REPORT OF PRELIMINARY GEOTECHNICAL INVESTIGATION

Lot 31, Rancho del Sol
APN 305-060-18-00
San Diego, California

JOB NO. 19-12420
16 October 2019

Prepared for:

Barczewski Family Trust

Geotechnical Exploration, Inc.

SOIL AND FOUNDATION ENGINEERING ● GROUNDWATER ● ENGINEERING GEOLOGY

16 October 2019

Barczewski Family Trust
4208 Lakeway Boulevard
Lakeway, TX 78734
Attn: Mr. Robert D. Barczewski, Trustee

Job No. 19-12420

Subject: **Report of Preliminary Geotechnical Investigation**
Lot 31, Rancho del Sol
APN 305-060-18-00
San Diego, California

Dear Mr. Barczewski:

In accordance with your request, and our proposal dated July 23, 2019, ***Geotechnical Exploration, Inc***. has performed a preliminary geotechnical investigation for the subject property. The field work was performed on September 6, 2019.

If the conclusions and recommendations presented in this report are incorporated into the design and construction of the proposed residences, it is our opinion that the site is suitable for the project.

This opportunity to be of service is sincerely appreciated. Should you have any questions concerning the following report, please do not hesitate to contact us. Reference to our **Job No. 19-12420** will expedite a response to your inquiries.

Respectfully submitted,

GEOTECHNICAL EXPLORATION, INC.

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TABLE OF CONTENTS

FIGURES

APPENDICES

REPORT OF PRELIMINARY GEOTECHNICAL INVESTIGATION
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The following report presents the findings and recommendations of ***Geotechnical Exploration, Inc.*** for the subject proposed residential development.

I. PROJECT SUMMARY AND SCOPE OF SERVICES

It is our understanding that the currently undeveloped lot will be developed to receive an access driveway extending northwest of Caminito Mendiola between Lots 15 and 16, forking into two driveways and ascending upslope to two separate proposed building pads located on the southwest and northeast portions of the subject lot. We anticipate that the proposed residences will be constructed with one- and/or two-story residential structures with slab on-grade floors. Preliminary grading plans by Farrington Engineering Consultants, Inc., dated June 20, 2019, were provided for use in the preparation of this report.

Final construction plans have not been provided to us during the preparation of this report. When completed, however, they should be made available for our review. Additional or modified recommendations may be provided as warranted. Based on the preliminary grading plans provided, we anticipate earthwork for the project to be moderate with cuts and fills of up to 15 feet in height.

Based on the preceding, the scope of work performed for this investigation included a site reconnaissance and subsurface exploration program, laboratory testing, geotechnical engineering analysis of the field and laboratory data, and the preparation of this report. The data obtained and the analyses performed were for the purpose of providing design and construction criteria for the project earthwork, building foundations, slab on-grade floors, retaining/basement walls, and driveways.

II. SITE DESCRIPTION AND HISTORY

The subject site is known as Assessor's Parcel No. 305-060-18-00, lot 31, located in the Rancho del Sol Unit 1 subdivision, according to Recorded Map No. 12477, in the City and County of San Diego, State of California. For the location of the subject site, refer to the Vicinity Map (Figure No. I).

Although the triangular-shaped, approximately 10.24-acre lot is currently undeveloped, there are signs of minor anthropologic disturbance in the area of each proposed building pad location, with a southwest-northeast trending access road running through the lot. The property is bordered on the north by a southeast descending, relatively undisturbed hillside with five residential properties bordering a small portion of the very northwest property boundary; on the west by a relatively undisturbed southerly descending hillside; and on the southeast by existing residential properties lower in elevation. Vegetation across the site consists primarily of thick to sparse native chaparral shrubs.

Elevations across the property range from approximately 297 feet above Mean Sea Level (MSL) along the northwest property boundary to 195 feet above MSL along the southwest property boundary. Information concerning approximate elevations across the site were obtained from a *"Preliminary Grading Plan"* with topographic data prepared by Farrington Engineering Consultants, Inc., dated June 19, 2019.

III. FIELD INVESTIGATION

The field investigation consisted of a surface reconnaissance and a subsurface exploration program using a rubber-tire backhoe to investigate and sample the subsurface soils. Seven exploratory trenches were excavated in the area of the proposed new building pads on September 6, 2019, to a maximum depth of 11 feet. The soils encountered in the trenches were continuously logged in the field by our geologist and described in accordance with the Unified Soil Classification System (Appendix A). The approximate locations of the exploratory trenches are shown on the Plot Plan (Figure No. II). Exploratory trench logs have been prepared on the basis of our observations and laboratory test results. Refer to Figure Nos. IIIa-g for details.

Representative samples were obtained from the exploratory trenches at selected depths appropriate to the investigation. All samples were returned to our laboratory for evaluation and testing.

IV. LABORATORY TESTS AND SOIL INFORMATION

Laboratory tests were performed on disturbed bulk samples of the soils encountered in order to evaluate their index, strength, expansion, and compressibility properties. Refer to Figures Nos. IIIa-g and IV for laboratory results and data. The following tests were conducted on the sampled soils:

1. *Determination of Percentage of Particles Smaller than No. 200 Sieve (ASTM D1140-17)*
2. *Laboratory Compaction Characteristics (ASTM D1557-12)*
3. *Expansion Index (ASTM D4829-11)*
4. *Direct Shear Test (ASTM D3080-11)*
5. *Atterberg Limits (D 4318-05)*

The particle size smaller than a No. 200 sieve analysis aids in classifying the tested soils in accordance with the Unified Soil Classification System and provides qualitative information related to engineering characteristics such as expansion potential, permeability, and shear strength. The test results are presented on the trench logs at the appropriate sample depths.

Laboratory compaction tests establish the laboratory maximum dry density and optimum moisture content of the tested soils and are also used to aid in evaluating the strength characteristics of the soils. The test results are presented on the trench logs at the appropriate sample depths.

The expansion potential of soils is determined, when necessary, utilizing the Standard Test Method for Expansion Index of Soils ASTM D4829. In accordance with the Standard (Table 5.3), potentially expansive soils are classified as follows:

EXPANSION INDEX	***EXPANSION POTENTIAL***
0 to 20	Very low
21 to 50	Low
51 to 90	Medium
91 to 130	High
Above 130	Very high

The expansion potential of the surficial, clayey sand and sandy clay weathered formational materials encountered was determined utilizing the procedures specified in (ASTM D4829-11). The measured Expansion Index values are 112 and 168, respectively. Based on the test results, the classification tests, and our past experience with similar materials, it is our opinion that the surficial, weathered Friars Formation materials encountered possess a ***high*** to ***very high expansion potential***. The test results are presented on the trench logs at the appropriate sample depths. Based on the particle size passing the No. 200 sieve, our classification, and our past experience with similar materials in San Diego, the sampled surficial topsoil/fill soils and the lower profile of the Friars Formation materials possess a ***very low*** to ***low expansion potential***.

A direct shear test *(ASTM D3080)* was performed on a remolded sample of the retrieved formational materials in order to evaluate their strength characteristics. The shear test was performed with a constant strain rate direct shear machine. The specimens tested were saturated, then sheared under various normal loads under drained conditions. Refer to Figure No. IV for the shear test results.

The Atterberg Limits (ASTM D 4318-05) are used to aid in classification of soils in accordance with the Unified Soil Classification System (ASTM D 2487). The Liquid Limit, Plastic Limit and Plasticity Index are also utilized, with other soil properties and published correlations, to aid in evaluating engineering properties such as compressibility, expansion potential, shear strength and permeability.

V. REGIONAL GEOLOGIC DESCRIPTION

San Diego County has been divided into three major geomorphic provinces: the Coastal Plain, Peninsular Ranges and Salton Trough. The Coastal Plain exists west of the Peninsular Ranges. The Salton Trough is east of the Peninsular Ranges. These divisions are the result of the basic geologic distinctions between the areas. Mesozoic metavolcanic, metasedimentary and plutonic rocks predominate in the Peninsular Ranges with primarily Cenozoic sedimentary rocks to the west and east of this central mountain range (Demere, 1997).

In the Coastal Plain region, the "basement" consists of Mesozoic crystalline rocks. Basement rocks are also exposed as high relief areas (e.g., Black Mountain northeast of the subject property and Cowles Mountain near the San Carlos area of San Diego). Younger Cretaceous and Tertiary sediments lap up against these older features to the west. These sediments form a "layer cake" sequence of marine and non-marine sedimentary rock units, with some formations up to 140 million years old. Faulting related to the La Nacion and Rose Canyon Fault zones has broken up this sequence into a number of distinct fault blocks in the southwestern part of the county. Northwestern portions of the county are relatively undeformed by faulting (Demere, 1997).

The Peninsular Ranges form the granitic spine of San Diego County. The property is located in this physiographic province. These rocks are primarily plutonic, forming at depth beneath the earth's crust 140 to 90 million years ago as the result of the subduction of an oceanic crustal plate beneath the North American continent. These rocks formed the much larger Southern California batholith. Metamorphism associated with the intrusion of these great granitic masses affected the much older sediments that existed near the surface over that period of time. These metasedimentary rocks remain as roof pendants of marble, schist, slate, quartzite and gneiss throughout the Peninsular Ranges.

Locally, Miocene-age volcanic rocks and flows have also accumulated within these mountains (e.g., Jacumba Valley). Regional tectonic forces and erosion over time have uplifted and unroofed these granitic rocks to expose them at the surface (Demere, 1997).

The Salton Trough is the northerly extension of the Gulf of California. This zone is undergoing active deformation related to faulting along the Elsinore and San Jacinto Fault Zones, which are part of the major regional tectonic feature in the southwestern portion of California, the San Andreas Fault Zone. Translational movement along these fault zones has resulted in crustal rifting and subsidence. The Salton Trough, also referred to as the Colorado Desert, has been filled with sediments to a depth of approximately 5 miles since the movement began in the early Miocene, 24 million years ago. The source of these sediments has been the local mountains as well as the ancestral and modern Colorado River (Demere, 1997).

As indicated previously, the San Diego area is part of a seismically active region of California. It is on the eastern boundary of the Southern California Continental Borderland, part of the Peninsular Ranges Geomorphic Province. This region is part of a broad tectonic boundary between the North American and Pacific Plates. The actual plate boundary is characterized by a complex system of active, major, right-lateral strike-slip faults, trending northwest/southeast. This fault system extends eastward to the San Andreas Fault (approximately 70 miles from San Diego) and westward to the San Clemente Fault (approximately 50 miles off-shore from San Diego) (Berger and Schug, 1991).

During recent history, the San Diego County area has been relatively quiet seismically. No fault ruptures or major earthquakes have been experienced in historic time within the San Diego area. Since earthquakes have been recorded by instruments (since the 1930s), the San Diego area has experienced scattered seismic events with Richter magnitudes (M) generally less than M4.0. During June 1985, a series of small earthquakes occurred beneath San Diego Bay, three of which had recorded magnitudes of M4.0 to M4.2. In addition, the Oceanside earthquake of July 13, 1986, located approximately 26 miles offshore of the City of Oceanside, had a magnitude of M5.3 (Hauksson and Jones, 1988). On June 15, 2004, a M5.3 earthquake occurred approximately 45 miles southwest of downtown San Diego (26 miles west of Rosarito, Mexico). Although this earthquake was widely felt, no significant damage was reported. A widely felt earthquake on a distant southern California fault was a M5.4 event that took place on July 29, 2008, west southwest of the Chino Hills area of Riverside County. The most recent widely felt earthquake in San Diego County occurred July 20, 2009. No significant damage was reported for the San Diego area.

On April 4, 2010, a large earthquake occurred in Baja California, Mexico. It was widely felt throughout the southwest including southwestern Arizona and southern California. This M7.2 event, the Sierra El Mayor earthquake, occurred in northern Baja California approximately 40 miles south of the Mexico-USA border at shallow depth along the principal plate boundary between the North American and Pacific plates. According to the U. S. Geological Survey this is an area with a high level of historical seismicity, and it has recently also been seismically active, though this is the largest event to strike in this area since 1892. The April 4, 2010, earthquake appears to have been larger than the M6.9 earthquake in 1940 or any of the early 20th century events (e.g., 1915 and 1934) in this region of northern Baja California.

This event's aftershock zone extends significantly to the northwest, overlapping with the portion of the fault system that is thought to have ruptured in 1892. Some structures in the San Diego area experienced minor damage and there were some injuries. Ground motions for the April 4, 2010, main event, recorded at stations in San Diego and reported by the California Strong Motion Instrumentation Program (CSMIP), ranged up to 0.058g.

In California, major earthquakes can generally be correlated with movement on active faults. As defined by the California Division of Mines and Geology (Hart, E.W., 1980), an "active" fault is one that has had ground surface displacement within Holocene time (about the last 11,000 years). Additionally, faults along which major historical earthquakes have occurred (about the last 210 years in California) are also considered to be active (Association of Engineering Geologists, 1973). The California Division of Mines and Geology defines a "potentially active" fault as one that has had ground surface displacement during Quaternary time, that is, between 11,000 and 1.6 million years (Hart, E.W., 1980).

VI. <u>SITE-SPECIFIC SOIL & GEOLOGIC DESCRIPTION</u>

Our field work, reconnaissance and review of the geologic map by Kennedy and Tan, 2008, *"Geologic Map of San Diego, 30'x60' Quadrangle, CA,"* indicates that the site is underlain by Tertiary-age Mission Valley Formation which is underlain by Tertiary-age Stadium Conglomerate which is underlain by Friars formation (Tf). Only the Friars Formation materials, however, were encountered during our field exploration and were encountered in all the exploratory trenches to the maximum depth of exploration on the lower portion of the site where the site development is proposed.

The Friars Formation is capped by a moderate to highly weathered profile with thicknesses ranging from approximately 1 to 3 feet, at depths ranging from 2 to 4 feet in all exploratory trenches. The weathered profile is overlain by approximately 1 to 2 feet of topsoil and fill soil. The topsoil was encountered in all the exploratory trenches. Fill soil, however, was only encountered in exploratory trenches T-2, T-3, and T-4 located on the southeastern portion of the site. Figure No. V presents a geologic map (Kennedy and Tan, 2008) of the general area of the site. Refer to Figure Nos. IIIa-g for details concerning description, depths, and thickness of these materials/soils.

A. Stratigraphy

Topsoil/Fill Soil (Qts/Qaf): The encountered topsoil consists of loose to medium dense, fine- to medium-grained silty sand. These relatively shallow, surficial soils are generally dry and brown. The fill soil encountered consists of disturbed sections of the topsoil. These soils are not considered suitable in their current condition for support of new fills or any improvements. Refer to Figure Nos. IIIa-g for details.

Weathered Friars Formation (Tf): The upper weathered profile of the formational materials encountered consist of very dense/very stiff, fine- to medium-grained clayey sand and sandy clay. The weathered formational materials are generally slightly moist to very moist, reddish brown with abundant iron oxide staining and were encountered in all the exploratory trenches. These materials possess a high to very high expansion for potential and are only considered adequate for support of new fills. Refer to Figure Nos. IIIa-g for details.

Friars Formation (Tf): The formational materials encountered consist of very dense, fine- to medium-grained silty sand. The formational materials are predominantly slightly moist, yellowish-pale-gray and were encountered to the maximum depth of exploration in all the exploratory trenches. An isolated pocket of the mudstone facies of the Friars Formation, however, was encountered at depth in exploratory trench T-2 only, located in the far southeast corner of the site. The mudstone formational materials consist of hard, fine-grained silty lean clay and are generally moist and pale olive gray. These materials are considered adequate for support of new fills or any improvements and, with the exception of the mudstone pocket encountered in T-2, possess a very low to low potential for expansion. Refer to Figure Nos. IIIa-g for details.

B. Structure

Friars Formation (Tf) (Sandstone): These formational sandstone materials, as exposed in our exploratory trenches, were observed to be homogenous sandstone deposits with no obvious visible bedding planes.

Friars Formation (Tf) (Mudstone): These formational mudstone materials, as exposed in exploratory trench T-2, located in the far southeast corner of the site, were observed to be thinly bedded and fissile. The observed mudstone unit is considered to be discontinuous across the site. A bedding attitude was measured within the mudstone materials and indicated a strike of N9°W with a dip of 5° to the northeast. The mudstone beds are dipping to the northeast, predominantly perpendicular and slightly into the slope face. The direction of dip indicates neutral to favorable geologic structure, with respect to slope instability.

Reference to the local geologic map, Figure No. V (Kennedy and Tan, 2008), displays a mapped bedding attitude within the Friars Formation, in relatively close proximity to the northeast of the subject site, indicating a measured bedding attitude of N7°W at a dip of 6° to the northeast.

Our measured bedding attitude along with the mapped bedding attitude display neutral to favorable conditions across the predominantly southerly to southeasterly descending natural hillside.

C. __Limitations__

The exploratory trench logs and related information depict subsurface conditions only at the specific locations shown on the Plot Plan and on the particular date designated on the logs. Subsurface conditions at other locations may differ from conditions occurring at these exploratory trench locations. Also, the passage of time may result in changes in the subsurface conditions due to environmental changes.

VII. __GROUNDWATER__

Free groundwater was not encountered in any of the exploratory trenches at the time of excavation. It must be noted, however, that fluctuations in the level of groundwater may occur due to variations in ground surface topography, subsurface stratification, rainfall, and other possible factors that may not have been evident at the time of our field investigation. It should be kept in mind that grading operations can change surface drainage patterns and/or reduce permeabilities due to the densification of compacted soils. Such changes of surface and subsurface hydrologic conditions, plus irrigation of landscaping or significant increases in rainfall, may result in the appearance of surface or near-surface water at locations where none existed previously. The appearance of such water is expected to be localized and cosmetic in nature, if good positive drainage is implemented, as recommended in this report, during and at the completion of construction.

It must be understood that unless discovered during initial site exploration or encountered during site grading operations, it is extremely difficult to predict if or where perched or true groundwater conditions may appear in the future. When site fill or formational soils are fine-grained and of low permeability, water problems may not become apparent for extended periods of time.

Water conditions, where suspected or encountered during construction, should be evaluated and remedied by the project civil and geotechnical consultants. The project developer and property owner, however, must realize that post-construction appearances of groundwater may have to be dealt with on a site-specific basis.

VIII. GEOLOGIC HAZARDS

Our review of some available published information including the City of San Diego Seismic Safety Study, Geologic Hazards and Faults Map Sheet No. 39, Figure No. VI, indicates that the site is located in two low to moderate risk, geologic hazard areas designated as Categories 53 and 23. Category 53 denotes the subject site's underlying formational materials as "*Variable Stability; Level or sloping terrain, unfavorable geologic structure; Low to moderate risk.*" Category 23 denotes the subject site's underlying formational materials as "*Potential Slope Instability; Slide-Prone Formations; Friars: Neutral or favorable geologic structure*." Our findings, analysis, and conclusions address these Geologic Hazard Categories in Section VIII.B, "Slope Stability." Based on the "*Geologic Map of San Diego, 30'x60' Quadrangle,* (Kennedy and Tan, 2008), Figure No. V, and the City of San Diego Seismic Safety Study, Geologic Hazards and Faults Map No. 39, there are no faults mapped on the subject site. In our explicit professional opinion, neither an active fault nor a potentially active fault underlies the subject site.

The following is a discussion of the geologic conditions and hazards common to this area of San Diego County, as well as project-specific geologic information relating to development of the subject property.

A. Local and Regional Faults

Rose Canyon Fault: The Rose Canyon Fault Zone (Mount Soledad and Rose Canyon Faults) is located approximately 7 miles southwest of the subject site. The Rose Canyon Fault is mapped trending north-south from Oceanside to downtown San Diego, from where it appears to head southward into San Diego Bay, through Coronado and offshore. The Rose Canyon Fault Zone is considered to be a complex zone of onshore and offshore, en echelon strike slip, oblique reverse, and oblique normal faults. The Rose Canyon Fault is considered to be capable of generating an M7.2 earthquake and is considered microseismically active, although no significant recent earthquakes are known to have occurred on the fault.

Investigative work on faults that are part of the Rose Canyon Fault Zone at the Police Administration and Technical Center in downtown San Diego, at the SDG&E facility in Rose Canyon, and within San Diego Bay and elsewhere within downtown San Diego, has encountered offsets in Holocene (geologically recent) sediments. These findings confirm Holocene displacement on the Rose Canyon Fault, which was designated an *"active"* fault in November 1991 (Hart, E.W. and W.A. Bryant, 2007, Fault-Rupture Hazard Zones in California, California Geological Survey Special Publication 42).

Coronado Bank Fault: The Coronado Bank Fault is located approximately 20 miles southwest of the site. Evidence for this fault is based upon geophysical data (acoustic profiles) and the general alignment of epicenters of recorded seismic activity (Greene, 1979). The Oceanside earthquake of M5.3 recorded July 13, 1986, is known to have been centered on the fault or within the Coronado Bank Fault Zone. Although this fault is considered active, due to the seismicity within the fault zone, it is significantly less active seismically than the Elsinore Fault (Hileman, 1973). It is postulated that the Coronado Bank Fault is capable of generating a M7.6 earthquake and is of great interest due to its close proximity to the greater San Diego metropolitan area.

Newport-Inglewood Fault: The Newport-Inglewood Fault Zone is located approximately 20 miles northwest of the site. A significant earthquake (M6.4) occurred along this fault on March 10, 1933. Since then no additional significant events have occurred. The fault is believed to have a slip rate of approximately 0.6 mm/yr with an unknown recurrence interval. This fault is believed capable of producing an earthquake of M6.0 to M7.4 (SCEC, 2004).

Elsinore Fault: The Elsinore Fault is located approximately 29 miles northeast of the site. The fault extends approximately 200 kilometers (125 miles) from the Mexican border to the northern end of the Santa Ana Mountains. The Elsinore Fault zone is a 1- to 4-mile-wide, northwest-southeast-trending zone of discontinuous and en echelon faults extending through portions of Orange, Riverside, San Diego, and Imperial Counties. Individual faults within the Elsinore Fault Zone range from less than 1 mile to 16 miles in length. The trend, length and geomorphic expression of the Elsinore Fault Zone identify it as being a part of the highly active San Andreas Fault system.

Like the other faults in the San Andreas system, the Elsinore Fault is a transverse fault showing predominantly right-lateral movement. According to Hart, et al. (1979), this movement averages less than 1 centimeter per year. Along most of its length, the Elsinore Fault Zone is marked by a bold topographic expression consisting of linearly aligned ridges, swales and hallows. Faulted Holocene alluvial deposits (believed to be less than 11,000 years old) found along several segments of the fault zone suggest that at least part of the zone is currently active.

Although the Elsinore Fault Zone belongs to the San Andreas set of active, northwest-trending, right-slip faults in the southern California area (Crowell, 1962), it has not been the site of a major earthquake in historic time, other than a M6.0 earthquake near the town of Elsinore in 1910 (Richter, 1958; Toppozada and Parke, 1982). However, based on length and evidence of late-Pleistocene or Holocene displacement, Greensfelder (1974) has estimated that the Elsinore Fault Zone is reasonably capable of generating an earthquake ranging from M6.8 to M7.1. Faulting evidence exposed in trenches placed in Glen Ivy Marsh across the Glen Ivy North Fault (a strand of the Elsinore Fault Zone between Corona and Lake Elsinore), suggest a maximum earthquake recurrence interval of 300 years, and when combined with previous estimates of the long-term horizontal slip rate of 0.8 to 7.0 mm/year, suggest typical earthquakes of M6.0 to M7.0 (Rockwell, 1985).

San Jacinto Fault: The San Jacinto Fault is located 52 miles to the northeast of the site. The San Jacinto Fault Zone consists of a series of closely spaced faults, including the Coyote Creek Fault, that form the western margin of the San Jacinto Mountains. The fault zone extends from its junction with the San Andreas Fault in San Bernardino, southeasterly toward the Brawley area, where it continues south of the international border as the Imperial Transform Fault (Earth Consultants International [ECI], 2009).

The San Jacinto Fault zone has a high level of historical seismic activity, with at least 10 damaging earthquakes (M6.0 to M7.0) having occurred on this fault zone between 1890 and 1986. Earthquakes on the San Jacinto Fault in 1899 and 1918 caused fatalities in the Riverside County area. Offset across this fault is predominantly right-lateral, similar to the San Andreas Fault, although some investigators have suggested that dip-slip motion contributes up to 10% of the net slip (ECI, 2009).

The segments of the San Jacinto Fault that are of most concern to major metropolitan areas are the San Bernardino, San Jacinto Valley and Anza segments. Fault slip rates on the various segments of the San Jacinto are less well constrained than for the San Andreas Fault, but the available data suggest slip rates of 12 ±6 mm/year for the northern segments of the fault, and slip rates of 4 ±2 mm/year for the southern segments. For large ground-rupturing earthquakes on the San Jacinto fault, various investigators have suggested a recurrence interval of 150 to 300 years. The Working Group on California Earthquake Probabilities (WGCEP, 2008) has estimated that there is a 31 percent probability that an earthquake of M6.7 or greater will occur within 30 years on this fault. Maximum credible earthquakes of M6.7, M6.9, and M7.2 are expected on the San Bernardino, San Jacinto Valley and Anza segments, respectively, capable of generating peak horizontal ground accelerations of 0.48g to 0.53g in the County of Riverside, (ECI, 2009). A M5.4 earthquake occurred on the San Jacinto Fault on July 7, 2010.

The United States Geological Survey has issued the following statements with respect to the recent seismic activity on southern California faults:

> The San Jacinto fault, along with the Elsinore, San Andreas, and other faults, is part of the plate boundary that accommodates about 2 inches/year of motion as the Pacific plate moves northwest relative to the North American plate. The largest recent earthquake on the San Jacinto fault, near this location, the M6.5 1968 Borrego Mountain earthquake April 8, 1968, occurred about 25 miles southeast of the July 7, 2010, M5.4 earthquake.
>
> This M5.4 earthquake follows the 4th of April 2010, Easter Sunday, M7.2 earthquake, located about 125 miles to the south, well south of the US Mexico international border. A M4.9 earthquake occurred in the same

area on June 12th at 8:08 pm (Pacific Time). Thus, this section of the San Jacinto fault remains active.

Seismologists are watching two major earthquake faults in southern California. The San Jacinto fault, the most active earthquake fault in southern California, extends for more than 100 miles from the international border into San Bernardino and Riverside, a major metropolitan area often called the Inland Empire. The Elsinore fault is more than 110 miles long, and extends into the Orange County and Los Angeles area as the Whittier fault. The Elsinore fault is capable of a major earthquake that would significantly affect the large metropolitan areas of southern California. The Elsinore fault has not hosted a major earthquake in more than 100 years. The occurrence of these earthquakes along the San Jacinto fault and continued aftershocks demonstrates that the earthquake activity in the region remains at an elevated level. The San Jacinto fault is known as the most active earthquake fault in southern California. Caltech and USGS seismologist continue to monitor the ongoing earthquake activity using the Caltech/USGS Southern California Seismic Network and a GPS network of more than 100 stations.

B. Other Geologic Hazards

Ground Rupture: Ground rupture is characterized by bedrock slippage along an established fault and may result in displacement of the ground surface. For ground rupture to occur along a fault, an earthquake usually exceeds M5.0. If a M5.0 earthquake was to take place on a local fault, an estimated surface-rupture length 1 mile long could be expected (Greensfelder, 1974). Our investigation indicates that the subject site is not directly on a known active fault trace and, therefore, the risk of ground rupture is remote.

Ground Shaking: Structural damage caused by seismically induced ground shaking is a detrimental effect directly related to faulting and earthquake activity. Ground shaking is considered to be the greatest seismic hazard in San Diego County. The intensity of ground shaking is dependent on the magnitude of the earthquake, the distance from the earthquake, and the seismic response characteristics of underlying soils and geologic units. Earthquakes of M5.0 or greater are generally associated with significant damage. It is our opinion that the most serious damage to the site would be caused by a large earthquake originating on a nearby strand of the Rose Canyon Fault Zone. Although the chance of such an event is remote, it could occur within the useful life of the structures.

Landslides: Based upon our geotechnical investigation, review of the geologic map (Kennedy and Tan, 2008), review of the referenced City of San Diego Seismic Safety Study -- Geologic Hazards Map Sheet 39 and stereo-pair aerial photographs (3-31-53, AXN-4M-13 and 14), there are no known or suspected ancient landslides located on the site.

Liquefaction: The liquefaction of saturated sands during earthquakes can be a major cause of damage to buildings. Liquefaction is the process by which soils are transformed into a viscous fluid that will flow as a liquid when unconfined. It occurs primarily in loose, saturated sands and silts when they are sufficiently shaken by an earthquake.

On this site, the risk of liquefaction of foundation materials due to seismic shaking is considered to be very low due to the dense natural-ground material and the lack of a shallow, static groundwater surface under the site. The groundwater surface is at a minimum of over 50 feet below the ground surface. The site does not have a potential for soil strength loss to occur due to a seismic event.

Slope Stability: Slope stability calculations were performed for the proposed cut slopes along geologic cross sections A-A' and B-B' (Figure Nos. VIIa-b) using the Janbu method of analysis and the computer program *XSTABL* Version 5.2. The results of our stability analyses are presented in Appendix B and indicate a factor of safety of greater than 1.5 against mass and surficial instability.

C. Geologic Hazards Summary

It is our opinion, based upon a review of available maps, our research, and our site investigation, that the site is underlain by relatively stable formational materials and is suitable for the proposed new residential development and associated improvements provided the recommendations presented herein are implemented.

No significant geologic hazards are known to exist on the site that would prevent the proposed construction. Ground shaking from earthquakes on active southern California faults and active faults in northwestern Mexico is the greatest geologic hazard at the property. Design of building structures in accordance with the current building codes would reduce the potential for injury or loss of human life. Buildings constructed in accordance with current building codes may suffer significant damage but should not undergo total collapse.

In our explicit professional opinion, no *"active"* or *"potentially active"* faults underlie the project site.

IX. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are based on our evaluation and analysis of the field investigation conducted by our firm, our laboratory test results, and our experience with similar soils and formational materials. The opinions, conclusions, and recommendations presented in this report are contingent upon ***Geotechnical Exploration, Inc.*** being retained to review the final plans and specifications as they are developed and to observe the site earthwork and installation of foundations. Accordingly, we recommend that the following paragraph be included on the grading and foundation plans for the project.

> If the geotechnical consultant of record is changed for the project, the work shall be stopped until the replacement has agreed in writing to accept the responsibility within their area of technical competence for approval upon completion of the work. It shall be the responsibility of the permittee to notify the City Engineer in writing of such change prior to the recommencement of grading and/or foundation installation work.

The primary feature of concern at the site is the high to very high expansion potential of the weathered, surficial formational materials covering the site. In order to minimize possible damage to the on-grade structures and associated on-grade improvements, such as flatwork, resulting from swelling and shrinkage of these materials, we recommend that they be completely removed in the areas of all on-grade improvements and buried at depth in landscape areas during the grading operations.

A. Preparation of Soils for Site Development

1. *Clearing and Stripping:* The areas of new construction should be cleared of any miscellaneous debris that may be present at the time of construction. After clearing, the ground surface should be stripped of surface vegetation as well as associated root systems. Holes resulting from the removal of buried obstructions, including tree roots, that extend below the proposed finished site grades should be cleared and backfilled with suitable material compacted to the requirements provided under Recommendation Nos. 4 and 5 below. Prior to any filling operations, the cleared and stripped materials should be disposed of off-site.

2. *Removal and Treatment of Expansive Materials:* In order to preclude damage to the proposed new on-grade improvements from swelling and shrinkage of the high to very high expansion potential weathered formational materials, we recommend that these surficial, relatively shallow materials be completely removed and only be reused as fill at a depth of at least 2 feet and at a lateral distance of at least 2 feet from the face of fill slopes in planned designated landscape areas. The limits of removal should extend 10 feet beyond the perimeter limits of all new on-grade improvements.

   A representative of our firm should be present at the start of grading operations to verify the depths and areal extent of these expansive soil removals and their subsequent placement.

3. *Subgrade Preparation:* After the site has been cleared, stripped, and the required excavations made, the exposed subgrade soils should be scarified to a depth of 6 inches, moisture conditioned to at least 2 percent above the laboratory optimum, and compacted to the requirements for structural fill.

4. *Material for Fill:* All on-site soils with an organic content of less than 3 percent by volume are in general suitable for reuse as fill except as noted in Recommendation No. 2 above. In addition, we recommend that only the silty sand low to very low expansion potential soils be used for trench and wall backfill material. Any needed imported fill material should be a low-expansion potential granular soil containing no rocks or lumps over 1 inch in greatest dimension and not more than 10 percent larger than ½-inch. No more than 15 percent of the fill should be larger than ¼-inch. All materials for use as fill should be approved by our representative prior to filling.

5. *Fill Compaction:* All soils, in general, should be compacted to a minimum degree of compaction of 90 percent at a moisture content at least 2 percent above the optimum based upon ASTM D1557-12. Fill materials should be spread and compacted in uniform horizontal lifts not exceeding 8 inches in uncompacted thickness. Before compaction begins, the fill should be brought to the recommended moisture content by either: (1) aerating and drying the fill if it is too wet, or (2) watering the fill if it is too dry. Each lift should be thoroughly mixed before compaction to ensure a uniform distribution of moisture.

6. *Permanent Slopes:* We recommend that any required permanent cut and fill slopes be constructed to an inclination no steeper than 2.0:1.0 (horizontal to vertical). The project plans and specifications should contain all necessary design features and construction requirements to prevent erosion of the on-site soils both during and after construction. Slopes and other exposed ground surfaces should be appropriately planted with a protective groundcover.

   Fill slopes should be constructed so as to assure that the recommended minimum degree of compaction is attained out to the finished slope face. This may be accomplished by "backrolling" with a sheepsfoot roller or other suitable equipment as the fill is raised. Placement of fill near the tops of slopes should be carried out in such a manner as to assure that loose, uncompacted soils are not sloughed over the tops and allowed to accumulate on the slope. Fills constructed on sloping ground having an inclination steeper than 5:1 (horizontal: vertical) ratio should be keyed and benched into competent formational material as illustrated on Figure No. XIII. The actual width of the toe keys and extent of removal of any existing loose surface soil or weathered formational materials should be determined by our representative in the field during construction. In addition, toe key excavations should be inspected by our representative prior to placing fill.

7. *Trench and Retaining/Basement Wall Backfill:* All backfill soils placed in utility trenches or behind retaining/basement walls should consist of low expansion potential soils and be compacted to a minimum degree of 90 percent relative compaction. Backfill material should be placed in lift thicknesses appropriate to the type of compaction equipment utilized and compacted to a minimum degree of 90 percent by mechanical means.

   Our experience has shown that even shallow, narrow trenches, such as for irrigation and electrical lines, that are not properly compacted can result in problems, particularly with respect to shallow groundwater accumulation and migration.

8. *Surface Drainage:* Positive surface gradients should be provided adjacent to any proposed new structures. Roof gutters and downspouts should be installed on the structures so as to direct water away from foundations and slabs toward suitable discharge facilities. Ponding of surface water should not be allowed anywhere on the site.

B. Foundation Recommendations

9. *Footings:* We recommend that the proposed new residential structures be supported on conventional, individual-spread and/or continuous footing foundations bearing on undisturbed formational materials and/or properly compacted fill soils prepared as recommended above in Recommendation No.

5. All footings should be founded at least 18 inches below the lowest adjacent finished grade.

At the recommended depth, footings may be designed for allowable bearing pressures of 2,000 pounds per square foot (psf) for combined dead and live loads and 2,700 psf for all loads, including wind or seismic. All footings should, however, have a minimum width of 12 inches.

10. *General Criteria for All Footings*: Footings located adjacent to the tops of slopes should be extended sufficiently deep so as to provide at least 10 feet of horizontal cover or 1½ times the width of the footing, whichever is greater, between the slope face and outside edge of the footing at the footing bearing level. Footings located adjacent to utility trenches should have their bearing surfaces situated below an imaginary 1.5 to 1.0 plane projected upward from the bottom edge of the adjacent utility trench.

All continuous footings should contain top and bottom reinforcement to provide structural continuity and to permit spanning of local irregularities. We recommend that a minimum of four No. 5 reinforcing bars be provided in the footings – two near the top and two near the bottom. A minimum clearance of 3 inches should be maintained between steel reinforcement and the bottom or sides of the footing. In order for us to offer an opinion as to whether the footings are founded on materials of sufficient load bearing capacity, it is essential that our representative inspect the footing excavations prior to the placement of reinforcing steel or concrete.

NOTE: The project Civil/Structural Engineer should review all reinforcing schedules. The reinforcing minimums recommended herein are not to be *construed as structural designs, but merely as minimum reinforcement to reduce the potential for cracking and separations.*

11. *Seismic Design Criteria:* Site-specific seismic design criteria for the proposed structure are presented in the following table in accordance with Section 1613 of the 2016 CBC, which incorporates by reference ASCE 7-10 for seismic design. We have determined the mapped spectral acceleration values for the site, based on a latitude of 32.9582 degrees and longitude of -117.1816 degrees, utilizing a third-party tool provided by the USGS, which provides a solution for ASCE 7-10 (Section 1613 of the 2016 CBC) utilizing digitized files for the Spectral Acceleration maps. Based on our past experience with similar conditions, we have assigned a Site Soil Classification of D.

TABLE I

Mapped Spectral Acceleration Values and Design Parameters

S_s	S_1	F_a	F_v	S_{ms}	S_{m1}	S_{ds}	S_{d1}
0.973g	0.377g	1.111	1.646	1.081g	0.620g	0.721g	0.414g

12. *Lateral Loads:* Lateral load resistance for the structures supported on footing foundations may be developed in friction between the foundation bottoms and the supporting subgrade. An allowable friction coefficient of 0.30 is considered applicable. An additional allowable passive resistance equal to an equivalent fluid weight of 300 pounds per cubic foot (pcf) acting against the foundations may be used in design provided the footings are poured neat against the adjacent undisturbed formational or compacted fill materials. These lateral resistance values assume a level surface in front of the footing for a minimum distance of three times the embedment depth of the footing and any shear keys.

13. *Settlement:* Settlements under building loads are expected to be within tolerable limits for the proposed structures. For footings designed in accordance with the recommendations presented in the preceding paragraphs, we anticipate that total settlements should not exceed 1 inch and that post-construction differential settlements should be less than ¼-inch in 25 feet.

14. *Retaining/Basement Walls*: Retaining and basement walls must be designed to resist lateral earth pressures and any additional lateral pressures caused by surcharge loads on the adjoining retained surface. We recommend that unrestrained (cantilever) walls with level backfill be designed for an equivalent fluid pressure of 35 pcf. We recommend that restrained walls (i.e., basement walls or any walls with angle points or are curvilinear that restrain them from rotation) with level backfill be designed for an equivalent fluid pressure of 35 pcf plus an additional uniform lateral pressure of 8H pounds per square foot where H is equal to the height of backfill above the top of the wall footing in feet. Wherever walls will be subjected to surcharge loads, they should also be designed for an additional uniform lateral pressure equal to one-third the anticipated surcharge pressure in the case of unrestrained walls and one-half the anticipated surcharge pressure in the case of restrained walls.

    For seismic design of unrestrained walls, we recommend that the seismic pressure increment be taken as a fluid pressure distribution utilizing an equivalent fluid weight of 11 pcf. For restrained walls we recommend that the seismic pressure increment be taken as a fluid pressure distribution utilizing an equivalent fluid weight of 17 pcf added to the active static fluid pressure utilizing an equivalent fluid weight of 35 pcf.

    The preceding design pressures assume that the walls are backfilled with low expansion potential materials (Expansion Index less than 50) and that there is sufficient drainage behind the walls to prevent the build-up of hydrostatic pressures from surface water infiltration. We recommend that wall drainage be provided using J-Drain 200/220 and J-Drain SWD. No gravel or pipe is used with the J-Drain system. The drain material should terminate 12 inches below the finish surface where the surface is covered by slabs or 18 inches below the finish surface in landscape areas.

Backfill placed behind the walls should be compacted to a minimum degree of 90 percent relative compaction using light compaction equipment. If heavy equipment is used, the walls should be appropriately temporarily braced.

C. *Concrete Slab on-grade Criteria*

15. *Minimum Floor Slab Thickness and Reinforcement:* Based on our experience, we have found that, for various reasons, floor slabs occasionally crack, causing brittle surfaces such as ceramic tiles to become damaged. Therefore, we recommend that all slabs on-grade contain at least a minimum amount of reinforcing steel to reduce the separation of cracks, should they occur.

15.1 Interior floor slabs should be a minimum of 5 inches actual thickness and be reinforced with No. 4 bars on 18-inch centers, both ways, placed at midheight in the slab. Slab subgrade soil should be verified by a ***Geotechnical Exploration, Inc***. representative to have the proper moisture content within 48 hours prior to placement of the vapor barrier and pouring of concrete.

15.2 Following placement of any concrete floor slabs, sufficient drying time must be allowed prior to placement of floor coverings. Premature placement of floor coverings may result in degradation of adhesive materials and loosening of the finish floor materials.

16. *Concrete Isolation Joints:* We recommend the project Civil/Structural Engineer incorporate isolation joints and sawcuts to at least one-fourth the thickness of the slab in any floor designs. The joints and cuts, if properly placed, should reduce the potential for and help control floor slab cracking. We recommend that concrete shrinkage joints be spaced no farther than approximately 20 feet apart, and also at re-entrant corners. However, due to a number of reasons (such as base preparation, construction techniques, curing procedures, and normal shrinkage of concrete), some cracking of slabs can be expected.

17. *Slab Moisture Protection and Vapor Barrier Membrane:* Although it is not the responsibility of geotechnical engineering firms to provide moisture protection recommendations, as a service to our clients we provide the following discussion and suggested minimum protection criteria. Actual recommendations should be provided by the architect and waterproofing consultants.

    Soil moisture vapor can result in damage to moisture-sensitive floors, some floor sealers, or sensitive equipment in direct contact with the floor, in addition to mold and staining on slabs, walls and carpets. The common practice in Southern California is to place vapor retarders made of PVC, or of polyethylene. PVC retarders are made in thickness ranging from 10- to 60-mil. Polyethylene retarders, called visqueen, range from 5 to 10 mil in thickness. These products are no longer considered adequate for moisture protection and can actually deteriorate over time.

    Specialty vapor retarding products possess higher tensile strength and are more specifically designed for and intended to retard moisture transmission into and through concrete slabs. The use of such products is highly recommended for reduction of floor slab moisture emission.

The following American Society for Testing and Materials (ASTM) and American Concrete Institute (ACI) sections address the issue of moisture transmission into and through concrete slabs: ASTM E1745-97 (2009) Standard Specification for Plastic Water Vapor Retarders Used in Contact Concrete Slabs; ASTM E154-88 (2005) Standard Test Methods for Water Vapor Retarders Used in Contact with Earth; ASTM E96-95 Standard Test Methods for Water Vapor Transmission of Materials; ASTM E1643-98 (2009) Standard Practice for Installation of Water Vapor Retarders Used in Contact Under Concrete Slabs; and ACI 302.2R-06 Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials.

17.1 Based on the above, we recommend that the vapor barrier consist of a minimum 15-mil extruded polyolefin plastic (no recycled content or woven materials permitted). Permeance as tested before and after mandatory conditioning (ASTM E1745 Section 7.1 and sub-paragraphs 7.1.1-7.1.5) should be less than 0.01 perms (grains/square foot/hour in Hg) and comply with the ASTM E1745 Class A requirements. Installation of vapor barriers should be in accordance with ASTM E1643. The basis of design is 15-mil StegoWrap vapor barrier placed per the manufacturer's guidelines. Reef Industries Vapor Guard membrane has also been shown to achieve a permeance of less than 0.01 perms. We recommend that the slab be poured directly on the vapor barrier, which is placed directly on the prepared subgrade soil; no sand or gravel layers are used.

17.2 Common to all acceptable products, vapor retarder/barrier joints must be lapped and sealed with mastic or the manufacturer's recommended tape or sealing products. In actual practice, stakes are often driven through the retarder material, equipment is dragged or rolled across the retarder, overlapping or jointing is not properly implemented, etc. All these construction deficiencies reduce the retarder's effectiveness. In no case should retarder/barrier products be punctured or gaps be allowed to form prior to or during concrete placement.

17.3 Vapor retarders/barriers do not provide full waterproofing for structures constructed below free water surfaces. They are intended to help reduce or prevent vapor transmission and/or capillary migration through the soil and through the concrete slabs. Waterproofing systems must be designed and properly constructed if full waterproofing is desired. The owner and project designers should be consulted to determine the specific level of protection required.

17.4 Following placement of concrete floor slabs, sufficient drying time must be allowed prior to placement of any floor coverings. Premature placement of floor coverings may result in degradation of adhesive materials and loosening of the finish floor materials.

18. *Exterior Slab Thickness and Reinforcement:* As a minimum for protection of on-site improvements, we recommend that all exterior pedestrian concrete slabs be 4½ inches thick and be founded on properly compacted and tested fill, with No. 4 bars at 24-inch centers, both ways, at the center of the slab, and contain adequate isolation and control joints. The performance of on-site improvements can be greatly affected by soil base preparation and the quality

of construction. It is therefore important that all improvements are properly designed and constructed for the existing soil conditions. The improvements should not be built on loose soils or fills placed without our observation and testing.

For exterior slabs with the minimum shrinkage reinforcement, control joints should be placed at spaces no farther than 15 feet apart or the width of the slab, whichever is less, and also at re-entrant corners. Control joints in exterior slabs should be sealed with elastomeric joint sealant. The sealant should be inspected every 6 months and be properly maintained.

D. ***Pavement***

19. *Concrete Pavement:* We recommend that concrete pavement, including garage slabs, as well as the drive and parking areas adjacent to the residences subject only to automobile and light truck traffic, be 5½ inches thick and be supported directly on properly prepared on-site subgrade soils. We recommend that the thickness be increased to 7 inches for driveways subject to occasional heavy truck traffic. The concrete should conform to Section 201 of The Standard Specifications for Public Works Construction, 2000 Edition, for Class 560-C-3250.

In order to control shrinkage cracking, we recommend that saw-cut, weakened-plane joints be provided at about 15-foot centers both ways. The pavement slabs should be saw-cut as soon as practical but no more than 24 hours after the placement of the concrete. The depth of the joint should be one-quarter of the slab thickness and its width should not exceed 0.02-foot. Reinforcing steel is not necessary unless it is desired to increase the joint spacing recommended above. In lieu of jointing for the garage slabs, they may be reinforced with No. 4 bars at 18-inch centers both ways.

E. ***General Recommendations***

20. *Project Start Up Notification:* In order to minimize any work delays during site development, this firm should be contacted 24 hours prior to any need for observation of footing excavations or field density testing of compacted fill soils. If possible, placement of formwork and steel reinforcement in footing excavations should not occur prior to observing the excavations; in the event that our observations reveal the need for deepening or redesigning foundation structures at any locations, any formwork or steel reinforcement in the affected footing excavation areas would have to be removed prior to correction of the observed problem (i.e., deepening the footing excavation, recompacting soil in the bottom of the excavation, etc.).

IX. ***GRADING NOTES***

Geotechnical Exploration, Inc. recommends that we be retained to verify the actual soil conditions revealed during site grading work and footing excavation to be as anticipated in this "*Report of Preliminary Geotechnical Investigation*" for the project. In addition, the compaction of any fill soils placed during site grading work must be observed and tested by the soil engineer. It is the responsibility of the grading contractor to comply with the requirements on the grading plans and the local grading ordinance. All retaining wall and trench backfill should be properly compacted. ***Geotechnical Exploration, Inc.*** will assume no liability for damage occurring due to improperly or uncompacted backfill placed without our observations and testing.

X. LIMITATIONS

Our conclusions and recommendations have been based on available data obtained from our document review, field investigation, laboratory testing and analysis, as well as our experience with similar soils and formational materials located in this area of San Diego. Of necessity, we must assume a certain degree of continuity between exploratory excavations. It is, therefore, necessary that all observations, conclusions, and recommendations be verified at the time grading operations begin or when footing excavations are placed. In the event discrepancies are noted, additional recommendations may be issued, if required.

The work performed and recommendations presented herein are the result of an investigation and analysis that meet the contemporary standard of care in our profession within the City of San Diego. No warranty is provided.

This report should be considered valid for a period of two (2) years, and is subject to review by our firm following that time. If significant modifications are made to the building plans, especially with respect to the height and location of any proposed structures, this report must be presented to us for immediate review and possible revision.

It is the responsibility of the owner and/or developer to ensure that the recommendations summarized in this report are carried out in the field operations and that our recommendations for design of this project are incorporated in the structural plans. We should be retained to review the project plans once they are available, to see that our recommendations are adequately incorporated in the plans.

This firm does not practice or consult in the field of safety engineering. We do not direct the contractor's operations, and we cannot be responsible for the safety of personnel other than our own on the site; the safety of others is the responsibility of the contractor. The contractor should notify the owner if any of the recommended actions presented herein are considered to be unsafe.

The firm of ***Geotechnical Exploration, Inc.*** shall not be held responsible for changes to the physical condition of the property, such as addition of fill soils or changing drainage patterns, which occur subsequent to issuance of this report and the changes are made without our observations, testing, and approval.

Once again, should any questions arise concerning this report, please feel free to contact the undersigned. Reference to our **Job No. 19-12420** will expedite a reply to your inquiries.

Respectfully submitted,

GEOTECHNICAL EXPLORATION, INC.

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Senior Geotechnical Engineer

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Staff Geologist

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Exp. 3/31/20

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REFERENCES

JOB NO. 19-12193

October 2019

Association of Engineering Geologists, 1973, Geology and Earthquake Hazards, Planners Guide to the Seismic Safety Element, Southern California Section, Association of Engineering Geologists, Special Publication, p. 44.

Berger & Schug, 1991, Probabilistic Evaluation of Seismic Hazard in the San Diego-Tijuana Metropolitan Region, Environmental Perils, San Diego Region, San Diego Association of Geologists.

Bryant, W.A. and E.W. Hart, 1973 (10th Revision 1997), Fault-Rupture Hazard Zones in California, Calif. Div. of Mines and Geology, Special Publication 42.

California Division of Mines and Geology – Alquist-Priolo Special Studies Zones Map, November 1, 1991.

Crowell, J.C., 1962, Displacement Along the San Andreas Fault, California; Geologic Society of America Special Paper 71, 61 p.

Demere, T.A., 2003, Geology of San Diego County, California, BRCC San Diego Natural History Museum.

Greene, H.G., 1979, Implication of Fault Patterns in the Inner California Continental Borderland between San Pedro and San Diego, in "Earthquakes and Other Perils, San Diego Region," P.L. Abbott and W.J. Elliott, editors.

Greensfelder, R.W., 1974, Maximum Credible Rock Acceleration from Earthquakes in California; Calif. Division of Mines and Geology, Map Sheet 23.

Hart, E.W., D.P. Smith, and R.B. Saul, 1979, Summary Report: Fault Evaluation Program, 1978 Area (Peninsular Ranges-Salton Trough Region), Calif. Division of Mines and Geology, OFR 79-10 SF, 10.

Hart E.W. and W.A. Bryant, 1997, Fault-Rupture Hazard Zones in California, California Geological Survey, Special Publication 42, Supplements 1 and 2 added 1999.

Hauksson, E. and L. Jones, 1988, The July 1988 Oceanside (M_L=5.3) Earthquake Sequence in the Continental Borderland, Southern California Bulletin of the Seismological Society of America, v. 78, p. 1885-1906.

Hileman, J.A., C.R. Allen and J.M. Nordquist, 1973, Seismicity of the Southern California Region, January 1, 1932 to December 31, 1972; Seismological Laboratory, Cal-Tech, Pasadena, Calif.

Kennedy, M.P., 1975, Geology of the San Diego Metropolitan Area, California; Bulletin 200, Calif. Division of Mines and Geology.

Kennedy, M.P., S.H. Clarke, H.G. Greene, R.C. Jachens, V.E. Langenheim, J.J. Moore and D.M. Burns, 1994, A digital (GIS) Geological/Geophysical/Seismological Data Base for the San Diego 30x60 Quadrangle, California—A New Generation, Geological Society of America Abstracts with Programs, v. 26, p. 63.

Kennedy, M.P. and S.H. Clarke, 1997A, Analysis of Late Quaternary Faulting in San Diego Bay and Hazard to the Coronado Bridge, Calif. Div. of Mines and Geology Open-file Report 97-10A.

Kennedy, M.P. and S.H. Clarke, 1997B, Age of Faulting in San Diego Bay in the Vicinity of the Coronado Bridge, an addendum to Analysis of Late Quaternary Faulting in San Diego Bay and Hazard to the Coronado Bridge, Calif. Div. of Mines and Geology Open-file Report 97-10B.

Kennedy, M.P. and S.H. Clarke, 2001, Late Quaternary Faulting in San Diego Bay and Hazard to the Coronado Bridge, California Geology.

Kennedy, M.P. and SS. Tan, 2008, Geologic Map of the San Diego 30' X 60' Quadrangle, California; California Geological Survey and the United States Geological Survey.

Kennedy, M.P., S.S. Tan, R.H. Chapman, and G.W. Chase, 1975; Character and Recency of Faulting, San Diego Metropolitan Area, California, Special Report 123, California Division of Mines and Geology.

Kennedy, M.P. and E.E. Welday, 1980, Character and Recency of Faulting Offshore, Metropolitan San Diego California, Calif. Div. of Mines and Geology Map Sheet 40, 1:50,000.

Kern, J.P. and T.K. Rockwell, 1992, Chronology and Deformation of Quaternary Marine Shorelines, San Diego County, California in Heath, E. and L. Lewis (editors), The Regressive Pleistocene Shoreline, Coastal Southern California, pp. 1-8.

Kern, P., 1993, Earthquakes and Faults in San Diego County, Pickle Press, San Diego, California.

Rockwell, T.K., D.E. Millman, R.S. McElwain, and D.L. Lamar, 1985, Study of Seismic Activity by Trenching Along the Glen Ivy North Fault, Elsinore Fault Zone, Southern California: Lamar-Merifield Technical Report 85-1, U.S.G.S. Contract 14-08-0001-21376, 19 p.

Toppozada, T.R. and D.L. Parke, 1982, Areas Damaged by California Earthquakes, 1900-1949; Calif. Division of Mines and Geology, Open-file Report 82-17, Sacramento, Calif.

Treiman, J.A., 1993, The Rose Canyon Fault Zone, Southern California, Calif. Div. of Mines and Geology Open-file Report 93-02, 45 pp, 3 plates.

URS Project No. 27653042.00500 (2010), San Diego County Multi-Jurisdiction Hazard Mitigation Plan San Diego County, California.

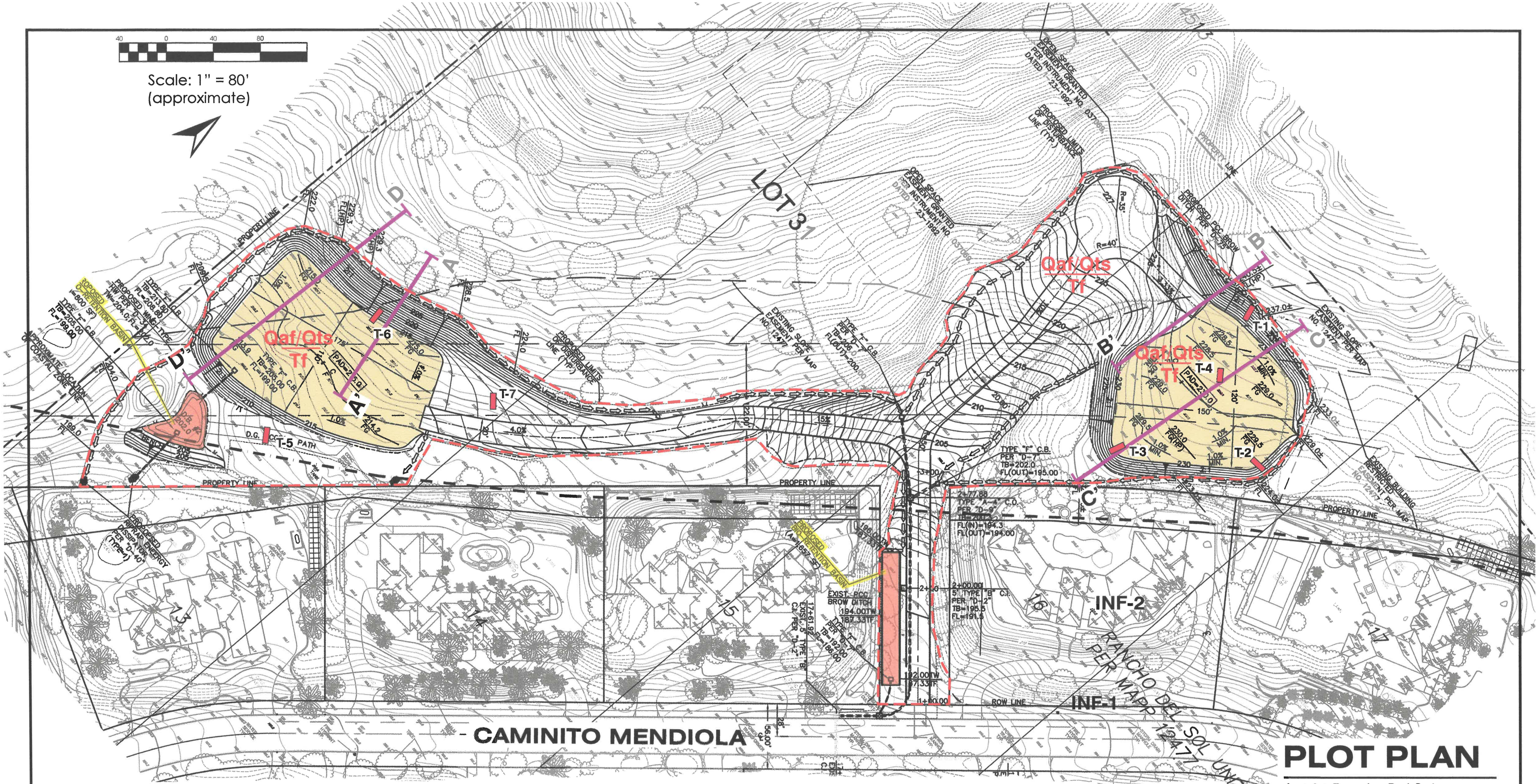
U.S. Dept. of Agriculture Stereo Pair Aerial Photographs AXN-4M-13 & 14, dated March 31, 1953.

VICINITY MAP

Thomas Bros. Guide San Diego County, pg 1188-G4

Lot 31 Rancho Del Sol
Caminito Mendiola
San Diego, CA.

Figure No. I
Job No. 19-12420



NOTE: This Plot Plan is not to be used for legal purposes. Locations and dimensions are approximate. Actual property dimensions and locations of utilities may be obtained from the Approved Building Plans or the "As-Built" Grading Plans.

REFERENCE: This PLOT PLAN was prepared from an existing PRELIMINARY GRADING PLAN by FARRINGTON ENGINEERING CONSULTANTS, INC. dated 6-20-19 and from on-site field reconnaissance performed by GEI.

LEGEND

T-7	Approximate Location of Exploratory Trench
D D'	Approximate Line of Cross Section
Qaf/Qts	Artificial Fill/Topsoil
Tf	Friars Formation
- - -	Proposed Limits of Grading

PLOT PLAN

Lot 31 Rancho Del Sol
Caminito Mendiola
San Diego, CA.
Figure No. II
Job No. 19-12420

Geotechnical Exploration, Inc.

October 2019

19-12420-p.ai

Geotechnical Exploration, Inc.

EQUIPMENT: Rubber tire backhoe

DIMENSION & TYPE OF EXCAVATION: 9.0-ft. x 3.0-ft x 6.75-ft. (L x W x D) Trench

DATE LOGGED: September 6, 2019

LOGGED BY: AH

SURFACE ELEVATION: ± 237' Above Mean Sea Level

REVIEWED BY: DH/JAB

GROUNDWATER/SEEPAGE DEPTH: Not Encountered

DEPTH (feet)	SYMBOL	SAMPLE	FIELD DESCRIPTION AND CLASSIFICATION DESCRIPTION AND REMARKS (Grain Size, Density, Moisture, Color)	U.S.C.S	IN-PLACE MOISTURE (%)	IN-PLACE DENSITY (pcf)	OPTIMUM MOISTURE (%)	MAXIMUM DRY DENSITY (pcf)	DENSITY (% of MDD)	EXPAN(+)/ CONSOL(-)	EXPANSION INDEX	BLOW COUNTS/ FT	SAMPLE O.D. (in)
1	▒	☒	**SILTY SAND,** fine- to medium-grained. Loose to medium dense. Dry. Brown. Trace organic materials. TOPSOIL (Qts) -- 32% passing the No. 200 sieve.	SM			10.7	116.2					
2	🟧	☒	**CLAYEY SAND,** fine- to medium-grained. Very dense. Slightly moist. Reddish brown with abundant iron oxide staining. -- 47% passing the No. 200 sieve. -- Atterberg limits: Liquid limit = 46, Plastic limit = 19, Plasticity index = 27. WEATHERED FRIARS FORMATION (Tf)	SC			12.0	120.6			112		
3 4 5 6	🟧	☒	**SILTY SAND,** fine- to medium-grained. Very dense. Slightly moist. Yellowish pale gray with trace iron oxide staining throughout. FRIARS FORMATION (Tf) (SANDSTONE) -- 26% passing the No. 200 sieve.	SM			12.4	118.4					
7 8			Bottom of trench at 6.75 feet.										

▼	**PERCHED WATER TABLE**
☒	**BULK BAG SAMPLE**
1	**IN-PLACE SAMPLE**
■	**MODIFIED CALIFORNIA SAMPLE**
S	**NUCLEAR FIELD DENSITY TEST**
▨	**STANDARD PENETRATION TEST**

JOB NUMBER: 19-12420

JOB NAME: Lot 31 Rancho del Sol

SITE LOCATION:
Lot 31 - Rancho del Sol
San Diego, CA

LOG NO. T-1

FIGURE NO. IIIa

Geotechnical Exploration, Inc.

EQUIPMENT: Rubber tire backhoe

DIMENSION & TYPE OF EXCAVATION: 10.0-ft. x 3.0-ft x 8.5-ft. (L x W x D) Trench

DATE LOGGED: September 6, 2019

LOGGED BY: AH

SURFACE ELEVATION: ± 227' Above Mean Sea Level

REVIEWED BY: DH/JAB

GROUNDWATER/SEEPAGE DEPTH: Not Encountered

FIELD DESCRIPTION AND CLASSIFICATION

DEPTH (feet)	SYMBOL	SAMPLE	DESCRIPTION AND REMARKS (Grain Size, Density, Moisture, Color)	U.S.C.S	IN-PLACE MOISTURE (%)	IN-PLACE DENSITY (pcf)	OPTIMUM MOISTURE (%)	MAXIMUM DRY DENSITY (pcf)	DENSITY (% of MDD)	EXPAN(+)/ CONSOL(-)	EXPANSION INDEX	BLOW COUNTS/ FT	SAMPLE O.D. (in)
1 2			**SILTY SAND,** fine- to medium-grained. Loose to medium dense. Dry. Brown. Trace organic materials. **TOPSOIL / FILL (Qts / Qaf)**	SM									
3 4		1	**SANDY CLAY,** fine- to medium-grained sand. Very stiff. Slightly moist. Reddish brown with abundant iron oxide staining. -- 61% passing the No. 200 sieve. **WEATHERED FRIARS FORMATION (Tf)**	CL	9.8								
5			**SILTY SAND,** fine- to medium-grained. Very dense. Slightly moist. Yellowish pale gray with trace iron oxide staining throughout. **FRIARS FORMATION (Tf) (SANDSTONE)**	SM									
6 7		☒	**SILTY CLAY with SAND,** fine-grained sand. Hard. Moist. Pale olive gray. Thinly bedded and fissile. **FRIARS FORMATION (Tf) (MUDSTONE)**	CL			15.1	110.7					
8		2	-- 97% passing the No. 200 sieve. -- Mudstone bedding attitude of N9°W@5°NE taken at 7.5 feet.		18.0								
9 10 11 12			Bottom of trench at 8.5 feet.										

▼	**PERCHED WATER TABLE**
☒	**BULK BAG SAMPLE**
1	**IN-PLACE SAMPLE**
■	**MODIFIED CALIFORNIA SAMPLE**
S	**NUCLEAR FIELD DENSITY TEST**
▨	**STANDARD PENETRATION TEST**

JOB NUMBER: 19-12420

JOB NAME: Lot 31
Rancho del Sol

SITE LOCATION:
Lot 31 - Rancho del Sol
San Diego, CA

LOG NO. **T-2**

FIGURE NO. **IIIb**

Geotechnical Exploration, Inc.

EQUIPMENT: Rubber tire backhoe

DIMENSION & TYPE OF EXCAVATION:
9.0-ft. x 3.0-ft x 7.0-ft. (L x W x D) Trench

DATE LOGGED: September 6, 2019

LOGGED BY: AH

REVIEWED BY: DH/JAB

SURFACE ELEVATION: ± 223' Above Mean Sea Level

GROUNDWATER/SEEPAGE DEPTH: Not Encountered

DEPTH (feet)	SYMBOL	SAMPLE	FIELD DESCRIPTION AND CLASSIFICATION DESCRIPTION AND REMARKS (Grain Size, Density, Moisture, Color)	U.S.C.S	IN-PLACE MOISTURE (%)	IN-PLACE DENSITY (pcf)	OPTIMUM MOISTURE (%)	MAXIMUM DRY DENSITY (pcf)	DENSITY (% of MDD)	EXPAN(+)/ CONSOL(-)	EXPANSION INDEX	BLOW COUNTS/ FT	SAMPLE O.D. (in)
			SILTY SAND, fine- to medium-grained. Loose to medium dense. Dry. Brown. **TOPSOIL / FILL (Qts / Qaf)**	**SM**									
1			**CLAYEY SAND,** fine- to medium-grained. Very dense. Slightly moist. Reddish brown with abundant iron oxide staining. **WEATHERED FRIARS FORMATION (Tf)**	**SC**									
2 3 4 5 6			**SILTY SAND,** fine- to medium-grained. Very dense. Slightly moist. Yellowish pale gray with trace iron oxide staining throughout. **FRIARS FORMATION (Tf) (SANDSTONE)**	**SM**									
7 8 9			Bottom of trench at 7.0 feet.										

▼	**PERCHED WATER TABLE**
☒	**BULK BAG SAMPLE**
1	**IN-PLACE SAMPLE**
■	**MODIFIED CALIFORNIA SAMPLE**
S	**NUCLEAR FIELD DENSITY TEST**
▨	**STANDARD PENETRATION TEST**

JOB NUMBER: 19-12420

JOB NAME: Lot 31
Rancho del Sol

SITE LOCATION:
Lot 31 - Rancho del Sol
San Diego, CA

LOG NO. T-3

FIGURE NO. IIIc

Geotechnical Exploration, Inc.

DATE LOGGED: September 6, 2019
LOGGED BY: AH
REVIEWED BY: DH/JAB

EQUIPMENT: Rubber tire backhoe
DIMENSION & TYPE OF EXCAVATION: 6.0-ft. x 3.0-ft x 4.5-ft. (L x W x D) Trench
SURFACE ELEVATION: ± 230' Above Mean Sea Level
GROUNDWATER/SEEPAGE DEPTH: Not Encountered

FIELD DESCRIPTION AND CLASSIFICATION

DEPTH (feet)	SYMBOL	SAMPLE	DESCRIPTION AND REMARKS (Grain Size, Density, Moisture, Color)	U.S.C.S	IN-PLACE MOISTURE (%)	IN-PLACE DENSITY (pcf)	OPTIMUM MOISTURE (%)	MAXIMUM DRY DENSITY (pcf)	DENSITY (% of MDD)	EXPAN(+)/ CONSOL(-)	EXPANSION INDEX	BLOW COUNTS/ FT	SAMPLE O.D. (in)
			SILTY SAND, fine- to medium-grained. Loose to medium dense. Dry. Brown. Trace organic materials. TOPSOIL / FILL (Qts / Qaf)	SM									
			SANDY CLAY, fine- to medium-grained sand. Very stiff. Very moist. Reddish brown with abundant iron oxide staining.	CH									
1		☒	-- 67% passing the No. 200 sieve.										
		☒	-- Atterberg limits: Liquid limit = 59, Plastic limit = 23, Plasticity index = 36.								168		
2		1	-- 69% passing the No. 200 sieve.		23.7								
			WEATHERED FRIARS FORMATION (Tf)										
3			**CLAYEY SAND,** fine- to medium-grained. Very dense. Slightly moist. Reddish brown with abundant iron oxide staining. WEATHERED FRIARS FORMATION (Tf)	SC									
4			**SILTY SAND,** fine- to medium-grained. Very dense. Slightly moist. Yellowish pale gray with trace iron oxide staining throughout. FRIARS FORMATION (Tf) (SANDSTONE)	SM									
			Bottom of trench at 4.5 feet.										
5													
6													

▼	**PERCHED WATER TABLE**
☒	**BULK BAG SAMPLE**
1	**IN-PLACE SAMPLE**
■	**MODIFIED CALIFORNIA SAMPLE**
S	**NUCLEAR FIELD DENSITY TEST**
▨	**STANDARD PENETRATION TEST**

JOB NUMBER: 19-12420
JOB NAME: Lot 31 Rancho del Sol
SITE LOCATION:
Lot 31 - Rancho del Sol
San Diego, CA

LOG NO. **T-4**

FIGURE NO. **IIId**

Geotechnical Exploration, Inc.

EQUIPMENT: Rubber tire backhoe

DIMENSION & TYPE OF EXCAVATION: 7.0-ft. x 3.0-ft x 3.5-ft. (L x W x D) Trench

DATE LOGGED: September 6, 2019

LOGGED BY: AH

SURFACE ELEVATION: ± 207.5' Above Mean Sea Level

REVIEWED BY: DH/JAB

GROUNDWATER/SEEPAGE DEPTH: Not Encountered

DEPTH (feet)	SYMBOL	SAMPLE	FIELD DESCRIPTION AND CLASSIFICATION DESCRIPTION AND REMARKS (Grain Size, Density, Moisture, Color)	U.S.C.S	IN-PLACE MOISTURE (%)	IN-PLACE DENSITY (pcf)	OPTIMUM MOISTURE (%)	MAXIMUM DRY DENSITY (pcf)	DENSITY (% of MDD)	EXPAN(+)/ CONSOL(-)	EXPANSION INDEX	BLOW COUNTS/ FT	SAMPLE O.D. (in)
			SILTY SAND, fine- to medium-grained. Loose to medium dense. Dry. Brown. Trace organic materials. **TOPSOIL (Qts)**	SM									
1			**CLAYEY SAND,** fine- to medium-grained sand. Dense. Slightly moist. Reddish brown with abundant iron oxide staining. **WEATHERED FRIARS FORMATION (Tf)**	SC									
		1	-- 41% passing the No. 200 Sieve.		10.6								
2			**SILTY SAND,** fine- to medium-grained. Very dense. Slightly moist. Yellowish pale gray with trace iron oxide staining throughout.	SM									
		2	**FRIARS FORMATION (Tf) (SANDSTONE)**										
3													
			Bottom of trench at 3.5 feet.										
4													
5													
6													

▼ **PERCHED WATER TABLE**
☒ **BULK BAG SAMPLE**
1 **IN-PLACE SAMPLE**
■ **MODIFIED CALIFORNIA SAMPLE**
S **NUCLEAR FIELD DENSITY TEST**
▨ **STANDARD PENETRATION TEST**

JOB NUMBER: 19-12420

JOB NAME: Lot 31
Rancho del Sol

LOG NO. **T-5**

SITE LOCATION:
Lot 31 - Rancho del Sol
San Diego, CA

FIGURE NO. **IIIe**

Geotechnical Exploration, Inc.

EQUIPMENT: Rubber tire backhoe

DIMENSION & TYPE OF EXCAVATION:
12.0-ft. x 3.0-ft x 11.0-ft. (L x W x D) Trench

DATE LOGGED: September 6, 2019

LOGGED BY: AH

REVIEWED BY: DH/JAB

SURFACE ELEVATION: ± 224' Above Mean Sea Level

GROUNDWATER/SEEPAGE DEPTH: Not Encountered

DEPTH (feet)	SYMBOL	SAMPLE	FIELD DESCRIPTION AND CLASSIFICATION DESCRIPTION AND REMARKS (Grain Size, Density, Moisture, Color)	U.S.C.S	IN-PLACE MOISTURE (%)	IN-PLACE DENSITY (pcf)	OPTIMUM MOISTURE (%)	MAXIMUM DRY DENSITY (pcf)	DENSITY (% of MDD)	EXPAN(+)/ CONSOL(-)	EXPANSION INDEX	BLOW COUNTS/ FT	SAMPLE O.D. (in)
1			**SILTY SAND,** fine- to medium-grained. Loose to medium dense. Dry. Brown. Trace organic materials. TOPSOIL (Qts)	SM									
2 3			**CLAYEY SAND,** fine- to medium-grained. Very dense. Slightly moist. Reddish brown with abundant iron oxide staining. WEATHERED FRIARS FORMATION (Tf)	SC									
4 6 8 10			**SILTY SAND,** fine- to medium-grained. Very dense. Slightly moist. Yellowish pale gray with trace iron oxide staining throughout. FRIARS FORMATION (Tf) (SANDSTONE)	SM									
12 14 16 18 20			Bottom of trench at 11.0 feet.										

▼	**PERCHED WATER TABLE**
☒	**BULK BAG SAMPLE**
1	**IN-PLACE SAMPLE**
■	**MODIFIED CALIFORNIA SAMPLE**
S	**NUCLEAR FIELD DENSITY TEST**
▨	**STANDARD PENETRATION TEST**

JOB NUMBER: 19-12420

JOB NAME: Lot 31
Rancho del Sol

LOG NO. T-6

SITE LOCATION:
Lot 31 - Rancho del Sol
San Diego, CA

FIGURE NO. IIIf

Geotechnical Exploration, Inc.

DATE LOGGED: September 6, 2019
LOGGED BY: AH
REVIEWED BY: DH/JAB

EQUIPMENT: Rubber tire backhoe
DIMENSION & TYPE OF EXCAVATION:
9.0-ft. x 3.0-ft x 6.0-ft. (L x W x D) Trench
SURFACE ELEVATION: ± 220.5' Above Mean Sea Level
GROUNDWATER/SEEPAGE DEPTH: Not Encountered

DEPTH (feet)	SYMBOL	SAMPLE	**FIELD DESCRIPTION AND CLASSIFICATION** **DESCRIPTION AND REMARKS (Grain Size, Density, Moisture, Color)**	U.S.C.S	IN-PLACE MOISTURE (%)	IN-PLACE DENSITY (pcf)	OPTIMUM MOISTURE (%)	MAXIMUM DRY DENSITY (pcf)	DENSITY (% of MDD)	EXPAN(+)/ CONSOL(-)	EXPANSION INDEX	BLOW COUNTS/ FT	SAMPLE O.D. (in)
1	▒		**SILTY SAND,** fine- to medium-grained. Loose to medium dense. Dry. Brown. Trace organic materials. TOPSOIL (Qts)	SM									
2	🟧		**CLAYEY SAND,** fine- to medium-grained. Very dense. Slightly moist. Reddish brown with abundant iron oxide staining. WEATHERED FRIARS FORMATION (Tf)	SC									
3 4 5	🟧		**SILTY SAND,** fine- to medium-grained. Very dense. Slightly moist. Yellowish pale gray with trace iron oxide staining throughout. FRIARS FORMATION (Tf) (SANDSTONE)	SM									
6			Bottom of trench at 6.0 feet.										

▼	**PERCHED WATER TABLE**
☒	**BULK BAG SAMPLE**
1	**IN-PLACE SAMPLE**
■	**MODIFIED CALIFORNIA SAMPLE**
S	**NUCLEAR FIELD DENSITY TEST**
▨	**STANDARD PENETRATION TEST**

JOB NUMBER: 19-12420
JOB NAME: Lot 31 Rancho del Sol
SITE LOCATION:
Lot 31 - Rancho del Sol
San Diego, CA

LOG NO. **T-7**

FIGURE NO. **IIIg**

Direct Shear Test (ASTM D3080-11)

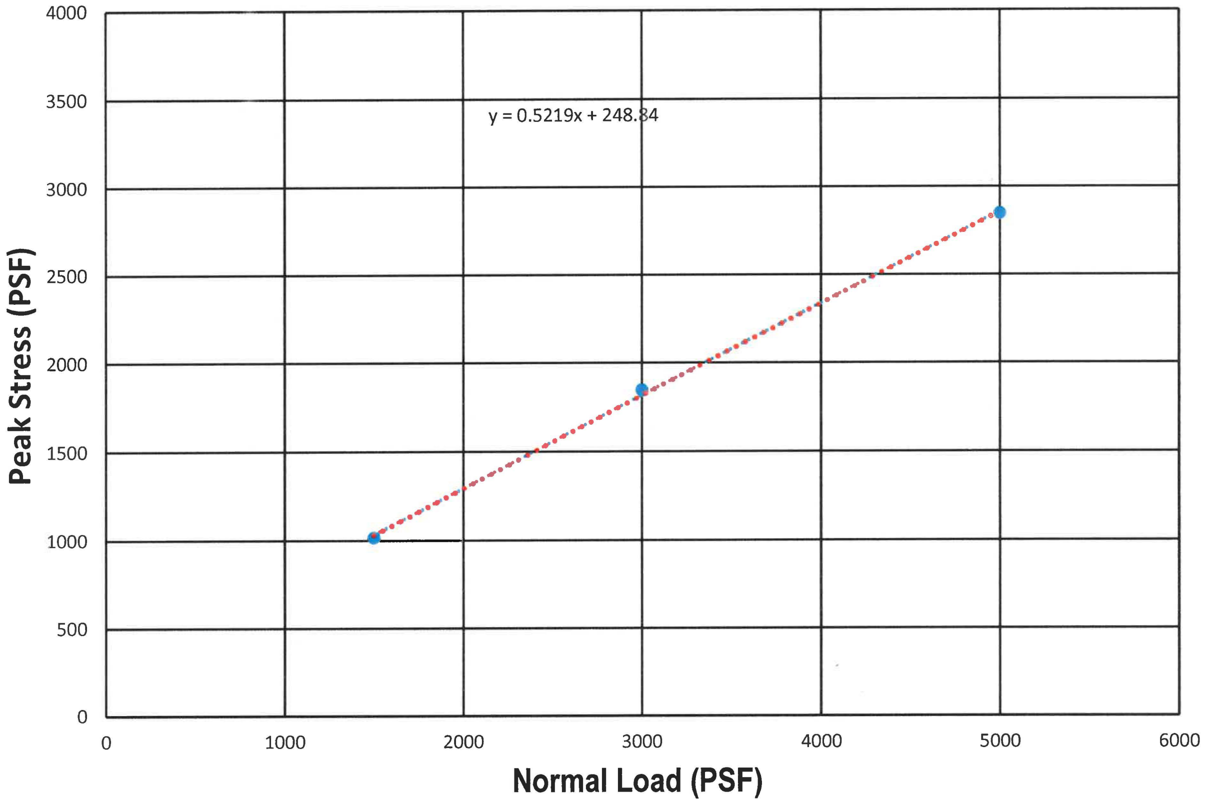
Geotechnical Exploration, Inc.

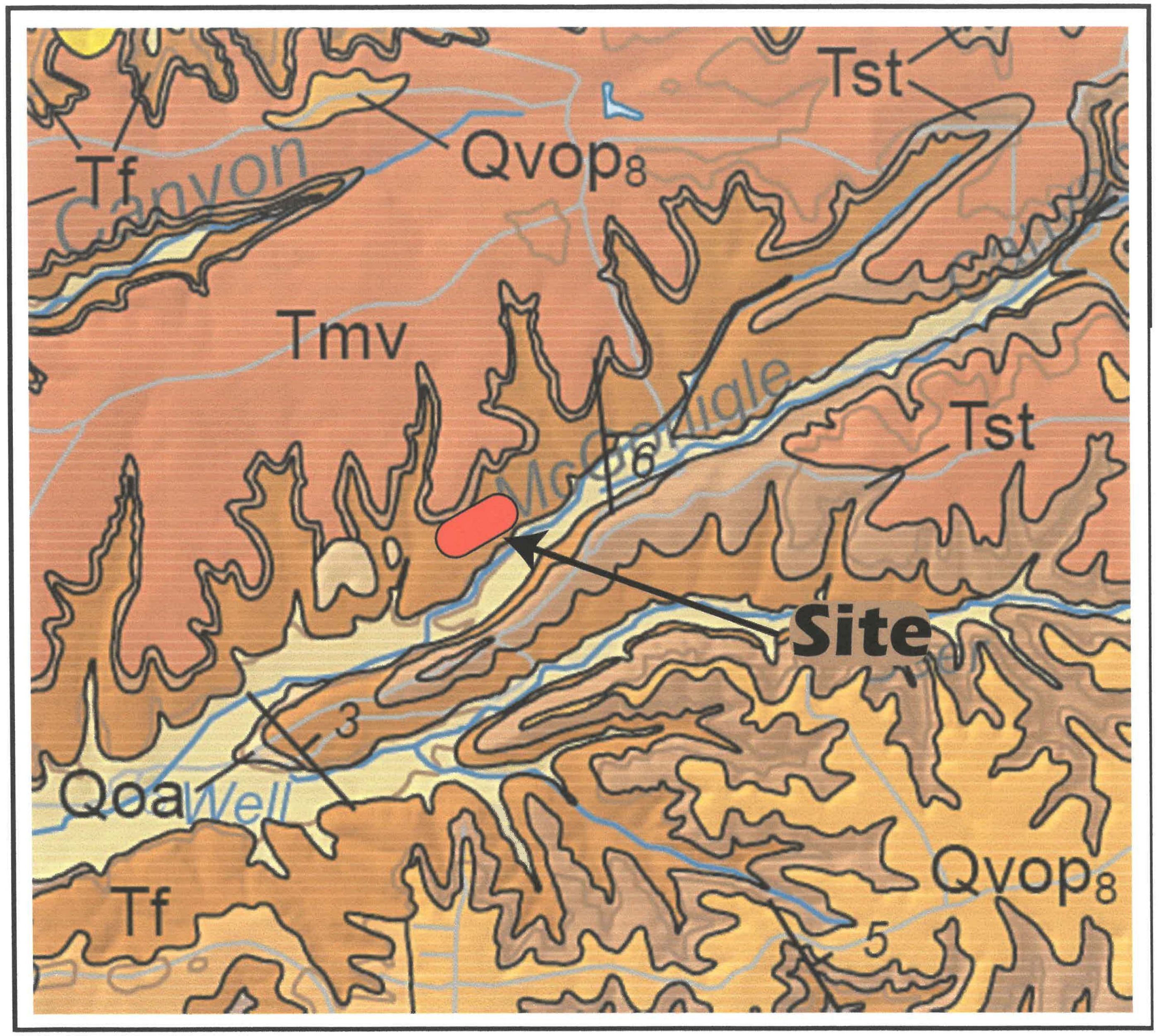
Figure No. IV

Job Number: 19-12420
Job Name: Lot 31 Rancho del Sol
Sample Number: T-1 @ 3.5'-5.5'
Sample Description: Silty Sand (SM) Yellowish-pale-gray
Test Method: Remolded to 90% of Maximum Dry Density - Saturated

Normal Load (PSF)	Peak Stress (PSF)
1500	1015
3000	1844
5000	2846

Phi Angle (Degrees)	27.6
Cohesion (PSF)	249





Lot 31 Rancho Del Sol
Caminito Mendiola
San Diego, CA.

EXCERPT FROM GEOLOGIC MAP OF THE SAN DIEGO 30' x 60' QUADRANGLE, CALIFORNIA

By
Michael P. Kennedy[1] and Siang S. Tan[1]
2008
Digital preparation by
Kelly R. Bovard[2], Anne G. Garcia[2], Diane Burns[2], and Carlos I. Gutierrez[1]

1. Department of Conservation, California Geological Survey
2. U.S. Geological Survey, Department of Earth Sciences, University of California, Riverside

ONSHORE MAP SYMBOLS

Contact - Contact between geologic units; dotted where concealed.

Fault - Solid where accurately located; dashed where approximately located; dotted where concealed. U = upthrown block, D = downthrown block. Arrow and number indicate direction and angle of dip of fault plane.

Anticline - Solid where accurately located; dashed where approximately located; dotted where concealed. Arrow indicates direction of axial plunge.

Syncline - Solid where accurately located; dotted where concealed. Arrow indicates direction of axial plunge.

Landslide - Arrows indicate principal direction of movement. Queried where existence is questionable.

Strike and dip of beds
- Inclined

Strike and dip of igneous joints
- Inclined
- Vertical

Strike and dip of metamorphic foliation
- Inclined

DESCRIPTION OF UNITS

Tmv	Mission Valley Formation
Tst	Stadium Conglomerate
Tf	Friars Formation

Base Map

Onshore base (hypsography, hydrography, and transportation) from U.S.G.S. digital line graph (DLG) data, San Diego 30' x 60' metric quadrangle. Shaded topographic base from U.S.G.S. digital elevation models (DEM's). Offshore bathymetric contours and shaded bathymetry from N.O.A.A. single and multibeam data. Projection is UTM, zone 11, North American Datum 1927.

This map was funded in part by the U.S. Geological Survey National Cooperative Geologic Mapping Program, STATEMAP Award no. 98HQAG2049.

Prepared in cooperation with the U.S. Geological Survey, Southern California Areal Mapping Project.

Lot-31-2008-geo.ai

Figure No. V
Job No. 19-12420

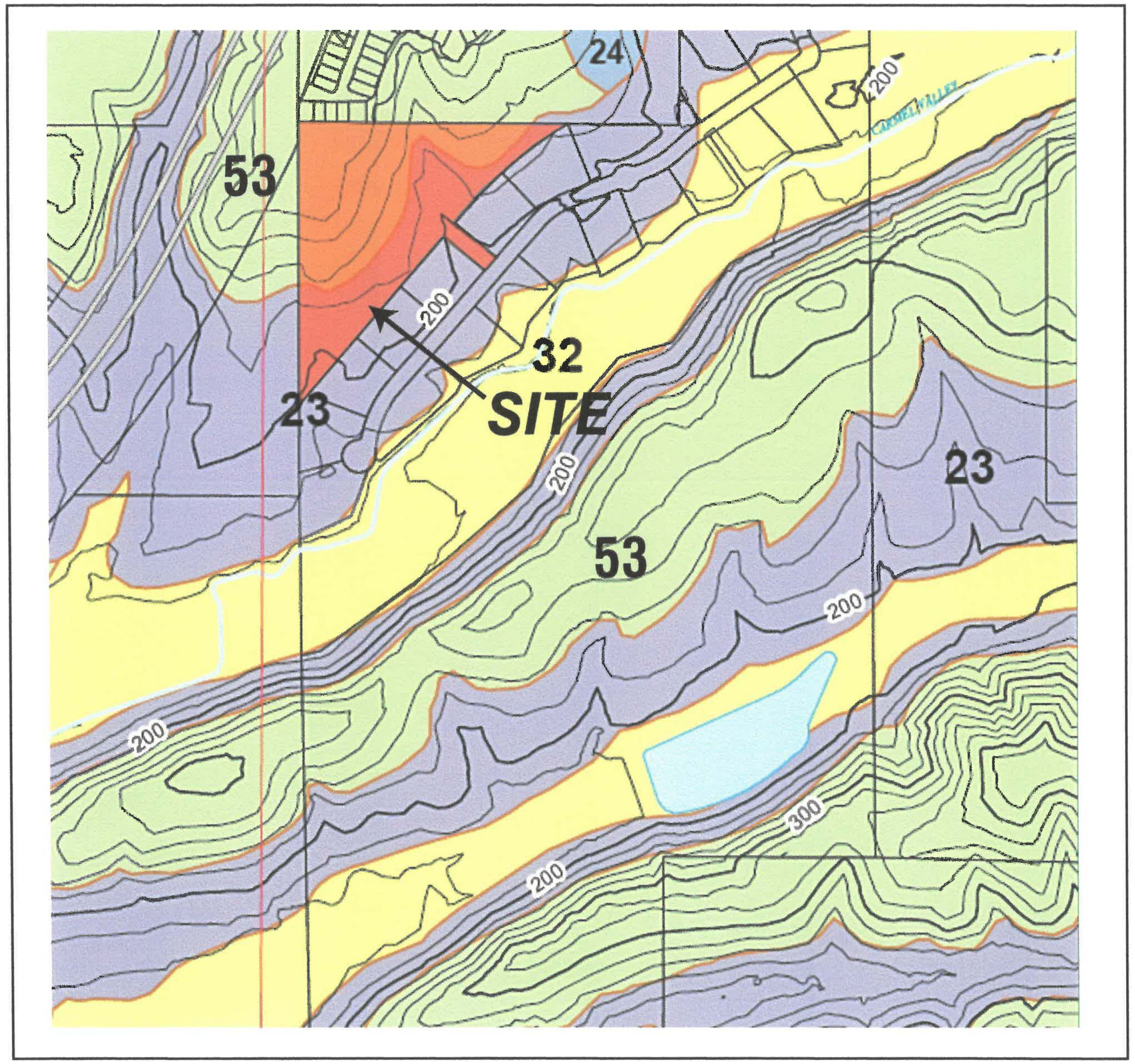
Geotechnical Exploration, Inc.

October 2019

Geologic Hazards Map Excerpt
from City of San Diego
Geologic Hazards and Fault Map
Sheet 39

Development Services Department

DATE: 4/3/2008



Lot 31 Rancho Del Sol
Caminito Mendiola
San Diego, CA.

LEGEND

Geologic Hazard Categories

FAULT ZONES

11 Active, Alquist-Priolo Earthquake Fault Zone

12 Potentially Active,
Inactive, Presumed Inactive, or Activity Unknown

13 Downtown special fault zone

LANDSLIDES

21 Confirmed, known, or highly suspected

22 Possible or conjectured

SLIDE-PRONE FORMATIONS

23 Friars: neutral or favorable geologic structure

24 Friars: unfavorable geologic structure

25 Ardath: neutral or favorable geologic structure

26 Ardath: unfavorable geologic structure

27 Otay, Sweetwater, and others

LIQUEFACTION

31 High Potential -- shallow groundwater
major drainages, hydraulic fills

32 Low Potential -- fluctuating groundwater
minor drainages

COASTAL BLUFFS

41 Generally unstable
Numerous landslides, high steep bluffs,
severe erosion, unfavorable geologic structure

42 Generally unstable
Unfavorable bedding plains, high erosion

43 Generally unstable
Unfavorable jointing, local high erosion

44 Moderately stable
Mostly stable formations, local high erosion

45 Moderately stable
Some minor landslides, minor erosion

46 Moderately stable
Some unfavorable geologic structure, minor or no erosion

47 Generally stable
Favorable geologic structure, minor or no erosion,
no landslides

48 Generally stable
Broad beach areas, developed harbor

OTHER TERRAIN

51 Level mesas -- underlain by terrace deposits and bedrock
nominal risk

52 Other level areas, gently sloping to steep terrain,
favorable geologic structure, Low risk

53 Level or sloping terrain, unfavorable geologic structure,
Low to moderate risk

54 Steeply sloping terrain, unfavorable or fault controlled
geologic structure, Moderate risk

55 Modified terrain (graded sites)
Nominal risk

Water (Bays and Lakes)

FAULTS

Fault

Inferred Fault

Concealed Fault

Shear Zone

Figure No. VI
Job No. 19-12420

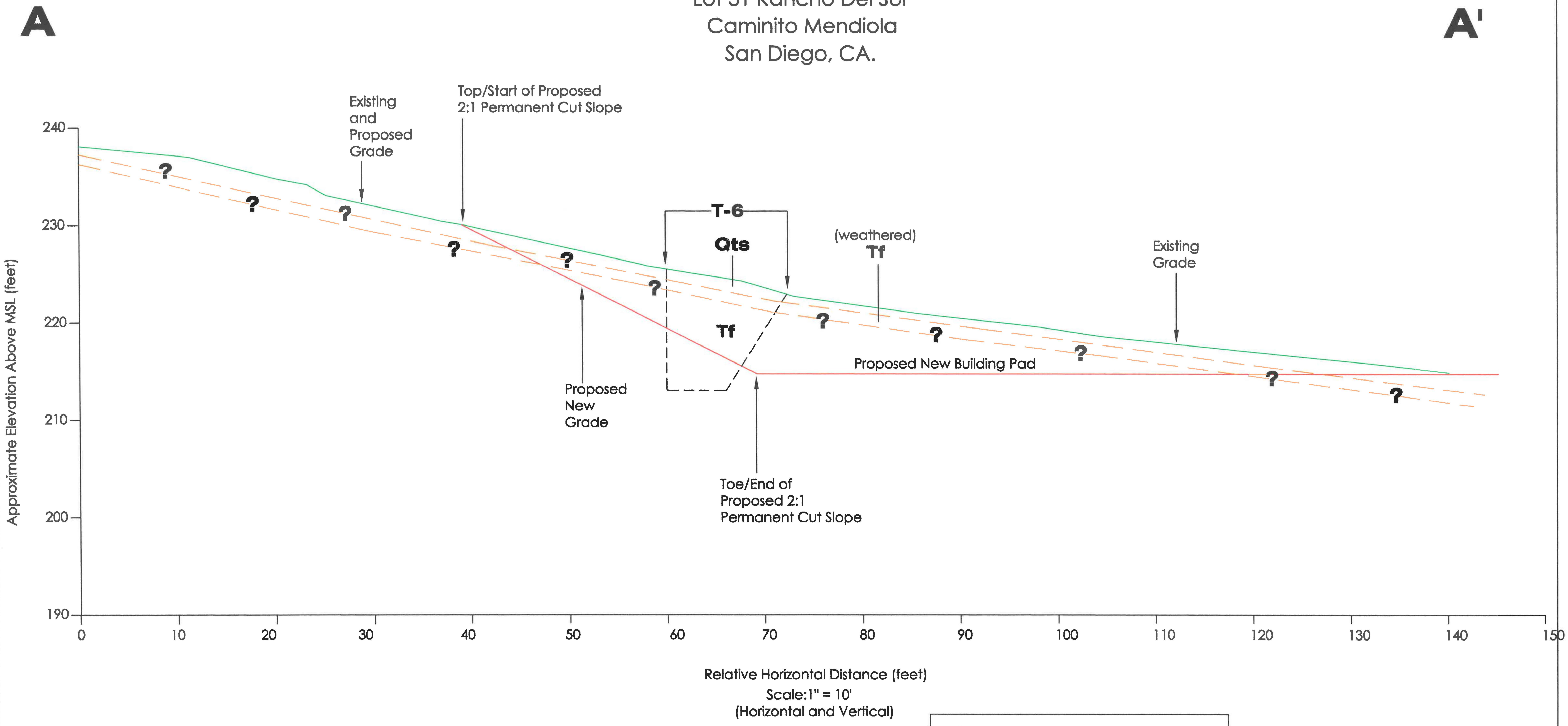
Geotechnical Exploration, Inc.

October 2019

Lot-31-seis-combo.ai

GEOLOGIC CROSS SECTION A-A'

Lot 31 Rancho Del Sol
Caminito Mendiola
San Diego, CA.



Qts	Topsoil (1 Foot)
Tf	Weathered Friars Formation (1 Foot)
Tf	Friars Formation
╱	Approximate Geologic Contact

Figure No. VIIa
Job No. 19-12420

Geotechnical Exploration, Inc.

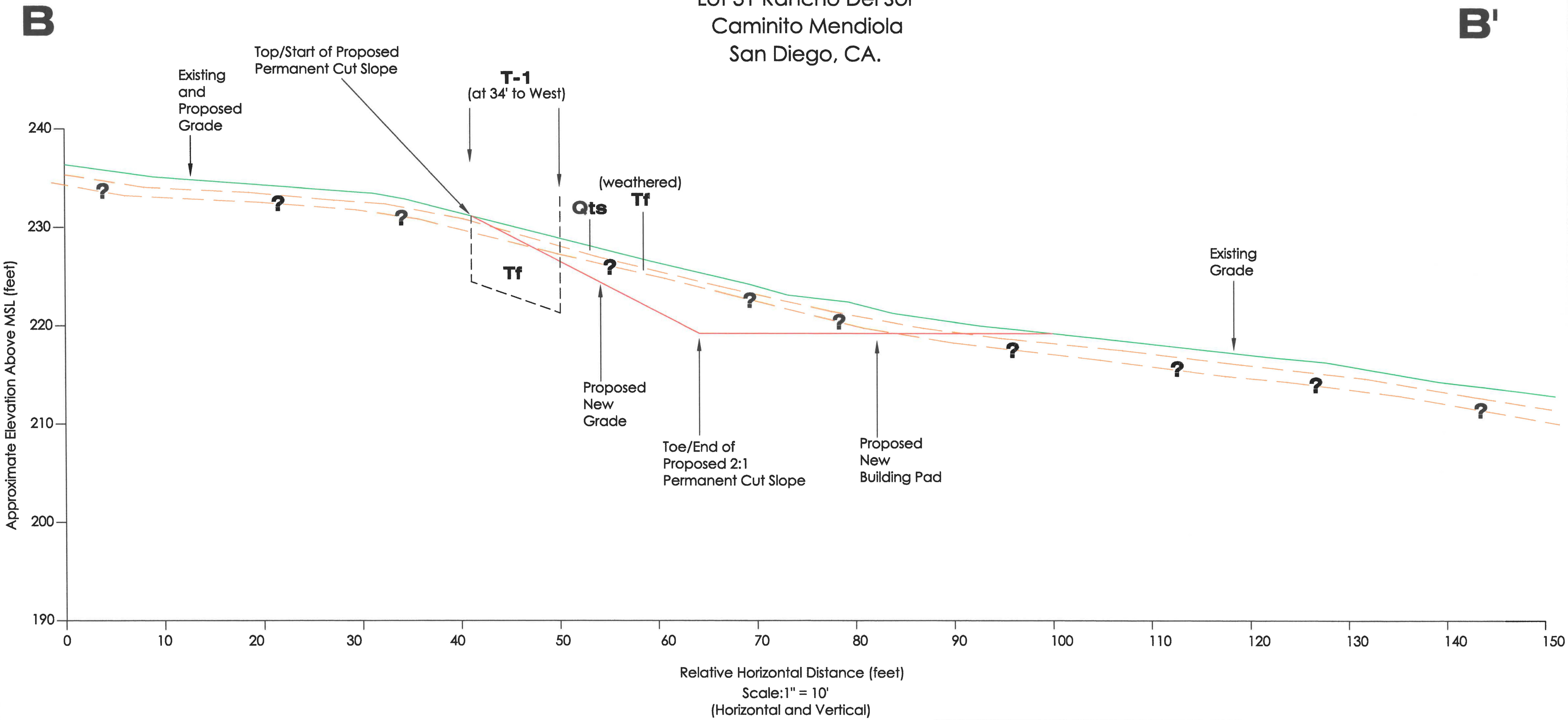
October 2019

NOTE: This Cross Section is not to be used for legal purposes. Locations and dimensions are approximate. Actual property dimensions and locations of utilities may be obtained from the Approved Building Plans or the "As-Built" Grading Plans.

19-12420-AA

GEOLOGIC CROSS SECTION B-B'

Lot 31 Rancho Del Sol
Caminito Mendiola
San Diego, CA.



Qaf/Qts	Fill/Topsoil (1 Foot)
Tf	Weathered Friars Formation (1 Foot)
Tf	Friars Formation
- - -	Approximate Geologic Contact

NOTE: This Cross Section is not to be used for legal purposes. Locations and dimensions are approximate. Actual property dimensions and locations of utilities may be obtained from the Approved Building Plans or the "As-Built" Grading Plans.

Figure No. VIIb
Job No. 19-12420

Geotechnical Exploration, Inc.

October 2019

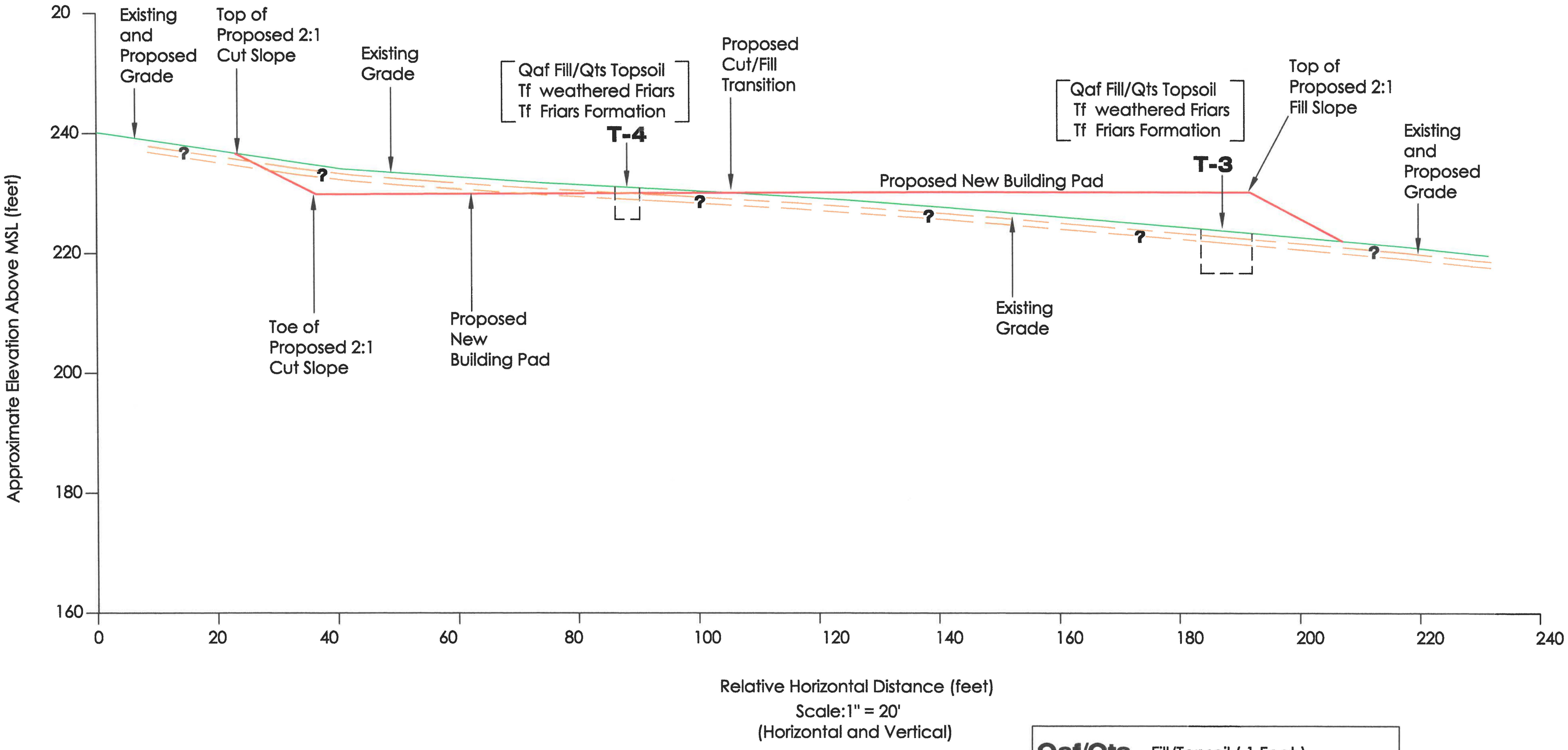
19-12420-BB

GEOLOGIC CROSS SECTION C-C'

C

C'

Lot 31 Rancho Del Sol
Caminito Mendiola
San Diego, CA.



Qaf/Qts	Fill/Topsoil (1 Foot)
Tf	Weathered Friars Formation (1 Foot)
Tf	Friars Formation
– – –	Approximate Geologic Contact

Figure No. VIIc
Job No. 19-12420

Geotechnical Exploration, Inc.

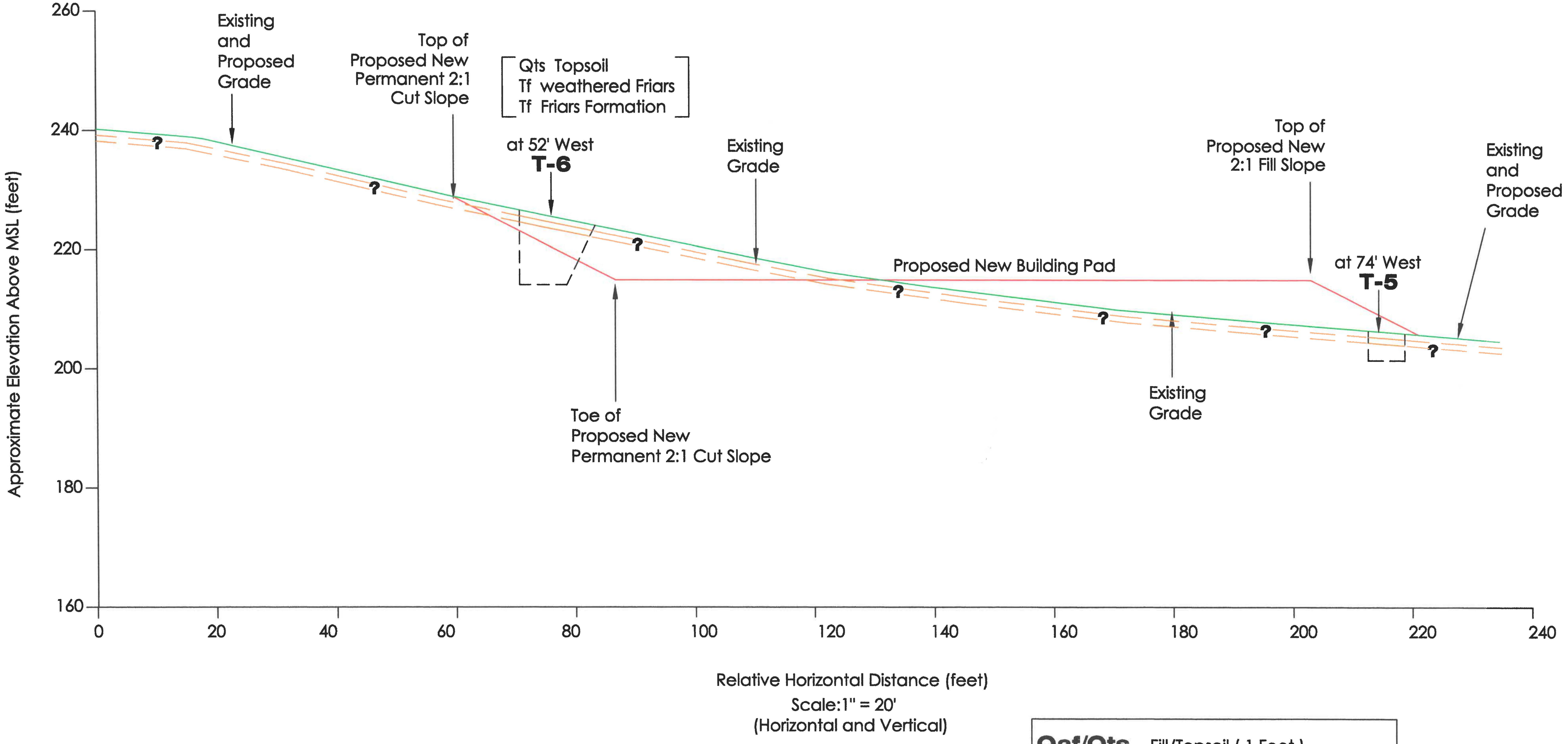
October 2019

NOTE: This Cross Section is not to be used for legal purposes. Locations and dimensions are approximate. Actual property dimensions and locations of utilities may be obtained from the Approved Building Plans or the "As-Built" Grading Plans.

GEOLOGIC CROSS SECTION D-D'

Lot 31 Rancho Del Sol
Caminito Mendiola
San Diego, CA.

D **D'**



Qaf/Qts	Fill/Topsoil (1 Foot)
Tf	Weathered Friars Formation (1 Foot)
Tf	Friars Formation
– – –	Approximate Geologic Contact

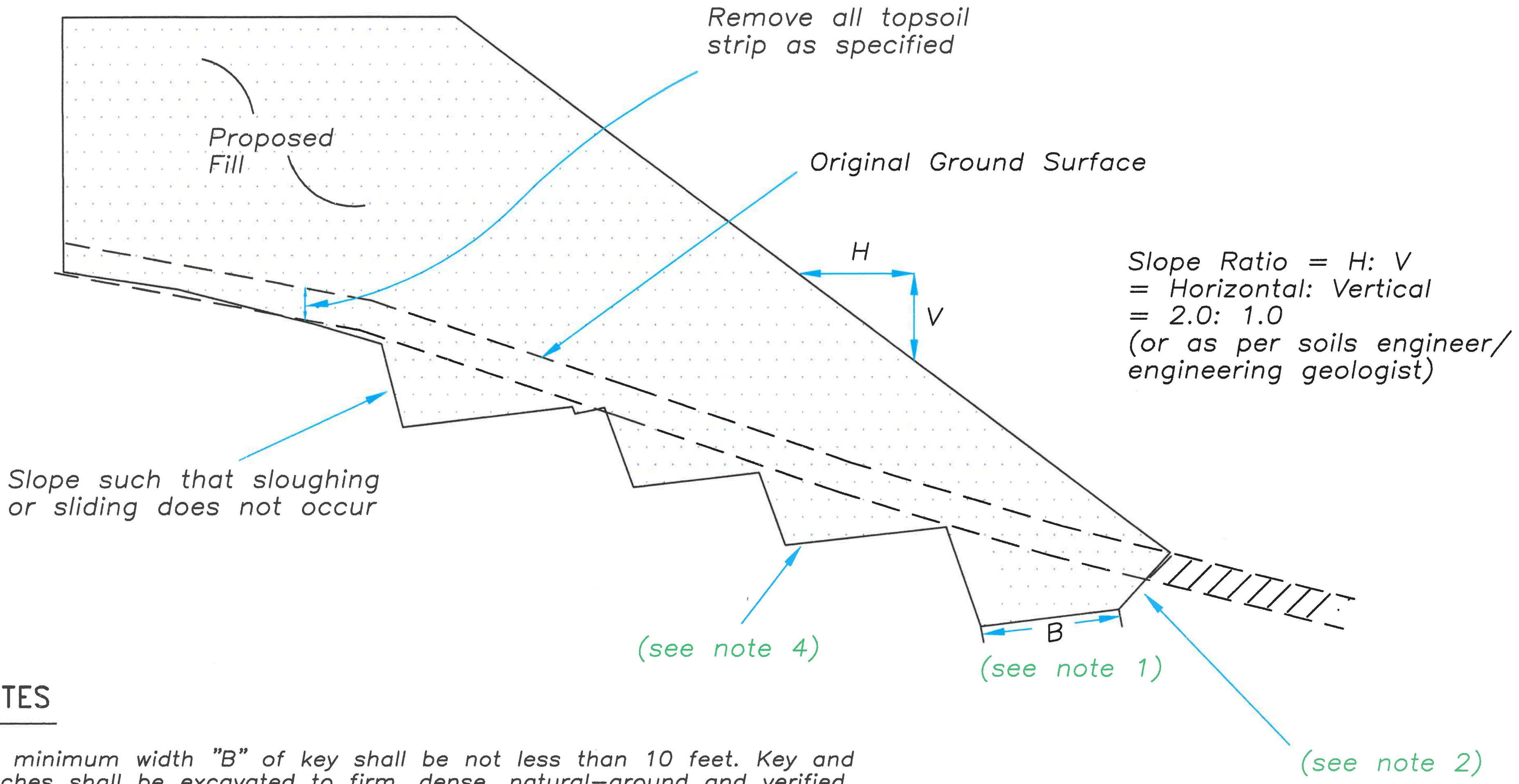
Figure No. VIId
Job No. 19-12420

Geotechnical Exploration, Inc.
October 2019

NOTE: This Cross Section is not to be used for legal purposes. Locations and dimensions are approximate. Actual property dimensions and locations of utilities may be obtained from the Approved Building Plans or the "As-Built" Grading Plans.

19-12420-DD

BENCH AND KEY REQUIREMENTS



NOTES

1. The minimum width "B" of key shall be not less than 10 feet. Key and benches shall be excavated to firm, dense, natural–ground and verified by a Soils Engineer/Engineering Geologist.
2. The outside edge of bottom key shall be below topsoil or loose surface material: Minimum one foot embedment into dense material (or as per Soils Engineer/Engineering Geologist).
3. Key and benching required where the natural slope is steeper than 5.0 horizontal to 1.0 vertical (5.0:1.0), or as per Soils Engineer/ Engineering Geologist.
4. Minimum 10% fall into slope (or as per Soils Engineer/Engineering Geologist).
5. Compaction test required every two (2) vertical feet from lowest fill area.

Figure No. VIII
Job No. 19–12420

Geotechnical Exploration, Inc.

19–12420–VIII

October 2019

APPENDIX A
UNIFIED SOIL CLASSIFICATION CHART
SOIL DESCRIPTION

Coarse-grained (More than half of material is larger than a No. 200 sieve)

GRAVELS, CLEAN GRAVELS (More than half of coarse fraction is larger than No. 4 sieve size, but smaller than 3")	GW	Well-graded gravels, gravel and sand mixtures, little or no fines.
	GP	Poorly graded gravels, gravel and sand mixtures, little or no fines.
GRAVELS WITH FINES (Appreciable amount)	GC	Clay gravels, poorly graded gravel-sand-silt mixtures
SANDS, CLEAN SANDS (More than half of coarse fraction is smaller than a No. 4 sieve)	SW	Well-graded sand, gravelly sands, little or no fines
	SP	Poorly graded sands, gravelly sands, little or no fines.
SANDS WITH FINES (Appreciable amount)	SM	Silty sands, poorly graded sand and silty mixtures.
	SC	Clayey sands, poorly graded sand and clay mixtures.

Fine-grained (More than half of material is smaller than a No. 200 sieve)

SILTS AND CLAYS

Liquid Limit Less than 50	ML	Inorganic silts and very fine sands, rock flour, sandy silt and clayey-silt sand mixtures with a slight plasticity
	CL	Inorganic clays of low to medium plasticity, gravelly clays, silty clays, clean clays.
	OL	Organic silts and organic silty clays of low plasticity.
Liquid Limit Greater than 50	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
	CH	Inorganic clays of high plasticity, fat clays.
	OH	Organic clays of medium to high plasticity.
HIGHLY ORGANIC SOILS	PT	Peat and other highly organic soils

(rev. 6/05)

APPENDIX B

SLOPE STABILITY CALCULATIONS

```
XSTABL File: LOT31R1    9-24-19   12:04

                  ******************************************
                  *              X S T A B L               *
                  *                                        *
                  *        Slope Stability Analysis        *
                  *              using the                 *
                  *           Method of Slices             *
                  *                                        *
                  *        Copyright (C) 1992 - 2008       *
                  *   Interactive Software Designs, Inc.   *
                  *        Moscow, ID 83843, U.S.A.        *
                  *                                        *
                  *          All Rights Reserved           *
                  *                                        *
                  *  Ver. 5.208                96 - 1358   *
                  ******************************************

          Problem Description : RDS Lot 31 Trial 1
                    Section A-A'

          -----------------------------
          SEGMENT BOUNDARY COORDINATES
          -----------------------------

              4  SURFACE boundary segments

                     Segment    x-left    y-left    x-right    y-right
Soil Unit            No.         (ft)      (ft)       (ft)       (ft)
Below Segment

  1                  1            .0      240.0      12.0      237.0
  1                  2          12.0      237.0      39.0      230.0
  1                  3          39.0      230.0      69.0      215.0
  1                  4          69.0      215.0      90.0      215.0
          ---------------------------
          ISOTROPIC Soil Parameters
          ---------------------------
           1 Soil unit(s) specified

          Soil    Unit Weight    Cohesion   Friction       Pore
                                                           Pressure
          Unit  Moist     Sat.   Intercept   Angle  Parameter
           No.  (pcf)    (pcf)     (psf)     (deg)       Ru

            1   115.0    125.0     250.0     27.50        .

A critical failure surface searching method, using a random
technique for generating CIRCULAR surfaces has been specified.
1200 trial surfaces will be generated and analyzed. 40 Surfaces
initiate from each of  30 points equally spaced along the ground
surface between  x = 65.0 ft  and  x = 80.0 ft
```

```
Each surface terminates between x =10.0 ft and x=37.0 ft

Unless further limitations were imposed, the minimum elevation at
which a surface extends is  y = .0 ft
5.0 ft line segments define each trial failure surface.
          ---------------------
          ANGULAR RESTRICTIONS
          ---------------------
The first segment of each failure surface will be inclined within
the angular range defined by :

          Lower angular limit :=   -45.0 degrees
         Upper angular limit :=  (slope angle - 5.0) degrees

          Factors of safety have been calculated by the :

          * * * * *   SIMPLIFIED JANBU METHOD   * * * * *

 The 10 most critical of all the failure surfaces examined are
displayed below - the most critical first

         Failure surface No. 1 specified by 13 coordinate points

                 Point      x-surf      y-surf
                  No.        (ft)        (ft)
                   1         70.69      215.00
                   2         65.87      213.67
                   3         60.92      212.94
                   4         55.92      212.84
                   5         50.95      213.36
                   6         46.08      214.49
                   7         41.39      216.22
                   8         36.95      218.52
                   9         32.83      221.36
                  10         29.10      224.68
                  11         25.81      228.45
                  12         23.01      232.59
                  13         22.10      234.38

    **  Corrected JANBU FOS =   2.476  **    (Fo factor = 1.069)


        Failure surface No. 2 specified by 13 coordinate points
                 Point      x-surf      y-surf
                  No.        (ft)        (ft)
                   1         71.21      215.00
                   2         66.38      213.70
                   3         61.43      212.98
                   4         56.43      212.86
                   5         51.46      213.35
                   6         46.57      214.43
```

```
             7          41.86       216.08
             8          37.37       218.30
             9          33.19       221.03
            10          29.36       224.25
            11          25.95       227.90
            12          23.00       231.94
            13          21.55       234.53

**  Corrected JANBU FOS =   2.479  **    (Fo factor = 1.068)


   Failure surface No. 3 specified by 13 coordinate points
            Point       x-surf       y-surf
             No.         (ft)         (ft)
             1          70.69       215.00
             2          65.97       213.34
             3          61.07       212.36
             4          56.08       212.07
             5          51.10       212.49
             6          46.22       213.61
             7          41.55       215.39
             8          37.18       217.82
             9          33.19       220.84
            10          29.67       224.38
            11          26.67       228.39
            12          24.27       232.77
            13          23.84       233.93

**  Corrected JANBU FOS =   2.480  **    (Fo factor = 1.074)


     Failure surface No. 4 specified by 13 coordinate points
            Point       x-surf       y-surf
             No.         (ft)         (ft)
             1          71.72       215.00
             2          66.92       213.62
             3          61.98       212.82
             4          56.99       212.61
             5          52.00       212.99
             6          47.10       213.97
             7          42.34       215.51
             8          37.81       217.62
             9          33.55       220.24
            10          29.64       223.35
            11          26.12       226.91
            12          23.05       230.85
            13          20.71       234.74

**  Corrected JANBU FOS =   2.480  **    (Fo factor =1.069)


     Failure surface No. 5 specified by 11 coordinate points
```

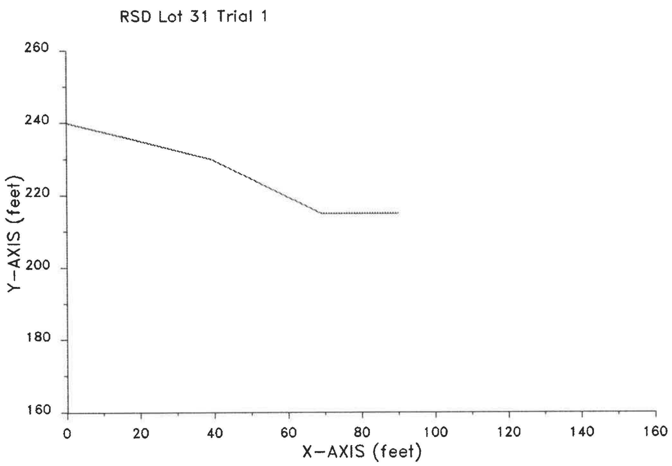
```
                 Point      x-surf      y-surf
                  No.        (ft)        (ft)
                   1         69.14      215.00
                   2         64.29      213.77
                   3         59.32      213.27
                   4         54.32      213.53
                   5         49.42      214.53
                   6         44.73      216.25
                   7         40.34      218.65
                   8         36.37      221.68
                   9         32.88      225.27
                  10         29.98      229.34
                  11         28.22      232.79

 **   Corrected JANBU FOS =   2.480  **    (Fo factor = 1.070)


      Failure surface No. 6 specified by 13 coordinate points
                 Point      x-surf      y-surf
                  No.        (ft)        (ft)
                   1         70.17      215.00
                   2         65.42      213.44
                   3         60.51      212.52
                   4         55.52      212.23
                   5         50.53      212.58
                   6         45.63      213.58
                   7         40.90      215.20
                   8         36.42      217.42
                   9         32.26      220.19
                  10         28.49      223.48
                  11         25.18      227.23
                  12         22.38      231.37
                  13         20.68      234.75

 **   Corrected JANBU FOS =   2.480  **    (Fo factor = 1.072)


      Failure surface No. 7 specified by 12 coordinate points
                 Point      x-surf      y-surf
                  No.        (ft)        (ft)
                   1         70.69      215.00
                   2         65.88      213.64
                   3         60.92      212.98
                   4         55.92      213.03
                   5         50.98      213.79
                   6         46.20      215.25
                   7         41.67      217.37
                   8         37.49      220.12
                   9         33.75      223.43
                  10         30.51      227.24
                  11         27.86      231.48
                  12         27.15      233.07
```

```
**  Corrected JANBU FOS =   2.481  **    (Fo factor = 1.071)


     Failure surface No. 8 specified by 13 coordinate points
              Point      x-surf      y-surf
               No.        (ft)        (ft)
                1         71.72      215.00
                2         67.03      213.27
                3         62.14      212.22
                4         57.16      211.88
                5         52.17      212.24
                6         47.28      213.30
                7         42.60      215.05
                8         38.21      217.44
                9         34.20      220.43
               10         30.65      223.95
               11         27.64      227.95
               12         25.23      232.32
               13         24.70      233.71

**  Corrected JANBU FOS =   2.481  **    (Fo factor = 1.075)


     Failure surface No. 9 specified by 14 coordinate points
              Point      x-surf      y-surf
               No.        (ft)        (ft)
                1         70.17      215.00
                2         65.31      213.83
                3         60.35      213.21
                4         55.35      213.13
                5         50.37      213.60
                6         45.48      214.62
                7         40.72      216.17
                8         36.17      218.23
                9         31.87      220.78
               10         27.88      223.79
               11         24.24      227.22
               12         21.00      231.03
               13         18.20      235.17
               14         18.06      235.43

**  Corrected JANBU FOS =   2.484  **    (Fo factor = 1.065)


     Failure surface No.10 specified by 14 coordinate points
              Point      x-surf      y-surf
               No.        (ft)        (ft)
                1         71.72      215.00
                2         66.91      213.66
                3         61.97      212.86
                4         56.98      212.61
```

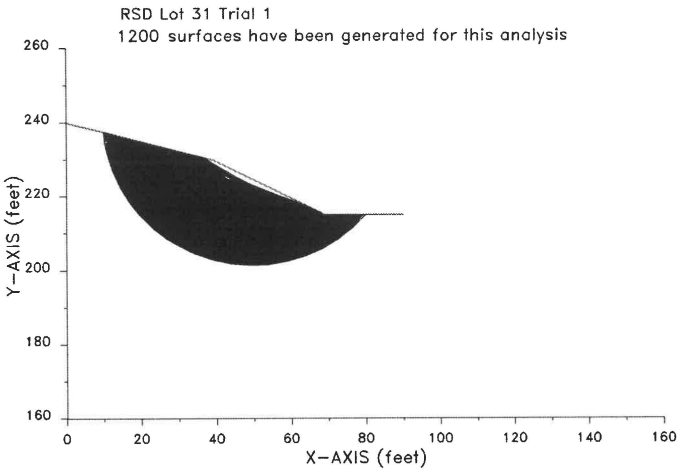
```
                    5          51.99      212.91
                    6          47.06      213.77
                    7          42.26      215.17
                    8          37.65      217.10
                    9          33.28      219.52
                   10          29.20      222.42
                   11          25.47      225.75
                   12          22.13      229.47
                   13          19.23      233.54
                   14          18.20      235.39

      **  Corrected JANBU FOS =   2.484  **    (Fo factor = 1.067)


      The following is a summary of the TEN most critical surfaces

             Problem Description : RSD Lot 31 Trial 1

                     Modified     Correction   Initial    Terminal
 Available
                    JANBU FOS       Factor     x-coord     x-coord
 Strength
                                                 (ft)        (ft)
 (lb)

               1.     2.476         1.069       70.69       22.10
 3.721E+04
               2.     2.479         1.068       71.21       21.55
 3.761E+04
               3.     2.480         1.074       70.69       23.84
 3.811E+04
               4.     2.480         1.069       71.72       20.71
 3.928E+04
               5.     2.480         1.070       69.14       28.22
 2.963E+04
               6.     2.480         1.072       70.17       20.68
 4.091E+04
               7.     2.481         1.071       70.69       27.15
 3.179E+04
               8.     2.481         1.075       71.72       24.70
 3.783E+04
               9.     2.484         1.065       70.17       18.06
 4.020E+04
              10.     2.484         1.067       71.72       18.20
 4.195E+04

                         * * *  END OF FILE  * * *
```

SECTION A-A'

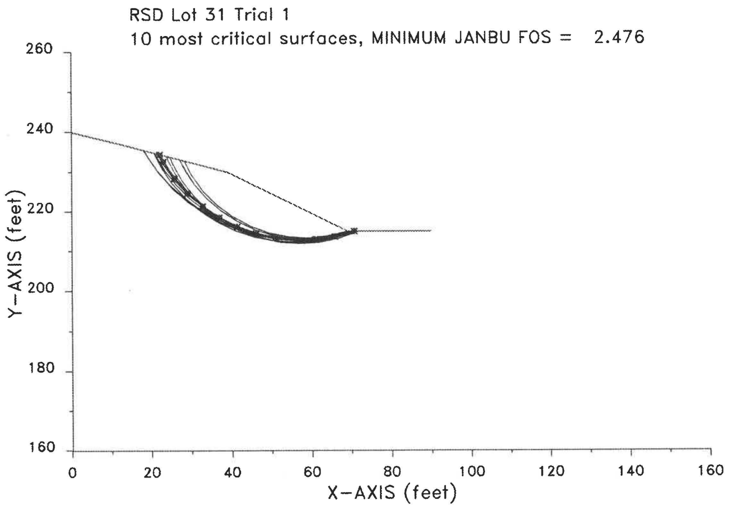
LOT31R1 9-24-19 12:04



LOT31R1 9-24-19 12:04



LOT31R1 9-24-19 12:04



```
XSTABL File: LOT31R2    9-24-19   13:16

             ******************************************
             *              X S T A B L               *
             *                                        *
             *        Slope Stability Analysis        *
             *                using the               *
             *            Method of Slices            *
             *                                        *
             *        Copyright (C) 1992 - 2008       *
             *   Interactive Software Designs, Inc.   *
             *        Moscow, ID 83843, U.S.A.        *
             *                                        *
             *          All Rights Reserved           *
             *                                        *
             *  Ver. 5.208                 96 - 1358  *
             ******************************************

  Problem Description:Rancho Del Sol Lot 31 Section  B

  -----------------------------
    SEGMENT BOUNDARY COORDINATES
    -----------------------------
    3 SURFACE boundary segments

    Segment    x-left    y-left    x-right   y-right     Soil Unit
       No.       (ft)      (ft)       (ft)      (ft)   Below Segment

        1        20.0     244.0       41.0     241.0         1
        2        41.0     241.0       64.0     229.0         1
        3        64.0     229.0       80.0     229.0         1

    --------------------------
    ISOTROPIC Soil Parameters
    --------------------------
     1 Soil unit(s) specified
    Soil    Unit Weight  Cohesion   Friction   Pore Pressure      Water
    Unit   Moist    Sat.  Intercept  Angle   Parameter Constant  Surface
      No.  (pcf)   (pcf)   (psf)      (deg)     Ru       (psf)     No.

       1   115.0   125.0     250.0    27.50      .000         .0     0

    A critical failure surface searching method, using a random
    technique for generating CIRCULAR surfaces has been specified.
    2000 trial surfaces will be generated and analyzed.
    50 Surfaces initiate from each of  40 points equally spaced
    along the ground surface between   x =     60.0 ft
                                  and  x =     75.0 ft

    Each surface terminates between    x =     22.0 ft
                                 and   x =     39.0 ft
```

```
Unless further limitations were imposed, the minimum elevation
at which a surface extends is  y =       .0 ft

* * * * *  DEFAULT SEGMENT LENGTH SELECTED BY XSTABL  * * * * *

    2.0 ft line segments define each trial failure surface.

---------------------
ANGULAR RESTRICTIONS
---------------------

  The first segment of each failure surface will be inclined
  within the angular range defined by :

          Lower angular limit :=   -45.0 degrees
          Upper angular limit :=  (slope angle - 5.0) degrees


  * * * * *   SIMPLIFIED JANBU METHOD   * * * * *

The 10 most critical of all the failure surfaces examined
are displayed below - the most critical first

Failure surface No. 1 specified by 20 coordinate points
       Point      x-surf      y-surf
        No.        (ft)        (ft)
         1         65.00      229.00
         2         63.13      228.28
         3         61.21      227.73
         4         59.25      227.34
         5         57.26      227.13
         6         55.26      227.09
         7         53.27      227.23
         8         51.29      227.54
         9         49.35      228.02
        10         47.45      228.67
        11         45.63      229.47
        12         43.87      230.44
        13         42.21      231.55
        14         40.65      232.81
        15         39.21      234.19
        16         37.89      235.70
        17         36.71      237.31
        18         35.68      239.02
        19         34.79      240.81
        20         34.35      241.95

 **  Corrected JANBU FOS =   2.752  **    (Fo factor = 1.075)


Failure surface No. 2 specified by 20 coordinate points
       Point      x-surf      y-surf
```

```
               No.         (ft)         (ft)
                1          64.23       229.00
                2          62.35       228.32
                3          60.42       227.81
                4          58.45       227.46
                5          56.45       227.28
                6          54.45       227.28
                7          52.46       227.45
                8          50.49       227.78
                9          48.56       228.29
               10          46.67       228.96
               11          44.85       229.79
               12          43.11       230.77
               13          41.46       231.90
               14          39.91       233.17
               15          38.48       234.56
               16          37.17       236.07
               17          35.99       237.69
               18          34.96       239.41
               19          34.08       241.20
               20          33.76       242.03

   **  Corrected JANBU FOS =   2.753  **    (Fo factor = 1.074)


  Failure surface No. 3 specified by 20 coordinate points
              Point      x-surf      y-surf
               No.         (ft)         (ft)
                1          65.00       229.00
                2          63.10       228.39
                3          61.15       227.92
                4          59.17       227.62
                5          57.18       227.47
                6          55.18       227.48
                7          53.19       227.65
                8          51.21       227.97
                9          49.27       228.46
               10          47.37       229.09
               11          45.53       229.87
               12          43.76       230.79
               13          42.07       231.86
               14          40.46       233.05
               15          38.95       234.36
               16          37.56       235.80
               17          36.28       237.33
               18          35.12       238.97
               19          34.10       240.69
               20          33.42       242.08

   **  Corrected JANBU FOS =   2.754  **    (Fo factor = 1.071)
```

```
Failure surface No. 4 specified by 19 coordinate points
      Point      x-surf      y-surf
       No.        (ft)        (ft)
        1         65.00      229.00
        2         63.13      228.29
        3         61.21      227.74
        4         59.24      227.38
        5         57.25      227.20
        6         55.25      227.20
        7         53.26      227.38
        8         51.29      227.75
        9         49.36      228.29
       10         47.50      229.00
       11         45.70      229.88
       12         44.00      230.93
       13         42.39      232.12
       14         40.90      233.46
       15         39.54      234.92
       16         38.32      236.51
       17         37.25      238.20
       18         36.34      239.98
       19         35.61      241.77

 **  Corrected JANBU FOS =   2.755  **    (Fo factor = 1.076)


Failure surface No. 5 specified by 20 coordinate points
      Point      x-surf      y-surf
       No.        (ft)        (ft)
        1         64.62      229.00
        2         62.76      228.25
        3         60.85      227.67
        4         58.89      227.26
        5         56.90      227.02
        6         54.90      226.96
        7         52.91      227.07
        8         50.93      227.35
        9         48.98      227.81
       10         47.08      228.43
       11         45.24      229.22
       12         43.48      230.16
       13         41.80      231.26
       14         40.23      232.49
       15         38.77      233.86
       16         37.44      235.35
       17         36.24      236.95
       18         35.19      238.65
       19         34.29      240.44
       20         33.64      242.05

 **  Corrected JANBU FOS =   2.758  **    (Fo factor = 1.076)
```

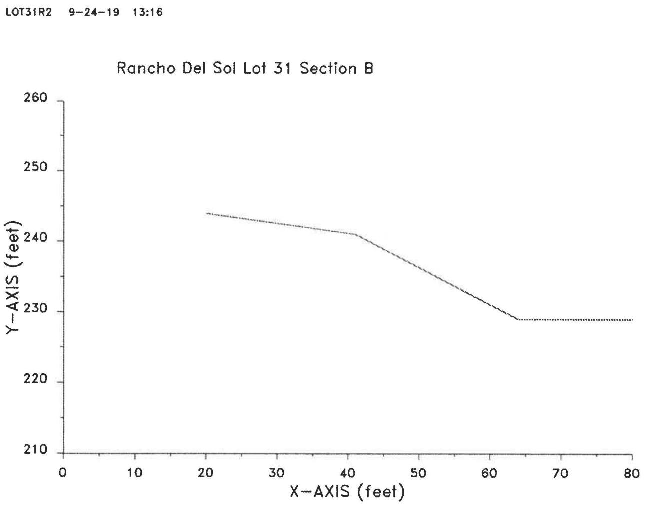
```
Failure surface No. 6 specified by 21 coordinate points
       Point      x-surf      y-surf
        No.        (ft)        (ft)
         1         66.15      229.00
         2         64.30      228.24
         3         62.40      227.63
         4         60.45      227.19
         5         58.47      226.90
         6         56.47      226.79
         7         54.47      226.84
         8         52.48      227.05
         9         50.52      227.43
        10         48.60      227.97
        11         46.72      228.67
        12         44.91      229.52
        13         43.18      230.52
        14         41.54      231.66
        15         39.99      232.93
        16         38.56      234.33
        17         37.25      235.83
        18         36.06      237.45
        19         35.02      239.15
        20         34.12      240.94
        21         33.68      242.05

 **   Corrected JANBU FOS =   2.759  **    (Fo factor = 1.075)


Failure surface No. 7 specified by 19 coordinate points
       Point      x-surf      y-surf
        No.        (ft)        (ft)
         1         64.62      229.00
         2         62.68      228.48
         3         60.72      228.12
         4         58.73      227.91
         5         56.73      227.86
         6         54.73      227.96
         7         52.75      228.22
         8         50.79      228.64
         9         48.87      229.20
        10         47.01      229.92
        11         45.20      230.78
        12         43.47      231.77
        13         41.82      232.91
        14         40.26      234.16
        15         38.81      235.54
        16         37.47      237.02
        17         36.25      238.61
        18         35.15      240.28
        19         34.24      241.97
```

```
 **  Corrected JANBU FOS =   2.759  **    (Fo factor = 1.068)


Failure surface No. 8 specified by 21 coordinate points
       Point      x-surf      y-surf
        No.        (ft)        (ft)
         1         65.38      229.00
         2         63.49      228.37
         3         61.55      227.89
         4         59.57      227.55
         5         57.58      227.37
         6         55.58      227.34
         7         53.59      227.47
         8         51.61      227.75
         9         49.65      228.18
        10         47.74      228.76
        11         45.88      229.49
        12         44.07      230.35
        13         42.34      231.35
        14         40.69      232.49
        15         39.14      233.74
        16         37.68      235.11
        17         36.33      236.59
        18         35.10      238.17
        19         34.00      239.84
        20         33.03      241.59
        21         32.76      242.18

 **  Corrected JANBU FOS =   2.760  **    (Fo factor = 1.071)


Failure surface No. 9 specified by 21 coordinate points
       Point      x-surf      y-surf
        No.        (ft)        (ft)
         1         66.54      229.00
         2         64.71      228.19
         3         62.82      227.54
         4         60.88      227.06
         5         58.90      226.75
         6         56.91      226.60
         7         54.91      226.63
         8         52.92      226.83
         9         50.95      227.20
        10         49.02      227.73
        11         47.15      228.43
        12         45.34      229.29
        13         43.62      230.30
        14         41.98      231.46
        15         40.46      232.75
        16         39.04      234.16
        17         37.76      235.70
        18         36.61      237.33
```

```
           19          35.61       239.06
           20          34.76       240.87
           21          34.36       241.95

 **   Corrected JANBU FOS =    2.763   **     (Fo factor = 1.077)


 Failure surface No.10 specified by 19 coordinate points
          Point        x-surf       y-surf
           No.          (ft)         (ft)
            1          64.62       229.00
            2          62.71       228.38
            3          60.76       227.93
            4          58.78       227.67
            5          56.78       227.59
            6          54.79       227.70
            7          52.81       227.99
            8          50.86       228.46
            9          48.97       229.11
           10          47.15       229.93
           11          45.41       230.91
           12          43.76       232.06
           13          42.23       233.34
           14          40.83       234.77
           15          39.56       236.31
           16          38.44       237.97
           17          37.47       239.72
           18          36.68       241.55
           19          36.66       241.62

 **   Corrected JANBU FOS =    2.765   **     (Fo factor = 1.073)


 The following is a summary of the TEN most critical surfaces

 Problem Description : Rancho Del Sol Lot 31 Section B

         Modified        Correction    Initial     Terminal     Available
        JANBU FOS          Factor      x-coord      x-coord      Strength
                                        (ft)         (ft)         (lb)

  1.       2.752           1.075        65.00        34.35     2.029E+04
  2.       2.753           1.074        64.23        33.76     2.032E+04
  3.       2.754           1.071        65.00        33.42     2.008E+04
  4.       2.755           1.076        65.00        35.61     1.905E+04
  5.       2.758           1.076        64.62        33.64     2.119E+04
  6.       2.759           1.075        66.15        33.68     2.164E+04
  7.       2.759           1.068        64.62        34.24     1.838E+04
  8.       2.760           1.071        65.38        32.76     2.093E+04
  9.       2.763           1.077        66.54        34.36     2.158E+04
 10.       2.765           1.073        64.62        36.66     1.720E+04
```

* * * END OF FILE * * *

SECTION B-B'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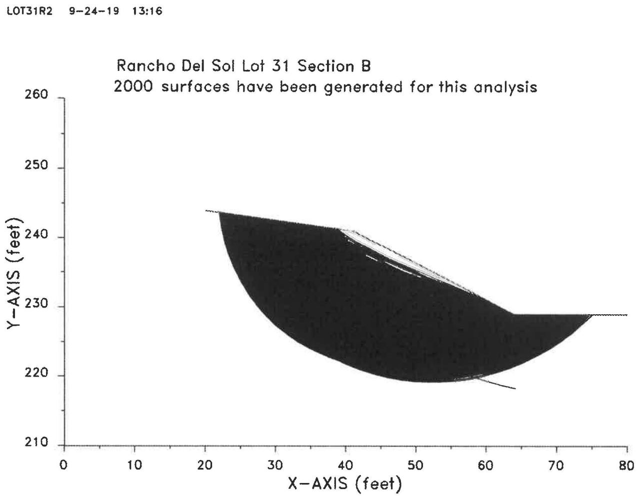
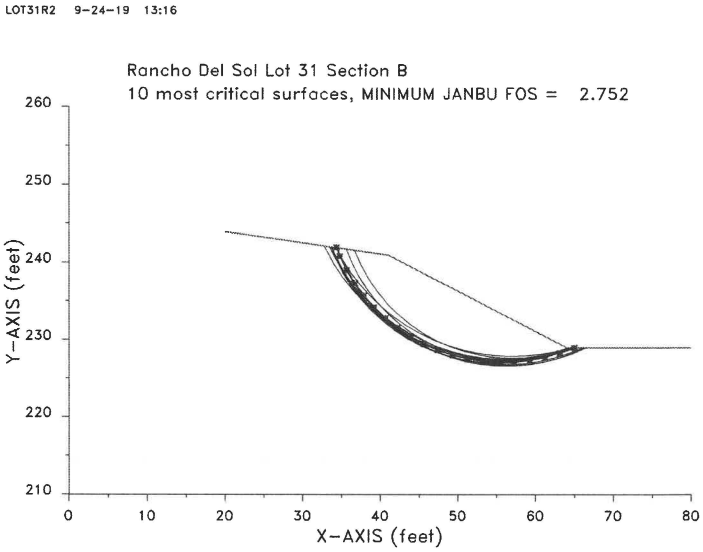
Rancho Del Sol Lot 31 Section B
Y-AXIS (feet)
260
250
240
230
220
210
0
10
20
30
40
50
60
70
80
X-AXIS (feet)


LOT31R2 9-24-19 13:16
Rancho Del Sol Lot 31 Section B
2000 surfaces have been generated for this analysis
Y-AXIS (feet)
260
250
240
230
220
210
0
10
20
30
40
50
60
70
80
X-AXIS (feet)


LOT31R2 9-24-19 13:16
Rancho Del Sol Lot 31 Section B
10 most critical surfaces, MINIMUM JANBU FOS = 2.752
Y-AXIS (feet)
260
250
240
230
220
210
0
10
20
30
40
50
60
70
80
X-AXIS (feet)

SURFICIAL STABILITY CALCULATIONS FOR PROPOSED CUT AND FILL SLOPES

slope ratio	slope angle
2 to 1	26.6

		radians
phi(deg)=	27.5	0.4800
c(psf)=	250	
gamma Sat(pcf)=	125	
gamma Buoy(pcf)=	62.6	
slope angle(deg)=	26.6	0.4643
depth=	5	
FS=	**1.52**