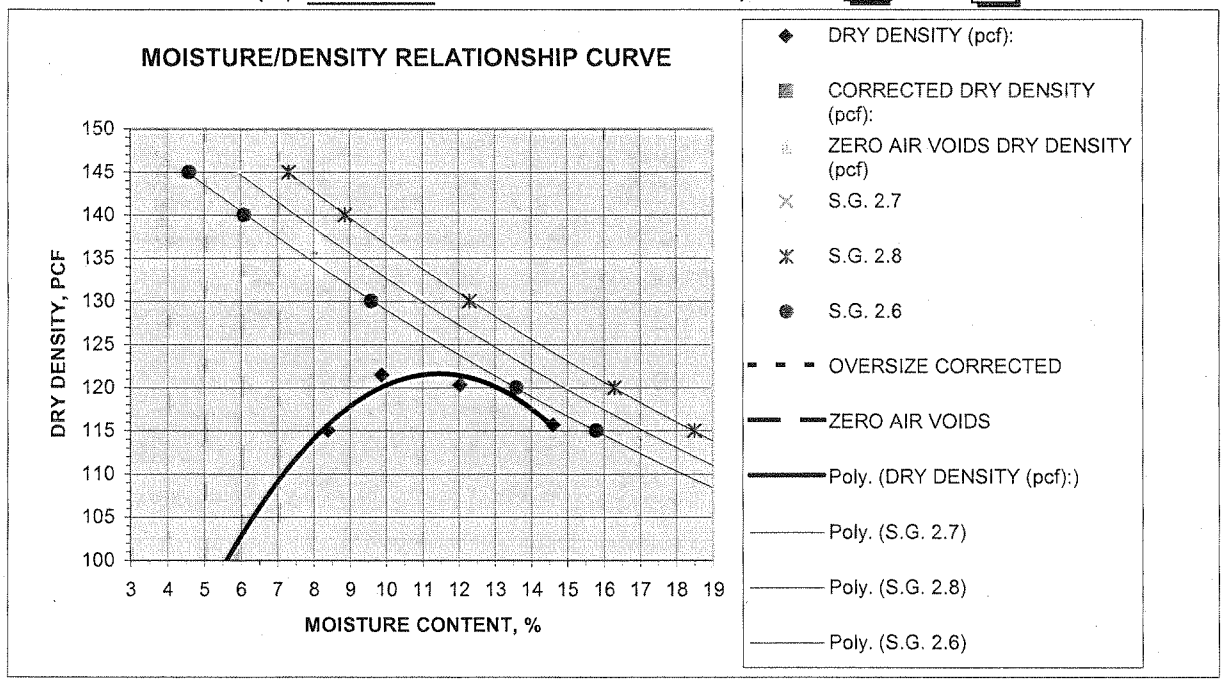
MOISTURE/DENSITY RELATIONSHIP

Client: Nolte Associates, Inc.
Project: Tahquitz Levee
Location: Palm Springs
Material Type: Brown Silty Sand
Material Supplier: N/A
Material Source: 0
Sample Location: B - 7
@ 0 - 5'
Sampled By: EHL
Received By: N/A
Tested By: FH
Reviewed By: N/A

Job No.: 0512-CR3
Lab No.: Riv

Date Sampled: 30-Jan-09
Date Received: 30-Jan-09
Date Tested: 10-Feb-09
Date Reviewed: 11-Feb-09

Test Procedure: ASTM 1557 **Method:** 0
Oversized Material (%): 0.0 **Correction Required:** ☐ yes ☐ no



MOISTURE DENSITY RELATIONSHIP VALUES

Maximum Dry Density, pcf	123.0	**@ Optimum Moisture, %**	10.5
Corrected Maximum Dry Density, pcf		**@ Optimum Moisture, %**	

MATERIAL DESCRIPTION

Grain Size Distribution:

	% Gravel (retained on No. 4)
	% Sand (Passing No. 4, Retained on No. 200)
	% Silt and Clay (Passing No. 200)

Atterberg Limits:

	Liquid Limit, %
	Plastic Limit, %
	Plasticity Index, %

Classification:
Unified Soils Classification:
AASHTO Soils Classification:

GEOTEK

4130 Flat Rock Drive, Suite 140, Riverside, CA, 92505-5864

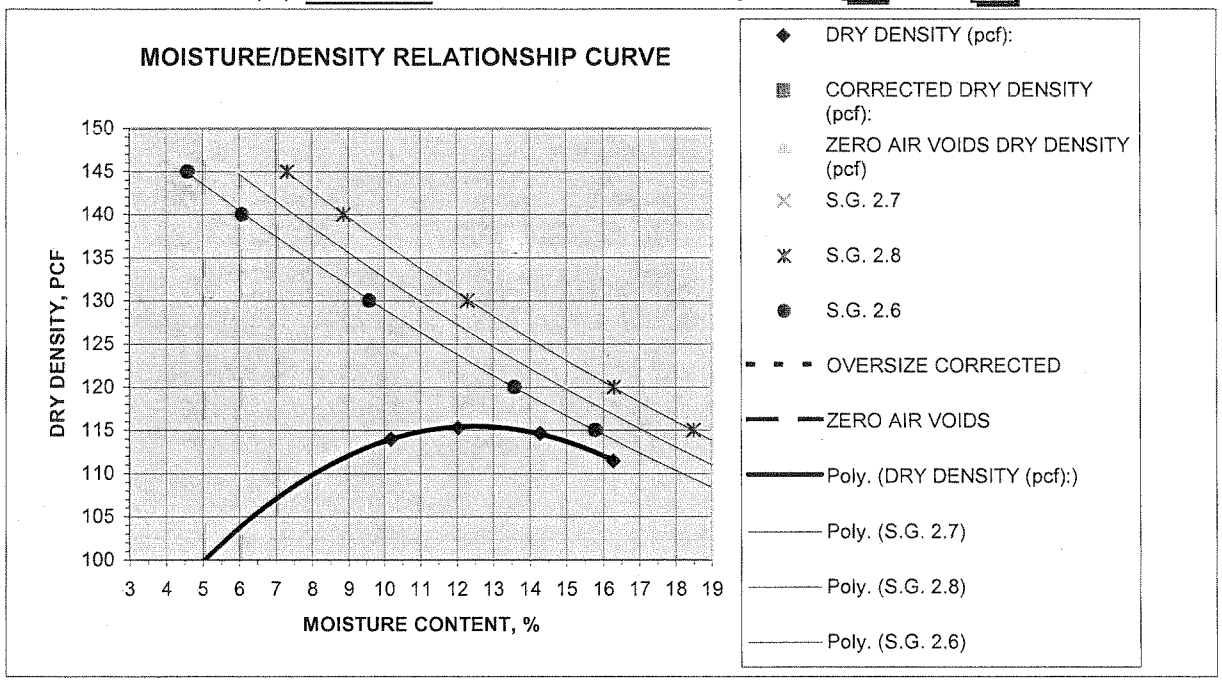
951-710-1160 Office 951-710-1167 Fax

MOISTURE/DENSITY RELATIONSHIP

Client:	Nolte Associates, Inc.	**Job No.:**	0512-CR3
Project:	Tahquitz Levee	**Lab No.:**	Riv
Location:	Palm Springs		
Material Type:	Brown Silty Sand		
Material Supplier:	N/A		
Material Source:	0		
Sample Location:	B - 3 @ 10 - 15'		
Sampled By:	EHL	**Date Sampled:**	29-Jan-09
Received By:	N/A	**Date Received:**	30-Jan-09
Tested By:	FH	**Date Tested:**	10-Feb-09
Reviewed By:	N/A	**Date Reviewed:**	11-Feb-09

Test Procedure: ASTM 1557 **Method:** 0

Oversized Material (%): 0.0 **Correction Required:** ☐ Yes ☐ No



MOISTURE DENSITY RELATIONSHIP VALUES

Maximum Dry Density, pcf	117.0	**@ Optimum Moisture, %**	13.5
Corrected Maximum Dry Density, pcf		**@ Optimum Moisture, %**	

MATERIAL DESCRIPTION

Grain Size Distribution:

	% Gravel (retained on No. 4)
	% Sand (Passing No. 4, Retained on No. 200)
	% Silt and Clay (Passing No. 200)

Atterberg Limits:

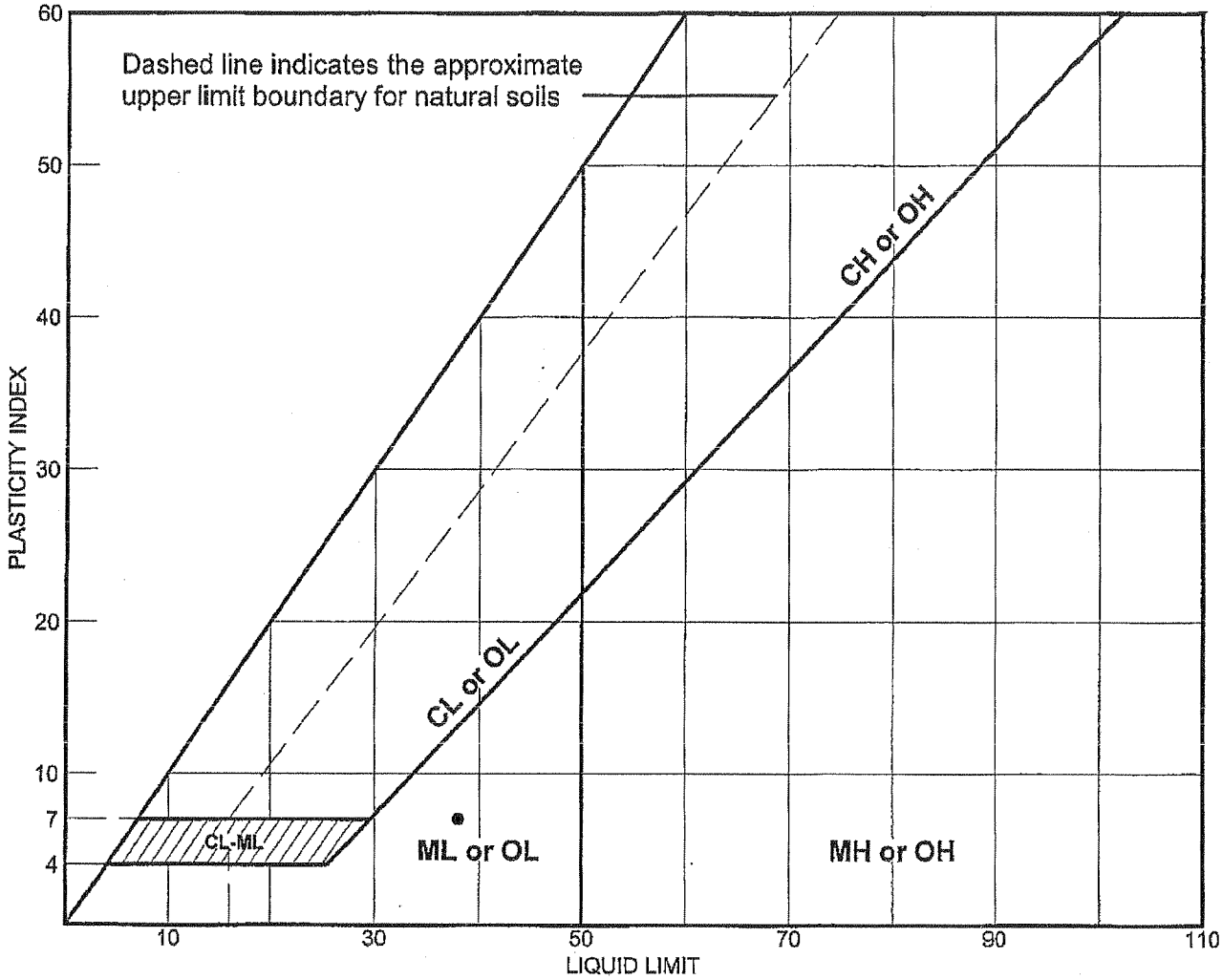
	Liquid Limit, %
	Plastic Limit, %
	Plasticity Index, %

Classification:

Unified Soils Classification: _____

AASHTO Soils Classification: _____

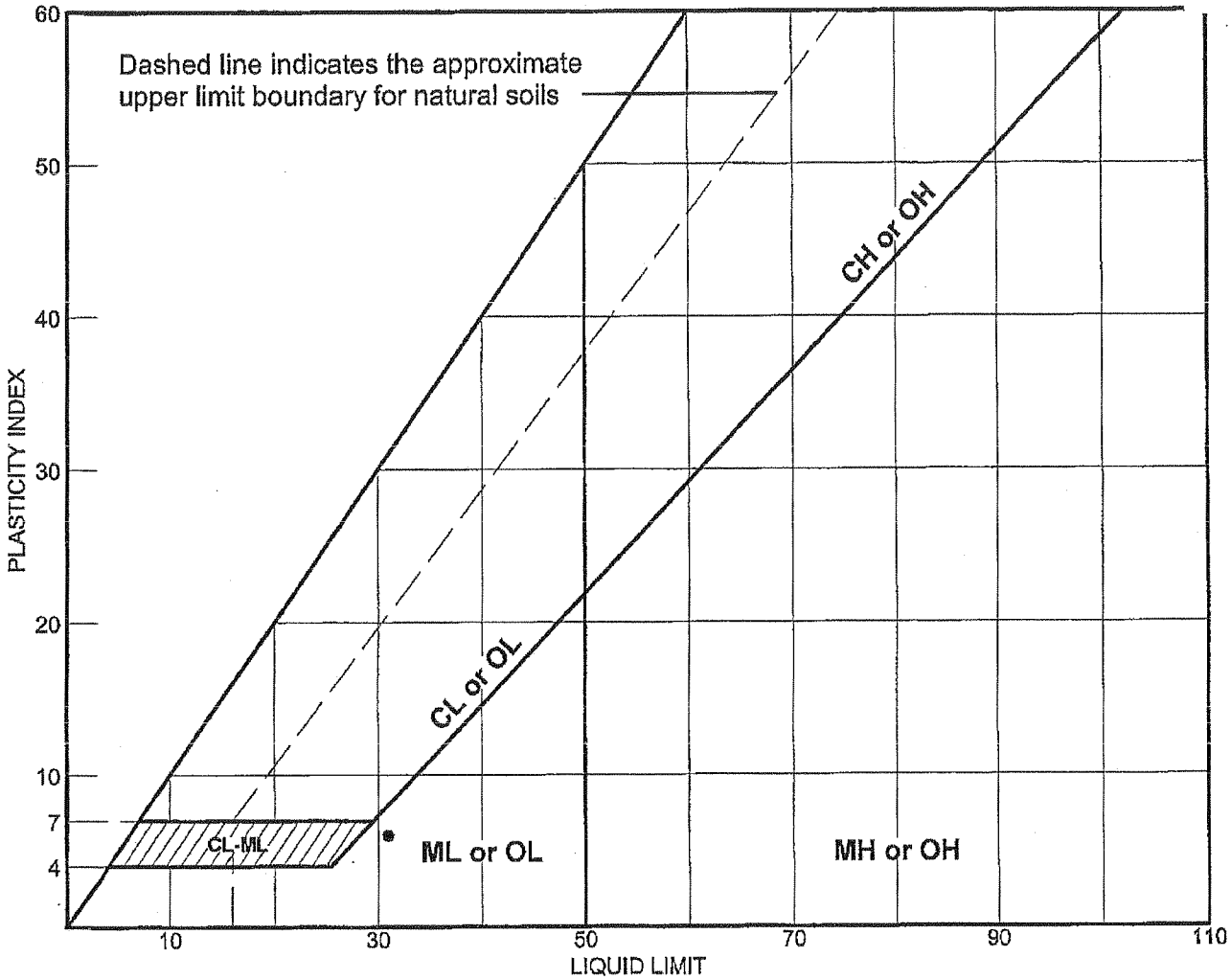
LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	B-1@30'	B-1@30'	30'	3.4	31	38	7	ML

LIQUID AND PLASTIC LIMITS TEST REPORT **GeoTek, Inc.**	**Client:** Nolte **Project:** Tahquitz Creek **Project No.:** 0512 CR3 **Plate**

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	B-2@30'	B-2@30'	30'	2.2	25	31	6	ML

LIQUID AND PLASTIC LIMITS TEST REPORT

GeoTek, Inc.

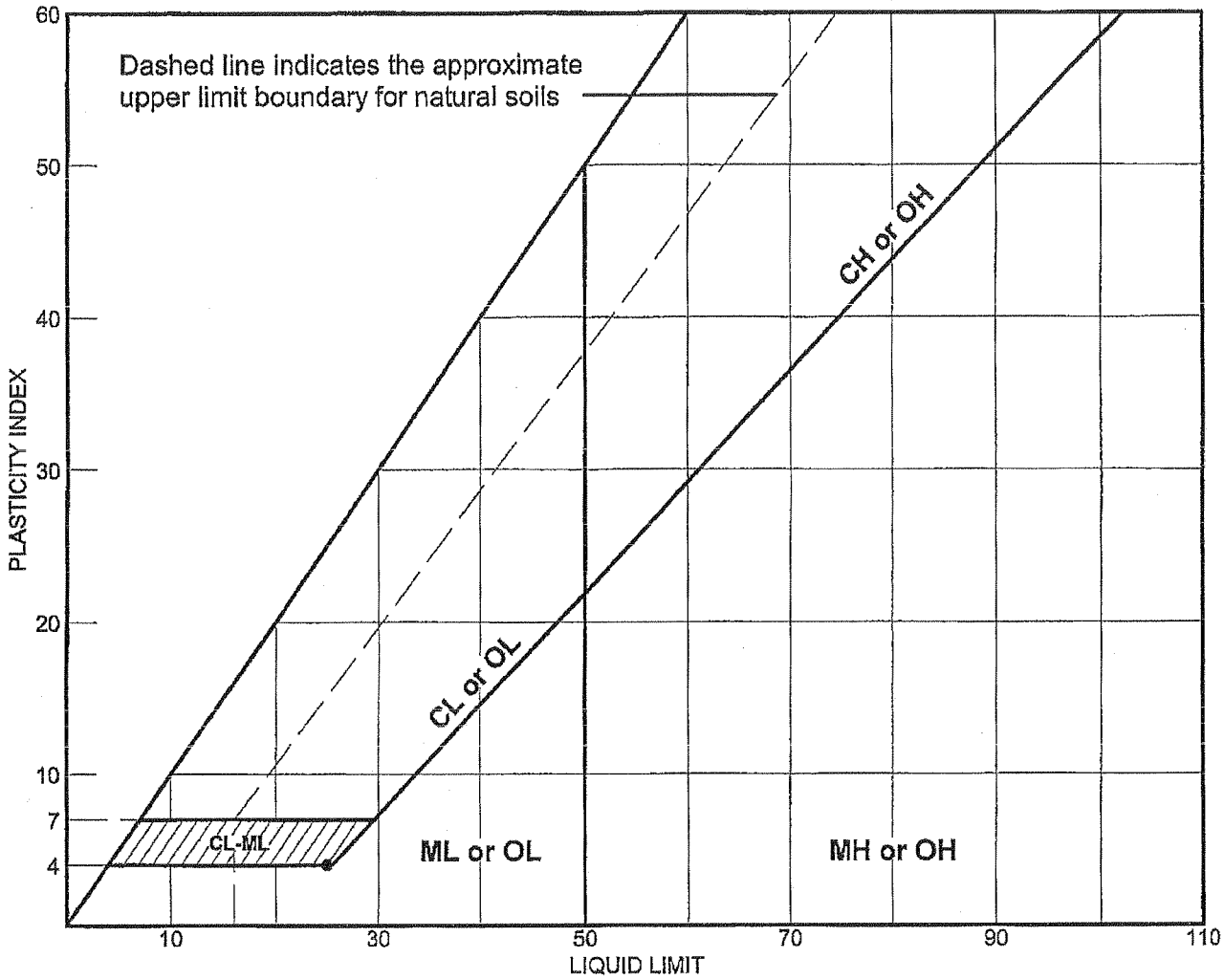
Client: Nolte

Project: Tahquitz Creek

Project No.: 0512 CR3

Plate

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	B-6@30'	B-6@30'	30'	2.1	21	25	4	CL-ML

LIQUID AND PLASTIC LIMITS TEST REPORT

GeoTek, Inc.

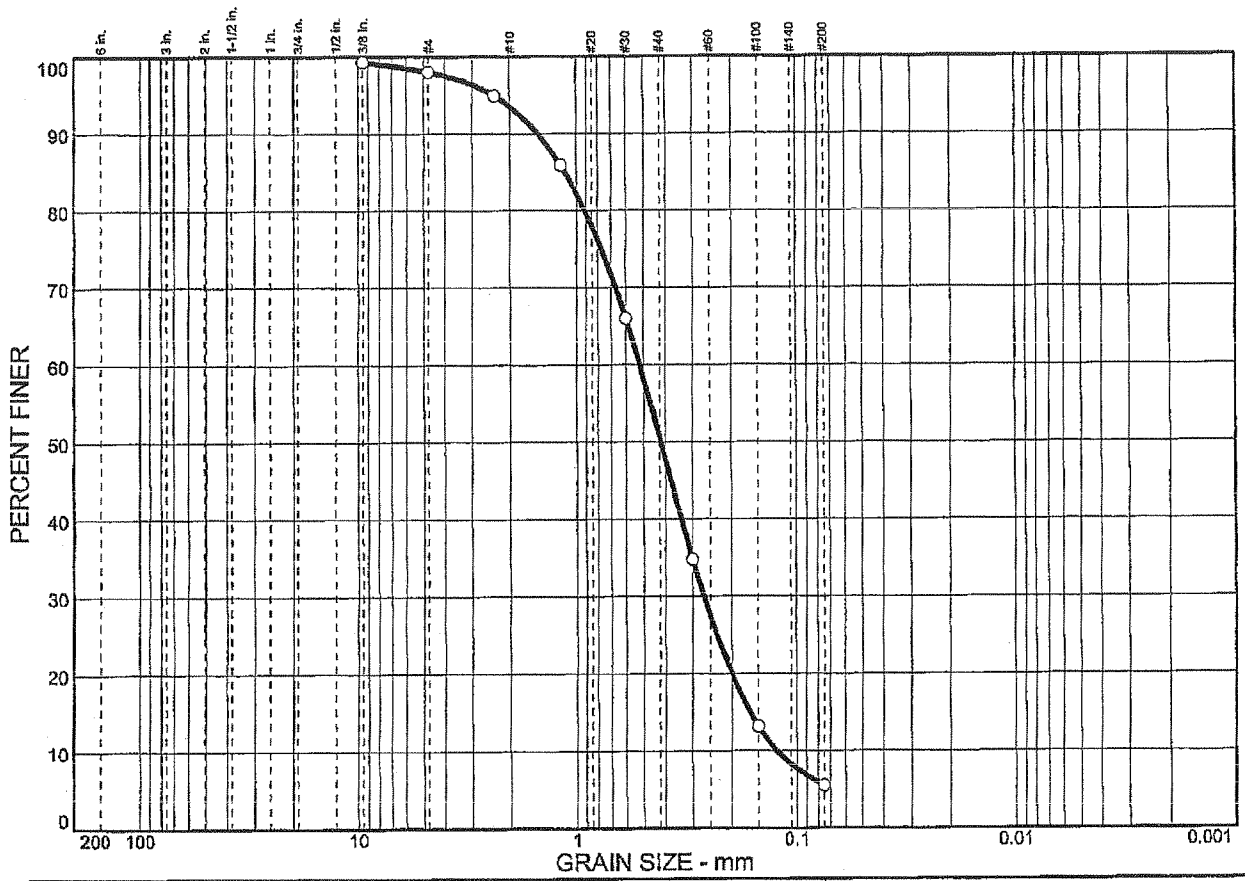
Client: Nolte

Project: Tahquitz Creek

Project No.: 0512 CR3

Plate

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
O				4.5	42.8	45.2	5.5	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
O	HA-1@1-4'	HA1@1-4'	1'-4'	Lt Brown, Poorly graded SAND with silt	SP-SM

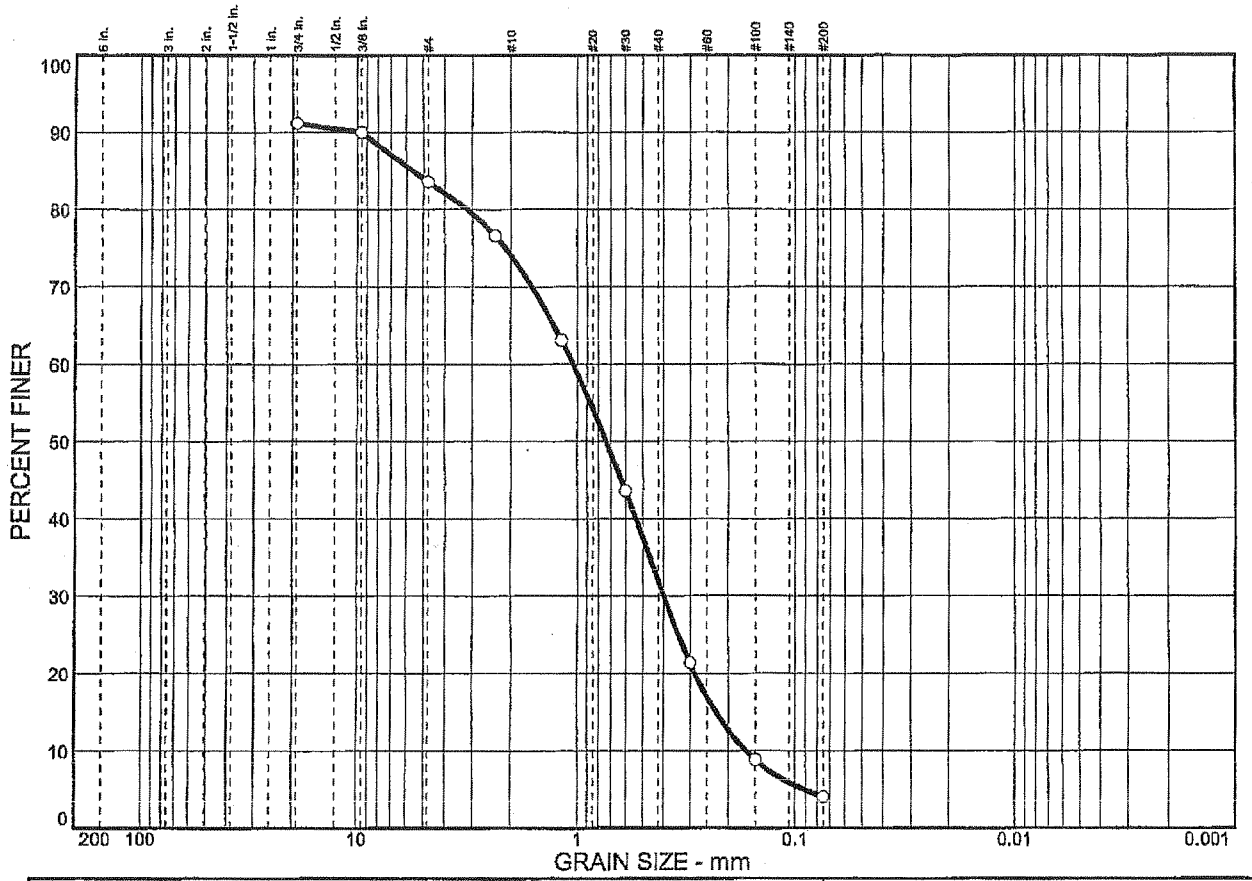
Particle Size Distribution Report

GeoTek, Inc.

Client: Nolte
Project: Tahquitz Creek
Project No.: 0512 CR3

Plate

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○			7.6	9.5	42.0	28.1	4.0	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
○	HA-2@1-4'	HA-2@1-4'	1'-4'	Lt.Brown, Poorly graded SAND with gravel	SP

Particle Size Distribution Report

GeoTek, Inc.

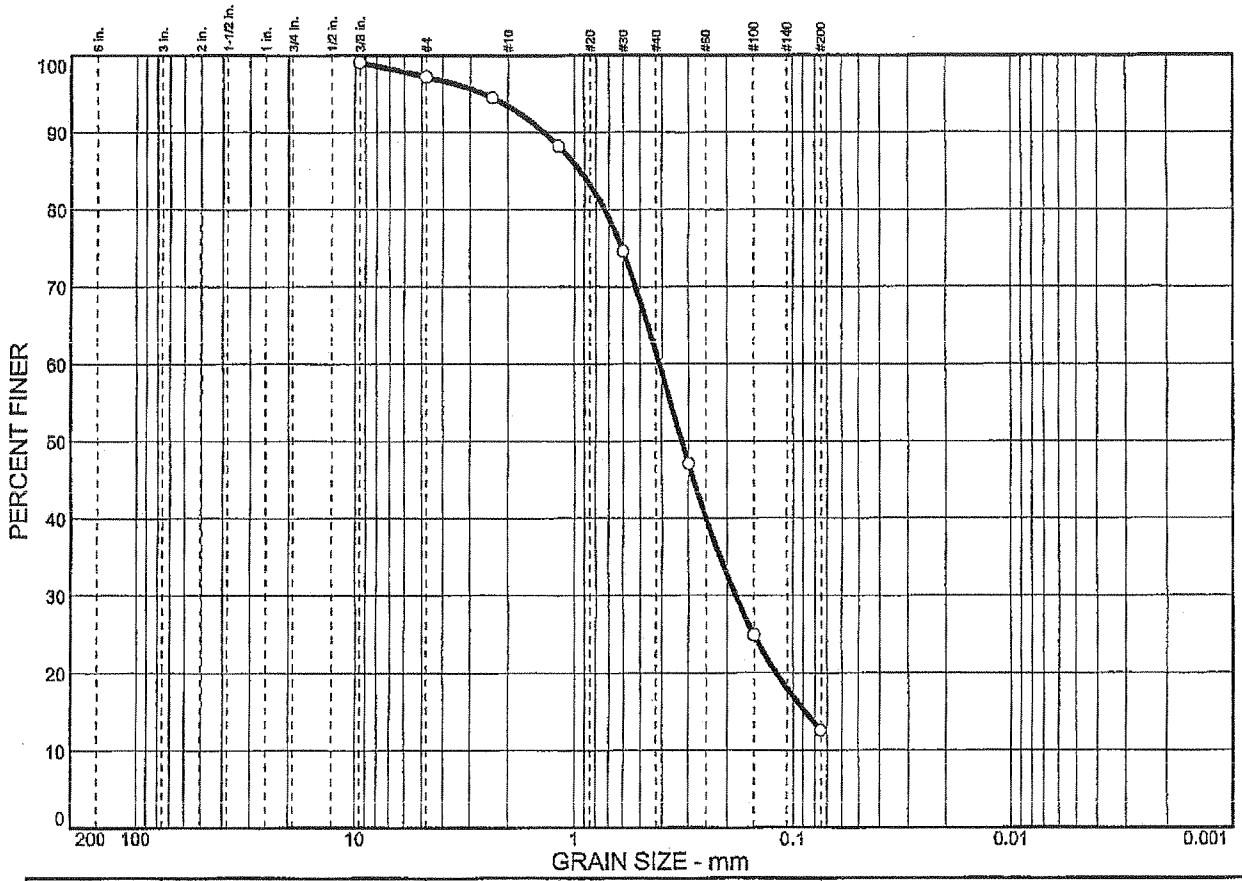
Client: Nolte

Project: Tahquitz Creek

Project No.: 0512 CR3

Plate

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○				3.8	31.8	49.0	12.6	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
○	HA-3@1-4'	HA-3@1-4'	1'-4'	Lt. Brown, Silty SAND	SM

Particle Size Distribution Report

GeoTek, Inc.

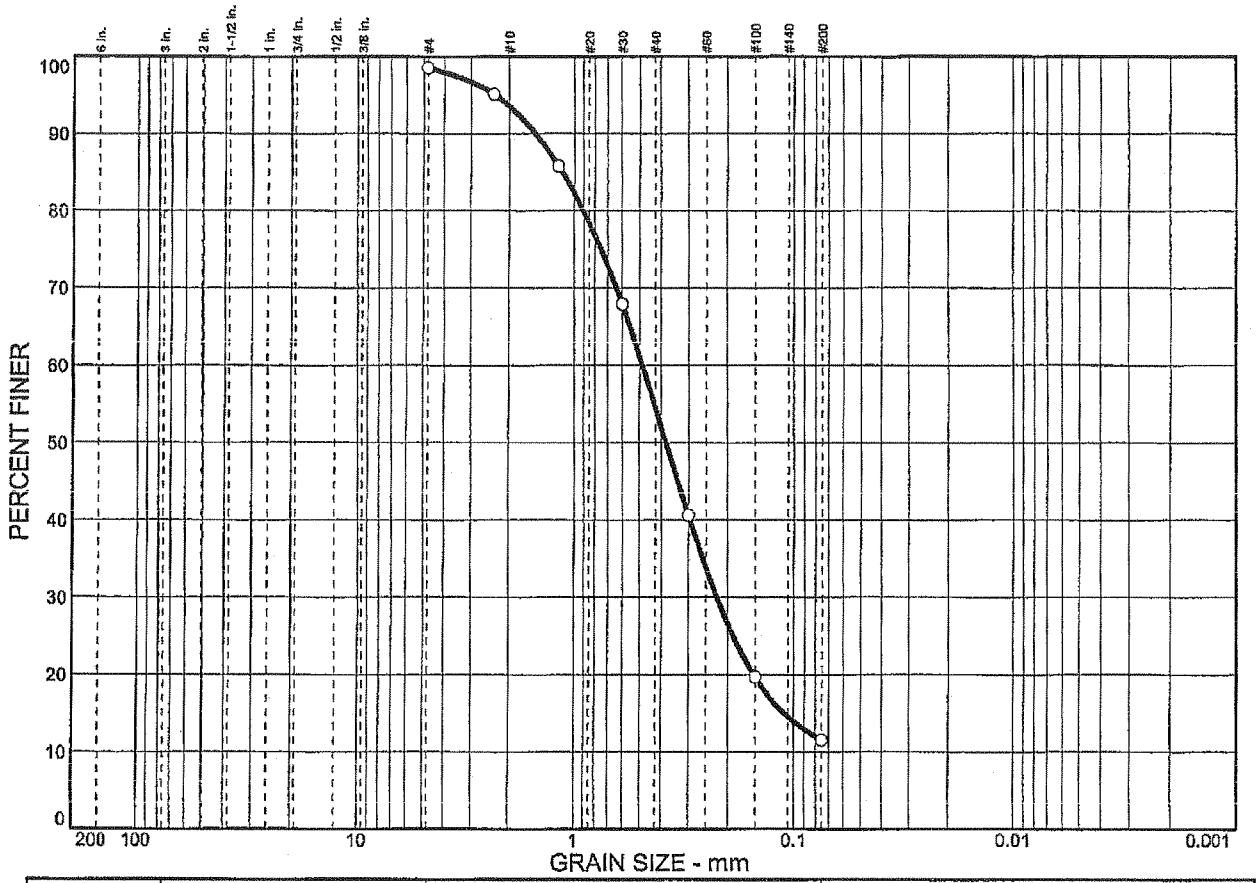
Client: Nolte

Project: Tahquitz Creek

Project No.: 0512 CR3

Plate

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○				4.9	38.9	43.2	11.5	

SOIL DATA

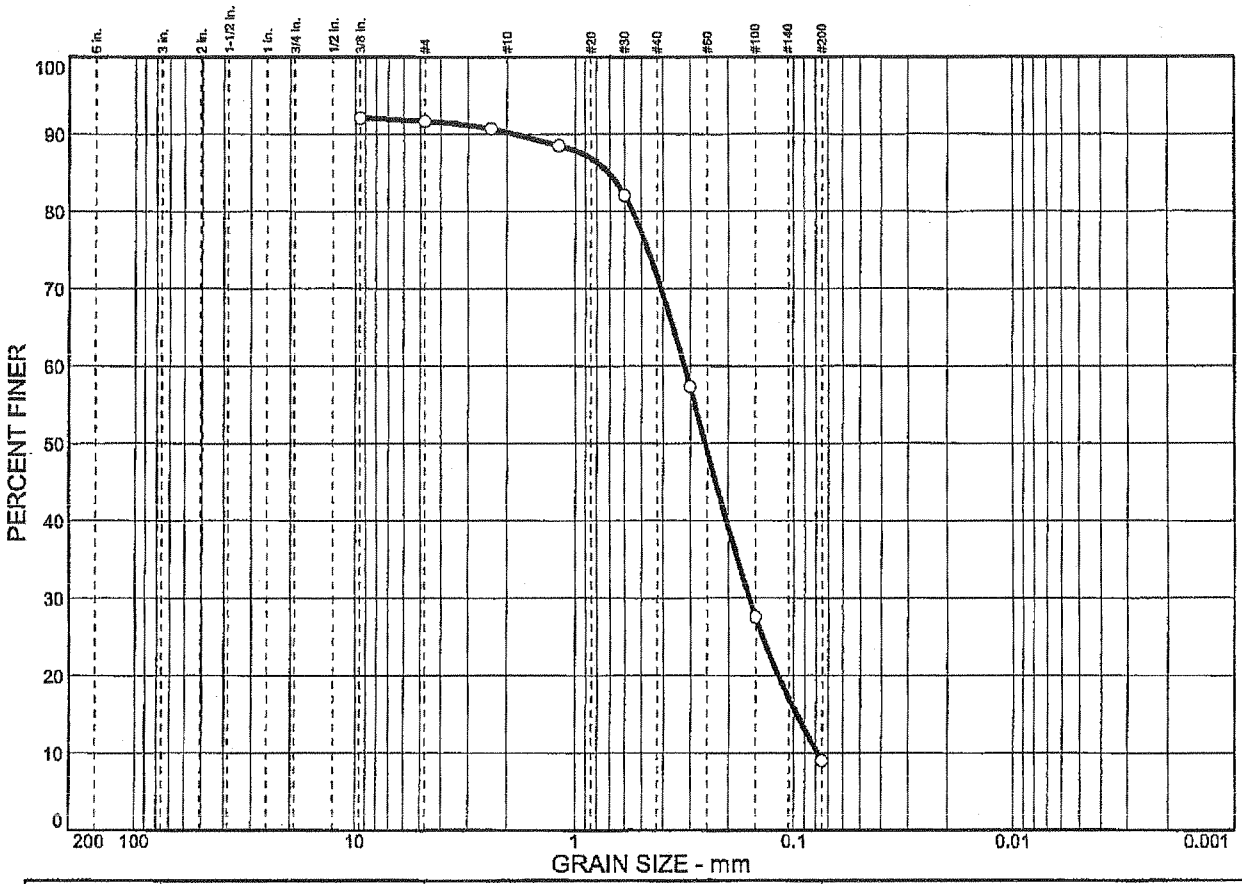
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
○	HA-4@1-4'	HA-4@1-4'	1'-4'	Lt. Brown, Poorly graded SAND with silt	SP-SM

Particle Size Distribution Report

GeoTek, Inc.

Client: Nolte
Project: Tahquitz Creek
Project No.: 0512 CR3 **Plate**

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○				1.4	18.5	62.8	9.0	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
○	B-1@5'	B1@5'	5'	Lt brown poorly graded SAND with silt	

Particle Size Distribution Report

GeoTek, Inc.

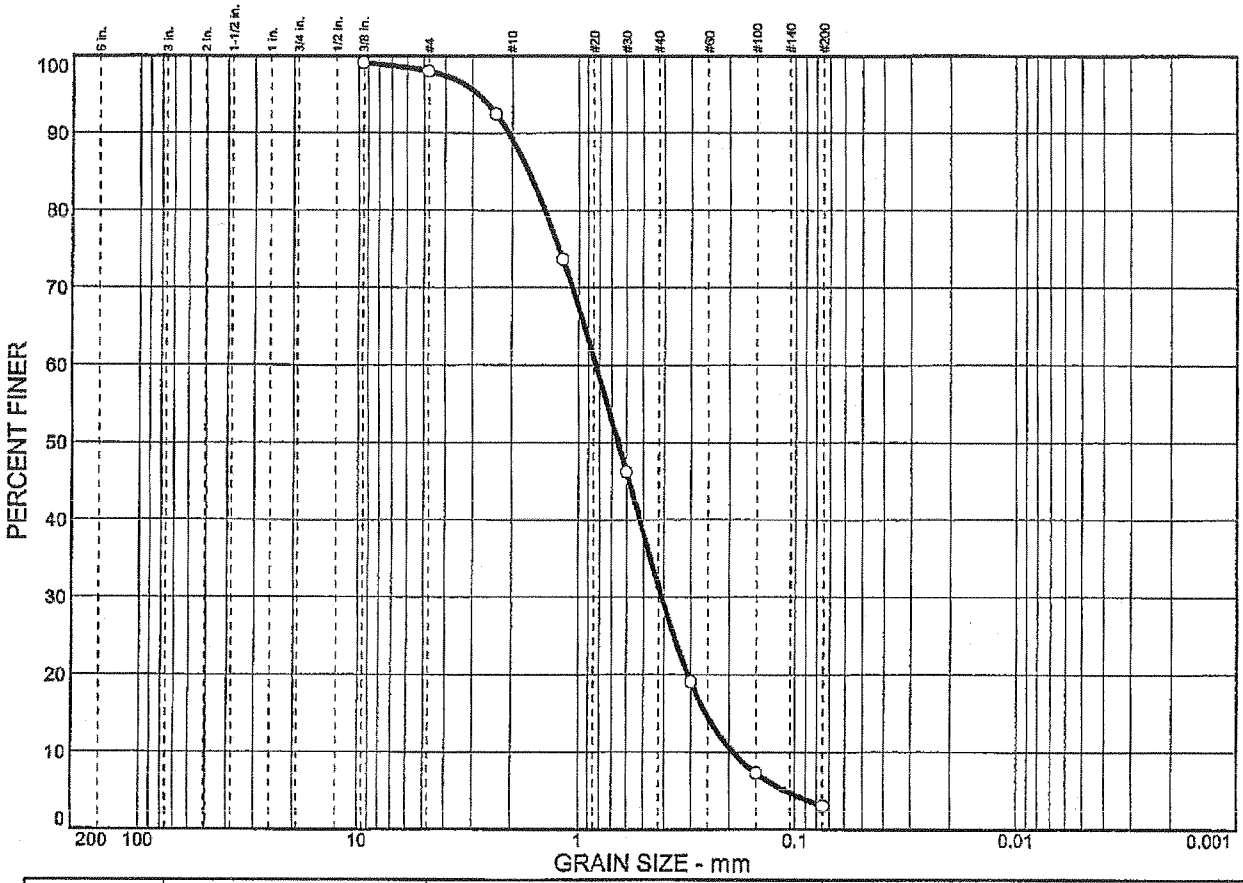
Client: Nolte

Project: Tahquitz Creek

Project No.: 0512 CR3

Plate

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○				8.7	57.8	28.5	3.0	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
○	B-1@10'	b-1@10'	10'	Lt brown poorly graded SAND	SP

Particle Size Distribution Report

GeoTek, Inc.

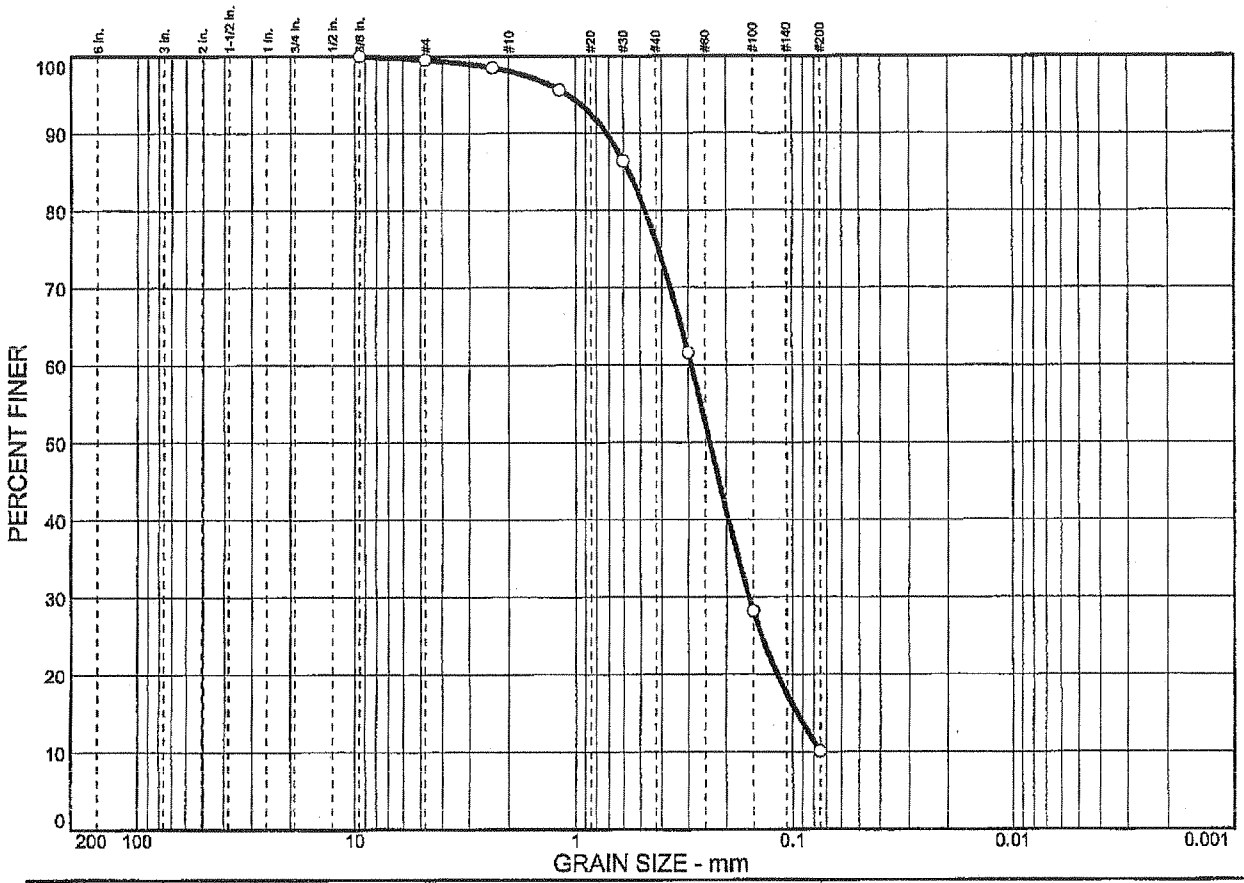
Client: Nolte

Project: Tahquitz Creek

Project No.: 0512 CR3

Plate

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	0.0	0.5	1.4	21.9	66.1	10.1	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
○	B-1@15'	B-1@15'	15'	Lt brown poorly graded SAND Poorly graded sand with silt	SP-SM

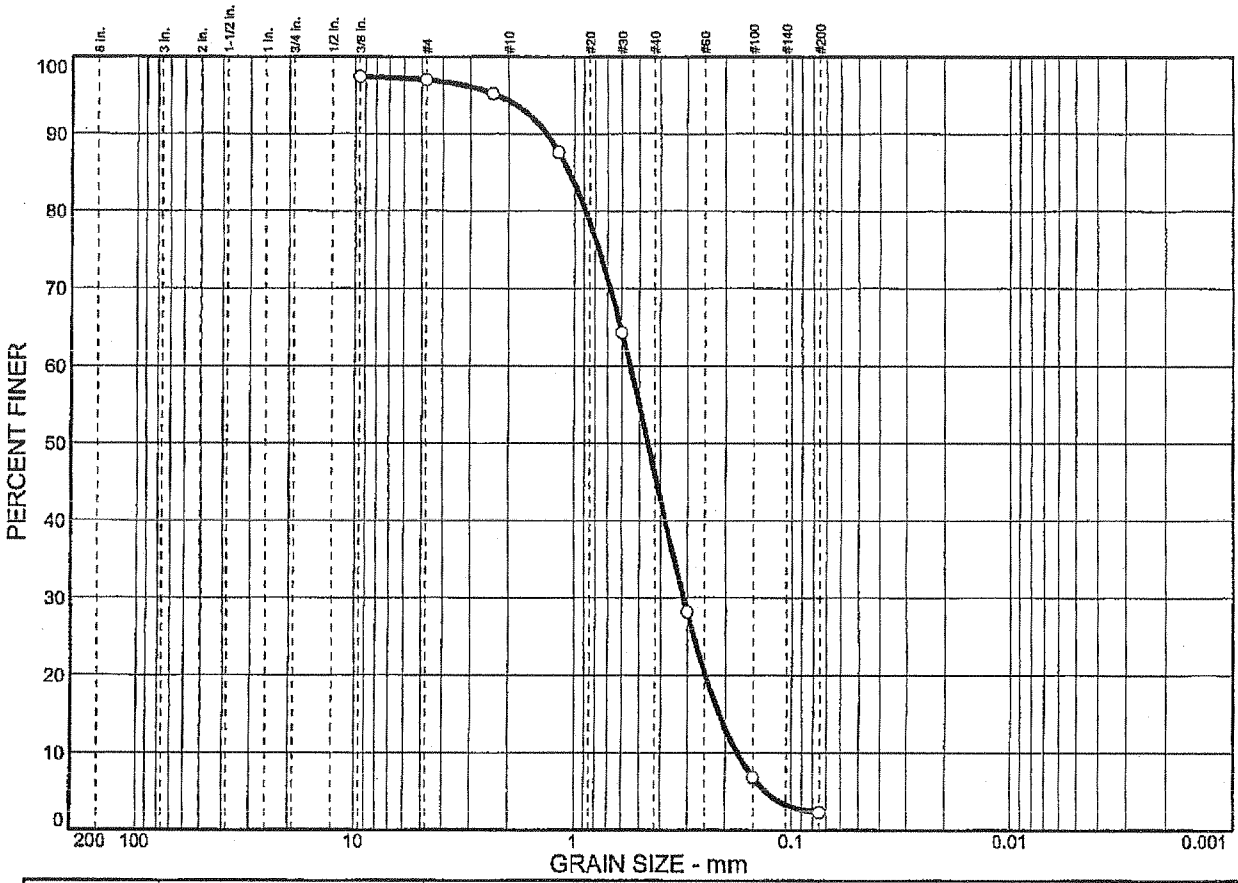
Particle Size Distribution Report

GeoTek, Inc.

Client: Nolte
Project: Tahquitz Creek
Project No.: 0512 CR3

Plate

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○				2.7	48.1	43.9	2.3	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
○	B-2@7.5'	B-2@7.5'	7.5'	Lt Brown,Poorly graded SAND	SP

Particle Size Distribution Report

GeoTek, Inc.

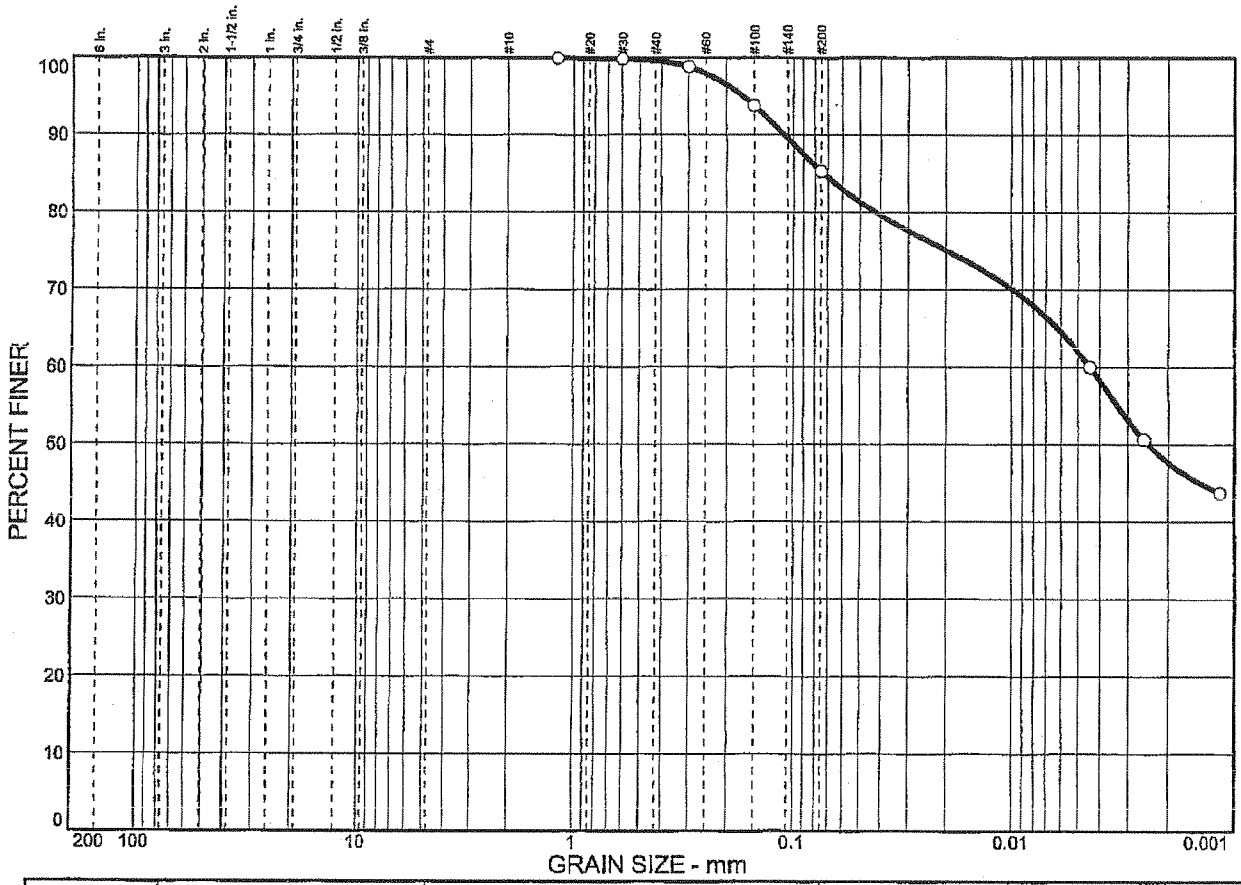
Client: Nolte

Project: Tahquitz Creek

Project No.: 0512 CR3

Plate

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○						14.3	23.3	62.0

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
○	B-2@30'	B-2@30'	30'	Grayish Brown SILT	ML

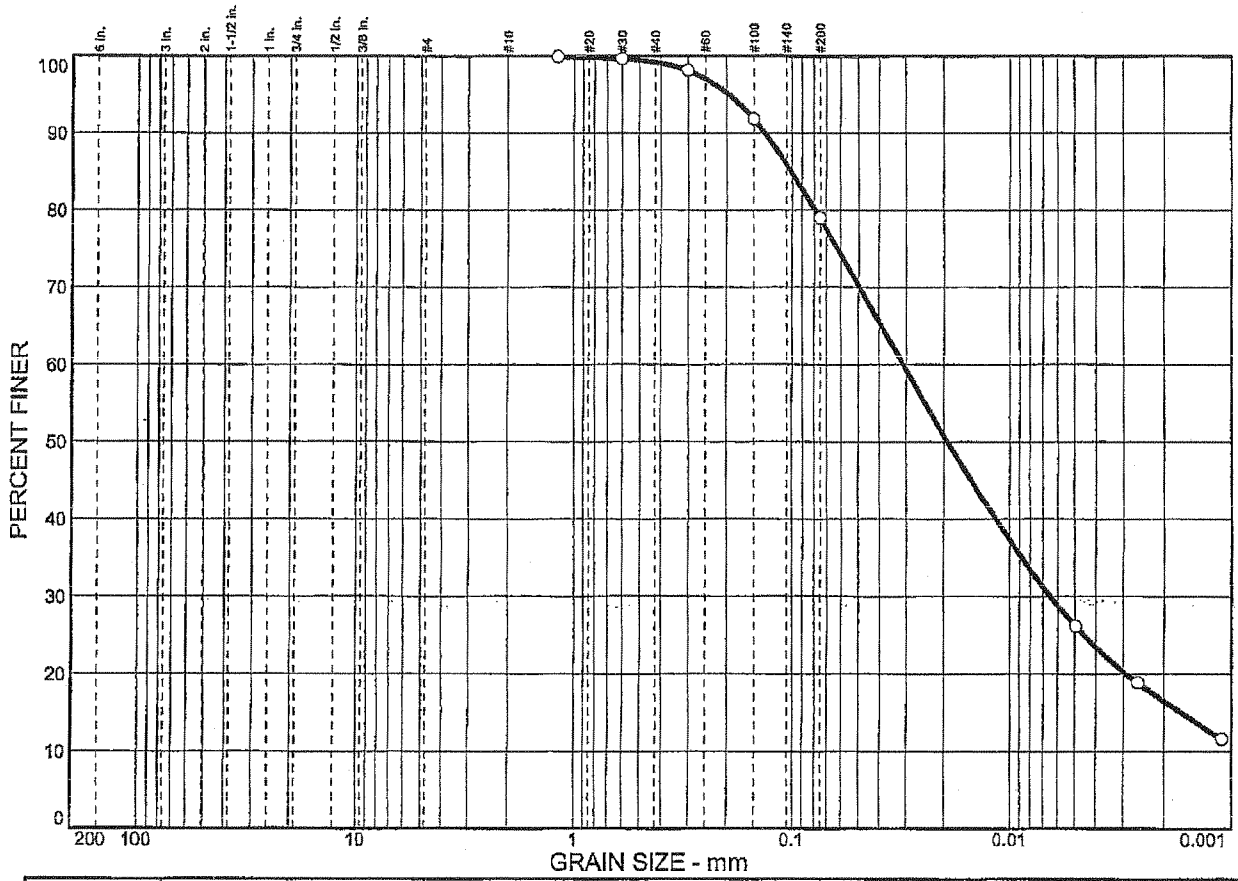
Particle Size Distribution Report

GeoTek, Inc.

Client: Nolte
Project: Tahquitz Creek
Project No.: 0512 CR3

Plate

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○						20.2	52.7	26.3

SOIL DATA

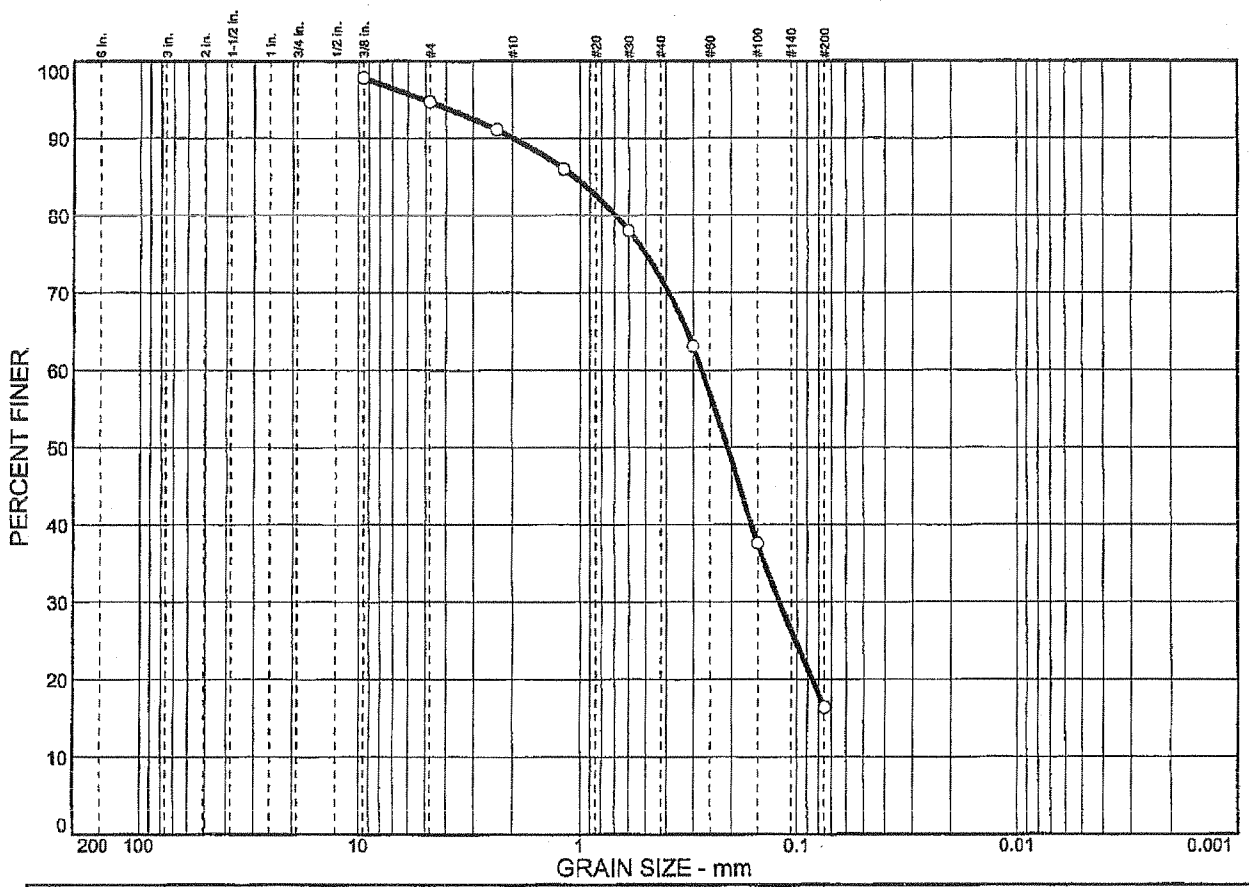
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
○	B-2a@30'	B-2a@30'	30'	Grayish brown SILT with sand	ML

Particle Size Distribution Report

GeoTek, Inc.

Client: Nolte
Project: Tahquitz Creek
Project No.: 0512 CR3
Plate

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○				4.6	18.1	55.6	16.4	

SOIL DATA

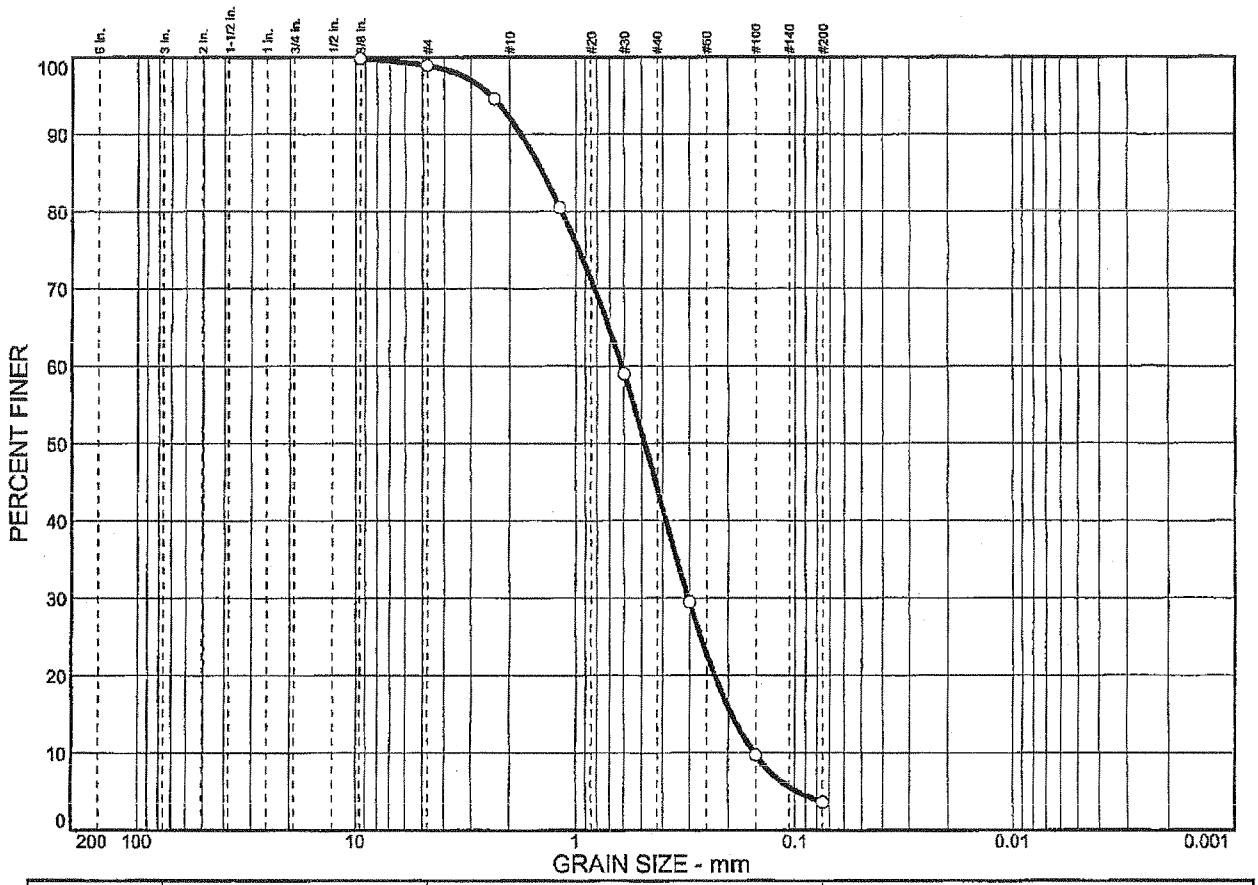
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
○	B-3@2.5'	B-3@2.5'	2.'	Lt Brown, Silty SAND	SM

Particle Size Distribution Report

GeoTek, Inc.

Client: Nolte
Project: Tahquitz Creek
Project No.: 0512 CR3 **Plate**

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○				6.8	47.8	40.7	3.6	

SOIL DATA

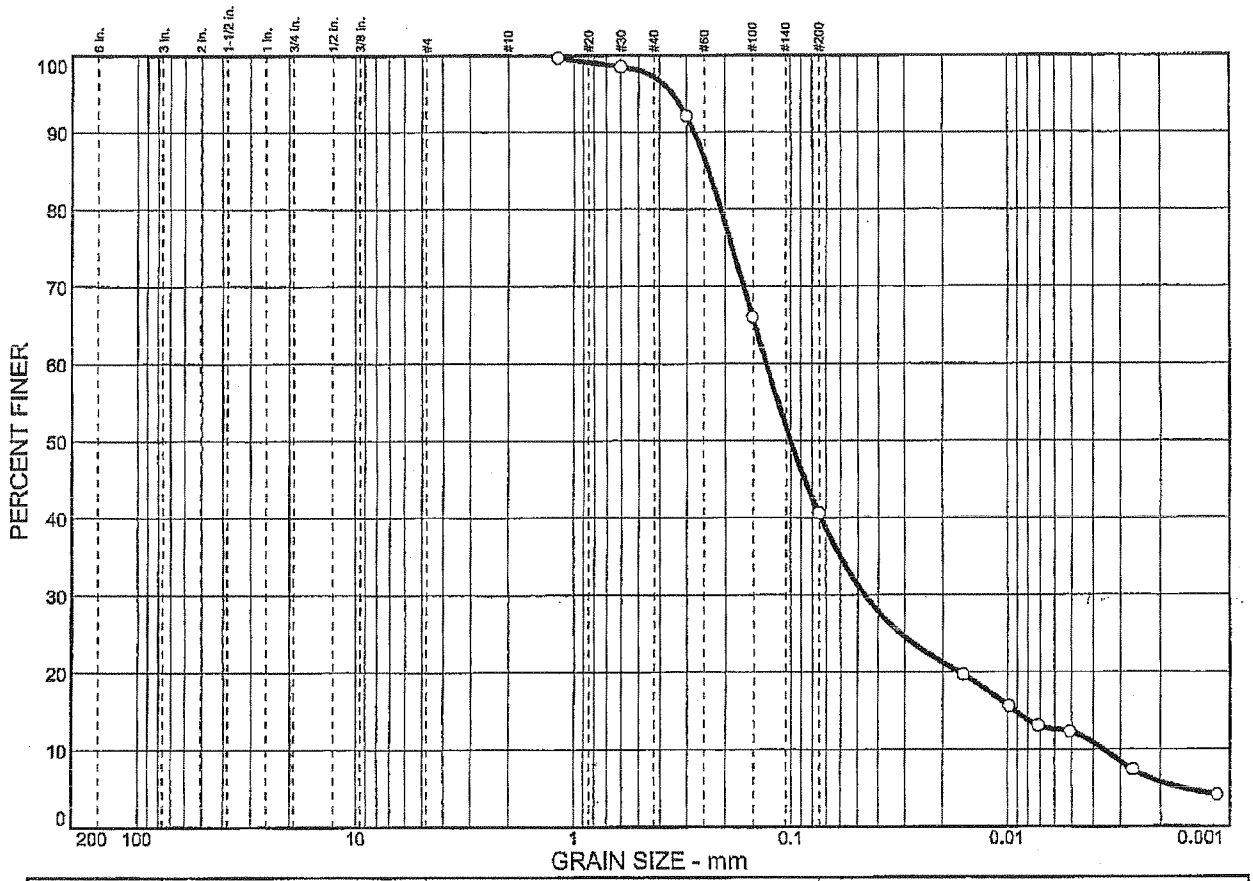
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
○	B-3@10'	B-3@10'	10'	Lt Brown,Poorly graded SAND	SP

Particle Size Distribution Report

GeoTek, Inc.

Client: Nolte
Project: Tahquitz Creek
Project No.: 0512 CR3 **Plate**

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○						56.6	28.4	12.2

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
○	B-3@30'	B-3@30'	30'	Gray Brown Silty SAND	

Particle Size Distribution Report

GeoTek, Inc.

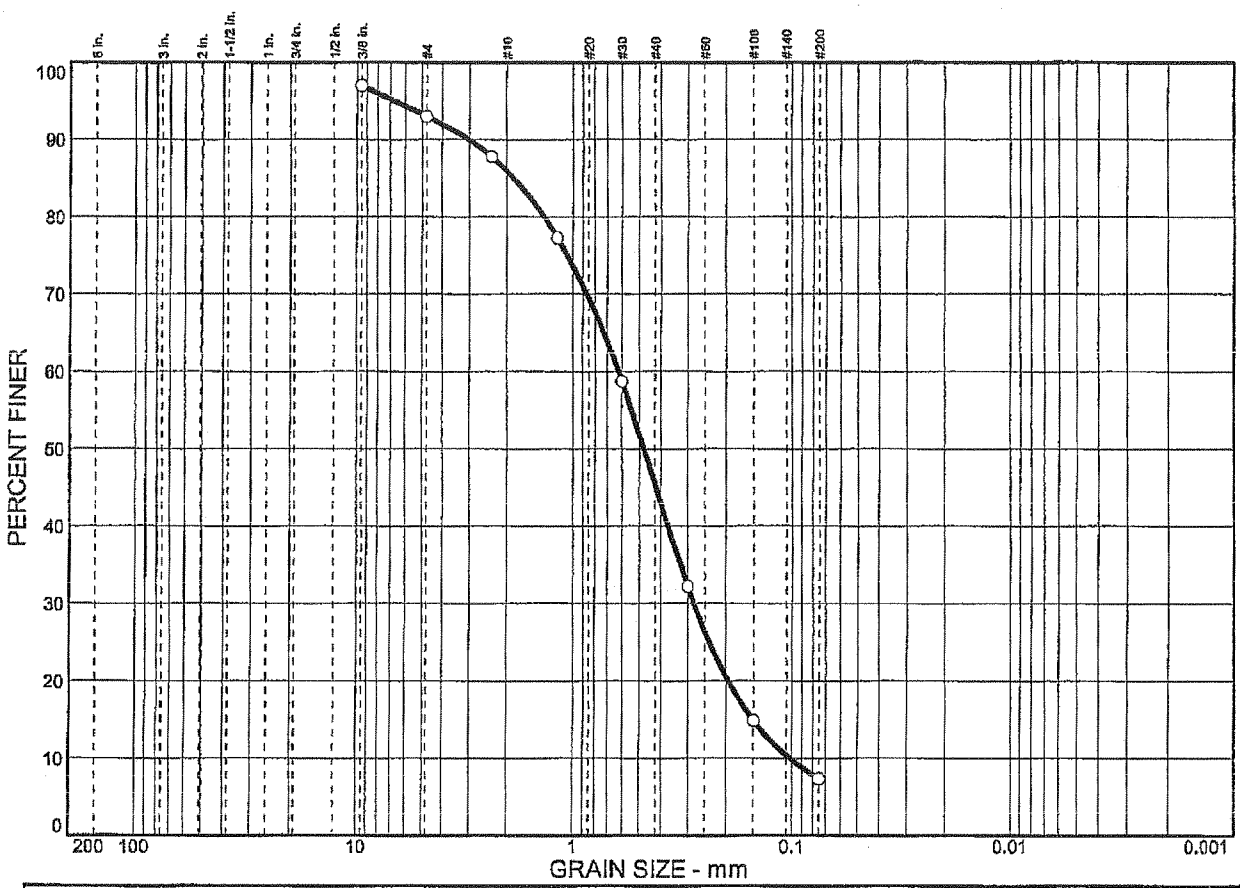
Client: Nolte

Project: Tahquitz Creek

Project No.: 0512 CR3

Plate

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○				7.1	40.5	38.1	7.3	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
○	B-4@2.5'	B-4@2.5'	2.5'	Lt, Brow, Well-graded SAND with silt	SW-SM

Particle Size Distribution Report

GeoTek, Inc.

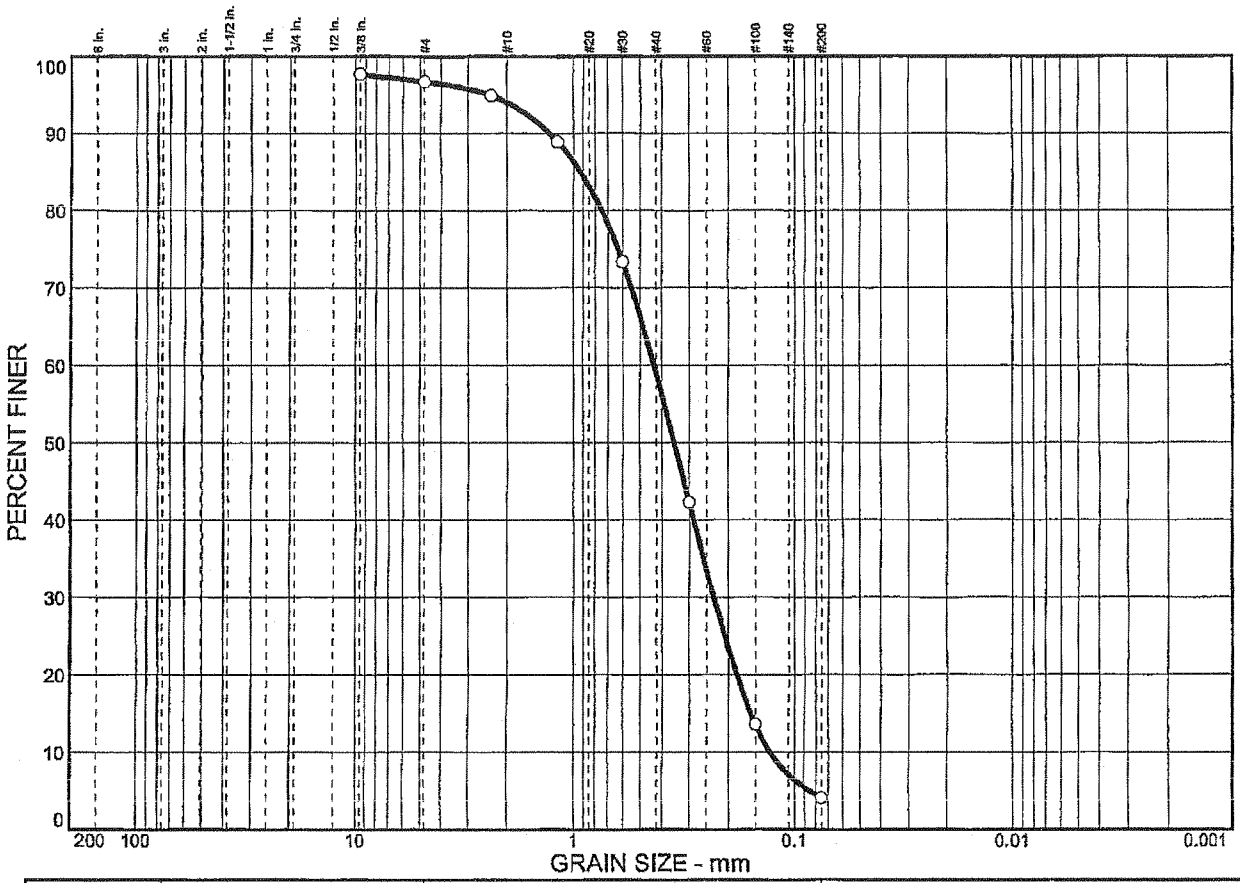
Client: Nolte

Project: Tahquitz Creek

Project No.: 0512 CR3

Plate

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○				2.7	34.9	55.0	4.1	

SOIL DATA

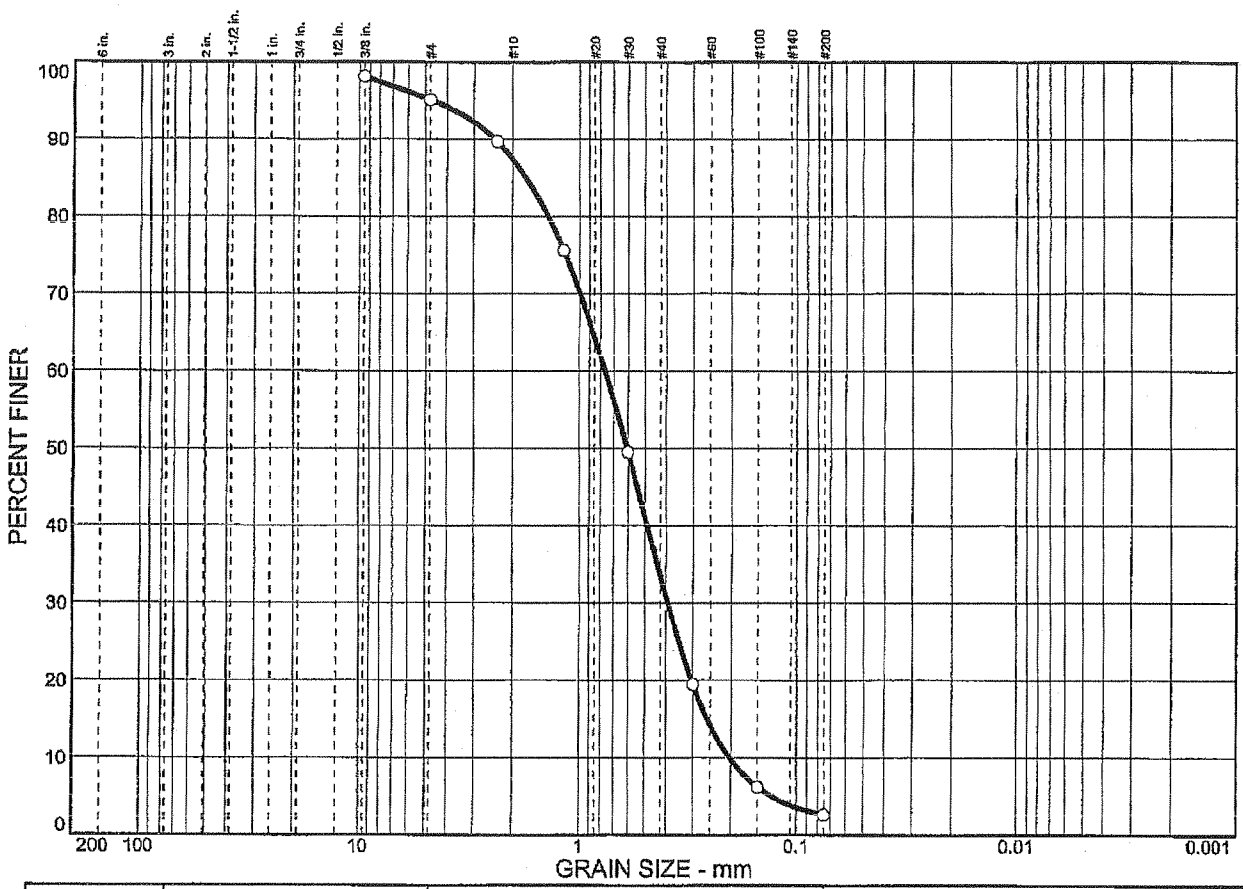
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
○	B-4@7.5'	B-4@7.5'	7.5	t Brown,Poorly graded SAND	SP

Particle Size Distribution Report

GeoTek, Inc.

Client: Nolte
Project: Tahquitz Creek
Project No.: 0512 CR3 **Plate**

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○				7.7	53.9	30.9	2.6	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
○	B-4@12.5'	B-4@12.5'	12.5'	Lt Brown, Poorly graded SAND	SP

Particle Size Distribution Report

GeoTek, Inc.

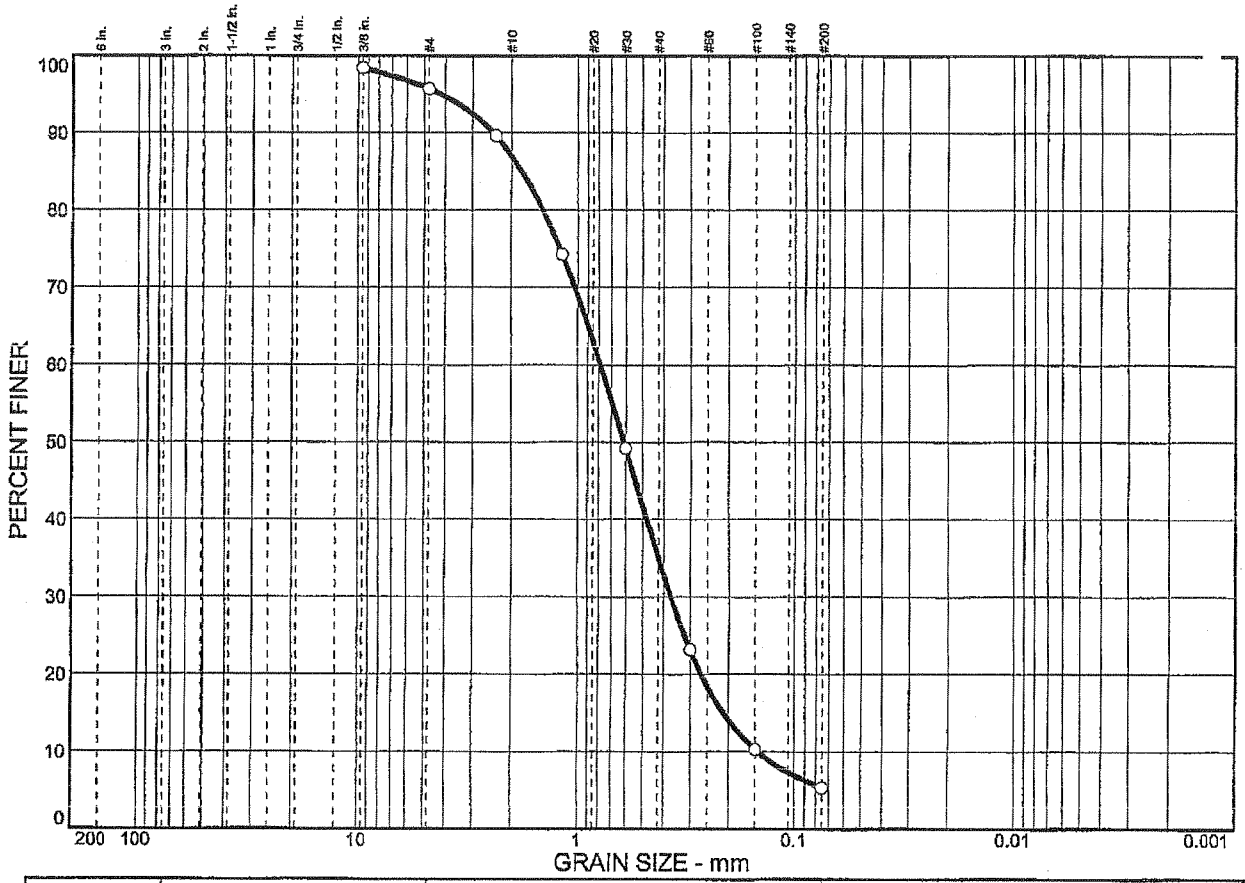
Client: Nolte

Project: Tahquitz Creek

Project No.: 0512 CR3

Plate

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○				8.7	51.7	30.0	5.3	

SOIL DATA

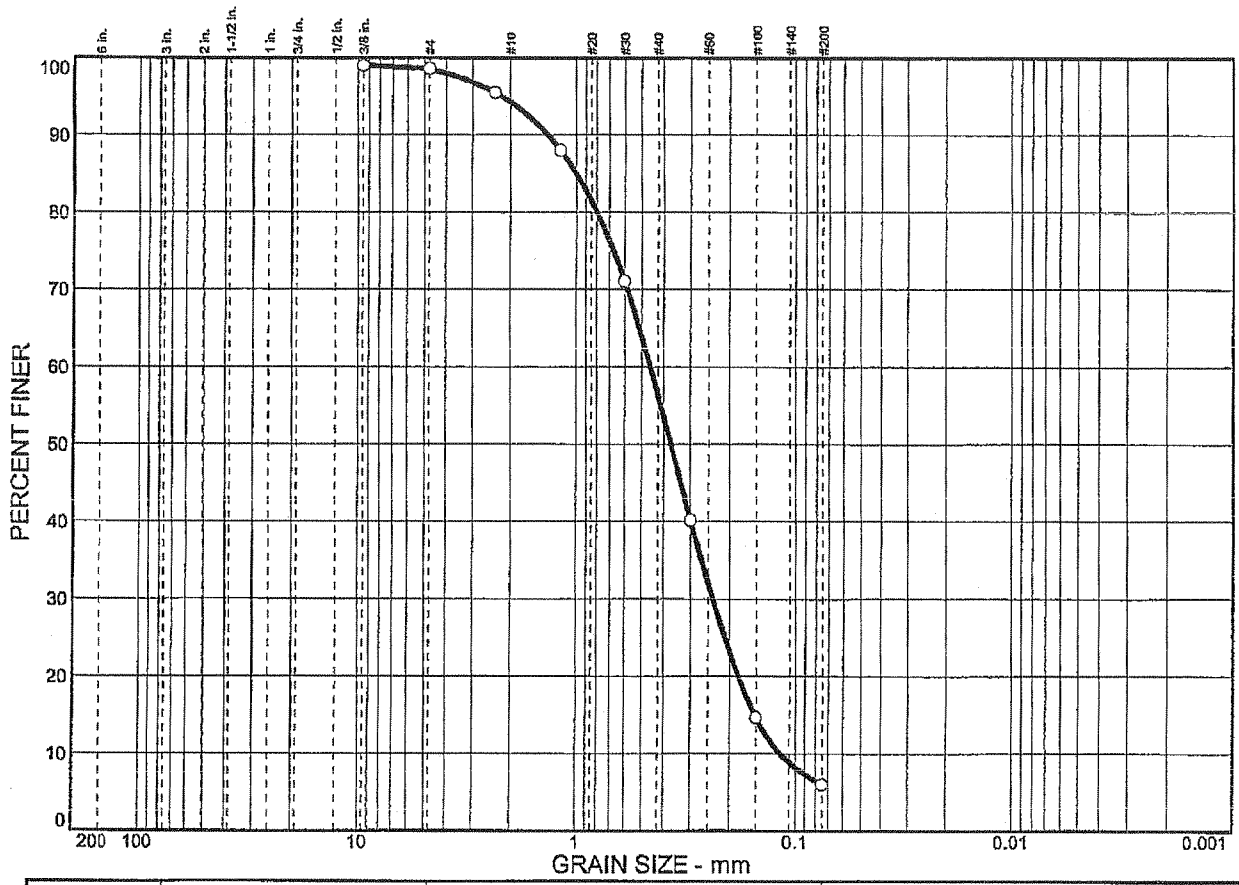
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
○	B-5@5'	B-5@5'	5'	Lt Brown,Poorly graded SAND with silt	SP-SM

Particle Size Distribution Report

GeoTek, Inc.

Client: Nolte
Project: Tahquitz Creek
Project No.: 0512 CR3
Plate

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
O				4.3	37.7	50.6	6.0	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
O	B-5@10'	B-5@10'	10'	Lt Brown,Poorly graded SAND with silt	SP-SM

Particle Size Distribution Report

GeoTek, Inc.

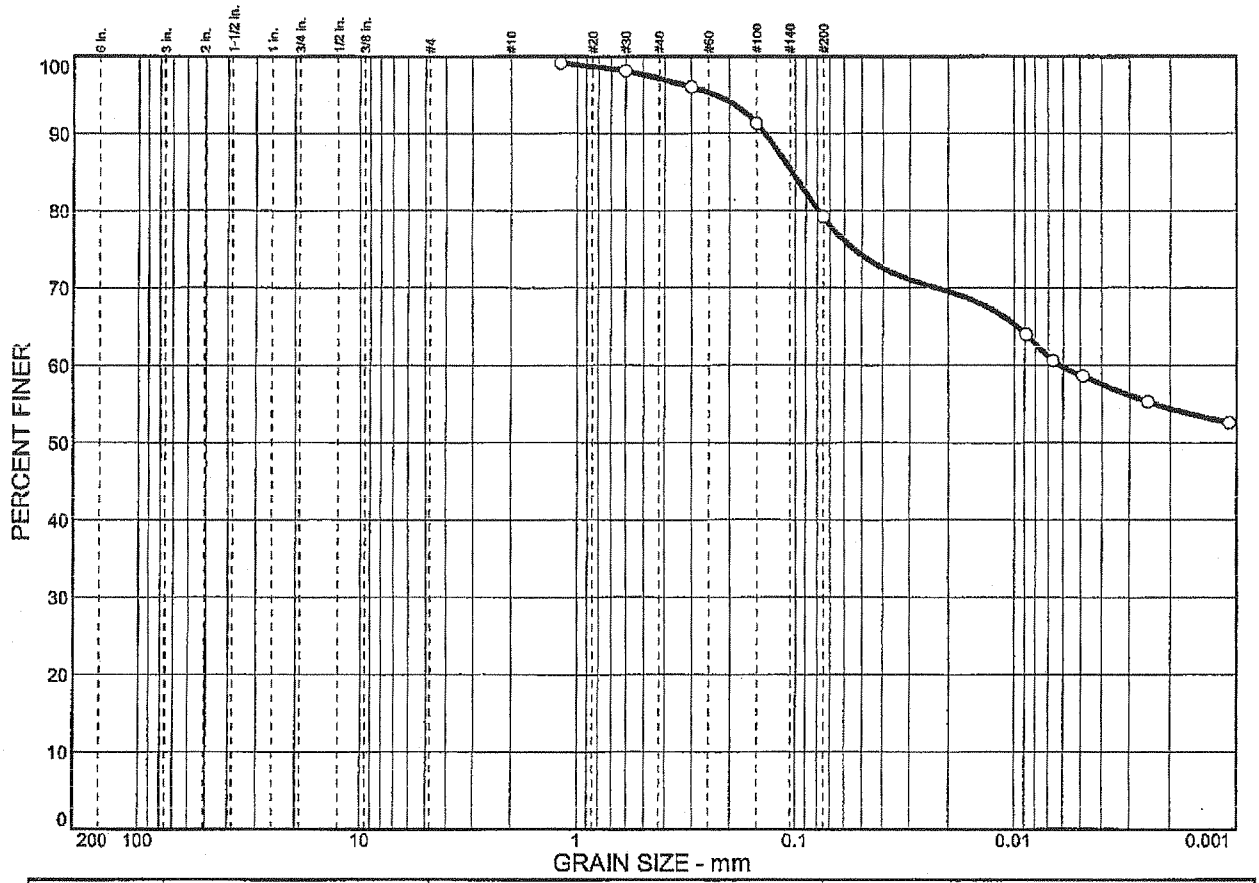
Client: Nolte

Project: Tahquitz Creek

Project No.: 0512 CR3

Plate

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○						18.0	20.5	58.8

SOIL DATA

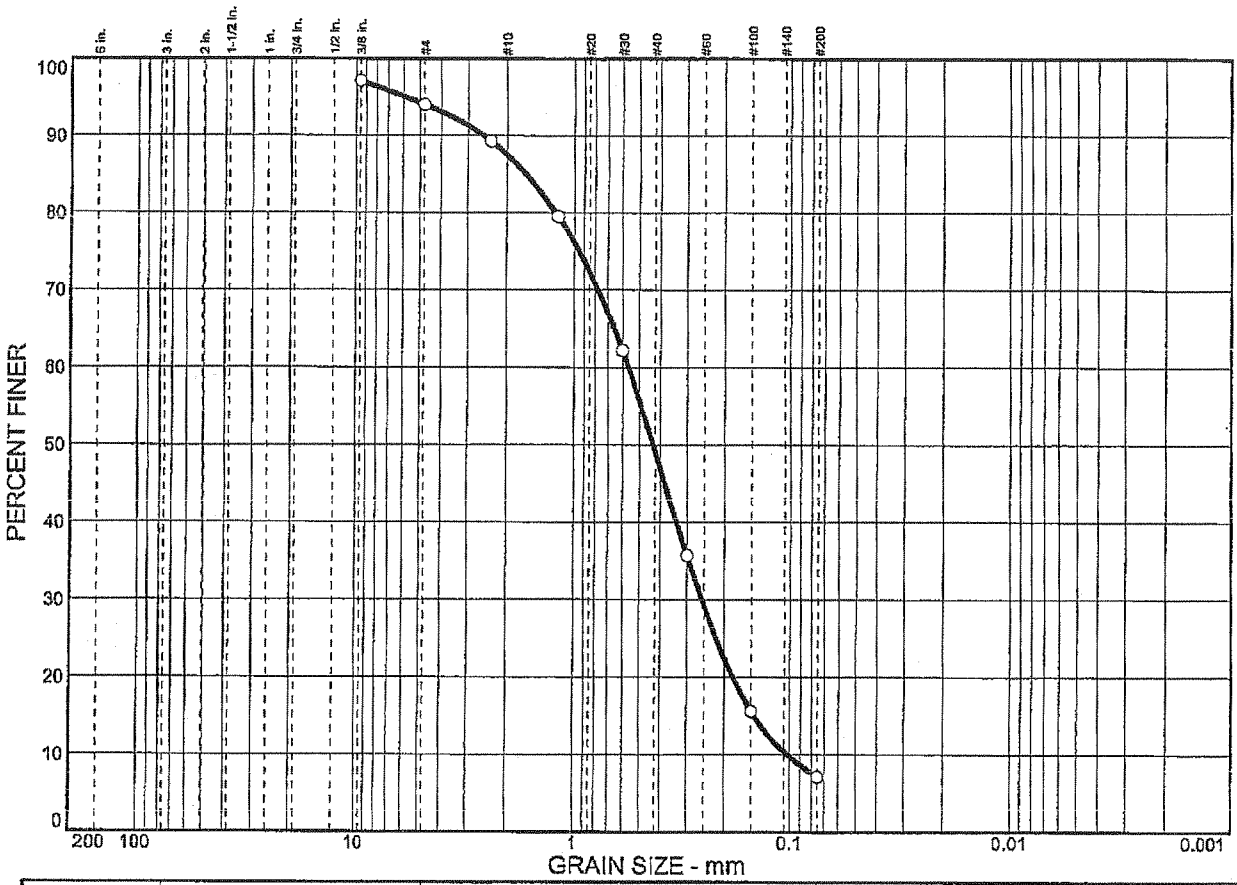
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
○	B-6@30'	B-6@30'	30'	Grayish Brown SILT	CL-ML

Particle Size Distribution Report

GeoTek, Inc.

Client: Nolte
Project: Tahquitz Creek
Project No.: 0512 CR3
Plate

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
O				6.5	38.2	42.2	7.1	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
O	B-7@5'	B-7@5'	5'	Lt' Brown,Poorly graded SAND with silt	SP-SM

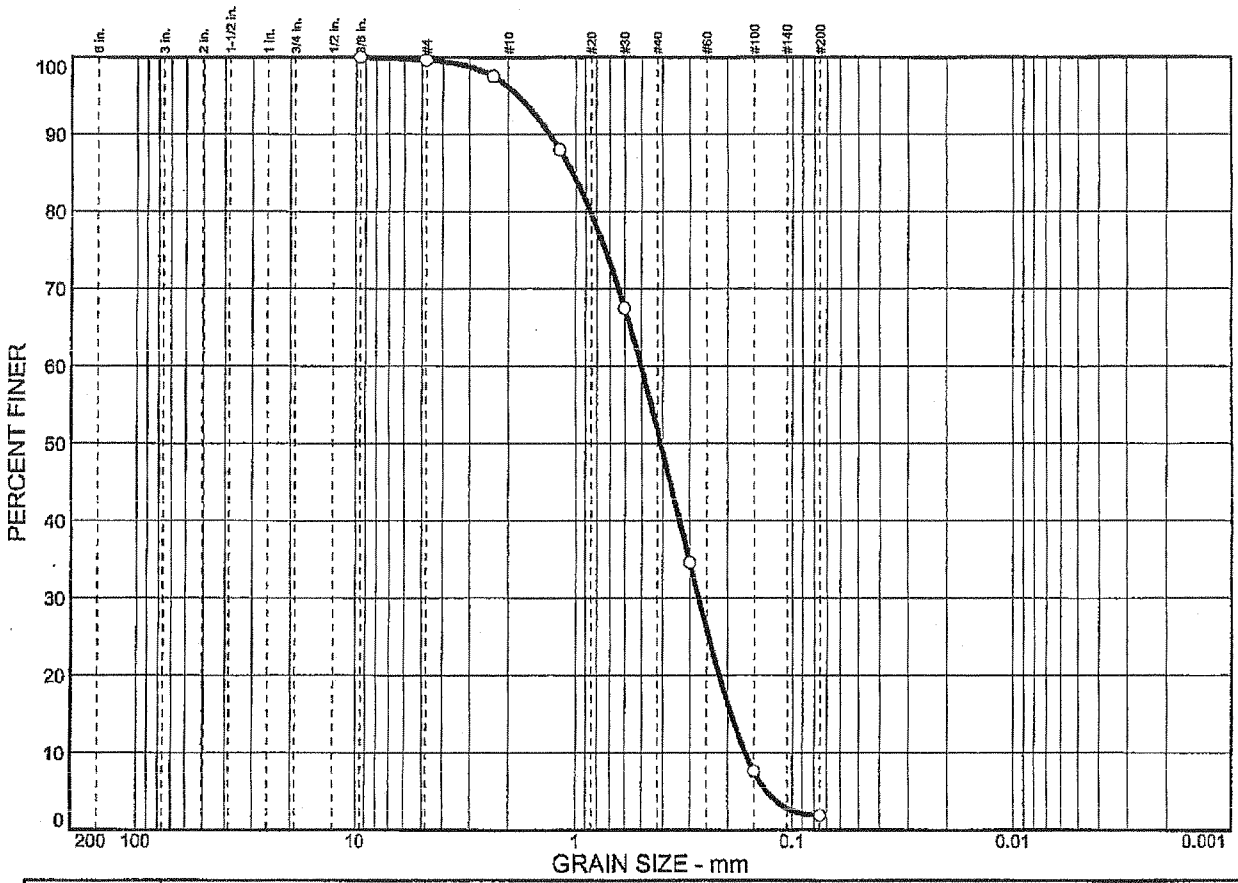
Particle Size Distribution Report

GeoTek, Inc.

Client: Nolte
Project: Tahquitz Creek
Project No.: 0512 CR3

Plate

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	0.0	0.4	3.5	44.3	49.9	1.9	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
○	B-7@10'	B-7@10'	10'	Lt Brown, Poorly graded SAND	SP

Particle Size Distribution Report

GeoTek, Inc.

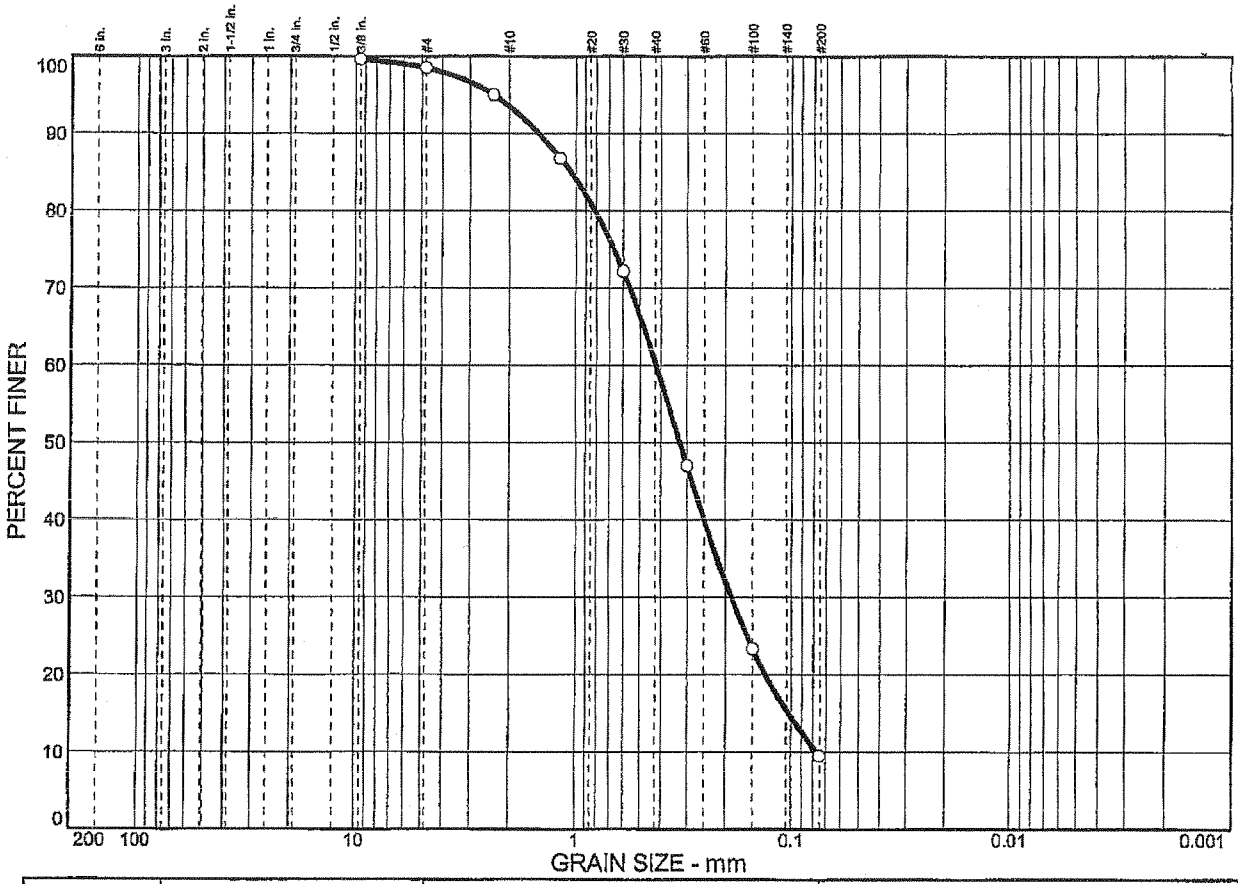
Client: Nolte

Project: Tahquitz Creek

Project No.: 0512 CR3

Plate

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
O				5.0	33.1	50.9	9.5	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
O	B-8@2.5'	B-8@2.5'	2.5'	Lt Brown, Poorly graded SAND with silt	SP-SM

Particle Size Distribution Report

GeoTek, Inc.

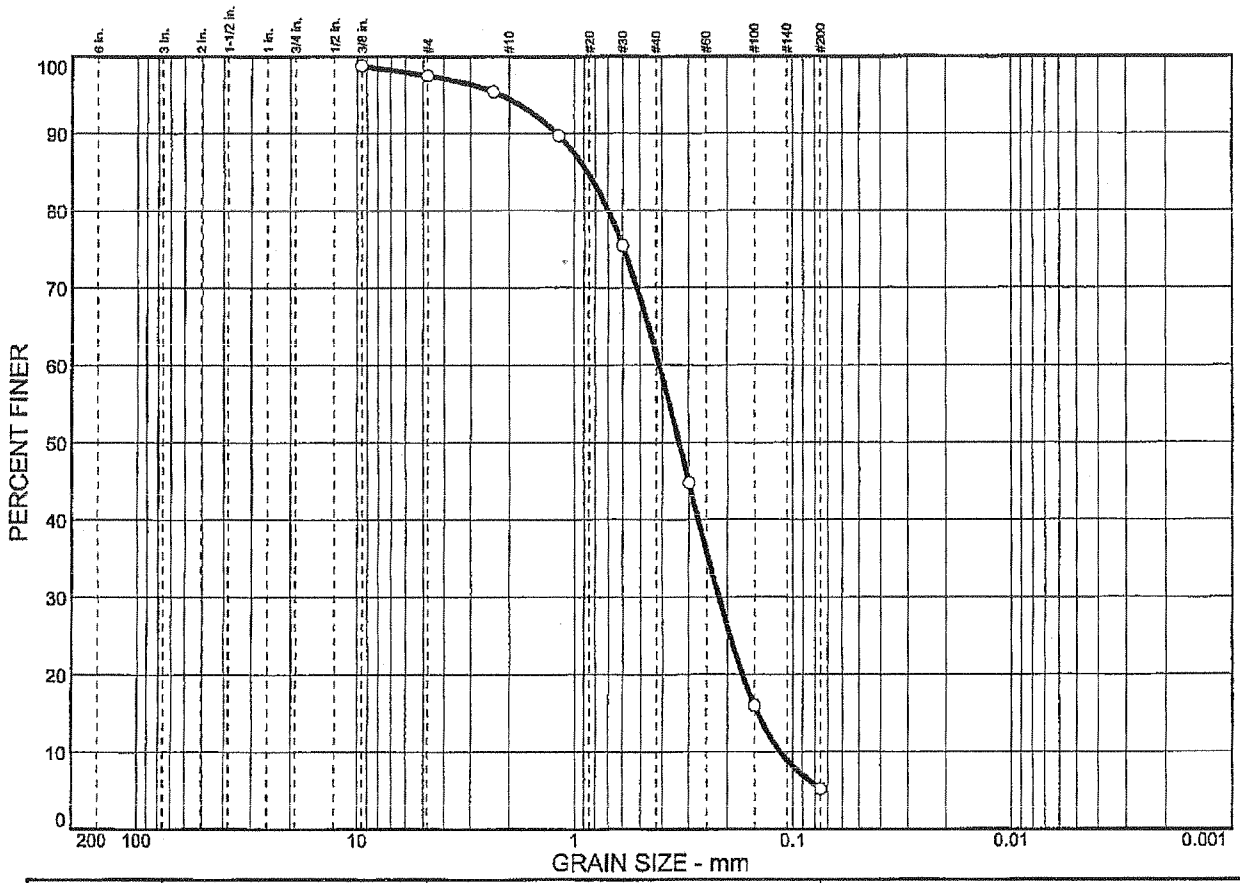
Client: Nolte

Project: Tahquitz Creek

Project No.: 0512 CR3

Plate

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○				3.0	32.9	56.4	5.2	

SOIL DATA

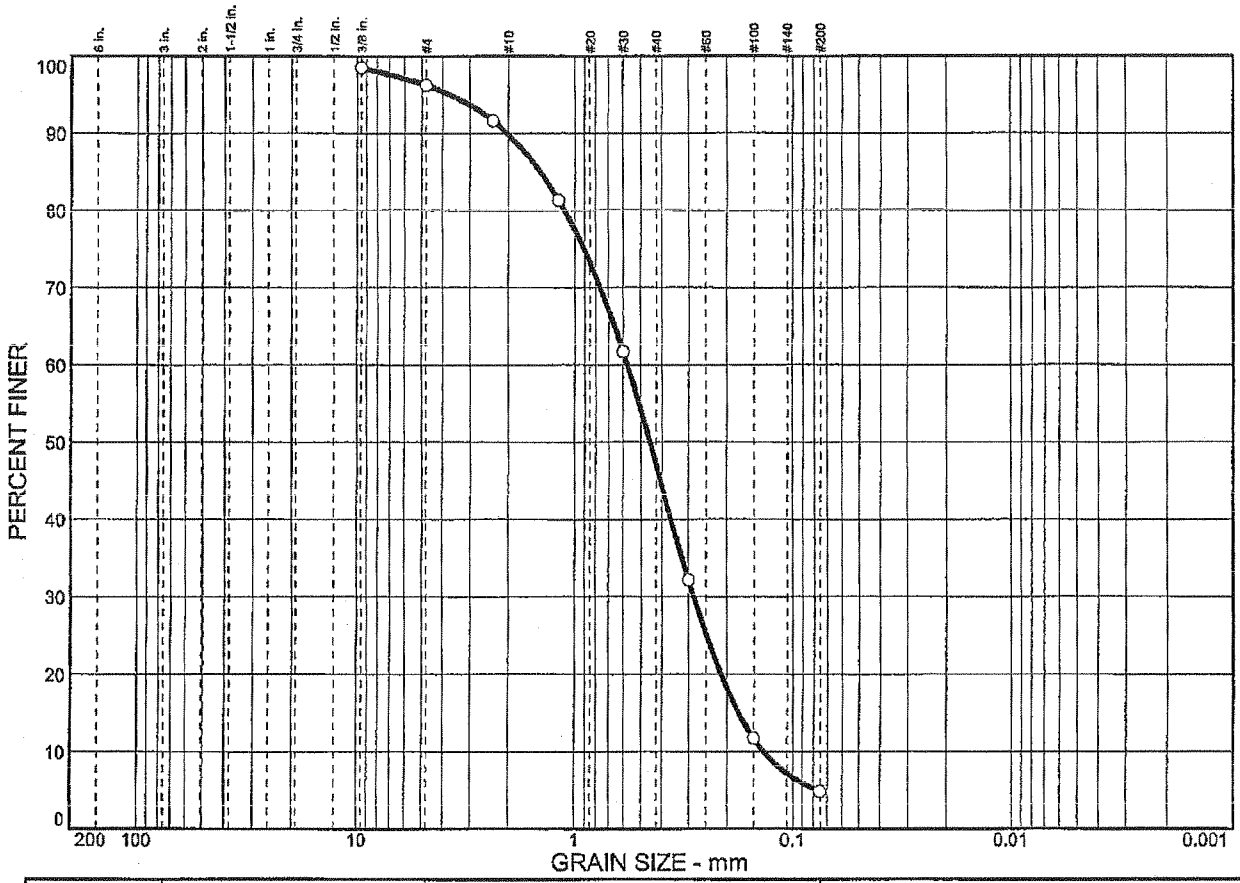
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
○	B-8@7.5'	B-8@7.5'	7.5'	Lt, Brown, Poorly graded SAND with silt	SP-SM

Particle Size Distribution Report

GeoTek, Inc.

Client: Nolte
Project: Tahquitz Creek
Project No.: 0512 CR3
Plate

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
O				6.4	42.6	42.4	4.8	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
O	B-9@5'	B-9@5'	5'	Lt Brown Poorly graded SAND	SP

Particle Size Distribution Report

GeoTek, Inc.

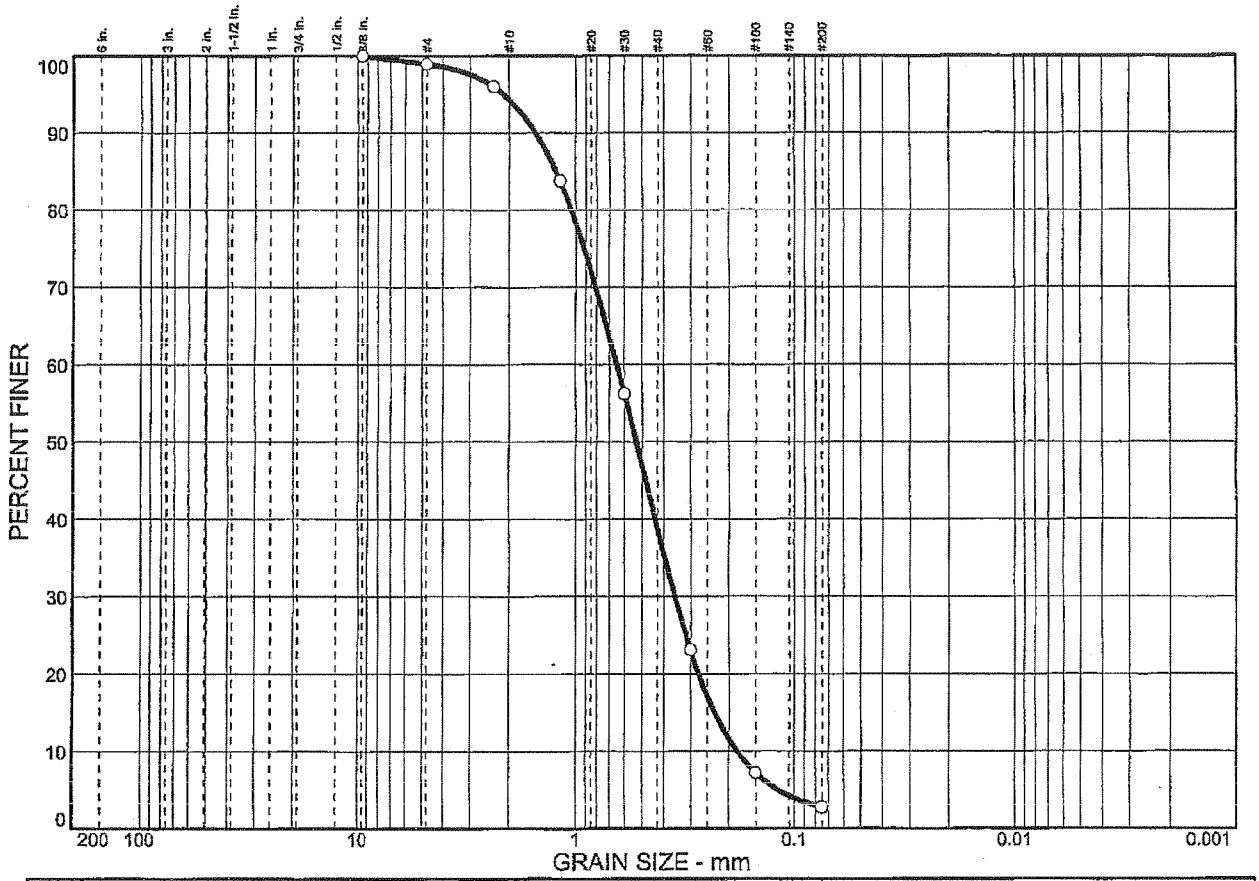
Client: Nolte

Project: Tahquitz Creek

Project No.: 0512 CR3

Plate

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	0.0	1.1	4.6	55.6	36.0	2.7	

SOIL DATA

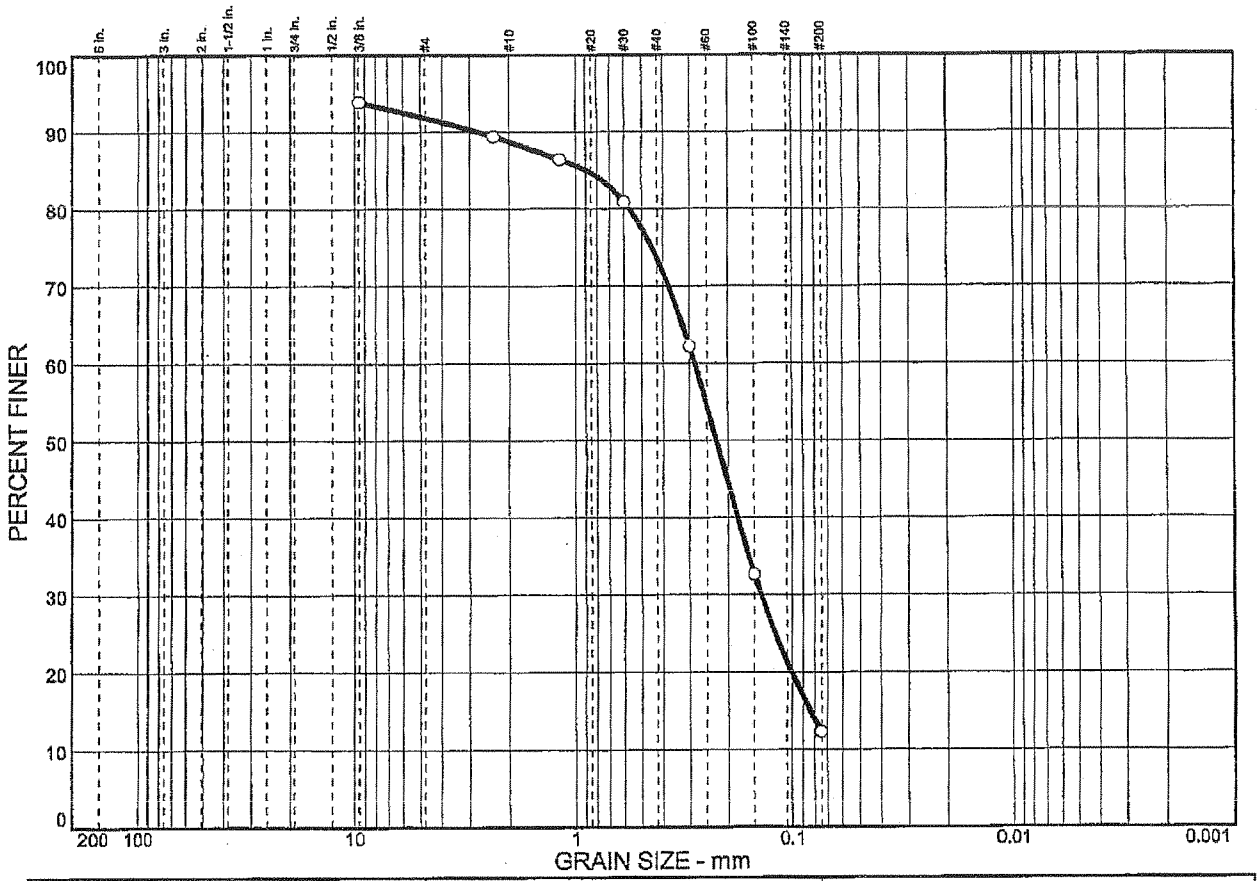
SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
○	B-9@10'	B-9@10'	10'	Lt. Brown, Poorly graded SAND	SP

Particle Size Distribution Report

GeoTek, Inc.

Client: Nolte
Project: Tahquitz Creek
Project No.: 0512 CR3
Plate

Particle Size Distribution Report



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○				3.1	15.1	61.4	12.3	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	DESCRIPTION	USCS
○	B-9@25'	B-9@25'	25'	Brown, Silty SAND	SM

Particle Size Distribution Report

GeoTek, Inc.

Client: Nolte
Project: Tahquitz Creek
Project No.: 0512 CR3
Plate

AP Engineering & Testing, Inc.

FLEXIBLE WALL HYDRAULIC CONDUCTIVITY TEST
ASTM D5084

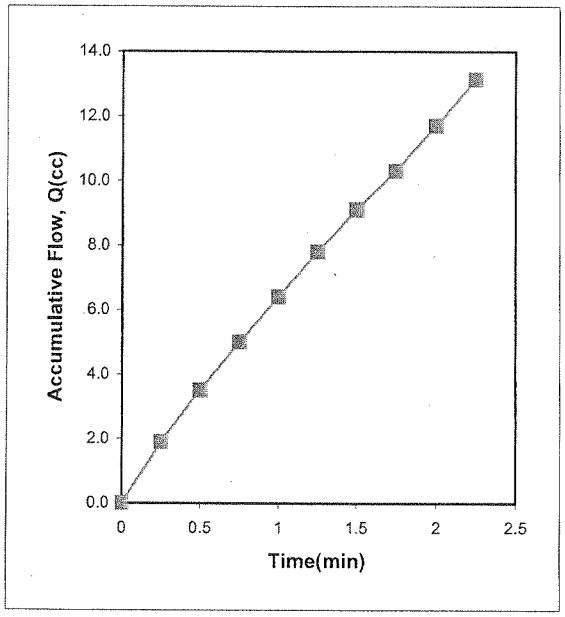
Project Name:	Tahquitz	Tested by:	KK	Date	04/23/09
Project No.:	0512-CR3	Calculated by:	KM	Date	04/24/09
Sample Location:	B-3	Checked by:	AP	Date	04/27/09
Sample No.:	- Depth: 7.5 feet				
Soil Description:	Grayish Brown Poorly-Graded Sand				
Test Condition:	Mod. Cal.				
	Confining Pressure = 5 psi				

INITIAL CONDITION OF SPECIMEN

Diameter (d)	2.38	in
Sample Area (A)	4.43	in²
Length (L)	2.00	in
Weight Before	213.16	g
Wet Density	91.64	pcf
Dry Density	86.86	pcf

	Before	After
Container No.		
Wt. Wet Soil+Container(gms)		301.36
Wt. Dry Soil+Container(gms)		244.34
Wt. Container (gms)		50.4
Moisture, (%)	5.50	29.40

TEST RESULTS



Time (min)	Flow Rdg (cm)	Burette Factor	Q (cc)	Head, h (psi)	h/L	Q/t (cc/s)
0	32.9	1	0.0	1.0	13.8	0
0.25	31.0	1	1.9	1.0	13.8	1.27E-01
0.5	29.4	1	3.5	1.0	13.8	1.07E-01
0.75	27.9	1	5.0	1.0	13.8	1.00E-01
1	26.5	1	6.4	1.0	13.8	9.33E-02
1.25	25.1	1	7.8	1.0	13.8	9.33E-02
1.5	23.8	1	9.1	1.0	13.8	8.67E-02
1.75	22.6	1	10.3	1.0	13.8	8.00E-02
2	21.2	1	11.7	1.0	13.8	9.33E-02
2.25	19.8	1	13.1	1.0	13.8	9.53E-02

Hydraulic Conductivity (cm/sec): 2.27E-04

AP Engineering & Testing, Inc.

FLEXIBLE WALL HYDRAULIC CONDUCTIVITY TEST
ASTM D5084

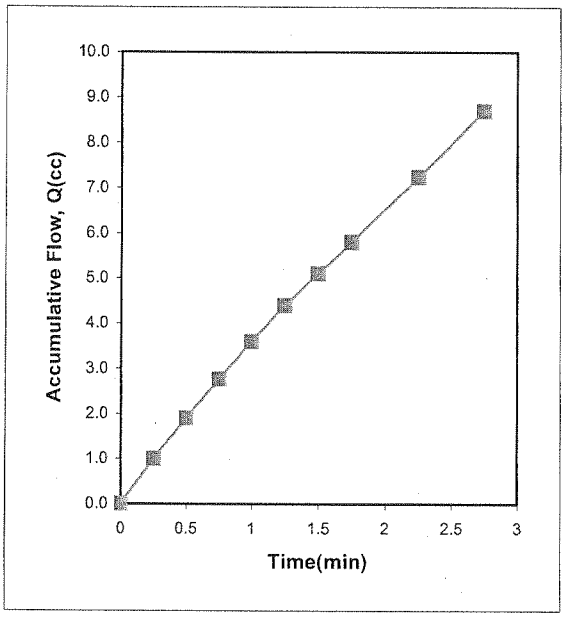
Project Name:	Tahquitz	Tested by:	KK	Date	04/23/09
Project No.:	0512-CR3	Calculated by:	KM	Date	04/24/09
Sample Location:	B-3	Checked by:	AP	Date	04/27/09
Sample No.:	- Depth: 12.5 feet				
Soil Description:	Grayish Brown Poorly-Graded Sand				
Test Condition:	Mod. Cal.				
	Confining Pressure = 5 psi				

INITIAL CONDITION OF SPECIMEN

Diameter (d)	2.38	in
Sample Area (A)	4.43	in²
Length (L)	2.00	in
Weight Before	218.89	g
Wet Density	94.10	pcf
Dry Density	90.66	pcf

	Before	After
Container No.		
Wt. Wet Soil+Container(gms)		292.28
Wt. Dry Soil+Container(gms)		240.39
Wt. Container (gms)		49.67
Moisture, (%)	3.80	27.21

TEST RESULTS



Time (min)	Flow Rdg (cm)	Burette Factor	Q (cc)	Head, h (psi)	h/L	Q/t (cc/s)
0	37.0	1	0.0	1.0	13.8	0
0.25	36.0	1	1.0	1.0	13.8	6.67E-02
0.5	35.1	1	1.9	1.0	13.8	6.00E-02
0.75	34.2	1	2.8	1.0	13.8	5.73E-02
1	33.4	1	3.6	1.0	13.8	5.60E-02
1.25	32.6	1	4.4	1.0	13.8	5.33E-02
1.5	31.9	1	5.1	1.0	13.8	4.67E-02
1.75	31.2	1	5.8	1.0	13.8	4.67E-02
2.25	29.8	1	7.2	1.0	13.8	4.80E-02
2.75	28.3	1	8.7	1.0	13.8	4.87E-02

Hydraulic Conductivity (cm/sec): 1.23E-04

APPENDIX D

Flood Loading and Rock Sizing Summary (Nolte)

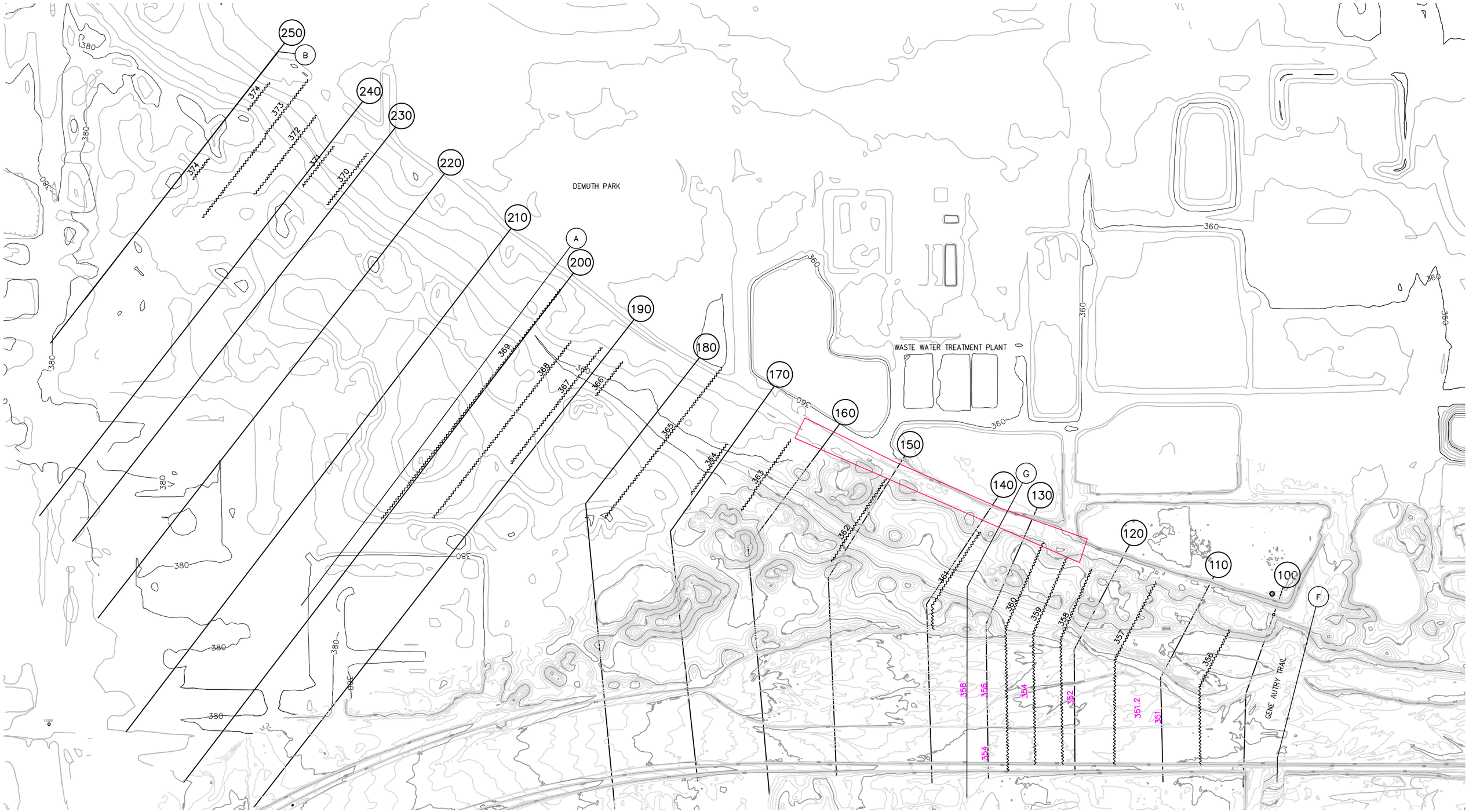
TABLE D-1

SUMMARY OF NOLTE FLOOD LOADING ELEVATIONS AND ROCK SIZING

Geotechnical Investigation Report
Tahquitz Creek Levee System
Palm Springs, California

Tahquitz Wash					
Station[1]	**Channel Velocity (ft/s)**	**WSEL (ft)**	**Top of Levee Elevation (ft)**	**Freeboard (ft)**	**Rock Sizing d_{50} (ft)**
230 - start of levee	9.17	369.93	376	6.07	Light = 1.35
220	5.66	369.3	374.9	5.6	No. 3 Backing = 0.4
210	2.61	369.33	373.4	4.07	No. 3 Backing = 0.4
200	3.88	369.02	372.2	3.18	No. 3 Backing = 0.4
190	10.43	366.67	372	5.33	Light = 1.35
180	7.78	365.53	370.51	4.98	No. 2 Backing = 0.7
170	8.34	363.83	369.26	5.43	Facing = 1.0
160	6.5	362.92	365.89	2.97	No. 3 Backing = 0.4
150	7.69	361.73	364.7	2.97	No. 2 Backing = 0.7
140	5.18	361.18	363.7	2.52	No. 3 Backing = 0.4
130	5.64	360.67	362.25	1.58	No. 3 Backing = 0.4
120	11.04	357.3	361	3.7	1/4 ton
110	7.04	356.57	360	3.43	No. 2 Backing = 0.7
100	8.73	355.28	363	7.72	Facing = 1.0

Note:
1. Based on Nolte Flood Loading Diagram.


DEMUTH PARK
WASTE WATER TREATMENT PLANT
GENE AUTRY TRAIL
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
A
B
F
G
374
373
372
371
370
369
368
367
366
365
364
363
362
361
360
359
358
357
356
355
354
353
352
351.2
351
380
360

APPENDIX E

Seepage Analysis Results

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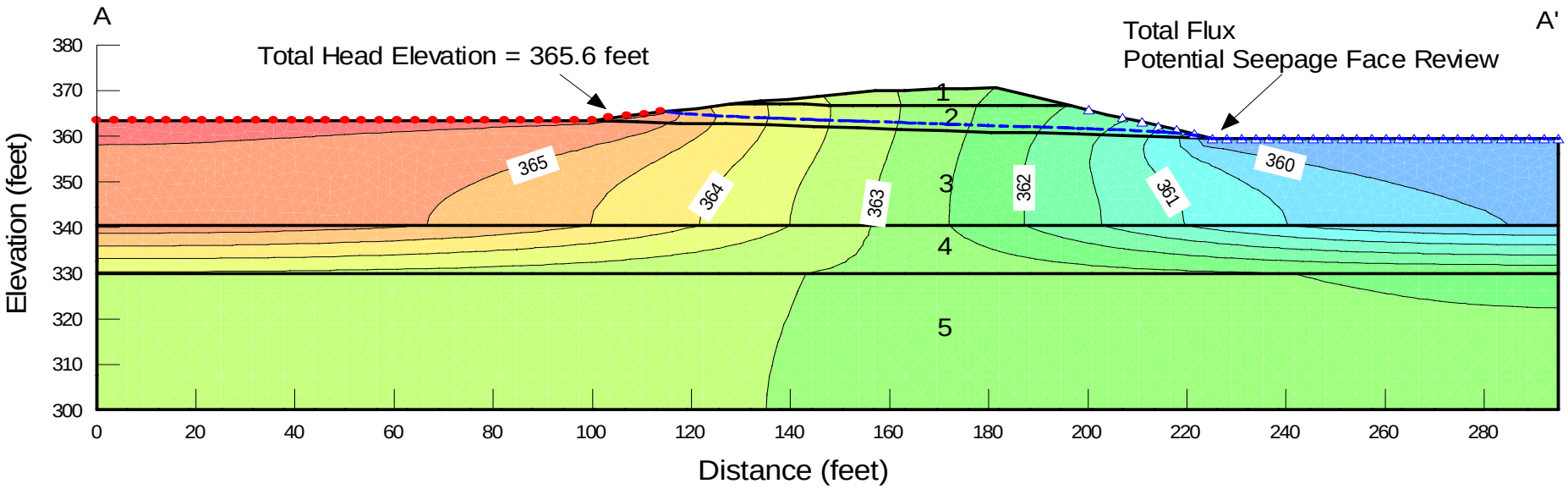
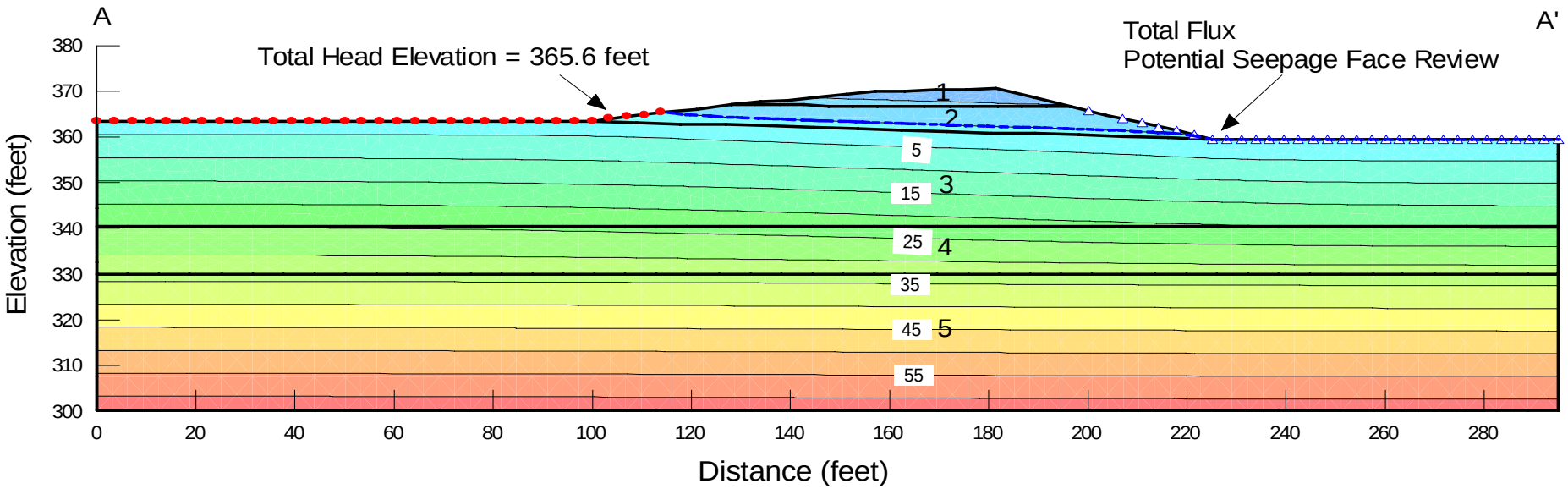


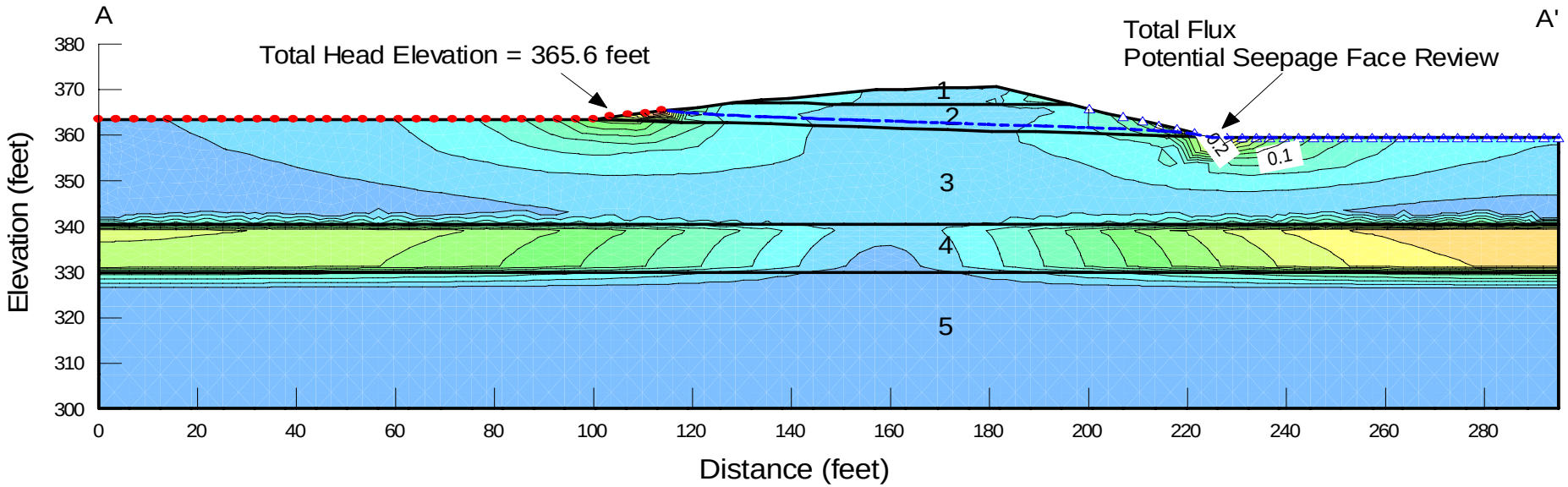
SEEPAGE ANALYSIS RESULTS, TOTAL HEAD
SECTION A-A'
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **E-1**



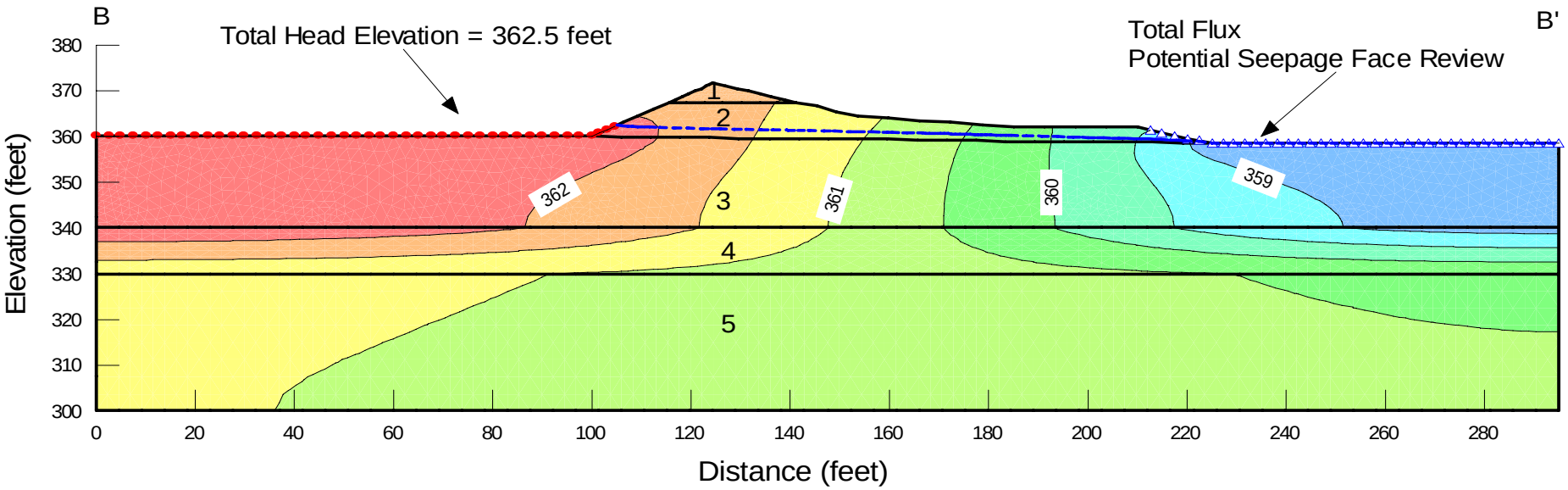
SEEPAGE ANALYSIS RESULTS, PRESSURE HEAD
SECTION A-A'
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **E-2**



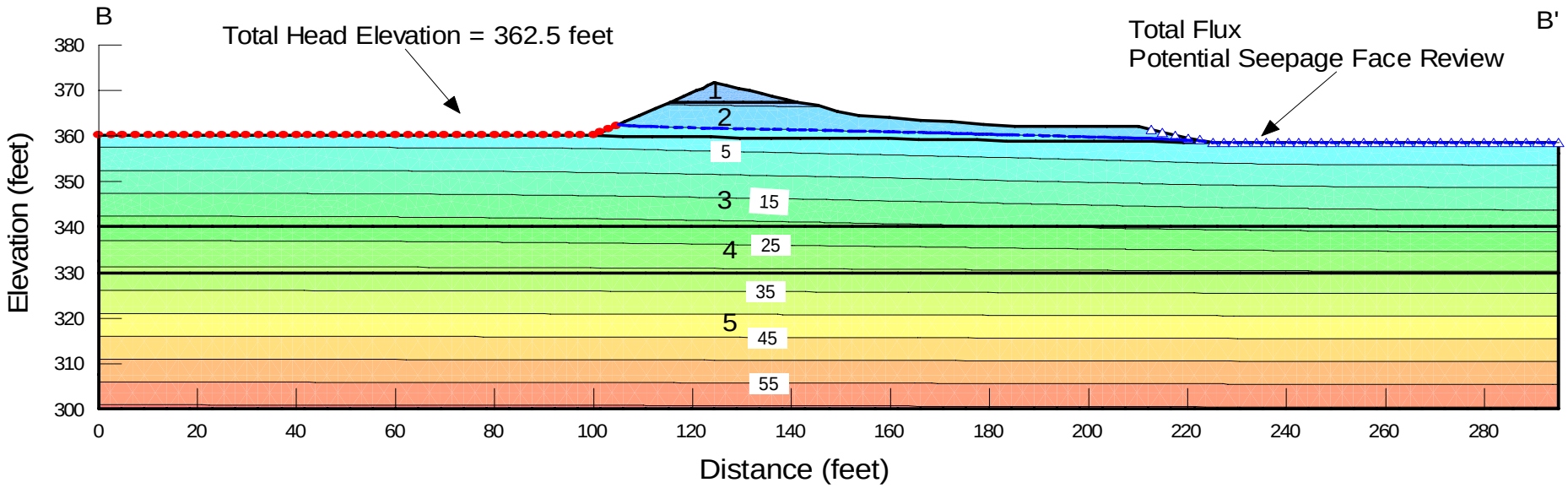
SEEPAGE ANALYSIS RESULTS, X-Y GRADIENTS
SECTION A-A'
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **E-3**



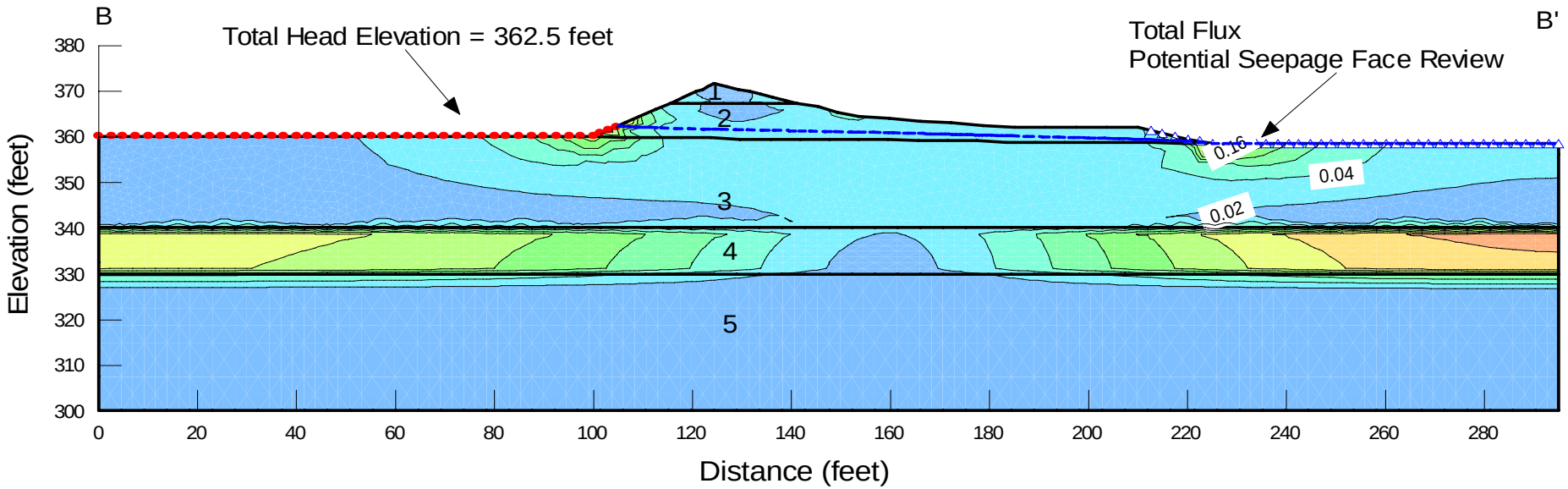
SEEPAGE ANALYSIS RESULTS, TOTAL HEAD
SECTION B-B'
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **E-4**



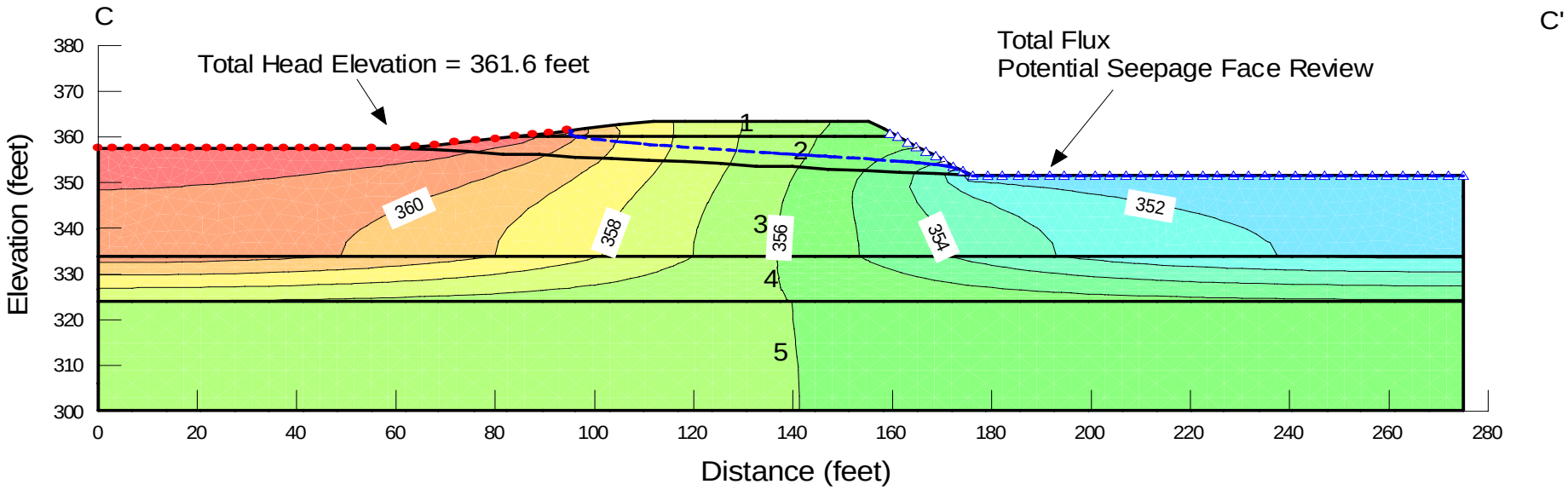
SEEPAGE ANALYSIS RESULTS, PRESSURE HEAD
SECTION B-B'
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **E-5**



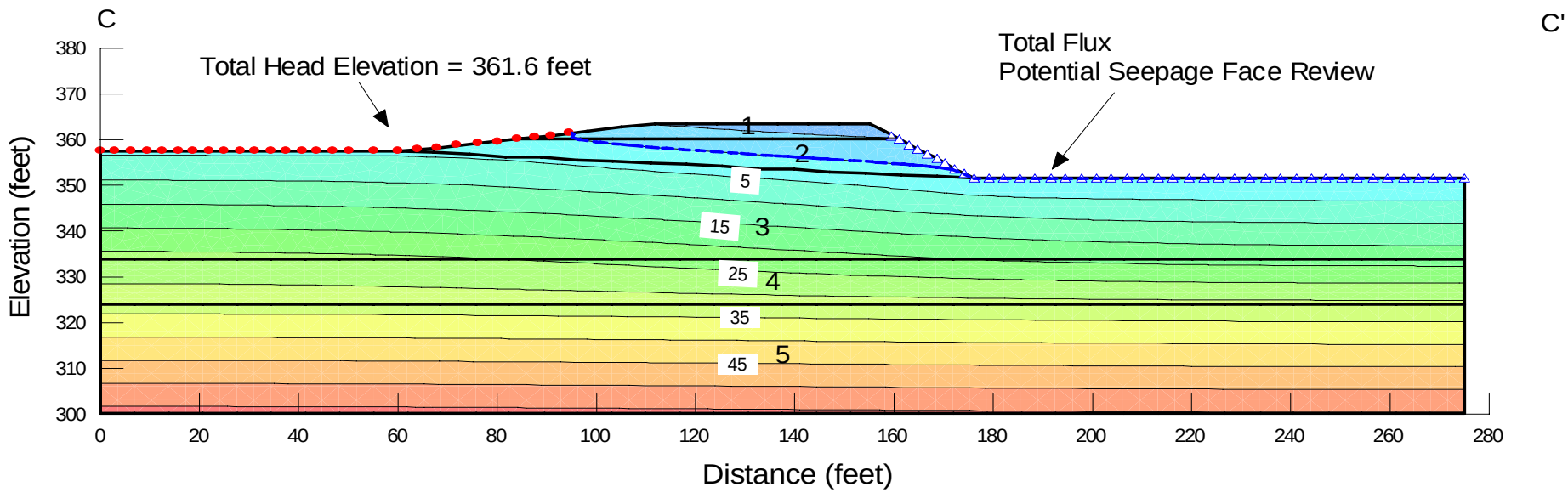
SEEPAGE ANALYSIS RESULTS, X-Y GRADIENTS
SECTION B-B'
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **E-6**



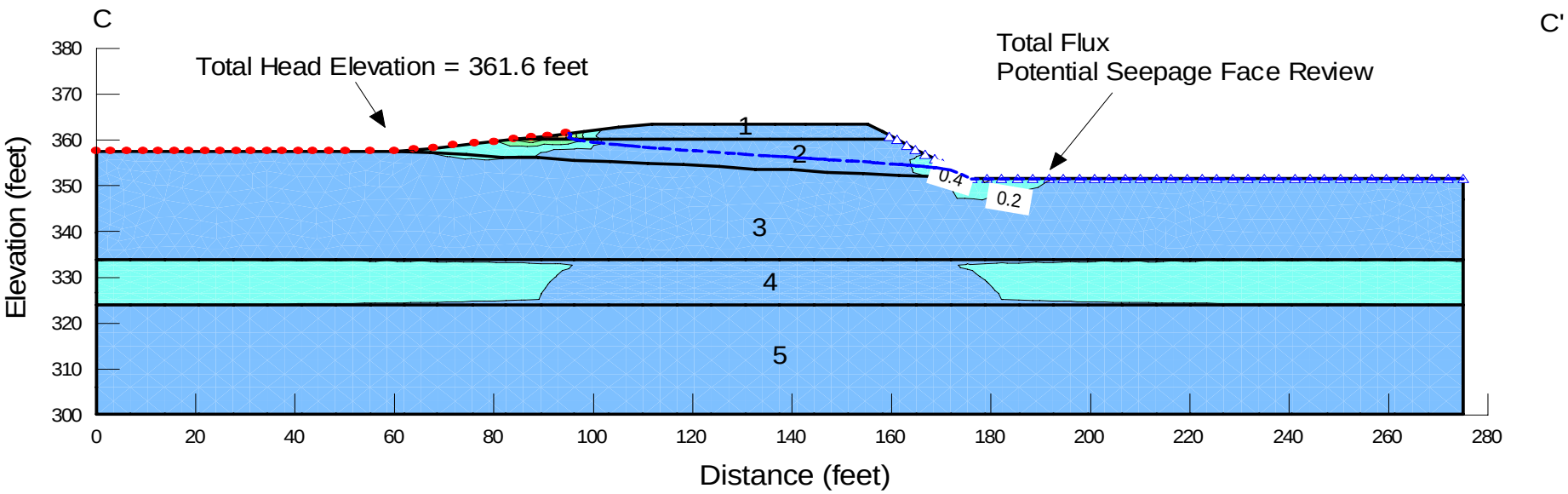
SEEPAGE ANALYSIS RESULTS, TOTAL HEAD
SECTION C-C'
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **E-7**



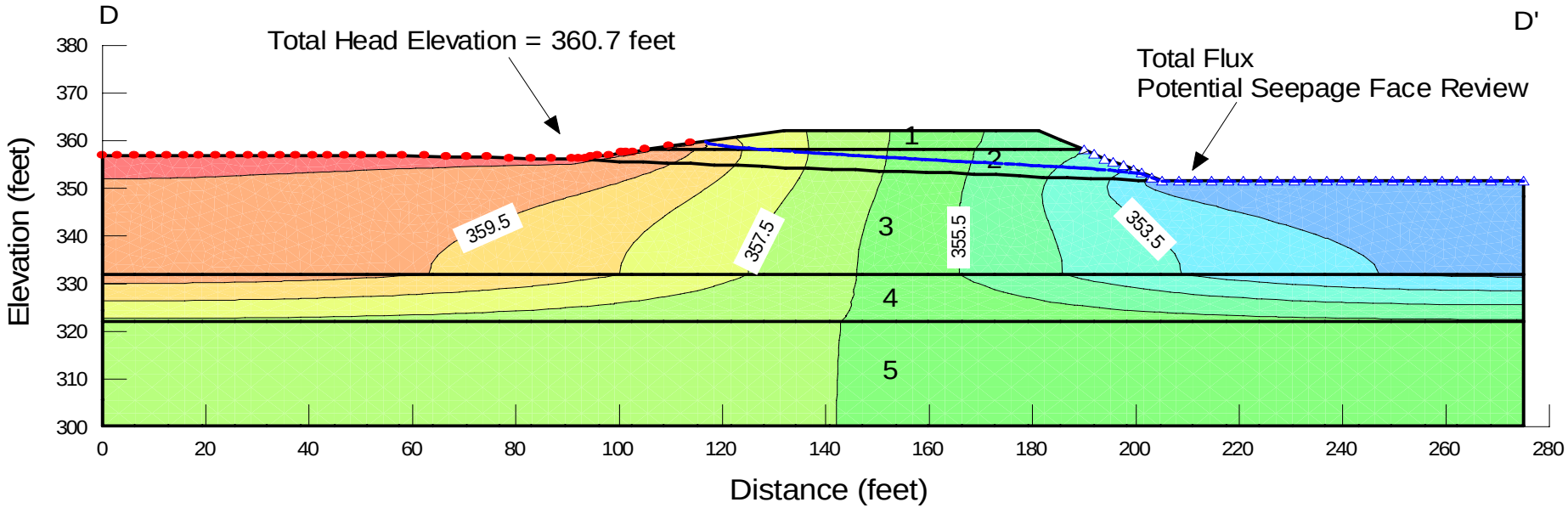
SEEPAGE ANALYSIS RESULTS, PRESSURE HEAD
SECTION C-C'
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **E-8**



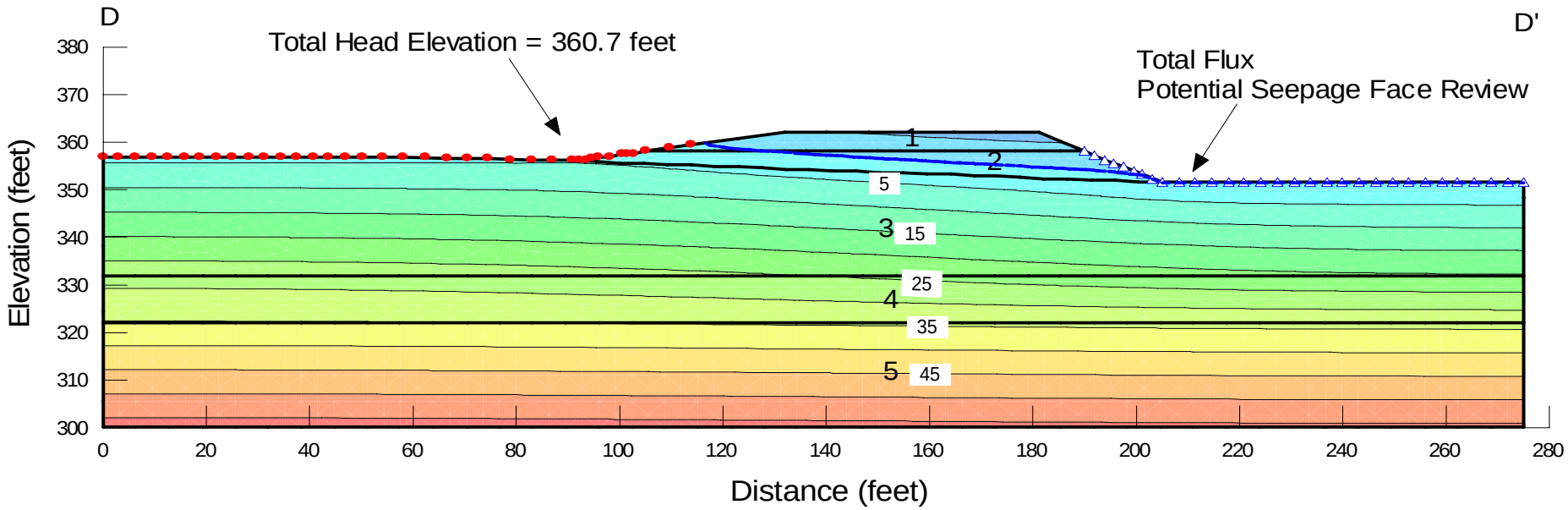
SEEPAGE ANALYSIS RESULTS, X-Y GRADIENTS
SECTION C-C'
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **E-9**



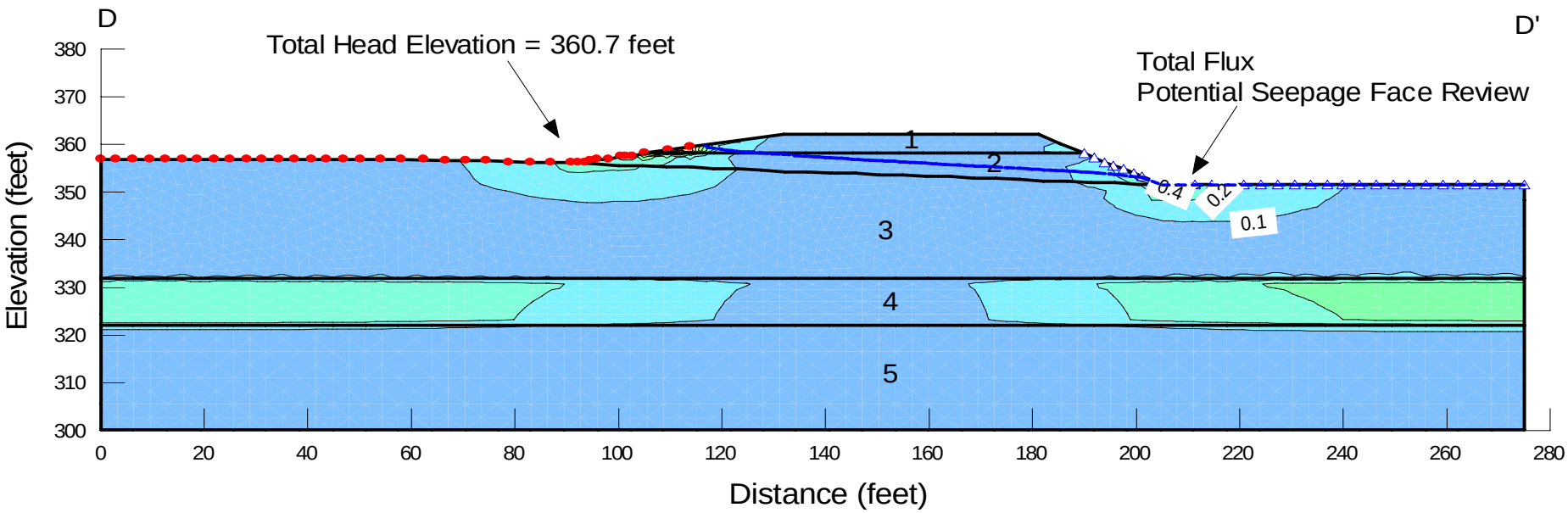
SEEPAGE ANALYSIS RESULTS, TOTAL HEAD
SECTION D-D'
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **E-10**



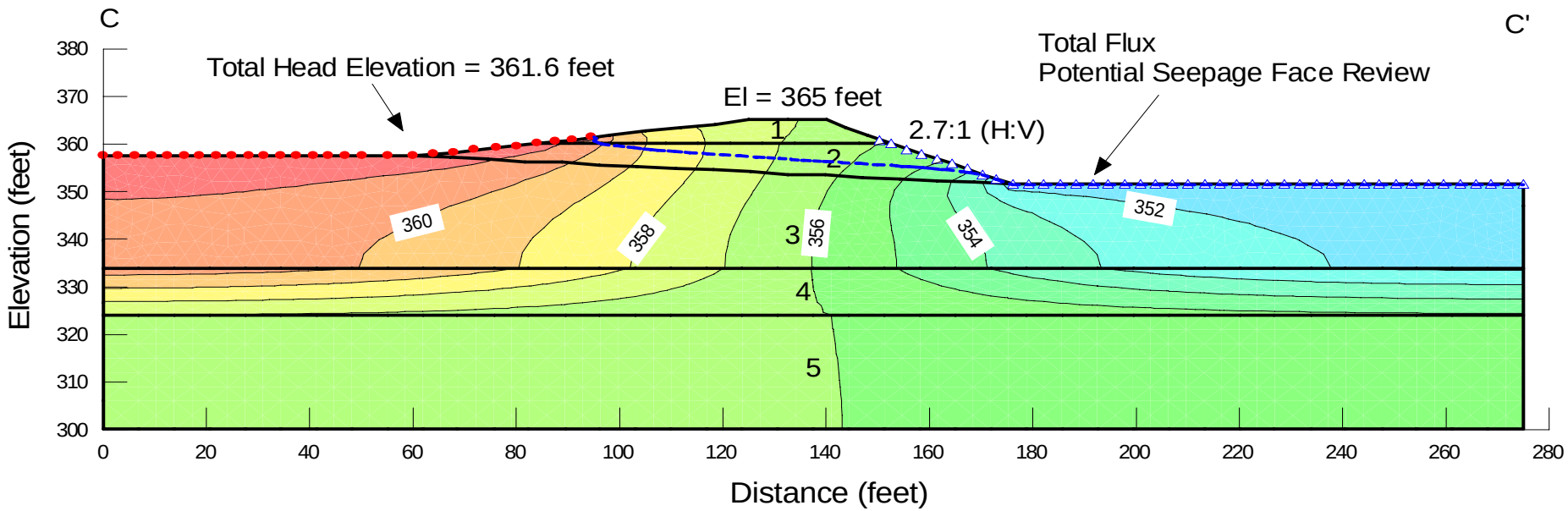
SEEPAGE ANALYSIS RESULTS, PRESSURE HEAD
SECTION D-D'
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **E-11**



SEEPAGE ANALYSIS RESULTS, X-Y GRADIENTS
SECTION D-D'
Tahquitz Creek Levee System
Palm Springs, California

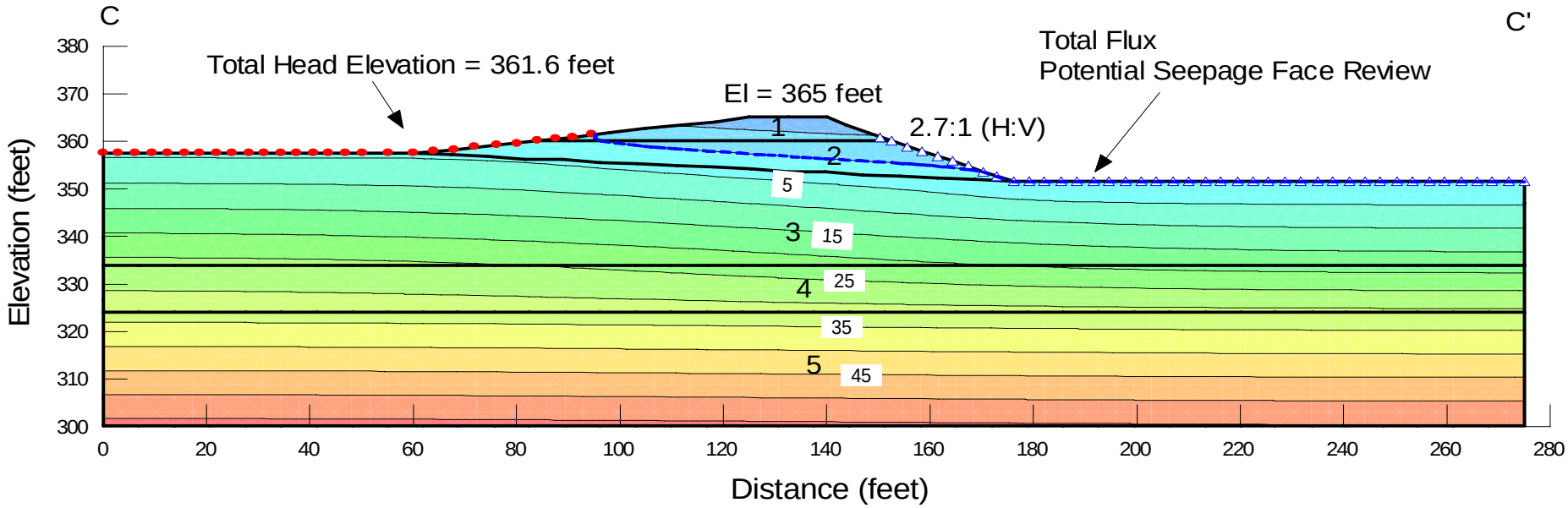
By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **E-12**



SEEPAGE ANALYSIS RESULTS, TOTAL HEAD
REMEDIAL CONCEPTUAL DESIGN SECTION C-C'
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **E-13**

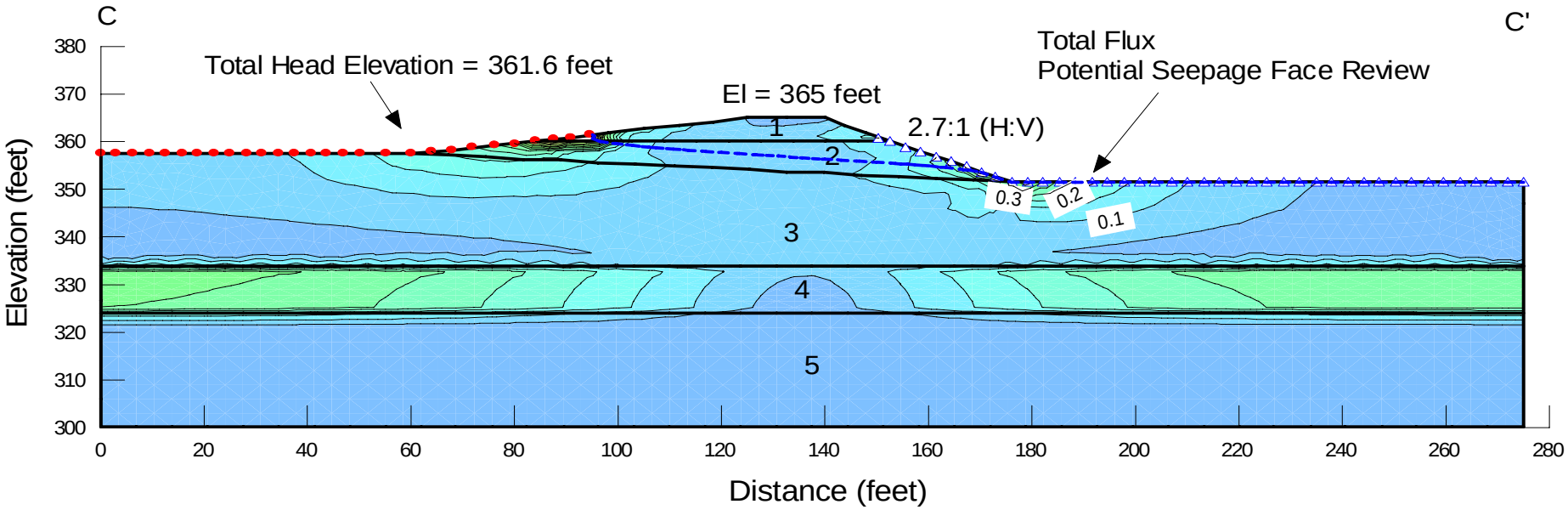
P:\13203.000.0\13203.001\Docs\FINAL Geotechnical Investigation Report\Appendix E\Appendix E2.xls



SEEPAGE ANALYSIS RESULTS, PRESSURE
REMEDIAL CONCEPTUAL DESIGN SECTION C-C'
Tahquitz Creek Levee System
Palm Springs, California

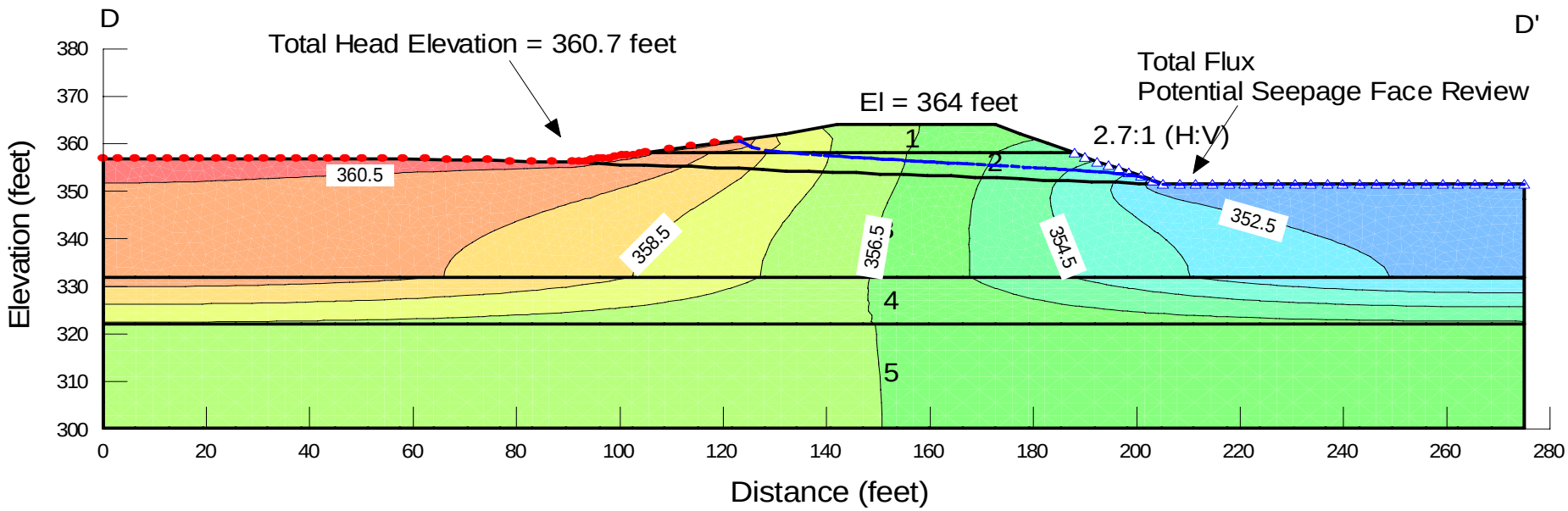
By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **E-14**

P:\13203.000.0\13203.001\Docs\FINAL Geotechnical Investigation Report\Appendix E\Appendix E2.xls



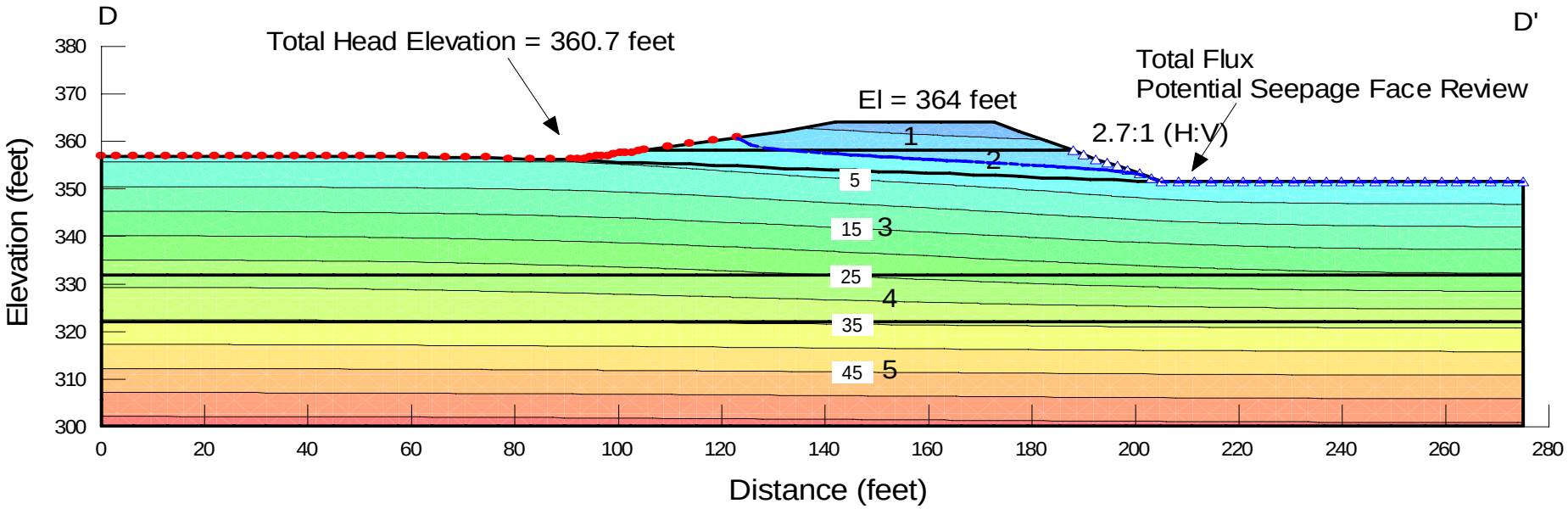
SEEPAGE ANALYSIS RESULTS, X-Y GRADIENTS
REMEDIAL CONCEPTUAL DESIGN SECTION C-C'
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **E-15**



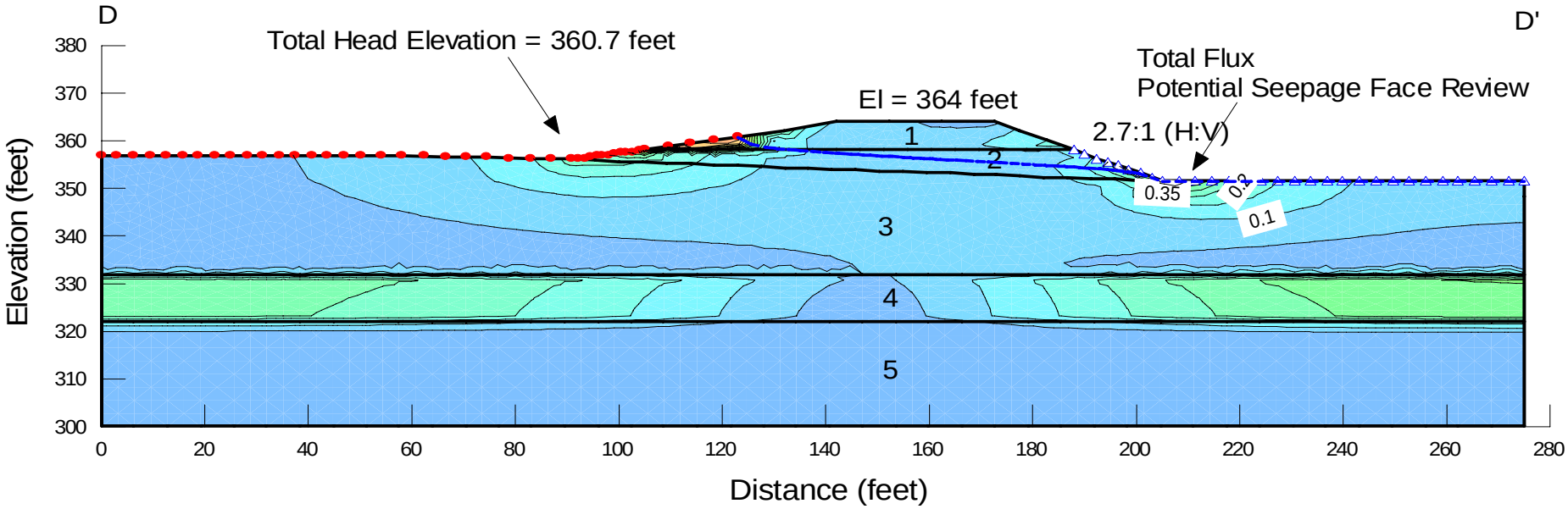
SEEPAGE ANALYSIS RESULTS, TOTAL HEAD
REMEDIAL CONCEPTUAL DESIGN SECTION D-D'
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **E-16**



SEEPAGE ANALYSIS RESULTS, PRESSURE REMEDIAL CONCEPTUAL DESIGN SECTION D-D'
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **E-17**

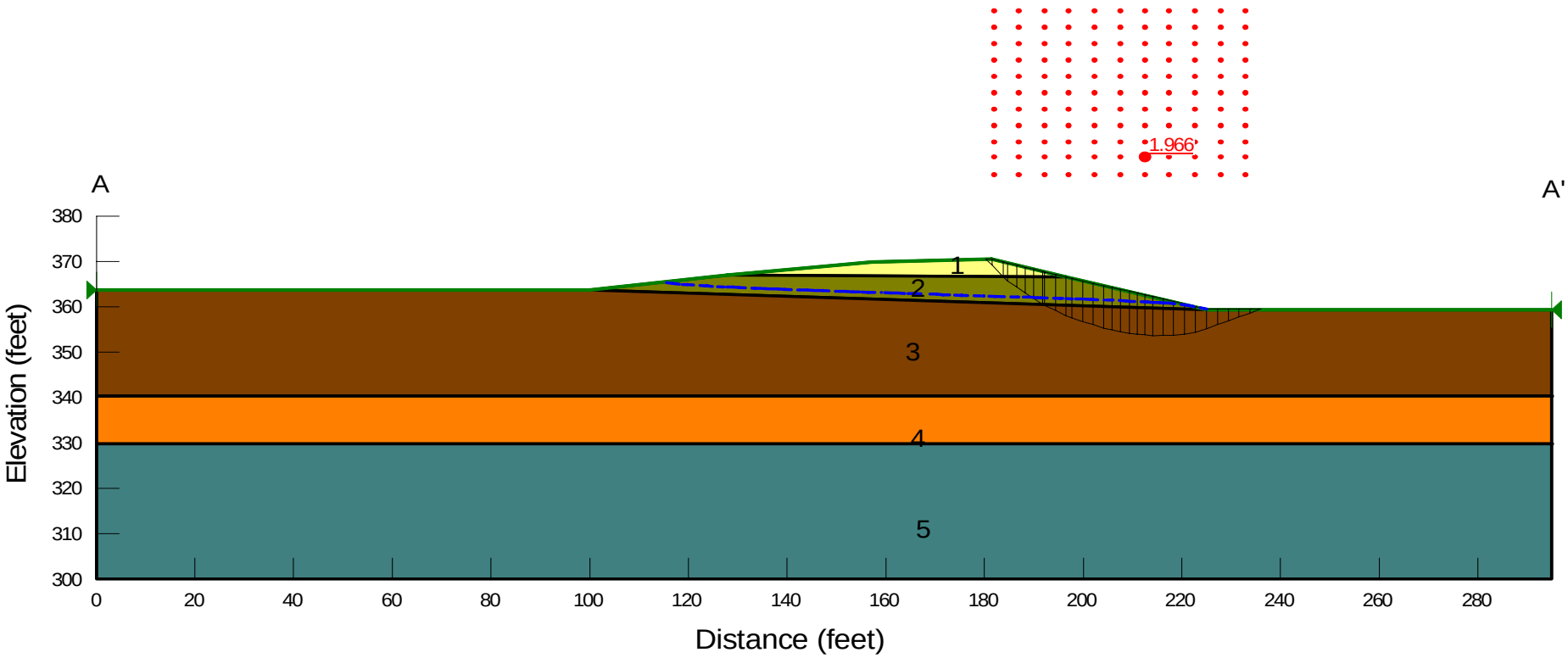


SEEPAGE ANALYSIS RESULTS, X-Y GRADIENTS
REMEDIAL CONCEPTUAL DESIGN SECTION D-D'
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **E-18**

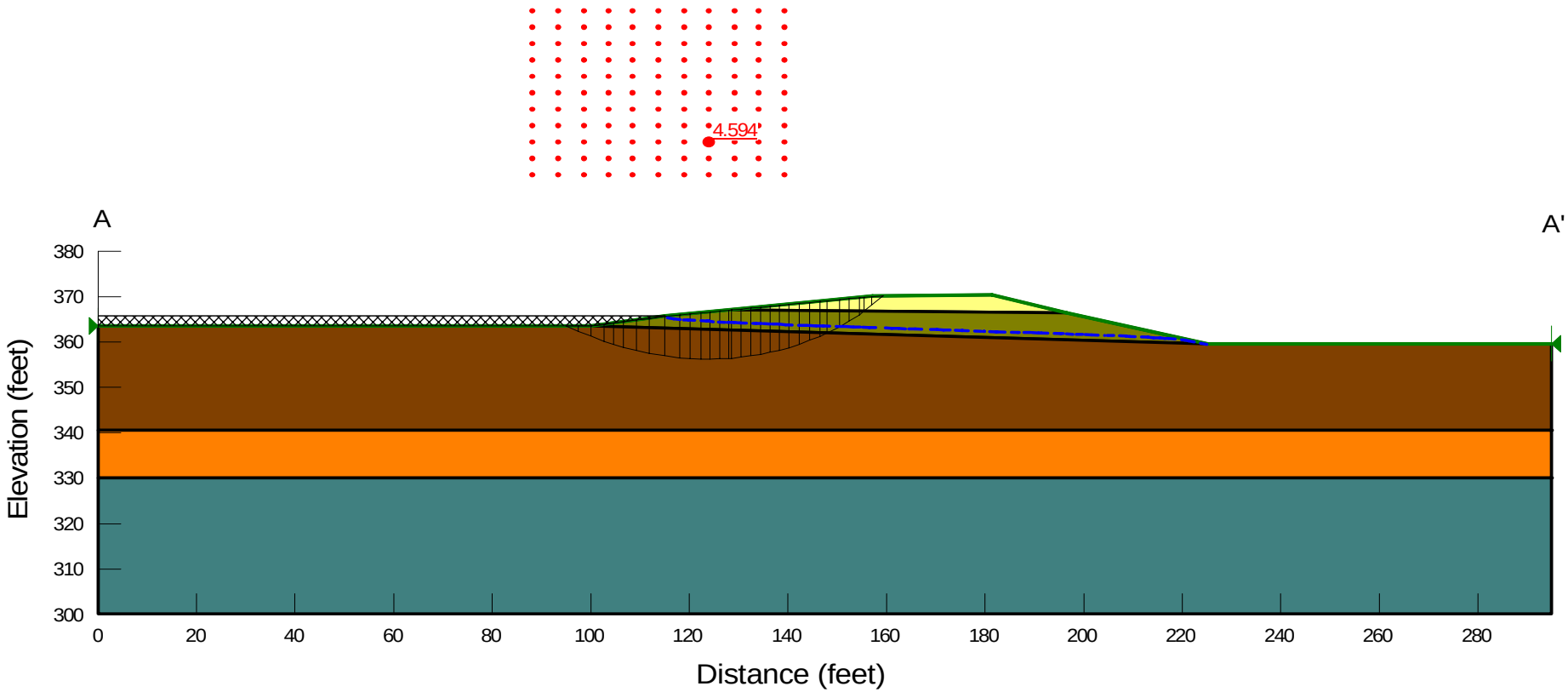
APPENDIX F

Slope Stability Results



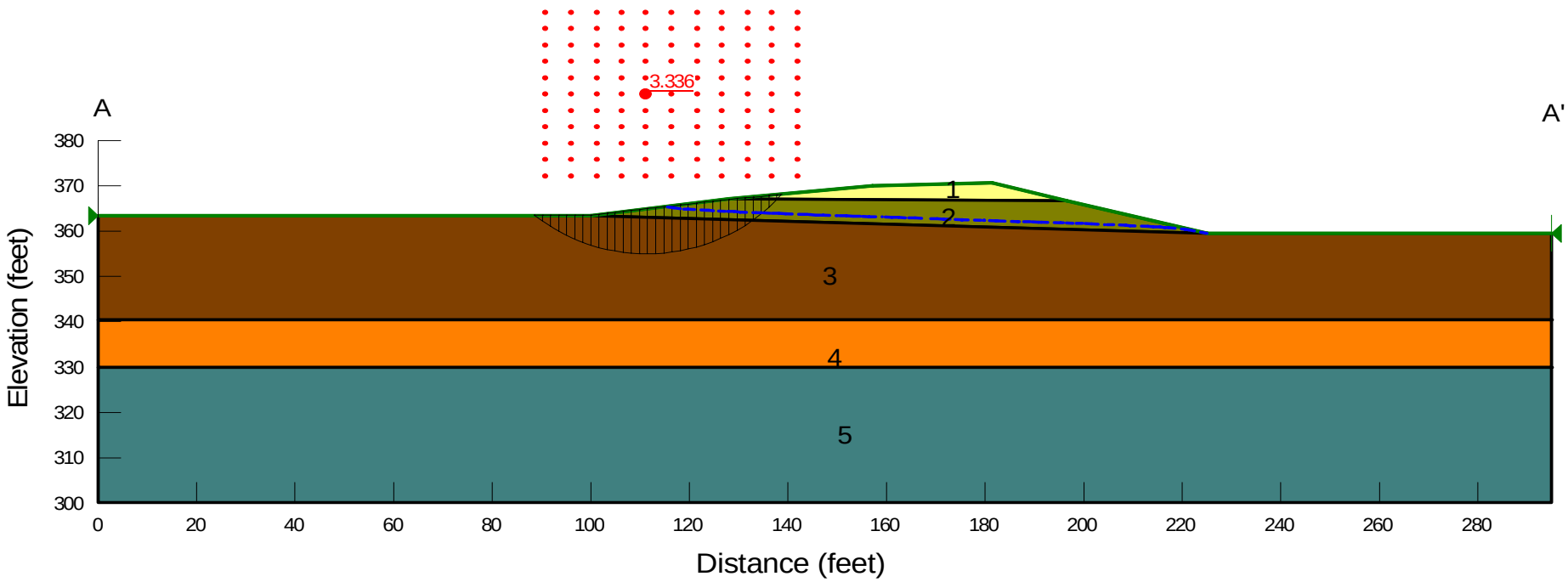
SLOPE STABILITY ANALYSIS RESULTS
SECTION A-A', SEEPAGE LANDSIDE
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-1**



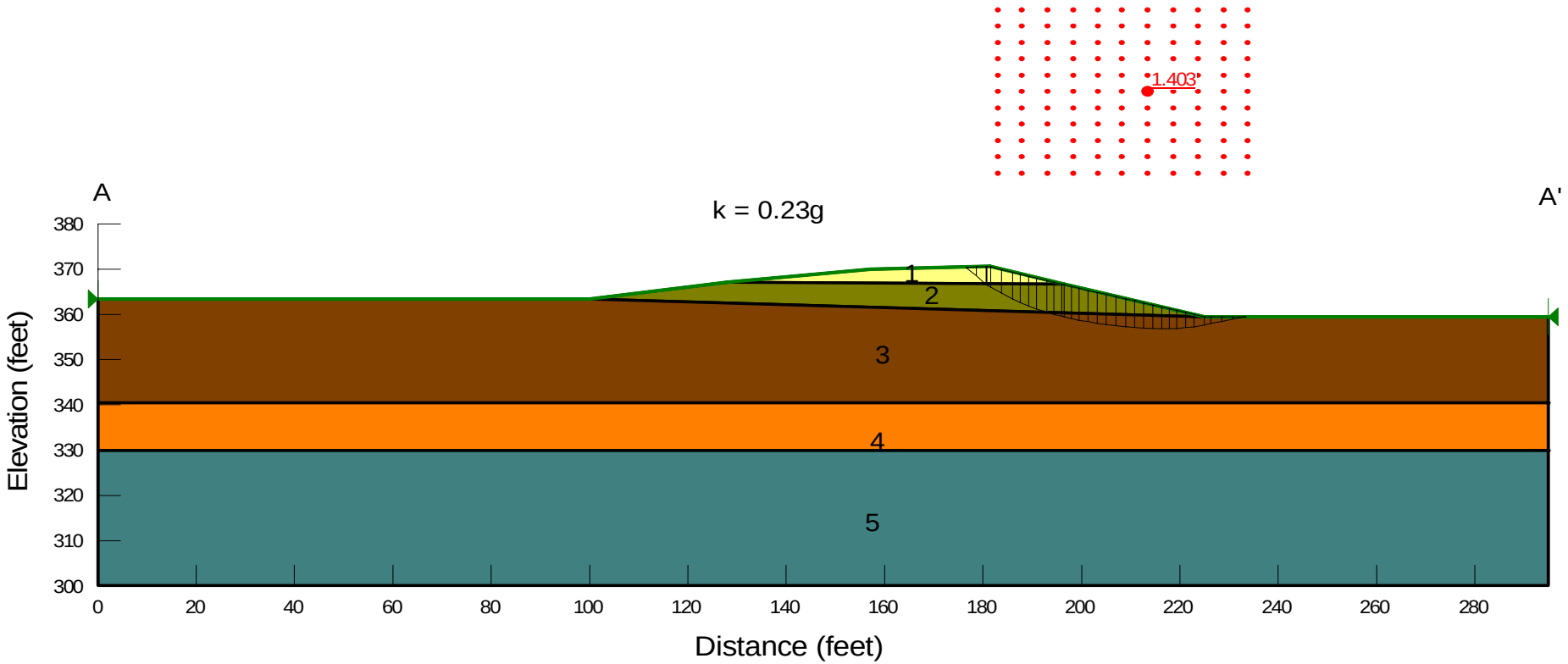
SLOPE STABILITY ANALYSIS RESULTS
SECTION A-A', SEEPAGE RIVERSIDE
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-2**



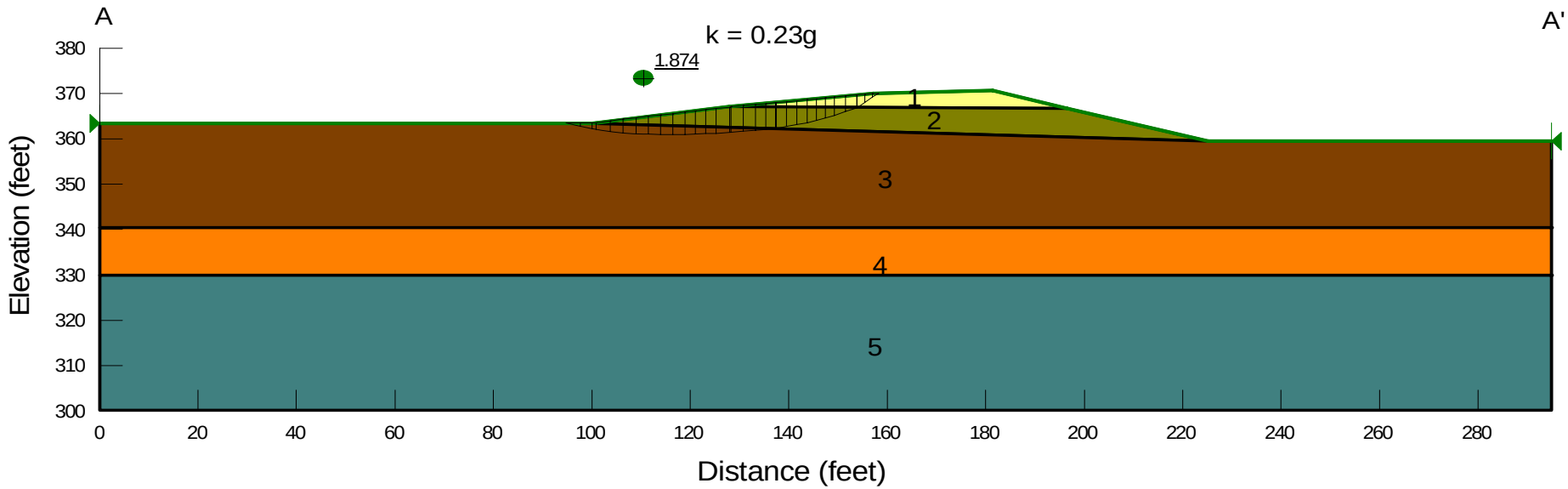
SLOPE STABILITY ANALYSIS RESULTS
SECTION A-A', RAPID DRAWDOWN
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-3**



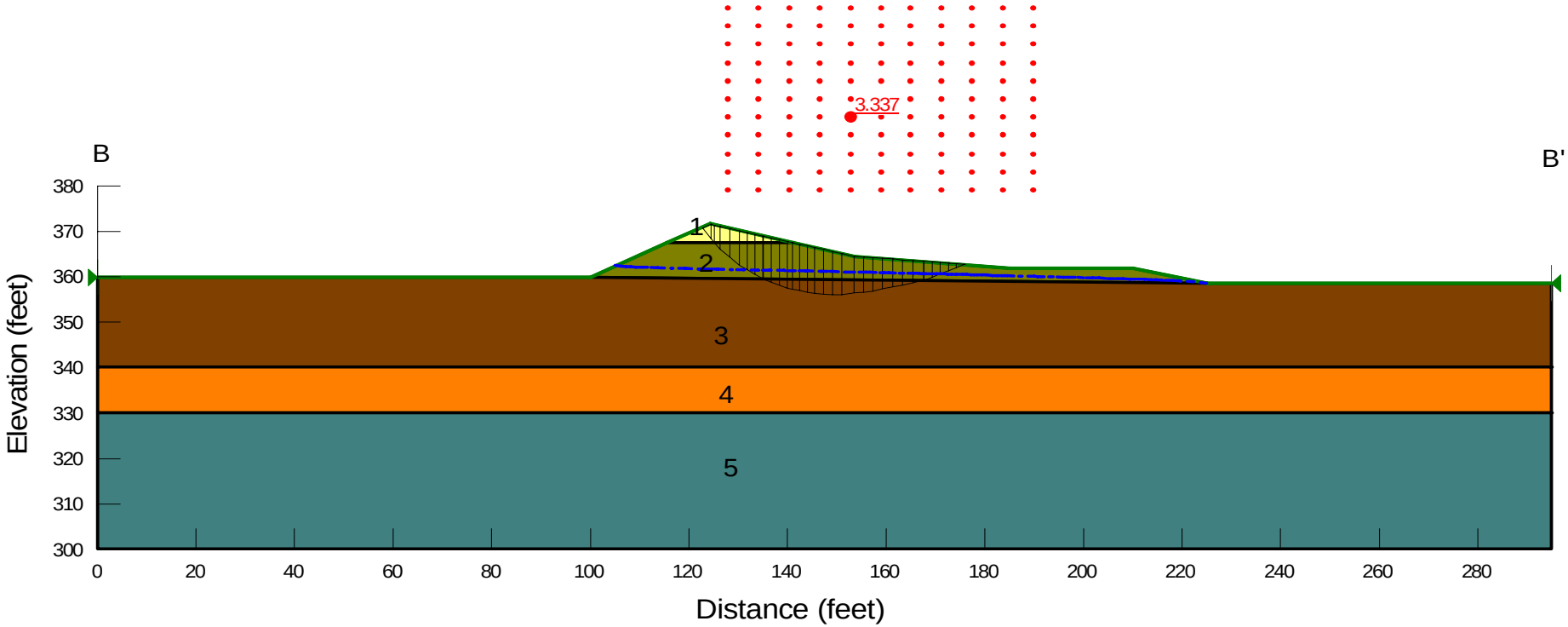
SLOPE STABILITY ANALYSIS RESULTS
SECTION A-A', SEISMIC LANDSIDE
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-4**



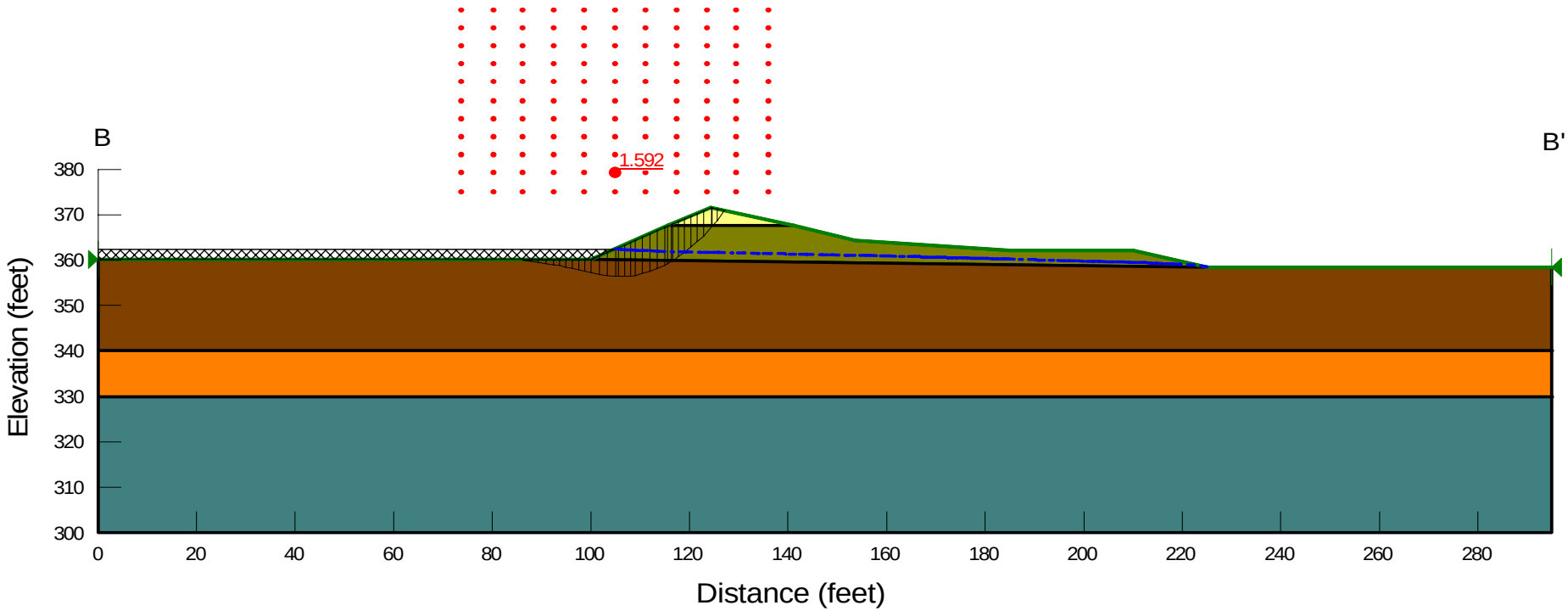
SLOPE STABILITY ANALYSIS RESULTS
SECTION A-A', SEISMIC RIVERSIDE
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-5**



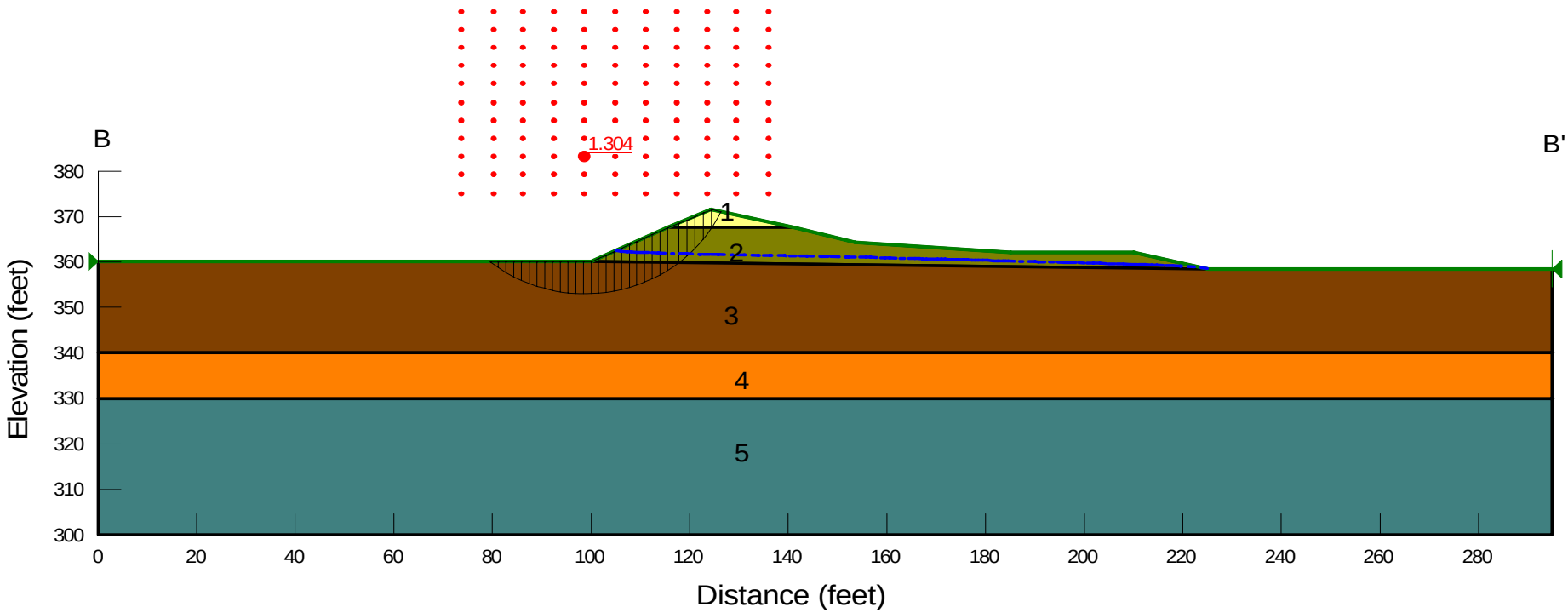
SLOPE STABILITY ANALYSIS RESULTS
SECTION B-B', SEEPAGE LANDSIDE
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-6**



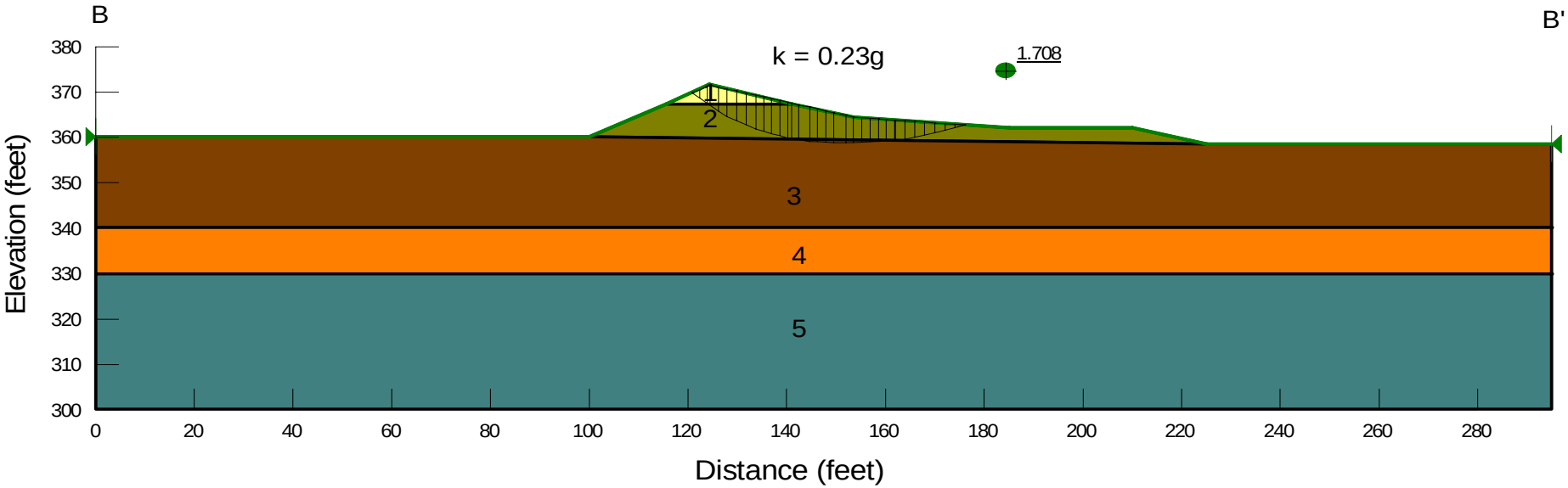
SLOPE STABILITY ANALYSIS RESULTS
SECTION B-B', SEEPAGE RIVERSIDE
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-7**



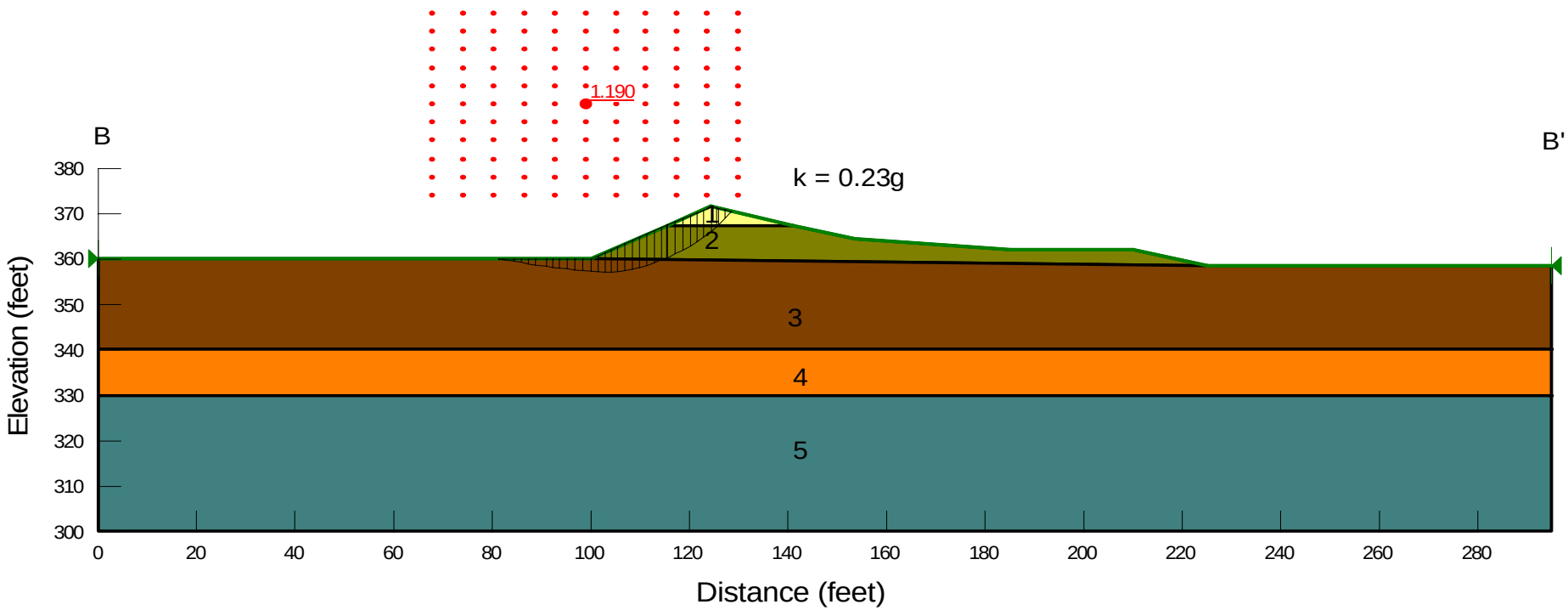
SLOPE STABILITY ANALYSIS RESULTS
SECTION B-B', RAPID DRAWDOWN
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-8**



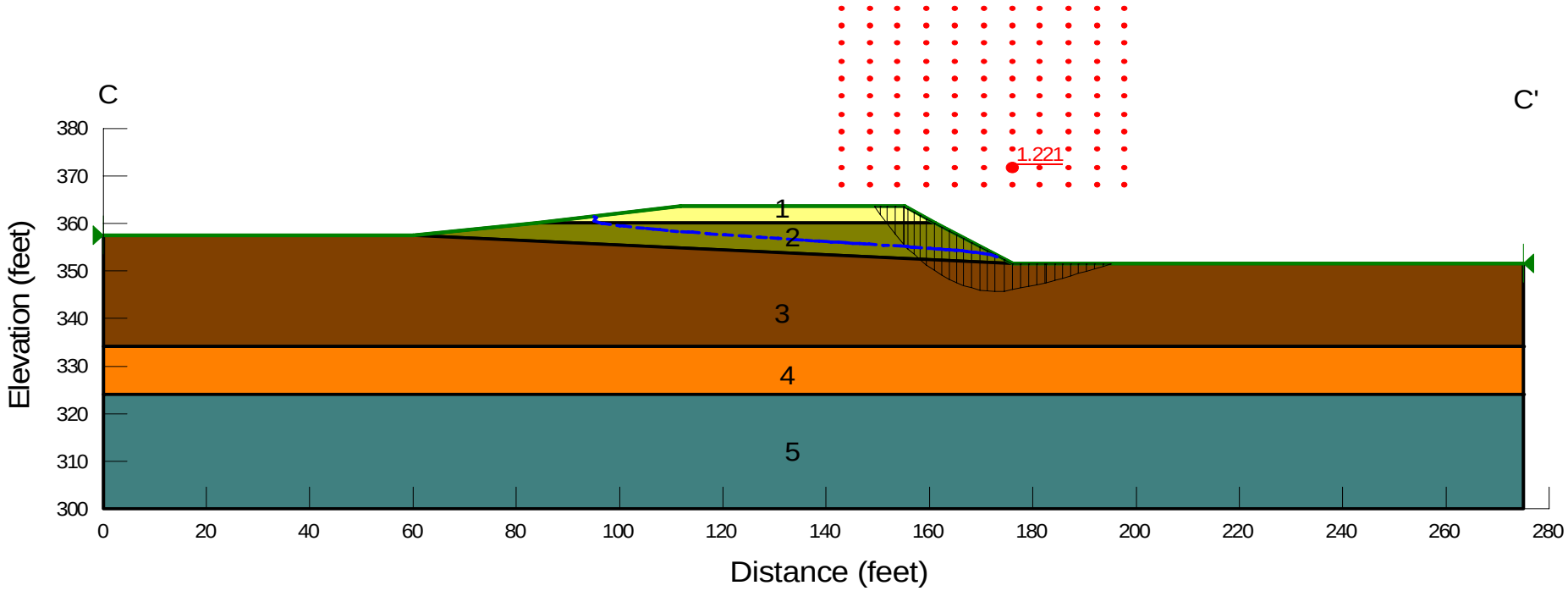
SLOPE STABILITY ANALYSIS RESULTS
SECTION B-B', SEISMIC LANDSIDE
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-9**



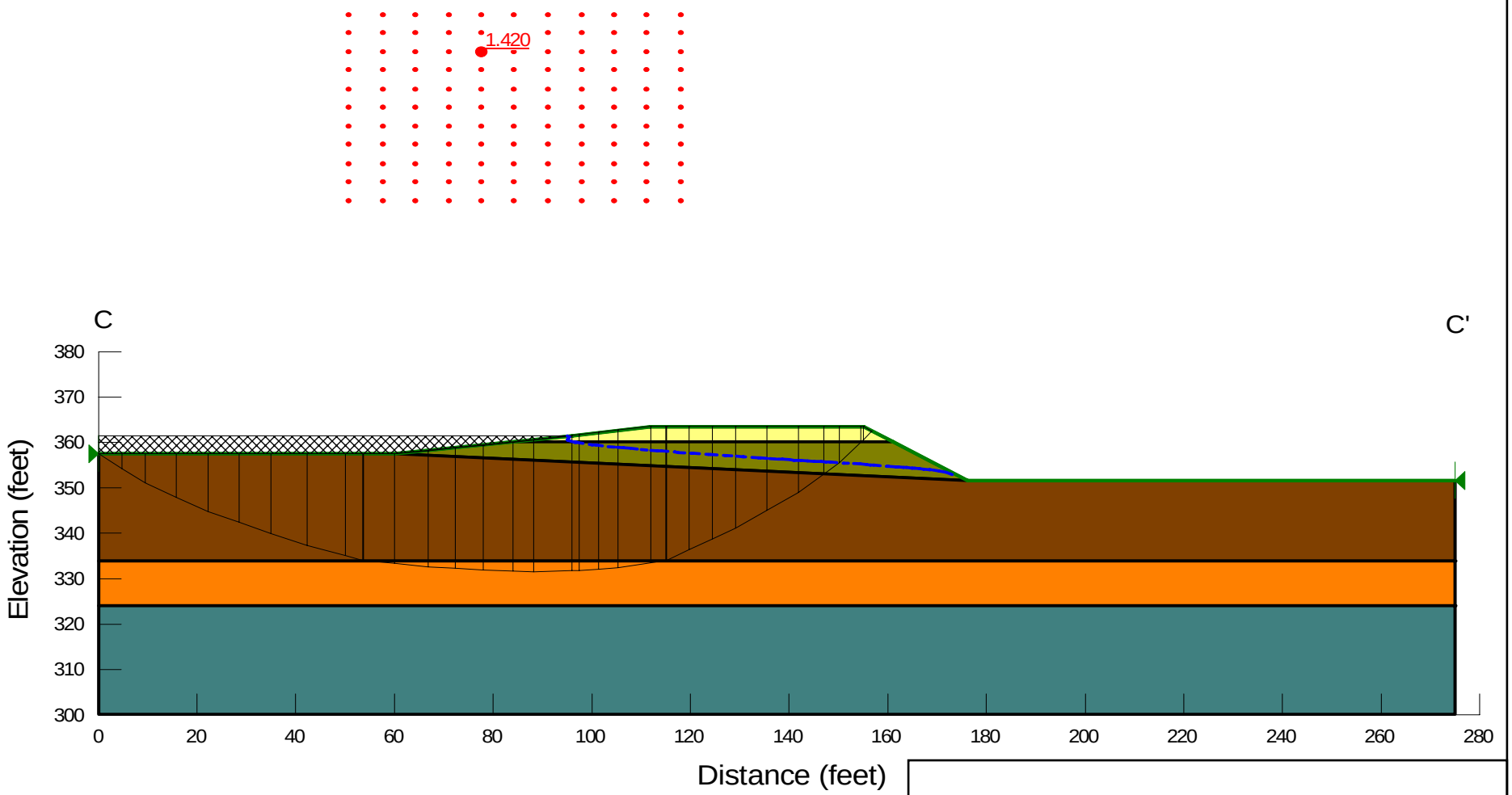
SLOPE STABILITY ANALYSIS RESULTS
SECTION B-B', SEISMIC RIVERSIDE
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-10**



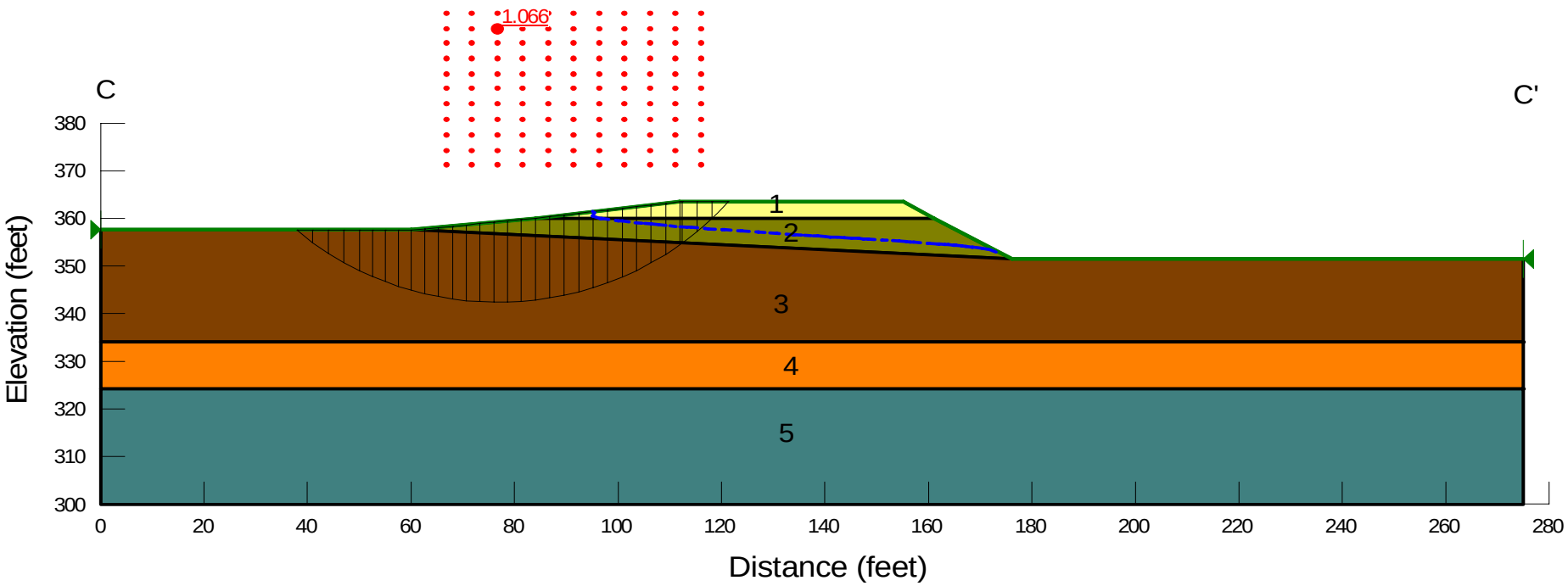
SLOPE STABILITY ANALYSIS RESULTS
SECTION C-C', SEEPAGE LANDSIDE
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-11**



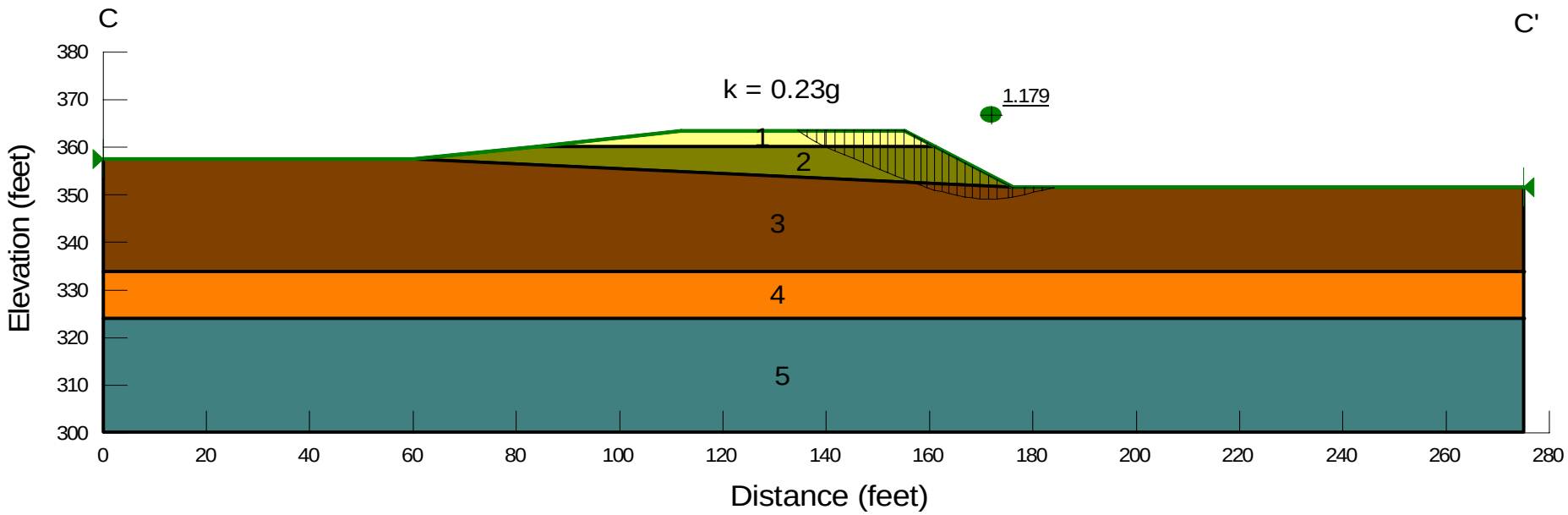
SLOPE STABILITY ANALYSIS RESULTS
SECTION C-C', SEEPAGE RIVERSIDE
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-12**



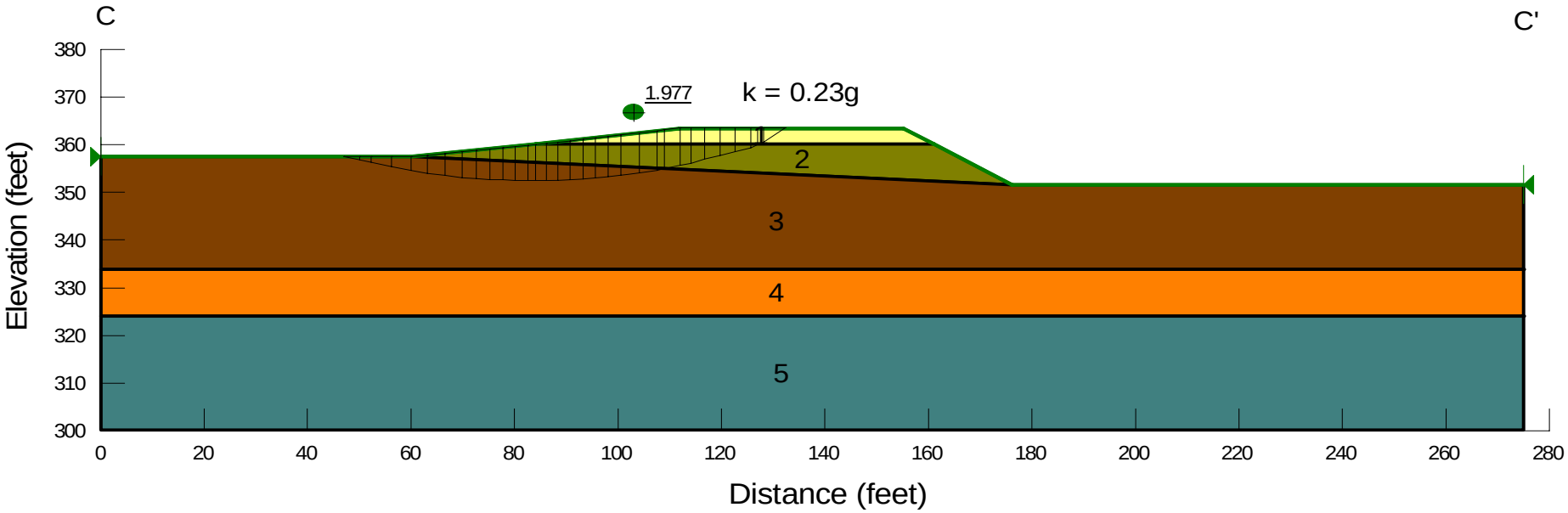
SLOPE STABILITY ANALYSIS RESULTS
SECTION C-C', RAPID DRAWDOWN
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-13**



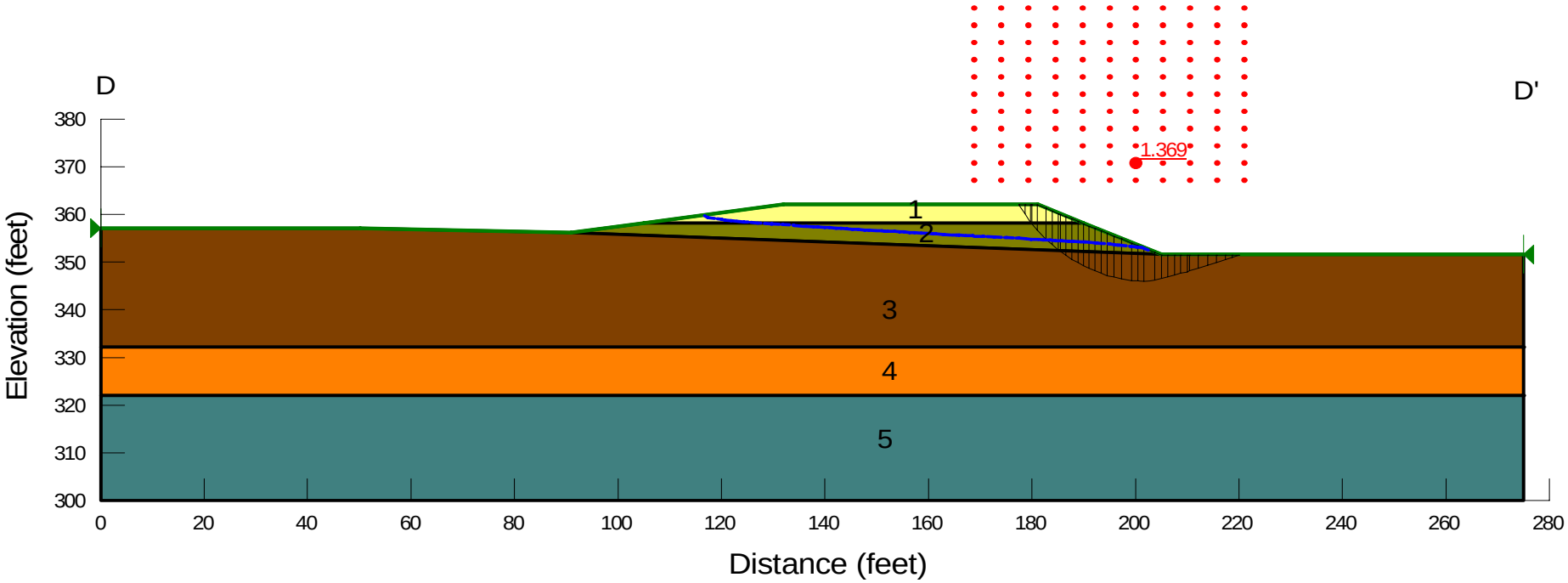
SLOPE STABILITY ANALYSIS RESULTS
SECTION C-C', SEISMIC LANDSIDE
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-14**



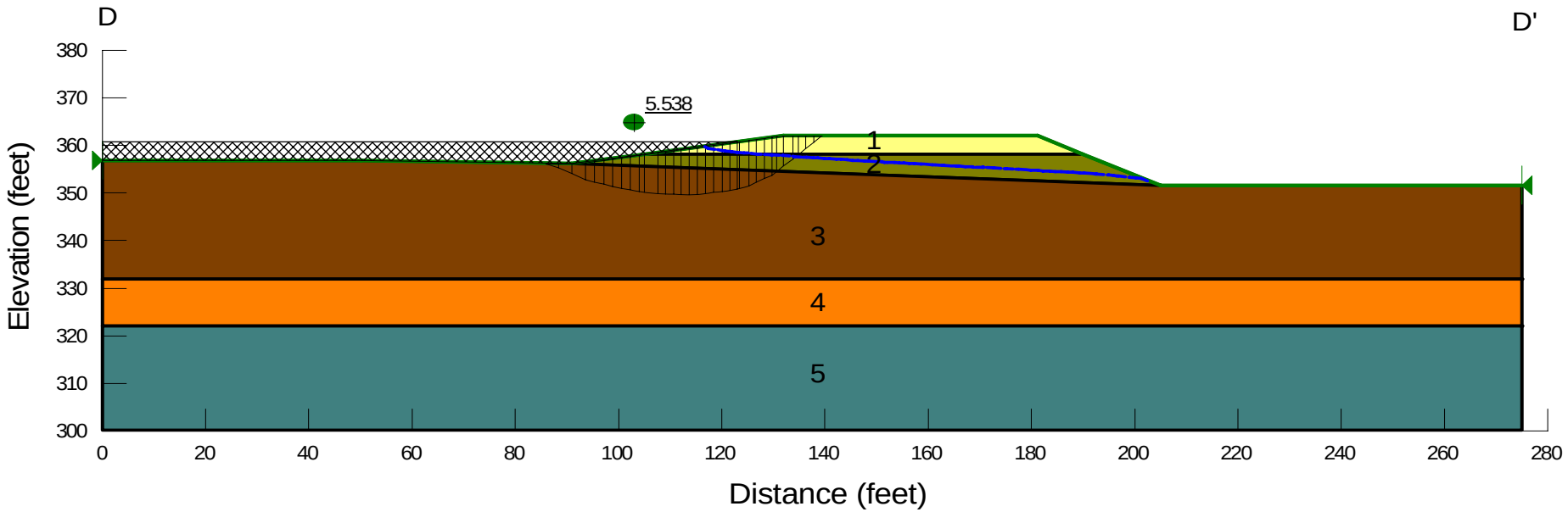
SLOPE STABILITY ANALYSIS RESULTS
SECTION C-C', SEISMIC RIVERSIDE
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-15**



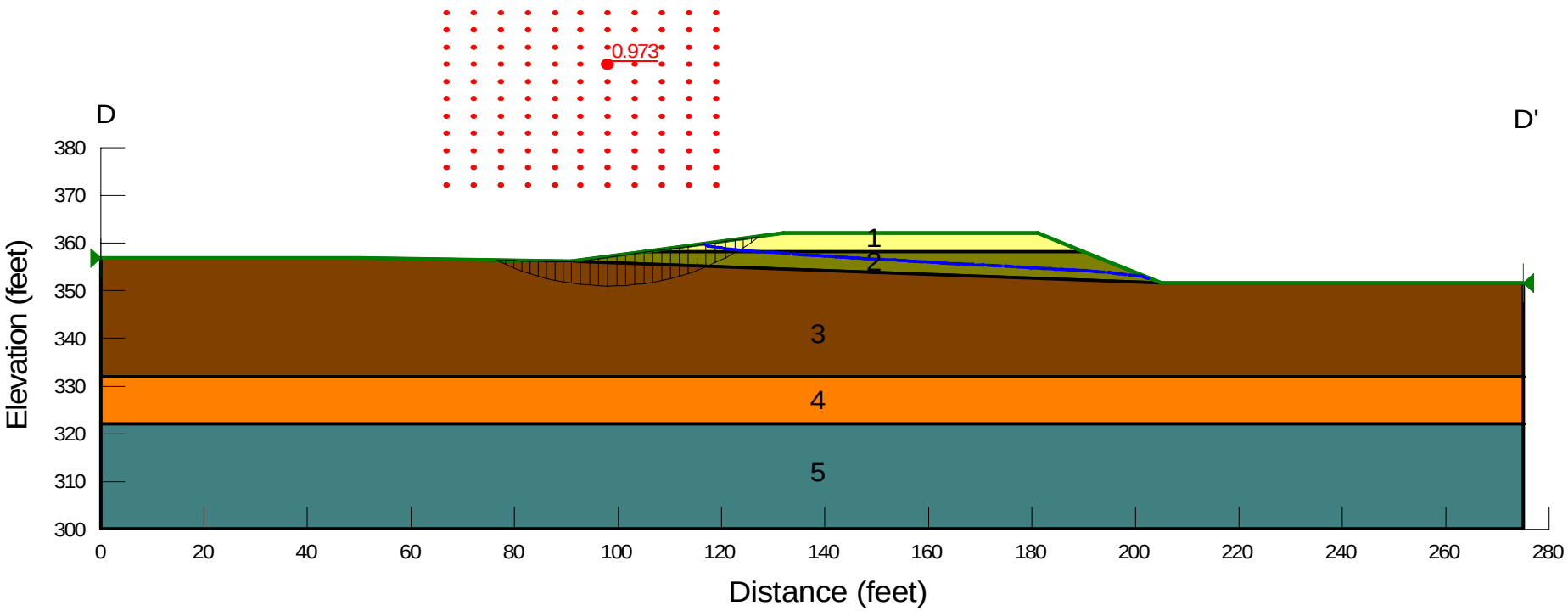
SLOPE STABILITY ANALYSIS RESULTS
SECTION D-D', SEEPAGE LANDSIDE
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-16**



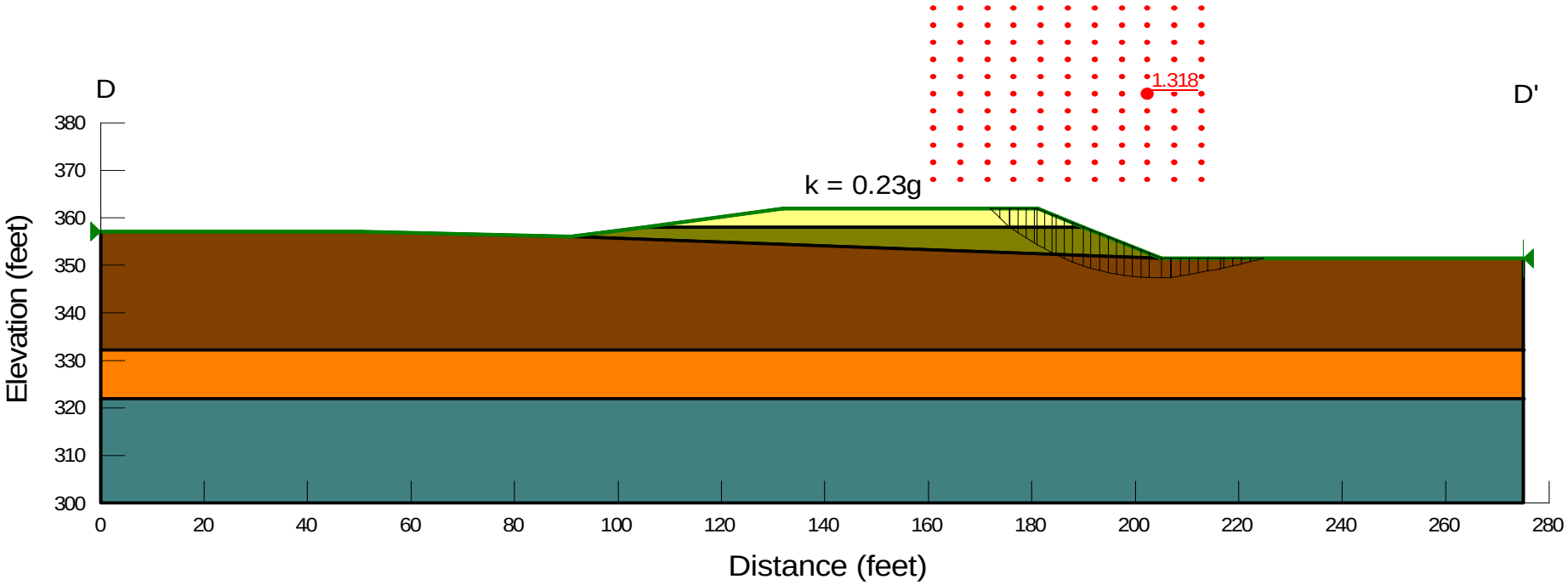
SLOPE STABILITY ANALYSIS RESULTS
SECTION D-D', SEEPAGE RIVERSIDE
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-17**



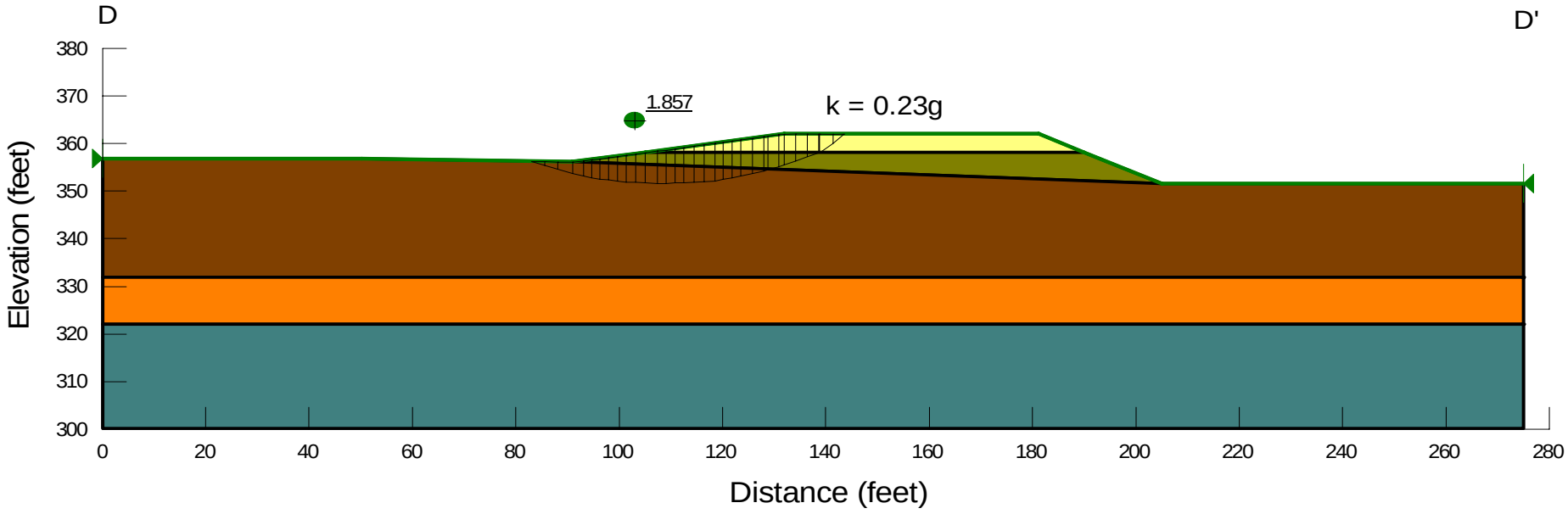
SLOPE STABILITY ANALYSIS RESULTS
SECTION D-D', RAPID DRAWDOWN
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-18**



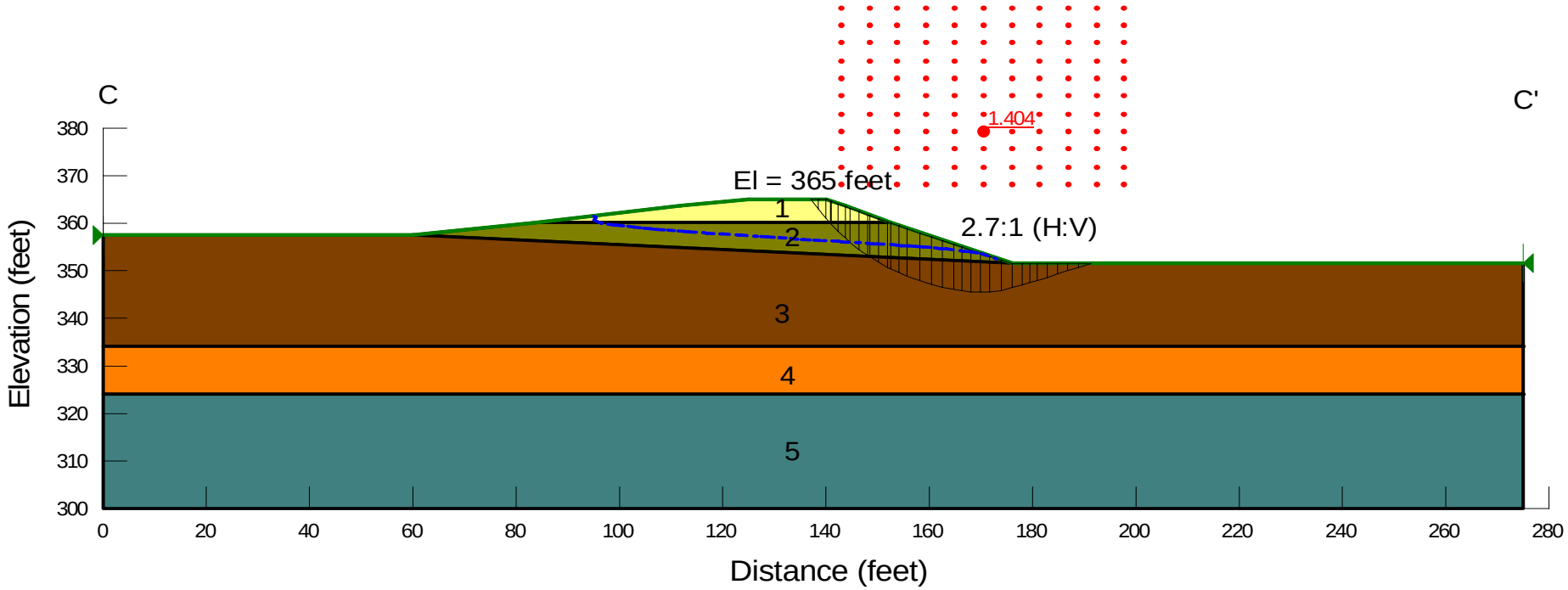
SLOPE STABILITY ANALYSIS RESULTS
SECTION D-D', SEISMIC LANDSIDE
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-19**



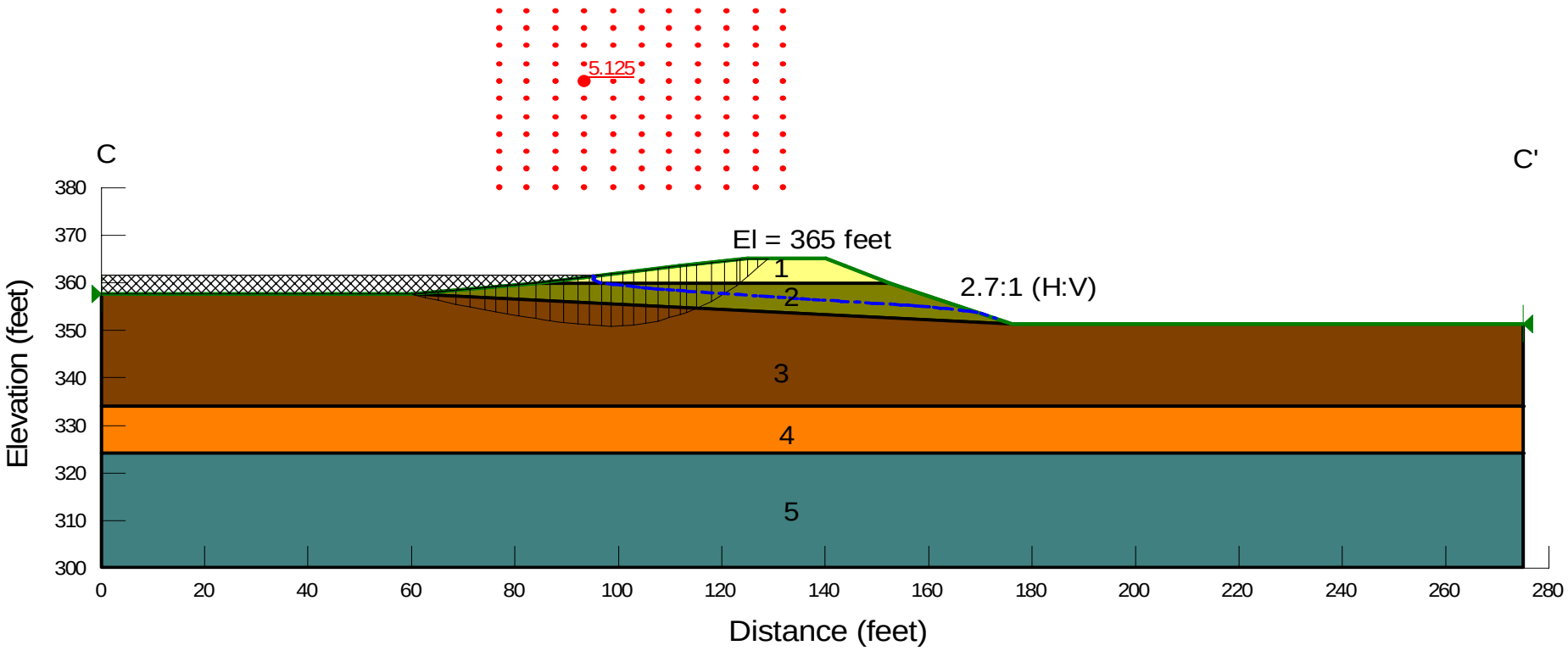
SLOPE STABILITY ANALYSIS RESULTS
SECTION D-D', SEISMIC RIVERSIDE
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-20**



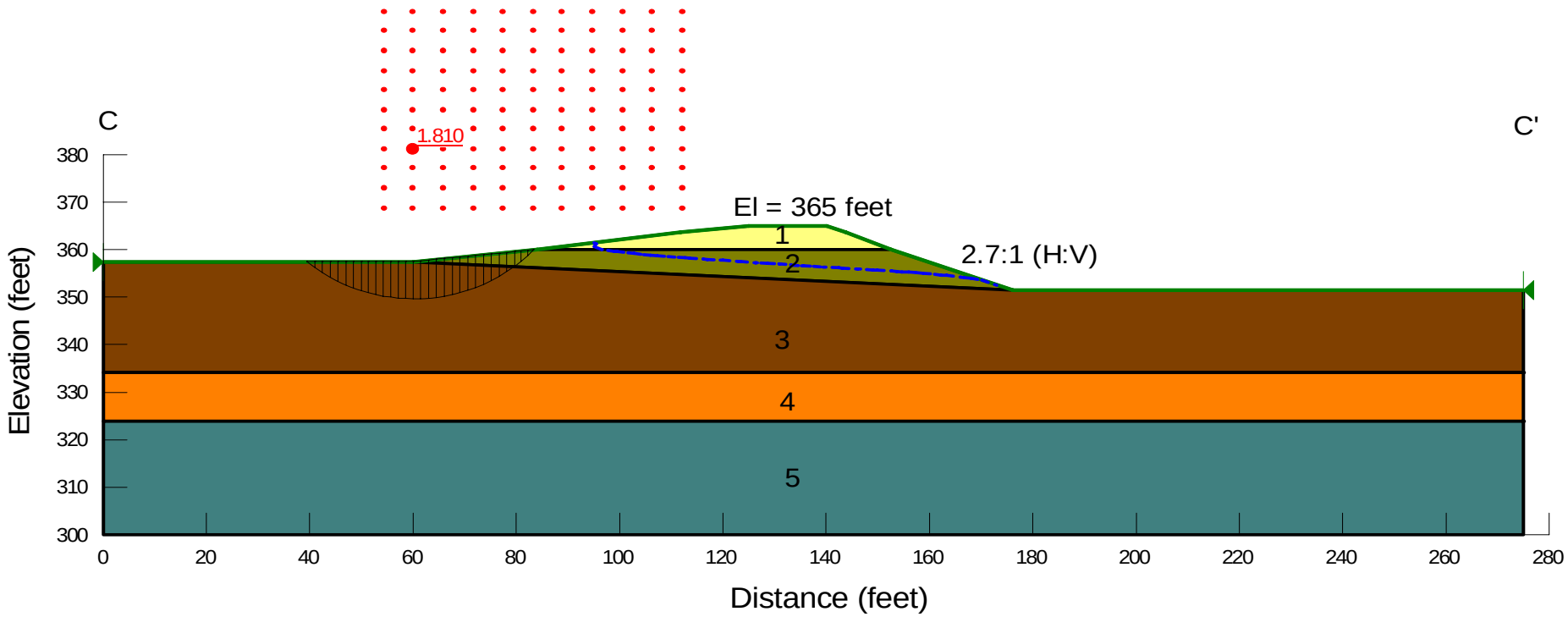
SLOPE STABILITY ANALYSIS RESULTS
REMEDIAL CONCEPTUAL DESIGN
SECTION C-C', SEEPAGE LANDSIDE
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-21**



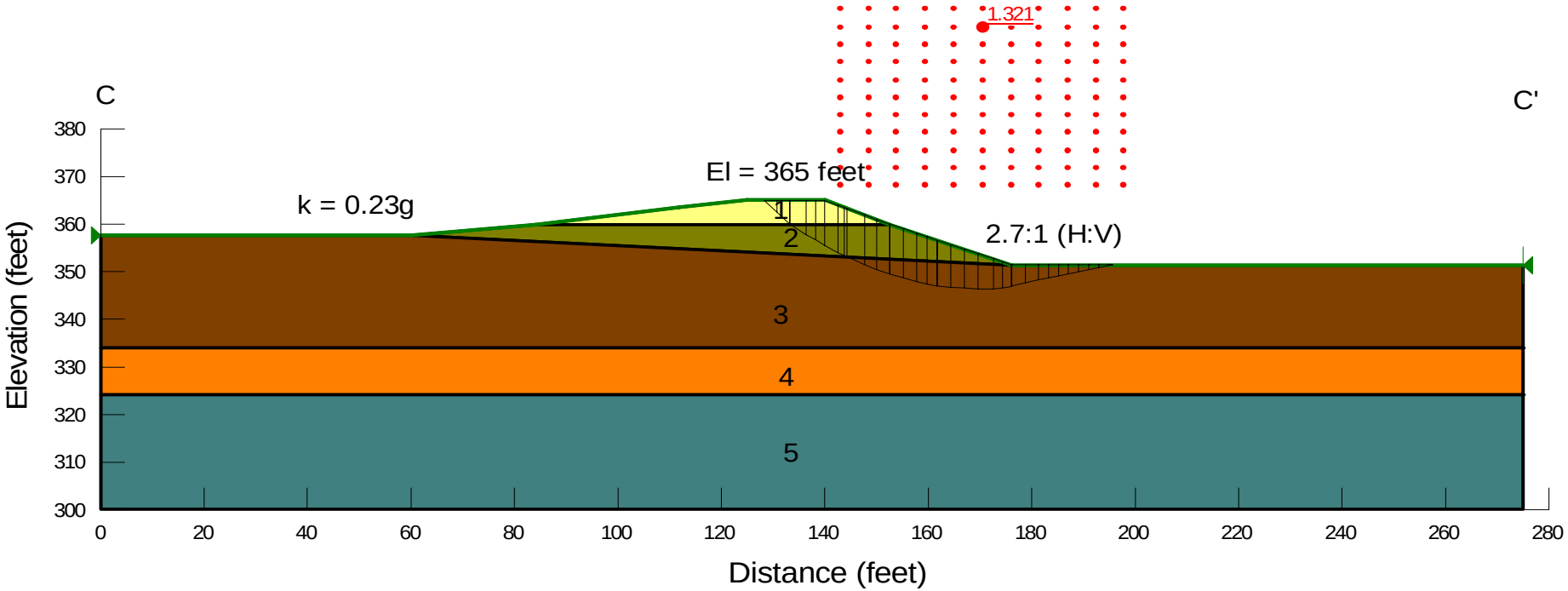
SLOPE STABILITY ANALYSIS RESULTS
REMEDIAL CONCEPTUAL DESIGN
SECTION C-C', SEEPAGE RIVERSIDE
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-22**



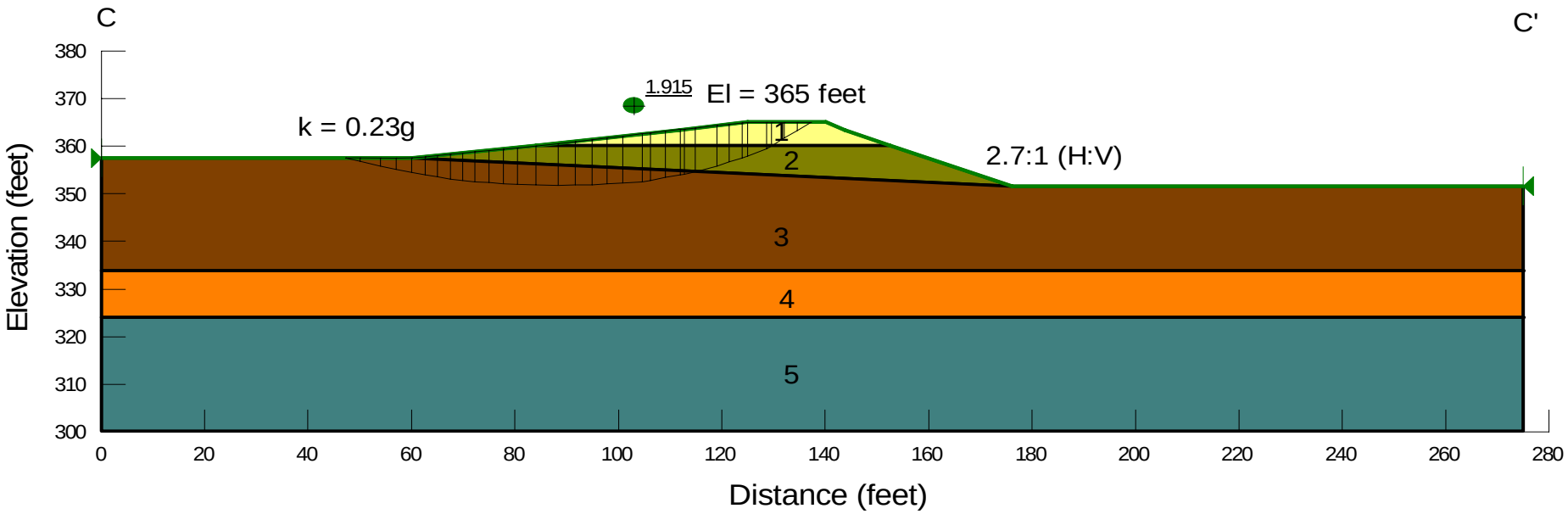
SLOPE STABILITY ANALYSIS RESULTS
REMEDIAL CONCEPTUAL DESIGN
SECTION C-C', RAPID DRAWDOWN
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-23**



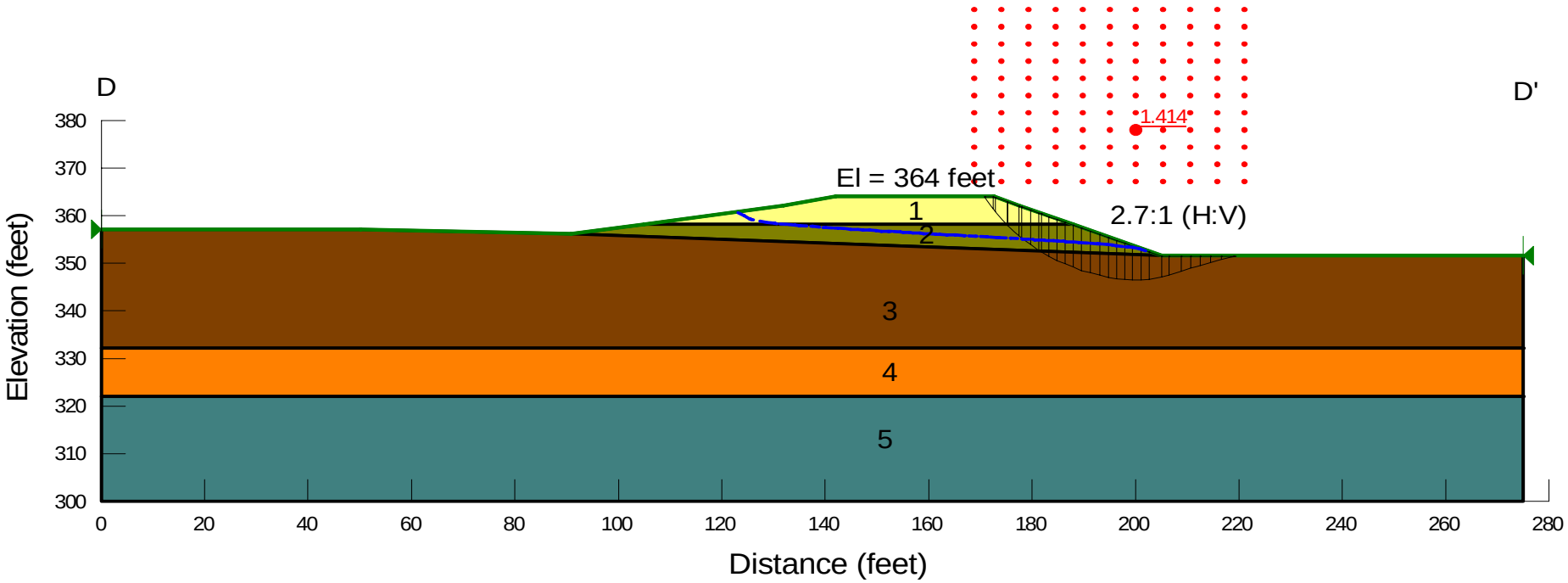
SLOPE STABILITY ANALYSIS RESULTS
REMEDIAL CONCEPTUAL DESIGN
SECTION C-C', SEISMIC LANDSIDE
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-24**



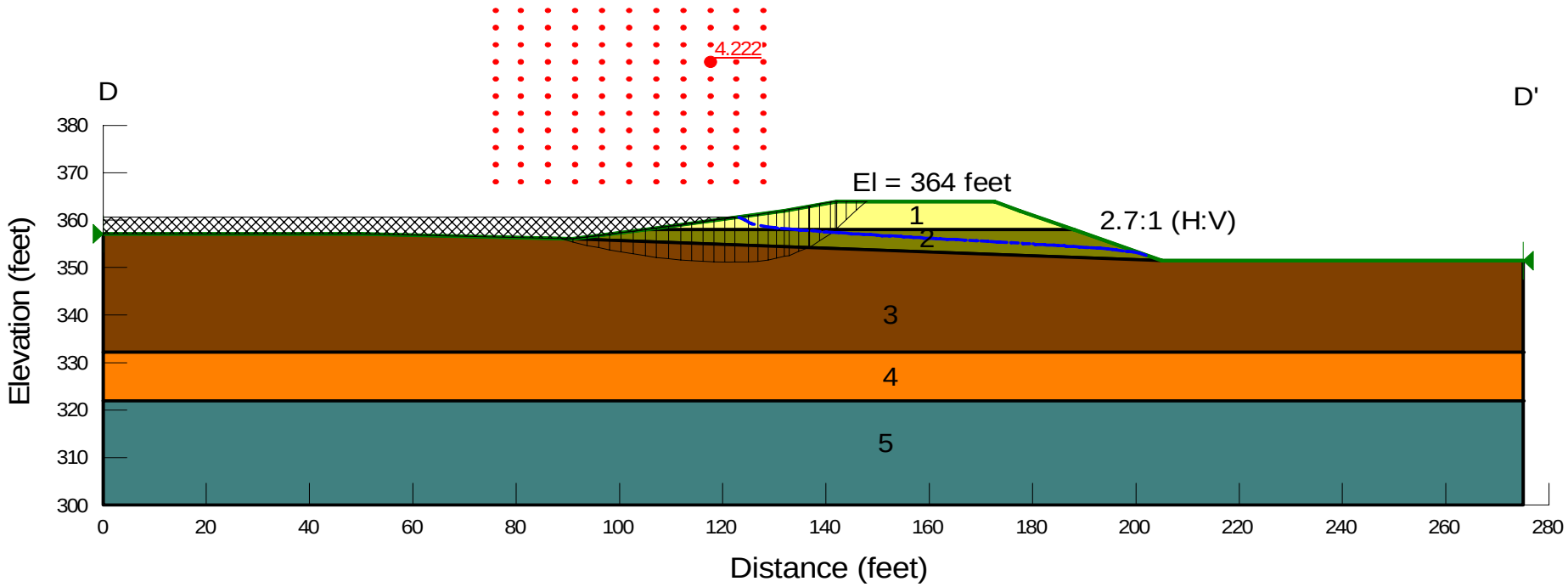
SLOPE STABILITY ANALYSIS RESULTS
REMEDIAL CONCEPTUAL DESIGN
SECTION C-C', SEISMIC RIVERSIDE
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-25**



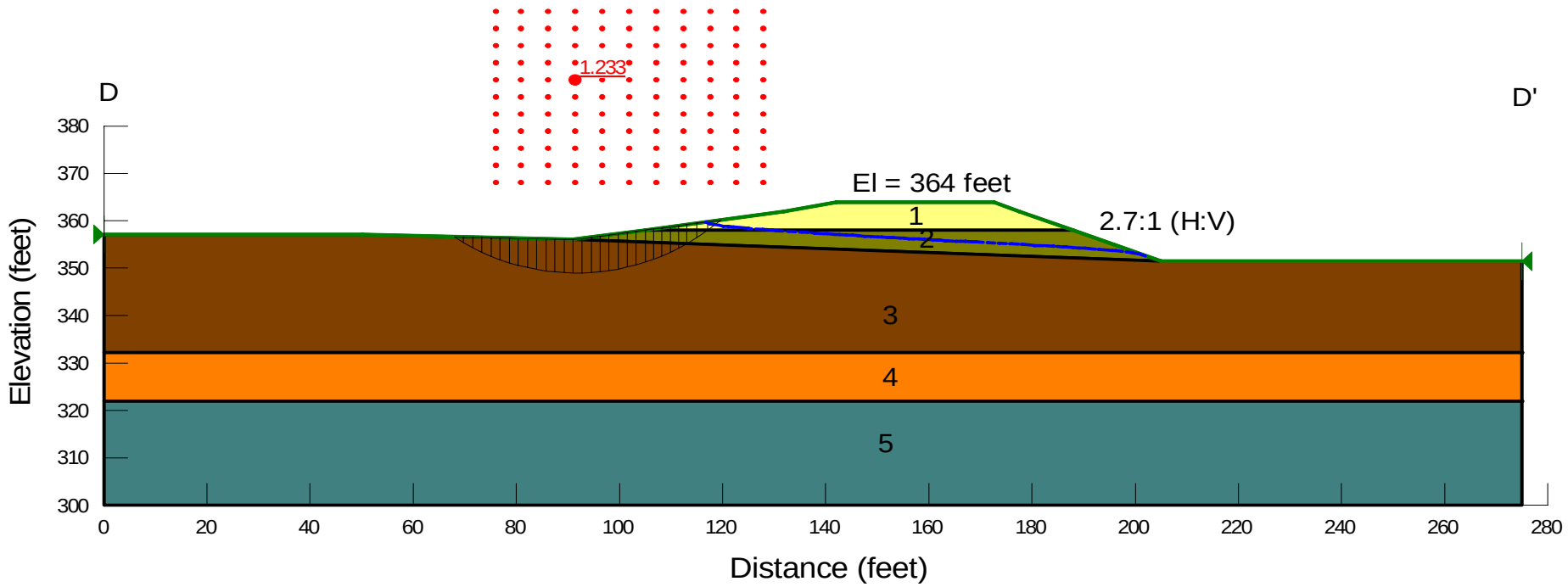
SLOPE STABILITY ANALYSIS RESULTS
REMEDIAL CONCEPTUAL DESIGN
SECTION D-D', SEEPAGE LANDSIDE
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-26**



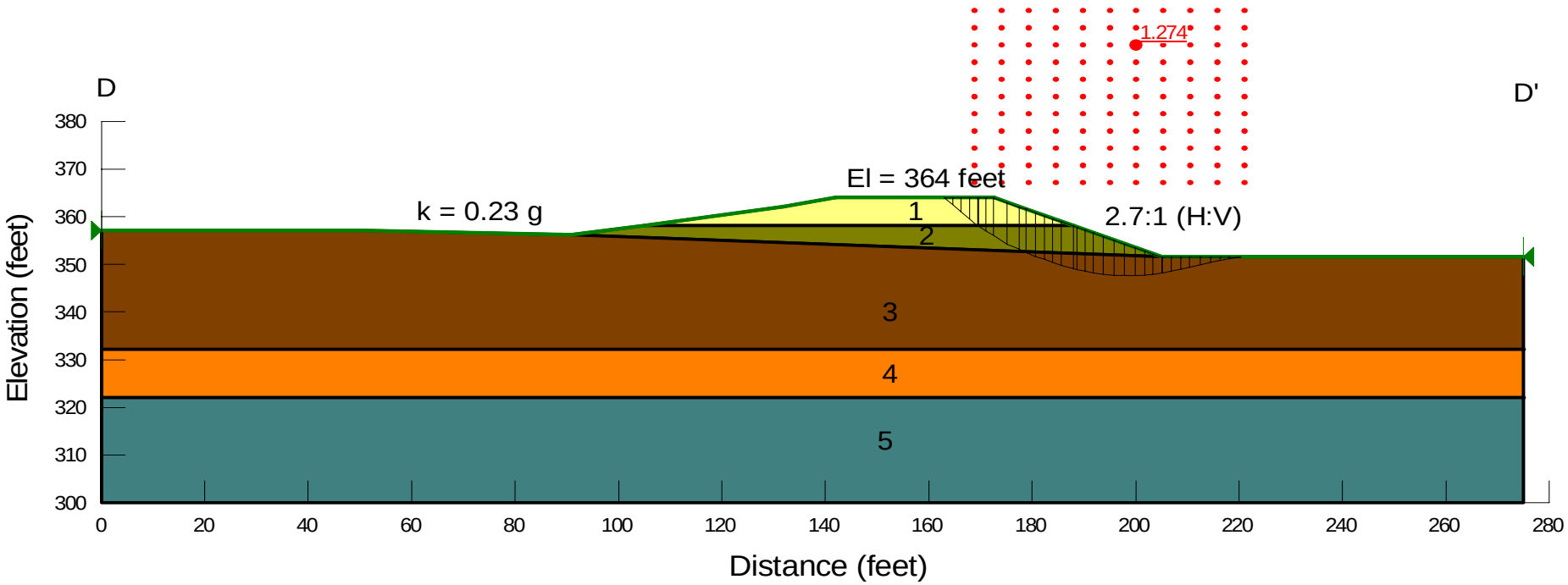
SLOPE STABILITY ANALYSIS RESULTS
REMEDIAL CONCEPTUAL DESIGN
SECTION D-D', SEEPAGE RIVERSIDE
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-27**



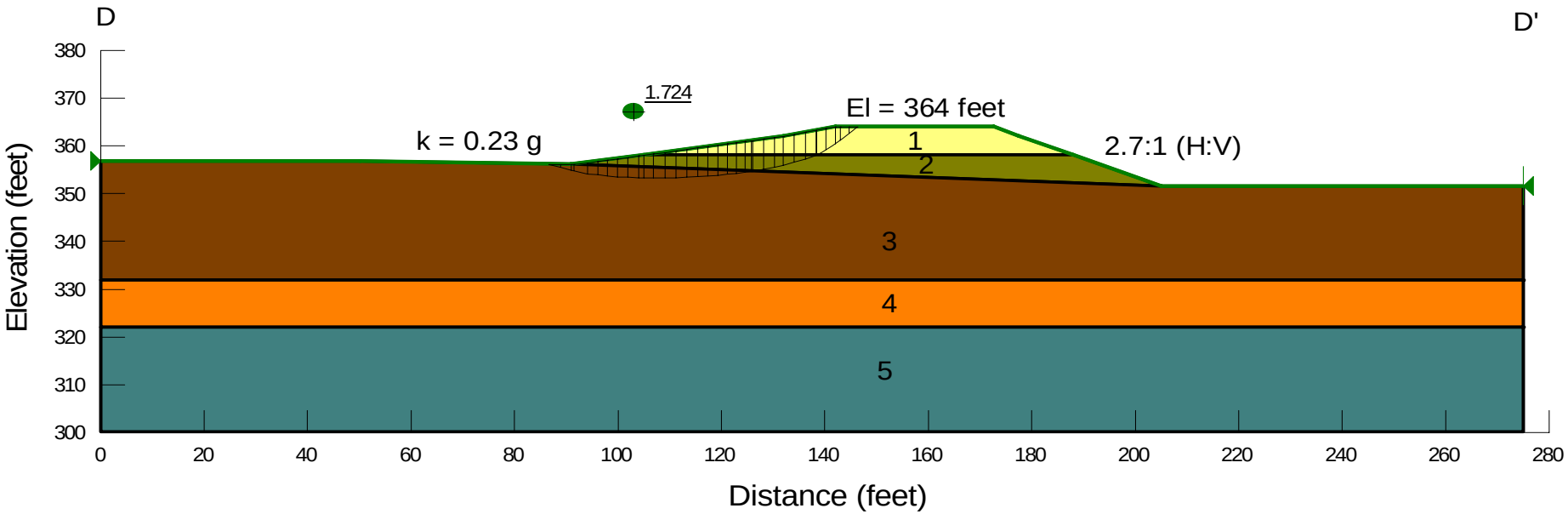
SLOPE STABILITY ANALYSIS RESULTS
REMEDIAL CONCEPTUAL DESIGN
SECTION D-D', RAPID DRAWDOWN
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-28**



SLOPE STABILITY ANALYSIS RESULTS
REMEDIAL CONCEPTUAL DESIGN
SECTION D-D', SEISMIC LANDSIDE
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-29**



SLOPE STABILITY ANALYSIS RESULTS
REMEDIAL CONCEPTUAL DESIGN
SECTION D-D', SEISMIC RIVERSIDE
Tahquitz Creek Levee System
Palm Springs, California

By: EF	Date: 8/17/09	Project No.: 13203.001.0
AMEC Geomatrix		Figure **F-30**