

# Cal Land Engineering & Associates, Inc.

Land Surveying, Geotechnical, Environmental, and Civil Engineering

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April 10, 2025

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Subject: Report of Geotechnical Engineering Investigation, Proposed Residential Development, 1003 Carbon Canyon Road, Lot 7, Block 3, Tract 2037, APN: 1000-143-04, Chino Hills, California. CLE Project No.: 25-210-003bEG

Gentlemen,

In accordance with your request, Cal Land Engineering (CLE) is pleased to submit this Geotechnical Engineering Report for the subject site. The purpose of this report was to evaluate the subsurface conditions and provide recommendations for foundation designs and other relevant parameters of the proposed construction.

Based on the findings and observations during our investigation, the proposed construction of the subject site for the intended use is considered feasible from the geotechnical engineering viewpoints, provided that specific recommendations set forth herein are followed.

This opportunity to be of service is sincerely appreciated. If you have any questions pertaining to this report, please call the undersigned.

Respectfully submitted,  
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**REPORT OF GEOTECHNICAL ENGINEERING  
INVESTIGATION**

**Proposed Residential Development**

**At**

**1003 Carbon Canyon  
Lot 7, Block 3, Tract 2037  
APN: 1000-143-04  
Chino Hills, California**

Prepared by  
CALLAND ENGINEERING (CLE)  
Project No.: 25-210-003bEG  
April 10, 2025

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## **1.0 INTRODUCTION**

### **1.1 Purpose**

This report presents a summary of our preliminary geotechnical engineering investigation for the proposed construction at the subject site. The purposes of this investigation were to evaluate the subsurface conditions at the area of proposed construction and to provide recommendations pertinent to grading, foundation design and other relevant parameters of the development.

### **1.2 Scope of Services**

Our scope of services included:

- Review of available soil engineering data of the area.
- Subsurface exploration consisting of excavating, logging and sampling of three (3) hand-dug test pits to a maximum depth of 14.0 feet below the existing grade at the subject site. The test pit logs are presented in the attached Appendix A.
- Laboratory testing of representative samples to establish engineering characteristics of the on-site soil. The laboratory test results are presented in the attached Appendices A and B.
- Engineering analyses of the geotechnical data obtained from our background studies, field investigation, and laboratory testing.
- Preparation of this report presenting our findings, conclusions, and recommendations for the proposed construction.

### **1.3 Proposed Construction**

Based on our review of the 1/8-scale architectural Site Plan by ZonouZ de Zine, dated March 18, 2025, it is our understanding that the proposed development is to construct a multilevel single-family residence with an attached garage, and associated improvements. The proposed residence is anticipated to be a three-story wood frame structure. Column loads are unknown at this time, but are expected to be light to medium. Minor cut and fill grading operation is anticipated to reach the desired grades.

### **1.4 Site Conditions**

The project site is located on the east side of Carbon Canyon Road, a relatively short distance south Hillside Drive, in the existing developed residential areas of the City of Chino Hills, California. The approximate location of the site is presented in the attached Site Location Map (Figure 1). The site is currently vacant land, the total lot size is approximately 4,300 square feet (0.1 acre).

The subject site is bounded in the on the north and south by existing residential structures, on the west by Carbon Canyon Road, and on the south by vacant land. The site is covered by an existing southerly descending slope. The total relief of this slope is approximately 27 feet, with an average slope gradient of 2.2:1 (Horizontal to Vertical), with a localized slope with an approximate 1.2:1 (H:V) gradient for a height of approximately 5 feet at the rear of the slope, which ties to an existing valley. Based on our visual observations during our field investigation, a small surface stream runs adjacent to the toe of the slope. Configuration of the site is presented in the attached Site Plan (Plate 1). No major surface erosions were observed during our subsurface investigation.

## **2.0 REVIEW OF GEOTECHNICAL REPORTS**

The subject site is a portion of Block 3, Tract 2037, in the City of Chino Hills, California. Based on our review of the referenced reports by Richard D. Merker and George E. Hawes, for the property located at 16980 Hillside Drive, located approximately 250 feet north from the subject site, this site is underlain by a thin layer of colluvial soils (Qcol) followed by a layer of terrace deposits (Qt), which is in turn underlain by bedrock of Puente Formation (Tp). The colluvial soils consists of sandy silt (ML), the terrace deposits consist of hard clayey sandy silt (ML), and the encountered bedrock is comprised of clayey siltstone, the bedding strikes generally towards the northwest and in the east-west direction and dips towards the north at low angles. The referenced reports by Richard D. Merker and George E. Hawes were reviewed and approved as preliminary investigation reports by County of San Bernardino's department of building and safety (LG0322) prior to the city's incorporation.

## **3.0 SUBSURFACE EXPLORATION AND LABORATORY TESTING**

### **3.1 Subsurface Exploration**

Our subsurface exploration consisted of excavating, logging, and sampling three (3) hand-dug test pits and borings to a maximum depth of 14.0 feet below the existing grade. The approximate locations of the test pits are shown in the attached Site Plan (Plate 1). The purpose of the explorations was to assess the engineering characteristics of the onsite soils with respect to the proposed development. The excavation of the test pits was supervised and logged by a CLE engineering geologist. Relatively undisturbed and bulk samples were collected during excavation of the test pits for laboratory testing. The test pit logs are presented in the attached Appendix A.

### **3.2 Laboratory Testing**

Representative samples were tested for the following parameters: in-situ moisture content and density, shear strength, consolidation settlement, percent fines, Atterberg limits, and expansion and corrosion potentials. The results of our laboratory testing along with a summary of the testing procedures are presented in the attached Appendix B. The in-situ moisture and density test results are provided on the test pit logs in the attached Appendix A.

## **4.0 SUMMARY OF GEOTECHNICAL CONDITIONS**

### **4.1 Site Geology**

The earth materials encountered at the subject site include colluvium and bedrock of Monterey formation. Description of the subsurface materials is provided as follows:

#### 4.1.1 Colluvium (Map Symbol, Qcol)

The subject site is underlain by a thick layer of colluvial soils. The encountered colluvium varied from 3.5 to 10 feet in thickness. The colluvium consists of sandy clay (CL), silty sand (SM), and clayey sand (SC). The colluvium generally exists in the slightly moist to very moist and loose to stiff and medium dense conditions.

#### 4.1.2 Bedrock of Monterey Formation – Soquel Sandstone Member (Map Symbols, Tmss)

The “Geologic map of the Yorba Linda & Prado Dam Quadrangles (Eastern Puente Hills), Los Angeles, Orange, San Bernardino, and Riverside Counties, California” by Thomas W. Dibblee, Jr., shown on the attached Regional Geology Map (Figure 4), and our subsurface investigation indicated that the subject site and adjacent areas are underlain by bedrock of Monterey Formation comprised Soquel member consisting of sandstone. The encountered bedrock is yellowish brown to tan brown in color, slightly moist to moist, and firm to hard in consistency. The encountered bedrock is weathered in the upper 2-3 feet and becomes more competent below the weathered zone.

The colluvial soils and weathered bedrocks have potential for scouring and erosion, therefore, placement of a grouted rip-rap along the toe of the slope is highly recommended.

## **4.2 Geologic Structures**

Based on the Regional Geology Map and our subsurface investigation, the encountered bedrock generally dips towards the northeast at low angles, which is considered favorable with respect to the site's global stability.

The bedding attitude observed during our subsurface investigation was mapped along the outcrops at the toe of the descending natural slope. No evidence of any major site instability, such as landslides or faulting was observed during our field investigation.

## **4.3 Groundwater**

Based on our review of the "Historically Highest Ground Water Contours and Borehole Log Data Locations, Yorba Linda Quadrangle" by of Conservation, Division of Mines and Geology (CDMG), shown in the attached Historical Highest Groundwater Level Map (Figure 3), it is estimated that the highest historical ground water level is approximately greater than 10 feet. It should be noted that the CDMG ground water map is obtained by evaluating technical publications, geotechnical borehole data, and water-well logs dating back to the "turn-of-the-century". No specific date was provided pertaining to the historically highest ground water level.

Moreover, no groundwater or seepage was encountered in the test pits to the maximum depth explored (14.0 feet below the existing grade). However, the presence of a small surface stream running adjacent to the toe of the slope was observed during our field investigation.

Groundwater is not expected to be a significant constraint during future near surface construction.

# **5.0 SEISMICITY**

## **5.1 Faulting**

Based on our review of the "Earthquake Zones of Required Investigation" by California Geological Survey (CGS), shown on the attached Seismic Hazard Map (Figure 2), it is concluded the subject site is not included within any Earthquake Fault Zones as created by the Alquist-Priolo Earthquake Fault Zoning Act (CGS, 2018). Our review of geologic literature pertaining to the site area indicates that there are no known active or potentially active faults located within or immediately adjacent to the subject property. The nearest known active regional fault is the Elsinore fault located approximately 2.6 miles from the subject site.

## 5.2 Seismicity

The subject site, like the rest of Southern California, is located within a seismically active region. The type and magnitude of seismic hazards affecting the site depend on the distance to causative faults, the intensity, and the magnitude of the seismic event. Table 1 indicates the distance of the fault zones and the associated maximum magnitude earthquake that can be produced by nearby seismic events. As indicated in Table 1, the Elsinore fault is considered to have the most significant effect to the site from a design standpoint.

**TABLE 1**  
**Characteristics and Estimated Earthquakes for Regional Faults**

| Fault Name                  | Approximate Distance to Site (mile) | Maximum Magnitude Earthquake (Mw) |
|-----------------------------|-------------------------------------|-----------------------------------|
| Elsinore;W+GI               | 2.6                                 | 7.2                               |
| Elsinore;W                  | 2.6                                 | 7.0                               |
| Elsinore;W+GI+T+J+CM        | 2.6                                 | 7.7                               |
| Elsinore;W+GI+T+J           | 2.6                                 | 7.7                               |
| Elsinore;W+GI+T             | 2.6                                 | 7.4                               |
| Chino, alt 1                | 4.3                                 | 6.7                               |
| Chino, alt 2                | 4.4                                 | 6.8                               |
| Puente Hills (Coyote Hills) | 5.9                                 | 6.9                               |
| San Jose                    | 8.4                                 | 6.7                               |
| Sierra Madre                | 12.2                                | 7.2                               |
| Sierra Madre Connected      | 12.2                                | 7.3                               |
| Cucamonga                   | 12.7                                | 6.7                               |
| Elsinore;GI                 | 13.5                                | 6.8                               |
| Elsinore;GI+T+J+CM          | 13.5                                | 7.7                               |
| Elsinore;GI+T               | 13.5                                | 7.2                               |

Reference: 2008 National Seismic Hazard Maps - Source Parameters

## 5.3 Estimated Earthquake Ground Motions

In order to estimate the seismic ground motions at the subject site, CLE has utilized the seismic hazard map published by California Geological Survey. According to this report, the peak ground Alluvium acceleration at the subject site for a 2% and 10% probability of exceedance in 50 years is about 0.935g and 0.479g respectively (2014 USGS Interactive Deaggregation).

The site modified peak ground acceleration (PGAM), corresponding to USGS Design Map Summary Report, ASCE 7-16 Standard, is 1.021g.

#### 5.4 Seismic Design Criteria

Based on our studies on seismicity, there are no known active faults crossing the property. However, the subject site is located in southern California, which is a tectonically active area. Based on ASCE 7 –16 Standard, CBC 2022, the following seismic related values may be used:

| Seismic Parameters (Latitude: 33.9455079, Longitude: -117.781315)                                           | Site Class "C" |
|-------------------------------------------------------------------------------------------------------------|----------------|
| Mapped 0.2 Sec Period Spectral Acceleration, <b>S<sub>s</sub></b>                                           | 1.976g         |
| Mapped 1.0 Sec Period Spectral Acceleration, <b>S<sub>1</sub></b>                                           | 0.685g         |
| Site Coefficient for Site Class "C", <b>F<sub>a</sub></b>                                                   | 1.2            |
| Site Coefficient for Site Class "C", <b>F<sub>v</sub></b>                                                   | 1.4            |
| Maximum Considered Earthquake Spectral Response Acceleration Parameter at 0.2 Second, <b>S<sub>MS</sub></b> | 2.371g         |
| Maximum Considered Earthquake Spectral Response Acceleration Parameter at 1.0 Second, <b>S<sub>M1</sub></b> | 0.959g         |
| Design Spectral Response Acceleration Parameters for 0.2 sec, <b>S<sub>DS</sub></b>                         | 1.581g         |
| Design Spectral Response Acceleration Parameters for 1.0 Sec, <b>S<sub>D1</sub></b>                         | 0.64g          |

The Project Structural Engineer should be aware of the information provided above to determine if any additional structural strengthening is warranted.

### 6.0 SLOPE STABILITY

#### 6.1 Existing Slope

The subject site is covered by an existing southernly descending slope. This slope exists at an average slope gradient of 2.2:1 (H:V). The total relief of this slope is approximately 27 feet. No evidence of major surficial erosions was observed during our field investigation.

## 6.2 Shear Strength of Onsite Soil/Bedrock

Selection of Coulomb shear strength parameters used for the slope stability analyses were derived from the laboratory direct shear test data on selected soil samples procured during our subsurface investigation for this study, and evaluated in light of past experience in similar soil and bedrock materials. A summary of these strength parameters is presented in the following table:

| Material             | Unit Weight (pcf.) | Cohesion (psf.) Static/Seismic | Friction Angle (°) Static/Seismic |
|----------------------|--------------------|--------------------------------|-----------------------------------|
| Surficial Soils (Qs) | 120                | 250/250                        | 28/28                             |
| Bedrock (Tmss)       | 120                | 300/370                        | 30/32                             |

## 6.3 Slope Stability Analyses

### 6.3.1 Gross Stability

The gross stability of the existing slope was analyzed using the computer program “GSTABL7 with STEDwin v.2” by Gregory Geotechnical Software. The computer print-outs are presented in the attached Appendix C. Based on our gross slope stability analysis, it is our opinion that the existing slope has a factor of safety greater than 1.5 under the design static conditions and a factor of safety greater than 1.1 under the design seismic conditions, provided the slope is properly maintained and normal rainfall with no concentrated flow on slope.

### 6.3.2 Surficial Slope Stability

The surficial slope stability analysis of the existing ascending slope bounding the rear yard with a slope ratio of approximately 2.2 to 1 (horizontal to vertical, i.e. 24°) was evaluated by utilizing the “infinite slope” method. An infinite slope with slippage parallel to the slope with a 4-foot-deep saturated zone was assumed. The results of our surficial stability analysis indicate that the existing slope has a factor of safety greater than the required factor of safety of 1.5. The result of our surficial stability analysis is presented in the attached Appendix C.

## 6.4 Landscaping

All slopes will be subject to surficial erosion. Therefore, slopes should be protected from surface runoff by means of top-of-slope compacted earth berms or concrete interceptor drains. All slopes should be landscaped with a suitable plant material requiring minimal cultivation and irrigation water in order to thrive. An irrigation system should be installed. Overwatering and subsequent saturation of slope surfaces should be avoided.

At all times avoid saturation or desiccation of the slope materials since these conditions tend to deteriorate the slope. Irrigation facilities should be turned off during the rainy season.

Maintenance includes correction of defective drainage terraces on slope, elimination of burrowing rodents, corrections of defective irrigation facilities, and controlled slope vegetation growth. Irrigation programs for all landscaped slopes should be well controlled and minimized. Seasonal adjustments should be made to prevent excess moisture in the slope soils. Overwatering, especially prior to winter storms, may generate surficial slope distress.

## **7.0 CONCLUSIONS**

The following is a summary of the geotechnical design and construction factors that may affect the development of the site:

### **7.1 Seismicity**

Based on our studies on seismicity, there are no known active faults crossing the property. However, the site is located in a seismically active region and is subject to seismically induced ground shaking from nearby and distant faults, which is a characteristic of all Southern California.

### **7.2 Seismic Induced Hazards**

#### **7.2.1 Liquefaction**

Based on our review of the "Earthquake Zones of Required Investigation" by California Geological Survey (CGS), shown on the attached Seismic Hazard Map (Figure 2), it is concluded that the site is not located in the mapped potential liquefaction areas.

#### **7.2.2 Landsliding**

Based on our review of the "Earthquake Zones of Required Investigation" by CGS, shown on the attached Seismic Hazard Map (Figure 2), it is concluded that the subject site is not located in the mapped potential seismic induced landslide areas. However, the adjacent properties bounding the site on the east, south, and west, are located in the mapped potential seismic induced landslide areas. Based on our slope stability analysis, it is our opinion that the existing slope is considered grossly and surficially stable under the design conditions, provided the slope is properly maintained and normal rainfall with no concentrated flow on slope.

### **7.3 Other Secondary Hazard**

#### **7.3.1 Fault Rupture**

There are no known active faults crossing the property and the property is not located within the Alquist-Priolo Earthquake Fault Zone. The nearest fault zone is the Elsinore fault which is located approximately 2.6 miles from the property. Therefore, the likelihood of a fault surface rupture is considered low.

#### **7.3.2 Seiches and Tsunamis**

Seiches are large waves generated in enclosed bodies of water as the results of major ground shaking. The site is located within the residential area in the City of Chino Hills, California. No water retaining structures are located immediately adjacent to site. Earthquake induced flooding, tsunamis and seiches are considered unlikely at the site.

#### **7.3.3 Oil Field and Historical Oil Wells**

Based on our review of the Munger Map Book of the California Oil and Gas Field, no oil wells are located on the subject property or any adjacent properties. It is our opinion that the potential of the presence of the methane zone at the site is considered low. However, should it be determined that the methane study is required; a qualified consultant should be retained for the study.

#### **7.3.4 Subsidence**

Land subsidence occurs when large amounts of groundwater, oil or gas have been withdrawn from fine-grained soils. It is our understanding that large scale extraction of groundwater, oil or gas is not planned at the site. The land subsidence at site appears to be unlikely.

#### **7.3.5 Expansive Soils**

Soil expansion is the tendency of the soil to expand when the soil contacts with water. Based on our laboratory test of the onsite soils, it is concluded that the onsite soils have high expansion potential. Foundation design and construction should be designed in accordance with the current building code to reduce the potential for any adverse effect as result of soil expansion.

### **7.4 Excavatability**

Based on our subsurface investigation, excavation of the subsurface materials should be able to be accomplished with conventional earthwork equipment.

## **7.5 Groundwater**

Groundwater was not encountered to the maximum depth explored (14.0 feet below existing grade). In our opinion, groundwater will not be a problem during the near surface construction.

## **8.0 RECOMMENDATIONS**

Based on the subsurface conditions exposed during field investigation and laboratory testing program, it is our opinion that the proposed development is feasible from the geotechnical engineering viewpoint. The following recommendations should be incorporated in the design and construction phases of the project.

### **8.1 Grading**

#### **8.1.1 Site Preparation**

Prior to initiating grading operations, any existing vegetation, trash, debris, over-sized materials (greater than 8 inches), and other deleterious materials within construction areas should be removed from the subject site.

#### **8.1.2 Buried Utilities**

Buried abandoned utilities such as sewer, water, and gas lines, or electrical conduits located within areas to receive pavements, structures, or compacted fill should be completely removed to a maximum depth of two feet below the finished grade. Concrete lines deeper than two feet below the finished grade and having diameters less than six inches can be crushed in place.

#### **8.1.3 Cavities**

Existing cavities as a result from clearing, grubbing, or prior demolition activities shall be backfilled with compacted fill. Backfill of smaller cavities where placement of compacted fill would result in challenging, concrete slurry mix may be used to backfill such cavities.

#### **8.1.4 Surficial Soil Removals**

Based on our field exploration and laboratory data obtained to date, it is recommended that the building pad areas be cut to grade and then observed by a representative of this office to verify the subgrade soil conditions and determine if additional removals or other mitigation measures are needed.

The existing near surface soils should also be removed to a depth of about 4 feet within the proposed driveway and concrete flatwork areas. The fills placed within the proposed driveway and concrete flatwork areas at the site should be classified as secondary fills and are only suitable for the flatwork support.

Locally deeper removals may be necessary to expose competent natural ground. The actual removal depths should be determined in the field as conditions are exposed. Visual inspection and/or testing may be used to define removal requirements.

#### 8.1.5 Treatment of Removal Bottoms

Soils exposed within areas approved for fill placement should be scarified to a depth of 6 inches, conditioned to near optimum moisture content, then compacted in-place to minimum project standards.

#### 8.1.6 Structural Backfill

The onsite soils may be used as compacted fill, provided they are free of organic materials and debris. Fills should be placed in relatively thin lifts (6 to 8 inches), brought to near optimum moisture content, and then compacted to at least 90 percent relative compaction based on laboratory standard ASTM D-1557-12.

### **8.2 Foundation Design**

#### 8.2.1 Caisson Foundation

Caissons should be a minimum of 5 feet into competent bedrock. All caissons should be at least 24 inches in diameter to facilitate cleanout. Caissons may be designed for an allowable end bearing pressure of 5,000 pounds per square foot (psf.). Caissons may be assumed fixed at 3 feet into bedrock.

The excavations of the caisson should be cleaned of all loose and/or disturbed soils. The weight of the concrete within the caissons may be neglected in considering the allowable caissons bearing capacity, provided the bottom of the caissons are cleared of loose and/or disturbed soil prior to the concrete placement. All caissons should be tied in two horizontal directions with grade beams or footings.

For caissons spacing greater than 3 times of the caisson diameter can be considered as isolated caissons. The reinforcement of the caissons and grade beam should be designed by the project structural engineer.

Resistance to lateral loading may be provided by friction acting at the base of the caissons and by passive earth pressure for the portion of the caissons embedded within the competent bedrock. Passive earth pressure may be computed as an equivalent fluid pressure of 350 pounds per cubic foot (pcf.), with a maximum earth pressure of 5,000 pounds per square foot. An allowable coefficient of friction between soil and concrete of 0.35 may be used with the dead load forces.

When combining passive pressure and frictional resistance, the passive pressure component should be reduced by one-third ( $1/3$ ). The above recommended passive earth pressure may be double for the caissons spacing at 3 caisson diameters (center to center).

#### 8.2.2 Settlement

Settlement of the footings placed as recommended, and subject to no more than allowable loads is not anticipated to exceed  $3/4$  inch. Differential settlement between adjacent columns is not anticipated to exceed  $1/2$  inch.

#### 8.2.3 Lateral Pressures (if applicable)

The active earth pressure to be utilized for cantilever retaining wall design may be computed as an equivalent fluid pressure of 45 pcf. when the slope of the backfill behind the wall is level. Earth pressure from horizontal backfill may be computed as an equivalent fluid weighting of 65 pounds per cubic foot for restrained retaining wall. This value assumes free-draining conditions.

#### 8.2.4 Wall Seismic Loading (if applicable)

Earthquake earth pressure distribution on retaining walls retaining more than 6 feet of soils when the slope of the backfill behind the wall is level is 32 pcf. at the base. Restrained retaining wall may be design with an equivalent fluid pressure of 52 pcf. (County of Los Angeles Guidelines S004.0 Rev. January 3, 2024). The point of application of dynamic load is at  $1/3H$ , where H is the retained height. The earthquake-induced pressure should be added to the static active earth pressure.

$$PGA = S_{DS} / 2.5 = 1.581 / 2.5 = 0.632$$

(Restrained) walls with level backfill,  $P_{ae} = \frac{1}{2} (\gamma)(H^2)(0.68 \cdot PGA/g)$  , EFP say 32

Cantilever (unrestrained) walls with level backfill,  $P_{ae} = \frac{1}{2} (\gamma)(H^2)(0.42 \cdot PGA/g)$  , EFP say 52

### 8.3 Residential Floor Slabs

Residential floor slabs should be designed as raised wood floors or structural slabs deriving support from the caisson foundations. If raised wood floors be used for the planned residence, adequate ventilation should be provided for crawl spaces below flooring to release accumulated moisture.

### 8.4 Concrete Slab and Flatworks

Concrete slab and flatworks should be a minimum of 5 inches thick and reinforced with a minimum of No. 4 reinforcing bar spaced 16-inch each way or its equivalent. All slab reinforcement should be supported to ensure proper positioning during placement of concrete.

In order to comply with the requirements of the 2022 CalGreen Section 4.505.2.1 within the moisture sensitive concrete slabs, a minimum of 4-inch-thick base of  $\frac{1}{2}$  inch or larger clean aggregate should be provided with a vapor barrier in direct contact with concrete. A 10-mil Polyethylene vapor retarder, with joints lapped not less than 6 inches, should be placed above the aggregate and in direct contact with the concrete slab. As an alternate method, 3 inches of sand then 10-mil polyethylene membrane and another 3 inches of sand over the membrane and under the concrete may be used, provided this request for an alternative method is approved by City Building Officials.

The recommendations presented in this report reflect the design criteria from the geotechnical engineering viewpoint. Architectural and structural engineering specifications which exceed our recommendations should prevail.

### 8.5 Retaining Wall Backfill (If Applicable)

It is recommended that a free-drainage, selected compacted backfill (SE of 30 or greater), should be used for backfill within 18 inches behind retaining wall. The upper 18 inches of backfill should consist of native soils.

All backfill should be compacted to at least 90 percent of the laboratory maximum dry density (ASTM D-1557-12). All backfill should be placed in relatively thin lifts, brought to near optimum, then compacted with handhold compactor or vibrator to a minimum relative compaction of 90 percent of laboratory standard (ASTM D-1557-12). Flooding or jetting of backfill materials should be avoided.

#### **8.6 Retaining Wall Drainage (If Applicable)**

Any proposed retaining walls retain more than 30 inches of soils at the site should be provided with backdrains to reduce the potential for the buildup of hydrostatic pressure. Backdrains should consist of 4-inch (minimum) diameter perforated PVC pipe surrounded by a minimum of 1 cubic foot per lineal foot of clean coarse gravel wrapped in filter fabric (Mirafi 140 or the equivalent) placed at the base of the wall. The drain should be covered by no less than 18 inches (vertical) of compacted wall backfill soils.

The backdrain should outlet through non-perforated PVC pipe or weepholes. Alternatively, commercially available drainage fabric (i.e., J-drain) could be used. The fabric manufacturer's recommendations should be followed in the installation of the drainage fabric backdrain.

If there is not enough room for placing the above-mentioned drainage systems, an alternative system such as pre-fabricated drainage system AQUADRAIN 100 BD with a 3-inch drain pipe set in gravel behind the wall, to prevent the buildup of hydrostatic pressure. This drain pipe may be connected to a 3-inch drain collector pipe connected to a sump pump.

#### **8.7 Temporary Excavation and Backfill**

All trench excavations should conform to CAL-OSHA and local safety codes. All utility trenches backfill should be brought to near optimum moisture content and then compacted to obtain a minimum relative compaction of 90 percent of ASTM D-1557-12. All temporary excavations should be observed by a field engineer of this office so as to evaluate the suitability of the excavation to the exposed soil conditions.

## 8.0 INSPECTION

As a necessary requisite to the use of this report, the following inspection is recommended:

- Attendance the pre-grade meeting on or off the site.
- Inspection of all removal bottoms.
- Observation and testing of all fill placements.
- Preparation of Rough Grading Compaction report.
- Inspection of caisson excavations
- Inspection of retaining wall subdrainage system, if any.
- Inspection and testing of all utility trenches backfill
- Preparation of Final Grading Compaction report.
- Observation and testing of subgrade for hardscape areas

The geotechnical engineer should be notified at least 1 day in advance of the start of construction. A joint meeting between the client, the contractor, and the geotechnical engineer is recommended prior to the start of construction to discuss specific procedures and scheduling.

## 9.0 DRAINAGE

All pads and roof should be properly drained away from structures via swales or other suitable drainage devises. The drainage pattern should be maintained during and after the proposed residence construction. No concentration flow is allowed to drain toward the slope. Drainage from the proposed residence should be directed away from the slope to avoid the concentrated flow. Any drainage pipes encountered during the onsite caisson construction should be re-routed to maintain the existing drainage pattern.

## 10.0 CORROSION POTENTIAL

Chemical laboratory tests were conducted on the existing onsite near surface materials sampled during CLE's field investigation to aid in evaluation of soil corrosion potential and the attack on concrete by sulfate soils. The testing results are presented in Appendix B.

According to 2022 CBC and ACI 318-19 (Reapproved 22), Section 19.3, Table 19.3.1.1, exposure category is Sulfate (S) and exposure class is (S0). A "negligible" exposure to sulfate can be expected for concrete placed in contact with the onsite soils. Therefore, Type II cement or its equivalent may be used for this project and minimum compressive strength of concrete should be 2,500 psi.

Based on the resistivity test results, it is estimated that the subsurface soils are moderately to severely corrosive to buried metal pipe. It is recommended that any underground steel utilities be blasted and given protective coating. Should additional protective measures be warranted, a corrosion specialist should be consulted.

### **11.0 REMARKS**

The conclusions and recommendations contained herein are based on the findings and observations at the exploratory locations. However, soil materials may vary in characteristics between locations of the exploratory locations. If conditions are encountered during construction, which appear to be different from those disclosed by the exploratory work, this office should be notified so as to recommend the need for modifications. This report has been prepared in accordance with generally accepted professional engineering principles and practice. No warranty is expressed or implied.

### **12.0 REFERENCES**

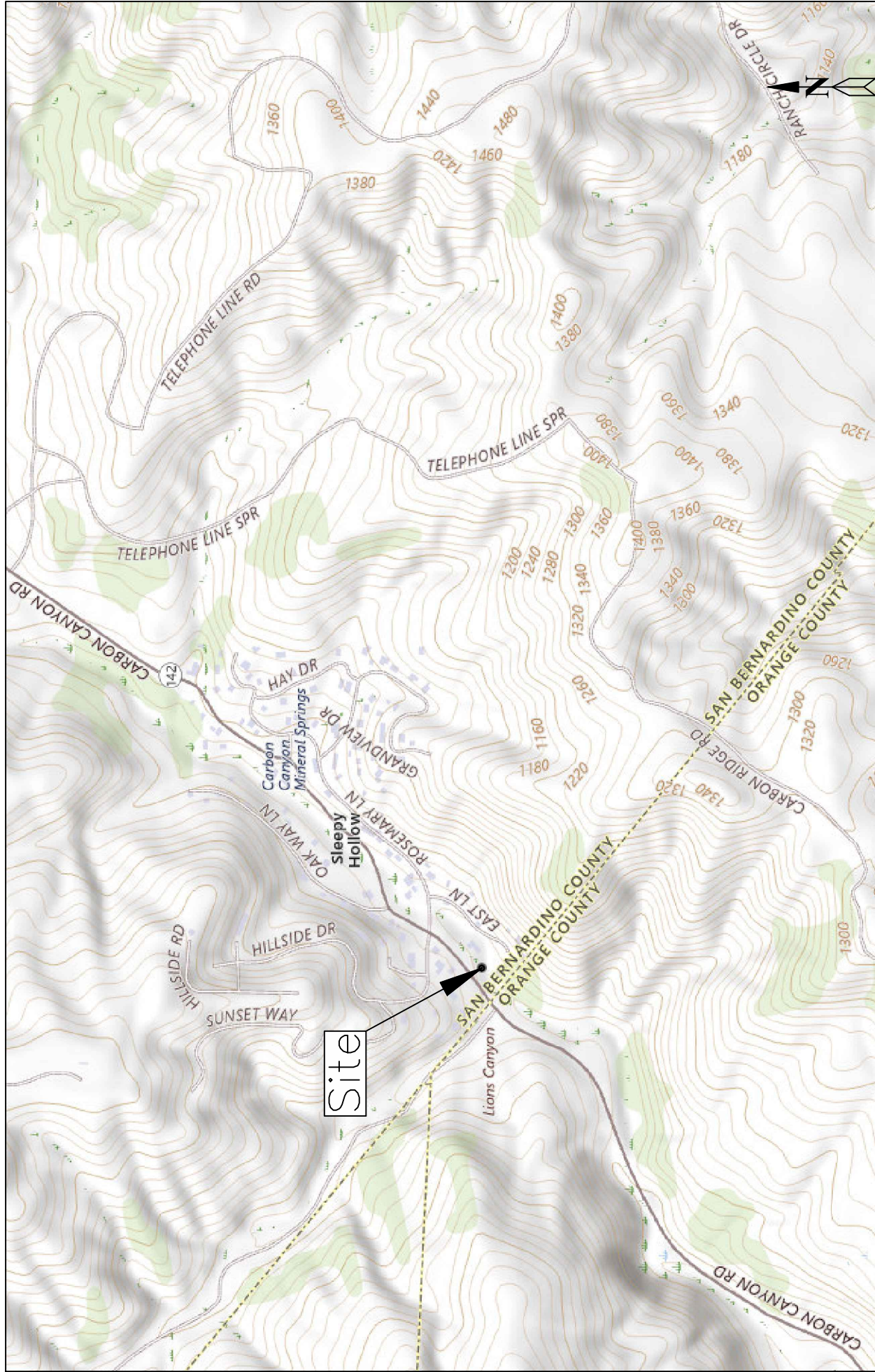
"Engineering Geologic Survey for Lot 2 [and] Lot 11, Tract 2037, 1024 Carbon Canyon Road [and] 16980 Hillside Drive" by Richard D. Merker, dated November 10, 1988.

"Preliminary Geotechnical Investigation, RE: Proposed Residential Development, Lots 2, Tract 2037, 1024 Carbon Canyon Road, Carbon Canyon, Lot 11, Tract, 2037, 16980 Hillside Drive, Carbon Canyon, San Bernardino County, California" by George E. Hawes, dated September 20, 1989.

"Inter-Office Memo, Review of Preliminary Geotechnical Investigation, RE: Proposed Residential Development, Lots 2, Tract 2037, 1024 Carbon Canyon Road, Carbon Canyon, Lot 11, Tract, 2037, 16980 Hillside Drive, Carbon Canyon, San Bernardino County, California (LG0322)" by County of San Bernardino, Building and Safety, dated January 5, 1990.

"Review of Preliminary Geotechnical Investigation, RE: Proposed Residential Development, Lots 2, Tract 2037, 1024 Carbon Canyon Road, Carbon Canyon, Lot 11, Tract, 2037, 16980 Hillside Drive, Carbon Canyon, San Bernardino County, California" by County of San Bernardino, Land Management Department, LG0322, dated January 26, 1990.

"Public Records Request 25-145" by Cal Land Engineering & Associates, Inc. to City of Chino Hills California via NextRequest software web portal, dated March 20, 2025.



Map modified from "National Map" by USGS

NOT TO SCALE



**CAL LAND**  
ENGINEERING & ASSOCIATES, Inc.

## Site Location Map

1003 Carbon Canyon Road, Chino Hills, California

Project No.: 25-210-003bEG

FIGURE 1



Map modified from "Earthquake Zones of Required Investigation" by CGS

NOT TO SCALE



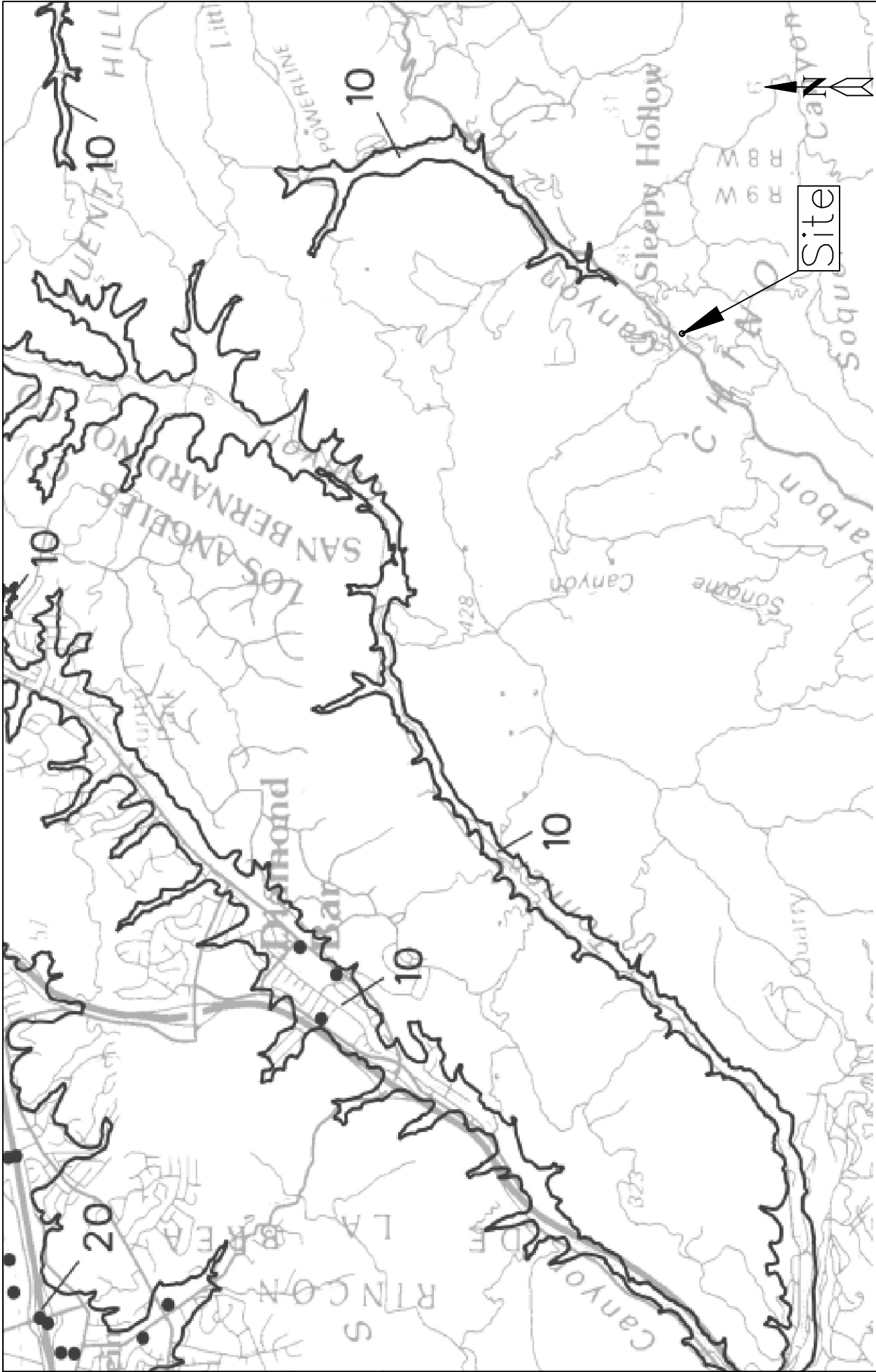
**CAL LAND**  
ENGINEERING & ASSOCIATES, Inc.

## Seismic Hazard Map

1003 Carbon Canyon Road, Chino Hills, California

Project No.: 25-210-003bEG

FIGURE 2



Map modified from "Historically Highest Ground Water Contours and Borehole Log Data Locations, Yorba Linda Quadrangle" by CDMG



**CAL LAND**  
ENGINEERING & ASSOCIATES, Inc.

## Historical Highest Groundwater Level Map

1003 Carbon Canyon Road, Chino Hills, California

Project No.: 25-210-003bEG

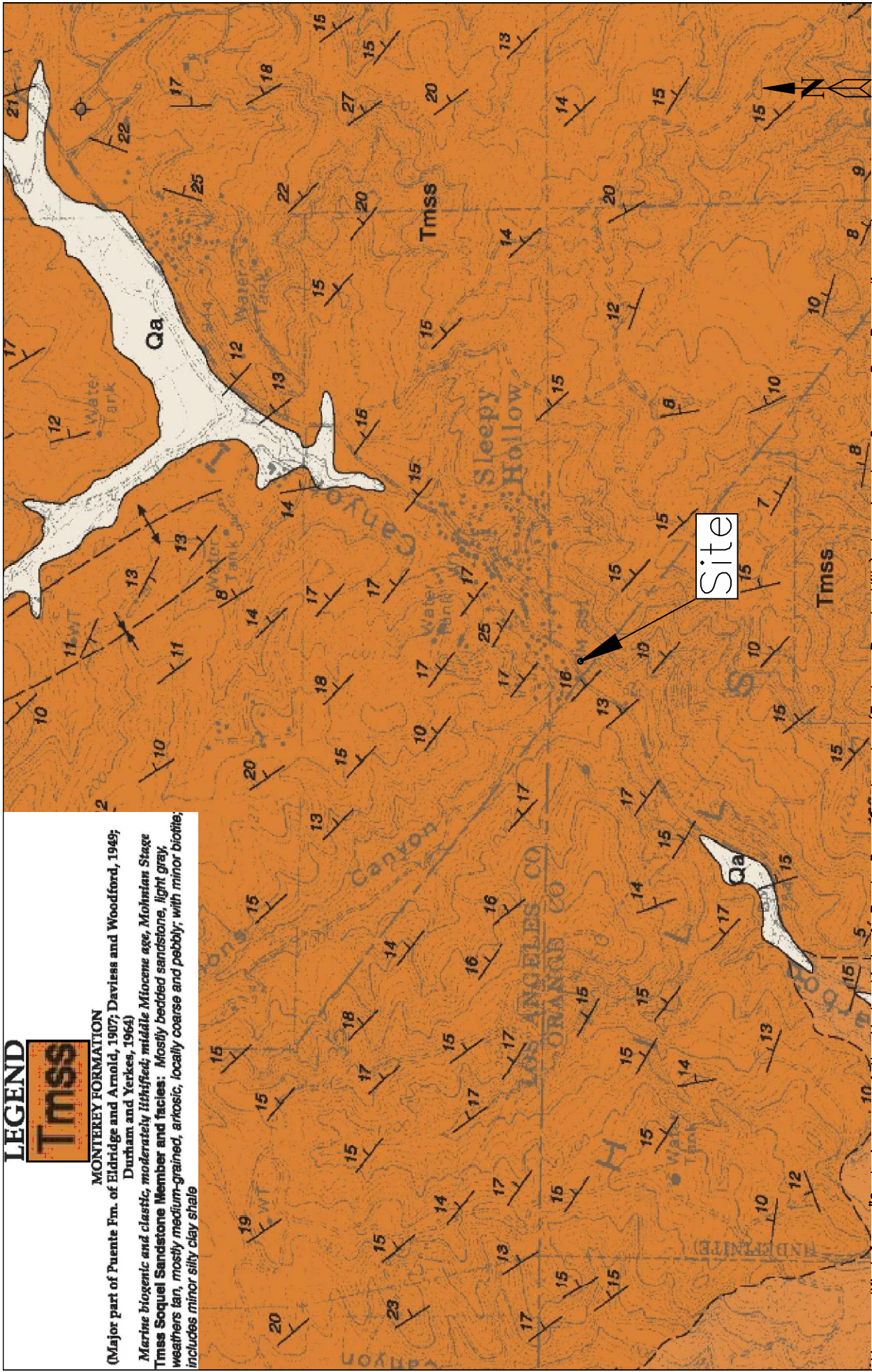
FIGURE 3

# LEGEND



## MONTEREY FORMATION

(Major part of Puente Fm. of Eldridge and Arnold, 1907; Daviss and Woodford, 1949; Durham and Yerkes, 1964)  
 Marine biogenic and clastic, moderately lithified; middle Miocene age, Mohanian Stage  
 Tmss Soquel Sandstone Member and facies: Mostly bedded sandstone, light gray, weathers tan, mostly medium-grained, arkosic, locally coarse and pebbly; with minor biotite, includes minor silty clay shale



Map modified from "Geologic map of the Yorba Linda & Prado Dam Quadrangles (Eastern Puente Hills), Los Angeles, Orange, San Bernardino, and Riverside Counties, California" by Thomas W. Dibblee, Jr., 2001

NOT TO SCALE



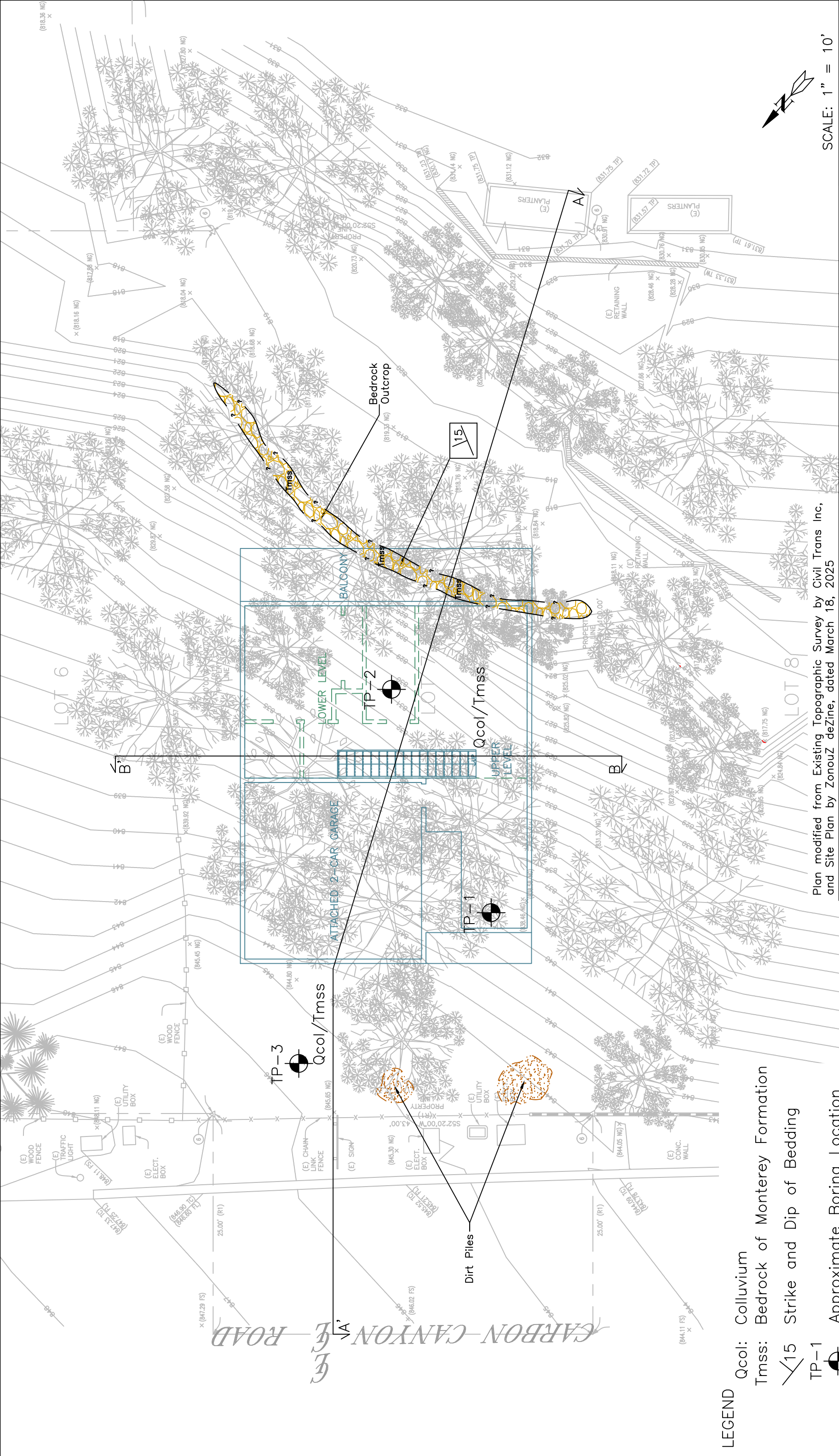
**CAL LAND**  
 ENGINEERING & ASSOCIATES, Inc.

## Regional Geology Map

1003 Carbon Canyon Road, Chino Hills, California

Project No.: 25-210-003bEG

FIGURE 4



LEGEND

- Qcol: Colluvium
- Tmss: Bedrock of Monterey Formation
- $\searrow 15$ : Strike and Dip of Bedding
- TP-1: Approximate Boring Location
- $\text{---} \text{?} \text{---}$ : Geologic Contact
- $\text{---} \text{A} \text{---}$ : Cross Section



SCALE: 1" = 10'

Plan modified from Existing Topographic Survey by Civil Trans Inc.,  
and Site Plan by ZonouZ deZine, dated March 18, 2025

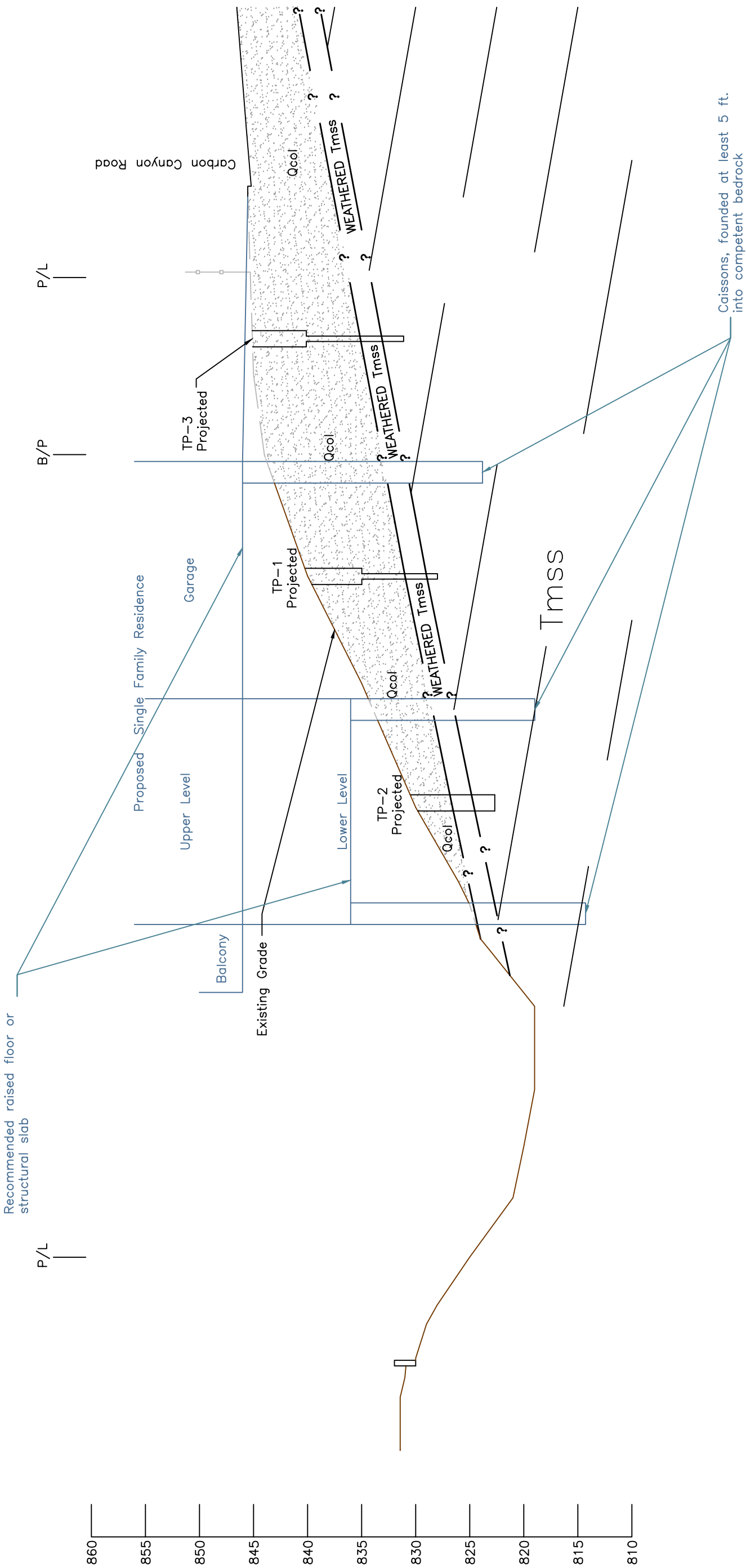


SITE PLAN

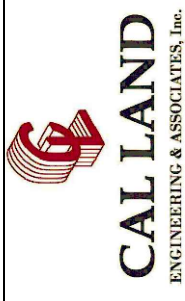
1003 Carbon Canyon Road, Chino Hills, California

Project No.: 25-210-003bEG

PLATE 1



|        |       |                                         |
|--------|-------|-----------------------------------------|
| LEGEND | Qcol: | Colluvium                               |
|        | Tmss: | Bedrock of Monterey Formation           |
|        | TP-1: | Projected Approximate Test Pit Location |
| BP:    |       | Breakpoint on Cross Section             |



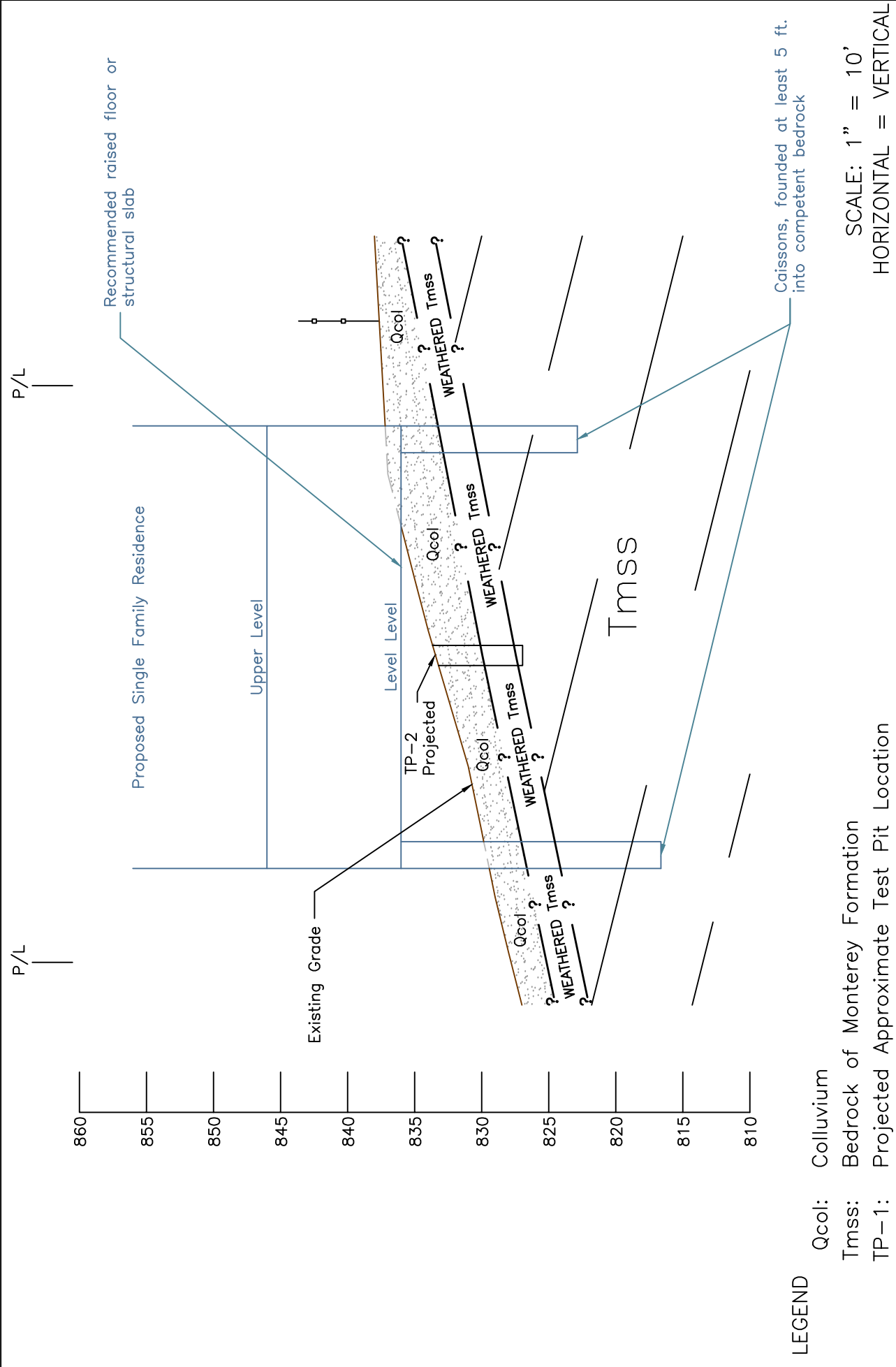
CROSS SECTION A--A'

1003 Carbon Canyon Road, Chino Hills, California

SCALE: 1" = 10'

HORIZONTAL = VERTICAL

Project No.: 25-210-003bEG



|                                                                                                                                                     |                                                                                          |                                                  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|--------------------------------------------------|
|  <p><b>CAL LAND</b><br/>ENGINEERING &amp; ASSOCIATES, Inc.</p> | <p><b>CROSS-SECTION B-B'</b></p> <p>1003 Carbon Canyon Road, Chino Hills, California</p> | <p>Project No.: 25-210-003bEG</p> <p>PLATE 3</p> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|--------------------------------------------------|

## **APPENDIX A**

### **FIELD INVESTIGATION**

Our subsurface investigation consisted of the excavating, logging, and sampling three (3) hand dug test pits to a maximum depth of 14.0 feet below the existing grade. The approximate locations of the borings are shown on the attached Site Plan (Plate 1). Upon completion of excavations, the test pits were backfilled with onsite soils that were removed from the excavations.

The excavation of the test pits was supervised by a CLE engineering geologist, who continuously logged the borings and visually classified the soils in accordance with the Unified Soil Classification System (USCS). Ring samples were taken at frequent intervals. These samples were obtained via hand sampler.

Representative undisturbed samples of the subsurface soils were retained in a series of brass rings, each having an inside diameter of 2.42 inches and a height of 1.00 inch. All ring samples were transported to our laboratory. Bulk surface soil samples were also collected for additional classification and testing.

**Calland Engineering and  
Associates, Inc.**

**TEST PIT LOG TP-1**

PROJECT LOCATION: 1003 Carbon Canyon Road, Chino Hills, California

DATE DRILLED: 3/26/2025

PROJECT NO.: 25-210-003bEG

SAMPLE METHOD: Hand Sampler

ELEVATION: N/A

LOGGED BY: FA

| Depth (ft) | Sample |             |          | USCS Symbol | Dry Unit Wt.<br>(pcf) | Moisture (%) | Description of Material                                                                                                                                                                                                                                                                             |
|------------|--------|-------------|----------|-------------|-----------------------|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|            | Bulk   | Undisturbed | Blows/6" |             |                       |              |                                                                                                                                                                                                                                                                                                     |
| 0          | B      |             |          | CL          |                       | 17.3         | <b>@0'-9', Colluvium (Qcol):</b><br>@0'-2', Sandy clay, dark brown, very moist, soft (upper 12") to firm, rooted<br>@2'-4', color changes to tank brown, moist, stiff, rooted<br>Percent of Fines: 62.0; LL=36, PL=24, PI=12<br>@4', Sandy clay, dark brown, slightly moist, stiff, slightly rooted |
| 2          |        |             |          |             |                       |              |                                                                                                                                                                                                                                                                                                     |
| 5          |        | R           |          | CL          | 95.2                  | 9.5          |                                                                                                                                                                                                                                                                                                     |
| 10         |        |             |          |             |                       |              | <b>@9', Bedrock of Monterey Formation (Tmss):</b><br>Sandstone, yellowish brown, moist, firm, weathered<br>@11', becomes dense, less weathered                                                                                                                                                      |
| 15         |        |             |          |             |                       |              | Total Depth: 12.0 feet<br>From 5 feet to 12 feet, hand auger only<br>No Groundwater<br>Pit Backfilled                                                                                                                                                                                               |
| 20         |        |             |          |             |                       |              |                                                                                                                                                                                                                                                                                                     |
| 25         |        |             |          |             |                       |              |                                                                                                                                                                                                                                                                                                     |
| 30         |        |             |          |             |                       |              |                                                                                                                                                                                                                                                                                                     |
| 35         |        |             |          |             |                       |              |                                                                                                                                                                                                                                                                                                     |

**Calland Engineering and  
Associates, Inc.**

**TEST PIT LOG TP-2**

PROJECT LOCATION: 1003 Carbon Canyon Road, Chino Hills, California

DATE DRILLED: 3/26/2025

PROJECT NO.: 25-210-003bEG

SAMPLE METHOD: Hand Sampler

ELEVATION: N/A

LOGGED BY: FA

| Depth (ft) | Sample |             |          | USCS Symbol | Dry Unit Wt.<br>(pcf) | Moisture (%) | Description of Material                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------|--------|-------------|----------|-------------|-----------------------|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|            | Bulk   | Undisturbed | Blows/6" |             |                       |              |                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 0          |        |             |          | CL          |                       |              | <b>@0'-3.5', Colluvium (Qcol):</b><br>@0'-2', Sandy clay, dark brown, very moist, soft (upper 12") to firm, rooted<br>@2', Silty sand, tan brown, slightly moist, medium dense, slightly rooted<br><b>@3.5', Bedrock of Monterey Formation (Tmss):</b><br>Sandstone, grayish tan brown, slightly moist, fine to medium grained, friable<br>massive, weathered; Percent of Fines: 29.2<br>@5.5', becomes less weathered, moderately hard, massive |
| 2          |        | R           |          | SM          | 98.8                  | 3.7          |                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 5          | B      | R           |          |             | 103.5                 | 5.4          |                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 10         |        |             |          |             |                       |              | Total Depth: 6.5 feet<br>No Groundwater<br>Pit Backfilled                                                                                                                                                                                                                                                                                                                                                                                        |
| 15         |        |             |          |             |                       |              |                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 20         |        |             |          |             |                       |              |                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 25         |        |             |          |             |                       |              |                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 30         |        |             |          |             |                       |              |                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 35         |        |             |          |             |                       |              |                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

**Calland Engineering and  
Associates, Inc.**

**TEST PIT LOG TP-3**

PROJECT LOCATION: 1003 Carbon Canyon Road, Chino Hills, California

DATE DRILLED: 3/26/2025

PROJECT NO.: 25-210-003bEG

SAMPLE METHOD: Hand Sampler

ELEVATION: N/A

LOGGED BY: FA

| Depth (ft) | Sample |             |          | USCS Symbol | Dry Unit Wt.<br>(pcf) | Moisture (%) | Description of Material                                                                                                                                                                                                                                                                                                 |
|------------|--------|-------------|----------|-------------|-----------------------|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|            | Bulk   | Undisturbed | Blows/6" |             |                       |              |                                                                                                                                                                                                                                                                                                                         |
| 0          |        |             |          | CL/         |                       |              | <b>@0'-10', Colluvium (Qcol):</b><br>@0'-2.5', Sandy clay to clayey sand, dark brown, very moist, firm to medium dense, slightly rooted<br>@2.5'-3.5', Clayey sand, tan brown, moist, medium dense<br>@3.5'-7', Sandy clay, dark brown, moist, very stiff<br><br>@7'-10', Silty sand, orange brown, moist, medium dense |
| 2          |        |             |          | SC          |                       |              |                                                                                                                                                                                                                                                                                                                         |
| 5          |        |             |          | CL          | 110.2                 | 10.8         |                                                                                                                                                                                                                                                                                                                         |
|            |        |             |          | SM          |                       |              |                                                                                                                                                                                                                                                                                                                         |
| 10         | B      |             |          |             | 102.9                 | 10.1         | <b>@10', Bedrock of Monterey Formation (Tmss):</b><br>Sandstone, fine grained, yellowish tan brown, moist, moderately hard<br>Percent of Fines: 22.8<br>@12', becomes hard, less weathered                                                                                                                              |
| 15         |        |             |          |             |                       |              |                                                                                                                                                                                                                                                                                                                         |
| 20         |        |             |          |             |                       |              | Total Depth: 14.0 feet<br>From 5 feet to 14 feet, hand auger only<br>No Groundwater<br>Pit Backfilled                                                                                                                                                                                                                   |
| 25         |        |             |          |             |                       |              |                                                                                                                                                                                                                                                                                                                         |
| 30         |        |             |          |             |                       |              |                                                                                                                                                                                                                                                                                                                         |
| 35         |        |             |          |             |                       |              |                                                                                                                                                                                                                                                                                                                         |

## **APPENDIX B**

### **LABORATORY TESTING**

During the subsurface exploration, CLE personnel collected relatively undisturbed ring samples and bulk samples. The following tests were performed on selected soil samples:

#### **Moisture-Density**

The moisture content and dry unit weight were determined for each relatively undisturbed soil sample obtained in the test pits in accordance with ASTM D2937 standard. The results of these tests are shown on the test pit logs in the attached Appendix A.

#### **Shear Tests**

Shear tests were performed in a direct shear machine of strain-control type in accordance with ASTM D3080 standard. The rate of deformation was 0.010 inch per minute. Selected samples were sheared under varying confining loads in order to determine the Mohr-Coulomb shear strength parameters: internal friction angle and cohesion. The shear test results are presented in the attached Figures.

#### **Consolidation Tests**

Consolidation tests were performed on selected undisturbed soil samples in accordance with ASTM D2435 standard. The consolidation apparatus is designed for a one-inch-high soil filled brass ring. Loads are applied in several increments in a geometric progression and the resulting deformations are recorded at selected time intervals. Porous stones are placed in contact with the top and bottom of each specimen to permit addition and release of pore fluid. The samples were inundated with water at a load of two kilo-pounds (kips) per square foot and the test results are shown on the attached Figures.

#### **Expansion Index**

Expansion Index tests were conducted on the existing onsite near surface materials sampled during CLE's field investigation. These tests are performed in accordance with ASTM D4829. The testing results are presented below:

| Sample Location | Expansion Index | Expansion Potential |
|-----------------|-----------------|---------------------|
| TP-1 @ 0' – 4'  | 91              | High                |

### Corrosion Potential

Chemical laboratory tests were conducted on the existing onsite near surface materials sampled during CLE's field investigation to aid in evaluation of soil corrosion potential and the attack on concrete by sulfate soils. These tests are performed in accordance with California Test Method 417, 422, 532, and 643. The testing results are presented below:

| Sample Location  | pH   | Chloride (ppm) | Sulfate (% by weight) | Min. Resistivity (ohm-cm) |
|------------------|------|----------------|-----------------------|---------------------------|
| TP-1 @ 0' – 4'   | 7.68 | 130            | 0.0020                | 1,000                     |
| TP-3 @ 10' – 12' | 7.94 | 360            | 0.0470                | 870                       |

### Percent Passing the #200 Sieve

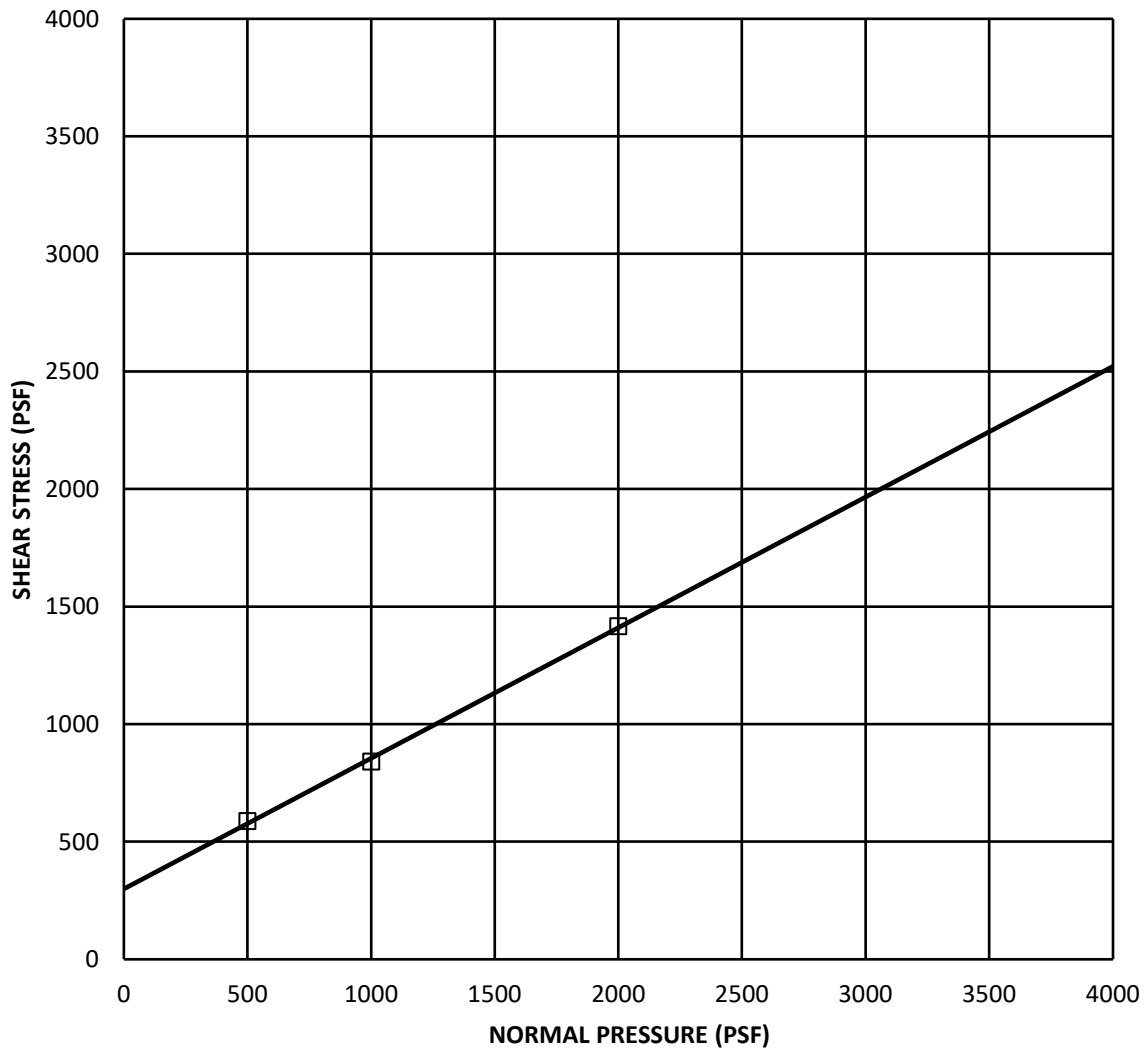
Percent of soil passing the #200 sieve was determined for selected soil samples in accordance with ASTM D1140 standard. The test results are presented in the following table:

| Sample Location  | % Passing #200 |
|------------------|----------------|
| TP-1 @ 0' – 4'   | 62.0           |
| TP-2 @ 3.5' – 5' | 29.2           |
| TP-3 @ 10' – 12' | 22.8           |

### Atterberg Limits

Laboratory Atterberg Limits tests were conducted on the existing onsite materials sampled during CLE's field investigation to aid in evaluation of soil liquefaction potential. These tests are performed in accordance with ASTM D4318. The testing results are presented below:

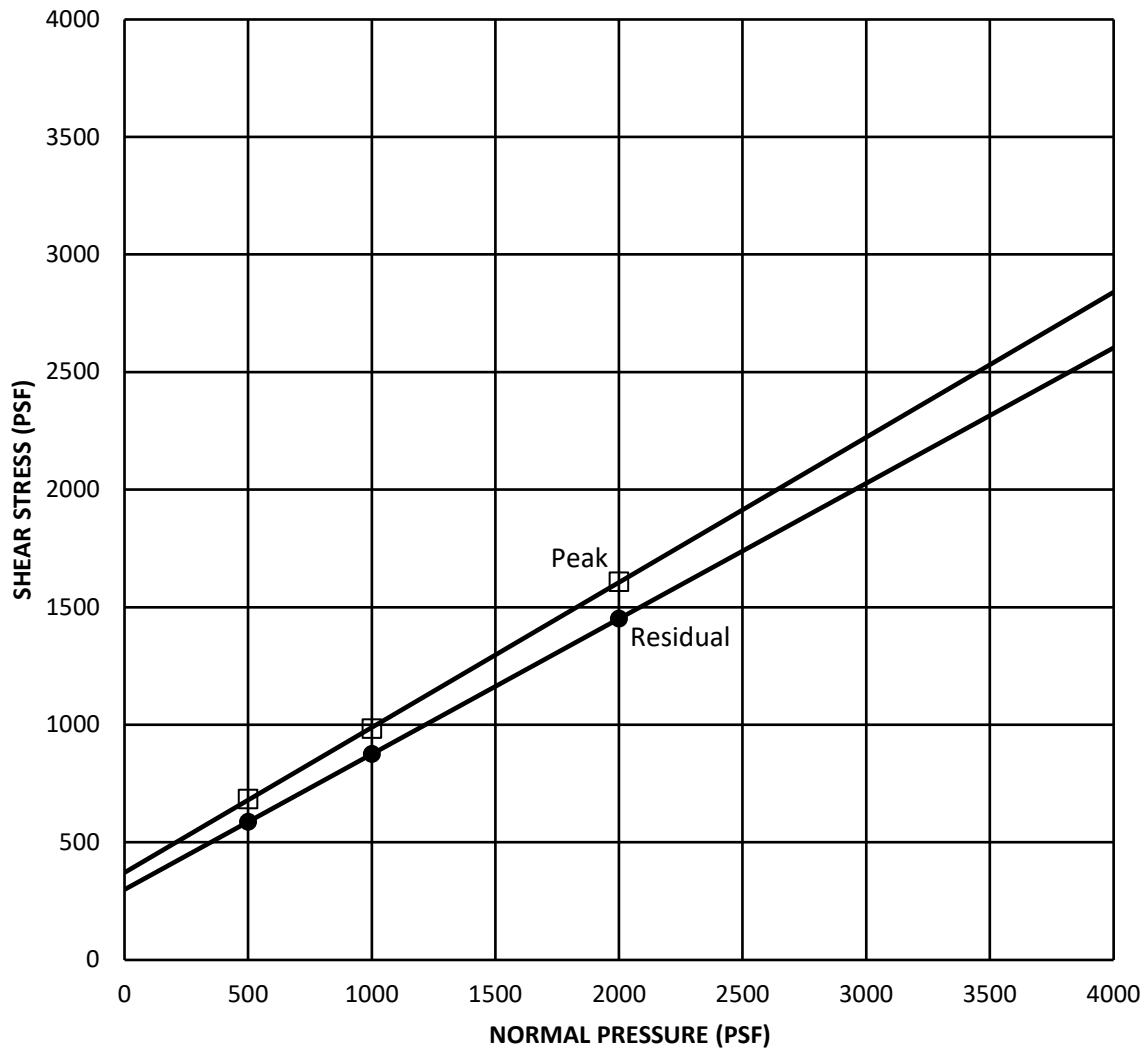
| Sample Location | USCS Class.<br>ASTM D2488 | Liquid Limit (%)<br>ASTM D4318 | Plastic Limit (%)<br>ASTM D4318 | Plasticity Index<br>ASTM D4318 |
|-----------------|---------------------------|--------------------------------|---------------------------------|--------------------------------|
| TP-1 @ 0' – 4'  | CL                        | 36                             | 24                              | 12                             |



| SYMBOL | TEST PIT NO. | SAMPLE NO. | DEPTH (FT) | SAMPLE TYPE | SOIL TYPE | COHESION (PSF) | FRICTION ANGLE (DEG) |
|--------|--------------|------------|------------|-------------|-----------|----------------|----------------------|
| □      | TP-3         | N/A        | 4.0        | RING        | CL        | 300            | 29                   |

| Vertical Loads (PSF) | Moisture Content Before Test (%) | Moisture Content After Test (%) |
|----------------------|----------------------------------|---------------------------------|
| 500                  | 10.8                             | 19.3                            |
| 1,000                | 10.8                             | 18.9                            |
| 2,000                | 10.8                             | 18.6                            |

|                                                                                                                       |                                                                                             |
|-----------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| <b>Calland Engineering and Associates, Inc.</b><br>Land Surveying, Geotechnical,<br>Environmental & Civil Engineering | Project Address:<br>APN: 1000-143-04<br>1003 Carbon Canyon Road,<br>Chino Hills, California |
|                                                                                                                       | <b>DIRECT SHEAR</b><br>(ASTM D3080)                                                         |



| SYMBOL | TEST PIT NO. | SAMPLE NO. | DEPTH (FT) | SAMPLE TYPE | SOIL TYPE | COHESION (PSF) | FRICTION ANGLE (DEG) |
|--------|--------------|------------|------------|-------------|-----------|----------------|----------------------|
| □      | TP-3         | N/A        | 12.0       | RING        | Sandstone | 370            | 32                   |
| ●      |              |            |            |             | (Tmss)    | 300            | 30                   |

| Vertical Loads (PSF) | Moisture Content Before Test (%) | Moisture Content After Test (%) |
|----------------------|----------------------------------|---------------------------------|
| 500                  | 10.1                             | 23.3                            |
| 1,000                | 10.1                             | 22.8                            |
| 2,000                | 10.1                             | 22.4                            |

**Calland Engineering and Associates, Inc.**

Land Surveying, Geotechnical,  
Environmental & Civil Engineering

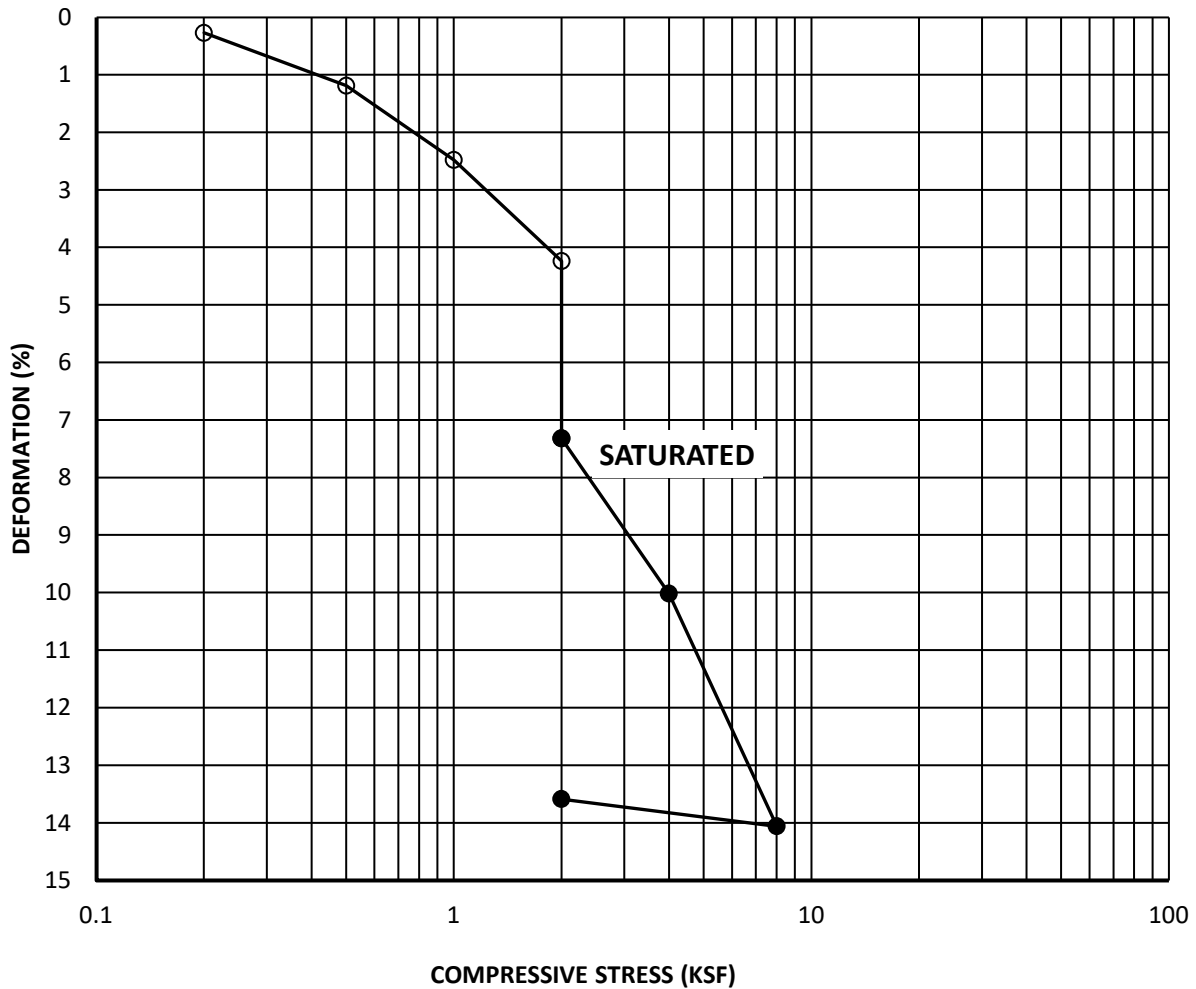
Project Address:

APN: 1000-143-04

1003 Carbon Canyon Road,  
Chino Hills, California

**DIRECT SHEAR**

(ASTM D3080)



| SYMBOL | TEST PIT NO. | SAMPLE NO. | DEPTH (FT) | SOIL TYPE | INIT. MOISTURE CONTENT (%) | INIT. DRY DENSITY (PCF) | INIT. VOID RATIO |
|--------|--------------|------------|------------|-----------|----------------------------|-------------------------|------------------|
| ○      | TP-1         | N/A        | 4          | CL        | 9.5                        | 95.2                    | 0.770            |

**CalLand Engineering  
and Associates, Inc.**

Land Surveying, Geotechnical,  
Environmental & Civil Engineering

Project Address:

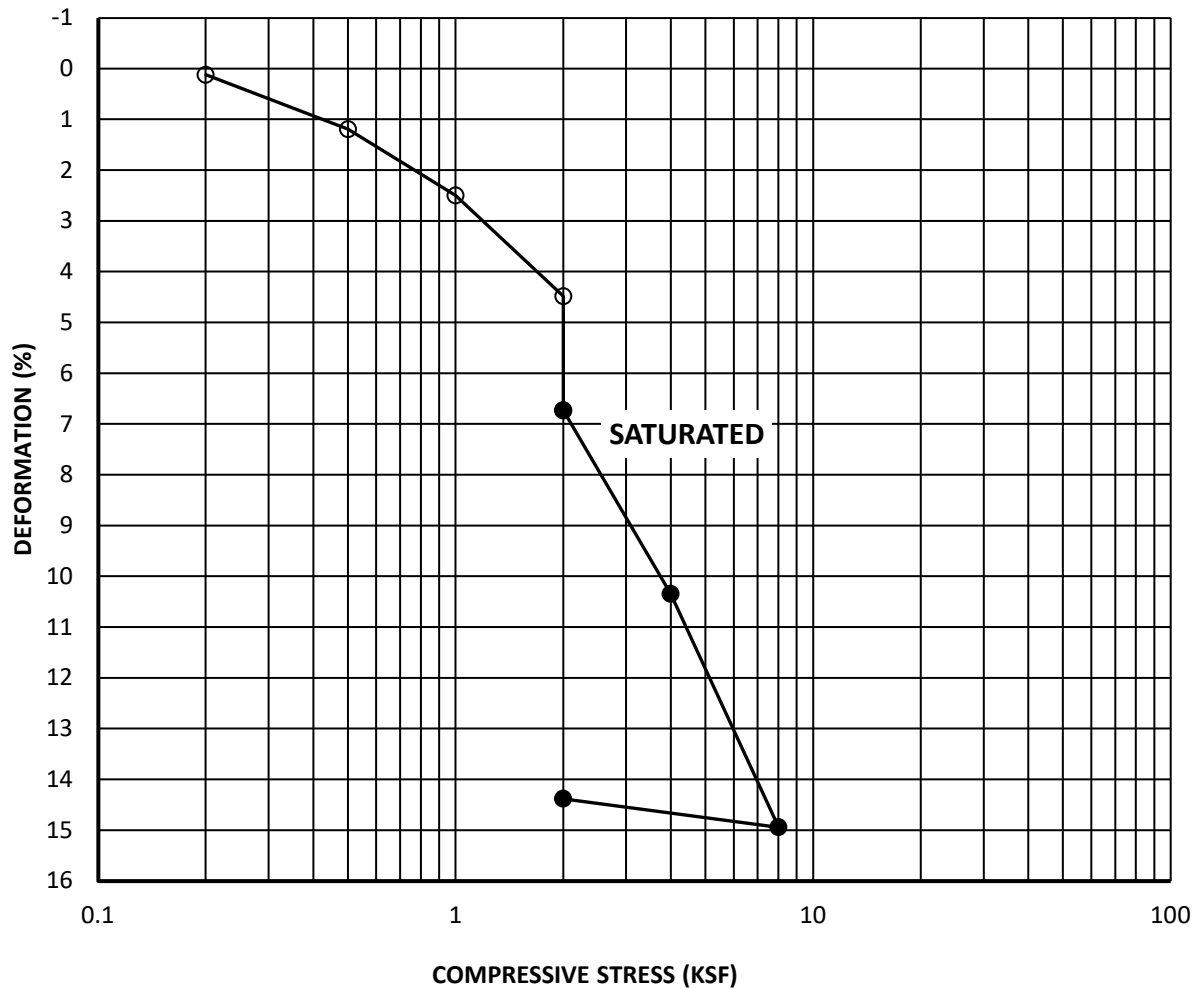
APN: 1000-143-04  
1003 Carbon Canyon Road,  
Chino Hills, California

## CONSOLIDATION

(ASTM D2435)

04/25

FIGURE 7



| SYMBOL | TEST PIT NO. | SAMPLE NO. | DEPTH (FT) | SOIL TYPE | INIT. MOISTURE CONTENT (%) | INIT. DRY DENSITY (PCF) | INIT. VOID RATIO |
|--------|--------------|------------|------------|-----------|----------------------------|-------------------------|------------------|
| ○      | TP-3         | N/A        | 4          | CL        | 10.8                       | 110.2                   | 0.529            |

**Calland Engineering  
and Associates, Inc.**

Land Surveying, Geotechnical,  
Environmental & Civil Engineering

Project Address:

APN: 1000-143-04

1003 Carbon Canyon Road,  
Chino Hills, California

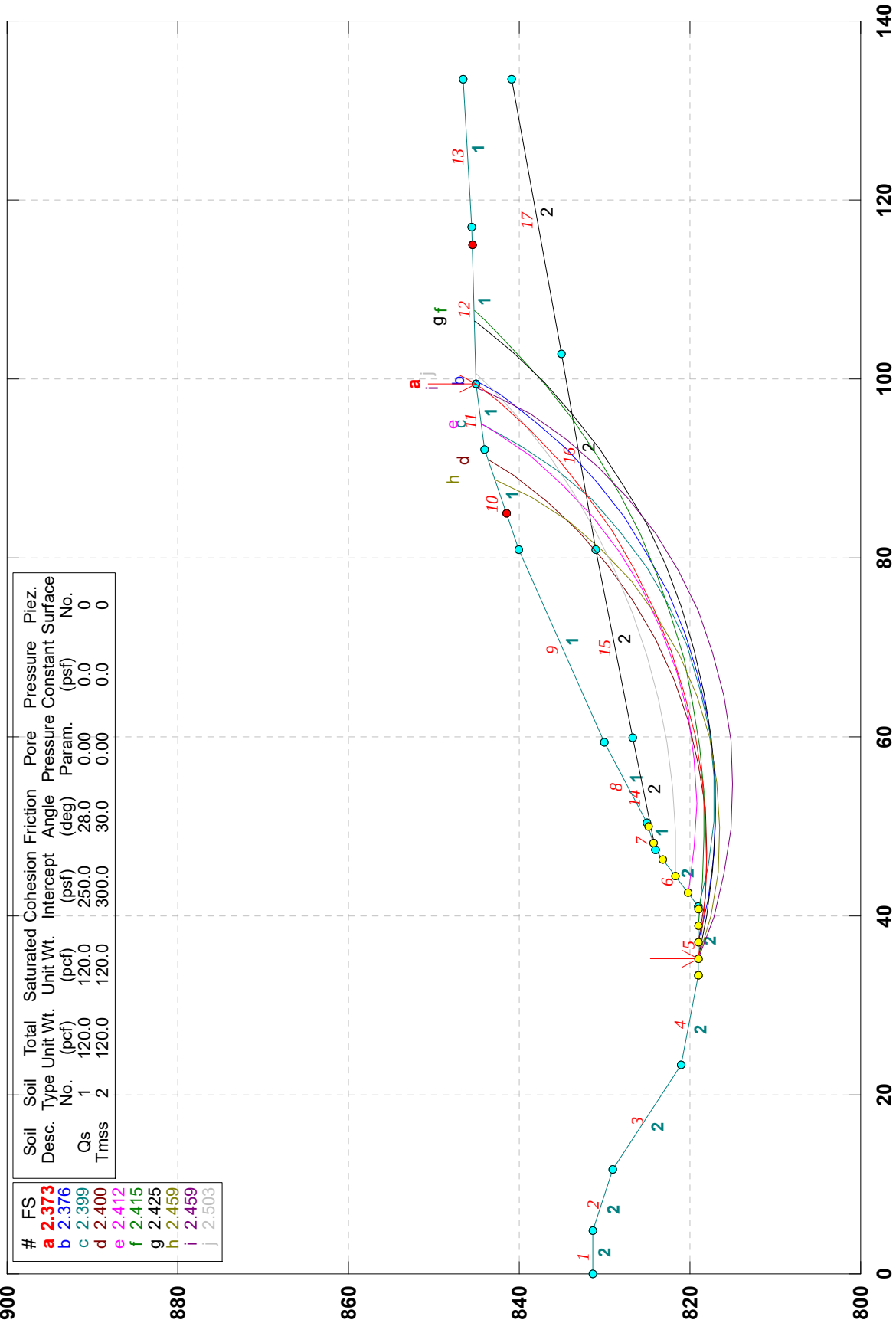
## CONSOLIDATION

(ASTM D2435)

**APPENDIX C**  
**RESULTS OF SLOPE STABILITY ANALYSES**

1003 Carbon Canyon Rd, Chino Hills, Sec A-A', Gross, Static

y:\soil reports\reports 25\chino hills\1003 carbon canyon rd\slope stability\la-a' 1003 carbon canyon rd, chino hills.pl2 Run By: Calland Engineering&Associates, Inc 4/7/2025 03:54PM



GSTABL7 v.2 FSmin=2.373  
Safety Factors Are Calculated By The Modified Bishop Method

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*** GSTABL7 ***
** GSTABL7 by Dr. Garry H. Gregory, Ph.D., P.E., D.GE **
** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **
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*****
SLOPE STABILITY ANALYSIS SYSTEM
Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*****
Analysis Run Date:      4/7/2025
Time of Run:           03:54PM
Run By:                CalLand Engineering&Associates, Inc
Input Data Filename:   Y:\SOIL REPORTS\REPORTS 25\Chino Hills\1003 Carbon Canyon Rd\Slope
Stability\A-A' 1003 Carbon Canyon Rd, Chino Hills.in
Output Filename:       Y:\SOIL REPORTS\REPORTS 25\Chino Hills\1003 Carbon Canyon Rd\Slope
Stability\A-A' 1003 Carbon Canyon Rd, Chino Hills.OUT
Unit System:          English
Plotted Output Filename: Y:\SOIL REPORTS\REPORTS 25\Chino Hills\1003 Carbon Canyon Rd\Slope
Stability\A-A' 1003 Carbon Canyon Rd, Chino Hills.PLT
PROBLEM DESCRIPTION:  1003 Carbon Canyon Rd, Chino Hills, Sec
                      A-A', Gross, Static

BOUNDARY COORDINATES
  13 Top Boundaries
  17 Total Boundaries
Boundary   X-Left   Y-Left   X-Right   Y-Right   Soil Type
No.        (ft)      (ft)      (ft)      (ft)      Below Bnd
  1         0.00     831.43     4.92     831.43     2
  2         4.92     831.43    11.69     829.00     2
  3        11.69     829.00    23.38     821.00     2
  4        23.38     821.00    33.37     819.00     2
  5        33.37     819.00    41.09     819.00     2
  6        41.09     819.00    47.33     824.00     2
  7        47.33     824.00    50.48     825.00     1
  8        50.48     825.00    59.49     830.00     1
  9        59.49     830.00    80.89     840.00     1
 10        80.89     840.00    92.12     844.00     1
 11        92.12     844.00    99.50     845.00     1
 12        99.50     845.00   116.96     845.52     1
 13       116.96     845.52   133.51     846.51     1
 14        47.32     824.00    59.91     826.68     2
 15        59.91     826.68    80.86     830.98     2
 16        80.86     830.98   102.84     835.11     2
 17       102.84     835.11   133.51     840.86     2
User Specified Y-Origin =      800.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
  2 Type(s) of Soil
Soil Total Saturated Cohesion Friction Pore Pressure Piez.
Type Unit Wt. Unit Wt. Intercept Angle Pressure Constant Surface
No. (pcf) (pcf) (psf) (deg) Param. (psf) No.
  1 120.0 120.0 250.0 28.0 0.00 0.0 0
  2 120.0 120.0 300.0 30.0 0.00 0.0 0
Specified Peak Ground Acceleration Coefficient (A) = 0.680(g)
Specified Horizontal Earthquake Coefficient (kh) = 0.150(g)
Specified Vertical Earthquake Coefficient (kv) = 0.000(g)
Specified Seismic Pore-Pressure Factor = 0.000
EARTHQUAKE DATA HAS BEEN SUPPRESSED
A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
  100 Trial Surfaces Have Been Generated.
  10 Surface(s) Initiate(s) From Each Of 10 Points Equally Spaced
Along The Ground Surface Between X = 33.37(ft)

```

and X = 50.00(ft)  
 Each Surface Terminates Between X = 85.00(ft)  
 and X = 115.00(ft)  
 Unless Further Limitations Were Imposed, The Minimum Elevation  
 At Which A Surface Extends Is Y = 0.00(ft)  
 5.00(ft) Line Segments Define Each Trial Failure Surface.  
 Following Are Displayed The Ten Most Critical Of The Trial

Failure Surfaces Evaluated. They Are  
 Ordered - Most Critical First.

\* \* Safety Factors Are Calculated By The Modified Bishop Method \* \*

Total Number of Trial Surfaces Attempted = 100

Number of Trial Surfaces With Valid FS = 100

Statistical Data On All Valid FS Values:

FS Max = 4.133 FS Min = 2.373 FS Ave = 3.068

Standard Deviation = 0.462 Coefficient of Variation = 15.06 %

Failure Surface Specified By 16 Coordinate Points

| Point<br>No. | X-Surf<br>(ft) | Y-Surf<br>(ft) |
|--------------|----------------|----------------|
| 1            | 35.218         | 819.000        |
| 2            | 40.172         | 818.324        |
| 3            | 45.163         | 818.028        |
| 4            | 50.162         | 818.114        |
| 5            | 55.141         | 818.582        |
| 6            | 60.068         | 819.427        |
| 7            | 64.918         | 820.647        |
| 8            | 69.659         | 822.233        |
| 9            | 74.266         | 824.176        |
| 10           | 78.712         | 826.465        |
| 11           | 82.969         | 829.086        |
| 12           | 87.015         | 832.025        |
| 13           | 90.824         | 835.264        |
| 14           | 94.375         | 838.784        |
| 15           | 97.646         | 842.565        |
| 16           | 99.442         | 844.992        |

Circle Center At X = 46.552 ; Y = 883.338 ; and Radius = 65.329

Factor of Safety

\*\*\* 2.373 \*\*\*

Individual data on the 25 slices

| Slice<br>No. | Width<br>(ft) | Weight<br>(lbs) | Water                 |                       | Tie<br>Force<br>Norm<br>(lbs) | Tie<br>Force<br>Tan<br>(lbs) | Earthquake            |                       | Surcharge<br>Load<br>(lbs) |
|--------------|---------------|-----------------|-----------------------|-----------------------|-------------------------------|------------------------------|-----------------------|-----------------------|----------------------------|
|              |               |                 | Force<br>Top<br>(lbs) | Force<br>Bot<br>(lbs) |                               |                              | Force<br>Hor<br>(lbs) | Force<br>Ver<br>(lbs) |                            |
| 1            | 5.0           | 200.9           | 0.0                   | 0.0                   | 0.                            | 0.                           | 0.0                   | 0.0                   | 0.0                        |
| 2            | 0.9           | 77.5            | 0.0                   | 0.0                   | 0.                            | 0.                           | 0.0                   | 0.0                   | 0.0                        |
| 3            | 4.1           | 1213.5          | 0.0                   | 0.0                   | 0.                            | 0.                           | 0.0                   | 0.0                   | 0.0                        |
| 4            | 2.2           | 1315.0          | 0.0                   | 0.0                   | 0.                            | 0.                           | 0.0                   | 0.0                   | 0.0                        |
| 5            | 0.0           | 7.1             | 0.0                   | 0.0                   | 0.                            | 0.                           | 0.0                   | 0.0                   | 0.0                        |
| 6            | 2.8           | 2161.5          | 0.0                   | 0.0                   | 0.                            | 0.                           | 0.0                   | 0.0                   | 0.0                        |
| 7            | 0.3           | 259.9           | 0.0                   | 0.0                   | 0.                            | 0.                           | 0.0                   | 0.0                   | 0.0                        |
| 8            | 4.7           | 4435.1          | 0.0                   | 0.0                   | 0.                            | 0.                           | 0.0                   | 0.0                   | 0.0                        |
| 9            | 4.3           | 5135.0          | 0.0                   | 0.0                   | 0.                            | 0.                           | 0.0                   | 0.0                   | 0.0                        |
| 10           | 0.4           | 541.0           | 0.0                   | 0.0                   | 0.                            | 0.                           | 0.0                   | 0.0                   | 0.0                        |
| 11           | 0.2           | 205.8           | 0.0                   | 0.0                   | 0.                            | 0.                           | 0.0                   | 0.0                   | 0.0                        |
| 12           | 4.8           | 6613.8          | 0.0                   | 0.0                   | 0.                            | 0.                           | 0.0                   | 0.0                   | 0.0                        |
| 13           | 4.7           | 6944.6          | 0.0                   | 0.0                   | 0.                            | 0.                           | 0.0                   | 0.0                   | 0.0                        |
| 14           | 4.6           | 6979.2          | 0.0                   | 0.0                   | 0.                            | 0.                           | 0.0                   | 0.0                   | 0.0                        |
| 15           | 4.4           | 6733.8          | 0.0                   | 0.0                   | 0.                            | 0.                           | 0.0                   | 0.0                   | 0.0                        |
| 16           | 2.1           | 3185.9          | 0.0                   | 0.0                   | 0.                            | 0.                           | 0.0                   | 0.0                   | 0.0                        |
| 17           | 0.0           | 43.9            | 0.0                   | 0.0                   | 0.                            | 0.                           | 0.0                   | 0.0                   | 0.0                        |
| 18           | 2.1           | 2975.4          | 0.0                   | 0.0                   | 0.                            | 0.                           | 0.0                   | 0.0                   | 0.0                        |
| 19           | 4.0           | 5293.8          | 0.0                   | 0.0                   | 0.                            | 0.                           | 0.0                   | 0.0                   | 0.0                        |
| 20           | 0.2           | 204.4           | 0.0                   | 0.0                   | 0.                            | 0.                           | 0.0                   | 0.0                   | 0.0                        |
| 21           | 3.6           | 4008.0          | 0.0                   | 0.0                   | 0.                            | 0.                           | 0.0                   | 0.0                   | 0.0                        |
| 22           | 1.3           | 1223.1          | 0.0                   | 0.0                   | 0.                            | 0.                           | 0.0                   | 0.0                   | 0.0                        |
| 23           | 2.3           | 1754.9          | 0.0                   | 0.0                   | 0.                            | 0.                           | 0.0                   | 0.0                   | 0.0                        |
| 24           | 3.3           | 1512.7          | 0.0                   | 0.0                   | 0.                            | 0.                           | 0.0                   | 0.0                   | 0.0                        |
| 25           | 1.8           | 235.4           | 0.0                   | 0.0                   | 0.                            | 0.                           | 0.0                   | 0.0                   | 0.0                        |

## Failure Surface Specified By 16 Coordinate Points

| Point<br>No. | X-Surf<br>(ft) | Y-Surf<br>(ft) |
|--------------|----------------|----------------|
| 1            | 37.066         | 819.000        |
| 2            | 41.938         | 817.878        |
| 3            | 46.892         | 817.203        |
| 4            | 51.887         | 816.978        |
| 5            | 56.882         | 817.207        |
| 6            | 61.836         | 817.887        |
| 7            | 66.707         | 819.013        |
| 8            | 71.457         | 820.576        |
| 9            | 76.045         | 822.562        |
| 10           | 80.435         | 824.955        |
| 11           | 84.590         | 827.736        |
| 12           | 88.477         | 830.882        |
| 13           | 92.062         | 834.367        |
| 14           | 95.317         | 838.162        |
| 15           | 98.216         | 842.237        |
| 16           | 99.832         | 845.010        |

Circle Center At X = 51.868 ; Y = 872.016 ; and Radius = 55.044

Factor of Safety

\*\*\* 2.376 \*\*\*

## Failure Surface Specified By 15 Coordinate Points

| Point<br>No. | X-Surf<br>(ft) | Y-Surf<br>(ft) |
|--------------|----------------|----------------|
| 1            | 40.761         | 819.000        |
| 2            | 45.630         | 817.862        |
| 3            | 50.595         | 817.269        |
| 4            | 55.595         | 817.229        |
| 5            | 60.568         | 817.742        |
| 6            | 65.455         | 818.801        |
| 7            | 70.194         | 820.393        |
| 8            | 74.729         | 822.500        |
| 9            | 79.003         | 825.095        |
| 10           | 82.964         | 828.147        |
| 11           | 86.563         | 831.617        |
| 12           | 89.757         | 835.464        |
| 13           | 92.506         | 839.641        |
| 14           | 94.776         | 844.095        |
| 15           | 94.881         | 844.374        |

Circle Center At X = 53.459 ; Y = 862.348 ; and Radius = 45.170

Factor of Safety

\*\*\* 2.399 \*\*\*

## Failure Surface Specified By 14 Coordinate Points

| Point<br>No. | X-Surf<br>(ft) | Y-Surf<br>(ft) |
|--------------|----------------|----------------|
| 1            | 37.066         | 819.000        |
| 2            | 42.011         | 818.263        |
| 3            | 47.005         | 818.017        |
| 4            | 51.999         | 818.265        |
| 5            | 56.944         | 819.005        |
| 6            | 61.791         | 820.229        |
| 7            | 66.495         | 821.926        |
| 8            | 71.008         | 824.078        |
| 9            | 75.286         | 826.665        |
| 10           | 79.289         | 829.662        |
| 11           | 82.976         | 833.039        |
| 12           | 86.312         | 836.763        |
| 13           | 89.264         | 840.799        |
| 14           | 90.894         | 843.563        |

Circle Center At X = 47.007 ; Y = 868.476 ; and Radius = 50.465

Factor of Safety

\*\*\* 2.400 \*\*\*

## Failure Surface Specified By 14 Coordinate Points

| Point<br>No. | X-Surf<br>(ft) | Y-Surf<br>(ft) |
|--------------|----------------|----------------|
| 1            | 42.609         | 820.217        |

|    |        |         |
|----|--------|---------|
| 2  | 47.552 | 819.463 |
| 3  | 52.546 | 819.219 |
| 4  | 57.539 | 819.488 |
| 5  | 62.477 | 820.267 |
| 6  | 67.311 | 821.548 |
| 7  | 71.987 | 823.317 |
| 8  | 76.458 | 825.556 |
| 9  | 80.676 | 828.240 |
| 10 | 84.597 | 831.343 |
| 11 | 88.179 | 834.831 |
| 12 | 91.386 | 838.668 |
| 13 | 94.182 | 842.812 |
| 14 | 95.028 | 844.394 |

Circle Center At X = 52.439 ; Y = 867.819 ; and Radius = 48.606

Factor of Safety  
\*\*\* 2.412 \*\*\*

Failure Surface Specified By 17 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|-----------|-------------|-------------|
| 1         | 38.913      | 819.000     |
| 2         | 43.886      | 818.476     |
| 3         | 48.882      | 818.279     |
| 4         | 53.880      | 818.409     |
| 5         | 58.859      | 818.866     |
| 6         | 63.798      | 819.648     |
| 7         | 68.675      | 820.751     |
| 8         | 73.469      | 822.171     |
| 9         | 78.159      | 823.902     |
| 10        | 82.727      | 825.937     |
| 11        | 87.151      | 828.265     |
| 12        | 91.414      | 830.879     |
| 13        | 95.497      | 833.766     |
| 14        | 99.381      | 836.913     |
| 15        | 103.052     | 840.309     |
| 16        | 106.492     | 843.937     |
| 17        | 107.576     | 845.241     |

Circle Center At X = 49.395 ; Y = 894.633 ; and Radius = 76.355

Factor of Safety  
\*\*\* 2.415 \*\*\*

Failure Surface Specified By 18 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|-----------|-------------|-------------|
| 1         | 35.218      | 819.000     |
| 2         | 40.108      | 817.956     |
| 3         | 45.062      | 817.280     |
| 4         | 50.052      | 816.973     |
| 5         | 55.052      | 817.039     |
| 6         | 60.033      | 817.476     |
| 7         | 64.967      | 818.283     |
| 8         | 69.828      | 819.454     |
| 9         | 74.588      | 820.984     |
| 10        | 79.221      | 822.864     |
| 11        | 83.702      | 825.083     |
| 12        | 88.005      | 827.629     |
| 13        | 92.107      | 830.489     |
| 14        | 95.984      | 833.645     |
| 15        | 99.616      | 837.081     |
| 16        | 102.983     | 840.778     |
| 17        | 106.065     | 844.716     |
| 18        | 106.393     | 845.205     |

Circle Center At X = 51.674 ; Y = 884.063 ; and Radius = 67.112

Factor of Safety  
\*\*\* 2.425 \*\*\*

Failure Surface Specified By 14 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|-----------|-------------|-------------|
| 1         | 35.218      | 819.000     |

|    |        |         |
|----|--------|---------|
| 2  | 40.010 | 817.572 |
| 3  | 44.936 | 816.720 |
| 4  | 49.929 | 816.456 |
| 5  | 54.919 | 816.784 |
| 6  | 59.834 | 817.699 |
| 7  | 64.607 | 819.188 |
| 8  | 69.171 | 821.231 |
| 9  | 73.462 | 823.798 |
| 10 | 77.419 | 826.854 |
| 11 | 80.987 | 830.357 |
| 12 | 84.117 | 834.256 |
| 13 | 86.764 | 838.498 |
| 14 | 88.794 | 842.815 |

Circle Center At X = 49.659 ; Y = 858.684 ; and Radius = 42.230

Factor of Safety

\*\*\* 2.459 \*\*\*

Failure Surface Specified By 17 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|-----------|-------------|-------------|
| 1         | 35.218      | 819.000     |
| 2         | 39.894      | 817.229     |
| 3         | 44.728      | 815.954     |
| 4         | 49.669      | 815.187     |
| 5         | 54.663      | 814.938     |
| 6         | 59.656      | 815.209     |
| 7         | 64.593      | 815.997     |
| 8         | 69.422      | 817.293     |
| 9         | 74.090      | 819.084     |
| 10        | 78.547      | 821.350     |
| 11        | 82.745      | 824.067     |
| 12        | 86.637      | 827.205     |
| 13        | 90.183      | 830.731     |
| 14        | 93.343      | 834.605     |
| 15        | 96.084      | 838.787     |
| 16        | 98.376      | 843.231     |
| 17        | 99.042      | 844.938     |

Circle Center At X = 54.559 ; Y = 863.013 ; and Radius = 48.075

Factor of Safety

\*\*\* 2.459 \*\*\*

Failure Surface Specified By 14 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|-----------|-------------|-------------|
| 1         | 44.457      | 821.698     |
| 2         | 49.457      | 821.689     |
| 3         | 54.446      | 822.021     |
| 4         | 59.400      | 822.693     |
| 5         | 64.297      | 823.702     |
| 6         | 69.114      | 825.042     |
| 7         | 73.829      | 826.708     |
| 8         | 78.419      | 828.692     |
| 9         | 82.862      | 830.984     |
| 10        | 87.139      | 833.573     |
| 11        | 91.230      | 836.449     |
| 12        | 95.114      | 839.597     |
| 13        | 98.775      | 843.003     |
| 14        | 100.680     | 845.035     |

Circle Center At X = 47.122 ; Y = 894.670 ; and Radius = 73.021

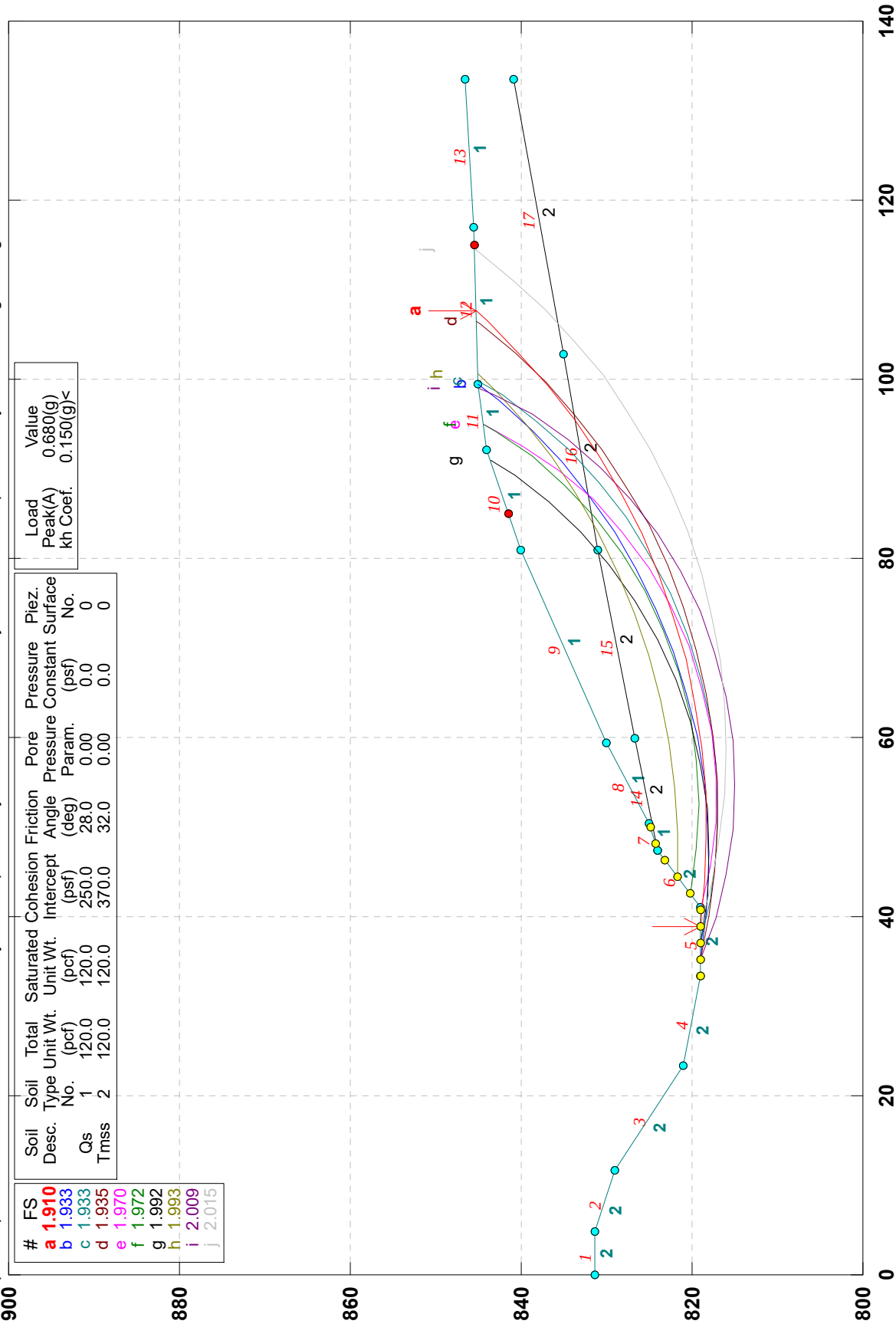
Factor of Safety

\*\*\* 2.503 \*\*\*

\*\*\*\* END OF GSTABL7 OUTPUT \*\*\*\*

1003 Carbon Canyon Rd, Chino Hills, Sec A-A', Gross, Seismic

y:\soil reports\reports 25\chino hills\1003 carbon canyon rd\slope stability\la-a' 1003 carbon canyon rd, chino hills.pl2 Run By: Calland Engineering&Associates, Inc 4/7/2025 03:56PM



GSTABL7 v.2 FSmin=1.910  
Safety Factors Are Calculated By The Modified Bishop Method

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*** GSTABL7 ***
** GSTABL7 by Dr. Garry H. Gregory, Ph.D., P.E., D.GE **
** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **
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*****
SLOPE STABILITY ANALYSIS SYSTEM
Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*****
Analysis Run Date:      4/7/2025
Time of Run:           03:56PM
Run By:                CalLand Engineering&Associates, Inc
Input Data Filename:   Y:\SOIL REPORTS\REPORTS 25\Chino Hills\1003 Carbon Canyon Rd\Slope
Stability\A-A' 1003 Carbon Canyon Rd, Chino Hills.in
Output Filename:       Y:\SOIL REPORTS\REPORTS 25\Chino Hills\1003 Carbon Canyon Rd\Slope
Stability\A-A' 1003 Carbon Canyon Rd, Chino Hills.OUT
Unit System:          English
Plotted Output Filename: Y:\SOIL REPORTS\REPORTS 25\Chino Hills\1003 Carbon Canyon Rd\Slope
Stability\A-A' 1003 Carbon Canyon Rd, Chino Hills.PLT
PROBLEM DESCRIPTION:  1003 Carbon Canyon Rd, Chino Hills, Sec
                      A-A', Gross, Seismic

BOUNDARY COORDINATES
  13 Top Boundaries
  17 Total Boundaries
Boundary   X-Left   Y-Left   X-Right   Y-Right   Soil Type
No.        (ft)      (ft)      (ft)      (ft)      Below Bnd
  1         0.00     831.43     4.92     831.43     2
  2         4.92     831.43    11.69     829.00     2
  3        11.69     829.00    23.38     821.00     2
  4        23.38     821.00    33.37     819.00     2
  5        33.37     819.00    41.09     819.00     2
  6        41.09     819.00    47.33     824.00     2
  7        47.33     824.00    50.48     825.00     1
  8        50.48     825.00    59.49     830.00     1
  9        59.49     830.00    80.89     840.00     1
 10        80.89     840.00    92.12     844.00     1
 11        92.12     844.00    99.50     845.00     1
 12        99.50     845.00   116.96     845.52     1
 13       116.96     845.52   133.51     846.51     1
 14        47.32     824.00    59.91     826.68     2
 15        59.91     826.68    80.86     830.98     2
 16        80.86     830.98   102.84     835.11     2
 17       102.84     835.11   133.51     840.86     2
User Specified Y-Origin =      800.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
  2 Type(s) of Soil
Soil Total Saturated Cohesion Friction Pore Pressure Piez.
Type Unit Wt. Unit Wt. Intercept Angle Pressure Constant Surface
No. (pcf) (pcf) (psf) (deg) Param. (psf) No.
  1 120.0 120.0 250.0 28.0 0.00 0.0 0
  2 120.0 120.0 370.0 32.0 0.00 0.0 0
Specified Peak Ground Acceleration Coefficient (A) = 0.680(g)
Specified Horizontal Earthquake Coefficient (kh) = 0.150(g)
Specified Vertical Earthquake Coefficient (kv) = 0.000(g)
Specified Seismic Pore-Pressure Factor = 0.000
A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
100 Trial Surfaces Have Been Generated.
10 Surface(s) Initiate(s) From Each Of 10 Points Equally Spaced
Along The Ground Surface Between X = 33.37(ft)
and X = 50.00(ft)

```

Each Surface Terminates Between X = 85.00(ft)  
and X = 115.00(ft)

Unless Further Limitations Were Imposed, The Minimum Elevation  
At Which A Surface Extends Is Y = 0.00(ft)

5.00(ft) Line Segments Define Each Trial Failure Surface.

Following Are Displayed The Ten Most Critical Of The Trial

Failure Surfaces Evaluated. They Are

Ordered - Most Critical First.

\* \* Safety Factors Are Calculated By The Modified Bishop Method \* \*

Total Number of Trial Surfaces Attempted = 100

Number of Trial Surfaces With Valid FS = 100

Statistical Data On All Valid FS Values:

FS Max = 3.153 FS Min = 1.910 FS Ave = 2.435

Standard Deviation = 0.339 Coefficient of Variation = 13.94 %

Failure Surface Specified By 17 Coordinate Points

| Point<br>No. | X-Surf<br>(ft) | Y-Surf<br>(ft) |
|--------------|----------------|----------------|
| 1            | 38.913         | 819.000        |
| 2            | 43.886         | 818.476        |
| 3            | 48.882         | 818.279        |
| 4            | 53.880         | 818.409        |
| 5            | 58.859         | 818.866        |
| 6            | 63.798         | 819.648        |
| 7            | 68.675         | 820.751        |
| 8            | 73.469         | 822.171        |
| 9            | 78.159         | 823.902        |
| 10           | 82.727         | 825.937        |
| 11           | 87.151         | 828.265        |
| 12           | 91.414         | 830.879        |
| 13           | 95.497         | 833.766        |
| 14           | 99.381         | 836.913        |
| 15           | 103.052        | 840.309        |
| 16           | 106.492        | 843.937        |
| 17           | 107.576        | 845.241        |

Circle Center At X = 49.395 ; Y = 894.633 ; and Radius = 76.355

Factor of Safety

\*\*\* 1.910 \*\*\*

Individual data on the 27 slices

| Slice<br>No. | Width<br>(ft) | Weight<br>(lbs) | Water                 |                       | Tie<br>Force<br>Norm<br>(lbs) | Tie<br>Force<br>Tan<br>(lbs) | Earthquake            |                       | Surcharge<br>Load<br>(lbs) |
|--------------|---------------|-----------------|-----------------------|-----------------------|-------------------------------|------------------------------|-----------------------|-----------------------|----------------------------|
|              |               |                 | Force<br>Top<br>(lbs) | Force<br>Bot<br>(lbs) |                               |                              | Force<br>Hor<br>(lbs) | Force<br>Ver<br>(lbs) |                            |
| 1            | 2.2           | 30.0            | 0.0                   | 0.0                   | 0.                            | 0.                           | 4.5                   | 0.0                   | 0.0                        |
| 2            | 2.8           | 502.1           | 0.0                   | 0.0                   | 0.                            | 0.                           | 75.3                  | 0.0                   | 0.0                        |
| 3            | 3.4           | 1734.0          | 0.0                   | 0.0                   | 0.                            | 0.                           | 260.1                 | 0.0                   | 0.0                        |
| 4            | 0.0           | 6.8             | 0.0                   | 0.0                   | 0.                            | 0.                           | 1.0                   | 0.0                   | 0.0                        |
| 5            | 1.6           | 1105.6          | 0.0                   | 0.0                   | 0.                            | 0.                           | 165.8                 | 0.0                   | 0.0                        |
| 6            | 1.6           | 1236.3          | 0.0                   | 0.0                   | 0.                            | 0.                           | 185.4                 | 0.0                   | 0.0                        |
| 7            | 3.4           | 3092.3          | 0.0                   | 0.0                   | 0.                            | 0.                           | 463.8                 | 0.0                   | 0.0                        |
| 8            | 5.0           | 5754.4          | 0.0                   | 0.0                   | 0.                            | 0.                           | 863.2                 | 0.0                   | 0.0                        |
| 9            | 0.6           | 825.6           | 0.0                   | 0.0                   | 0.                            | 0.                           | 123.8                 | 0.0                   | 0.0                        |
| 10           | 0.4           | 559.4           | 0.0                   | 0.0                   | 0.                            | 0.                           | 83.9                  | 0.0                   | 0.0                        |
| 11           | 3.9           | 5488.6          | 0.0                   | 0.0                   | 0.                            | 0.                           | 823.3                 | 0.0                   | 0.0                        |
| 12           | 4.9           | 7580.1          | 0.0                   | 0.0                   | 0.                            | 0.                           | 1137.0                | 0.0                   | 0.0                        |
| 13           | 4.8           | 8025.6          | 0.0                   | 0.0                   | 0.                            | 0.                           | 1203.8                | 0.0                   | 0.0                        |
| 14           | 4.7           | 8213.4          | 0.0                   | 0.0                   | 0.                            | 0.                           | 1232.0                | 0.0                   | 0.0                        |
| 15           | 2.7           | 4812.8          | 0.0                   | 0.0                   | 0.                            | 0.                           | 721.9                 | 0.0                   | 0.0                        |
| 16           | 0.0           | 53.6            | 0.0                   | 0.0                   | 0.                            | 0.                           | 8.0                   | 0.0                   | 0.0                        |
| 17           | 1.8           | 3262.3          | 0.0                   | 0.0                   | 0.                            | 0.                           | 489.3                 | 0.0                   | 0.0                        |
| 18           | 4.4           | 7614.5          | 0.0                   | 0.0                   | 0.                            | 0.                           | 1142.2                | 0.0                   | 0.0                        |
| 19           | 4.3           | 6863.2          | 0.0                   | 0.0                   | 0.                            | 0.                           | 1029.5                | 0.0                   | 0.0                        |
| 20           | 0.7           | 1079.6          | 0.0                   | 0.0                   | 0.                            | 0.                           | 161.9                 | 0.0                   | 0.0                        |
| 21           | 3.3           | 4635.8          | 0.0                   | 0.0                   | 0.                            | 0.                           | 695.4                 | 0.0                   | 0.0                        |
| 22           | 0.1           | 87.6            | 0.0                   | 0.0                   | 0.                            | 0.                           | 13.1                  | 0.0                   | 0.0                        |
| 23           | 3.9           | 4373.3          | 0.0                   | 0.0                   | 0.                            | 0.                           | 656.0                 | 0.0                   | 0.0                        |
| 24           | 0.1           | 114.2           | 0.0                   | 0.0                   | 0.                            | 0.                           | 17.1                  | 0.0                   | 0.0                        |
| 25           | 3.6           | 2722.3          | 0.0                   | 0.0                   | 0.                            | 0.                           | 408.3                 | 0.0                   | 0.0                        |

|    |     |        |     |     |    |    |       |     |     |
|----|-----|--------|-----|-----|----|----|-------|-----|-----|
| 26 | 3.4 | 1252.7 | 0.0 | 0.0 | 0. | 0. | 187.9 | 0.0 | 0.0 |
| 27 | 1.1 | 82.6   | 0.0 | 0.0 | 0. | 0. | 12.4  | 0.0 | 0.0 |

Failure Surface Specified By 16 Coordinate Points

| Point<br>No. | X-Surf<br>(ft) | Y-Surf<br>(ft) |
|--------------|----------------|----------------|
| 1            | 35.218         | 819.000        |
| 2            | 40.172         | 818.324        |
| 3            | 45.163         | 818.028        |
| 4            | 50.162         | 818.114        |
| 5            | 55.141         | 818.582        |
| 6            | 60.068         | 819.427        |
| 7            | 64.918         | 820.647        |
| 8            | 69.659         | 822.233        |
| 9            | 74.266         | 824.176        |
| 10           | 78.712         | 826.465        |
| 11           | 82.969         | 829.086        |
| 12           | 87.015         | 832.025        |
| 13           | 90.824         | 835.264        |
| 14           | 94.375         | 838.784        |
| 15           | 97.646         | 842.565        |
| 16           | 99.442         | 844.992        |

Circle Center At X = 46.552 ; Y = 883.338 ; and Radius = 65.329

Factor of Safety

\*\*\* 1.933 \*\*\*

Failure Surface Specified By 16 Coordinate Points

| Point<br>No. | X-Surf<br>(ft) | Y-Surf<br>(ft) |
|--------------|----------------|----------------|
| 1            | 37.066         | 819.000        |
| 2            | 41.938         | 817.878        |
| 3            | 46.892         | 817.203        |
| 4            | 51.887         | 816.978        |
| 5            | 56.882         | 817.207        |
| 6            | 61.836         | 817.887        |
| 7            | 66.707         | 819.013        |
| 8            | 71.457         | 820.576        |
| 9            | 76.045         | 822.562        |
| 10           | 80.435         | 824.955        |
| 11           | 84.590         | 827.736        |
| 12           | 88.477         | 830.882        |
| 13           | 92.062         | 834.367        |
| 14           | 95.317         | 838.162        |
| 15           | 98.216         | 842.237        |
| 16           | 99.832         | 845.010        |

Circle Center At X = 51.868 ; Y = 872.016 ; and Radius = 55.044

Factor of Safety

\*\*\* 1.933 \*\*\*

Failure Surface Specified By 18 Coordinate Points

| Point<br>No. | X-Surf<br>(ft) | Y-Surf<br>(ft) |
|--------------|----------------|----------------|
| 1            | 35.218         | 819.000        |
| 2            | 40.108         | 817.956        |
| 3            | 45.062         | 817.280        |
| 4            | 50.052         | 816.973        |
| 5            | 55.052         | 817.039        |
| 6            | 60.033         | 817.476        |
| 7            | 64.967         | 818.283        |
| 8            | 69.828         | 819.454        |
| 9            | 74.588         | 820.984        |
| 10           | 79.221         | 822.864        |
| 11           | 83.702         | 825.083        |
| 12           | 88.005         | 827.629        |
| 13           | 92.107         | 830.489        |
| 14           | 95.984         | 833.645        |
| 15           | 99.616         | 837.081        |
| 16           | 102.983        | 840.778        |
| 17           | 106.065        | 844.716        |
| 18           | 106.393        | 845.205        |

Circle Center At X = 51.674 ; Y = 884.063 ; and Radius = 67.112

Factor of Safety  
\*\*\* 1.935 \*\*\*

Failure Surface Specified By 15 Coordinate Points

| Point<br>No. | X-Surf<br>(ft) | Y-Surf<br>(ft) |
|--------------|----------------|----------------|
| 1            | 40.761         | 819.000        |
| 2            | 45.630         | 817.862        |
| 3            | 50.595         | 817.269        |
| 4            | 55.595         | 817.229        |
| 5            | 60.568         | 817.742        |
| 6            | 65.455         | 818.801        |
| 7            | 70.194         | 820.393        |
| 8            | 74.729         | 822.500        |
| 9            | 79.003         | 825.095        |
| 10           | 82.964         | 828.147        |
| 11           | 86.563         | 831.617        |
| 12           | 89.757         | 835.464        |
| 13           | 92.506         | 839.641        |
| 14           | 94.776         | 844.095        |
| 15           | 94.881         | 844.374        |

Circle Center At X = 53.459 ; Y = 862.348 ; and Radius = 45.170

Factor of Safety  
\*\*\* 1.970 \*\*\*

Failure Surface Specified By 14 Coordinate Points

| Point<br>No. | X-Surf<br>(ft) | Y-Surf<br>(ft) |
|--------------|----------------|----------------|
| 1            | 42.609         | 820.217        |
| 2            | 47.552         | 819.463        |
| 3            | 52.546         | 819.219        |
| 4            | 57.539         | 819.488        |
| 5            | 62.477         | 820.267        |
| 6            | 67.311         | 821.548        |
| 7            | 71.987         | 823.317        |
| 8            | 76.458         | 825.556        |
| 9            | 80.676         | 828.240        |
| 10           | 84.597         | 831.343        |
| 11           | 88.179         | 834.831        |
| 12           | 91.386         | 838.668        |
| 13           | 94.182         | 842.812        |
| 14           | 95.028         | 844.394        |

Circle Center At X = 52.439 ; Y = 867.819 ; and Radius = 48.606

Factor of Safety  
\*\*\* 1.972 \*\*\*

Failure Surface Specified By 14 Coordinate Points

| Point<br>No. | X-Surf<br>(ft) | Y-Surf<br>(ft) |
|--------------|----------------|----------------|
| 1            | 37.066         | 819.000        |
| 2            | 42.011         | 818.263        |
| 3            | 47.005         | 818.017        |
| 4            | 51.999         | 818.265        |
| 5            | 56.944         | 819.005        |
| 6            | 61.791         | 820.229        |
| 7            | 66.495         | 821.926        |
| 8            | 71.008         | 824.078        |
| 9            | 75.286         | 826.665        |
| 10           | 79.289         | 829.662        |
| 11           | 82.976         | 833.039        |
| 12           | 86.312         | 836.763        |
| 13           | 89.264         | 840.799        |
| 14           | 90.894         | 843.563        |

Circle Center At X = 47.007 ; Y = 868.476 ; and Radius = 50.465

Factor of Safety  
\*\*\* 1.992 \*\*\*

Failure Surface Specified By 14 Coordinate Points

| Point<br>No. | X-Surf<br>(ft) | Y-Surf<br>(ft) |
|--------------|----------------|----------------|
|--------------|----------------|----------------|

|    |         |         |
|----|---------|---------|
| 1  | 44.457  | 821.698 |
| 2  | 49.457  | 821.689 |
| 3  | 54.446  | 822.021 |
| 4  | 59.400  | 822.693 |
| 5  | 64.297  | 823.702 |
| 6  | 69.114  | 825.042 |
| 7  | 73.829  | 826.708 |
| 8  | 78.419  | 828.692 |
| 9  | 82.862  | 830.984 |
| 10 | 87.139  | 833.573 |
| 11 | 91.230  | 836.449 |
| 12 | 95.114  | 839.597 |
| 13 | 98.775  | 843.003 |
| 14 | 100.680 | 845.035 |

Circle Center At X = 47.122 ; Y = 894.670 ; and Radius = 73.021  
Factor of Safety  
\*\*\* 1.993 \*\*\*

Failure Surface Specified By 17 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|-----------|-------------|-------------|
| 1         | 35.218      | 819.000     |
| 2         | 39.894      | 817.229     |
| 3         | 44.728      | 815.954     |
| 4         | 49.669      | 815.187     |
| 5         | 54.663      | 814.938     |
| 6         | 59.656      | 815.209     |
| 7         | 64.593      | 815.997     |
| 8         | 69.422      | 817.293     |
| 9         | 74.090      | 819.084     |
| 10        | 78.547      | 821.350     |
| 11        | 82.745      | 824.067     |
| 12        | 86.637      | 827.205     |
| 13        | 90.183      | 830.731     |
| 14        | 93.343      | 834.605     |
| 15        | 96.084      | 838.787     |
| 16        | 98.376      | 843.231     |
| 17        | 99.042      | 844.938     |

Circle Center At X = 54.559 ; Y = 863.013 ; and Radius = 48.075  
Factor of Safety  
\*\*\* 2.009 \*\*\*

Failure Surface Specified By 19 Coordinate Points

| Point No. | X-Surf (ft) | Y-Surf (ft) |
|-----------|-------------|-------------|
| 1         | 38.913      | 819.000     |
| 2         | 43.744      | 817.709     |
| 3         | 48.657      | 816.780     |
| 4         | 53.625      | 816.218     |
| 5         | 58.621      | 816.025     |
| 6         | 63.618      | 816.202     |
| 7         | 68.588      | 816.750     |
| 8         | 73.504      | 817.664     |
| 9         | 78.338      | 818.939     |
| 10        | 83.065      | 820.570     |
| 11        | 87.658      | 822.546     |
| 12        | 92.092      | 824.856     |
| 13        | 96.343      | 827.489     |
| 14        | 100.387     | 830.430     |
| 15        | 104.202     | 833.662     |
| 16        | 107.767     | 837.168     |
| 17        | 111.062     | 840.928     |
| 18        | 114.070     | 844.922     |
| 19        | 114.406     | 845.444     |

Circle Center At X = 58.725 ; Y = 883.472 ; and Radius = 67.447  
Factor of Safety  
\*\*\* 2.015 \*\*\*  
\*\*\*\* END OF GSTABL7 OUTPUT \*\*\*\*

## SURFICIAL SLOPE STABILITY INFINITE SLOPE W/PARALLEL SEEPAGE

$$F.S. = \frac{C + (\gamma_t - \gamma_w) \times H \times \cos^2 \alpha \times \tan \phi}{\gamma_t \times H \times \cos \alpha \times \sin \alpha}$$

$\alpha$  : Slope Angle  
 $\phi$  : Effective Friction Angle of Soil  
 $C$  : Effective Cohesion of Soil, psf  
 $H$  : Vertical Depth of Saturation, feet  
 $\gamma_t$  : Total Unit Weight of Soil, pcf  
 $\gamma_w$  : Unit Weight of Water, pcf

Soil Properties and Slope Ratio:

$\alpha$  : 24.4° (2.2:1 Slope, Horizontal to Vertical)

$\phi$  : 30°                       $C$  : 200 psf

$H$  : 4 feet

$\gamma_t$  : 120.0 pcf                       $\gamma_w$  : 62.4 pcf

$$F.S. = \frac{300 + (120.0 - 62.4) \times 4 \times \cos^2 24.4 \times \tan 29}{120.0 \times 4 \times \cos 24.4 \times \sin 24.4} = \frac{405.92}{180.58} = 2.248 > 1.5$$

Therefore, the existing 2.2:1 slope has the adequate factor of safety against surficial stability under saturated conditions to the depth of 4 feet.